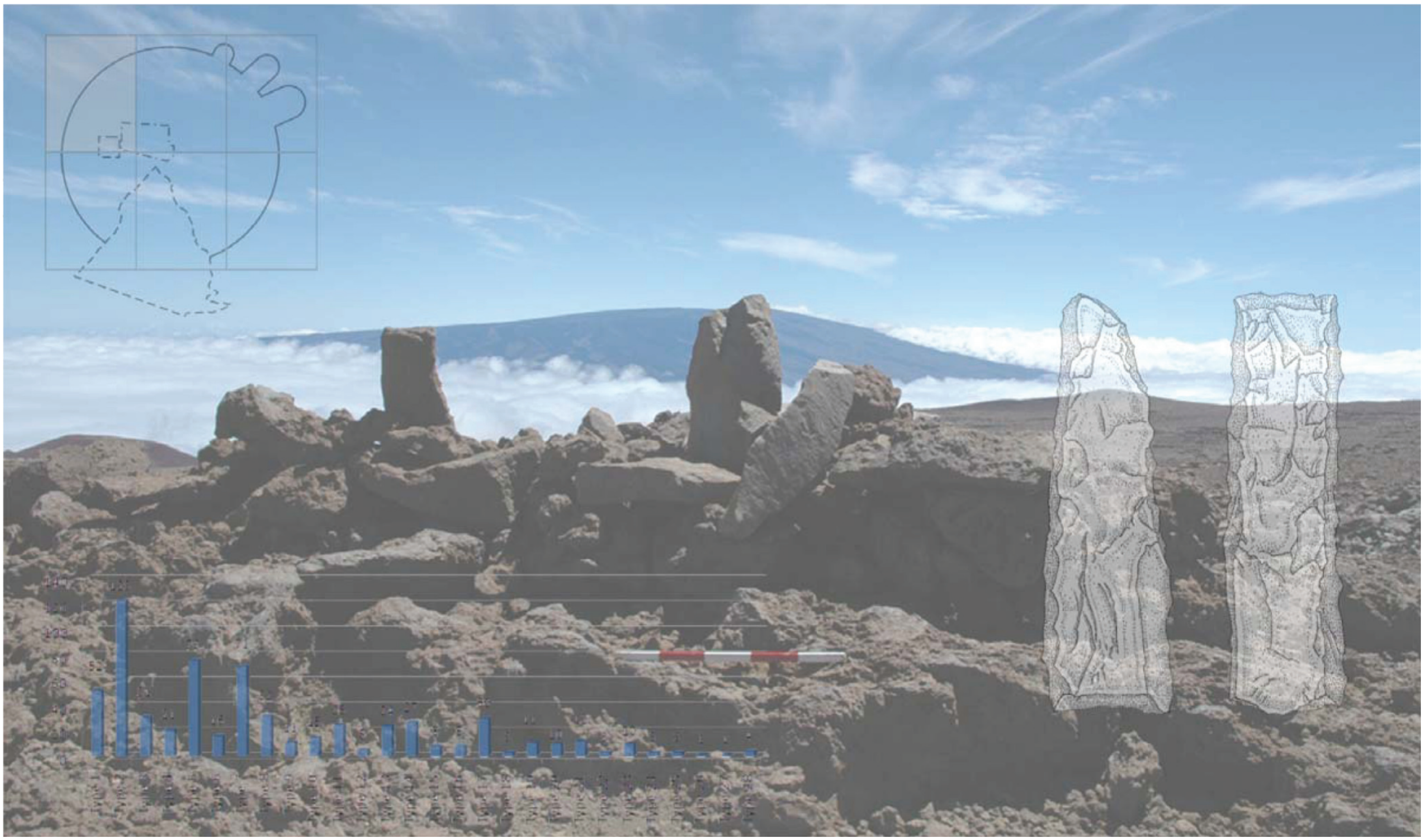
FINAL REPORT

Archaeological Inventory Survey of the Mauna Kea Science Reserve

Ka`ohe Ahupua`a, Hāmākua District, Island of Hawai`i TMK: (3) 4-4-015:09

Volume 1: Inventory Survey Report



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August 2010

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Archaeological Inventory Survey of the Mauna Kea Science Reserve
Ka`ohe Ahupua`a, Hāmākua District, Island of Hawai`i
TMK: (3) 4-4-015: 09 (por.)

Volume 1: Inventory Survey Report

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EXECUTIVE SUMMARY

An archaeological inventory survey of the 11,288-acre Mauna Kea Science Reserve was undertaken over a period of 20 weeks between 2005 and 2009. The survey followed on earlier archaeological reconnaissance surveys of selected areas of the Science Reserve that had identified 95 sites between 1975 and 1999.

The primary objective of the inventory survey was to identify, record, and evaluate the significance of all of the historic properties in the Science Reserve, and to make recommendations regarding their preservation and continued protection. The survey was viewed as the initial step in developing a cultural resources management plan (CRMP).

A total of 263 sites were identified in the survey, including the 95 previously recorded sites and two traditional cultural properties (Kūkahau`ula and Pu`u Līlīnoe) that were given Statewide Inventory of Historic Places (SIHP) site designations by SHPD in 1999. Shrines are the most common site type in the Science Reserve, but the relative number of sites has little meaning because of differential site complexity. The next most common site type is a complex of adze quarries/workshops found in the Pōhakuloa Gulch area. This site complex is part of the larger Mauna Kea Adze Quarry Complex, which was placed on the National Register of Historic Places in 1962 as a National Historic Landmark. The Mauna Kea Adze Quarry Complex consists of: (1) the quarry proper, which is defined as the source areas of tool-quality basalt, and (2) diverse activity remains located outside of the quarry proper as just defined, but an integral part of the quarry industry because of the activities that took place. These include isolated adze manufacturing by-products (e.g., cores, flakes), hammerstones and unfinished adzes in various stages of completion; shrines with associated lithic scatters of uncertain function and/or offerings; a ritual complex and two possible burials with lithic artifacts that suggest the possibility of adze maker interments. Burials and possible burials are another fairly common site type, but they are localized to just a few places. The remainder of the historic property inventory is represented by small numbers of diverse site types, such as markers/memorials, temporary shelters, one and possibly two of the camps occupied by the 1926 USGS survey party, and an isolated horseshoe located along what is believed to have been the `Umi Koa Trail. The function of a few sites could not be determined,

The survey included test excavations at two sites and probes at several overhangs to determine the presence/absence of buried cultural deposits. A single radiocarbon date of AD 1420-1480 was obtained on a piece of wood charcoal from a thin cultural layer in a rockshelter located in the Pōhakuloa Gulch area. This is currently the only dated site in the Science Reserve other than some of the historic sites.

The amount of data obtained in the survey is overwhelming when compared to most archaeological surveys in Hawai`i. This has limited the data analyses that could be undertaken to the shrines and selected artifact assemblages from the Pōhakuloa Gulch quarry-workshop site complex. The shrine analysis is aimed at: (1) identifying and analyzing what are believed to be the most significant variables and attributes; (2) developing a shrine typology for descriptive and comparative purposes; and (3) examining the spatial distribution of the various attributes, shrine types, and the types or styles of uprights. The artifact analysis is focused on a sample of adze preforms and hammerstones from 13 sites in the Pōhakuloa Gulch area. Because of the large number of artifacts, the number of analyzed attributes is also limited in number.

The data collected in the survey have contributed significantly to an understanding of land use patterns in the summit region of Mauna Kea, although there are still too few absolute dates to understand diachronic changes. It is now possible, for example, to talk about culturally meaningful places within the summit region, such as the summit, Lake Waiau and Keanakāko`i (one of the names for either a site in the adze quarry or the whole quarry). In addition, the survey data have made it possible to discuss specific cultural practices associated with each place, such as pilgrimages to the summit, Kūkahau`ula.

As a result of the survey there is a much better understanding of the size and complexity of the Mauna Kea Adze Quarry Complex as a process, rather than simply a place in the landscape. This includes the recognition of multiple routes or corridors to and from the quarry emanating from different sides of the mountain. The data support an earlier hypothesis that the quarry was utilized by adze makers from different parts of the island and that the workers were craft specialists supported by chiefs. The relevance of the adze quarry to issues in Hawaiian archaeology, such as craft specialization, socio-political processes at the regional level, territoriality and property rights, are discussed.

A comparison of the Mauna Kea shrines to similar structures elsewhere in Hawai`i and other parts of East Polynesia indicates "family resemblances." The function and meaning of the uprights (god-stones) that are the defining characteristic of shrines remains elusive, but there are clear indications that the uprights at least have what is called a "deliberative history" in their selection from the natural environment. Some shrines also exhibit signs of a larger, more encompassing "life history" in the respect and disrespect shown to the uprights.

Continuity in the use of the summit area from pre-contact times to the present is evidenced in modern altars (*lele*) and less formal rock piles without offerings. Remains that are either modern or cannot be classified with any level of confidence as historic sites because of their uncertain age, such as many of the rock piles, were recorded as "find spots," following a practice begun by the State Historic Preservation Division (SHPD) during a reconnaissance survey of selected areas of the Mauna Kea Science Reserve in 1997. A total of 339 find spots were recorded in the project area. It is highly likely that some of these are actually historic properties, but to demonstrate this would require a more detailed analysis of their morphology and location.

All of the historic properties in the Science Reserve are located in the Mauna Kea Summit Region Historic District (Site 50-10-23-26869). The sites are contributing properties to the district which is significant under multiple criteria. The historic district is significant under all four National Register criteria and criterion "e" of the Hawaii Administrative Rules, Chapter §13-275-6. The district is significant under criterion "a" because of the presence of the Mauna Kea Adze Quarry Complex (a National Historic Landmark), which was used over a period of 500-700 years or more and the hundreds of shrines in and outside of the quarry. Both the quarry and the shrines are associated with broad patterns and events in Hawaiian prehistory. The district is significant under criterion "b" because of the association with several gods who may have been deified ancestors. These include Kūkahau`ula, Līlīnoe and Waiau. The sites in the adze quarry and many of the shrines embody distinctive characteristics of traditional Hawaiian stone tool manufacture by craft specialists and a distinctive type of shrine construction found in only a few other places in the Hawaiian Islands. These make the district significant under criterion "c." Studies of the Mauna Kea Adze Quarry Complex and the on-going archaeological survey of the Mauna Kea Science Reserve have already made a significant contribution to our understanding of Hawaiian prehistory and history, and hold the potential to make even more contributions. The district is thus significant under criterion "d." Finally, the district is significant under criterion "e" because of the presence of numerous burials and the hundreds of shrines which have been interpreted as evidence of a previously unknown land use practice in the form of pilgrimages to the summit of Mauna Kea to worship the gods and goddesses.

All of the sites in the Science Reserve will be preserved and continue to be managed by OMKM. A series of specific management actions from a draft Cultural Resource Management Plan (CRMP) covering all of the UH management areas on Mauna Kea is presented at the end of the report.

Due to the large amount of data collected in the survey, the analyses that followed, and discussion of the results, the report is presented in two volumes. Volume 1 presents environmental, cultural and historical background information; a summary of previous archaeological investigations in the high elevation areas of Mauna Kea the findings of the 2005-2009 survey; data analyses, and a synthesis and discussion of the wealth of information in terms of its relevance to an understanding of human use of the Mauna Kea summit region over time and the relevance of the data to several different issues in Hawaiian archaeology. Volume 2 contains all of the primary site data and documentation. The bulk of Volume 2 consists of individual site descriptions, which also include plan view maps and photographs. The results of the test excavations undertaken as part of the survey are also presented in Volume 2.

ACKNOWLEDGMENTS

A project spanning 20 weeks of fieldwork over 5 years (2005-2009) and hundreds of hours of laboratory analysis and report writing is obviously indebted to a number of people and, indeed, numerous individuals contributed to the successful completion of the work described in this report. First among them is Stephanie Nagata, Interim Director of the Office of Mauna Kea Management (OMKM), who was not only instrumental in making it possible to begin the process of conducting an archaeological inventory survey of the Mauna Kea Science Reserve, but was also successful in securing the funds to finish the survey and all of the post-field laboratory and office work entailed in producing a final report. Stephanie and her assistant, Dawn Pamarang, also assumed the responsibility of making arrangements for the field crews to stay at the Mid-Elevation Facility at Hale Pōhaku. We are extremely grateful to Stephanie and all of the OMKM staff for the opportunity to conduct the archaeological survey of the Science Reserve and their commitment to fulfilling their mandate to the preserve, protect and enhance the cultural resources of Mauna Kea.

The survey would not have been possible without the approval and support of the Kahu Kū Mauna Council. The Council gave freely of their time to meet with PCSI staff on several occasions. *Mahalo nui loa* to Ed Stevens for his guidance and constant support throughout the project.

The staff at the Visitor Information Station at the Onizuka Center for International Astronomy, and Dave Byrne in particular, provided various kinds of assistance. OMKM rangers Pablo McCloud, Kimo Pihana, Ahiena Kanahele, Kenyan Beals, Shane Fox , Don Weir, Joel Kelly and Matt Church showed a keen interest in the project and assisted us in many ways. They provided much appreciated logistical support that made it possible on numerous occasions to leave our rental vehicle at a location that eliminated the need for an arduous, time-consuming uphill climb at the end of the day.

The authors owe more than a simple thanks for the hard work and perseverance under very trying conditions of our current and former PCSI co-workers and other colleagues over the past five years. The survey would have never have been completed without the tireless, unflagging efforts of the following persons over the five year period of the survey:

2005: Dennis Gosser and Reid Yamasato

2006: Reid Yamasato, Keola Nakamura, Jeanne Krauss, Sara Collins, and Eric Komori

2007: Keola Nakamura, Jeanne Krauss, and Sara Collins

2008: Keola Nakamura, Valerie Park, and Sara Collins

2009: Keola Nakamura, Valerie Park and Melanie Mintmier

The senior author wishes to thank the numerous individuals that participated in the reconnaissance surveys conducted in the Science Reserve between 1982 and 1999 and to others that provided other kinds of assistance. The latter includes the late Dorothy Barrere who kindly provided the senior author and Holly McEldowney information on mythology, legends, and traditional history, and shared her knowledge of Hawaiian religion. The 1982 survey was funded by the Hawaii Institute for Astronomy, which also provided financial assistance, based on the efforts of Bob McLaren, for the 1995 and 1997 surveys, which were undertaken by the State Historic Preservation

Division. Sincere thanks are extended to the following individuals for their hard work and perseverance under very trying conditions:

1982 crew: Aki Sinoto, Ragnar Schousboe, Judy McCoy and volunteer Holly McEldowney

1984 crew: Paul Cleghorn, June Cleghorn, and Mary Riford, and volunteers Matthew Spriggs, Melinda Allen, Laura Carter, Judy McCoy, Holly McEldowney and Jennie Peterson

1995 crew: Holly McEldowney, Eric Komori, Marc Smith and Dodie Lau

1997 Holly McEldowney, Eric Komori, Marc Smith and Cathy Dagher and Bill Hoffman a University of Hawaii at Hilo student volunteer,

1999: Marc Smith

The various laboratory analyses were done by our PCSI colleague, Mary Riford. The EDXRF analyses were done by Dr. Peter Mills and Steve Lundblad (UH-Hilo). Gail Murakami (International Archaeological Research Institute Inc.) identified the charcoal that was submitted for dating to Beta Analytic.

The report would never have been completed without the help of our colleagues, Steve Clark, Andy Tomlinson, Keola Nakamura, Mary Riford, and Jackie Pamerleau-Walden. In addition to managing the project, Steve took on some heavy editorial responsibilities. Andy put in what seems like countless hours in drafting, revising and producing many of the figures. Keola, a man of all trades, did whatever was asked of him in producing many of the graphics. Jackie helped with the formatting. The two aerial photographs (Figures 2.1 and 2.7) that appear in this report were obtained from George McEldowney, father of Holly McEldowney many years ago.

The senior author has benefited greatly from discussions with Holly McEldowney, Paul Cleghorn, Scott Williams and Aki Sinoto regarding the archaeology of the Mauna Kea Summit region. We have not always agreed, but the exchange of ideas has been a good one.

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1.0 INTRODUCTION

This report presents the results of an archaeological inventory survey of the 11,288-acre Mauna Kea Science Reserve (TMK: (3) 4-4-015:09; Figure 1.1) conducted by Pacific Consulting Services, Inc. (PCSI) for the Office of Mauna Kea Management (OMKM). The survey, originally intended to be completed in 14 weeks during the summer months of 2005-2007, was extended another 5 weeks in 2008 and one week in 2009. The duration of the survey was thus 20 weeks over a five year period (2005-2009). The length of time required to complete the survey is primarily due to the discovery of an unexpectedly larger number of sites than had been originally anticipated.

The project, unlike most archaeological surveys in Hawai`i, was not triggered by a proposed action that would automatically require compliance with Chapter 6E rules and regulations. Rather, the project was developed in response to recommendations in the Mauna Kea Science Reserve Master Plan (Group 70 International Inc. 2000) to undertake an archaeological inventory survey of the Science Reserve, and earlier agreements between the University of Hawaii (UH) and the Department of Land and Natural Resources (DLNR) concerning the need to complete an historic preservation plan (Wilson 1995).

Though there was no trigger that would require review and approval of a report by the State Historic Preservation Division (SHPD), the survey was nevertheless guided by Hawaii Revised Statutes (HRS), Chapter 6E, and Title 13 of the Hawaii Administrative Rules (HAR), Subtitle 13 (State Historic Preservation Division Rules), Chapter 276 (Rules Governing Standards for Archaeological Inventory Surveys and Reports) to ensure that OMKM is in compliance with these rules and regulations.

1.1 Project Objectives and Scope of Work

Prior to 2005 only about 3,700 acres, or roughly one-third, of the Science Reserve had been surveyed and all but a few of the known sites had been found in reconnaissance surveys that covered large areas in a short periods of fieldwork (McCoy 1999a). The project, as originally conceived, had two primary objectives:

> <u>Objective 1</u>: To undertake a comprehensive archaeological inventory survey to more accurately determine the number, variety, location and significance of historic properties in the Science Reserve and to record all sites to inventory level standards.
>
> <u>Objective 2</u>: To develop an Archaeological Monitoring Plan (AMP) and a programmatic agreement (PA), which were identified in a draft plan prepared by SHPD (2000), as essential components of an historic preservation management plan for the Science Reserve.

Objective 1 was viewed as an essential first step in addressing the frequent complaint by some Native Hawaiian groups and individuals and other interested parties that only a small portion of the Science Reserve had been surveyed and that not all of the culturally significant sites, such as burials and shrines, had been found and, thus, could be damaged, destroyed, or their integrity diminished in future observatory construction projects because of impacts such as obstructed view planes. A systematic survey of the entire Science Reserve was also viewed as a prerequisite to completing a

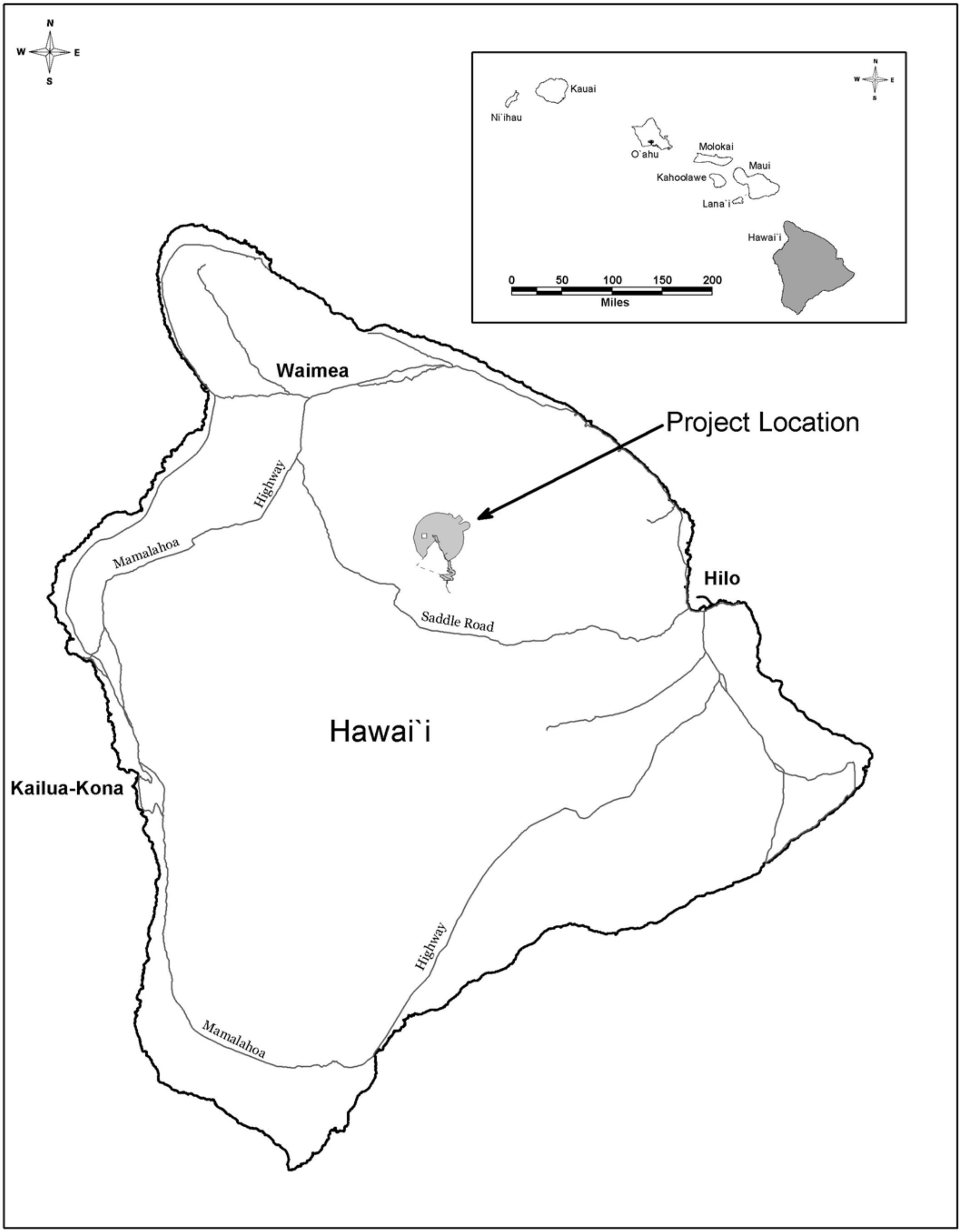


Figure 1.1 Project Area Location.

cultural resource management plan (CRMP) based on the conviction that the cultural landscape of the Science Reserve could not be adequately managed without a fuller knowledge of the number, variety, location and significance of the historic properties found within its boundaries. The development of a PA had several goals. One was to clearly define the roles and responsibilities of the different agencies involved in the management of the lands on Mauna Kea. A second goal was to identify routine actions and activities that would not require historic preservation review and compliance with Chapter 6E.

Two interim reports on the survey were prepared, one at the end of the first field season in 2005 and another in 2006. Interim Report 1, covering the 2005 fieldwork, summarized the preparation of a database, other work undertaken prior to the survey and a summary of findings which was focused on presenting a written narrative of each site found in the survey and illustrations (maps and photographs) of selected sites (McCoy et al. 2005). Interim Report 2, covering the 2006 season was a similarly descriptive report (McCoy and Nees 2006). The Scope of Work (SOW) did not call for preparation of an interim report for the 2007 field season, which as noted above was intended to be the final field season. The discovery of a large site complex the last week of the 2007 field season resulted in a revision to the SOW that added 5 more weeks of fieldwork in 2008.

In addition to the two interim reports, a summary and preliminary analysis of the findings of the survey through 2007 are presented in the draft CRMP for the UH Management Areas on Mauna Kea prepared by PCSI for OMKM (McCoy et al. 2009). The current report, which is the final Archaeological Inventory Survey Report (AIS) for the Science Reserve replaces the site information that appears in the draft CRMP.

This report fulfills the requirements for Objective 1. An interim Archaeological Monitoring Plan (AMP) was prepared in 2007 but was not implemented for a variety of reasons that are explained in the draft CRMP (McCoy et al. 2009). Preparation of the PA had to be abandoned because a number of intractable problems that are discussed in the draft CRMP (McCoy et al. 2009).

The original SOW, prepared in 2005, included three tasks:

1) Developing an integrated spatial database and entry of all existing information, including site maps and photographs, into the database. The database will include information on sites found within the Astronomy Precinct, as well as other known sites within the Mauna Kea Science Reserve. The first task also included development of a new site recording form.

2) Conducting an archaeological field survey of roughly 1,200 acres of land in the Science Reserve, including the 525-acre Astronomy Precinct and adjacent lands on the north and northwest slopes of the mountain, down to the approximately 12,800 ft elevation between Pu`u Pōhaku (a part of the Mauna Kea Ice Age Natural Area Reserve) and Pu`u Māhoe, and a second, smaller area located on the east side of the summit road (see Figure 1.1).

3) Entering data collected during the field survey into the database and preparing an interim report, which will constitute a progress report in the broader context of producing a final comprehensive archaeological inventory survey report for the entire Mauna Kea Science Reserve.

The contract was modified several times after the initial field season in 2005, but the survey objectives remained the same. PCSI consulted with OMKM's cultural advisory group, the Kahu Kū Mauna Council, prior to the start of the survey and presented progress reports to the council on several occasions. Consultation was also undertaken with the Hawaii Island Burial Council (HIBC) regarding the eventual need to develop a Burial Treatment Plan for the Science Reserve (see McCoy et al. 2009). In 2006 PCSI began preparing a CRMP for the Science Reserve. The CRMP will be appended to the Comprehensive Management Plan that was approved with conditions by the Board of Land and Natural Resources (BLNR) on April 9, 2009.

Though not included in the SOW, the survey continued the practice, begun by former SHPD staff in a reconnaissance survey of selected areas of the Mauna Kea Science Reserve, in 1997, of recording cultural remains that are either obviously modern or cannot be classified with any level of confidence as historic properties because of their uncertain age and/or function (e.g., one stone or several stones on top of a boulder). The recording of these remains, originally called "locations" and now referred to as "find spots," is part of a resource management strategy aimed at obtaining baseline data with which to evaluate long-term changes to the cultural landscape in both the Science Reserve and the adjacent Mauna Kea Ice Age Natural Area Reserve (TMK: (3) 4-4-015:10 and 11; see Figure 1.1).

1.2 Report Organization

Because of the large amount of data collected in the survey and the data analyses that followed, the report is presented in two volumes. Volume 1 contains everything except for the site descriptions which are presented in Volume 2. Volume 1 is divided into nine sections excluding the list of references. It also includes A – N appendices.

Section 1: Introduction--the report begins with a description of the project objectives and scope of work; the organization of the report, and a brief description of the project area location, the fieldwork schedule.

Section 2: Project Area Background--provides a summary of the environmental, cultural and archaeological context. This includes a discussion of the geoecology of the summit region, the traditional cultural context, and a chronological summary of land use practices and other cultural practices before and after European contact.

Section 3: Previous Archaeological Research and Cultural Resource Management Studies in the Alpine Desert and Sub-alpine Forest Zones of Mauna Kea--summarizes earlier archaeological research, traditional property assessments, cultural impact assessments and mitigation plans for the higher elevation regions of Mauna Kea.

Section 4: Archaeological Theory and Practice--presents an overview of archaeological theory and practice and the authors' theoretical orientation. It also includes a discussion of three important methodological issues in the practice of archaeology.

Section 5: Summary of Work and Findings--includes a summary of the work outlined in the scope of work; field methods and site recording procedures; limitations of the survey; the findings or results of the survey which in addition to the collection of basic site data also included the recording of artifact data on field forms, the collection of selected surface artifacts and test excavations at two sites. The number and distinguishing characteristics of each class of sites and site complexes are described in this section. Site descriptions and details on the test excavations are presented in Volume 2.

Section 6: Data Analyses--includes formal, spatial and statistical analyses of selected shrine attributes; an attribute analysis of collected artifacts from isolated localities and adze manufacturing workshops; chronometric dating and wood charcoal identification, and geochemical sourcing of artifacts from various areas of the Science Reserve.

Section 7: Summary, Synthesis and Conclusions--presents a summary, synthesis and discussion of the wealth of data collected in the survey. It includes discussions of site diversity and distribution patterns; the development of specific places in the summit area and the broader context of the summit region and its relevance to selected research topics in Hawaiian archaeology.

Section 8: Significance Evaluations--presents a discussion of the significance of the historic properties found in the survey in the context of the Mauna Kea Summit Region Historic District.

Section 9: Recommendations--are made regarding the protection and continued preservation of the historic properties in the Science Reserve. All but one of the recommendations, which include the need to develop and implement a monitoring plan come from the CRMP for the UH Management Areas on Mauna Kea prepared by PCSI in 2008 (McCoy et al. 2008).

Section 10: References Cited.

Appendix A: List of Sites Recorded Between 1975 and 1999 in the Mauna Kea Science Reserve.

Appendix B: Site Number Concordance Table for Historic Properties in the Hale Pōhaku Area.

Appendix C: List of Historic Properties in the Mauna Kea Science Reserve.

Appendix D: Summary of Site Components.

Appendix E: List of Other Cultural Resources (Find Spots) in the Mauna Kea Science Reserve.

Appendix F: Metric and Non-Metric Data for Shrines in the Mauna Kea Science Reserve.

Appendix G: Metric and Non-Metric Data for Workshops in the Pōhakuloa Gulch Area Quarry/Workshop Complex.

Appendix H: List of Artifacts Collected during Inventory Survey of the Mauna Kea Science Reserve.

Appendix I: Metric and Non-Metric Data Collected in the Field for Adze Preforms.

Appendix J: Metric and Non-Metric Data for Collected Adze Preforms.

Appendix K: Metric and Non-Metric Data Collected in the Field for Hammerstones.

Appendix L: Radiocarbon Data from Beta Analytic, Inc.

Appendix M: List of Samples Submitted and Results for EDXRF Analysis.

Appendix N: A Statistical Summary and Analysis of Selected Shrine Attributes.

1.3 PROJECT AREA LOCATION

The Mauna Kea Science Reserve (TMK: (3) 4-4-15:09) was established in 1968 when the BLNR approved a 65-year lease (Lease No. S-4191) to the University of Hawai`i for a 13,321-acre area centered on the summit of Mauna Kea, extending out an average distance of 2.5 miles from the University of Hawai`i 44-inch telescope and encompassing all of the land above the 12,000 ft elevation. The boundary on the northeast side of the Science Reserve (see Figure 1.1) extends further down the mountain to include Pu`u Makanaka and two other large cinder cones. The rationale for creating such a large Reserve is stated in the lease:

> The land hereby leased shall be used by the Lessee as a scientific complex, including without limitation thereof an observatory, and as a scientific reserve being more specifically a buffer zone to prevent the intrusion of activities inimical to said scientific complex.

The boundaries of the Science Reserve changed in 1981 when some 2,033.2-acres of land were withdrawn from the lease for the creation of the Mauna Kea Ice Age Natural Area Reserve (NAR). The NAR consists of two separate parcels of land, a 1,889.7-acre pie-shaped parcel (TMK: (3) 4-4-15:10) that encompasses most of the Mauna Kea Adze Quarry and Lake Waiau, and a 143.5-acre parcel surrounding Pu`u Pōhaku (TMK: (3) 4-4-15:11). The Science Reserve now encompasses an area of roughly 11,288 acres. The 2000 Master Plan divided the Science Reserve into a 10,760-acre Natural and Cultural Preserve and a roughly 525-acre Astronomy Precinct (Figure 1.2).

The Science Reserve is one of three areas on Mauna Kea managed by UH. The other two areas include a 19.3-acre leased parcel at Hale Pōhaku (TMK: (3) 4-4-15:12), and a 400-yd wide easement along the summit access road from Hale Pōhaku to the lower boundary of the Science Reserve at approximately the 12,000-foot elevation (see Figure 1.2).

1.4 FIELDWORK SCHEDULE

Fieldwork was limited to the summer months because of health and safety concerns related to weather conditions and the impracticability of conducting surveys at any other time of the year. Though the summer months are on the whole somewhat warmer and less windy, inclement weather can occur at any time of the year as the field crews witnessed in each of the five years of the project. The total length of the project was 20 weeks. A more detailed summary of each field season is presented in the Summary of Work in Section 5.

One benefit of multi-phase projects carried out over an extended period of time, such as the current project, is the opportunity to evaluate and revise field methods and recording procedures. This was the case with the shrine recording form which was revised several times to reflect the knowledge gained in a previous season of fieldwork.

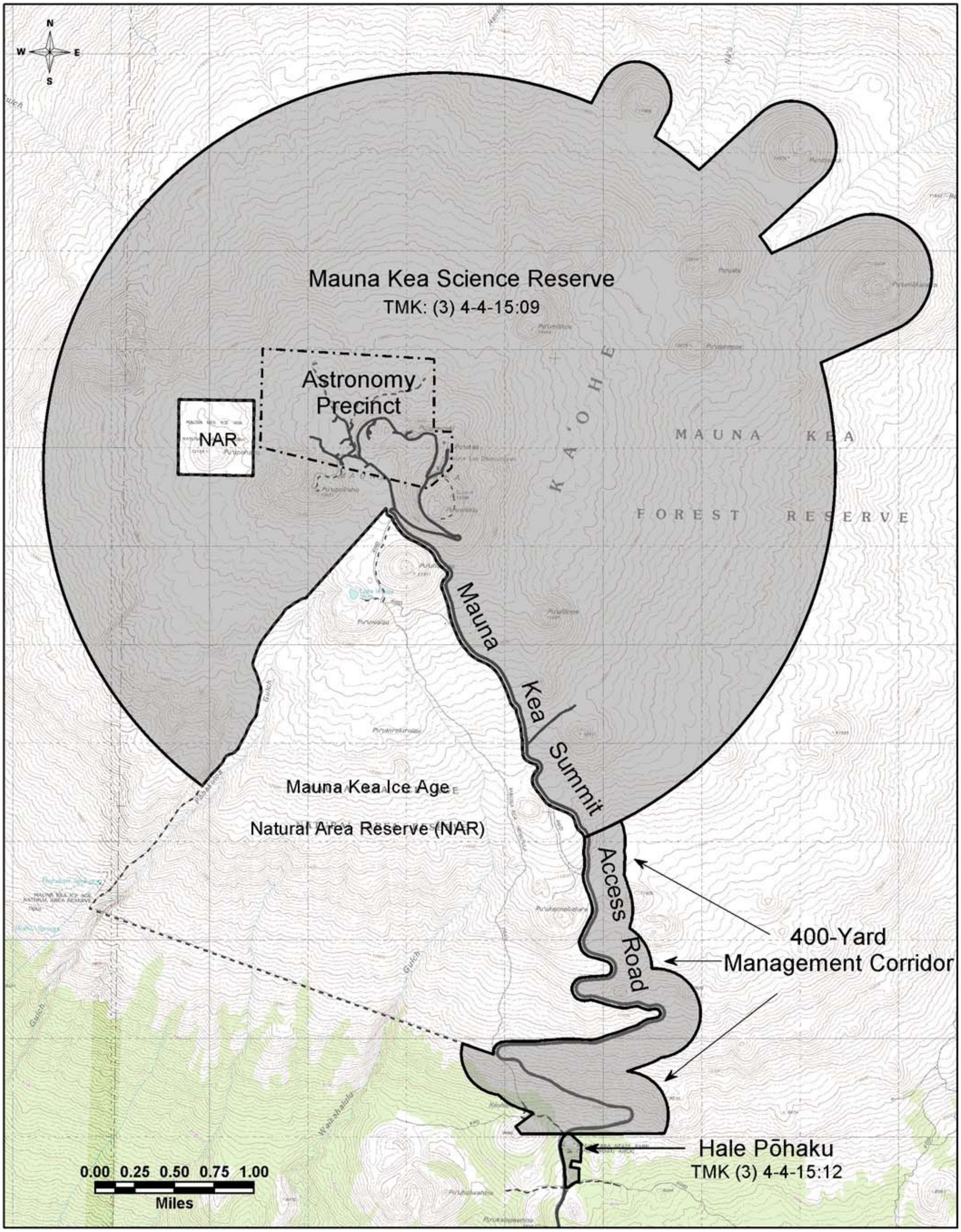


Figure 1.2 University of Hawaii Management Areas on Mauna Kea.

2.0 ENVIRONMENTAL, CULTURAL AND HISTORICAL CONTEXT OF THE MAUNA KEA SUMMIT REGION

In a departure from the orthodox practice in Hawaiian archaeology of describing the environmental and culture-historical setting of a project area as "background information," this report employs the term context. This is based on the view that what is commonly called "background" in archaeological reports is more than what the name implies. The overview that follows is taken primarily from other reports and papers (e.g., McCoy 1982a, 1990; McCoy and Nees 2009).

2.1 GEOECOLOGY

The environment on the upper slopes of Mauna Kea evinces similarities to other high mountains, including the marked interdependency of biotic and abiotic processes that has given rise to the term "geoecology" in the recent literature on arctic and alpine environments (Troll 1972; Winterhalder and Thomas 1978; Webber 1979). The complexities that the term geoecology engenders prevent a total environmental analysis in a report of this length. The focus of attention is on what are believed to be the most relevant biogeoclimatic characteristics for understanding the archaeological record of the summit region (McCoy 1985a). The summit region as defined here encompasses the vast alpine desert ecosystem on the top of the mountain.

2.1.1 Geologic History, Landforms, Topography and Soils

Mauna Kea, the highest (13,796 ft asl) and second largest of the five shield volcanoes that form the island of Hawai`i, is estimated to be between 600,000 and 1.5 million years old (Moore and Clague 1992; DePaolo and Stolper 1996; Wolfe et al. 1997; Sharp and Rene 2005). The earliest stage of volcanism consists of a basaltic shield which Stearns and Macdonald (1946) called the Hāmākua Volcanic Series. The latest stage, which caps the mountain, consists of andesitic lavas (Macdonald and Abbott 1970:142; Wolfe and Morris 1996; Wolfe et al. 1997; Sherrod et al. 2007) which were called the Laupāhoehoe Volcanic Series by Stearns and Macdonald (1946). Stephen Porter renamed these the Hāmākua Group and Laupāhoehoe Group (Porter 1979a: Figure 2). The older lavas, which are part of a tholeiitic suite, contain basalts with varying percentages of olivine and feldspars, while the younger lavas, which are grouped in an alkalic suite, consist of primarily hawaiite (Porter 1979a:Figure 5). Even though the last eruption occurred sometime between 4,580 and 8,200 years ago (Sherrod et al. 2007:470), the U.S. Geological Survey (USGS) considers Mauna Kea to be an active post-shield volcano (U.S. Geological Survey 2002).

There are numerous cinder cones and associated lava flows on what is popularly known as the summit plateau (Figures 2.1 and 2.2). One of the earliest known descriptions of the plateau was made by Hitchcock who wrote "There is a sort of plateau upon the higher part of Mauna Kea above the contour of 12,500 feet, with an area of from thirty-five to forty square miles" (Hitchcock 1909:51). A more detailed description was made by Wentworth and Powers:

> Above 11,000 to 12,000 feet is the summit plateau, a rudely circular dome 5 or 6 miles in diameter rising between 500 and 1000 feet per mile to a central area above 13,000 feet (Wentworth and Powers 1941:1197).

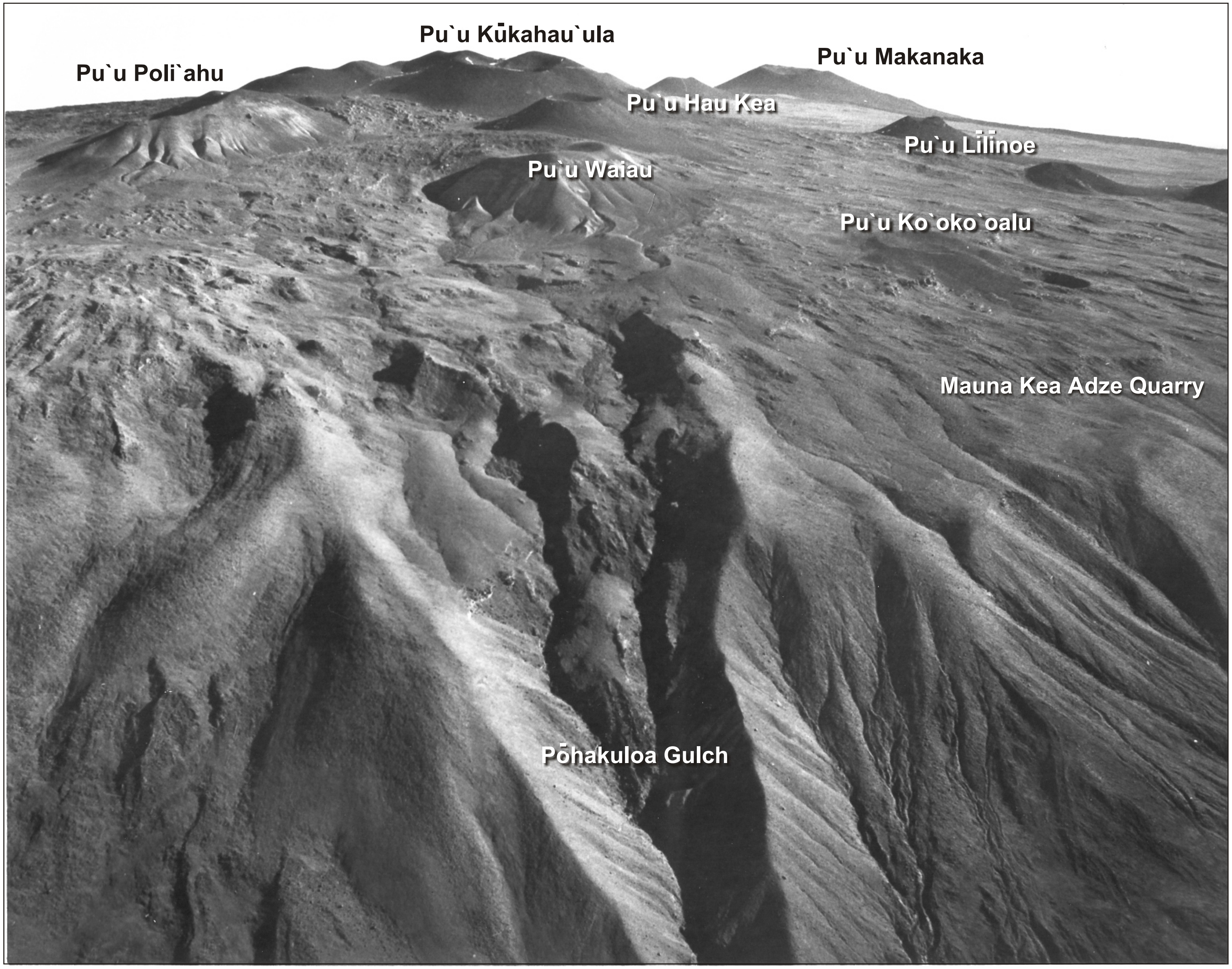


Figure 2.1. Aerial View of the Summit Plateau and Dissected Landscape Below in the Pohakuloa Gulch Area.

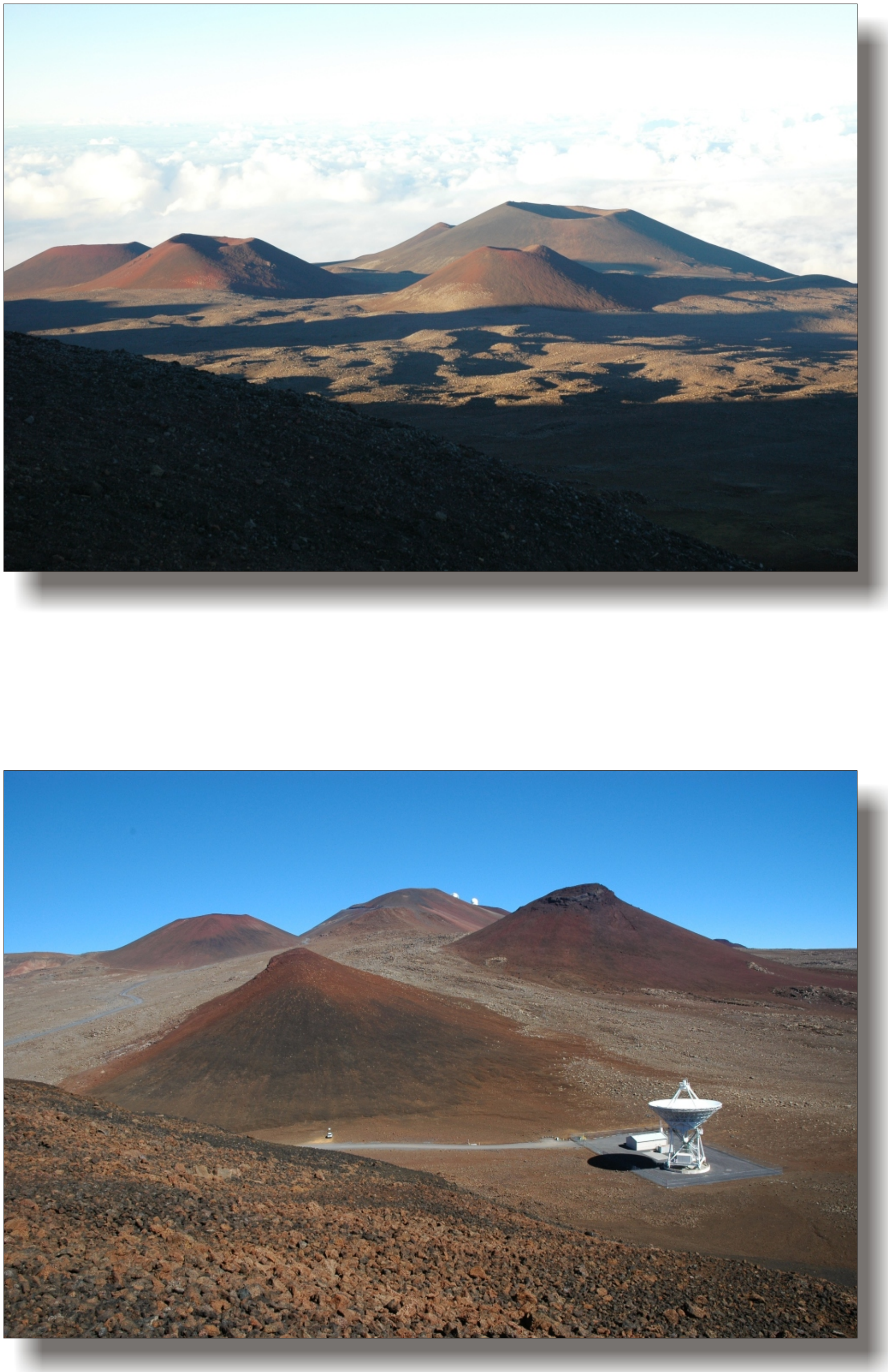


Figure 2.2. Photographs Showing Cinder Cones Located on the Summit Plateau.

Mauna Kea was for many years the only known mountain in the tropical mid-Pacific with evidence of Pleistocene glaciation (Daly 1910; Porter 1972, 1975, 1979b 1979c, 1987). Possible evidence for glaciation has apparently been found recently on Haleakalā (Moore et al. 1993). A number of geologists have studied the glacial deposits on Mauna Kea (e.g., Gregory and Wentworth 1937; Wentworth and Powers 1941; Stearns 1945), but the definitive study was undertaken by Stephen Porter in the 1970s. Porter mapped a succession of four glacial drift sheets, located between the ca. 2,800 m (9,184 ft) and 4,200 m (13,776 ft) elevations, which correspond to four periods of glaciation. From earliest to latest the glacial deposits were named, using local place names, the Pōhakuloa Formation, Waihu Formation, and the Makanaka Formation. The latter includes an older drift and a younger drift (Porter 1979c: Figure 2). More recent investigations suggest that there may have only been three major stages of glaciation, rather than four (Wolfe et al. 1997). Glacial moraines and associated drift deposits cover a large part of the summit region (Figure 2.3).

Porter provides a good description of the effects of glaciation on the topography of the summit plateau:

> Behind the belt of end moraines lies a broad zone of dominantly erosional topography irregularly mantled by thin patches of drift. Within this zone, lava-flow surfaces have been abraded into stoss-and-lee forms and are extensively striated, and the flanks of cinder cones have been oversteepened by glacial erosion so they stand at angles of 30 to 34, instead of the more typical 24 to 26 (Porter 1972; 1975:247).

The stoss and lee forms to which Porter refers are *roches moutonees* (Davies 1972:171), also commonly known as "whaleback ridges" (Porter 1975:247) and "muttonback ridges" (Figure 2.4). A good description of these glacial landforms appears in an early report by Gregory and Wentworth:

> A conspicuous feature of glacial erosion is the “whale-backed” smoothing (roche moutonne). Many of the ledges that extend radially down the slope of the dome (Pl. 1, fig. 2) have been eroded and smoothed on the top sides, with a stoss approach upslope and a plucked cliff or series of steps at the downslope end. In general, the roches moutonnes are long and narrow, with parallel sides and a straight rather than oval or domed longitudinal profile. The form of many, if not all of them, has been determined by the original lava flow. Commonly the irregularities of the lava flow are still in evidence, and in places the deeper pahoehoe wrinkles have not been completely removed. It appears that only a small amount of erosion and smoothing has sufficed to form rather characteristic glacial outlines and surfaces, owing to the similarity in direction of motion of the glacial ice and the lava flows (Gregory and Wentworth 1937:1733).
>
> A thin and discontinuous ground moraine overlies striated bed rock in much of the glaciated area (Pl. 1, fig. 2). It consists of fragments of lava, in many places mingled with cinders from nearby cones or with finer rock detritus washed from the slopes. Nearly all of the fragments are angular or slightly rounded at their edges, though a few are marked by minor grooves and facets and generally granular surfaces. It seems obvious that the “erratics” have not travelled far or been subjected to intense and repeated grinding. Some of them are joint blocks plucked from the underlying ledge; others are slabs broken from low cliffs over which the ice stream passed; still others seem to have been transported within, or on top of, the glaciers, without modification in shape (Gregory and Wentworth 1937:1734).

Figure 2.3. Photographs Showing Glacial Moraines.

Figure 2.4. Photographs Showing Whaleback Ridges.

The presence of fossil ice [permafrost] in the summit region is further testimony to earlier glacial conditions (Woodcock et al. 1970; Woodcock 1974; Furumoto and Woolard 1970). According to Porter, there is no evidence for renewed glaciation since the disappearance of the last ice cap more than 9,100 years ago (Porter 1975:250; 1979b 184-185).

The lower reaches of the Science Reserve on the southwestern flank of the mountain is an area of predominantly steep topography. In one of the early reports on the glacial geology of Mauna Kea Gregory and Wentworth wrote that " between 11,000 and 7,000 feet, the general gradient is 1,600 feet, with a few small areas as steep as 2,000 feet, a mile" (Gregory and Wentworth 1937:1724). The general lack of deep radial valleys on slopes that average nearly 40 per cent in many places has been attributed to a combination of low rainfall and porous soils. Pōhakuloa and Waikahalulu, the only substantial gulches on the southwest flank of the mountain, attain a maximum depth of roughly 30 to 90 m between the 2,438 and 3,353 m elevations (Wentworth and Powers 1941:1198). Water is not totally lacking and in fact there are a number of springs and seeps perched in glacial drift deposits above and below treeline (Wentworth and Powers 1943).

The summit region resembles a stony alpine desert. The soils, like those in alpine environments generally, are poorly developed (Ugolini ms.). In the absence of a vegetative cover and, thus, a surface organic layer, the ground surface in many places is a desert pavement (Ugolini 1974:189).

2.1.2 Geomorphic Processes

Mechanical weathering by frost is the most important mass-movement process in the periglacial regime and attains real significance in landscape evolution in the absence of trees (Caine 1974; Davies 1972:11). On current evidence the effective lower limit of this regime on Mauna Kea is treeline (Ugolini ms.). The primary evidence of a periglacial climate and geomorphic processes is the occurrence of diverse forms of patterned ground, such as stone stripes (see Figure 2.2) and polygons that are widespread in the cold regions of the world (Washburn 1956, 1979). The most common type of mass-movement landform in the summit region of Mauna Kea is the stone-banked terrace or lobe (Davies 1972:49-51) which is variably called either solifluction or gelifluction terraces and lobes (Figure 2.5). Here we follow Washburn (1979) and Embleton and King (1975:97) who have noted the advantage of the term gelifluction in clearly denoting a periglacial regime as opposed to other climatic regimes, including low elevation deserts, where similar forms of patterned ground are also found (Cooke and Warren 1973:129).

While there is no evidence of renewed glaciation in the last 9,000 years or so, there is a possibility of a change to a colder and/or wetter climate having occurred during the last 1,000 years. The evidence for this change is based on Porter's interpretation of gelifluction lobe development (Porter 1975:250, 1979b:184-85).

2.1.3 Modern Climate

The climate of the higher elevations on Mauna Kea is like all mountain climates kaleidoscopic, consisting of a great number of individual elements that are continually changing through space and time. It exhibits all of the universal changes that occur in

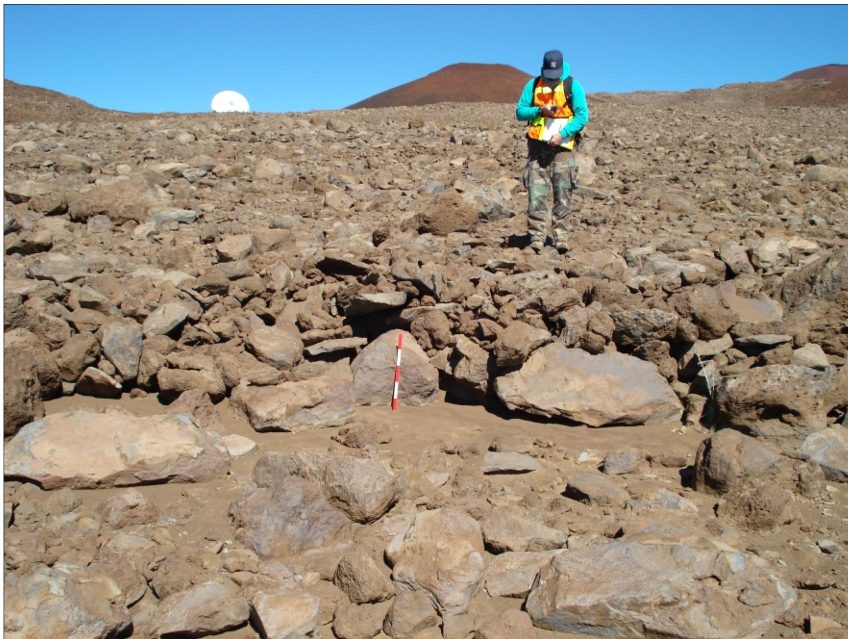


Figure 2.5. Photographs Showing Gelifluction Lobe- Terraces.

the atmosphere with increasing altitude (e.g., decreasing temperature, air density and water vapor) in addition to local effects directly related to latitude and the "mountain mass effect" (Barry 1981; Price 1981). The summit region climate is both dry and cold, but there are few available statistics for evaluating annual and cyclical variability. At this latitude (19-20 degrees N) there is little difference in the mean minimum and mean maximum temperature ranges throughout the year in contrast to pronounced diurnal variation. Precipitation at the higher elevations frequently averages less than one inch in every month of the year, primarily in the form of sleet, hail and snow, which rarely accumulates below the 3,050 m elevation, however. The prevailing winds are from the east-northeast. Fog and other forms of ground condensation are not uncommon and appear to be generally associated with increased cloudiness at midday (Powers and Wentworth 1941).

The modern climate is periglacial, a term that is inconsistently used with reference to a variety of cold climates as well as geomorphological regimes (Davies 1972:9; Embleton and King 1975:2). Mauna Kea is an example of what Tricart (1970) has called the "low latitude mountain variety" of periglacial climate. There are frequent frosts but they are of low magnitude or intensity, penetrating to only shallow depths (Davies 1972:13). As mentioned above, features attesting to a modern periglacial environment include permafrost (Woodcock 1974), gelifluction lobes and terraces (Ugolini n.d.), stone stripes and polygons, and pot-lid or ring crack fractures on smoother rock surfaces (Figure 2.6). Intensive freeze-thaw cycles are also evidenced in the splitting and upheaving of rocks on the edges of lava flows that also exhibit the plucking and abrasive effects of glacial ice movement (Gregory and Wentworth 1937; Wentworth and Powers 1941).

2.1.4 Biota

The biota is predictably impoverished in this oceanic, high mountain ecosystem as the result of extreme isolation which is reflected in a high degree of endemism among a few closely related taxa. The alpine ecosystem on Mauna Kea, as with all high mountain ecosystems, is "at the upper ends of environmental and evolutionary gradients that originate in the surrounding lowlands" (Billings 1979:101). In the summit region there is an "aeolian zone" occupied by a variety of insects (Howarth and Montgomery 1980; Papp 1981) that are believed to have been the only resident fauna in the alpine desert prior to European contact.

The vegetation above the 3,000 m elevation has been classified as a semiarid, barren alpine tundra (Krajina 1963). It consists of lichens, mosses, and a few bunch grasses such as *Trisetum glomeratum* and *Agrostis sandwichensis* (Hartt and Neal 1940; Krajina 1963; Mueller-Dombois and Krajina 1968; Smith, Hoe and O'Connor 1982). A lower xerophytic scrub zone, extending down as far as the 2,100 m elevation, is characterized by the presence of *Styphelia douglasii, Vaccinium peleanum* and *Coprosma* spp. in addition to the higher elevation species. There is some evidence, including the discovery in the course of archaeological investigations of the adze quarry in 1975-76 of the remains of a silversword colony (*Argyroxiphium sandwichensis*) at the 3,475 to 3,658 m elevation, that this zone formerly contained a much richer flora, such as the arborescent Dubautias (Allen 1981:46). Porter (1979b:178-185), in a discussion on the paleoclimatic implications of the latest ice-cap glaciation, suggests that the treeline was depressed to about the 2,000 m (6,560 ft) elevation.

Figure 2.6. Photographs Showing Stone Stripes (top) and Pot-lid Fractures (bottom).

W.D. Alexander's account of his survey trip in 1892 [see below] noted that "The upper limit of the mamane tree is not far from 10,000 feet. The Raillardia, apiipii, extends a thousand feet higher. The beautiful Silver Sword (Argyroximphium), once so abundant is nearly extinct, except in the most rugged and inaccessible localities" (Alexander 1892).

The first systematic study of the flora at Lake Waiau was made by the1935 Hawaiian Academy of Sciences Expedition. Constance Hartt and Marie Neal, the expedition botanists, described their findings in two publications:

> Near the lake a fenced area about forty paces square showed what might result by protection from wild and tame grazing animals. It enclosed approximately 800 plants, most chickweed, grasses, dandelion, and sorrel. Three tiny planted pine trees were merely existing (Neal 1939:7).
>
> More species of plants were found in Waiau Crater than elsewhere in the summit area, probably because that is the chief destination of pack animals and because of the moisture from melting snow. In addition to the fern and grass just named, the following plants were found near Lake Waiau upon a rocky terrain: *Stellaria media*, *Cirsium vulgatum*, *Erigeron linifolus*, *Taraxacum officinale*, *Poa annua*, and *P. pratensis* (Hartt and Neal 1940:256-257).
>
> A census was taken of the plants in the area enclosed by a fence (fig. 21), located in the crater of Lake Waiau. The enclosure was 46 by 43 paces. No planted trees labeled *Juniperus* or *Picea* were found alive; three living specimens of *Pinus contorta* were found, all very short (6 to 8 inches in height) (Hartt and Neal 1940: 257-258).

A fossil diatom flora has been found in the bottom sediments (Massey 1978).

2.1.5 Hydrology

Lake Waiau (see Figures 1.2 and 2.7), the only permanent body of water on the summit plateau and one of the few lakes in Hawai`i (Maciolek 1982), is located in a glacially scoured cinder cone named Pu`u Waiau. Two intermittent streams, Pōhakuloa Gulch and Waikahalulu Gulch, originate in the environs of the lake. The highly dissected landscape on the south leeward slope of Mauna Kea (see Figure 2.1) is due in large part to the retreat (melting) of the Waihu and Makanaka glaciers rather than modern stream flow. The effects of the hydrological regime on the local topography and reasons for the absence of permanent streams are described by Wentworth and Powers:

> Despite the fact that that the average slope approaches 40 per cent in many places, erosion by running water has been feeble in consequence of the extremely porous character of the cinder and lava surfaces and the relatively light precipitation occurring at the higher levels. Stream channels more than 25 to 50 feet deep, or wider than small ravines, are uncommon. The deepest of these radial valleys are Pohakuloa, Waikahalulu, and Hanipoe gulches on the southwest, south, and north, respectively (Wentworth and Powers 1941:1198).
>
> Only one flowing stream was observed above 7,000 feet by the writers in July, 1939, namely the west branch of Pohakuloa Gulch for a short distance above the 10,000-foot level. Here a water table, very likely of the perched type, is held up by a bed of early glacial drift and gives rise to a flow of small volume where the channel is cut through overlying lavas...Nevertheless, abundant freshly scoured

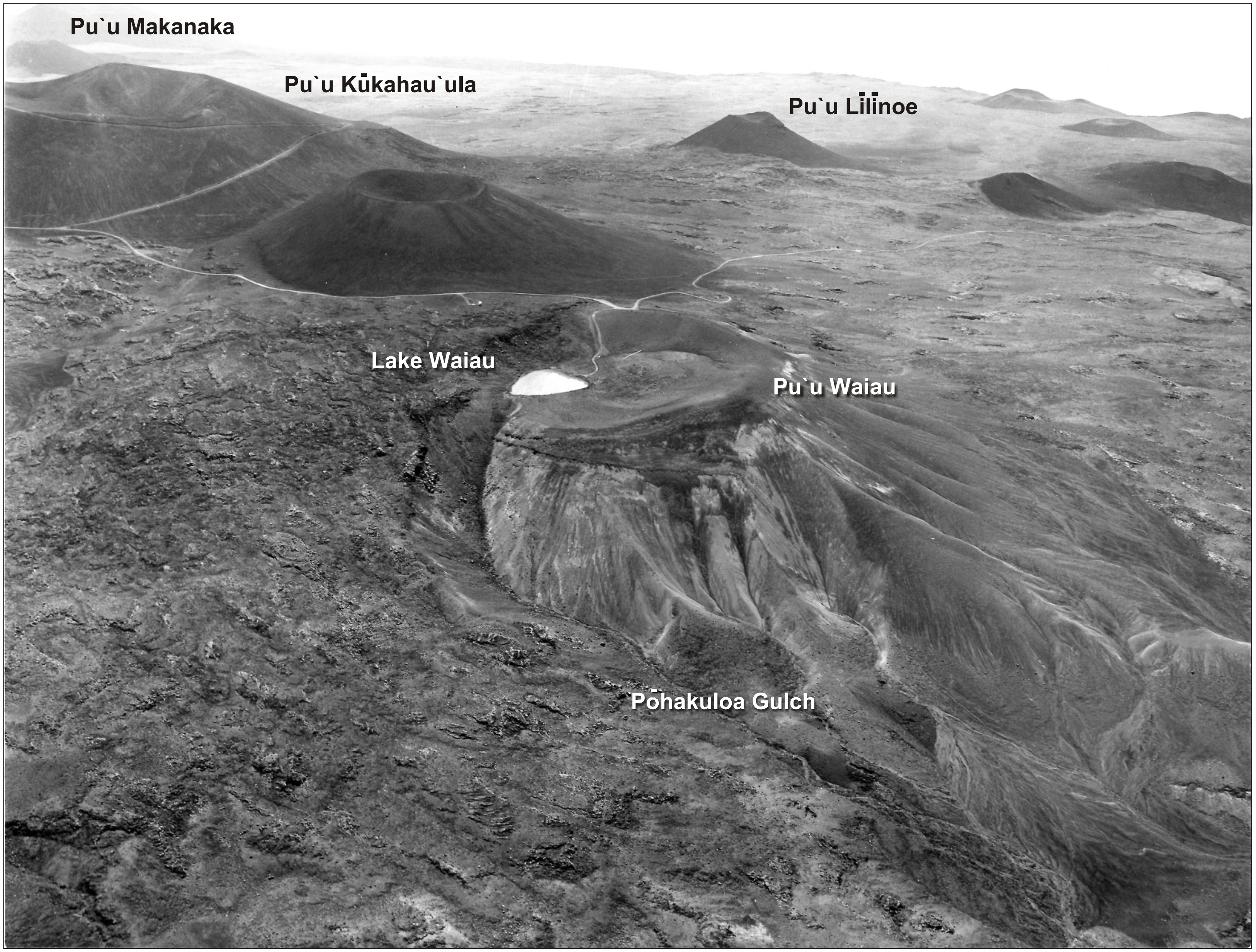


Figure 2.7. Aerial View of Lake Waiau and Surrounding Landscape.

potholes and rock channels are found throughout most of the gulches (Pl. 3, Fig. 1), indicating effective stream flow and scour presumably when the snowcap of the summit area melts. The character of these channels throws light on the former glaciation of Mauna Kea. Stream scour, effective even now, must have been much greater during melting of the icecap when stream flow was able to carry boulders up to 6 feet in size far beyond the ice margin (Wentworth and Powers 1941:1198-1199).

The most detailed study of the springs and seeps was undertaken by Wentworth and Powers, in 1937 and 1939. Their research, primarily in the area they called the Waihu branch of Pōhakuloa Valley [this gulch is the one that contains Hopukani, Waihu and Liloe Springs], led them to conclude that the ground water supplying the springs is perched in and on top of permeable glacial drift deposits, some of which are buried under later lava flows (Wentworth and Powers 1943:543). Stearns (1945:274) questioned the glacial origin of the springs based on his reinterpretation of the glacial stratigraphy of Mauna Kea in the type localities in Pōhakuloa and Waikahalulu gulches. The glacial thesis appears to be correct, however, based on evidence collected by Porter regarding the origin of Lake Waiau and, thus, probably all of the freshwater lenses at higher elevations on Mauna Kea.

There are a number of different theories concerning the geologic origin of the lake. One of the first was advanced by Gregory and Wentworth who recognized that the interior of Pu`u Waiau was not an ordinary crater and that the lake may have been created by the retention of glacial ice:

> Lake Waiau lies in the bowl of Puu Waiau—a cone built chiefly of fine-grained and much-weathered cinders and ash. On its north side, the cone is breached and thus forms an outlet for the lake at high water stages. As the average depth of the lake when full of water is about 15 feet and the muck at its bottom as much as 8 feet, the floor of its basin lies 23 feet below the lowest part of its rim. In superficial view, Waiau has the appearance of an ordinary crater, but striae directed toward the basin from the northeast, morainal deposits high up on its southern slope, and scour marks on its outlet bar, show that it was occupied by glacial ice. It seems probable that ice to a depth of 100 feet or more was forced into the basin and after a temporary halt was forced to join the larger ice tongues moving down Pohakuloa Gulch. Scouring by the ice doubtless deepened the original basin, and it may be that some ice remained after the glaciers disappeared. The possibility is suggested that downward seepage of lake water is impeded not only by fine-grained ash and organic material but also by ground ice that probably forms each year (Gregory and Wentworth 1937:1736).

Stephen Porter summarized earlier interpretations and offered his own views regarding the origins of the lake:

> Gregory and Wentworth (1937) suggested that water is retained in the basin because downward percolation is impeded not only be fine-grained ash and organic matter but also by ground ice. The discovery of permafrost in the crater of Summit Cone (Woodcock, 1974) and its probable existence in Douglas Cone and Goodrich Cone (A.J. Woodcock, 1971, personal communication.) has enhanced the hypothesis that impermeable ground ice may be responsible for Lake Waiau. However, lakes are not present in the craters of cones where permafrost has been found. The crater floor of Puu Waiau lies at the top of the hyaloclastite core of the cone and probably has been somewhat deepened by ice scour, as inferred by Gregory and Wentworth (1937), whereas the crater floor of Summit Cone lies above the seismic discontinuity that may represent the upper

> limit of a hyaloclastite core. Consequently, the presence of water in the closed crater basin of Puu Waiau and its absence in the similarly closed crater of Summit Cone suggest that the relatively impermeable hyaloclastite, rather than permafrost, is the primary reason for the lake (Porter 1979c:1039).

Edward Wolfe and his colleagues, who carried out geological investigations at a later date, agree that reduced permeability explains the retention of water in the lake but that the reasons are different from what Porter had suggested:

> The ice-contact flow that originates at the base of Puu Hau Kea buried the north rim of Puu Waiau. A small lobe of this flow extended into the crater, where an isolated remnant now occurs, along with Makanaka drift, on the south side of Lake Waiau (Wolfe et al. 1997:52).
>
> In both cones, the alteration products weakly cemented the pryoclasts and reduced the permeability of warm water or steam through the cone during or soon after its eruption. Because of reduced permeability, such cones are more susceptible to gullying; water runs of instead of percolating downward. The reduced permeability also apparently accounts for retention of water to form a small permanent lake (Lake Waiau) within the crater of Puu Waiau (Wolfe et al. 1997:51).

Pu`u Waiau is one of the most eroded cones in the summit region (see Figure 2.7) Gregory and Wentworth (1937:1734) noted that:

> Headway cutting by the Pohakuloa stream, which at times of spring melting must carry considerable volumes of water, has reached to within about 100 feet of the margin of Lake Waiau. Blocks of basalt of many tons weight have broken off and tumbled down the steep channel side, probably to be shoved a bit farther by the stream torrent at its occasional maximum.

The depth of the lake sediments was determined in 1966 to be more than 7.5 m based on a probe using a steel rod. Two radiocarbon dates were obtained at this time from the upper 2.0 m of lake sediments from one of two cores collected in 1966 (Pow-Foong Fan 1978:219). At one meter the deposit dated to 2,270 +/- 500 years (Sample W-1834) and at 2.0 m, 7,160 +/- 500 years (Sample W-1833) (Woodcock, Rubin and Duce 1966: 647). Radiocarbon dating of organic material from cores indicates that sediments began accumulating in the lake basin between roughly 13,000 and 14,000 years ago (Dorn et al. 1991:460).

The springs in the Pōhakuloa Gulch area are briefly mentioned in two accounts of expeditions to the summit of Mauna Kea. The first was made by W.D. Alexander who wrote "A spring on the southern side of the mountain, called ‘Wai Hu’, is believed by the natives to be connected to this lake" (Alexander 1892). The second reference is in an amusing story of the experiences of a Sol. N. Sheridan in an article illustrated by the well-known photographer, Alonzo Gartley:

> Afterwards, when we had had the coldest drink in these islands, from a mountain spring at an elevation of 10,500 feet that is probably seepage from the Crater Lake [Lake Waiau], Rawhide Ben [the nickname of Eben Low] and the Secretary went off to shoot wild bullocks, leaving the balance of us hanging in the air on a pinnacle just above the forest line, to which we had descended by a series of long slides (Anonymous 1911:410).

The spring referred to in this account is in all probability Hopukani which is located at the 10,400 ft elevation and is the largest of the springs in the Pōhakuloa Gulch area (see Figure 1.1).

2.1.6 The "Effective Environment"

On current evidence the "effective environment" of the summit region, defined as the ecosystem that humans both adapt to and influence (Smith and Winterhalder 1981:8), has been since the end of the last ice age an alpine desert ecosystem. The biogeoclimatic characteristics common to most high-altitude environments (cf. Winterhalder and Thomas 1978:32; Thomas 1979:146-147; Billings 1979:119; Allen 1981:37), including the Mauna Kea summit region, are the following:

(1) reduced partial pressure of oxygen and carbon dioxide, low absolute vapor pressure, and high background radiation;

(2) rugged topography and poorly developed soils;

(3) low temperature with pronounced diurnal variation and frequent frosts, which can occur in any season;

(4) low and irregular monthly distribution of precipitation occurring in various forms (rain, hail, sleet and snow), periodic droughts; and

(5) extreme biotic impoverishment.

What are believed to have been the primary environmental constraints on life and work in this region and the adze quarry in particular are summarized below:

> For humans, it is a particularly difficult environment in which to work and live because of the physiological effects of high altitude (Van Wie 1974), low temperatures and biotic impoverishment (McCoy 1990:91).
>
> The quarry environment is above all else a 'non-subsistence' environment, incapable of supporting a population of any size for any length of time without the introduction of food, clothing, and firewood. The only sources of fuel above treeline are the few arborescent plants and silverswords (Westervelt 1902:15) which would have been hardly adequate or sufficient in terms of the amount of heat they give off and their long-term availability. The biotic environment is an undependable resource and in fact the only subsistence requirement that this environment afforded in any abundance were the margins of lava flows that could be utilised as shelters (McCoy 1990:91-92).

2.2 Traditional Culture-Historic Context

Much of what is known concerning the traditional culture history of the summit region of Mauna Kea was summarized by Holly McEldowney in a 1982 report, based on a review of early journal accounts and maps, ethnographic collections, and the Boundary Commission Book for Hawai'i (McEldowney 1982). More recent research by Kepa Maly (1998, 1999) and Charles Langlas (Langlas et al. 1997; Langlas 1999), both of whom have conducted oral interviews in addition to archival research, have provided additional information on the traditions associated with Mauna Kea and its cultural and spiritual significance for Hawaiians today. A major compilation of native traditions, historical accounts and oral history interviews on Mauna Kea and surrounding lands can be found in a study entitled "Mauna Kea—Ka Piko Kaulana o Ka `Aina (Mauna Kea—the Famous Summit of the Land) by Maly and Maly (2005) that was commissioned by OMKM. The overview that follows is based on these studies which should be consulted for more detailed information.

2.2.1 Socio-political Context

The summit of Mauna Kea is located in an *ahupua`a* (a territorial unit generally equated with the community) called Ka`ohe in the Hāmākua District (Figure 2.8). Ka`ohe is perhaps the classic example of the unusually large *ahupua`a* found in what Lyons referred to as the "almost worthless wastes of interior Hawaii" in the following account:

> Then there are the large ahupuaas which are wider in the open country than the others, and on entering the woods expand laterally so as to cut off the smaller ones, and extend toward the mountain till they emerge into the open interior country; not however to converge to a point at the tops of the respective mountains. Only a rare few reach those elevations, sweeping past the upper ends of all the others, and by virtue of some privilege in bird-catching, or some analogous right, taking the whole mountain to themselves...The whole main body of Mauna Kea belongs to one land from Hamakua, viz., Kaohe, to whose owners belonged the sole privilege of capturing the *ua`u*, a mountain-inhabiting but sea-fishing bird.
>
> These same lands generally had the more extended sea privileges. While the smaller ahupuaas had to content themselves with the immediate shore fishery extending out not further than a man could touch bottom with his toes, the larger ones swept around outside of these, taking to themselves the main fisheries much in the same way as that in which the forests were appropriated. Concerning the latter, it should here be remarked that it was by virtue of some valuable product of said forests that the extension of territory took place. For instance, out of a dozen lands, only one possessed the right to *kalai wa`a*, hew out canoes from the koa forest. Another land embraced the *wauke* and *olona* grounds, the former for kapa, the latter for fish-line (Lyons 1875:111).

The boundaries of Ka`ohe, as shown on modern maps, are open to question. A map of the adjoining *ahupua'a* of Humu`ula made by S.C. Wiltse in 1862 (Register Map No. 668) included the adze quarry and Lake Waiau, which was labeled on the map as "Pond Poliahu" (Figure 2.9). Maly and Maly note that "By the time the Commissioners of Boundaries were authorized to certify the boundaries for lands brought before them in 1874, disputes over the boundary of Humu`ula and Ka`ohe had arisen" and "by the time of settlement in 1891, the boundary of Humu`ula was taken down to around the 9,000 foot elevation, with Ka`ohe taking in the entire summit region" (Maly and Maly 2005:280). The testimony of Kahue of Humu`ula, presented in Maly and Maly (2005:287), mentions the boundary running from a gulch called Kahawai Koikapue, where mele were sung, to Waiau and then to the summit which was called Pu`uokūkahau`ula. In parentheses there is a notation that "half of the water in the gulch belonging to Ka`ohe and half to Humu`ula".

The name of the gulch does not appear on any known maps, but in all probability is what is now called Pōhakuloa Gulch, since this is not only the major gulch below the

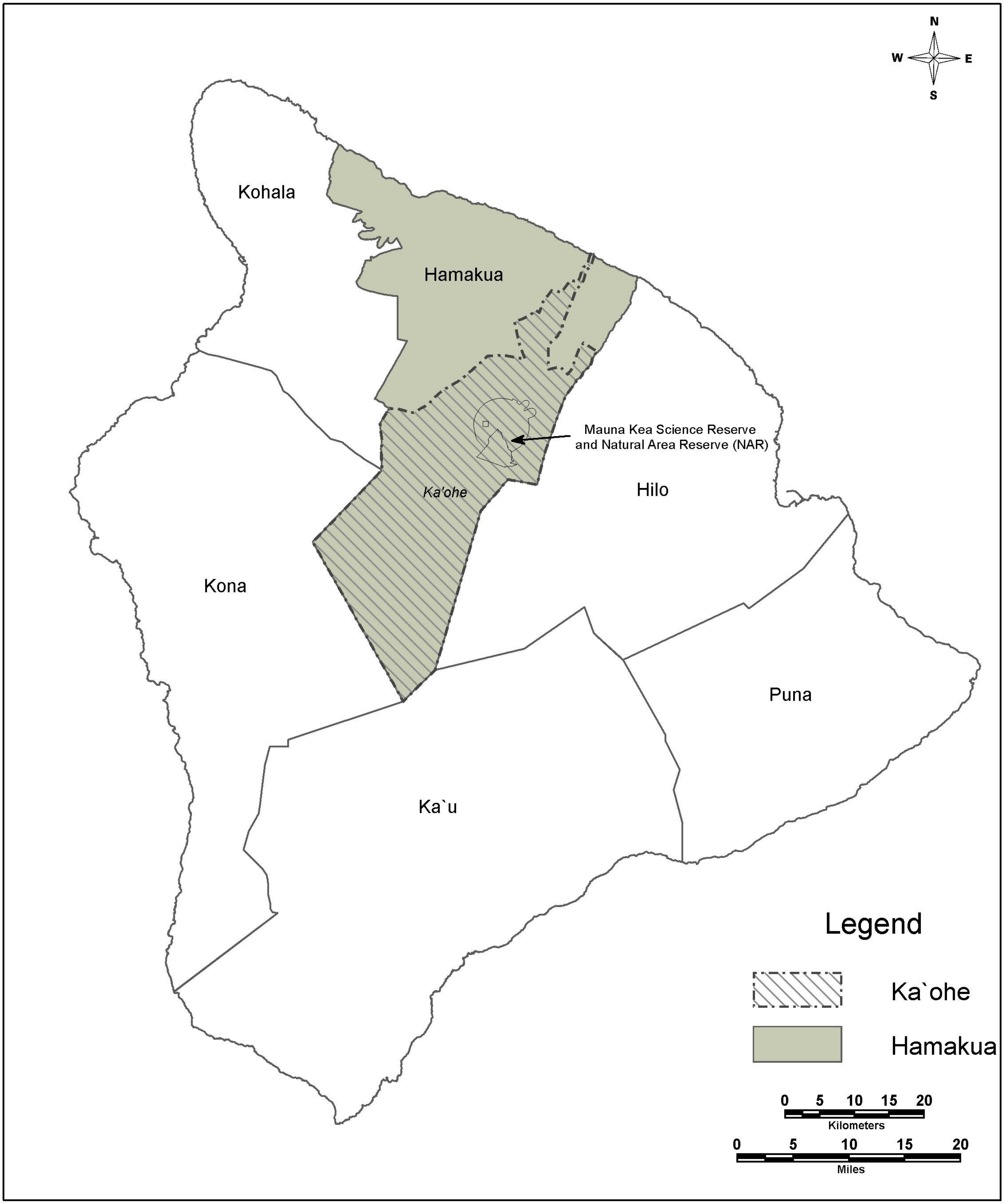


Figure 2.8. Socio-Political Map of the Island of Hawaii Showing the Location of the Project Area in Ka`ohe Ahupua`a, Hamakua District.

Figure 2.9. 1862 Wiltse Map Showing Boundary of Kaohe. Register Map No. 668, the Land of Humuula (S.C. Wiltse, April 1862). (Modified from Kumu Pono Associates LLC 2005:281).

lake but the only one on the south side of the mountain that is described in historic and modern times as containing running water. The reference to Waiau is presumably to the cinder cone, rather than the lake which according to the name on the 1862 Wiltse map was associated with the goddess Poli`ahu, although Waiki [or Haiki], a contemporary of Kahue, claimed the lake was called Waiau.

Waiki, who gave testimony at the same time as Kahue (McEldowney 1982:1.7), claimed that Kaluakaakoi, "the cave where they used to get stone adzes out" was in Ka`ohe as was Poliahu, which he described as a cave where Līlīnoe used to live (Maly and Maly 2005:291).

> They told me Kaohe bounded Humuula from Pohakuhanalei down Mauna Loa, on the Kona side. I never heard my parents say that Kaalaala joined Humuula. The pond of water called Waiau is on Kaohe and not on Humuula. My parents told me Humuula went to Kaluakaakoi and Poliahu. We used to go there after adzes for the Humuula people (Maly and Maly 2005:292).

In addition to the district and ahupua`a system of land tenure, there were other traditional land classifications, including one that employed the term *wao* for a series of natural and cultural zones (Malo 1951:16-18). According to some descriptions the *wao kanaka* was a low-lying coastal area where the *maka`āinana* were free to move and inhabit. The *wao kele* was the upland forested area that the *maka`āinana* could only access for gathering purposes. The *wao akua*, which was believed to be inhabited by *akua*, was the subalpine desert region above the tree line. The *maka`āinana* were hesitant to venture into the *wao akua* and could do so only by offering prayer and displaying great respect (NASA 2005:3-18, 3-19).

The Mauna Kea summit region is commonly described today as lying within the *wao akua,* which is different, however, from Malo's description of this zone which placed it at a lower elevation in forested lands (Malo 1951:17). As noted in the footnotes to Malo's *Hawaiian Antiquities* (Malo 1951:18), *wao akua* can also be understood to mean "a remote desolate location where spirits, benevolent or malevolent, lived and people did not live. Usually these places were deep interior regions, inhospitable places such as high mountains, deserts and deep jungles. These areas were not necessarily *kapu* but were places generally avoided out of fear or respect" (PHRI 1999, 24). Indeed, when Rev. William Ellis toured the island in 1823, he noted the reluctance of native Hawaiians to venture into the summit areas of Mauna Kea.

> …numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit---as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit (Ellis 1979:292).

Today, the *ahupua`a* system of land and resource management, with *kapu* restrictions, is no longer in existence legally, due to the collapse of the *ali`i* – *maka`āinana* social and cultural system. Still, knowledge of the some traditional *kapu* restrictions endures, although both traditional and contemporary cultural practices and belief are apparent. One cultural practitioner, Pualani Kanaka`ole Kanahele reveals traditional knowledge of *kapu* restrictions and her traditional cultural practice regarding entering *kapu* areas. She learned from her *kūpuna* that the forested regions are not the realm of humans; instead, the forest's *kupa* (citizens) are the trees. Kanahele says that "when I go *maha`oi* [intrude] in their realm, I have to ask permission to be up there"

(Maly 1999:A-371). In a similar sense, Irene Loeyland Lindsey-Fergerstrom reveals, in the context of taking *piko* up to the Mauna Kea summit, that her *tūtū* (grandmother) had knowledge of the *kapu* restriction that only *ali`i* were permitted on the summit. Yet, Lindsey-Fergerstrom's *tūtū* instructed her to take her family's *piko* to the summit anyways, saying "it's not like we going be *ali`i*, but at least you can try…" (Maly 1999:A-390).

2.2.2 Land Uses

On present evidence the slopes of Mauna Kea, above the limits of agriculture and permanent settlement, were a vast montane "wilderness" probably known to only a small number of Hawaiians engaged in primarily "special purpose" activities, such as bird-catching, canoe making, stone-tool manufacture, or burial of the dead (McEldowney 1982). Ethnographic information relating to a specific locality in this and other mountainous regions in Hawai'i is either sketchy, or, as is more frequently the case, lacking altogether.

Little is known ethnographically about the uses of the alpine and sub-alpine zones on Mauna Kea except for brief accounts about adze manufacture and burials. Most of what is known regarding traditional land uses is the result of archaeological investigations undertaken since the mid-1970s.

2.2.3 Myths, Legends, and Traditional Histories

Native Hawaiian traditions state that ancestral *akua* (gods, goddesses, deities) reside within the summit area. These personages are embodied within the Mauna Kea landscape – they are believed to be physically manifested in earthly form as various *pu`u* and as the waters of Waiau. Because these *akua* are connected to the Mauna Kea landscape in Hawaiian genealogies, and because elders and *akua* are revered and looked to for spiritual guidance in Hawaiian culture, Mauna Kea is considered a sacred place.

Native Hawaiian genealogical *mele* (poems, chants) explain the centrality of Mauna Kea within Hawaiian genealogy and cultural geography. *Mele* recount that as a result of the union of Papa and Wākea, who are considered the ancestors of Native Hawaiians, the island of Hawai`i was birthed. In the *Mele a Paku`i*, a chant describing the formation of the earth, Mauna Kea is likened as the first-born of the island children of Papa and Wākea, who also gave rise to Hāloa, the first man from whom all Hawaiians are descended (Kamakau 1991:126 in Maly and Maly 2005:7-8). A *mele hānau* (birth chant) for Kamehameha III, who was born in 1814, describes the origins of Mauna Kea:

Born of Kea was the mountain,
The mountain of Kea budded forth.
Wākea was the husband, Papa
Walinu`u was the wife,
Born was Ho`ohoku, a daughter,
Born was Hāloa, a chief,
Born was the mountain, a mountain-son of Kea
(Pukui and Korn 1973:13-28 in Maly and Maly 2005:9).

Some contemporary Native Hawaiian cultural practitioners continue to view Mauna Kea as a first-born child of Papa and Wākea, and thus, the mountain is revered as "the *hiapo*, the respected older sibling of all Native Hawaiians" (Kanahele and Kanahele 1997 in Langlas 1999:7). Cultural practitioner Kealoha Piscotta explains that this link to Papa and Wākea "is the connection to our ancestral ties of creation" (Orr 2004:61). Pualani Kanaka`ole Kanahele states that "the very fact that it is the 'Mauna a Wākea' tells you that it is the *mauna* that is meeting Wākea" (Maly 1999:A-368).

Traditional genealogical *mele* (poems, chants) and *mo`olelo* (stories, traditions) recount associations between Mauna Kea and the following *akua* – Poli`ahu, Līlīnoe, Waiau, and Kahoupakane. In a *mo`olelo* recounting the travels of Pūpū-kani-`oe, it was said that Mauna Kea was a mountain "on which dwell the women who wear the *kapa hau* (snow garments)" (Maly and Maly 2005:31). Yet another *mo`olelo*, which dates to the 1300s, explains that Ka-Miki was sent atop Mauna Kea's summit to the royal compound of Poli`ahu, Līlīnoe, and their ward, Ka-piko-o-Waiau, to fetch water for use in an *`ai-lolo* ceremony (Maly and Maly 2005:42-43).

In the post-Contact period, Native Hawaiian historian S.N. Haleole transcribed *Ka Mo`olelo o Laiekawai* in 1844, which tells that after Poli`ahu broke her engagement to Aiwohikupua, she took up residence on Mauna Kea along with her three maidens Līlīnoe, Waiaie (Waiau), and Kahoupakane (Maly and Maly 2005:20-26). As well, other 19th century ethnographers published on the associations between Mauna Kea and Poli`ahu, Līlīnoe, and Waiau. W.D. Westervelt claimed that Poli`ahu, Līlīnoe, and Waiau were snow goddesses "who embodied the mythical ideas of spirits carrying on eternal warfare between heat and cold, fire and frost, burning lava and stony ice" (Westervelt 1963:55-56). Westervelt also credits Poli`ahu as the rival of the fire-goddess, Pele, said that she battled Pele on numerous occasions, and credits her with having "kept the upper part of the mountain desolate under her mantle of snow and ice" (Westervelt 1963:62).

In 1931, Emma Ahu`ena Taylor, a historian of Hawaiian descent and with genealogical ties to the lands of Waimea and Mauna Kea, reported on Poli`ahu's residence at Mauna Kea, but also described the creation of Lake Wai`au. She wrote:

> Poliahu, the snow-goddess of Mauna-kea, was reared and lived like the daughter of an ancient chief of Hawaii. She was restricted to the mountain Mauna-kea by her godfather Kane. She had a nurse Lihau who never left her for a moment. Kane created a silvery swimming pool for his daughter at the top of Mauna-kea. The pool was named Wai-au. The father placed a supernatural guard [Mo`o-i-nanea] at that swimming pool so that Poliahu could play at leisure without danger of being seen by a man… (Maly and Maly 2005:53).

According to Taylor, on Mauna Kea, Poli`ahu's attendants – Līlīnoe, Lihau, and Kipu`upu`u drove away her suitor, Kūkahau`ula (the pink-tinted snow god). But Mo`o-i-nanea allowed the snow god to embrace Poli`ahu, and to this day, Taylor reports, "Ku-kahau-ula, the pink snow god, and Poli`ahu of the snow white bosom, may be seen embracing on Mauna-kea" (Maly and Maly 2005:53).

In modern-day accounts, Poli`ahu continues to be commonly referred to as "the beautiful snow goddess of Mauna Kea" while Līlīnoe is called "a goddess of the mists and younger sister of the more famous Poliahu" (Pukui and Elbert 1971:392, 396). Langlas reports that Pualani Kanaka`ole Kanahele told him that three *pu`u*—Poli`ahu, Līlīnoe, and Wai`au, were sister goddesses who are female forms of water and that all three of the cinder cones or *pu`u* that bear their names are important religious sites (Langlas 1999). McEldowney (1982:1.3-1.4) recounts that Fornander included Līlīnoe as a person in his genealogies and legends, including a reference to her as the "wife of

Nu`u, the "Noah", of the discredited Hawai`i Loa legend involving a great flood. McEldowney (1982:1.4) noted that Kamakau called Līlīnoe "the woman of the mountains" and named her as ancestress of Pae, a *kahuna* of Umi's time (Kamakau 1961:215)."

There are several myths concerning Poli`ahu and Līlīnoe. W.D. Westervelt claimed that Poli`ahu was one of four snow goddesses "who embodied the mythical ideas of spirits carrying on eternal warfare between heat and cold, fire and frost, burning lava and stony ice" and who, according to several legends, was the rival of the fire-goddess, Pele (Westervelt 1963:55). Poli`ahu, who battled Pele on numerous occasions, is credited by Westervelt as having "kept the upper part of the mountain desolate under her mantle of snow and ice… (Westervelt 1963:62). Poli`ahu continues to be commonly referred to as the "The beautiful snow goddess of Mauna Kea" (Pukui and Elbert 1971:396). Kealoha Piscotta also retains knowledge that Mo`o Ina`ne`a was the guardian for Poli`ahu and Līlīnoe (Orr 2004:51).

Today, in regards to Lake Waiau, cultural practitioner Pualani Kanaka`ole Kanahele believes that because the waters of Waiau have not "had a chance to come down to the rest of us, then it is sacred water…that water, Waiau, is the most sacred because it isn't the water that has been spilled, it is still up there in the realm of Wākea" and in her estimation, "water is the source of life" (Maly 1999:A-368, A-370). Kealoha Piscotta believes the cultural significance of Lake Waiau rests in several facts - the Kūmulipo creation chant describes a lake that resides in the heavens, the ancient trails meet at the lake, the lake is a navigational gourd, and it is a jumping off point for ancient Hawaiian souls (Orr 2004:44-45).

While there are a number of myths and legends associated with the summit area of Mauna Kea, the higher elevation areas of the mountain do not figure prominently in Hawaiian traditional histories, which McEldowney points out:

> …revolve mainly around the lives and exploits of prominent chiefs, as passed down through genealogies, chants, and stories, and recorded primarily in works by Fornander an Kamakau (Barrere 1962:62-63. No major events from these histories occur within the summit plateau of Mauna Kea (McEldowney 1982:1.4).

The origins of Mauna Kea and its central place in Hawaiian genealogy and cultural geography are told in myths and chants. Pualani Kanaka`ole Kanahele and her deceased husband, Edward Kanahele, who were interviewed by Dr. Charles Langlas for the Hawaii Defense Access Road and Saddle Road Improvement Project in 1998, referred to two chants, Mele a Paku`i and `O Hānau ka Mauna a Wakea. These chants:

> describe, respectively, the birth of Hawai`i island from the union of Papa and Wakea, the ancestors of Native Hawaiians, and the birth and "budding upward" of Mauna Kea a mountain named for Wakea. As the firstborn of Papa and Wakea, Hawai`i island is the <u>hiapo</u>, the respected older sibling of all Native Hawaiians. The mountain of Mauna Kea is the <u>piko</u> or origin point for the island, more specifically for its northern half, and therefore is a place of great <u>mana</u>. Because of the mana of the mountain and of Lake Wai`au at its summit, Queen Emma went there to bathe in the water in 1874 (Langlas 1999:7).

The second goddess of Mauna Kea is Līlīnoe, who according to Pukui and Elbert (1971:392) was "a goddess of the mists and younger sister of the more famous Poliahu." Westervelt claimed that Līlīnoe was another of the four snow goddesses. McEldowney (1982:1.3-1.4) recounts that Fornander included Līlīnoe as a person in his genealogies and legends, including a reference to her as the "wife of Nu`u, the "Noah", of the discredited Hawai`i Loa legend involving a great flood. McEldowney (1982:1.4) noted that "Kamakau called Lilinoe "the woman of the mountains" and named her as ancestress of Pae, a *kahuna* of Umi's time" (Kamakau 1961:215).

Waiau is also mentioned as a goddess in several legends. Westervelt wrote that she was another of the snow-goddesses or maidens, as he sometimes referred to them (Westervelt 1963:56). Langlas reports that Pua Kanahele told him that three *pu`u*—Poli`ahu, Līlīnoe, and Wai`au, were sister goddesses who are female forms of water and that all three of the cinder cones or *pu`u* that bear their names are important religious sites.

While there are a number of myths and legends associated with the summit area of Mauna Kea, the higher elevation areas of the mountain do not figure prominently in Hawaiian traditional histories, which McEldowney points out:

> revolve mainly around the lives and exploits of prominent chiefs, as passed down through genealogies, chants, and stories, and recorded primarily in works by Fornander an Kamakau (Barrere 1962:62-63). No major events from these histories occur within the summit plateau of Mauna Kea (McEldowney 1982:1.4).

2.2.4 Mortuary Practices

There are numerous references to human burials on the high elevation northern and eastern slopes of Mauna Kea (see discussion in McEldowney 1982). The practice of burying the dead in remote, high elevation areas may have been a common practice, based on the information collected by Thomas Thrum for Haleakala on Maui:

> The use of the craters within Haleakala as burial places, far removed from places of habitation, is quite in keeping with ancient Hawaiian practice. Distances and difficulties were no bar to faithful execution in carrying out the instruction of a dying relative or friend (Thrum 1921:258).

One reason, but undoubtedly not the only one, for taking the dead to remote areas was the fear that the bones might be used to make fishhooks. A person named Nainoa gave such an explanation in testimony before the Boundary Commission:

> In old times, if anyone died, could not wail, but people come and steal shin bones for fishhooks, so used to carry body secretly and bury in mountains (quoted in McEldowney 1982:1.9).

There are a couple of early accounts of burials having been found in the general vicinity of Pu`u Līlīnoe. E.D. Preston's account of his work at Lake Waiau, in 1892, noted that "At an elevation of nearly 13,000 feet, near Līlīnoe, a burying ground was found, where the ancient chiefs were laid to rest in the red volcanic sand" (Preston 1895:601). W.D. Alexander's surveying party saw what they interpreted as graves on the top of Pu`u Līlīnoe, also in 1892:

> The same afternoon [July 25, 1892] the surveyors occupied the summit of Lilinoe, a high rocky crater, a mile southeast of the central hills [the 'summit'] and a little over 13,000 feet in elevation. Here, as at other places on the plateau, ancient graves are to be found. In olden times, it was a common practice of the natives in the surrounding region to carry up the bones of their deceased relatives to the summit plateau for burial (Alexander 1892).

Kamakau indicated that Queen Ka`ahumanu, who like Fornander also considered Līlīnoe a person, made an unsuccessful attempt to recover her bones on

Mauna Kea in 1828 (McEldowney 1982:1.4). Kamakau added that the body of Līlīnoe "was said to have lain for more than a thousand years in a well-preserved condition, not even the hair having fallen out" (Kamakau 1961:285). Kamakau's description of Līlīnoe's body is probably the source of modern stories about a mummified body having been found on Mauna Kea and removed to some unknown location.

Of the many locations with confirmed and possible burial sites, Pu`u Mākanaka is perhaps the best known. The 1925-26 USGS survey team found human remains on the summit of Pu`u Mākanaka:

> To set up Camp Four at 12,400 feet near Puu Makanaka, we had difficulty finding a small flat area for the tents. Makanaka is the largest and most perfectly formed cone in the summit area, 1,500 feet in diameter at the rim and 300 feet deep, while the base is more than 600 feet below the rim at one point. On the rim I found a partially uncovered grave, eroded by high winds, with an incomplete human skeleton. This was unknown, as far as I could discover, to anyone familiar with the area. The name Puu Makanaka means "Hill crowded with many people" and the grave must have been ancient (Kilmartin 1974:15).

Ed Stevens maintains that "oral history and traditions tell us that…the bones of very special personages were placed in the *pu`u* at or near the summit for safekeeping… they were the special ones" (Maly 1999:C-10, 13). Daniel Kaniho Sr. suggests that "they were all *ali`i*…they were kind of high-ranking people" (Maly 1999:A-169).

2.2.5 Trails and Trail Markers

Not surprisingly, perhaps, scant information exists about ancient trails in the summit area of Mauna Kea. A *mo`olelo* associated with chief Pili-a-Ka`aiaea, and thus dating from the 1300s, recounts the journey of two brothers, Ka-Miki and Maka-iole, who traveled around the island using ancient *ala hele* (trails). Sent up to the Mauna Kea summit, Ka-Miki was guided by the following traveling *mele:*

> *The path goes to the uplands*
> *The path goes to the lowlands*
> *It is a lonely path to the mountain*
> *A damp dreary path*
> *A fire will be the wrap*
> *Warming you along the sacred trail…*
> (Maly and Maly 2005:42)

Kamakau wrote of a battle that ensued between `Umi-a-Liloa and the chief of Hilo in the 1500s, wherein `Umi-a-Liloa and his warriors traveled from Waipi`o to Hilo via Mauna Kea. Kamakau states that "it was shorter to go by way of the mountain to the trail of Poli`ahu and Poli`ahu's spring at the top of Mauna Kea, and then down toward Hilo. It was an ancient trail used by those of Hāmākua, Kohala, and Waimea to go to Hilo" (Kamakau 1961:16 in Maly and Maly 2005:453). Maly and Maly (2005:454) contend that ancient trail systems across all the mountain lands afforded travel to burial sites and facilitated travel for the collection of resources like adze stone, canoe *koa*, and bird feathers.

The ancient trails were essentially footpaths, which, by the 1840s, proved inadequate for travel with the newly-imported horses, wagons, and wagon team animals associated with cattle ranching and bullock-hunting activities; hence, formal wagon road developments, funded by the Hawaiian Kingdom, ensued in the lowland mountain slope regions (Maly and Maly 2005:454). However, the mountain's summit region remained accessible only by trails, on foot or horseback. The difficulty of travel on the terrain by horse and on foot is well documented in historical accounts by European visitors and surveying expedition field notes. Formalized road developments continued in the lowlands into the early 20th century, with the CCC (Civilian Conservation Corps) and the U.S. Army Corps of Engineers improving existing roads, such as the Saddle Road, to accommodate vehicular traffic (Maly and Maly 2005:482).

There are two major named trails in the summit region of Mauna Kea, the Mauna Kea-Humu`ula Trail and the Mauna Kea-Umikoa Trail. The better known of the two, is the Humu`ula Trail which apparently began in the Kalaieha area where the Humu`ula Sheep Station is located. The earliest map showing the upper part of the trail was made by W.D. Alexander's survey party in 1892 (Alexander 1892; Preston 1895). The Alexander map and the 1930 edition of the USGS Mauna Kea Quadrangle map show the trail going around the eastern flank of Pu`u Keonehehee and onward up the mountain to Lake Waiau. This alignment closely follows the modern road (Figure 2.10).

An account of the Alexander survey, published in the *Pacific Commercial Advertiser* on September 14, 1892, indicated that the Humu`ula Trail did not pass through the adze quarry and that the site marked on later maps as Keanakako`i was in fact some 100 yards west of the trail:

> The trail next turned to the east, winding around an immense sand crater called "Keonehehee," 11,500 feet in elevation, which stands on the edge of the summit plateau. Further to the southeast we were shown a pillar of stones which was raised to commemorate Queen Emma's journey over the mountain to Waimea in 1883 [1882] (Maly and Maly 2005:183).

The Alexander map of the summit plateau published in Preston (1895:602, Illustration 34) also shows the trail, which is labeled Trail to Kalaieha, cutting across the south and eastern slope of Keonehehee. This indicates that the Queen Emma memorial was southeast of the trail, contrary to Maly's interpretation (Maly and Maly 2005:Figures 8b and 8c) that it is located on the rim of Pu`u Ko`oko`olau, which is in the adze quarry and the middle, rather than edge of the summit plateau (see Figure 2.10). Preston mentions that there was more than one cairn:

> Some interesting pyramids of stones, built to commemorate Queen Emma's visit, were seen on the edge of the plateau, and at elevation of 12,000 feet was found Keanakakoi, a famous quarry opened by the natives many centuries ago for the manufacture of battle axes (Preston 1895:601).

The 1928 Walter E. Wall map of the Island of Hawai`i shows both the Humu`ula and Umikoa trails, neither of which are labeled as such, however. The map shows two other unnamed trails in the summit area. One leads to Pu`u Poliahu from a junction with the old Waimea Road that passed through the area between Mauna Kea and Mauna Loa that is commonly referred to as the "Saddle." The second trail, which is joined to the Pu`u O`o Trail on the eastern side of the mountain, is a straight line path that crosses over the Umikoa Trail and ending at the summit (Figure 2.11).

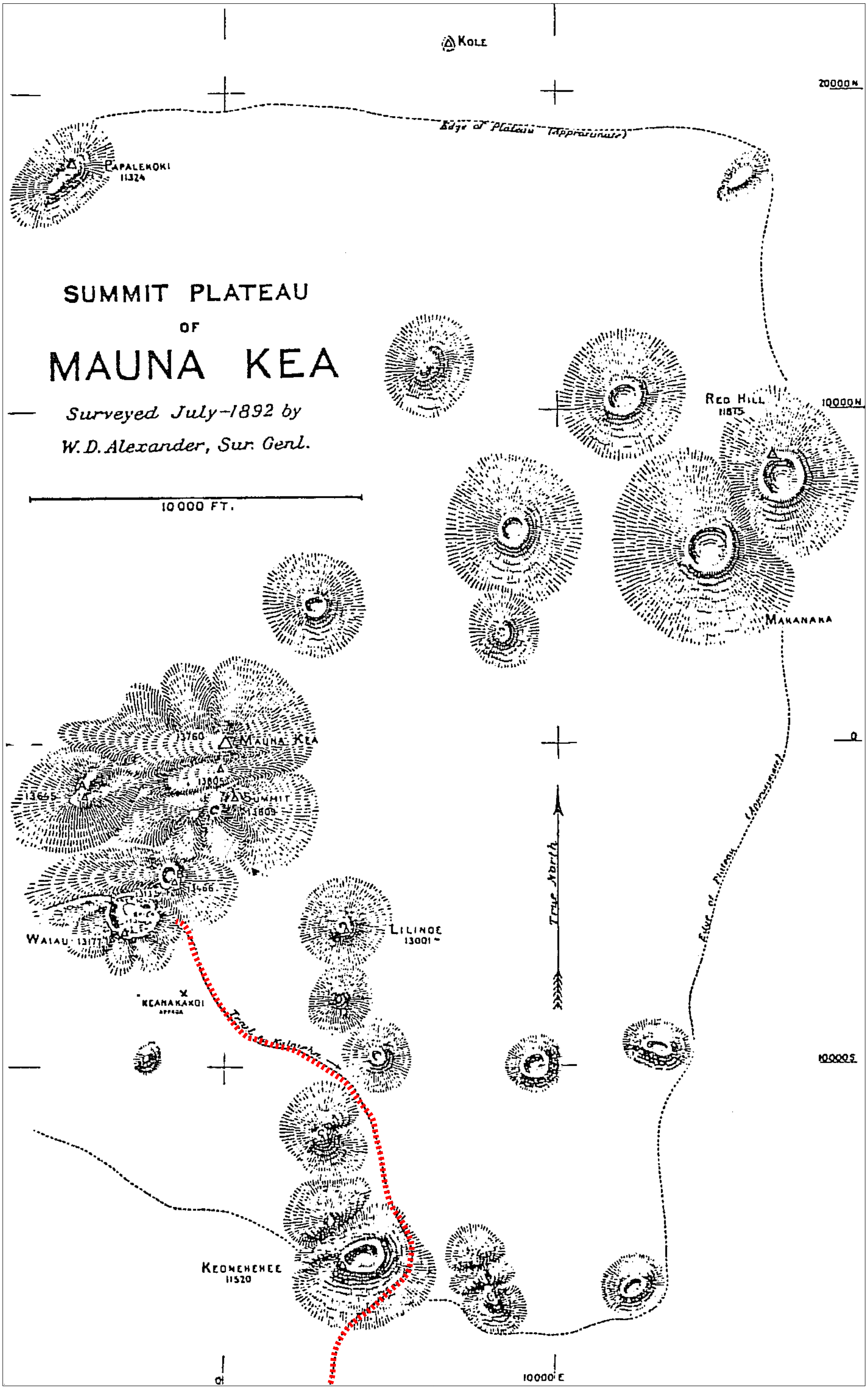


Figure 2.10.1892 Alexander Map of the Summit Plateau and Alignment of the Humu`ula Trail.

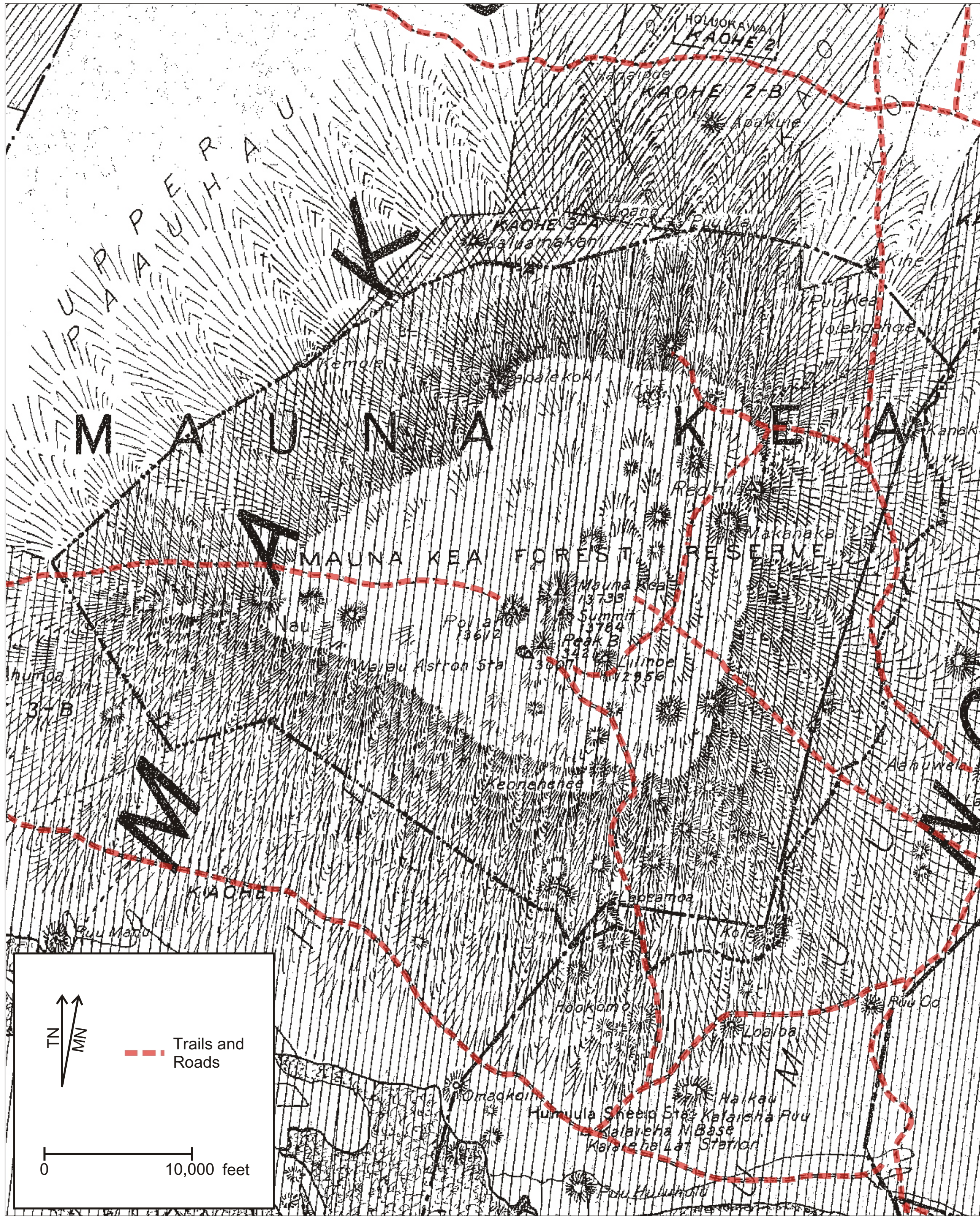


Figure 2.11. 1928 Walter E. Wall Map of the Island of Hawaii Showing Trails and Roads in the Summit Area and Lower Elevations.

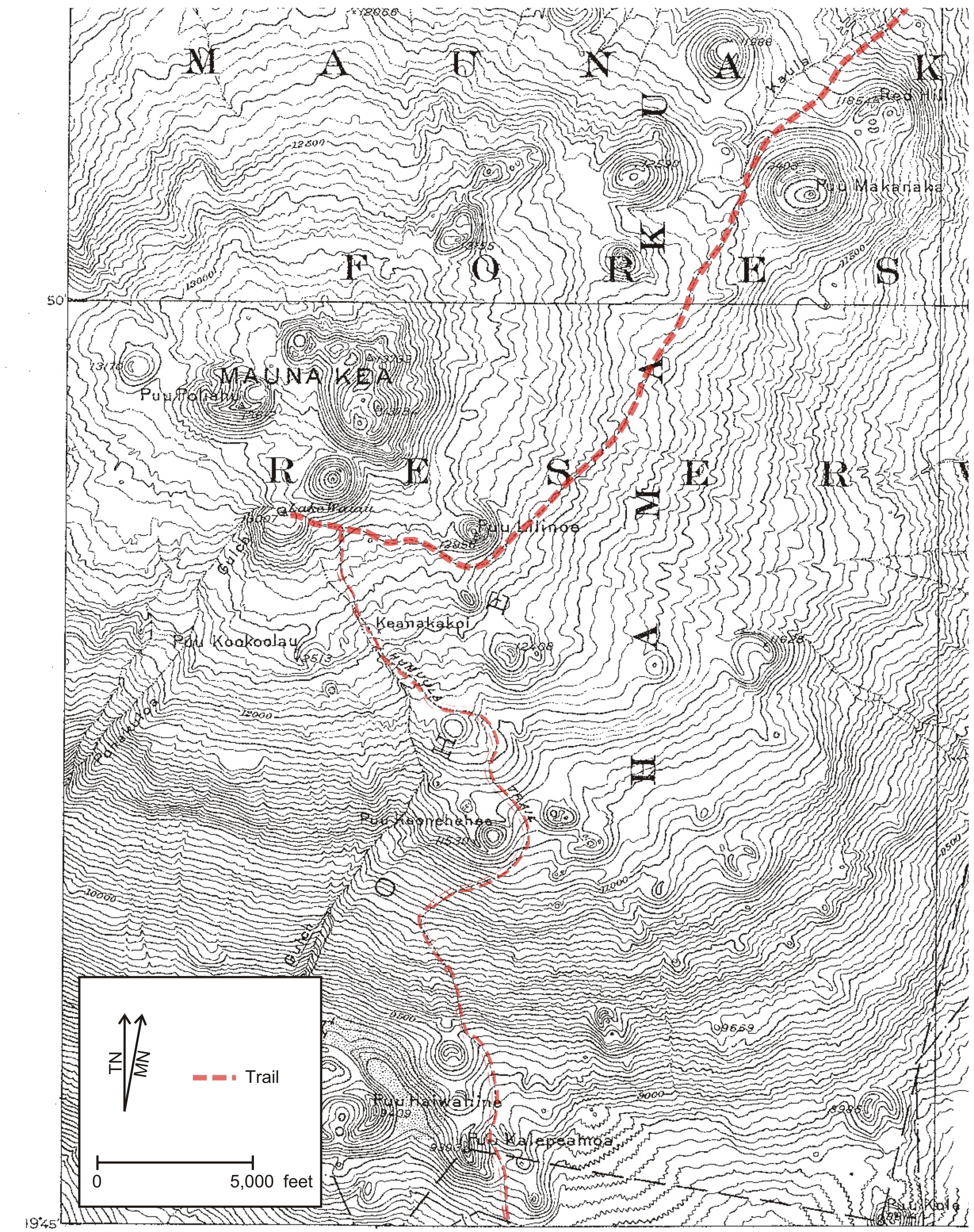


Figure 2.12. 1930 U.S.G.S. Mauna Kea Quadrangle Map Showing Trails in the Summit Area and Lower Elevations.

The 1930 USGS Mauna Kea quadrangle map (Figure 2.12) shows the Humu`ula Trail joining a second trail just below the lake. This trail, which is not named, is labeled on the later USGS maps as the Umikoa Trail. This trail is not mentioned in any early accounts, however. While it may very well have been an ancient trail, the name would appear to be modern and most likely derived from the Umikoa Ranch, where some of the horseback trips to the summit area in the early part of the 20th century and possibly earlier began. The unpublished manuscript of the 1935 Hawaiian Academy of Sciences Expedition noted that "In recent years a few people have visited the summit in small parties on horseback, with a guide from Umikoa or Humuula" (Wentworth et al. n.d.:1-2).

A new section of the Humu`ula trail was built by the CCC in the 1930s that took a straighter course to the west of Pu`u Keonehehee (see Figure 2.12). The new trail was described by L. Bryan in a 1939 article in *Paradise of the Pacific*:

> During the past few years this lake has been visited by increasingly large numbers of visitors. Three years ago the Civilian Conservation Corp reconstructed an old trail from near the Humuula Sheep Station (Kalaieha), past Hookomo and Halepohaku to Lake Waiau and thence to the summit. This trail is well made and carefully marked on the ground with Ahus or piles of stones and the trip to the lake and on to the summit can easily be made by strangers without the assistance of a guide (Maly and Maly 2005:257).

The Umikoa Trail, which is labeled the Mauna Kea-Umikoa Trail on some maps, first appears as a named trail on the advance sheet of the Lake Waiau Quadrangle that was based on the mapping by J.O. Kilmartin in 1925-26. This trail, and the Mauna Kea-Humu`ula Trail are shown as terminating at Lake Waiau on the Kilmartin map. The absence of the Umikoa Trail on the 1892 map may be significant.

McEldowney came to the conclusion that the Humu`ula and Umikoa trails are probably more recent:

> After comparing the evidence for trails on historic maps, in descriptions of routes taken throughout the historic period, and in native boundary testimonies, it appears that the major trails or formalized routes as shown on the present U.S.G.S. Quadrangle are of recent origin, and that any specific trails or routes existing in the early historic or possibly prehistoric periods are not discernible in the literature (McEldowney 1982:1.12).

McEldowney (1982:A-9) found references to "commemorative and religious features as well as boundary and trail markers" in the Boundary Commission Book for Humuula (Vol. B), as well as mention of "formalized resting places (*o`io`ina*), areas "where mele were sung," and localities where propitiation would be made to various gods or spirits to insure safe passage or completion of a task" (McEldowney 1982:A-9). None of the accounts applied specifically to the higher elevation lands on Mauna Kea, however.

2.2.6 Place Names

The place names in the summit region are a mix of traditional names and modern names (see discussion in McEldowney 1982 and Tables 1.1 and 1.2 from her report). The origin and meaning of some names is unknown. The name Mauna Kea itself is open to various interpretations. The commonly accepted, literal translation as "White

Mountain" appears in this early account by the Rev. William Ellis who toured the island of Hawai`i in 1823:

> The snow on the summit of the mountain, in all probability, induced the natives to call it Mouna-Kea, (mountain white), or, as we should say, white mountain. They have numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit---as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit (Ellis 1979:292).

As already noted, the reference to Mauna Kea as the abode of the gods is emphasized in some native Hawaiian traditions in which the word "Kea" is taken to be an abbreviated form of Wakea, the male god who procreated with Papa to form the mountain. In an account of Queen Emma's trip to the lake in 1881 or 1882 and the mele that were written about that trip, Kihei and Mapuana de Silva present some more detail about the names of the mountain and the lake. They note, following Puakea Nogelmeier, that Emma's poets refer to the summit as Piko o Wakea and that:

> Although Maunakea is popularly translated as "white mountain," Kea is also an abbreviated form of Wakea, the sky father who, with Papa, the earth mother, stands at the apex of Hawaiian genealogy. Mauna Wakea is thus viewed traditionally as the sacred meeting point of sky and earth, father and mother, Wakea and Papa. Emma's poets were well-acquainted with the older name and its lasting significance; they refer to Waiau as "ka piko on Wakea"—as the mountain's navel/genital/umbilical/connecting-point/center (de Silva and de Silva 2007: footnote 7).

The name for the summit, which unlike many mountain summits does not consist of a single peak, is now widely accepted as Kūkahau`ula ("Kūkahau`ula of the red-hewed dew or snow") instead of the formerly used name Pu`u Wekiu. On present evidence the name Kūkahau`ula referred to both a legendary figure and to a character in traditional histories and genealogies. The latter includes references to Kūkahau`ula as the husband of Līlīnoe and as an *`aumakua* (family deity) of fishermen (Hibbard 1999). The place name evidence indicates that the "summit" was at the very least a legendary place or *wahi pana* (Pukui and Elbert 1971). Maly and Maly (2005:vi) give the name as Pu`u o Kūkahau`ula, which they say was "named for a form of the god Ku, where the *piko* of new-born children were taken to insure long life and safety. This practice is still participated in at the present time." According to Maly and Maly (2005:vi):

> The name Pu`u of Kukahau`ula is the traditional name of the summit cluster of cones on Mauna Kea, appearing in native accounts and cartographic resources until c. 1932. The recent names, Pu`u Wekiu, Pu`u Hau`oki and Pu`u Haukea, have, unfortunately, been used since the 1960s (since the development of astronomy on Mauna Kea), and have displaced the significant spiritual and cultural values and sense of place associated with the traditional name, Pu`u o Kukahau`ula.

The names Kūkahau`ula and Līlīnoe are both attributed to cinder cones in the summit region: Kūkahau`ula to the summit and Līlīnoe to a cone immediately to the southeast of the summit cluster. These names, along with that of Waiau, appear on the earliest reliable maps in 1884 and are repeated in the next survey of the summit region in 1892 by Alexander in 1892. Kūkahau`ula is given as the name of "the highest peak" even earlier in 1873 land boundary testimonies. Of all the place names in the summit region, these three are applied the earliest and most consistently to specific landmarks on the mountain. In compiling the 1892 map of Mauna Kea, W.D. Alexander refers to these as "genuine native names." The place name Poli`ahu appears in traditions and native testimonies as being applied to a trail, spring, pond, and cave, but it is not consistently applied to a single and identifiable landscape feature until 1892 when W.D. Alexander proposes attaching this name to "a nameless peak" in honor of the demigoddess, Poli`ahu, who appears in the tale of Laieikawai (McEldowney 1982:14; Table 2.1).

Some other place names date to the 1930s (Table 2.2). Gregory and Wentworth made a point of noting that they assigned names to cinder cones that did not have official names at the time (Gregory and Wentworth 1937:1725 footnote 14):

> As an aid in description, names have been adopted for the following cones not recorded on official maps: Puu Mahoe (Twin Cones), Puu Poepoe (Round Cone), Puu Hoaka (Crescent Cone), Puu Ala (Trail Cone), Puu Waiau (incloses Lake Waiau), Puu Kea (White Cone), Goodrich Cone (Joseph Goodrich, Hawaiian missionary, 1823), Macrae Cone (James Macrae, botanist of the *Blonde*, 1825), Douglas Cone (David Douglas, Hawaiian botanist, 1884), Summit Cone (highest point on Mauna Kea).

In a 1973 letter to Libert Landgraph, District Forester, L.W. Bryan wrote that he had obtained the following names from the "old Hawaiians" in the 1920s.

1. The summit cone, 13,796 is called Puu Wekei.
2. Goodrich cone is called Puu Hau Kea
3. Macrae Cone is known as Puu Hau Oki
4. Douglas Cone is called Puu Pohaku

He added that he had no objection to Pu`u Mahoe, Pu`u Ala and Pu`u Poepoe, but that "I wonder how Lake Waiau and Puu Waiau secured their names? Waiau is not descriptive of the lake. Hau Oki would be more applicable" (Bryan 1973). In a letter dated January 16, 1974 Robert Schmitt, Chairman of the Advisory Committee on Geographic Names, presented recommended changes in some place names, particularly those named after Europeans. He suggested that Puu Wekei be changed to Puu Wekiu because he could not find the word *wekei* in the dictionary whereas wekiu was included and translated as summit. He added that the Pukui and Elbert book on Hawaiian place names wrote Pu`u Hau Oki as Pu`u Hau`oki. Place names currently in use for localities and trails in the summit area are shown on Figure 2.13.

Waiau appears now to be the universally accepted name of the lake, rather than other names, such as Pond Poliahu, that appeared on the 1862 Wiltse map. Waiau, like other place names in the summit region, has been variously translated. In *A Dictionary of the Hawaiian Language*, published by Lorrin Andrews in 1865, Waiau was translated as "A place where water runs continually; water where one can always bathe" (Andrews 2003:513). According to Westervelt (1963:56), "The name Wai-au means water of sufficient depth of bathe." In an article published in *Paradise of the Pacific* in 1939, L. Bryan, a forester, remarked that:

> The name "Waiau" has several meanings, for example, "water to swim in." However, it is questionable whether much use was ever made of this water for swimming or whether this exact meaning was intended by the Hawaiians when they named it. It could mean, "the place of the water" (Maly and Maly 2005:257).

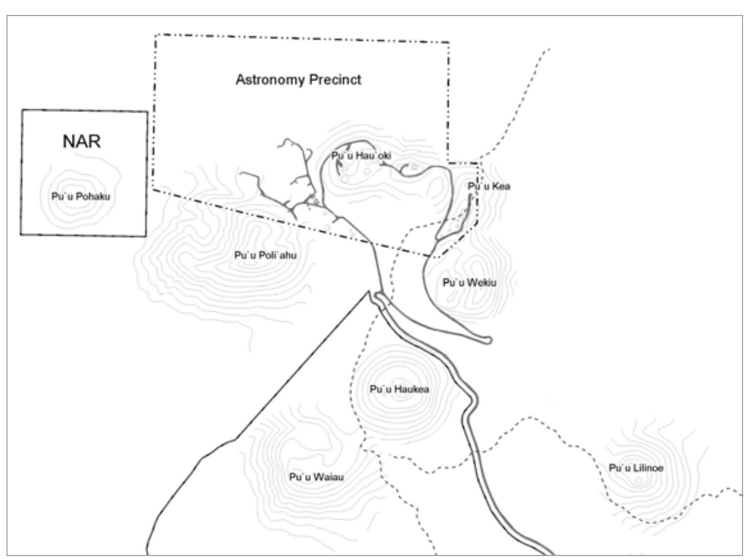
Table 2.1. Earliest Recorded Place Names for the Mauna Kea Summit Plateau Region.

					Within Summit Plateau	
Documentation	**Summit**	**Waiau and Lake**	**Poli`ahu**	**Adze Quarry**	**South Section**	**North Section**
Wiltse Map (1862)		Pond Poli`ahu	Pond Poli`ahu	Kaluahakai	Laimakeloa	Kamahakalau
Boundary Commission Book for Hawaii (1873)	Pu`u o Kūkahau`ula (highest peak)	Waiau (water in gulch)	Poli`ahu (on side of the mountain)	Kaluahaakoi (a cave … stone adzes)	Lanikepue (a pali)	Makanaka (a large ahu)
		Waiau (pond of water)	Poli`ahu (cave where Lilinoe lived)	Kaluakaakoi (two times)		Kamakahalau (a hill)
		Waiau (three times)	Poli`ahu (five times)			Kamakahalau (one time)

Table 2.2. Correlations Between Named Cinder Cones (and Peaks), Mauna Kea Quadrangle (modified after McEldowney 1982).

Map	Place Names of the Summit Region Cones (between 1884-1956)									Place Names of the Summit Plateau Region (between 1884-1956)								
1884-91 Lyons[1]	Summit Kukahau`ula						Waiau		Lilinoe								Kaupo Red Hill	White Hill Makanaka
1892 Alexander	Summit[2]	Mauna Kea		Poli`ahu[2]			Waiau	Waiau[2]	Lilinoe	Keonehehee[2]		Keanakāko`i					Red Hill Kaupo	Makanaka
1925-26 U.S. Coast and Geodetic Survey	Summit			Pu`u Poli`ahu			Lake Waiau	Waiau Crater	Lilinoe	Keonehehee[2]	Pu`u Ko`oko`olau	Keanakāko`i					Red Hill	Pu`u Makanaka
1928 U.S.G.S.	Summit	Mauna Kea		Poli`ahu		Peak B	Waiau Astrom. Station		Lilinoe	Keonehehee							Red Hill	Makanaka
1937 Gregory and Wentworth		Puu Kea	Macrae Cone	Pu`u Poliahu	Douglas Cone	Goodrich	Lake Waiau	Pu`u Waiau	Pu`u Lilinoe	Keonehehee[2]		Keanakāko`i	Pu`u Mahoe	Pu`u Poepoe	Pu`u Ala	Pu`u Hoaka		Pu`u Makanaka
1956 U.S. Geological Survey	Puu Wekiu[3]	Puu Kea	Puu Hauoki[3]	Pu`u Poli`ahu	Pu`u Pōhaku[3]	Puu Hau Kea[3]	Lake Waiau	Puu Waiau	Pu`u Lilinoe	Keonehehee[2]	Pu`u Ko`oko`olau	Keanakāko`i	Pu`u Mahoe	Pu`u Poepoe	Pu`u Ala	Pu`u Hoaka	Red Hill	Pu`u Makanaka
Currently Used Place Names	Kukahauula	Pu`u Kea	Pu`u Hau`oki	Pu`u Poli`ahu		Pu`u Haukea	Lake Waiau	Pu`u Waiau	Pu`u Lilinoe	Pu`u Keonehehee	Pu`u Ko`oko`olau		Pu`u Mahoe		Pu`u Ala			Pu`u Makanaka

[1] Some place names and accompanying notes on this map appear to have been written at different times and/or by different people. These variations are in keeping with the map's title (i.e., Information Map) and time span given on the label, but they raise the possibility that names from different time periods were added.
[2] Names reported by Alexander to be "genuine native names" with the exception of Poliahu. He attached the name Poliahu to this "nameless peak" in honor of the "demi-goddess" who appears in the "Legend of Laieeikawai." In Alexander's table, the highest peak is listed as Kukakauula, although this name does not appear on his 1892 map (Preston 1895:596).
[3] Names given to L.W. Bryan "by the old Hawaiians in the early 1920"s (Schmitt 1974a).



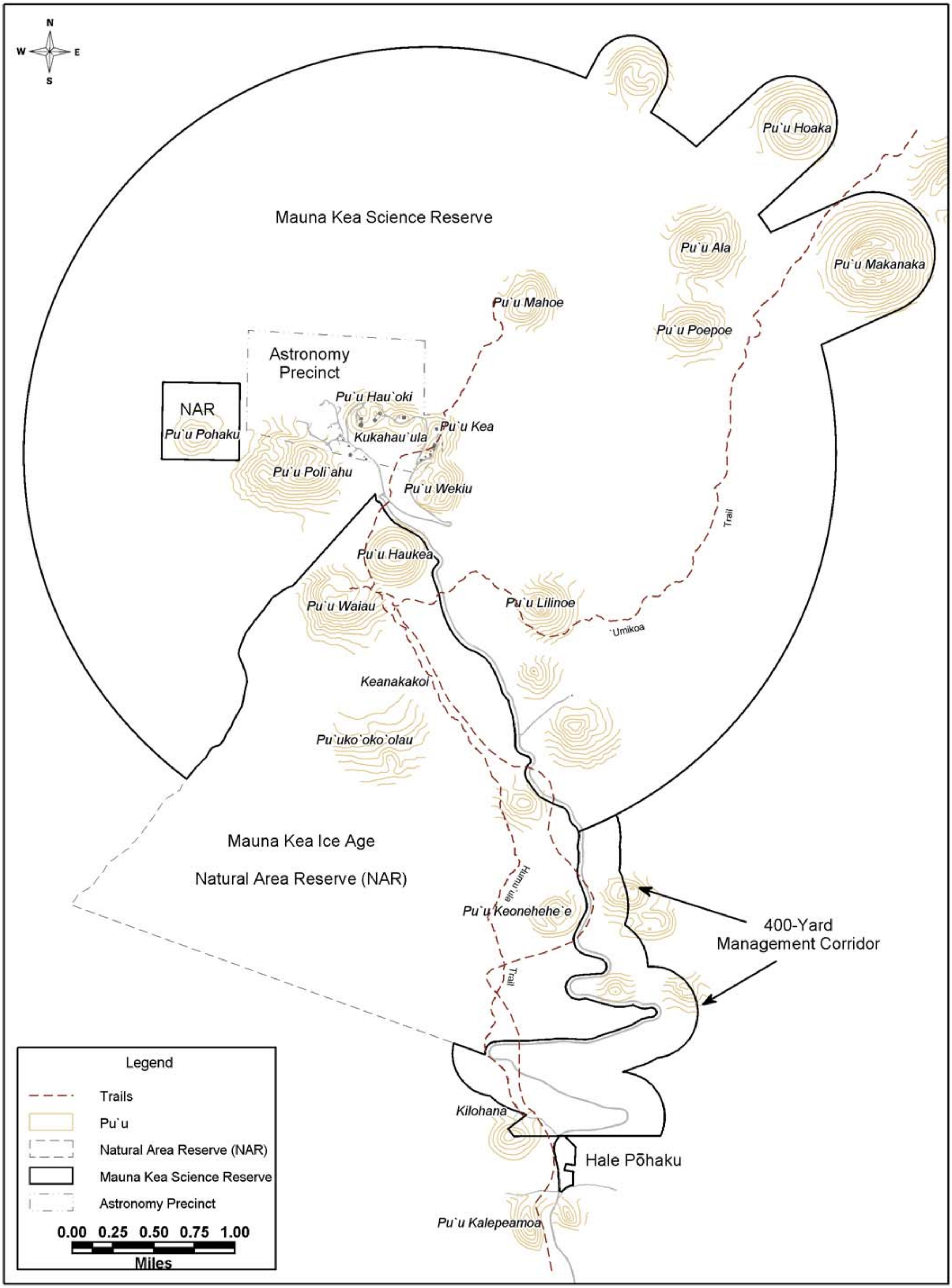


Figure 2.13 Place Names Currently in Use for Localities and Trails in the Summit Region of Mauna Kea.

According to Pukui and Elbert (1986:377) Waiau means “swirling water of a current.” Maly and Maly (2005:vi) give the following account of Waiau:

> **Waiau**, named for the mountain goddess, Waiau (Ka piko o Waiau), and home of the *mo`o* (water-form) goddess Mo`o-i-nanea. Place where piko of newborn children were taken to ensure long life; and from which “ka wai kapu on Kane” (the sacred water of Kane) was collected. These practices are still participated in at the present time.

Charles Langlas, who conducted a traditional cultural property assessment of Mauna Kea, commented on the cultural significance of the lake:

> Taken together, Lake Wai`au and Pu`u Wai`au which contains it are the best attested specific ritual site at the top of Mauna Kea. Kupuna X was taught that the water of the lake had *mana* and was used traditionally to purify and heal. The newspaper story noted by the Kanahele’s about Queen Emma bathing in the lake water to gain spiritual power in her competition with David Kalakaua bears out the Hawaiian belief in the *mana* of the lake. Kupuna X and Kupuna Y both describe it as a place where children’s naval cords were placed, with the ritual purpose of giving the children long life. Belief in the spiritual power of the lake and ritual activities connected with it go back in time to the time of their great-grandparents and before. The use of the name Waiau goes back at least to the nineteenth century. The name Waiau [presumably Wai`au] was given by elderly Hawaiians testifying to Boundary Commission in 1873 and was given by Alexander in 1892 as a “genuine native name” (McEldowney 1982: 14, Table 1.2). Protection of the lake’s *mana* is still important to Kupuna X, who indicated that individuals who entered the lake carelessly could contaminate its *mana* (Langlas 1999:9-10).

Below Lake Waiau and west of Pōhakuloa Gulch, are three named springs – Hopukani, Waihu, and Liloe. None of the springs are listed in *Place Names of Hawaii* (Pukui, Elbert, and Mookini 1974). The names of all three springs first appeared on the 1927 U.S.G.S. Ahumoa Quadrangle (1:31,680) topographic map. On this same map there is a second locality labeled Waihu, a short distance below Liloe Spring. This may be a general place name since there is a similar name (Waiku) in the same area on the 1911 edition of the United States Coast and Geodetic Survey map of the island of Hawai`i. According to the Ka-Miki legends translated by Maly the proper name of Waihu Spring is Ka-wai-hu-a Kane as noted in the following account:

> …at that time, the guardians [Pohakuakane and Pohakuloa] saw the water rippling, and overflowing from the spring. As they went to investigate, they saw a shadow pass them. Because of the overflowing of the water, the spring came to be called Ka-wai-hu-a-kane (The-overlowing-waters-of-Kane), and so it remains named to this day [Figure 6]. It overflowed because Ka-Miki scooped the water, filling the `awa bowl of the god (Maly and Maly 2005:47).

Maly (1999: D-26) notes variations of Hopukani, including Houpo-o Kane and Ka-houpo-o-kane. Maly (1999:D-26) added, “Interestingly, at Ka-haupo-o-kane are found the waters of Pohakuloa, Hopukani, and Waihu (also known by the name “Ka-wai-hu-a Kane.”

2.3 Chronological Summary of Land Use and Other Practices and Beliefs

For the purposes of this report the culture history of the Mauna Kea summit region, has been arbitrarily divided into two time periods: (1) the Pre-Contact Period (pre-1778); (2) the Post-Contact Period. Continuing cultural practices and beliefs are summarized in a separate section.

2.3.1 Pre-Contact Period

While there is good reason to believe that the summit region was known to early Hawaiians because of the probable desire to investigate the snow-capped mountain, the only activity that is known with certainty to have occurred in the pre-contact period is the manufacture of stone adzes. Radiocarbon dates on wood charcoal and 230 Thorium dates on branch coral indicate that the adze quarry was in use over a period of possibly as much as 700 years between ca. A.D. 1100 and 1800 (McCoy 1986:Figure 28; 1990:Figure 4), although a shorter chronology of perhaps just 500 years now seems more likely. When the quarry was abandoned is unknown and may never be known with any certainty, but there is some evidence that it may have occurred as late as European contact in 1778 or shortly thereafter.

An interesting account of the adze quarry was published by Brigham at the turn of the 20th century:

> Let us climb to the workshop of the adze maker. All these were in high places, and one on Mauna Kea, Hawaii, was nearly 12,900 ft. above the sea. As good clinkstone was not found in many places the known quarries hardly exceeded half-a-dozen. On Hawaii was the most important of all, that on Mauna Kea, where the workmen could only work in favorable seasons for the snow frequently covered the quarry, but from the immense quantity of fragments and chips the work must have extended over many generations; so far as known, this was the earliest quarry exploited, and it is puzzling how the place was discovered when we consider the aversion the Hawaiians had to even visiting those high, bleak and desert regions, the supposed abode of spirits not always friendly. It is possible that the tradition which speaks of the survivor of the deluge of Kahinalii grounding on Mauna Kea and following the receding waters to the lower levels, discovering the koi pohaku on the way, may point to the considerable antiquity of adze-making in this place, but I am inclined to believe that all traditions of the Hawaiian deluge date after the coming of the Spanish discoverers. It has always seemed strange that the axe-makers did not bring the raw material down to their homes and work it up in comfort instead of freezing in their kapa garments at this great altitude. It may be that the mystery of the place and its very solitude kept the trade in few hands and so enhanced the value of a tool that so many must have (Brigham 1902:75-76).

Brigham's account, though lacking documentation of some of the information presented, is nevertheless of great interest for a couple of reasons, including: (1) the reference to a legend connected with the discovery of the source; (2) the general agreement between the legendary evidence and the immense quantity of waste material in pointing to a quarry of great antiquity compared to the few others known at the time; (3) the reference to the aversion of Hawaiians to high desolate places and the discomfort of working under such conditions, and (4) the possible link between environmental conditions and the labor component of the production process and the probable influence this had on the value of a tool that as he so neatly puts it "so many must have." The quarry and Brigham's interpretations of it are discussed in more detail in Sections 5-7.

2.3.2 Post-Contact Period

Changes to the traditional Hawaiian lifestyle began soon after the arrival of Captain James Cook in 1778. One significant change was the rapid adoption in the major trading centers and nearby communities of Western tools, clothing and other items, initially by the chiefs and then the common people. The impact on traditional technologies is known in a general way from historic accounts, such as diaries and newspapers, but for remote centers of traditional crafts, such as the Mauna Kea Adze Quarry, there is little or no information on how long they continued to be utilized before abandonment.

The first recorded ascent of Mauna Kea by a European was made by the Rev. Joseph Goodrich on August 26, 1823 (Goodrich 1833:200). A number of visits followed shortly thereafter, including ones by such prominent figures as the renowned botanist David Douglas (see Maly and Maly 2005 for a comprehensive overview of early visits and expeditions to the top of Mauna Kea). Macrae mentions that Goodrich found a "heap of stones" on a cinder cone which many have interpreted as located on the summit. Macrae's description suggests a cinder cone at a lower elevation on the edge of the summit plateau:

> Rev. Joseph Goodrich, who, on this occasion, was unfortunately laid up with mountain sickness, had on 26th August, 1823, reached the summit of Mauna Kea. This is the first recorded instance of the ascent of this mountain, although Mr. Goodrich mentions that on reaching the top of one of the terminal cones that encircle the main plateau of Mauna Kea, he discovered a heap of stones, probably erected by some former visitor. Who this former visitor was is unknown, but he was probably one of the white men that in the early years of the nineteenth century got a living by shooting wild bullocks that roved on the side of Maunt Kea. It is very unlikely that any native had reached the top of the terminal cones on the summit, owing to being unprovided with warm clothing to resist the great cold and also to the fact that the natives had a superstitious dread of the mountain spirits or gods. About six months after the date of the first ascent of Mauna Kea by Mr. Goodrich, the peak was scaled by Dr. Abraham Blatchley and Mr. Samuel Ruggle, both connected with the American Mission (Macrae 1922:55).

There are other early references to the building of cairns on the "summit," including one by Jarves in 1844:

> My companions, not having seen the snow, disbelieved the guide's statement the evening previous, and started themselves to seek the summit. Having ascended the hill which the guide had pointed out, they found another arising two hundred or more feet above that, which, after great labor, they scaled. These hills are composed of loose sand, into which one slips knee deep at every step. The second one was frozen hard. This was found to be the highest point; it was covered with slag, lava, and gravel. The snow, or rather ice, lay in chasms, in a few spots, in masses ten feet deep, fourteen wide, and three hundred long...Having piled a cairn, as a memorial of their success, they returned in all haste to the camp (Jarves 1844:228).

Kamehameha, in the company of Kekuhaupi`o, is reported as having made an offering close to Lake Waiau (Desha 2000:94; Maly and Maly 2005:50). Of the many people that made the arduous ascent of the mountain in the 19th century, the trip made by Queen Emma in 1881 or 1882 is one of the best known (de Silva and de Silva 2007). The Queen Emma trip, which was made on horseback, started at Mānā in Waimea.

From there the party rode to Kalaieha [the name for the area occupied by the Humu`ula Sheep Station] where the night was spent before riding to the summit the next day. Mary Kalani Ka`puni Phillips, a descendant of W.S. Lindsey, one of the guides that accompanied the Queen, has written that:

> Queen Emma rode on the back of Waiaulima, and he swam around Waiau pond at Mauna Kea. And then he lifted Queen Emma, and carried her to a rocky place. The people were amazed to see Queen Emma's on-the-back swim, and they returned and told the mo`olelo to us (de Silva and de Silva 2007:3).
>
> The historical record of pilgrimages to Maunakea is not limited to Emma's mele and Phillips's mo`olelo. Steve Desha writes, that as a young man, Kamehameha Pai`ea went to Waiau to pray and leave an offering of `awa. Kamakau tells us that Ka`ahumanu made the same journey in 1828 in an unsuccessful attempt to retrieve the iwi of her ancestress Lilinoe. Kauikeaouli visited Waiau and the summit in 1830, Alexander Liloliho in 1849 and Peter Young Ka`eo in 1854 (de Silva and de Silva 2007:5).

As the summit area of Mauna Kea became better known to the public, it also began drawing the attention of scientists toward the end of the 19th century. The first major scientific study was conducted at Lake Waiau in 1892. W.D. Alexander, Surveyor General of the Kingdom and E.D. Preston, an astronomer with the U.S. Coast and Geodetic Survey, organized an expedition that is sometimes referred to as the "Pendulum Survey Party" because of Preston's objective of making pendulum and meteorological observations. A number of other individuals participated in the Pendulum Party survey which is described in detail in Maly and Maly (2005). The Alexander party found a cairn on the summit, which may have been the one described by Jarves in 1844:

> On Monday, the 25th, the thermometer stood at 20 deg. at sunrise. Messrs. Muir and Alexander ascended the second highest peak on the northwest, overlooking Waimea, 13645 feet height to continue their survey. In the cairn on the summit a tin can was found, which contains brief records of the visits of five different parties from 1870 to the present time, to which we added our own. A party of eight girls from Hilo, "personally conducted" by Dr. Wetmore and D.H. Hitchcock, Esq., in 1976, must have been a merry one. Cpt. Long of H.B.M.'s Ship Fantome had visited this spot in 1876, and Dr. Arning with several Kohala residents in 1885 (Alexander 1892).

The early 20th century for all practical purposes marked the beginning of a new era in the land use history of Mauna Kea. Large numbers of wild sheep were devastating the forests below the summit in the early part of the century. The extent of the devastation was the impetus for a monumental fencing program undertaken by the CCC in the 1930s. The CCC was also engaged at the same time in improving roads and building facilities for visitors. In 1936 the CCC made improvements to what is believed to have been a section of the old Mauna Kea-Humu`ula Trail, from near the Humu`ula Sheep Station at Kalaieha to the summit (Bryan 1939:11). According to Bryan (1939:11), the first stone cabin, from which Hale Pōhaku takes its name (Hale Pōhaku- "House of Stone'), was built by the CCC about this same time. Prior to the construction of a road above Ho`okomo, the cabin at Hale Pōhaku provided a convenient overnight rest spot for hikers and ski enthusiasts (McCoy 1984c:8).

Beginning with the Alexander survey party in 1892, Lake Waiau was used as a base camp by scientists. The geologist, Herbert Gregory, for example, camped at the lake on August 5-6, 1921 and spent some additional time there on July 23, 1926. The

1925-26 USGS mapping team also camped at the lake (Kilmartin 1974). In addition to research, Mauna Kea continued to attract the curious and even resulted in the formation of an organization called the Mauna Kea Association, Limited as described in the following account:

> At the highest point, an elevation of 13,825 feet, a mound of rocks is built, and in this a can lines that contained lists of the names of those who, in recent years, had climbed the mountain, and deposits of silver money made toward a fund for a monument there, and divers [sic] articles, the leaving of which had suited the taste and fancy of the depositor. One had left a small compass, another a bunch of sulphur matches, another a brass button, another a penny.
>
> We copied the names of those who had been there before us, and left our own and gave each of a bit of silver the Summit Monument. Then we be-though ourselves that as the sum in the can had reached the amount of $4.05, it was time some steps were taken looking to the carrying out of the purposes of the contributors. And so we then and there perfected the organization of the Mauna Kea Association, Limited, and elected Joseph G. Pratt, president, Eben P. Low secretary and collector, and A.L.C. Atkinson treasurer. The amount of the collection was turned over to the treasurer, and it was determined that any person who has made the ascent of Mauna Kea, the highest point in the Hawaiian Islands, shall be eligible for membership upon proof that he has been on top of the mountain, and that each member contributing to the monument fund shall receive a certificate stating the date of his ascent and acknowledging the amount of his contribution (Anonymous, Mid-Pacific Magazine 1911:408).

In 1935 the Hawaiian Academy of Science organized the first multi-disciplinary scientific expedition to Mauna Kea. The expedition included specialists in a number of different fields, including the team leader, Chester Wentworth. With the assistance of the U.S. Army, the expedition established three camps. The Humu`ula Sheep Station was the main base camp. Above that was the Ho`okomo Ranger cabin. The uppermost camp was at Lake Waiau which was occupied between July 30 and August 21, 1935. An unpublished account of the expedition, titled *The Mauna Kea Expedition of 1935: Hawaiian Academy of Science*, by Chester Wentworth, John Coulter and Constance Hartt, is on file at Bernice P. Bishop Museum. A popular account of the expedition, *Mauna Kea Here We Come*, was published by one of the members, Ed Bryan, in 1979.

On August 12, 1935 several members of the Hawaiian Academy of Science Expedition took part in the first and perhaps only radio broadcast from the summit. The event is briefly described in Ed Bryan's booklet:

> In the morning Raine and Downing had taken the radio to the top and Downing had set up and operated the first radio station on the top of the Pacific. Six messages were sent and one received. The set was worked for approximately one hour and then carried back to Lake Waiau. The trip took one hour, each of the two carrying about forty pounds of equipment. Thinking that it would be a good time to test the merits of the Pep Caramels, a few of them were taken along but chewing them interfered with breathing so that no comprehensive tests could be made (Bryan 1979:33-34).

The description of this highly momentous event was recorded on film by Raine, who photographed Downing sitting on a stool beside a stone cairn on which was placed the radio equipment. The photographs of this cairn (Bryan 1979:35) indicate that this is Site 21209 (see description in Volume 2).

Gregory and Wentworth commented on the high probability of unrecorded visits to the summit and a greater knowledge of the upper mountain area in the late 19th century:

> There have doubtless been many unrecorded visits to the summit of Mauna Kea since Goodrich's time. Indeed, it is probable that fifty or more years ago, when ranch operations were of relatively greater importance and the old Makahalau-Keanakolu trail was in general use as a route from Kawaihae and Waimea to Hilo, the upper slopes of the mountain were more generally known to the residents of Hawaii than they are today (Gregory and Wentworth 1937:1722).

Construction of the Saddle Road, begun in 1943 for what would become the Pōhakuloa Training Area, was extended after World War II. The completed road, which linked Hilo and Waimea, provided easier access to the south side of Mauna Kea. The first road to the summit of Mauna Kea was completed in 1964. The first astronomy facility, the Lunar and Planetary Station located on the summit of Pu`u Poli`ahu (Group 70 International 2000: Figure IX-1), was opened in July of 1964. Improvements to the original jeep road in the 1970s made access to the mountain top much easier, resulting in more public and commercial activities and as a consequence, conflicts between different public user groups.

2.3.3 Continuing Cultural Practices and Belief

Cultural practices and beliefs involving Mauna Kea have been changing since the arrival of the earliest Polynesian settlers, an evolutionary process that continues today. Absent a written language, Hawaiian practices and beliefs were originally recorded in chants and oral histories that were passed on from generation to generation for over 1,000 years. The earliest written records of native Hawaiian beliefs and practices were created by European explorers and settlers in the late 18th century.

The arrival of European and Asian settlers also marked the beginning of wide-spread changes in cultural practices and beliefs throughout much of Hawai`i. Because of the evolutionary nature of cultures and beliefs, current cultural practices and beliefs involving Mauna Kea are diverse. Over the last 200 years, many practices have been modified or abandoned altogether as non-Hawaiian religious and cultural practices were introduced to the islands.

A variety of cultural and religious beliefs and practices pertain to and are occurring on the mountain today. Whereas some traditional and customary Hawaiian practices and beliefs have survived and have gained wider practice in recent generations, other traditional and customary cultural practices and beliefs appear not be in practice. In addition, recent archaeological and ethnographic studies of Mauna Kea show that contemporary practices and beliefs have developed based on modern beliefs or have evolved from a traditional practice or belief. The difficulty in thoroughly documenting cultural practices is increased by the reluctance of some cultural practitioners to describe their practices and beliefs to researchers.

Traditional and customary cultural practices and beliefs have been defined as "those beliefs, customs, and practices of a living community of people that have been passed down through generations, usually orally or through practice" (Parker and King 1998:1; PHRI 1999:1). Traditional and customary cultural practices and beliefs contribute to the maintenance of a community's cultural identity and demonstrate historical continuity through the present. This is demonstrated through actual practice or through historical documentation of a practice or belief, including both written and oral historical sources (Parker and King 1998:1; PHRI 1999:2).

Contemporary cultural practices and beliefs have been defined as “those current practices and beliefs for which no clear specific basis in traditional culture can be clearly established or demonstrated – for example, the conducting of ritual ceremonies at sites or features for which no such prior traditional use and associated beliefs can be demonstrated. In some cases, however, it may be possible to demonstrate the reasonable evolutionary development of a contemporary practice from an earlier traditional practice” (PHRI 1999:3).

2.3.3.1 Religious Beliefs and Practices

At the time of Contact, Hawaiian cultural and religious practices were inseparably intertwined as were many other activities. When describing the organization, structure and lifeways of traditional societies, it is important to remember that the terms used today, such as religion, economics and politics, are modern analytical constructs.

Ranging from Euro-American explorers and missionaries journal accounts to early native Hawaiian historians like David Malo, Kepelino, and S.M. Kamakau, and to later 19th and 20th century ethnologists, there is rich documentation of religious ceremonial and ritual life throughout the islands (Valeri 1985:37-44). Indeed, prior to and following significant undertakings, such as battles, dance, voyaging, the cultivation and harvesting of crops and fish, apprenticeship training, and the manufacture of tools or structures, etc., rites marked by offerings or sacrifices occurred. Propitiatory offerings were made to *`aumakua*, or family gods, and *akua* to avert disasters, like famines, volcanic eruptions and disease, or to ensure the coming of rain, success in crop fertility and fish harvest bounties, or victory in battle.

Following European contact, increasing numbers of Hawaiians converted to Christianity, while restrictions were placed upon traditional religious observances. As a result, traditional oral histories and written documentation of historic religious practices and any associated beliefs on Mauna Kea remain virtually non-existent. Because Ka`ahumanu abolished the *kapu* system in 1819 and imposed restrictions on certain traditional Hawaiian religious practices in the post-Contact period (Kamakau 1961:307, 322), in all likelihood, the voices of those practitioners were silenced, or perhaps simply muted, with traditional knowledge being passed on covertly. It is possible that close proximity to missionary settlements and Christian-converted chiefs may have, to a greater degree, influenced decline in traditional religious practice. In areas further removed from Christian centers, where new religious teachings had less appeal, traditional religious practices may have continued (Barrere et al. 1980:34).

Aside from Ka`ahumanu’s restrictions, it has also been suggested that it may be culturally inappropriate for practitioners to speak aloud of their ceremonial or ritual practices and beliefs. As Jess Hannah points out when asked about the presence of *heiau* or burials upon Mauna Kea, “those days…if they know about them…they don’t talk about `em. Even Alex [Bell], he knew ‘em all, they had something here and there, but they would never pin ‘em down. You couldn’t pin point it. Something about how they were brought up or raised, it was bad luck or hard luck to talk” (Maly and Maly 2006:A-437,438). Likewise, when Johnny Ah San was asked about burial locations on Mauna Kea, he revealed that “you take those Hawaiians, they were superstitious, and they hardly want to talk about that” (Maly 1999:A-75).

Nevertheless, modern-day oral history interviewees explain their knowledge, as well as an unfortunate lack thereof, concerning the presence of and meaning of *ahu* and burials in the summit region. And cultural practitioners also describe their knowledge of and beliefs surrounding the following contemporary religious practices - *kūahu* (family shrine) erection, the scattering of cremation remains, *piko* deposition in Wai`au, pilgrimage, offerings, and prayer.

2.3.3.2 Construction of Ahu and Kūahu

Although the archaeologically-documented presence of *ahu* and *kūahu* within the summit region of Mauna Kea indicates religious observances of various kinds in the Hawaiian past, no knowledge regarding the traditional practices and beliefs associated with these structures exists today. In the early post-Contact period, the existence of *ahu* on Mauna Kea are reported – however, information is unavailable concerning their traditional function, be it ritual, ceremonial, or otherwise. In the 1880s – 1890s, two surveyors, J.S. Emerson and E.D. Baldwin, independently denoted various *ahu* located upon *pu`u* in the lowlands surrounding Mauna Kea and the presence of “a pile of stones on the highest point of Mauna Kea” (Maly and Maly 2005:494-502, 505).

It is of interest that the word *kūahu*, a more obscure and presumably older term for one kind of Hawaiian shrine (the *ko`a* or fisherman’s shrine is another), does not appear in any of the early accounts. By the post-contact era it appears that *kūahu* was no longer in common use, as opposed to *ahu*, a word with many meanings. Morphologically, *ahu* are a pile or mound of stones, yet in the functional sense, *ahu* may have served historically as altars or shrines, or as markers signifying burial locales, *ahupua`a* boundaries, or trail routes. When Thomas Thrum visited Haleakala on Maui in the 1920s, he reports that *ahu* functioned as trail and way marks, memorials of traveling parties, land boundaries, burial markers, or tributes to deities (Thrum 1921:259). While Emerson and Baldwin certainly confirm the presence of *ahu* as they are defined morphologically, the surveyors do not specifically speak to the functional meanings of the *ahu* on Mauna Kea.

Likewise, oral history interviewees reveal that they have heard of or have seen the presence of *ahu* on the summit plateau and on the Mauna Kea summit (Orr 2004:47; Maly 1999:A-134, -372; Maly and Maly 2006:A-183, -335, -349, -565). Yet, little information is available about the particularities of traditional religious observances practiced in association with the *ahu*. Libert Landgraf states that he had “no idea whether they were trail markers or a grave site or something else” (Orr 2004:47). Pualani Kanaka`ole Kanahele discloses that she does not know if *ahu* “represent these *ahupua`a* markers…or whether they are actually *kūahu* (altar) or *ahu* for different families that lived in that mountainous area…or if it had to do with *konohiki* (land overseers) that were in charge of a particular *ahupua`a* and so this family went there to mark the upper regions…they could also be new ones” (Maly 1999:A-372). On the other hand, Kealoha Piscotta offers up the following explanation of the significance of *ahu* – “some of the shrines mark the birth stars of certain *ali`i*…and also birth and death” (Orr 2004:47).

Piscotta is the only cultural practitioner to describe a contemporary attempt to maintain a *kūahu* (family shrine) on Mauna Kea, which was undermined by repeated destruction and removal of the shrine. It is significant to note that in 1870 Kamakau wrote that “it was not right to trespass on someone else’s altar” (Kamakau 1964:96). This statement is the only indication of a traditional cultural practice that regulated people's access to *kūahu* and *ahu*. Piscotta explains that she erected the *ahu*, which consists of a stone from her family, on Mauna Kea because as an employee of one of the observatories, "I thought I would put it where I'm going all the time. And also it was very beautiful and I was always attracted to that place. I prayed at that place all the time" (Orr 2004:52). Piscotta's contemporary cultural practice of erecting *kūahu* represents continuity of a traditional practice, except that she imported her upright stone rather than selecting a local stone.

In 1998 the Royal Order of Kamehameha I erected a *lele* (altar) on the summit. In the last decade the *lele* has been extensively modified. Several years ago it was dismantled and then rebuilt in a new form. Figure 2.14 illustrates how the *lele* looked in 1999 and 2005.

2.3.3.3 *Piko* Beliefs and Practices

The cultural weight that Mauna Kea carries within the Hawaiian community is also evident in the phrase, "*piko kaulana o ka `āina*," which translates as "the famous summit of the land" and is used as a term of endearment (Maly 1999:A-3). However, the phrase also expresses the belief that the mountain is a *piko* (the navel, the umbilical cord) of the island and for this reason it is sacred (Maly 1999:D-20). In this context, the significance of the cultural practice of transporting and depositing a baby's *piko* on Mauna Kea may be better understood. Pualani Kanaka`ole Kanahele explains the symbolic importance of this practice, saying that:

> the *piko* is that part of the child that connected the child back to the past. Connected the child back to the mama. And the mama's *piko* is connected back to her mama and so on. So it takes it back, not only to the *wā kahiko* [ancient times], but all the way back to Kumu Lipo…So it's not only the *piko*, but it is the extension of the whole family that is taken and put up in a particular place, that again connects to the whole family line. And it not only gives *mana* or life to that *piko* and that child, but life again to the whole family (Maly 1999:A-376).

Other Native Hawaiian cultural practitioners illustrate that for some families the practice of *piko* deposition on Mauna Kea is a long-standing traditional cultural practice. In 1956, Kaleohano Kalihi revealed that his grandfather had taken a gourd container "the *piko* of Mauna Kea. The place of the *punawai* [spring]…" which had been filled with 40 *piko* from "all of the people that had been born into this family" (Maly 1999:A-1). Kahili also mentioned that until he took the *piko* to Lake Waiau, his grandfather had "taken care of" those *piko*. Another practitioner, Elizabeth 'Tita' Lindsey Kimura, describes being a *piko* caretaker for her family – "I still have some of her *piko* that she [her mother] collected. Not collected, but when she goes to my sisters that have babies and the *piko hā`ule* [a *piko* that has fallen off], she'd pick it up and bring it home. …yes, I have it in the *`ōmole* [bottle]…And I'm waiting for somebody to go up to Mauna Kea with it" (Maly and Maly 2006:A-217). One of Kimura's relatives, Irene Loeyland Lindsey-Fergerstrom, also confirms that she took her children's *piko* and the *piko* of her one of her relatives up to Mauna Kea (Maly 1999:390).

These cultural practitioners also provide insight into the proper means of placing the *piko*. Irene Loeyland Lindsey-Fergerstrom recalls that "we put the *piko* in a little cotton and put 'em in a bottle. And sometimes it's hard to come out, so *kūkū* [grandmother] Laika said all you do is take the cover off and put it on the ground and it

Figure 2.14. Photographs Showing *Lele* (altar) on the Summit Erected by the Royal Order of Kamehameha.

will just deteriorate" (Maly 1999:A-392). Also, when Lindsey-Fergerstrom took *piko* to Mauna Kea, her husband "dug a little hole and put the *piko* in…the summit" (Maly 1999:A-391). Elizabeth 'Tita' Lindsey Kimura relates that her mother "was very particular…you don't just *hana kapulu* [to act carelessly or slovenly]…you got to treat it with respect" (Maly and Maly 2006:A-217). Kimura also says that the reason for taking the *piko* up to Mauna Kea is that the mountains is "neat" and "clean," practitioners "don't want any *kapulu*…in the discarding of the *piko*" (Maly and Maly 2006:A-217). It is clear that maintaining cleanliness and purity is an important component in this cultural practice. Kealoha Piscotta explains that in light of some practitioners belief that Lake Wai`au has become polluted, she fears that "people won't put the *piko* of the baby in there it it's polluted" (Orr 2004:45).

There were many reasons for hiding the *piko* of newborn babies. One was to ensure a long life. Another was to avoid the person from growing up as an irresponsible adult. There is a well known Hawaiian proverb concerning *piko*--*He piko pau `iole* which translates as "*an umbilical cord taken by a rat*." Pukui interpreted the proverb to mean:

> A chronic thief. The umbilical cords of infants were taken to special places where the cords of other family members were kept for many generations. If a rat took a cord before it was hidden away safely, the child became a thief (Pukui 1983:96).

2.3.3.4 Burial

Today, numerous oral history interviewees reveal that they have knowledge of burials located at a number of *pu`u* dotting Mauna Kea's western and eastern slopes, including Ahumoa, Kemole, Papalekoki, Mākanaka, Kihe, Kanakaleonui, Kaupō, and Pu`u O`o (Maly 1999:A-22, -48, -75, -165, -250, -279, -351, -395, -397).

Some cultural practitioners explain practices that relate to ancient family burials atop the mountain. Alexander Kanani`alika Lancaster reveals that he and his family members went up to Mauna Kea "for ceremonial. They go up there bless the whole mountain for all our ancestors who's buried up there…the old folks always said, 'Our family is up there'" (Maly 1999:240). As no documentation exists on traditional cultural practices relating to ancient Mauna Kea burials, it is unknown whether blessing ceremonies would be considered a traditional cultural practice or a contemporary cultural practice.

Other cultural practitioners reveal that they have participated in the practice of scattering the cremated remains of loved ones from atop Mauna Kea. It is noteworthy that cremation was not a common practice in traditional Hawaiian culture, and when it was done it was a punishment and meant to defile the dead person. Writing in the 1830s, native Hawaiian historian David Malo stated that "the punishment inflicted on those who violated the tabu of the chiefs was to be burned with fire until their bodies were reduced to ashes" and that cremation was practiced on "the body of anyone who had made himself an outlaw beyond the protection of the tabu" (Malo 1951:57, 20). In recent years, noted Native Hawaiian historian and ethnologist Mary Kawena Pukui explains why cremation was a defilement – "if the bones were destroyed, the spirit would never be able to join its `*aumakua*" (Pukui et al. 1972:109).

The cultural practitioners who express participation in cremation-related cultural practices on Mauna Kea include Toshi Imoto, Tita Elizabeth Kauikeōlani Ruddle-Spielman, and Kealoha Piscotta. Imoto explained that in 1954, he and six others ascended to Mauna Kea's summit, where *paniolo* Eben Low's ashes were scattered from an *ahu*, which is described as an old survey marker. It is also noteworthy that at the time Low's ashes were scattered, a commemorative cement plaque was placed at Lake Waiau in Low's honor (Maly 1999:25-26). Ruddle-Spielman, who happens to be the granddaughter of Eben Low, explained that in 1969, she and her family members scattered her parents' cremation ashes from the Mauna Kea summit (Maly 1999:273-274). Kealoha Piscotta also revealed that she brought her aunties' ashes to Mauna Kea (Orr 2004:52). Finally, Theodore "Teddy" Bell says that he wants his ashes to be scattered from the mountain (Maly and Maly 2006:A-293).

Undoubtedly, the scattering of cremation ashes today is a contemporary cultural practice that has taken the place of traditional interment practices. But debate ensues over whether this practice has evolved from traditional practices and beliefs or whether it is a new practice based on modern customs and beliefs. Pualani Kanaka`ole Kanahele explains that while the scattering of cremation remains on Mauna Kea may be viewed by some as non-traditional, she counters that notion saying: "it may not be the *iwi* [bones] itself, but the ashes are the essence of what is left of the *iwi*. It doesn't matter, it's going back" (Maly 1999:A-377). On the contrary, in 1970, a woman identified solely as Kolokea C. testified before the Hawaiian Culture Committee of the Queen Liliuokalani Children's Center that when her brother died, she intended to have his body cremated. However, she was told by her 73-year old great-great-grandaunt that "cremation was *puhi i ka iwi* [bone burning]" and that cremation was an expressly prohibited by Kolokea's great-great-grandfather. This auntie recommended burial in the ground or at sea instead, as with a cremation "the body will be without peace." In the end, Kolokea C. decided to bury her brother (Pukui et al. 1972:106-107). Ms. Kanahele explains that cremation is an evolutionary development of a contemporary practice from an earlier traditional practice, whereas Kolokea C. concluded that cremation was non-traditional in learning of the traditional prohibitions of this practice.

2.3.3.5 The Spiritual Resonance of Mauna Kea: Modern Pilgrimages to Chant, Pray and Make Material Offerings

In public testimony before the Mauna Kea Advisory Committee, Ed Stevens ascribed Mauna Kea's spiritual significance to the fact that it is the highest point in Polynesia. Stevens states the mountain is significant "because it was considered to be the gateway to heaven. When the ancient *kāula* (priests, prophets) made their treks to the summit, it was to be nearest to *akua* where prayers could be offered in the highest reverence" (Maly 1999:C-10).

Instances of the cultural importance of Mauna Kea are related in several pilgrimages made to the mountain by royalty to partake in ceremonial practices in the post-Contact period. During the reign of Kamehameha I, fearing dissension amongst some of his chiefs, in the company of Kekuhaupi`o, the king is reported to have traveled to Mauna Kea to make a ceremonial offering close to Lake Waiau (Desha 2000:94 in Maly and Maly 2005:50). In 1881 or 1882, Queen Emma ascended Mauna Kea and at Lake Waiau, she swam across the lake, riding on the back of Waiaulima (de Silva and de Silva 2006 in McCoy and Nees 2008; Maly and Maly 2005:158; Maly 1999:A-4, -5, -387). Queen Emma's swim across Waiau was a cleansing ceremony initiated in an effort to prove her genealogical connection to Wākea and Papa (Kanahele and Kanahele 1997:9 in Maly 1999:D-21).

In addition, some oral history interviewees reveal seeing offerings left on Mauna Kea in recent times. Libert Landgraf recalls seeing *pu`olo* (offerings) left at Lake Waiau and on the summit of Mauna Kea, which he describes as "a gift or something wrapped in *ti* leaves. My feeling of that is it has cultural, I don't want to go out on a limb and say religious, but it has a significant cultural significance…someone is taking a gift or presentation to a particular area" (Orr 2004:51). Other interviewees, including Rally Greenwell, Hisao Kimura, Coco Vredenburg-Hind, and Daniel Kaniho Sr., testify that they either saw or had heard that *`opihi* shells were present in the Mauna Kea adze quarry (Maly and Maly 2006:A-37, -215; Maly 1999:A-118, -260). Archaeologists theorize that because these *`opihi* shells are too few to be interpreted as the remains of food consumption activities; it is more likely that they were offerings to the *akua* (McCoy 1990:108).

Other oral history interviewees demonstrate the spiritual resonances of Mauna Kea in the following statements:

> Libert Landgraf – "I looked at sites, the area, as the church. …In this instance maybe the summit of Mauna Kea represents to us what the church is, and the individual sites or the individual platforms is the altar" (Orr 2004:49).
>
> Kealoha Piscotta – "This is a really hard issue for Hawaiian people, because Hawaiian people have really no temples. [They're] in the state or national parks....So Mauna Kea represents one of the last kind of places where the practice can continue. …But for Mauna Kea, it's not a temple built by man. It's built by Akua…" (Orr 2004:49).
>
> Pualani Kanaka`ole Kanahele – "If you want to reach *mana*, that [the summit] is where you go" (Maly 1999:A:372).
>
> Pualani Kanaka`ole Kanahele – "Mauna Kea was always *kūpuna* [an elder, ancestor] to use. …And there was no wanting to go on top. You know, just to know that they were there…was just satisfying to us. And so it was kind of a hallowed place that you know it is there, and you don't need to go there. You don't need to bother it. …And it was always reassuring because it was the foundation for our island" (Maly 1999:A:366).
>
> Florence La`i-ke-aloha-o-Kamāmalu 'Coco' Vredenburg-Hind oral history – "I don't think I could live anywhere else. I feel like it's right, I belong to the dirt, the soil….It just like they protect all of us. These mountains protect us" (Maly 1999: A-117, 120).
>
> Alexander Kanani`alika Lancaster – "My grandmother…she said, 'When you go up there, you going feel the spirit.' And you do feel the spirit" (Maly 1999:A:234).
>
> Tita Elizabeth Kauikeōlani Ruddle-Speilman – "Yes the *mana* is there. There is no question" (Maly 1999: A-286).

Clearly, these statements demonstrate that Mauna Kea continues to be viewed as a realm of great spiritual and sacred importance, a belief rooted in Hawaiian tradition.

2.3.3.6 Collection of Water for Healing

Little documentation exists that Hawaiians sought to collect water or snow in ancient times, yet Lloyd Case says that "they went there because that mountain has the power to heal and it still does…I've heard of the old ones getting water from Waiau to use for healing…" (Maly 1999:A-353). Presently, cultural practitioners engage water and snow collection for ceremonial/medicinal purposes. Regarding the waters on the mountain, Anita Leilani Kamaka`ala Lancaster and Alexander Kanani`alika Lancaster explain that their family uses the "sacred water" of Waiau for baptisms (Maly 1999:A:246). And Kealoha Piscotta states that "its for medicine…all of these waters" (Orr 2004:45). However, concern surrounding the purity of Lake Waiau is also a factor influencing the contemporary practices of Lake Waiau water collection and snow collection on Mauna Kea. Some cultural practitioners believe that effluent from the observatories enters the aquifer and has caused the green coloration of Lake Waiau's water. Although scientific studies disprove the theory that effluent has in fact leached into the aquifer, Kealoha Piscotta states that "we are not really trusting to take the water for the medicine anymore" (Orr 2004:45). Piscotta states that because she is unsure about the purity of the Waiau waters, she gathers snow instead. In her words, "the snow along this ridge in here and by the lake, is what I was told is the snow to collect. It's powerful snow…" (Orr 2004:51).

2.3.3.7 Adze Manufacture

The manufacture of stone adzes made from discarded preforms left by ancient Hawaiian adze makers or from unmodified pieces of raw material in the Mauna Kea Adze Quarry is a practice occurring today, about which relatively little is known, however. One reason is that the collection of material from the quarry, a large part of which is located in the NAR, is not a permitted activity under the NAR rules. The collection and use of material from the quarry thus tends to be clandestine.

Cultural practitioners also have different beliefs concerning the appropriateness of using material from the quarry for adze manufacture and whether this activity should be taking place at all. For instance, Lloyd Case does not believe adze collection should take place whatsoever. Case states:

> I think that what ever is there should stay there. Because not only would it be a resource that people can go and see, what the old Hawaiians did and how things were. But if you take everything off of that mountain, and people keep taking things, you have nothing to show for our past (Maly 1999:A-352).

On the other hand, Hannah Springer believes that if it can be demonstrated that the quarries lack potential for archaeological analysis, adze quarrying could be permitted. She expresses that she does not know how access could or should be regulated, but expects that if it were stipulated that practice be done in a traditional manner, not many individuals would engage in quarrying. Springer says:

> Should there be fresh mining? I don't know if there's information that can still be extracted from the fragments that remain from past work done there. If already there has been tremendous removal of material, how valid is the data that remains? What sort of picture would we get from analysis of it? I cannot answer that. If it has relatively low value maybe we would want people to continue to mine an already tapped source. Hundred and eighty degrees away from that, I can't imagine how many people would make the effort if they had to go *kālai* [carve or cut] the *pōhaku* [stone]. So that might be self regulation, right there. To identify and designate an area where people could go. And again I don't know how you determine who's authentic to go up there (Maly 1999:A-310).

Pualani Kanaka`ole Kanahele believes that adze quarrying should be permitted, but only if those quarrying can demonstrate a genealogical tradition of adze quarrying. She says:

> I have two *mana`o* [opinion, thought] for that. One is, an old site should be approached...it depends on what you are taking it for. I can only say, 'Yes, take it if I see that you bring down the *ko`i* [adze] and you use it for something.' It has to be functional for you, and not just a show piece or something that you want to use commercially. …So I am thinking that if you would go to an old place to mine the *ko`i*, then you need to show some kind of genealogy where your *kūpuna* also had that kind of function. So if your *kūpuna* were some kind of *kālai ki`i* [carvers of images] or *kālai wa`a* [canoe makers] or had some kind of function with the *ko`i*, if you have that…Because then it would make us stronger to know that you still have that and that you still continue this in some form. …So it's not like saying, 'Oh you cannot, first you have to show us your genealogy.' No. 'Show us what your genealogy is because that makes you stronger, that makes us stronger, that brings *mana* to the place.' That it is still being continued by the *mo`opuna kuakāhi*, *kualua*, *kuakolu* [the great; great great great; and great great great grandchildren] of this *kūpuna* (Maly 1999:A-373-374).

Modern-day adze collection and quarrying can be considered a traditional cultural practice that has been modified to include the use of contemporary methods and tools (such as steel rock hammers).

2.3.3.8 Navigation/Orienteering

Kepā Maly notes in his collection of archival documentation on traditional practices that no specific references to *kilo hōkū* (observing and discerning the nature of the stars) upon Mauna Kea are present (Maly and Maly 2005:95). Maly speculates it is likely that *kilo hōkū* was practiced upon the mountain, as the gods and deities associated with the mountain are also embodied in the heavens, but such accounts are absent from the historical literature (Maly and Maly 2005:95). Libert Landgraf also says that he has "no personal knowledge of it," but he suspects "that it probably was a very good observation [point]" (Orr 2004:55). Lloyd Case says that he believes a platform, which he believes to have been a "navigational *heiau*" was present on the Mauna Kea summit. He states that "before the observatories were there, they had one when all the stones were piled up, kind of similar to some of the *heiau* at Mahukona" (Maly 1999:A-349).

In contrast to Maly's statement that there is an absence of evidence of traditional Hawaiian astronomical observations, cultural practitioner Kealoha Piscotta believes that "the lake [Wai`au] is like the navigation gourd," a concept which she learned from her auntie (Orr 2004:45). According to Piscotta, her auntie also instructed her to go to the lake and when she did, Kealoha says "I could see clearly why she wanted to look into the lake. Because when you look into the lake, the whole heavens are reflected in it and it's just like the gourd that they carry on the canoe with the water and the *ane ane*" (Orr 2004:45).

Piscotta states that *mo`olelo* passed down from her auntie describe solstice alignments with Mauna Kea, thus she believes that the solstices were marked from the Mauna Kea summit. Piscotta emphasizes that she does not doubt the validity of *mo`olelo*, but she is interested in understanding how the solstice alignments work. Thus, she has concerns that the view plane from Mauna Kea has been diminished and obstructed by the leveling of *pu`u* and the erection of observatory domes (Orr 2004:54-

55). Piscotta reveals the importance of the solstice alignments by stating that "if you do not measure the solstice and the equinox, you cannot keep track of the sacred time. And if you don't know what year you're at, you don't know part of the *wā* or the epic period you're in, so you don't know where you are in the prophesy either" (Orr 2004:58-59). It is noteworthy that not only is Piscotta interested in validating traditional Hawaiian astronomy techniques, she also holds a degree in physics and has worked as a telescope systems specialist at a Mauna Kea observatory.

On a similar note, Tita Elizabeth Kauikeōlani Ruddle-Spielman conveys the significance of the Mauna Kea view plane, but as a landscape viewed from the sea. She says:

> It was so important when we used to go fishing with uncle Francis, I used to go with him. From Keawaiki. When we started out, he'd say 'Now watch the *pu`u* on the mountain.' And we'd go out, and that was my job to watch the *pu`u* as we went along. And as soon as a cloud came down to that certain *pu`u* we'd turn around and go right home again, because he knew that the ocean would change. It was anywhere that we went, whether we were going towards Kona or coming this side towards Kohala. He said 'You watch that *pu`u* and as soon as you see the clouds hug it, or heading towards it, let me know, because we are turning around and going home.' And he never failed. ….No, it was on the side, the slopes [not the *pu`u* near the summit, but on the slopes]. But he knew, and sure enough, by the time we got home, that wind would change, but we had gotten home safely. ...that is very important, this whole idea of line of sight, cultural landscape. So not only is it important close up on top, but as viewed from afar (Maly 1999:A-282).

2.3.3.9 Hunting

There is no evidence that hunting in the summit region was a traditional cultural practice. Available information indicates that it was not until the late 19th century and throughout the 20th century, following the introduction of numerous non-native ungulate species such as bullock (cattle), goats, and sheep, that hunting for subsistence and for sport began on Mauna Kea. Following the Māhele, livestock was deemed the property of the King and the government, although private parties could apply for license to own and brand livestock (Maly and Maly 2005:270). Interestingly, government correspondence dating from 1850-1856 shows that illegal hunting activity by individuals was becoming problematic (Maly and Maly 2005:270-273).

In 1861, a legal dispute over hunting rights led to the decision that no hunting activities could take place on Mauna Kea, except for individuals who acquired leasehold interests in the mountain lands or who gained special permission to hunt (Maly and Maly 2005:274-277). In the years that the forested slopes of Mauna Kea were controlled by cattle ranching operations, Jess Hannah contends that one benefit of being employed as a ranch hand lay in one's ability to practice subsistence hunting. He says, "If you go hunting that was the main benefit because guys could go hunt pig, sheep, and all that. You could always eat" (Maly and Maly 2006:A-428). Dave Woodside, a former government naturalist, concurs and explains that it was only after the World War II era that public hunting on Mauna Kea lands was permitted. This managed hunting policy was developed in part because non-native goats and sheep were adversely impacting the forests and in part because individuals interested in sport and subsistence hunting organized to gain the right to hunt (Maly and Maly 2006:A-323-326). Indeed, Lloyd Case explains the importance of subsistence hunting to many ranch families, "a lot of my brothers and the old timers like David Hogan Kauwē, when they went out hunting, it was basically a hunt where each family took home so much of the meat so that everybody had meat" (Maly 1999:A-345).

Based on all available evidence, subsistence hunting, within the UH management areas on Mauna Kea is a contemporary cultural practice that has evolved from non-Hawaiian traditions.

3.0 PREVIOUS ARCHAEOLOGICAL RESEARCH AND CULTURAL RESOURCE MANAGEMENT STUDIES IN ALPINE AND SUB-ALPINE ZONES ON MAUNA KEA

A number of research and cultural resource management (CRM) studies have been undertaken in the alpine and sub-alpine zones of Mauna Kea. The two zones essentially correspond to the ecosystems above and below tree line, which varies between roughly 9,200 and 9,500 ft amsl. The majority of the studies have been CRM projects conducted in areas managed by the University of Hawaii (UH) for astronomical research. The CRM studies that have been conducted for the UH management areas include:

1) archaeological surveys and mitigation projects;

2) traditional cultural property assessments;

3) cultural impact assessments;

4) preparation of a burial treatment plan; and

5) preservation and cultural resource management plans.

CRM studies have also been undertaken west of Pōhakuloa Gulch at Hopukani, Waihu, and Liloe Springs.

In contrast to the long history of geological research on Mauna Kea the only area that has been the subject of problem-oriented archaeological research is the Mauna Kea Adze Quarry Complex which encompasses parts of the NAR, the Science Reserve, and the Mauna Kea Forest Reserve in the vicinity of Hopukani, Waihu and Liloe Springs and elsewhere on the south flank of the mountain. The overview of CRM and problem-oriented research that follows is organized primarily by modern administrative units. In some cases there is an overlap between two or more administrative units. There are also a couple of studies that covered a larger area of the mountain, including one traditional cultural property assessment and two preservation/management plans covering all three UH management areas. These are discussed separately.

The history of archaeological investigations in each of the primary administrative units and management areas are described below. Figure 3.1 is an index map showing the series of maps for each of the administrative units that follow (Figures 3.2-3.5).

3.1 MAUNA KEA SCIENCE RESERVE

The first systematic archaeological investigations in the Mauna Kea Science Reserve were carried out in 1975-76 in the context of a National Science Foundation funded research project on the Mauna Kea Adze Quarry (McCoy 1977, 1990; Cleghorn 1982; Allen 1981; Williams 1989) (see Figure 3.2; Table 3-1). The primary research objectives of the 1975-76 Mauna Kea Adze Quarry Project as originally conceived were to:

1) develop a technological model of adze manufacture based on a characterization of techniques, stages, and activity pattern variability within and between sites in the quarry complex;

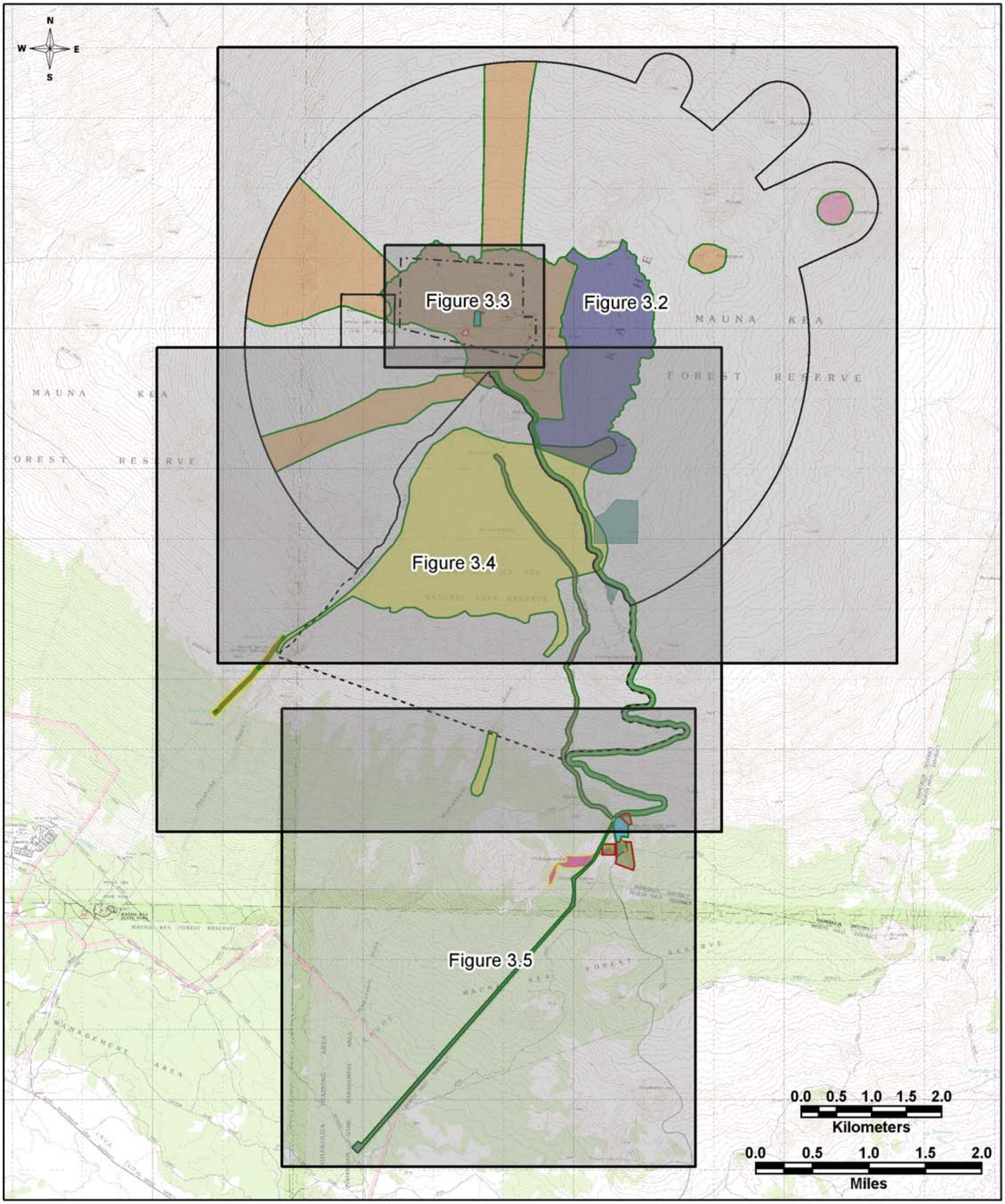


Figure 3.1 Index of Maps Showing the Location of Previous Archaeological Investigations in the Alpine and Sub-Apline Zones on the South Flank of Mauna Kea.

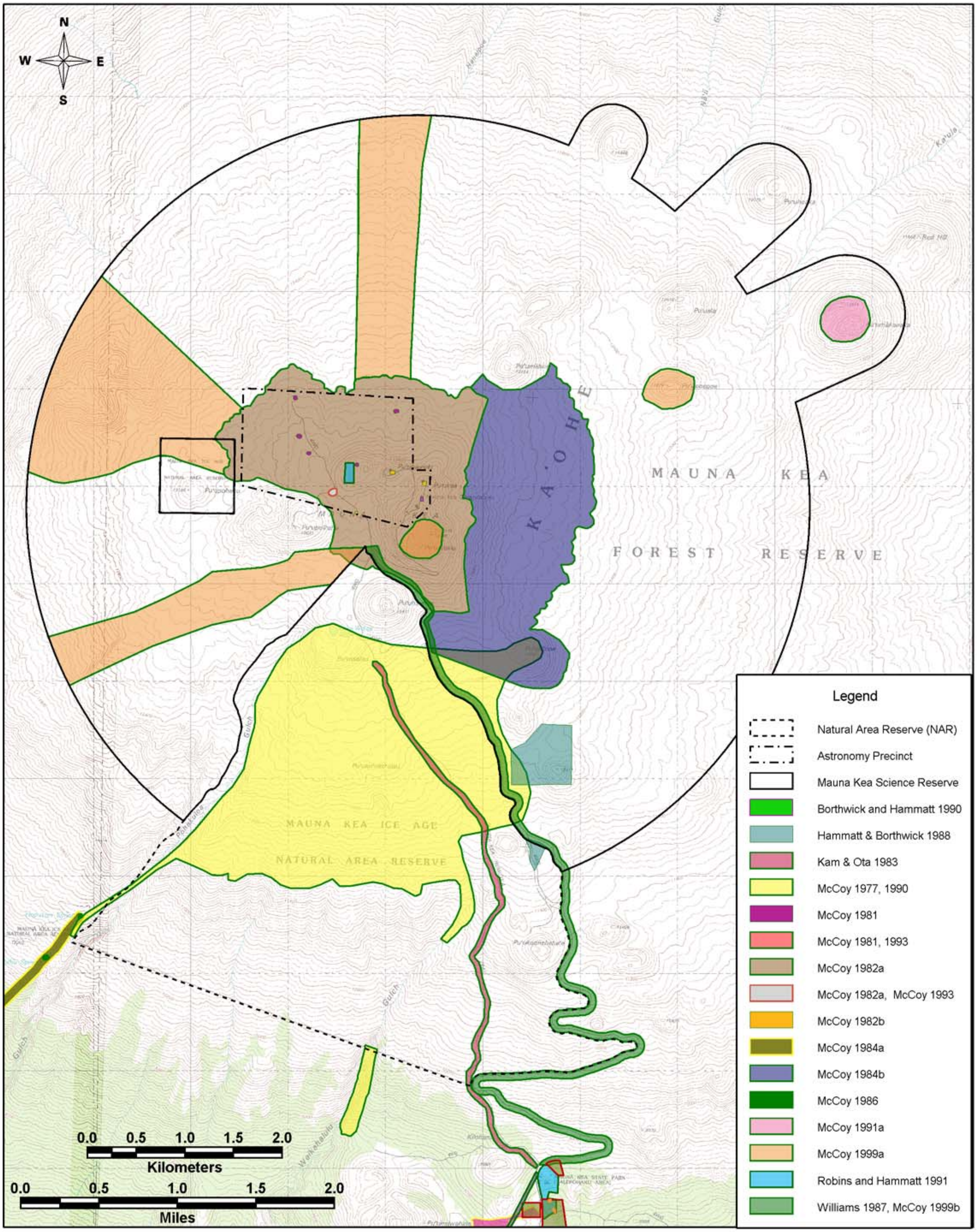


Figure 3.2 Locations of Previous Archaeological Surveys in the Mauna Kea Science Reserve.

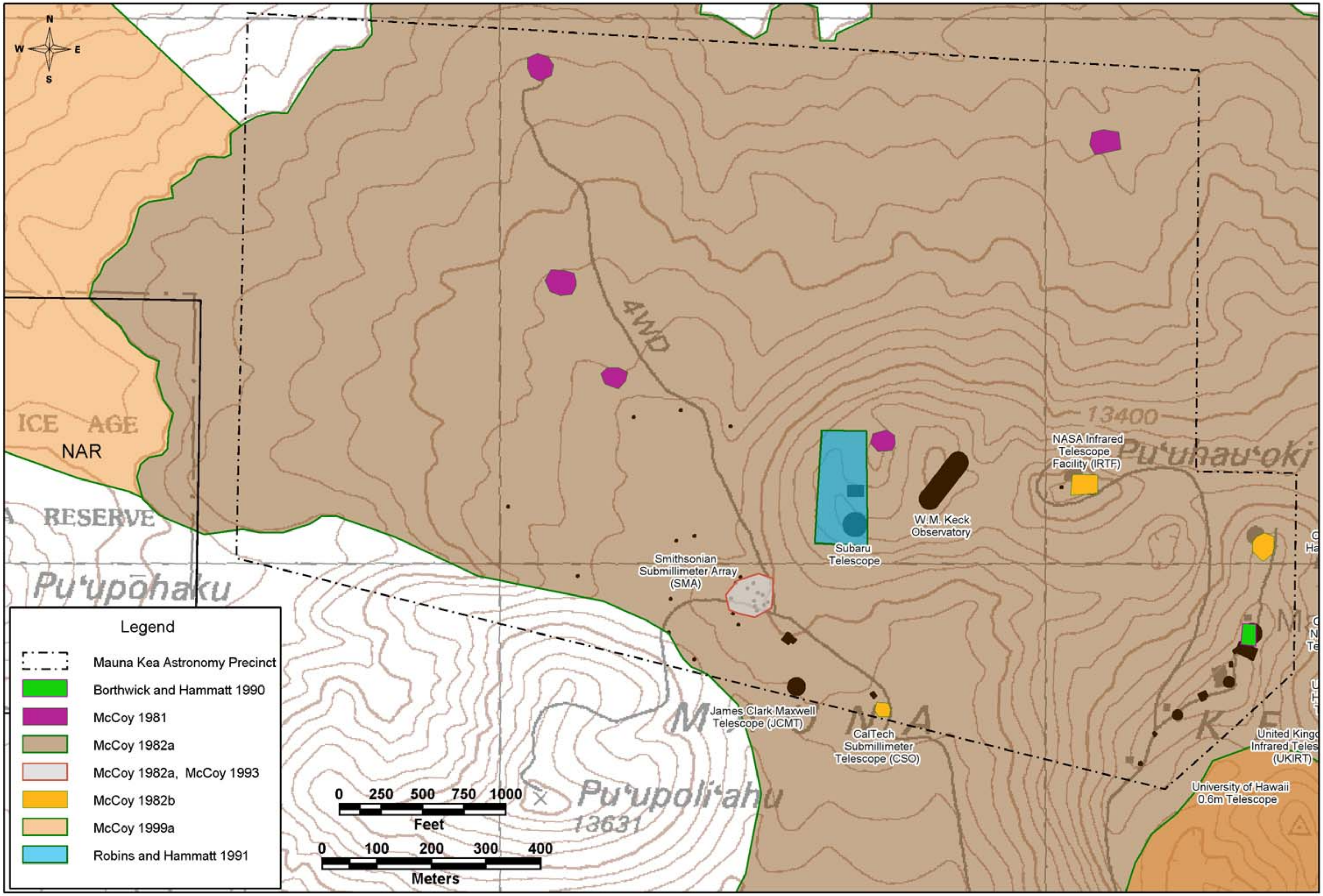


Figure 3.3 Locations of Previous Archaeological Surveys of Observatories, Telescopes and Arrays in the Astronomy Precenct Portion of the Science Reserve.

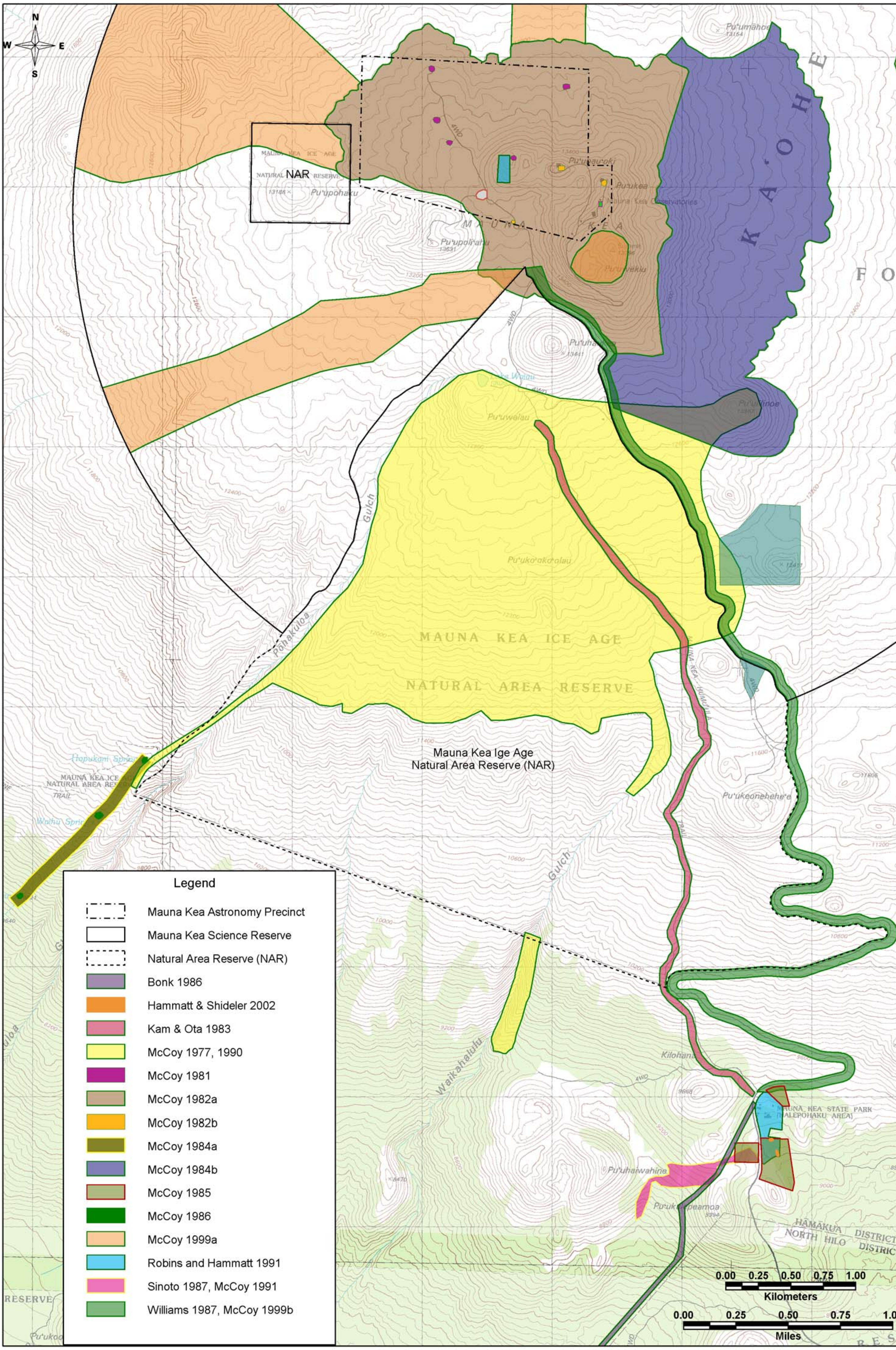


Figure 3.4 Locations of Previous Archaeological Research and Data Recovery Projects in the Natural Area Reserve, alont the Mauna Kea Access Observatories Access Road and in the Hopukani, Waihu and Liloe Springs Area.

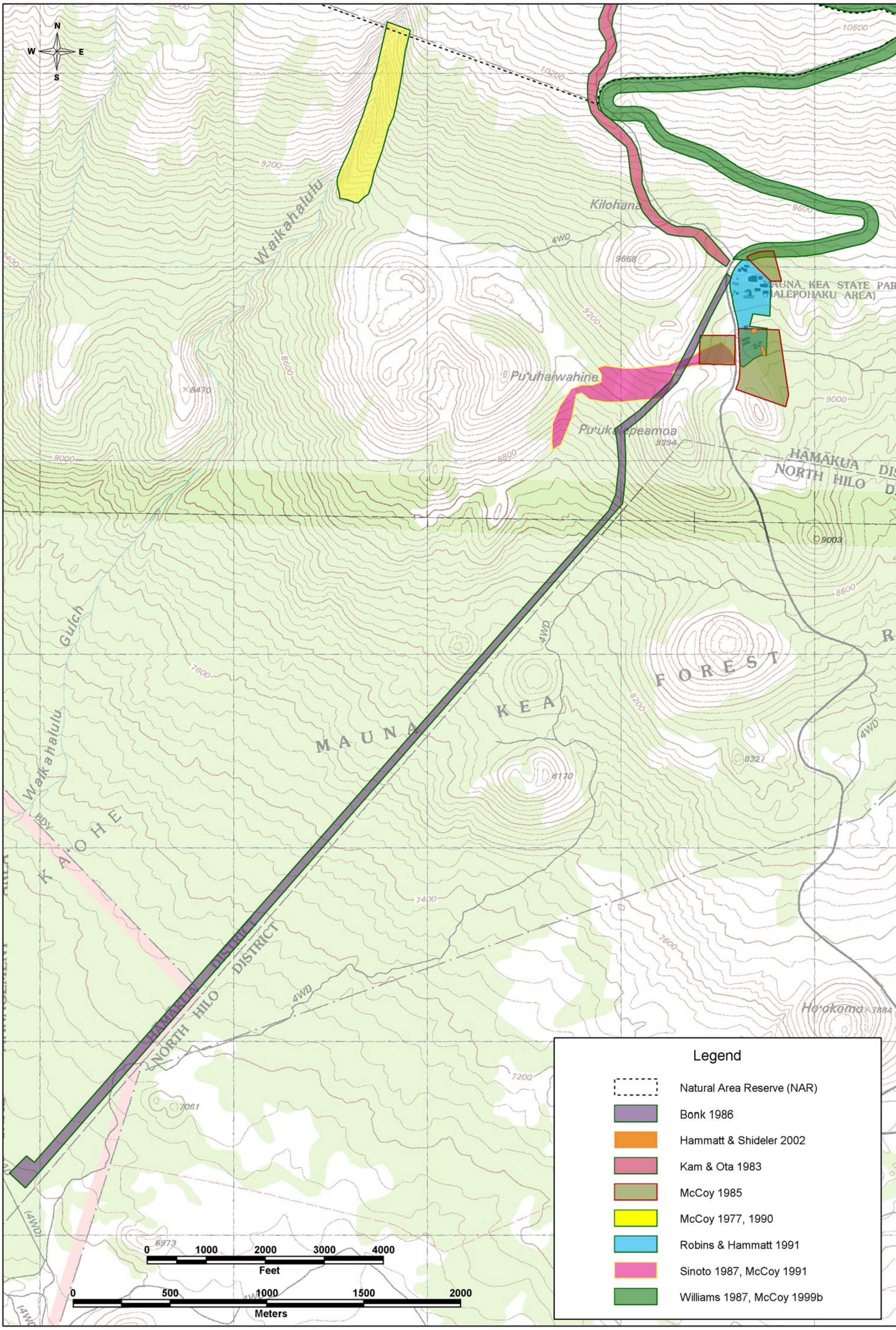


Figure 3.5 Locations of Previous Archaeologicial Surveys and Data Recovery Projects in the Hale Pohaku Area.

Table 3.1. Summary of Previous Archaeological Surveys in the Mauna Kea Science Reserve and Number of New Sites Recorded

Year	Project	Survey Type	New Sites	Reference
1975-76	NSF Research Project on the Mauna Kea Adze Quarry	Reconnaissance and inventory	3	McCoy 1976, 1977; Cleghorn 1982
1981	Kitt Peak National Observatory	Reconnaissance	0	McCoy 1981
1982	Hawaii Institute for Astronomy	Reconnaissance	21	McCoy 1982a and McEldowney 1982
1982	Caltech Telescope	Reconnaissance	0	McCoy 1982b
1983	Mauna Kea Observatory Power Line	Reconnaissance	0	Kam and Ota 1983
1984	NSF Grant-in-Aid Survey	Reconnaissance	19	McCoy 1984
1987	Summit Road Improvement	Reconnaissance	0	Williams 1987; McCoy 1999
1988	VLBA Telescope	Reconnaissance	2**	Hammatt and Borthwick 1990
1990	Subaru Telescope	Reconnaissance	0	Robins and Hammatt 1990
1990	Gemini Telescope	Reconnaissance	0	Borthwick and Hammatt 1990
1991	Pu`u Mākanaka	Reconnaissance	1	McCoy 1999a
1995	SHPD site relocation and GPS recording	Reconnaissance	17	McCoy 1999a
1997	SHPD transect survey	Reconnaissance	31	McCoy 1999a
1999	SHPD survey of Pu'u Wekiu	Reconnaissance	1	McCoy 1999a

Note: Three previously identified sites (16183, 11076 and 11078) were deleted from the inventory during the work undertaken by the State Historic Preservation Division in 1995. A reassessment of Site 16183, recorded in 1982 as an open-air shelter with modern rubbish on the floor (McCoy 1982), convinced us that the walls are also modern. Site 11076 had been previously recorded in 1975 and 11078, a rockshelter, showed no evidence of modification or use. The number of sites found in the 1997 survey include two that are just outside the Science Reserve boundaries. These were left out of the count used in McCoy (1999a), which referred to a total of 93 sites.

2) provide new data on chronological changes in Hawaiian adze types, and

3) determine the relationship of this particular quarry industry to other forms of economic specialization and the development of socio-political complexity (McCoy 1976, 1986:7).

A reconnaissance survey undertaken in 1975 to determine the boundaries of the quarry, a National Historic Landmark, found one site just inside the Science Reserve boundaries on the eastern side of the summit road, between the ca. 12,250 and 12,300 ft elevations (see Figure 3.2). The site (BPBM Site No. 50-Ha-G28-1; State Site No. 50-10-23-16204) as defined at the time, using the site definition criteria employed in the quarry project, consists of five shrines, 25 open-air enclosures (shelters) and a diffuse lithic scatter of adze manufacturing by-products (McCoy 1977, 1999b). Two other sites were found in the Science Reserve in the 1976 field season, which involved more intensive survey and site recording. One site (BPBM Site No. 50-Ha-G28-38; State Site No. 50-10-23-16163) is a shrine with a diffuse scatter of flakes located on a ridgetop at the ca. 12,880 ft elevation. The second site (BPBM Site No. 50-Ha-G28-76; State Site No. 50-10-23-16195) are the remains of two stone mounds on the rim of Pu`u Līlīnoe. These would appear to be the remnants of the burial interment features noted by W.D. Alexander's survey party in 1892.

On June 2, 1981 the Bishop Museum conducted an archaeological reconnaissance survey of five locations on the north slope of the mountain that were under consideration as sites for the proposed Kitt Peak National Observatory data-collecting stations. Each of the alternative facility sites (see Figure 3.3) which were only generally located on a map, was inspected and found to be devoid of historic sites (McCoy 1981).

The first major survey in the Science Reserve was conducted by the Bishop Museum over 5 1/2 days between July 12 and 17, 1982 for the Hawaii Institute for Astronomy (IfA) and encompassed roughly 1,000 acres of land on the summit and northern slope of the mountain, down to the ca. 13,000-ft elevation (see Figure 3.1). Few, if any, archaeological sites were predicted to occur within the boundaries of the project area, given the high altitude location and presumed absence of exploitable resources, including adze-quality stone, which was believed to be restricted to the south slope of the mountain. A total of 22 sites were recorded in this survey (McCoy 1982a). For field purposes, all but one site, an open-air shelter, were classified as "shrines," earlier defined by Buck (1957:527) as "a convenient term to designate a simple altar without a prepared court." The open-air shelter, which contained modern debris, was later deleted from the historic places inventory because of the belief that it is a modern feature. The number of historic properties found in the 1982 survey has thus been changed to 21.

The 1982 project also included ethnographically-oriented archival research on a variety of topics, such as land use patterns, place names, and practices in the summit region of Mauna Kea (McEldowney 1982). A survey of the Caltech Telescope site was conducted at the same time as the larger survey. No sites were found within the proposed project area, but two sites were found in close proximity (McCoy 1982b).

In 1983 SHPD conducted a reconnaissance survey of a proposed underground power line from Hale Pōhaku to the summit (see Figure 3.5). The survey, which did not identified any historic properties, was undertaken before the final alignment had been determined, however.

Archaeological survey of the Science Reserve was resumed in 1984 by the Bishop Museum with the support of a National Historic Preservation Grant-in-Aid. The 1984 survey (see Figure 3.2), which was carried out over a period of 6 days between July 23 and 28, was aimed at completing an inventory of archaeological remains on the east-southeast flank of the mountain adjoining the proposed northern boundary of the Mauna Kea Adze Quarry (McCoy 1978). The survey strategy and methodology were the same as those employed in the 1982 fieldwork. A total of 20 new, dispersed and aggregated sites was recorded in the survey (McCoy 1984b), which covered ca. 1,000 acres on the eastern slope of the mountain. Time did not permit survey of the upper slopes and summit of Pu`u Māhoe as originally planned.

In 1988 Cultural Surveys Hawaii, Inc. conducted a reconnaissance survey of two areas that were being considered as alternative sites for the National Radio Astronomy Observatory (now called the Very Long Base Array). No archaeological sites were found in the survey of the first area, an area of some 15 acres located between the 11,560 and 11,840 ft elevations near the junction of the summit road and a utility road (Hammatt and Borthwick 1988:1). Four archaeological sites were recorded in the survey of the second alternative site, an area of some 100 acres located on the east side of the summit road at the 12,100 to 12,225 ft elevations. Three of the sites (11076, 11077, and 11079) were interpreted as possible shrines; the fourth site (11078) is a small rockshelter (Hammatt and Borthwick 1988:21). Sites 11076 and 11078 were subsequently deleted from the inventory. Site 11076 had been previously recorded as part of Site 16204 (McCoy 1999a) and Site 11078 showed no evidence of human modification or use.

Two archaeological surveys were undertaken in the Science Reserve in 1990, both by Cultural Surveys Hawaii, Inc. The first involved a resurvey of a portion of Pu`u Hau Oki for the proposed Japan National Large Telescope (JNLT-- later renamed the Subaru Telescope) (see Figure 3.3). No sites were found in this survey, which covered an area of 5.1 acres (Robins and Hammatt 1990). The second survey was done for the proposed Galileo Telescope (later renamed the Gemini Telescope) (see Figure 3.3). Two alternative sites were inspected, both of them located on what the authors called the "summit ridge" (Borthwick and Hammatt 1990). No sites were found in either area.

In 1991 an unofficial one-day reconnaissance of the top of Pu`u Mākanaka was undertaken by Holly McEldowney and Marc Smith (SHPD) and Patrick McCoy (Mountain Archaeology Research Corp.) to relocate previously reported burials (see Figure 3.2). The survey, which was interrupted by bad weather, found a number of burials, none of which were mapped, however (McCoy 1991 field notes) a single state site number (50-10-23-16248) was assigned to the burials on the *pu`u* at that time.

As part of their Section 106 compliance, the Smithsonian Institution Astrophysical Observatory (SMA) contracted Mountain Archaeology Research Corp. in December 1992 to relocate two previously recorded sites in the general vicinity of one of the pads (see Figure 3.3). The two sites (50-10-23-16164 and 16165), which were found in the 1982 survey and described as shrines (see discussion of site types below) were found to be located well outside of the observatory footprint. Flagging of the two sites was recommended as a precautionary measure (McCoy 1993).

In 1995 SHPD with financial support from IfA, initiated a project designed to result in a historic preservation management plan for the Science Reserve. The first task, which was begun in 1995, involved the relocation and GPS locational mapping of the sites recorded in the 1982 and 1984 surveys (see Figure 3.2). In the course of the fieldwork 17 new sites were found and recorded (McCoy 1999a).

In 1997 SHPD undertook a reconnaissance survey of five previously unsurveyed areas aimed at obtaining a better idea of site distribution patterns for both management and research purposes. The 1997 survey area included three transects on the north, northwest and southwest slopes of the mountain from the summit area to the lower boundary of the Science Reserve at the ca. 12,000 ft elevation and two other areas—Pu`u Poepoe and a small piece of land located near the Science Reserve boundary downslope of the CalTech observatory (see Figure 3.2). A total of 31 new sites, including two located just below the Science Reserve boundary (21436 and 21437), were found in the 1997 project, which was conducted over a period of 6 days (McCoy 1999a).

The 1997 survey also began the process of recording what were initially referred to as "locations" but are now being termed "find spots"--a general term referring to man-made remains that are either obviously modern features (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder).

In summary, archaeological surveys undertaken between 1975 and 1999, the last year archaeological surveys were conducted in the Science Reserve prior to the current project, identified a total of 95 sites (McCoy 1975, 1977, 1982a, 1982b, 1984, 1990, 1999a; Hammatt and Borthwick 1988, 1990) in an area encompassing some 3,711 acres, which represents roughly 33% of the 11,288 acre Science Reserve (Table 3.2; see Figure 3-2). With the exception of a survey undertaken as part of a research project on the Mauna Kea Adze Quarry Complex, all of these surveys were reconnaissance level studies, which by definition are limited in terms of coverage and completeness. The list of previously identified sites is presented in Appendix A.

Five of the 95 sites are of unknown function. The other 90 sites include: (1) 77 shrines; (2) 1 isolated adze quarry-workshop; (3) 1 adze manufacturing workshops; (3) 1 positively identified burial site and 4 possible burial sites with an unknown number of interments at each site, and (4) 5 cairns that appear to be markers built either by surveyors or visitors to commemorate a visit (Appendix A).

Of the original 95 sites identified in the Science Reserve, 77 or 81% were classified as shrines. An additional 8 shrines are associated with adze manufacturing by-products, one each on Sites 11079, 16203, and 21211 and five on Site 16204. These four sites have been previously interpreted as a different kind of workshop, but the functions are not readily clear. The total number of shrines recorded in the Science Reserve through 1999 is thus 85. The locations of the 95 sites are shown on Figure 3.6.

Table 3.2. Historic Property Types Recorded in the Science Reserve between 1975-1999

Site Type	Number	Percent Total
Shrines	77	81.05
Isolated Adze Quarry-Workshop	1	1.05
Workshop	1	1.05
Adze Quarry Ritual Complex	1	1.05
Burials and Possible Burials	5	5.26
Stone Markers/Memorials	5	5.26
Unknown Function	5	5.26
TOTAL	**95**	**100%**

Note: The number of sites recorded between 1975 and 1999 was previously reported as 93 (McCoy 1999a). Two sites (21436 and 21437) located just below the Science Reserve boundary that were recorded in 1997 were omitted. They are included as part of the inventory because of their proximity to the boundary.

3.2 HALE PŌHAKU AREA

The second area that is managed by UH is a 19.3-acre site at Hale Pōhaku (CDUP No. HA-1819, Tax Map Key 4-4-15:12) encompassing the Onizuka Center for International Astronomy (OCIA), the Visitor Information Station, and an old construction laborer camp. Some of the cabins in the old camp are now used by the OMKM rangers; others are available for rent by the public for short-term use.

A number of archaeological investigations have been conducted at Hale Pōhaku, both in and outside of the 19.3-acre parcel (Table 3.3; see Figure 3.5), beginning with a one-day reconnaissance survey by the Bishop Museum in 1979 for the Hale Pohaku Mid-Level Complex Development Plan. No sites were found at that time (McCoy 1979).

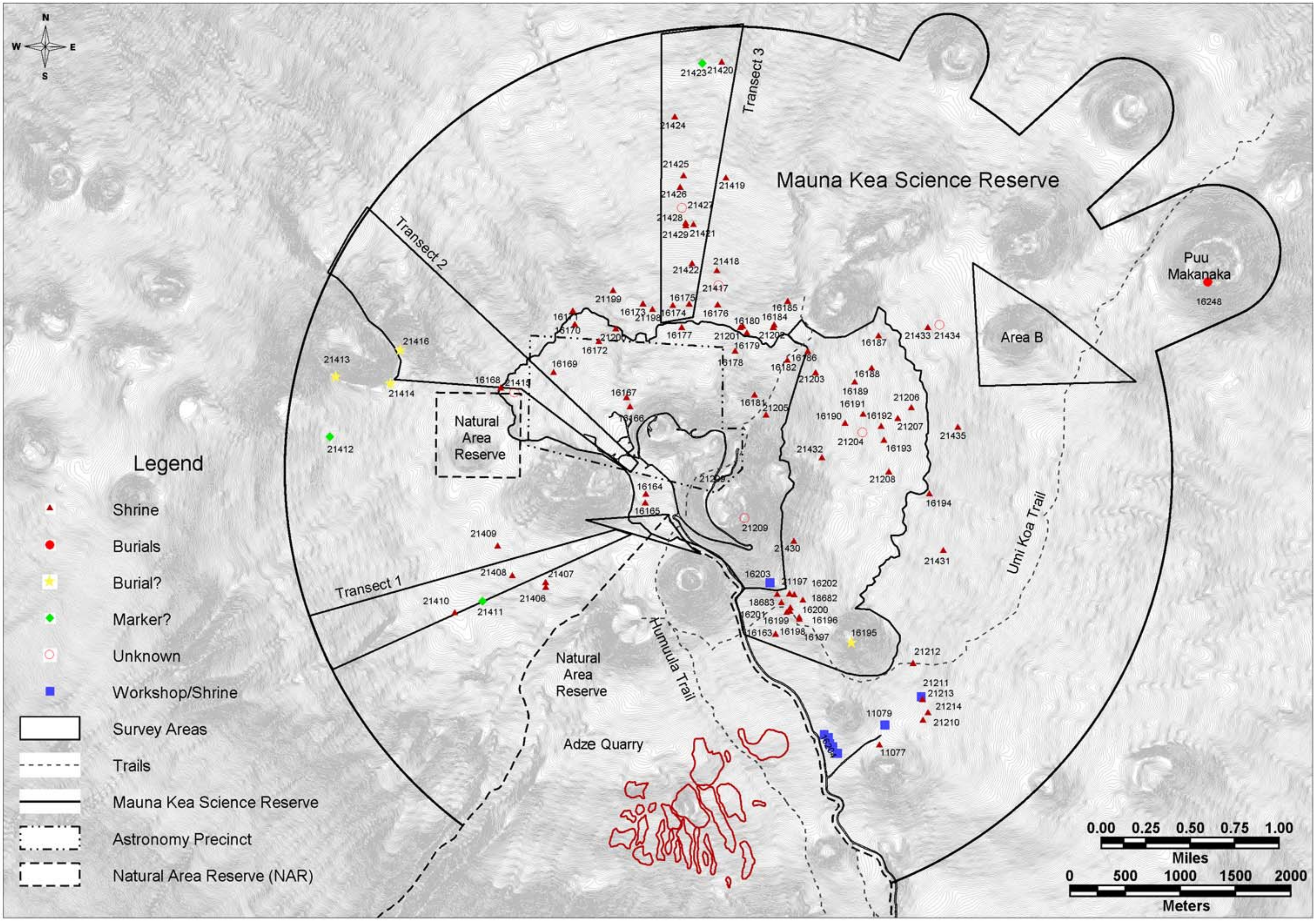


Figure 3.6 Location of Historic Properties and Other Cultural Resources Identified in the Science Reserve Between 1975 and 1999.

Table 3.3. Previous Archaeological Investigations at Hale Pōhaku.

Year	Project	Investigation	Reference
1979	Hale Pōhaku Mid-Level Facilities Complex Development Plan	Reconnaissance survey	McCoy 1979
1984-85	Supplemental EIS for Construction Laborer Camp	Reconnaissance survey	McCoy 1985
1986	HELCO transmission line and substation	Reconnaissance survey	Bonk 1986
1987	HELCO transmission line and substation	Reconnaissance survey	Sinoto 1987
1987	HELCO substation and surrounding area	Data recovery	McCoy 1991
1990	Japan National Large Telescope Dormitories	Reconnaissance Survey	Robins and Hammatt 1990
1993	Japan National Large Telescope Dormitories	Data Recovery	Hammatt and Shideler 2002
2005	Septic Tank Excavations	Monitoring	McCoy 2005

Three more surveys were conducted by the Bishop Museum between July 1984 and June 1985 as part of the preparation of a supplemental Environmental Impact Statement (EIS) for a permit to build a new construction laborer camp (McCoy 1985). Two shrines and five lithic scatters comprised of adze manufacturing by-products and octopus sinker manufacturing by-products were recorded in the surveys, which encompassed roughly 40 acres on the west and east sides of the Mauna Kea Observatory Access Road between the ca. 9,080 and 9,200 ft elevations. The lithic scatters and shrines, one of which has octopus manufacturing by-products on it that have been interpreted as offerings, were designated the Pu`u Kalepeamoa Site (Bishop Museum site number 50-Ha-G28-87) after the name of one of the large cinder cones at Hale Pōhaku (McCoy 1985). This cone, through which the summit access road passes, is the source of the stone (primarily dunite and gabbro) used in the manufacture of the sinkers. The two shrines and some of the lithic scatters found in the 1984-85 work are located outside of the Mid-Level facility parcel, as are some other 9 recorded lithic scatters found in later work (see Figure 3.5). SHPD arbitrarily assigned SIHP numbers to the two shrines and 12 lithic scatters (Cordy 1994) and to the site complex as a whole (16244) which corresponds to the BPBM site number. The Bishop Museum designations and corresponding SIHP numbers are presented in Appendix C of the draft Cultural Resource Management Plan for the UH management areas on Mauna Kea (McCoy et al. 2009; Appendix C).

In early 1986 the late William Bonk of the University of Hawaii at Hilo conducted a reconnaissance survey of a proposed new HELCO transmission line and substation located at Hale Pōhaku. No historic sites were found in the survey which extended from an existing 69 KV powerline north of the Saddle Road and west of the Mauna Kea Access Road, (Bonk 1986) to the substation location at Hale Pōhaku. The alignment that Bonk surveyed, however, was different from the final alignment (see Figure 3.5).

The subsequent discovery of lithic artifacts in the vicinity of the HELCO substation led to a data recovery project that involved additional survey and surface collections at 11 different lithic scatters and limited test excavations of two of the scatters (Sinoto 1987; McCoy 1991; Figure 3.7). A total of 2,364 artifacts and 129 faunal remains were collected. In addition to the debris related to adze and octopus sinker manufacture some 20 special purpose bird cooking stones called *pohaku `eho* were found. Three radiocarbon dates from charcoal recovered in fire pits indicate that the

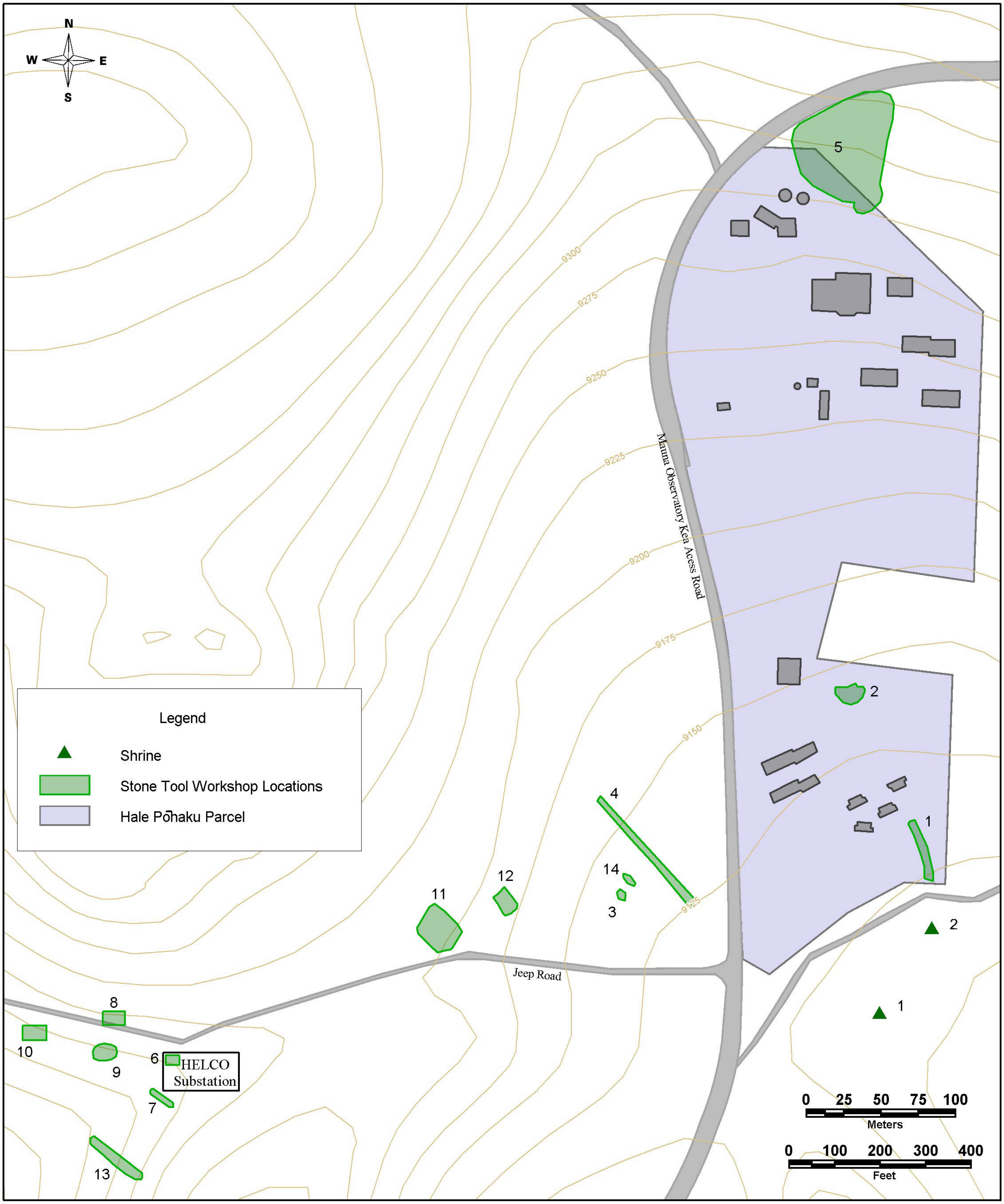


Figure 3-7 Locations of Historic Properties in the Hale Pōhaku Area

site, which has been interpreted as a temporary camp occupied on the ascent to and descent from the Mauna Kea Adze Quarry, is of late pre-contact age (ca. AD 1600-1700).

Cultural Surveys Hawaii conducted another reconnaissance survey at Hale Pohaku on August 9, 1990. The survey, which was done in conjunction with the construction of dormitories for the Japan National Large Telescope (later renamed the Subaru Telescope), covered a portion of the area surveyed by the Bishop Museum in 1985. The survey, which relocated two lithic scatters, recommended data recovery investigations prior to construction of the dormitories (Robins and Hammatt 1990). The data recovery work was conducted October 19-20, 1993 by Cultural Surveys Hawaii. Two radiocarbon dates were obtained that support the idea of a late prehistoric camp site (Hammatt and Shideler 2002).

The most recent work at Hale Pōhaku, conducted in March 2005, involved archaeological monitoring of four septic tank excavations (McCoy 2005). The monitoring report noted that while all of the known surface features in the lease area have undergone data recovery and no longer exist, there is a possibility that buried cultural deposits might exist in some undisturbed areas (McCoy 2005). There is one other historic property, the stone cabins constructed by the CCC in the 1930's, in the Mid-Level Facility parcel that have recently been documented at the inventory survey level. The inventory reports for these buildings are currently under review by SHPD.

3.3 Mauna Kea Access Road

The third UH management area is the summit access road from the OCIA at Hale Pōhaku to the Science Reserve boundary at the approximately 12,000-foot elevation. This includes a corridor approximately 400 yards wide on either side of the road, except for sections that fall within the boundaries of the Natural Area Reserve (see Figure 1.2).

In 1987 the Bishop Museum was contracted by the Facilities Planning and Development Office of the University of Hawaii to undertake an archaeological reconnaissance survey of the Mauna Kea Observatories Access Road above Hale Pōhaku, the former cement batch plant located in the Natural Area Reserve, and a stockpile area as part of the planning process for road improvements and new parking areas (see Figure 3.4). The survey covered a 100-foot wide corridor on both sides of the road. A post-field letter report dated July 7, 1987 (Williams 1987) indicates that no new sites were found during the road survey and the resurvey of the batch plant and stockpile area. New data on Site 16204 (see description below), located in close proximity to the road, was obtained during the project (McCoy 1999b). A final report on the road survey was never prepared by the Museum.

Survey of the road easement was undertaken in 2009. A final report is located at SHPD.

3.4 Mauna Kea Ice Natural Area Reserve

As noted above, the Mauna Kea Ice Age Natural Area Reserve was created in 1981. The NAR consists of two separate parcels, a 3750.0 -acre pie-shaped parcel (TMK: (3) 4-4-15:10) that encompasses most of the Mauna Kea Adze Quarry and Lake Waiau, and a 143.5-acre parcel (TMK: (3) 4-4-15:11) surrounding Pu`u Pōhaku, where fossil ice has been found (see Figure 3.4). Table 3.4 presents a list of previous archaeological research and investigations conducted within the NAR since 1935.

Table 3.4. Previous Archaeological Research and Cultural Resource Management Studies in the Natural Area Reserve

Year	Project	Study	Reference
1935	Hawaiian Academy of Science Expedition	Reconnaissance	Wentworth et al. nd
1937	Independent Research on Mauna Kea Adze Quarry	Reconnaissance	Emory 1938
1956	Independent Research on Mauna Kea Adze Quarry	Mapping and Description of a rockshelter	Y. Sinoto field notes
1971	Geo-Archaeological Research on Mauna Kea Adze Quarry	Test Excavation of Site 50-Ha-G28-6	Barrera field notes
1975-76	NSF Research Project on the Mauna Kea Adze Quarry	Reconnaissance and inventory survey	McCoy 1977, 1978, 1990; Cleghorn 1982; Allen 1981; Williams 1989)
1984	Bishop Museum Survey	Reconnaissance of Lake Waiau and Pu`u Hau Kea	Carter and Peterson field notes
1997	SHPD Survey	Reconnaissance of Lake Waiau	SHPD field notes
2007	PCSI Survey	Inventory Survey of Lake Waiau Area	McCoy and Nees 2008

Several 19th century expeditions to the summit region spent some time passing through what is now the Mauna Kea Ice Age Natural Area Reserve and occasionally stopping at one well known locality named Keanakako`i, or Keanakāko`i, which translates literally as "cave of the adze," appeared for many years on USGS quadrangle maps and according to some is the traditional name for what has become to be called the Mauna Kea Adze Quarry Complex, although another similar name, Kaluakako`i also appears in the literature (Maly and Maly 2005:279). The existence of the adze quarry was reported in the first recorded European ascent of Mauna Kea by Joseph Goodrich in 1823. Short accounts of the quarry complex appear in the records of other late 19th century and early 20th century expeditions to the mountain. One of the most informative is the account of W.D. Alexander's party, in 1892. About half an hour after leaving Lake Waiau, on the descent back to base camp, the party came to what they called the "axe-makers" cave called Keanakāko`i:

> This is situated about a mile south of Waiau, and a hundred yards west of the trail, in a ledge of that hard, fine-grained kind of rock, which ancient Hawaiians preferred for their stone implements. Here we saw the small cave in which the axe-makers lodged, their fire place, and remains of the shell fish they ate. In front of it is an immense heap of stone flakes and chips some 60 feet across and 20 or 30 feet high. Near by several hundred unfinished axes are piled up just as they were left by the manufacturers, when the arrival of foreign ships and the introduction of iron tools had ruined their trade…It was here that the late Dr. Hillebrand found a curious idol, which is still in the possession of his family (Maly and Maly 2005:189).

One of the earliest and most interesting descriptions of the adze quarries on Mauna Kea was made by William Brigham in his treatise *Stone Implements and Stone Work of the Ancient Hawaiians*.

His description, which contains several factual errors, was nonetheless the first to acknowledge the quarry as the most important of all those known at the time:

> Let us climb to the workshop of the adze maker. All these were in high places, and one on Mauna Kea, Hawaii, was nearly 12,900 ft. above the sea. As good clinkstone was not found in many places the known quarries hardly exceeded half-a-dozen. On Hawaii was the most important of all, that on Mauna Kea, where the workmen could only work in favorable seasons for the snow frequently covered the quarry, but from the immense quantity of fragments and chips the work must have extended over many generations; so far as known, this was the earliest quarry exploited, and it is puzzling how the place was discovered when we consider the aversion the Hawaiians had to even visiting those high, bleak and desert regions, the supposed abode of spirits not always friendly. It is possible that the tradition which speaks of the survivor of the deluge of Kahinalii grounding on Mauna Kea and following the receding waters to the lower levels, discovering the koi pohaku on the way, may point to the considerable antiquity of adze-making in this place, but I am inclined to believe that all traditions of the Hawaiian deluge date after the coming of the Spanish discoverers. It has always seemed strange that the axe-makers did not bring the raw material down to their homes and work it up in comfort instead of freezing in their kapa garments at this great altitude. It may be that the mystery of the place and its very solitude kept the trade in few hands and so enhanced the value of a tool that so many must have (Brigham 1902:75-76).

Of particular interest is Brigham's reference to the aversion of Hawaiians to high desolate places and the discomfort of working under less than favorable conditions; the possible link between environmental conditions and the labor component of the production process, and the probable influence this had on the value of a tool that as he so neatly put it *"so many must have*."

Robert Aitken, a member of the 1935 Hawaiian Academy of Science Expedition, made some general observations about the quarry which are summarized in the unpublished manuscript of the expedition (Wentworth et al. n.d.). In 1937 Bishop Museum archaeologist Kenneth Emory visited the quarry over a three day period. He photographed and briefly described some of the shrines and rockshelters. A popular account of Emory's visit appeared in *Paradise of the Pacific* (Emory 1938:21-22).

Dr. Yosihiko Sinoto sketched and described one rockshelter in 1956. In 1971, the late William Barrera partially excavated a 50 cm square test pit in the floor of a rockshelter that was subsequently recorded as Bishop Museum Site 50-Ha-G28-6-R1 (SIHP Site 50-10-23-16209). The excavation was undertaken in conjunction with geological and soil studies by Drs. Stephan Porter and Fiorenzo Ugolini of the University of Washington. No report was ever prepared on the excavations (McCoy 1977:223-224).

The first major archaeological investigations of the adze quarry were conducted over a 7-month period in the summers of 1975-76. The 1975-76 project, which did not cover the whole of the quarry, identified 37 sites, two of which are located in the Science Reserve. The sites included 263 workshops comprised of 1566 "chipping stations" with 182 open-air enclosures; 39 rockshelters (this includes what were originally called overhang shelters); 40 shrines; 2 rock art localities and 1 basaltic glass source and workshop.

The Mauna Kea Adze Quarry Complex, one of the most significant historic sites in the Hawaiian Islands, was placed on the National register of Historic Places in 1962 as a National Historic Landmark (NHL). The boundaries of NHL have yet to be officially established by the National Park Service. Boundary recommendations were made in 1978 following the research in the best known and most accessible part of the quarry in 1975-76 (McCoy 1978:Figure 2). On present evidence the quarry covers not only more area but also contains a larger volume of manufacturing by-products and related archaeological remains than all of the other known adze quarries in the Hawaiian Islands combined (McCoy 1977; McCoy and Gould 1977). Fieldwork west of Pōhakuloa Gulch, in 1984-85 and again in 2007, indicates that the quarry encompasses a larger area than what was reported earlier, at the conclusion of the first phase of research in 1975-76 (McCoy 1977; McCoy and Gould 1977). Most of the quarry complex is located in the NAR, but some sites are located in the Science Reserve. Quarry and workshop sites have also been found on Mauna Kea Forest Reserve lands.

A reconnaissance survey of the Lake Waiau area was conducted in 1976 during the second field season of the Mauna Kea Adze Quarry research project (McCoy 1977, 1978). Little time was devoted to the survey of the lake area after finding that there was no tool-quality basalt in the immediate environs. No artifacts linking the lake to the adze quarry were found in the survey, but the lake was included in the proposed boundaries of the Mauna Kea Adze Quarry National Historic Landmark based on the assumption that not only was the lake a part of the "effective environment" used and possibly modified by Hawaiian adze makers, but because of the potential of the lake to aid in the interpretation of paleoenvironmental changes through the study of fossil pollens contained in the lake sediments (McCoy 1978:17-18). In addition, it was assumed that the location of the lake, just below the summit of the mountain, held special cultural significance for the adze makers and other Hawaiians. One site, a cluster of cairns located above the northwestern side of the lake, was recorded and assigned a site number in 1976 (BPBM Site No. 50-Ha-G28-36). The site marks the northwest corner of the proposed NHL boundary (McCoy 1978:Figure 2).

A sketch map showing cultural features at the lake and on the rim of Pu`u Hau Kea was made on July 28, 1984 at the end of the reconnaissance survey of ca. 1,000 acres of land on the east slope (McCoy 1984b). A number of features were noted on the rim of the Pu`u Waiau and below, along the margins of the lake. Two possible cairns were noted in a quick reconnaissance around the rim of Pu`u Haukea (Carter and Peterson, unpublished field notes).

Prior to an archaeological inventory survey conducted in 2007 (see below) only one site at Lake Waiau had been given a Statewide Inventory of Historic Places (SIHP) number. A cluster of five cairns and two uprights was assigned Bishop Museum site number (50-Ha-G28-36) in 1976 for the purpose of marking one corner of the recommended boundaries for the Mauna Kea Adze Quarry National Historic Landmark (McCoy 1978: Figure 2). The site was later given a SIHP number (50-10-23-16232) by Cordy during the writing of his *Regional Synthesis of the Hamakua District* (Cordy 1994).

While a number of other features were observed in 1976, 1984 and at other times, it was not until 1997 that a conscientious effort was made to begin recording all of the sites and features at the lake. The survey initiated by SHPD in 1997 was constrained by time, with the result that many sites and features were left unrecorded. The quality of much of the data that were collected was, moreover, not up to inventory survey standards. In view of the obvious need for a more comprehensive survey no SIHP numbers were assigned to the remains recorded in 1997.

Material support for the theory that the lake was frequented by the adze makers was found in the 1997 survey. A flake, presumed to be a waste flake from the adze quarry based on its texture and color, was found near the outlet to lake. While there is no way of knowing when the flake was introduced, it is not part of any modern construction and was in fact found in close proximity to a petroglyph, the first recorded at the lake.

PCSI conducted an archaeological inventory survey of Lake Waiau, located at the 13,020 ft elevation in the Mauna Kea Ice Age Natural Area Reserve, over a 6-day period in July 2007. The survey followed on earlier archaeological reconnaissance surveys in 1976, 1984, and 1997 that had identified a number of features in the immediate environs of the lake. A total of 21 sites comprised of 99 features were found in the survey area which covered approximately 43 acres (McCoy and Nees 2009).

The features recorded during the 2007 survey include possible burials; cairns that may have functioned as survey markers, boundary markers or trail markers; shrines and possible shrines; one trail segment; petroglyphs; lithic scatters related to adze manufacture; a cemented stone pedestal for survey equipment from an 1892 expedition; an historic dump and stone markers or memorials, including the remnants of a memorial plaque to a local cowboy. A number of features that had never been seen before because they are normally covered by water were found in the lakebed which was at a low stand in 2007. Most of these features, which are morphologically similar to previously identified structural remains on the rims of a number of cinder cones in the Mauna Kea summit region, are interpreted as possible burials.

If the remains are in fact burials, it indicates a much more diverse set of mortuary practices than what was previously known at the lake. It mirrors the on-going cultural practice of placing umbilical cords (*piko)* in the lake and on the land. The lithic scatters, which consist of primarily flakes but in one area also include an adze preform and a hammerstone, confirm a long suspected use of the lake by Hawaiian adze makers working in the Mauna Kea Adze Quarry Complex as not only as a probable source of freshwater but for other activities as well.

While none of the 21 sites have been dated, the presence of adze manufacturing by-products suggests that the cultural chronology of Lake Waiau began sometime in the pre-contact era. Continuity in the use of the lake from pre-contact times to the present is evidenced in the remains left by early scientific expeditions, modern altars (*lele*) and less formal rock piles. Remains that are either modern or cannot be classified with any level of confidence as historic sites because of their uncertain age, such as many of the rock piles, were recorded as “find spots,” following a practice begun by the State Historic Preservation Division (SHPD) during a reconnaissance survey of selected areas of the Mauna Kea Science Reserve in 1997. A total of 63 find spots were recorded in the project area (McCoy and Nees 2008).

3.5 Hopukani, Waihu, and Liloe Springs

The first published reference to the existence of archaeological sites in the Pōhakuloa Gulch area is contained in a report by Wentworth and Powers (1943) who made the following observations during the course of their geological investigations in 1939:

> One section of the valley is isolated by the steep walls of thick lava flows, above and below which are stone walls built many years ago as a trap in which to

> impound wild cattle that frequented the spring area. The last of the wild cattle have been killed, but a few skulls were to be seen in 1939.
>
> In the area to the east and up the slope from the springs are numerous small heaps of pre-European stone adz workings. Certain lava caves contain evidence of habitation, suggesting that the springs were frequented by adz workers. The latter not only secured adz material from lava flows in places but carried on a surprising amount of casual prospecting on dense basalt boulders included in the moraines and outwash strewn several thousand feet down the mountain (Wentworth and Powers 1943:544).

In a later report on this area, Richardson and Woodside (1954:326-7) noted the presence of dark-rumped petrel (*Pterodroma phaeopygia)* bones and artifacts in a site they named Hopukane Shelter Cave, located at the ca. 10,000 ft elevation. This must be one of the habitation caves seen by Wentworth and Powers in 1939. It appears, more precisely, to be site 50-Ha-G28-34 (renamed Hopukani Rockshelter) based on information obtained from Woodside (personal communication).

The first systematic archaeological investigations in the Pōhakuloa Gulch area were undertaken in 1976, during the second field season of the Mauna Kea Adze Quarry Project (Table 3.5; see Figure 3.4). A reconnaissance survey of the Pōhakuloa Gulch area, between Lake Waiau and Mauna Kea State Park, was conducted over a two-day period (August 14-15, 1976). Five sites were recorded in this survey (unpublished field notes). Two of these sites (50-Ha-G28-34 and 35) are located along or in close proximity to the Pohakuloa Training Area (PTA) waterline. The proposed western boundary of the National Historic Landmark (McCoy 1978: Fig. 2) was established on the basis of the findings made during this survey.

In 1984 six archaeological sites and a number of find spots were identified in a reconnaissance survey of the PTA waterline catchments and pipeline at Hopukani, Waihu, and Liloe springs, located between the ca. 10,400 and 8,640 ft elevations in the western sector of the Mauna Kea Adze Quarry Complex (McCoy 1984a). The 1984 reconnaissance survey consisted of an intensive survey within a 100 meter radius of each spring and a walk-through survey of the intervening areas, covering roughly 50 meters on either side of the pipeline. The survey area encompassed approximately 16 hectares (McCoy 1984a:3). Five adze manufacturing sites and one historic corral were identified in the survey, which confirmed expectations of a significantly larger number and variety of sites in this part of the quarry complex, which includes sites located above and below modern treeline at the ca. 9,500 ft elevation. Indications of even more sites to the west of the major Pōhakuloa Gulch drainage area suggest the probability of a future boundary amendment and need to reassess what has been implicitly regarded as a fringe or marginal area of the larger quarry complex.

A data recovery project was undertaken in 1985 to mitigate the possible adverse effects of proposed repairs to the pipeline on the sites identified in 1984 (see Table 3.4). Test excavations of a small overhang shelter at Hopukani Spring (10,400 ft) revealed a small assemblage of waste flakes, hearths and faunal remains suggestive of a temporary, short-term occupation. A much larger and more diversified collection of lithic artifacts and organic materials was recovered in the survey and test excavations of Hopukani Rockshelter (10,160 ft), the only previously known base camp in this region of the quarry. Investigations of the isolated site in the subalpine forest at Liloe Spring (8,921 ft) resulted in the definition of site boundaries and acquisition of data pointing to the existence of an open camp site at this lower elevation locality.

Table 3.5. Previous Cultural Resource Management Studies at Hopukani, Waihu, and Liloe Springs

Year	Project	Study	Location	Reference
1984	PTA Waterline Improvement	Reconnaissance	Hopukani, Waihu, and Liloe Springs	McCoy 1984a
1985	PTA Waterline Improvement	Data Recovery	Hopukani and Liloe Springs	McCoy 1986

The chronology for this area of the quarry, based on a total of eight radiocarbon dates for the three excavated sites, spans a period of some 700-800 years beginning ca. AD 1000 and terminating some time prior to 1800. Some preliminary ideas regarding the significance of adze manufacturing sites and other sites located in the two major drainages on the south slope of the mountain were presented in a 1984 report:

> The sites located in the mid-elevation reaches of the Pohakuloa and Waikahalulu Gulch drainage systems are of particular importance with regard to questions relating to ascent routes, resource ownership, and general relationships to the main quarry area at the 12,200 to 12,400 ft. elevations. Material recovered in the excavations of Waikahalulu Rockshelter (Site 50-Ha-G28-11-R1) at the c. 10,000 ft. elevation on the gulch of the same name, suggest a strategically located mid-elevation base camp on a southerly ascent route to the primary sources of raw material further up the mountain. Both this site and Hopukani Rockshelter (50-Ha-G28-34) are located just above present treeline in close proximity to freshwater springs, thus providing ready access to water, firewood, and other forest products, including birds, of which there are a number of species in the Waikahalulu camp site (McCoy 1983). The final provisioning of some task groups of adze makers residing in the rockshelters at higher elevations probably took place at these two intermediate camp sites and possibly much of the cooking of foods such as taro and yams as well, although there is as yet no direct archaeological evidence for these activities. There is the added implication, again admittedly speculative, that these upper montane forest base camps were occupied by family groups, including women, engaged in a variety of activities directly related to adze production and, perhaps, other unrelated economic pursuits as well (e.g. feather, fiber and wood crafts).
>
> Equally significant from an historical perspective on later land-use and socio-economic patterns are the walls and corral that functioned as a wild cattle trap. This site reflects a socially, and environmentally critical period in the early post-contact era of Hawaiian-European relations in Hawaii and the Mauna Kea-Waimea-Kawaihae areas in particular (McCoy 1984a:26-27).

3.6 Radiocarbon Chronology for Previously Excavated Sites in the Alpine and Sub-alpine Zones

A suite of 23 radiocarbon dates from eight excavated sites (Figure 3.8; Table 3.6) indicate that the adze quarry industry spanned a period of some 700 years between ca. AD 1100 and 1800. A lower limiting date of perhaps AD 800-1000 seems likely based on the interpretation of stratigraphic evidence from several of the excavated rockshelters. The basal layer of Ko`oko`olau Rockshelter No. 1, for example, is undated and where test excavations have been undertaken exterior of the dripline there is an indication of earlier activity. With regard to an upper limiting or terminal date, there is archaeological as well as ethnohistoric evidence (McEldowney 1982:7) suggesting that

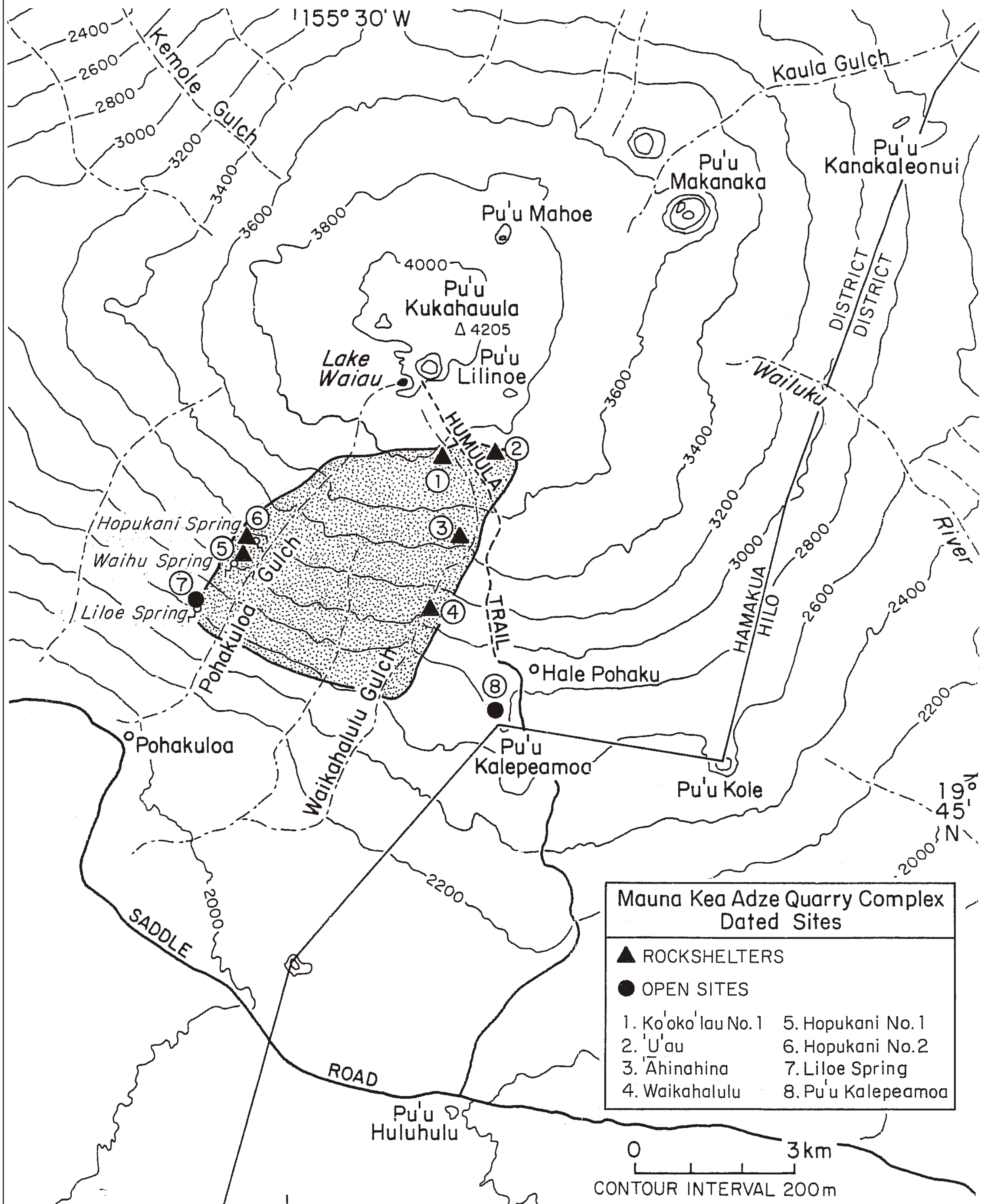


Figure 3.8. Location of Radiocarbon Dated Sites from Previously Excavated Sites.

Table 3.6 Radiocarbon Age Determinations for Previously Excavated Sites

Zone	Elevation (m)	Site	Provenience[1]	HRC No.[2]	Lab NO.	Uncorrected Age[3]		Corrected Age (A.D.)[4]
						B.P.	A.D.	
I	3780	Ko'oko'olau Rockshelter No. 1	B2 IV F1*	279	I-9128	355 ± 80	1595 ± 80	1400-1660
			B3 VI F3*	311	I-9743	470±75	1480±75	1350-1495
			B3-B4 VIII F4*	312	I-9744	775±80	1175±80	1045-1340
	3727	'Ua'u Rockshelter	C5 II F2*	267	I-9070	190±80	1760±80	1490-1950
			B5 IV F3*	263	I-9069	490±80	1460±80	1315-1520
			G5 VI/3 **	275	I-9071	425±80	1525±80	1340-1465
			E5 VIII**	277	I-9072	355±165	1595±165	1335-1950
			E5 VIII F15**	299	I-9929	655±80	1295±80	1225-1415
II	3475	Ahinahina Rockshelter	C3 II F2*	300	I-9741	345±75	1605±75	1420-1650
			surface*	340	W-4539	<200[5]		
III	3170	Hopukani Rockshelter No. 2	7C-8C II F1*	828	Beta-15644	840±60	1110±60	1050-1265
	3100	Hopukani Rockshelter No. 1	M24 II/III*	862	Beta-15647	290±80	1660±80	1415-1950
			M24 V F5*	869	Beta-15648	250±70	1700±70	1495-1800
			M28 II F1**	836	Beta-15645	810±60	1140±60	1065-1285
			M28 III F2b**	842-843	Beta-16400	520±60	1430±60	1330-1430
			M28 IV**	845	Beta-16401	520±60	1430±60	1330-1430
			M28 V F3**	853-857	Beta-15646	470±60	1480±60	1350-1495
	3050	Waikahalulu Rockshelter	C4 III F1*	304	I-9742	430±75	1520±75	1400-1515
			D4 V F3**	307	W-4538	370±60	1580±60	1415-1640
	2712	Liloe Spring Workshop		874	Beta-15649	500±90	1450±90	1310-1515
IV	2800	Pu'u Kalepeamoa	87-8 H8 II	979	Beta-23417	modern		
			87-8 H8 II	981	Beta-23418	250±70	1700±70	1495-1800
			87-7 II	1008	Beta-26377	130±50	1820±50	1650-1950
			10,310 II		Beta-71138	660 ± 60	1290±60	1260-1410
			10,311 II		Beta-71139	250 ± 60	1700±60	1510-1950

1 Square or excavation unit [e.g. B2], layer/level, [e.g. VI/3] feature no. [e.g. F1]; *=interior context [back of the dripline] **=exterior context [beyond the dripline]
2 HRC=Bishop Museum Hawaii Radiocarbon No.
3 the uncorrected dates for sites in Zones III and IV are C13 adjusted
4 based on Klein et al (1982)
5 silversword; all other dates are on wood charcoal except for Beta-71138 which is organic sediment

the quarry may have been abandoned prior to or just following first known European contact in 1778 (see Section 7 for further discussion of the chronology of adze.

The 840 +/- 60 B.P. date (Beta-15644) for the occupation of the Hopukani Spring Overhang Shelter is somewhat older than expected, but not out of line with the early dates for `Ua`u Rockshelter and Ko`oko`olau Rockshelter No. 1 in the main quarry (see Figure 3.8; see Table 3.6). The date is associated with a temporary occupation and, thus, should not be interpreted as marking the beginning of intensified adze manufacture at this locality, or even this region of the quarry. On present evidence the chronology of long-term, repeated exploitation of the drift deposits on and below the Makanaka and Waihu glacial moraines is believed to have begun ca. AD 1300. Terminal dates are not available for Hopukani Rockshelter, but the cultural sequence almost certainly ends prior to 1800. The 500 +/- 90 B.P. date (Beta-15649) for the Liloe Spring Site is consistent with the Hopukani Rockshelter dates, thus suggesting broad contemporaneity of adze manufacturing locales in the subalpine forest and the larger, more visible ones above treeline. This interpretation is consistent with the chronological relationships of lower and higher elevation sites elsewhere in the quarry.

On present evidence, which is limited to five dates from very limited testing, the Pu'u Kalepeamoa site is a late prehistoric and possibly even protohistoric age site (see Figure 3.8; see Table 3.6). It appears to be one of the latest sites in the quarry sequence which spans a period of approximately 700 years between ca. AD 1100 and 1800. Given that all but one of the dates are consistently late, there does not appear to an "old wood problem" (Schiffer 1987:309-312; cf. also Gould 1990:19-21). The one anomalous date (Beta-71138) is organic sediment (Hammatt and Shideler 2002).

A comparison of the available dates (see Table 3.6) indicates that the sites with the earliest and longest sequences are located along the escarpment in what I have elsewhere referred to as Zone 1 (McCoy 1990) and at Hopukani Spring in Zone 3. In sharp contrast to this pattern are the lowest elevation sites, the Pu`u Kalepeamoa site and the Saddle Road lava tube shelter, which appear to have been occupied for a brief period of time after ca. AD 1600-1700.

3.7 Assessments and Mitigation Plans

Cultural assessment studies have been undertaken for two of the more recent projects. One is a traditional cultural property assessment and the other a cultural impact assessment, which is now required under Chapter 343 for Environmental Impact Statements. A draft Historic Preservation Plan (HPP) was developed for the UH Management Areas on Mauna Kea in 1999 and PCSI is in the process of developing a cultural resource management plan for the same areas.

3.7.1 Traditional Cultural Property Assessments

Traditional cultural properties are a type of historic property that was formally defined for the first time in 1998 by Patricia Parker and Thomas King, in National Register Bulletin 38 (*Guidelines for Evaluating and Documenting Traditional Cultural*

Properties). TCP's, to use the commonly used acronym, were defined by Parker and King defined as follows:

> A traditional cultural property, then, can be defined generally as one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King:1998:1).

Parker (1993) notes that an important difference between traditional cultural properties and other kinds of historic properties is that the significance of tcp's "cannot be determined solely by historians, ethnographers, ethnohistorians, ethnobotanists, and other professionals. The significance of traditional cultural properties must be determined by the community that values them" (Parker 1993:5). The Hawaiian oral traditions summarized in Section 2 testify to the importance of Mauna Kea and the summit in particular.

At the request of SHPD, Dr. Charles Langlas of the University of Hawaii at Hilo conducted a TCP assessment of Mauna Kea in 1997 as part of the cultural resource management studies for the Hawaii Defense Access Road and Saddle Road Project. Langlas' work was undertaken in conjunction with a social impact assessment of the proposed road improvements on the *mamane-naio* forest (Kanahele and Kanahele 1997). The studies had two objectives: "(1) to evaluate the two areas as to their potential eligibility for the National Register of Historic Places, and (2) if eligible, determine the effect of the project and how to mitigate any adverse effect" (Langlas 1999:1). A letter written in March 1999 that accompanied the submittal of a supplement to the main study (Langlas et al. 1997), indicated that "the author intended to conclude that although the whole upper zone of Mauna Kea should be considered eligible as a traditional cultural property for the National Register of Historic Sites (as a historic district), he cannot recommend that the summit peak be considered eligible as a specific site, because he cannot make public the information he collected by Kupuna X" (Langlas 1999).

During the preparation of the Master Plan, in 1999-2000, SHPD designated three areas as TCP's because of their association with legendary figures and on-going cultural practices. Two of the TCPs, which are described in Section 5, are located in the Science Reserve. These include the summit (Kūkahau`ula) and Pu`u Līlīnoe. The third is Lake Waiau, which is located just outside of the Science Reserve in the Mauna Kea Ice Age Natural Area Reserve.

Tom King, in the declaration he submitted as part of the contested case hearing for the Keck Outrigger project (King 2003), stated his opinion that the landscape on the upper slopes of Mauna Kea meets the eligibility criteria for inclusion in the National Register as a TCP (King 2003:6-7). There are other individuals who believe that all of the lands above the 6,000 ft elevation should be recognized as a TCP (NASA 2005:xv).

3.7.2 Cultural Impact Assessments

A cultural impact assessment study was undertaken by Paul H. Rosendahl, Ph.D. Inc. (PHRI) for the EIS for the Master Plan under "Chapter 343-Environmental Impact Statements" (HRS) and "Title 11, Chapter 200-Environmental Impact Statement Rules" (HAR, Department of Health). Office of Environmental Quality Control (OEQC) guidelines were employed in the study, which was focused on determining what effects implementation of the Master Plan would have on Native Hawaiian cultural practices, features and beliefs. The primary sources of information used in the assessment were oral histories and consultations undertaken by Kepa Maly, who at the time was employed by PHRI. Another of Maly's reports was included in the Master Plan as Appendix I (Maly 1999).

The cultural impact assessment identified a number of traditional and customary practices, several potential traditional cultural properties and several kinds of contemporary cultural practices, some of which may represent continuity of older practices, but also including practices where "no clear specific basis in traditional culture can be clearly established or demonstrated" (PHRI 1999:Table 2, 40). The PHRI report summarized Native Hawaiian perspectives on the Master Plan, from which Maly presented six recommendations, and a concluding discussion of potential mitigation measures.

3.7.3 Preservation and Burial Treatment Plans

In 1999-2000 the State Historic Preservation Division of the Department of Land and Natural Resources began preparing a Historic Preservation Plan (HPP) for the UH management areas on Mauna Kea. A final HPP was never completed before the authors of the plan left SHPD, but parts of the HPP were included in the Mauna Kea Science Reserve Master Plan as appendices. These included "Mauna Kea Historic Preservation Plan Management Components" (Appendix F, SHPD 2000) and "Mauna Kea Science Reserve Archaeological Site Inventory: Formal, Functional, and Spatial Attributes" (Appendix K, McCoy 1999a).

The SHPD Plan identified all of the major activities and actions that could have a potential adverse effect on historic properties located in the state lands managed by UH and the means by which such effects could be mitigated to ensure the long-term protection of individual historic properties and the Mauna Kea Summit Region Historic District as a whole. It also summarized existing management policies, which included the NAR, and made a number of additional policy recommendations.

In 1999 NASA proposed the addition of four and possibly as many as six outrigger telescopes to the W.M. Keck Observatory. After consultation with SHPD, NASA determined that the proposed project, which was classified as an undertaking under Section 106 of the National Historic Preservation Act would have an adverse effect on the summit, which had been recognized as a significant historic property. The finding of adverse effect prompted the development of a Memorandum of Agreement (MOA). One of the stipulations in the MOA was the need to develop, prior to construction, an Inadvertent Discovery of Human Remains and Archaeological Properties Monitoring Plan.

While NASA later withdrew the funding for the Outrigger Project, following legal challenges, the MOA (Appendix B) and the Burial Treatment Plan (Appendix C) included in the Final Environmental Impact Statement (FEIS) are important documents that could be used as models in the development of future construction monitoring plans and burial treatment plans.

PCSI began preparing a CRMP for all three of the UH management areas on Mauna Kea in 2007. A draft of the CRMP (McCoy et. al. 2009) has been reviewed by OMKM and its cultural advisory group, the Kahu Kū Mauna Council. A series of public consultation meetings were held on the island of Hawai`i in 2008. The results of these meetings have been summarized in the draft plan. The CRMP was approved by the UH Board of Regents on November 19, 2009.

4.0 ARCHAEOLOGICAL THEORY AND PRACTICE

Many archaeologists, including the authors of this report, have ambivalent feelings toward "archaeological theory," especially toward some of the grand theories with a capital "T" that derive from philosophy, such as the covering law model. For us, theory is not synonymous with the hypothetico-deductive system.

One of the problems with modern archaeological theory is that it has become increasingly "rarified and removed" (Hodder 2001:4). Another problem is the existence of competing and often conflicting theoretical paradigms which tend, moreover, to be abstract. Without any obvious or immediate relevance "Abstract theory for theory's sake becomes engaged in battles over opposing abstract assertions" (Hodder 2001:4). Some archaeologists even question the existence of archaeological theory. Johnson argues that *we are all theorists* (his emphasis), whether we admit to it or not, because anyone involved in the production of archaeological knowledge uses "theories, concepts, ideas, assumptions in their work" (Johnson 1999:6). Shanks and Tilley go even farther in concluding that "The facts of the case become facts only in relation to convictions, ideas and values" (Shanks and Tilley 1987:104).

Hodder, who is clearly opposed to abstract theory, has noted that "archaeological theory is always "of something" and the recognition of this "undermines claims for a universality and unity of archaeological theory" (Hodder 2001:5). Lacking a universal theoretical underpinning, there are many archaeologists who argue that we should forget about theory and just "get on the business with doing archaeology." For other archaeologists, including the senior author, this is unacceptable:

> Ignoring philosophical and theoretical concerns is no way out. Such an approach, urging us to simply press on with the study of data without worrying about the niceties of theory, presumably inviting us to respond directly to that data, assumes that the lack of any systematic approach or procedure is somehow a miraculous guarantee of objectivity. Such a common-sense approach systematically evades any confrontation with its own premises, safeguards any methodology which is currently available and, in this manner, produces the very opposite of objective problem-free research. Empirical research presented as the obvious stuff of common sense is never called upon to guarantee its consistency, silences, and contradictions and hence is entirely unsatisfactory (Shanks and Tilley 1987:33).

4.1 THE THEORY-DATA DIALECTIC

While there is certainly a place for theory, it is, of course, also possible to go into the field without any theoretical presuppositions and make useful observations that can contribute to new ideas and new theories. Indeed, many archaeological projects are "*data-led"* (Hodder 1999:51). One reason is that the kinds of sites under investigation constrain the types of questions that can be asked (Hodder 1999:51). In the case of archaeological surveys there are, moreover, several potential problems with a strict problem-oriented approach and rigid adherence to the deductive method:

> It may be recognized (Charles Redman, in discussion) that strict problem orientation may miss a great deal, and that simply being open to what may happen to turn up in an excavation is a quite legitimate research strategy. There is nothing wrong with sensitive exploration, being open to finding out (Shanks and Hodder 1995:16).

> The usual contemporary attempt to provide research with rigor, to conquer the difficulties inherent in the natural process of observation and conceptualization, is framed deductively. Studies, we are instructed, should begin and move forward with explicitly stated hypotheses that are continuously tested and refined. Such studies are always methodologically admirable, but they may easily become trivial if the initial hypothesis was incorrectly formed with relation to the objects selected for study. An equally important trouble with the general demand for deductive research is that the scholar might like to approach a new problem, and yet find himself without enough information to form a useful first hypothesis (Glassie 1975:14).

Without hypotheses to test it is necessary to use an inductive approach based on the search for meaningful patterns in the data that have been collected. More important is the need for a rigorous method of recording data (Glassie 1975:116). As Glassie has written, “It is no test of the scholar or his craft to invent a theory and pop bits of information into it” (Glassie 1975:13).

Whether a researcher starts with a theory or collection of raw data, to make any significant contribution to archaeological knowledge requires going back and forth between the two (Jones 2002:37). Shanks and Tilley (1987) and Hodder (1999) describe the tacking between data and theory as a dialectical process:

> Archaeological interpretations of the past are not secondary to the physical reality of the past, the objects in the archaeological record. Understanding the past is a dialectical process occasioned by continual adjustments of ideas, concepts and representations and is not something that could be fixed by a single method such as the hypothetico-deductive method (Shanks and Tilley 1987:108).

4.2 THEORETICAL ORIENTATION

Philosophically, the senior author is a realist in the way it was defined by Hirst (1967) and summarized by Bunge: “Realism is the view that material objects exist externally to us and independently of our sense experience” (Hirst 1967). It is the epistemology that all of us adopt tacitly when not under the influence of narcotics or anti-scientific philosophies” (Bunge 1996:326). Trigger provided a short but useful contrast with an idealist and a positivist:

> An idealist epistemology generalizes the everyday processes by which human beings deal with each other; a positivist one generalizes the way in which humans cope with the natural world; and a realist one takes account of the selective processes acting on all forms of human behavior (Trigger 1998:9).

In contrast to idealism and positivism, realism is “anti-reductionist and embraces a view of science that takes account of the need for employing different modes of inquiry to study different kinds of phenomena” (Trigger 1998:6). The realist, in Trigger’s view, “believes that some imperceptible entities, either processes or phenomena that are presently unobservable, are appropriate objects for scientific investigation even if they can be known only conceptually” (Trigger 1998:6).

For a realist the “archaeological record is a product of human behavior that was shaped with varying degrees of directness by material constraints, as these were comprehended in terms of culturally conditioned understandings of reality” (Trigger

1998:12). Aronson et al. (1995:43) summarize a point of view that to them and many other people is obvious, that “nature is intransigent and unforgiving” and that “There are causal structures that exist independently of the theories and projects and beliefs of human kind, that are totally unaffected by the way we classify things” (Boyd 1990:183). We agree. As discussed in an earlier report on Mauna Kea (McCoy 1990:86), there is a need to recognize that there are different kinds of material realities, including some like climate, which "remains outside the direct or indirect sway of humankind, but never ceases to affect it" (Godelier 1986:4).

Rather than claiming that the environment is limiting we think it is preferable to follow Glassie in saying that "The physical environment constrains, but it does not direct. It provides the stage upon which cultural options are sorted out, rejected, accepted, and ordered into a particular cultural logic" (Glassie 1975:189; cf. Sahlins 1976 for a similar but even stronger statement, albeit a controversial one, regarding the autonomy of cultural logic). Hodder elaborates on the implications for archaeology:

> The causes of variability in the archaeological record are not cultural or natural. They are both. Many archaeologists would now accept that while the environment and material forces constrain human endeavour, the specific character of human behaviour is equally informed by cultural choice and human intention. This dialectical view has been arrived at from many directions (Hodder 1999:199).

The senior author also favors the interpretive as opposed to the evolutionary perspective as summarized by James Peacock in the following passage:

> The evolutionary perspective tends to an "objective" positivist stance. This is partly due to the large scale of the evolutionary perspective, so that life is viewed from afar in order to see the whole panorama. Accordingly, life is viewed, not engaged...If humans are seen as aspects of a process, they are seen as worked over by such massive mechanisms as natural selection, the process through which the survival of traits is determined by the environment. The subjective viewpoints are of little interest and, in fact, raise the spectre of what evolutionists term the "teleological fallacy" (the fallacy that subjective purposes affect the evolutionary process, which, instead, should be seen as governed by the law of natural selection regardless of any petty motives and purposes...). Given the irrelevance of the actor's viewpoint, humans are treated as part of nature and analyzed according to natural laws (Peacock 1986:98-99).

It is not that the evolutionary perspective is wrong, but that like all paradigms, including the ecological paradigm with which it is commonly linked in the New Archaeology, it is limited (Peacock 1986:96; Pauketat 2004). Trigger summarizes the major shortcomings of the evolutionist perspective in the context of the debate between the older “processual” and the newer “post-processual” archaeology:

> Yet, contrary to the predictions of processual archaeology, during the last fifteen years there has been a growing realization among archaeologists that there is more variation in the archaeological record, and hence in human behavior, than can be accounted for in terms of neo-evolutionism and ecological determinism. This calls into question the distinction that processual archaeologists drew between evolutionism and history, as well as their assertion that, because evolutionism is more generalizing, its study is superior to that of history, in the sense that all or most specific historical situations can be explained in terms of small number of evolutionary generalizations. Post-processualism denies that

> neo-evolutionary generalizations adequately account for specific situations (Trigger 1991:66-67).

In favoring the historical approach, the senior author differs from many Hawaiian archaeologists who interpret the archaeological record in primarily evolutionary terms as a series of unilinear transformations or stages of development from simple to complex. This approach, which is focused on the development of so-called "complex societies," is typically presented in terms of periods or phases, such as the Colonization Period, Expansion Period, etc. (Kirch 1984, 1985; Hommon 1976,1986; Carson and Mintmier 2006). The senior author agrees with Barrett who has argued that archaeologists should view material culture as a medium of social practice rather than "an external trace or record of a type of society" (Barrett 1994:35), such as a tribe or chiefdom (see also Pauketat 2007).

The senior author holds to the view that archaeology is an interpretive social science and that the "archaeological record" must be understood in both materialist (ecosystem) and idealist terms (the conviction that ideas, beliefs, values, motives, intentions, etc. are of paramount importance in human life). As remarked on elsewhere (McCoy 1991:25), humans, unlike other animals, do not simply adapt to the constraints of the external world (see also Johnson 1999:100); they also make their world--physically, by changing or altering it, and symbolically, by imposing a structure based on beliefs and values. This point of view is today becoming better known as "practice theory." Pauketat, citing Bordieu (1977) and Giddens (1979), has defined practice theory as "…a theory of the continuous and historically contingent enactments or embodiments of people's ethos, attitudes, agendas, and dispositions" (Pauketat 2000:115). Sahlins' writings on how the ideology of a people is changed in practice has been summarized by Hodder:

> In Hawaii, Sahlins recognises sets of preconceptions and ideas which are part of action. For example, *mana* is a creative force that renders visible the invisible, that gives meaning to goodness and godliness. The divine *mana* of chiefs is manifest in their brilliance, their shining, like the sun. On the daily level, such notions orientate actions, as habitus, but they are changed in practice, in `structures of the conjuncture'. No-one can ever know exactly how a particular event or meeting will be played out in practice. The intended and unintended consequences of action lead to reformulation of the habitus and of the social structure (Hodder 1986:85).

Like other brands of archaeology, including what have been called "processual" and "post-processual" archaeologies, there is no consensus on what constitutes a proper field of study in the field of practice theory because of differences in definitions of key terms, such as agency and action (Dobres and Robb 2000; Clark 2000:97; Dornan 2002; Pauketat 2004). Pauketat has said that what he earlier called "historical processualism" (Pauketat 2001) "is not a rigidly structured or even internally coherent research program with a unified agenda" (Pauketat 2004:199). Johnson (2007) summarizes what is a core concept in views of agency and practice theory: "Practice, then insists that people's actions are bound up with a "real world" but that this world is created by them; its elements are constituted through their subjective experience, their view of the world, not an explicit or implicit economic model imposed by a modern writer" (Johnson 2007:145).

Practice theory, which recognizes the centrality of human intentionality in social life (Ortner 2001:272), has been used previously in arguing that the Mauna Kea Adze

Quarry represents something more important and meaningful than the adaptation to raw material scarcity (McCoy 1990:87). Rather, the quarry represents in the senior author’s view a pre-eminent form of social action in the production of goods and reproduction of the social order, so that even though the primary activity was technological and economic, the underlying motives and intentions were in large part social and political, and encompassed societal as well as individual motives--the pursuit of personal careers (see Goldschmidt 1990) governed by the motivation to achieve a status, to seek prestige and honor (McCoy 1990:110; 1991:25).

In a paper written a number of years ago, the senior author concluded that work in the Mauna Kea Adze Complex was an integral part of the social construction of reality (McCoy 1990:114). The term “social construction” has become a common phrase in the writings of many social scientists. Some believe that everything, including nature, is socially constructed (see discussion in Johnson 1999:102). Ian Hacking (1999) has warned against the “strong view” of social construction (see also Weiner 2001). Hacking has written “Social construction has in many contexts been a truly liberating idea, but that which on first hearing has liberated some had made all too many others smug, comfortable, and trendy in ways that have become merely orthodox. The phrase has become a code” (Hacking 1999:vii). The senior author, taking heed of Hacking’s critique, has adopted the “weak view” of “social construction.”

5.0 PROJECT SUMMARY

The project summary that follows includes: (1) a discussion of preparatory work undertaken prior to the start of fieldwork; (2) a chronological summary of work completed in each year of the survey; (3) a discussion of survey objectives, field methods and limitations, and (4) a summary of the findings. The findings, which are described in detail in Volume 2, include a summary description of all of the historic properties that were identified in the survey; artifacts collected during the fieldwork, and a summary of other cultural resources that were found and recorded. The latter encompasses parts of the built environment that are suspected of being less than 50 years old and thus do not qualify as historic properties under Chapter 6E and the National Historic Preservation Act of 1966.

5.1 PRE-FIELDWORK TASKS

Two tasks in the SOW were started before going into the field: (1) development of an integrated spatial database, and (2) the preparation of a new site and feature recording forms and artifact recording forms. Minor changes to the forms were made as the survey progressed.

5.1.1 Development of an Integrated Spatial Database

Copies of all relevant existing reports pertaining to cultural resources in the Science Reserve were assembled and the information contained therein incorporated into a Geographical Information System (GIS) to facilitate information management, mapping, and general data access. Some unforeseen difficulties were encountered in the development of the database which thus remains a work in progress. A plan to complete it at a later date has been discussed with OMKM.

5.1.2 Preparation of Site and Artifact Recording Forms

Because virtually all of the previous archaeological surveys undertaken in the Science Reserve had been reconnaissance surveys (see summary of previous work in Section 3), the data that had been collected were in certain respects limited and incomplete. Review of the site records for the 95 sites recorded prior to the start of the current survey in 2005 revealed two major short-comings:

(1) The first was a predictable degree of unevenness in both the type and quality of data that were collected. In an effort to improve the quality of data, by ensuring that the same information would be recorded for every site, a decision was made during the surveys conducted by SHPD staff in 1995 and 1997 to use a site recording form for the first time. The form, which was primarily designed for the recording of shrines, was a first attempt to begin collecting more detailed information on this, the most common site type, in the Science Reserve. Some important information was omitted, however, and because of the lack of sufficient time and resources, some information was not recorded in a consistent manner.

(2) The second short-coming, in the opinion of the senior author, was the insufficient attention given in earlier surveys to the recording of the shape or form of the upright stones (“god-stones” called *`eho*) found on all of the shrines. The descriptions of some

of the sites recorded in the earlier surveys contain observations on upright shape and other attributes, such as size (McCoy 1984, 1999a), but the data were not recorded in a systematic fashion and were incomplete.

In an effort to use a more rigid approach to field recording along the lines recommended by Glassie (see Section 4), a number of new field forms were prepared during the course of the survey. These included a new site and feature form and forms for the recording of shrine attributes, adze quarry workshop characteristics, adze performs, and hammerstones.

A brief description of the attributes that were selected for characterizing each of the above is presented below in Section 5.4.2.1. An analysis of the attributes appears in Section 6 (Data Analyses and Results) of the report.

5.2 A Chronological Summary of The 2005-2009 Survey

A chronological summary of the 2005-2008 survey is presented below by field season. The summary includes the dates of each survey, names of the field crew, location and acreage of the survey and the number of sites and “find spots” identified in each season. Figure 5.1 shows the areas covered in each field season.

5.2.1 2005 Field Season

The 2005 survey was conducted over a 10-day period between August 29 and September 9, 2005 by Co-Principal Investigators Patrick McCoy and Dennis Gosser, and two other PCSI staff, Richard Nees, and Reid Yamasato. The primary objective of the first season of fieldwork was to resurvey the ca. 525-acre Astronomy Precinct. The survey of Survey Area 1, which includes the area set aside in 2000 Master Plan as the Astronomy Precinct (see Figure 5.1) began on the northwestern edge of the project area on August 29 and was completed on September 6, 2005. Fieldwork in Survey Area 2 (see Figure 5.1) was conducted on September 7-8, 2005. The final day of the 2005 project was devoted to the review and organization of field records and the downloading and logging of photographs on a computer at the Mid-Level Facility at Hale Pōhaku.

Forty five previously identified sites were relocated in the two surveys areas. All of the previously identified sites, most of which were found in reconnaissance surveys conducted in 1982 and 1984, were evaluated in terms of the completeness and adequacy of the existing maps and descriptions. A number of the maps were either redrawn or annotated with new observations.

Twelve new archaeological sites were found in the survey, which encompassed two separate areas, totaling approximately 1,200-acres. Nine of the twelve sites are interpreted as shrines based on ethnographic information and archaeological characteristics. One site, located on the south rim of Pu`u Māhoe, consists of three cairns that are believed to be either survey markers or memorials left by visitors in the historic period, or perhaps even more recently. The function of one site (21449), a small terrace located in the Astronomy Precinct, was recorded as unknown. The twelfth site, located outside the 2005 survey area on the rim of an unnamed cinder cone, is interpreted as a burial. Site 21209, which was found in 1999 on the rim of Pu`u Wekiu, south of the USGS marker, was found to have been effectively destroyed by recent activity (see site description in Volume 2). Site 21209 was the only previously identified archaeological site on the summit.

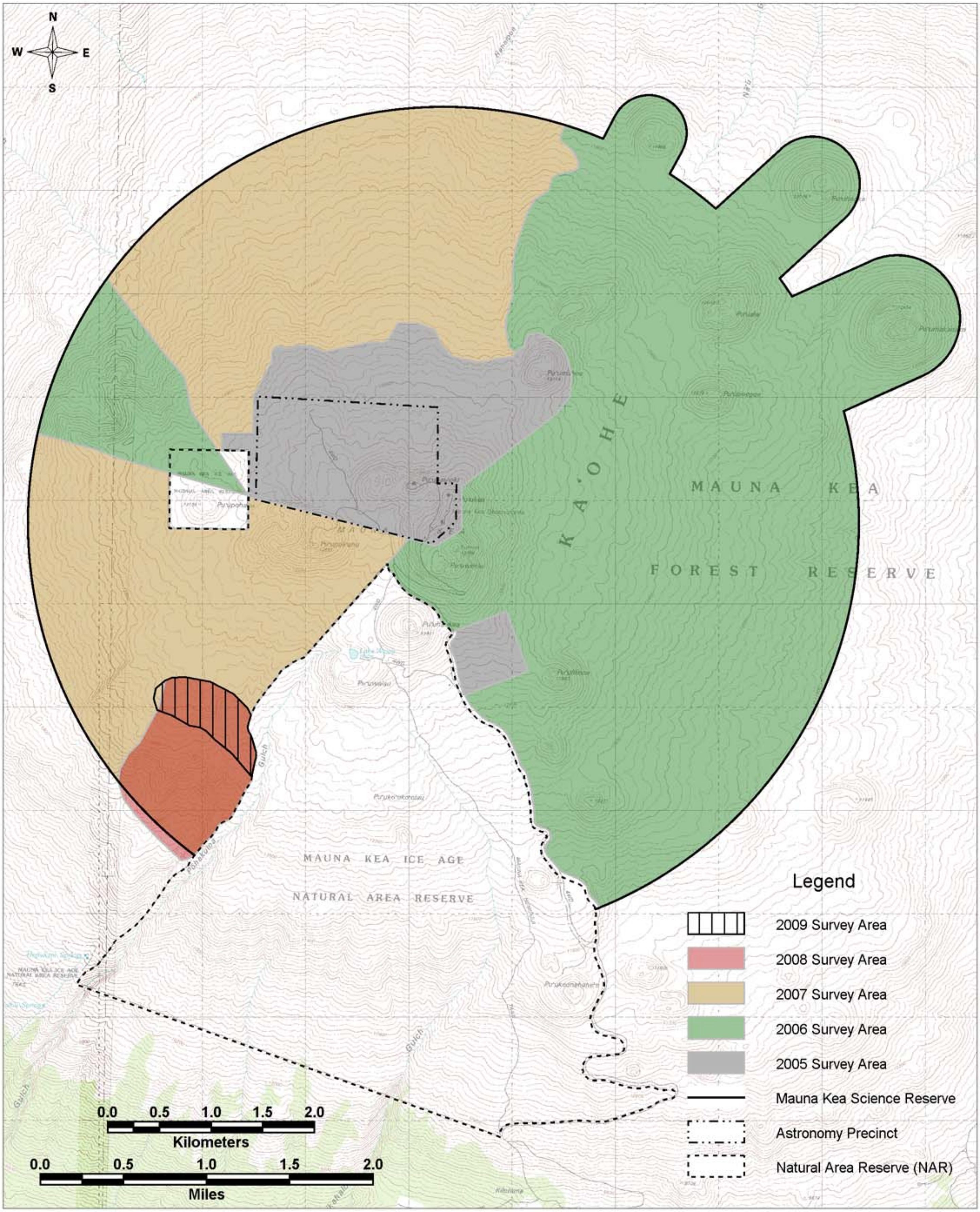


Figure 5.1 Location of 2005 - 2009 Survey Areas by Year.

Previous surveys identified a number of small overhang areas along the edge of some ridges or lava flow margins. Some may have been utilized as temporary shelters, although no artifacts or other evidence of human use have ever been found on the surface of any overhang. Still, there is a possibility that cultural materials may exist beneath the surface and have been simply buried by naturally occurring geomorphic or cultural processes. Small (50.0 cm) test probes were excavated at two overhangs on the north slope (Sites 16177 and 21205) in 2005. No cultural deposits or evidence of human use were found in either overhang.

The number of new sites (12) found in the 2005 survey is not surprising given that nine of these are located in areas that had not been previously surveyed. The finding of three new sites in the 1982 and 1984 surveys areas is also unsurprising given that both of the earlier projects were reconnaissance surveys. It does demonstrate, however, that though an area may have been surveyed on more than one occasion, the finding of a small number of new sites is to be expected, despite the intensity of the survey.

The 2005 survey also identified some 36 “find spots,” defined as man-made remains that are either obviously modern features (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder).

5.2.2 2006 Field Season

The 2006 survey was conducted in two increments and covered two geographically separate areas of the Science Reserve (see Figure 5.1). The first period of work, undertaken July 10-28, 2006 by a crew of four archaeologists (Patrick McCoy, Richard Nees, Keola Nakamura, and Jeanne Knapp), covered roughly 475 acres on the northwestern side of the mountain (Area 1) and an estimated 3,000 acres on the eastern slope (Area 2). The second period of work, August 28-September 16, 2006, utilized a crew of three to four archaeologists at different times (Patrick McCoy, Richard Nees, Sara Collins, Keola Nakamura and Eric Komori) and was focused on the eastern half of the Science Reserve. The survey extended down to the lower boundary of the Science Reserve at the roughly 11,800 +/- foot elevation, except for one section on the eastern slope where the survey stopped a little short. A total of roughly 6,744 acres were surveyed in 2006—5,269 acres on the eastern side and 475 acres on the western side of the mountain.

The 2006 survey identified a total of 73 new sites and updated the records for 29 previously recorded sites in the two survey areas. The sites in Survey Area 1 (see Figure 5.1) are located in the U.S. Geological Survey Ahumoa Quadrangle, and the sites in Survey Area 2, in the Mauna Kea Quadrangle. Several possible sites were also noted, but not recorded due to the lack of time to revisit them and make any kind of final determination. Because of the lack of time we were also unable to update the information for four other previously identified sites (Sites 16192, 21204, 21431, and 21432) and to complete the recording of several new sites.

A total of 20 new burial or possible burial sites were found in 2006—four in Area 1 and 16 in Area 2. All of the sites, which include a total of 37 separate features, are on the tops of cinder cones, except for Sites 25770 and 25774 which are in open areas on the eastern flank of the mountain. The largest number of burial sites is on Pu`u

Mākanaka where 17 features were found at nine sites. Four of the features are confirmed burials. Human remains had been found earlier at Site 16248, thus making a total of at least five unequivocal burials on Pu`u Mākanaka. Four sites containing six features, one of which is a confirmed burial, were found on Pu`u Ala. Three other burial sites were found on another cinder cone with no known name in the northeastern portion of the Science Reserve, near Pu`u Mākanaka and Pu`u Ala.

No sites were excavated in the 2006 survey, but a small number of artifacts, primarily adze preforms and manufacturing waste flakes or debitage, were collected. This was in large part a response to the vandalism of a previously recorded shrine in the 2005 survey area where artifacts had been removed, resulting in the loss of important information (see McCoy et al. 2005) and changes to sites at the VLBA noted in 1997 (McCoy 1999). Lithic artifacts were also collected for the more specific purpose of undertaking a geochemical analysis to determine the number of source areas. A total of 47 lithic artifacts and one historic artifact (a horseshoe) were collected in 2006. The lithic artifacts include 13 adze preforms, 33 flakes and 1 hammerstone. The 2006 survey also identified 189 new "find spots."

5.2.3 2007 Field Season

The 2007 survey was conducted in three increments and covered two geographically separate areas of the Science Reserve (see Figure 5.1). The first period of work, undertaken 18 July through 2 August by a crew of four archaeologists (Patrick McCoy, Richard Nees, Keola Nakamura, and Reid Yamasato), covered roughly 2,061 acres on the northwestern side of the mountain (Area 1) and an estimated 1,903 acres on the eastern slope (Area 2). The second and third periods of work, 20 August through 29 August, and 10 September through 17 September 2007, utilized a crew of three to four archaeologists at different times (Richard Nees, Sara Collins, Keola Nakamura, and Jeanne Knapp) and focused on the western and southwestern half of the Science Reserve. The survey extended down to the lower boundary of the Science Reserve at the roughly 11,800 +/- foot elevation, except for one section on the eastern slope where the survey stopped a little short. A total of roughly 3,964 acres were surveyed in 2007.

The 2007 survey identified a total of 66 new sites and updated the records for 21 previously recorded sites in the two survey areas. The sites in Survey Area 1 are located in the U.S. Geological Survey Ahumoa Quadrangle, and the sites in Survey Area 2 (see Figure 5.1), in the Mauna Kea Quadrangle.

No sites were excavated in the 2007 survey, but a small number of adze preforms and manufacturing waste flakes or debitage, were collected for the purpose of undertaking a geochemical analysis to determine source areas. The 2007 survey also identified 102 new "find spots."

5.2.4 2008 Field Season

The 2008 survey was conducted over a period of 5 weeks between 27 August and 2 October by a crew of three to four archaeologists (Patrick McCoy, Richard Nees, Keola Nakamura, Valerie Park, and Sara Collins). The survey, which was focused on recording an adze quarry complex discovered at the end of the 2007 field season covered roughly 387 acres on the southwestern side of the mountain.

Two excavations were conducted in 2008. The first was at Site 21449 which was found in the 2005 survey of the Astronomy Precinct and described as a terrace of unknown function (McCoy et al. 2005). It was assigned a SIHP number with some hesitation. Because of its location in the Astronomy Precinct and proximity to an area tentatively selected as the location of the proposed Thirty Meter Telescope (TMT), OMKM asked PCSI to excavate the “site” to obtain more information on which to make an informed interpretation of its possible function.

The second excavation was undertaken at Rockshelter 1, a component of Site 26253. This site is located in the newly discovered quarry complex in the Pōhakuloa Gulch area.

5.2.5 2009 Field Season

The 2009 field season was limited to 5 days within a two week period. The work, undertaken between 23 September and 3 October, was conducted in the southwest portion of the Science Reserve by a crew of four archaeologists (Richard Nees, Keola Nakamura, Valerie Park, and Melanie Mintmier). The fieldwork focused on finishing the recordation of the adze quarry complex discovered at the end of the 2007. The area investigated was roughly 111 acres.

5.3 Survey Objectives, Methods and Limitations

As noted in the summary of previous archaeological investigations in Section 3, with the exception of the adze quarry research in 1975-76, all previous archaeological surveys in the Science Reserve were reconnaissance surveys. In keeping with the definition of reconnaissance surveys, the coverage was partial and selective, rather than intensive and complete. A significant part of the work undertaken in the 2005-2009 survey was thus devoted to up-dating the information on the 95 previously recorded sites to ensure the accuracy and completeness of the data and to comply with SHPD requirements.

5.3.1 Survey Objectives

In addition to fulfilling SHPD requirements for archaeological inventory surveys, which are *minimal* requirements (HAR 13-276), the survey had other more specific objectives. Based on the senior author’s conviction that archaeological surveys should do more, when possible, than simply meet regulatory requirements, an effort was made to collect data amenable to new and different kinds of analyses and the formulation of propositions and hypotheses. As mentioned above, more attention was given in the project to recording shrine and artifact attributes and making representative collections artifacts for sourcing and technological analyses.

5.3.2 Data Requirements

The definition of what constitutes an adequate database to achieve the objectives of most archaeological projects, including site surveys, is never a simple, straightforward matter. Much of the time the issue is simply ignored. The assumption is that there is a consensus amongst archaeologists on what is important to record and what is not. Charles Redman has referred to the minimal information necessary to characterize a site as “baseline information,” which in his view is different from the information necessary to address a research problem:

> ...much of the fieldwork we do is designed to collect a common body of information that characterizes the site. I will refer to this as *baseline* information. Baseline information is the minimal set of information that most archaeologists agree must be retrieved from an excavation or survey (Redman 1987:257-258).
>
> Realistically, there are two genres of minimal data requirements with which one must be concerned: those that provide adequate baseline information, and those that solve the specific problems one has chosen to investigate (Redman 1987:259).

What Redman and many other archaeologists fail to recognize is that “baseline information” is theory dependent:

> Now, as all archaeologists know, or should know, there are a multitude of possible competing descriptions of an artifact, an assemblage, or any set of remains encountered in the archaeological record. The choice involved in the description of these remains is related to the theories used to understand them (Shanks and Tilley 1987:109).

If a person believes, for example, that nature is not real, but rather a socially constructed category or analytical construct, then the observations she or he will make will be different from those who hold to the view that humans adapt to a world not entirely of their own making. Lewontin describes how theories, or what he calls organizational metaphors, affect the kinds of observations that are made:

> The metaphor of construction replacing the metaphor of adaptation would completely change the problematic and the nature of evidence because many of the problems are the provision of the evidence of adaptation, looking for ways to show that an adaptation has occurred. But if we deny in the first place that an adaptation has occurred and change the metaphor to one of construction, how organisms have constructed the world in which we live, then we look for totally different kinds of observations (Lewontin 1994a:506).

The “archaeological record” itself oftentimes determines what are appropriate baseline data. The kinds of baseline data that are useful for characterizing quarry sites, for example, are quite different from those needed to present a description of a simple shrine. Simply put, different kinds of sites require different baseline data.

5.3.3 Site and Feature Definitions

No universally accepted definitions of site and feature exist in Hawaiian archaeology and it is unlikely that any ever will because of the architectural complexities of the archaeological landscape in many areas of the Hawaiian Islands, and the different perspectives that archaeologists hold on how the archaeological landscape should be observed and recorded. It is in fact rather uncommon to see a definition of site and feature in Hawaiian archaeological reports, especially those written in the last decade or so. Our impression is that there was more concern with definitions in the 1970s and 1980s. Rob Hommon is one of the few Hawaiian archaeologists to have offered a definition of site and feature:

> An *archaeological site* is a location with evidence of human activity in the past and consists of either a single feature or a complex of features. An

> *archaeological feature* is a spatially limited cluster of evidence of past human activities whose boundaries are determined by the extent of the evidence and/or by the boundaries of the artificial structure or natural land-form that contains it. An *archaeological complex* is a site composed of two or more features that appear to be related in some archaeologically significant way (Hommon 1980:37).

Though Hommon's definitions were never widely employed, perhaps because the distinguishing criteria are somewhat vague, he at least realized the importance of site and feature definitions. It is of interest in this regard that HAR 13-276 does not contain definitions of site and feature and does not even require them.

In our view site and feature definitions for project areas like the Mauna Kea Science Reserve need to be developed in the field and modified as seen fit, instead of trying to pigeonhole every find into a single, predetermined set of definitions. The site definitions and recording procedures employed in this report derive in part from decisions made in earlier surveys, which recognized a simple distinction between "simple" sites, such as shrines, and "complex sites" which refers specifically to the Mauna Kea Adze Quarry Complex where there are a number of different kinds of activity remains.

With the exception of a newly discovered area of the Mauna Kea Adze Quarry Complex, the vast majority of the known archaeological remains in the Science Reserve are single component activity remains. In the 2005-2009 survey each set of such remains, which are typically well separated from one another, was assigned an individual site number. In the case of shrines, where there is more than one set of uprights within 5-10 meters or so of each other, each set was assigned a feature number. Though obviously subjective, the use of a predetermined distance between features would have been just as subjective and would not have taken local circumstances into account.

In the earlier research on the Mauna Kea Adze Quarry Complex, a portion of which is located in the Science Reserve, a *site* was defined as a topographically discrete constellation of what were presumed to be functionally integrated *activity remains*, such as rockshelters, overhang shelters, workshops, shrines and locales with rock art (McCoy 1977; Cleghorn 1982). Each class of activity remains, which were interpreted as the result of groups of adze makers living and working in the quarry, was considered a *site component* and numbered sequentially within a site (e.g., Site 14, Rockshelter 1; Site 14, Shrine 1; Site 3, Shrine 1). Physically discrete portions of the larger, more complex activity remains were assigned f*eature* designations (e.g., Site 14, Workshop 15, Feature 2). In the case of the workshops, many of the features correspond to what are often called "chipping stations," where one or perhaps two individuals were engaged in adze manufacture.

Some archaeologists would probably have assigned either site numbers or feature numbers to each formal category (e.g., lithic scatter, rock overhang, upright stones). While some of these may have been grouped during the analysis of the field data, in order to talk about site structure it would have become necessary, for example, to describe Site X (an overhang) as possibly related to Site Y (an upright stone) and Site Z (a lithic scatter). If feature designations had been used for rockshelters, shrines, and other remains, this would have inevitably resulted in having to talk about features within features which is cumbersome, to say the least. The 1975-76 survey dispensed with this methodology because of the confidence that an upright or group of uprights were a shrine and the obvious fact that shrines, as places where rituals were conducted, were an integral part of the adze manufacturing process and thus not a separate site. The same logic applied to the use of the term workshop instead of lithic scatter given the context and experience of senior staff in recognizing the debitage, unfinished adzes and hammerstones as a workshop area.

The 2005-2009 survey utilized the same general site designation scheme as the 1975-76 project, with a several modifications:

1) A decision was made to dispense with workshop feature designations and to number all workshops consecutively from 1 - # within a site.

2) Diffuse debitage scatters, some of which occupy the spaces between sites and thus complicate the determination of site boundaries, were identified in the field, plotted on a map and described as "flake scatters."

3) Isolated lithic artifacts and scatters located outside of the geologic source areas of tool-quality basalt were given site designations for reasons explained below.

Site boundaries were established based on topographic location, spatial discreteness and clustering, inferred functional differences and obvious differences in age. This does not mean that a site had but one function. On the contrary, some sites include remains with multiple inferred functions. The underlying assumption, of course, is that the material remains are contemporaneous. The function of a number of features and sites, as might be expected, is either simply unknown, or the level of confidence is such that a site is classified, for example, as a possible burial or possible shrine.

The decision to record isolated finds as sites was based on the context of the artifacts, which include adze preforms, adze manufacturing waste flakes and hammerstones far removed from a known geological source. There are a number of differing perspectives amongst archaeologists on how isolated finds, such as these, should be treated and managed. The authors' followed the lead of the National Park Service regarding isolated Early American or Paleoindian artifacts:

> Because documenting isolated finds is so critical for research purposes, they are here viewed as a specific Paleoindian property type. It is also strongly recommended that all isolated finds of Late Pleistocene age should be formally recorded in state site files, as either sites or in a special isolated find category, and that they should receive the same level of written documentation as true sites (National Park Service Archaeology Program, The Earliest Americans Theme Study).

Burtchard et al. (1994) present an interesting discussion of sites and isolated finds in a report on the John Day Fossil Beds National Monument in Oregon:

> Sites are distinguished from isolated finds on the basis of artifact density. As identified here, prehistoric archaeological *sites* contain multiple chipped stone flakes and fragments with or without stone tools. Presence of lithic debitage suggests some form of direct or sustained use of the locality. Increasing density and/or duration of use is roughly reflected by increasing artifact density and variety. *Isolated finds* typically are individual tools without evidence of associated use of the immediate area. Isolated artifacts generally are assumed to be spent shots or tools lost in more generalized use of the landscape. It is important to note that the distinction is arbitrary. <u>All</u> localities are archaeological sites of value for understanding human land-use processes. They are separated here to ease

> management efforts and to distinguish between direct versus generalized use of the landscape. All known sites and isolated finds are treated in similar fashion in dealing with larger land-use issues (Burtchard et al. 1994:6, footnote 5).

In the end Burtchard and his colleagues recognized isolated artifacts as a site type, but did not assign each find a state site number (Burtchard et al. 1994: Table 1.1).

5.3.4 Survey Methodology

In the field of archaeology generally, and in Hawaiian archaeology in particular, there is evidence that archaeological field methods tend on the whole to be taken for granted. The unstated assumption is that the observations made in the field do not differ from one archaeologist to another and that "standard archaeological recording procedures" are universal and known to every archaeologist. This is obviously not the case as a review of the literature would demonstrate. There is always an element of subjectivity, combined with objectivity, in field methods and, as discussed above, the process of defining on the ground the boundaries of sites in a large quarry like that on Mauna Kea.

The problems with doing archaeology without reflecting on field techniques and methods are highlighted in this statement made by Bradley:

> The practice of archaeology is not as objective as fieldworkers would like to believe; nor is it as subjective as theorists often suppose. Its procedures employ a mixture of objectivity and subjectivity…The observations made in the field depend on a whole series of assumptions that are not discussed because they are taken for granted. It is only when those ideas are challenged that archaeologists can recognize their own vulnerability. All their primary observations are influenced by their knowledge and experience, but what they accept as knowledge, and what they think of as relevant experience, will change when the assumptions behind them are questioned. The methods used in the field constrain the interpretations formed at the time, and those techniques may not be the best ones for investigating different problems (Bradley 1998:3).

5.3.4.1 Description and Interpretation and the Importance of Context

Description can no longer be regarded as a totally objective and purely methodological undertaking. In deciding what is important to record and why it is clear that description is an interpretive act. Peacock (1986) notes how description is not only inseparable from interpretation, but how interpretation is also theory-laden:

> The impossibility of making a carbon copy of reality and therefore the necessity of interpreting even as one describes is true in all sciences. One definition of the fact captures this point: A fact is a percept viewed through a frame of reference. The observer-describer brings to his object of observation his own theories and questions as well as implicit biases and attitudes, and these set a framework for his perceptions (Peacock 1986:66-67).

Hodder notes how description and interpretation are both subject to being contested:

> Descriptions seem obvious and undisputed. Interpretations involve the selection of information according to certain criteria, and they involve judgements that can be contested by others. However, all description involves selecting and ordering information (Hodder 1999:67).

> All description involves an interpretive component. But equally, all interpretation involves trying to link sense to data. Interpretation is always interpretation of something. Thus it is always partially a description (Hodder 1999:67).

The philosopher Richard Shusterman elaborates on the questionable distinction between describing and interpreting and notes that the distinction can only be relative:

> First of all, we must remember that every description of a work of art involves an interpretation of it, since it involves a selection of what to describe, what aspects of the work are important as to be worth describing. No description describes everything, egalitarianly reflecting all that can said truly about a work. But what more acutely undermines the idea of any firm and distinct distinction between descriptive truth (presenting the work's core of incontrovertible properties) and interpretive elaboration is that what is taken as descriptively true (the so-called hard fact on which interpretation is based) will often shamelessly depend on which interpretation of the work we come to adopt...More generally, we can be led from what we originally see as simple facts about the work to reach an interpretation of the work which dislodges or recasts the facts by showing the work in such a way that the original descriptions no longer ring true or adequate (Shusterman 1992:71).
>
> Thus, any distinction between describing and interpreting (as between understanding and interpreting) can only be relative and formal. It must be a pragmatic, shifting, heuristic distinction, not an unchanging one which would provide a firm and incorruptible core of determinate truth for simple and final description. In other words, it is not that we all agree how to describe the facts and differ only in what interpretations we elaborate from them. It is rather that the descriptive facts are simply whatever we all strongly agree upon, while interpretations are simply what commands less consensus and displays (and tolerates) wider divergence (Shusterman 1992:71-72).

Archaeological interpretations are not only theory-laden, they are also heavily dependent on context (Hodder 1987; Papaconstantinou 2006). Glassie has written that "To explain the object the analyst needs to know something of its meaning, and to know its meaning he needs some understanding of its context" (Glassie 1975:116). Richard Gould argues that "Anthropology's greatest and most lasting contribution to the social sciences lies in its recognition that context [interrelated conditions in which something exists or occurs] is everything in explaining variability and change in human behavior," and that "when disagreements arise in archaeological interpretation, they usually spring from different assumptions about what constitutes the relevant context: Not all archaeologists can agree on what contextual variables to control for, with the result that there may be widely divergent explanations for the same archaeological assemblages" (Gould 1990:5).

There are, of course, many different kinds of context, such as the culture-historic context of the project area described in Section 2. There is also the environmental context, which can be broken down into a number of specific contexts, such as the physiographic or geomorphological context.

The periglacial environment of the summit region is of major importance because of the dominance of frost-activated mass-movement slope processes (primarily gelifluction) and the effects these have on the spatial integrity of sites and quarry workshops in particular. The surface area of many workshops, for example, is in part a result of the downslope movement of flakes, cores, adze preforms and hammerstones. The problems created by the long-term, cumulative effects of post-depositional movement in determining workshop and site boundaries cannot be overemphasized, even in areas with a gentle slope (Figure 5.2). A salient characteristic of gelifluction is the abnormally low angle over which material is transported (Davies 1972:1). The extent or degree of disturbance, which includes both horizontal and vertical displacement of surface material (i.e., burial in the geological matrix of gelifluction lobes and terraces), cannot be accurately determined without excavation.

In some cases it is possible to distinguish the natural and the cultural without excavation (cf. Williams 1973; Tilley et al. 2000). For example, with experience it becomes possible to distinguish with some degree of confidence a gelifluction terrace, which occur in such numbers that they are essentially uncountable, from a man-made terrace of which there are relatively few in the Science Reserve (see Figure 2.5). As discussed elsewhere (McCoy 1999b), while an understanding of natural site formation processes (Schiffer 1983, 1987) helps to understand some aspects of the archaeological record, it is by itself never adequate to fully comprehend the meaning of the artifact assemblages found on a gelifluction terrace, for example.

5.3.4.2 Field Techniques

The techniques employed during the survey were on the whole rather uniform, with the exception of the adze quarry (discussed below in site recording procedures). Based on the results of the earlier surveys, ridge tops and other areas of high relief were the focal points of the most intensive search for sites, since this is where the vast majority of sites had been found. Apart from this fact, the tops of lava ridges and lava domes also provide excellent vantage points from which to scan the terrain below with the eye or binoculars. It is important to note in this regard that “archaeological visibility” in the summit region, indeed on the whole top of the mountain above the tree line, is exceptionally good. Areas of low relief, such as the glacial drift deposits and moraines, can be scanned very quickly to determine the presence/absence of historic sites.

While the survey methods employed in earlier projects had proven to be generally successful, the current survey also employed the use of systematic transects, following either a set azimuth or more often, topographic features (ridge tops), to ensure that the coverage was as complete as possible. The spacing of individuals within transects varied and was determined by the kinds of landforms present in a given area. In open areas with no rock outcrops, individual crew members were more widely spaced, whereas areas of relief required closer spacing.

Beginning with the 1982 reconnaissance survey (McCoy 1982; McEldowney 1982) the practice in all subsequent archaeological surveys in the Science Reserve has been to not test possible burial features to determine the presence/absence of human remains. This same practice was adhered to in the current project out of respect and because the sites are being preserved. One result of this decision is that many structural features believed to be burials are classified in this report as “possible burials” because no human remains were observed at the time the site was recorded.

Figure 5.2. Photographs Showing Adze Manufacturing Debitage in an Active Geligluction Lobe.

Because of the lack of ready access in most areas of the Science Reserve, some logistical planning was needed. The OMKM rangers assisted the survey crews as much as possible in executing vehicle drop-offs at strategic locations, so the crew could depart from one place and walk back to a vehicle by another route. This not only saved time and energy, it also meant that some areas, such as the east slope, were surveyed in a crisscross pattern, thus adding to a sense of more complete survey coverage.

5.3.5 Site Recording Methods and Procedures

Previously identified sites were relocated using GPS locational data recorded by SHPD in 1995 and 1997. New GPS readings were taken at all sites. Field observations were recorded on the Site Recording Form developed prior to the start of fieldwork. The completeness and, thus, adequacy of the 95 site records that existed at the start of the survey, including maps and descriptions, were evaluated in the process of filling out a new form for each site. Most of the sites required a new scaled map to replace the sketch maps made during the earlier reconnaissance surveys. In a few cases it was possible to annotate an existing map with new information.

Digital photographs were taken of all sites. The general location and direction of each photograph was marked on site maps to serve as photographic reference points. The purpose in establishing such points is to provide future land managers and researchers with a guide for taking new photographs from the same places on a site to assist in the monitoring of changes in site condition. The large number of workshops in the quarry precluded taking a photograph of every one.

The magnitude of the gelifluction process in the quarry forced us to reconsider how to map and describe workshops. In the end a new descriptive category was adopted to deal with the problem of dispersed manufacturing by-products, primarily waste flakes, some of these areas, termed “flake scatters” cover large areas.

5.3.5.1 Primary Site Information

As described in Section 5.2, a site and feature recording form was developed at the beginning of the project for use in the field and for creating a site database. The form, which was based in part on an earlier form developed by SHPD in 1997, was aimed at ensuring that all of the normal site information (e.g., location, area or size, etc.) would be systematically recorded. Some minor revisions to the form were made during the course of the survey. The baseline site data that were recorded included:

***Site Number*:** Unfortunately, the sites recorded in the 1982 and 1984 surveys have several numbers---a Bishop Museum number and a State number that were assigned in the 1982 survey and used in the 1982 report, and another State number that was mistakenly assigned by Cordy in his synthesis of the Hāmākua District (Cordy 1994). Because Cordy’s publication has been widely circulated, a decision was made to use the number he assigned.

***State Site Number*:** The Mauna Kea Science Reserve is located within portions of two USGS quadrangles (Mauna Kea and Ahumoa) and there are thus two different prefixes for the sites in the Reserve: 50-10-22- for the Ahumoa Quad and 50-10-23- for the Mauna Kea Quad.

***Bishop Museum Site Number*:** The Bishop Museum (BPBM) site numbers assigned in the earlier surveys (see **Section 3**) are all prefixed by 50 (Hawaii)-Ha (Hawaii Island)-G (Hāmākua District) and 28 (Ka`ohe Ahupua`a): example 50-Ha-G28-2.

***Temporary Field Number*:** The number assigned during fieldwork, prior to the assignment of a State number.

***GPS File Number*:** These are the field readings, which can be converted to either northing/easting, UTM, or Lat./Long.

***Elevation*:** The site elevations used in this report are based on the USGS quadrangle map plots that were determined using GPS field readings. The elevations for most all sites are believed to be accurate within 5 feet. A different set of elevations, sometimes nearly identical to those on the contour maps but often considerably higher, appear in the field records and in the GPS logs. In deciding to use the USGS map data as the standard for presenting elevation data, there is recognition of the fact that USGS contour maps may contain errors, especially in areas of high relief, and that the true elevations of the sites on Mauna Kea are essentially unknown or open to question.

***Formal Site Type*:** See definitions below.

***Functional Site Type*:** See definitions below.

***Feature Number*:** Feature numbers, when used, were numbered sequentially within a site.

***Site Dimensions*:** Most of the sites in the Science Reserve are not bounded or circumscribed by anything, such as a wall, thus making the determination of site size problematic; the dimensions presented in the site descriptions are the maximal area encompassed by a feature or set of features; they should not be interpreted as necessarily reflecting the area of a site or the boundary of the ritual activities performed, in the case of shrines.

5.3.6 Artifact Recording and Collection: Philosophy, Objectives and Methods

We do not subscribe to the “no collection strategy” advocated by various public and private agencies (see comments in Butler 1979). Instead, we hold to the opposite view for several reasons, among which is that we think it is naive to think that the artifacts in areas with high surface visibility, such as the adze quarry complex on Mauna Kea, will always be there for study in the future (Butler 1979:796; Schaafsma 1989). At the same time we think that in the case of quarry sites, where there is an abundance of surface artifacts, we must also consider alternatives to collecting.

The recording of attribute data in the field is one alternative to collecting. The primary rationale for this particular kind of data collection approach, which was used in 1985 in the context of a data recovery project in the Hopukani and Liloe Springs area of the Mauna Kea Adze Quarry Complex (McCoy 1986) and at the Pu`u Moiwi Adze Quarry on Kaho`olawe (McCoy et al. 1993), is that it is a quick and efficient method of obtaining useful data for:

1) recognizing general patterns, such as inter-site assemblage variability;

2) making informed interpretations on reduction strategies, and

3) developing hypotheses for future work.

It is necessary to emphasize that this method is *not* a substitute for permanent collections. The great value of permanent collections, of course, is that they can be studied over and over from different perspectives and with new and different techniques.

5.3.6.1 Sampling Design and Recording Procedures

In the adze quarry, the primary objective was to make systematic and, to the extent possible, "representative" surface collections. Representative collections should be made using an appropriate sampling design of the kind suggested by Sullivan, who has useful things to say as well about the matter of redundancy in sites such as quarries:

> Not only must individual collections possess characteristics that make them useful for continuing research, the aggregate sample of the archeological record preserved in collections must allow continuing study of the broadest possible range of research problems (Sullivan 1992:4).
>
> While a certain level of redundancy in collected information is necessary for research purposes, excessive redundancy in collected materials may exist for some types of sites and projects. Sites with large and highly redundant sets of materials, e.g., quarry sites and brickyards, pose questions of trade-offs between large samples and costs of facility space...What constitutes a sufficient sample of material from these sites? Regional variation in the archeological record must be considered since redundancy at the regional level, e.g., regions with many quarry sites, may allow conservatism in sample size at the site level. Consideration of sample size and composition leads to a second key factor in ensuring a satisfactory database for future research--the overall representation of the archeological record in curated collections (Sullivan 1992:4).

The artifact recording and collecting "sampling design" was dictated in large part by time and personnel limitations. The selection criteria varied from site to site and were dependent in large part on assemblage size (i.e., the number of specimens of a class of artifacts). On sites with larger assemblages we were forced to reduce the sample size and make more choices in terms of what was either recorded or collected. In some cases we tended to pass over irregular-shaped, hard to classify specimens. Some of the collections consist of just "grab samples."

Two different methods were employed in mapping and collecting artifacts. In the adze quarry, artifact locations were plotted on a scaled map. Each class of artifacts was numbered consecutively 1 - # for each workshop. Measurements were made with tape measures and rounded off to the nearest millimeter.

A total of 76 artifacts, primarily adze preforms and hammerstones were collected in the survey.

5.3.7 Excavation Methods and Procedures

Controlled excavations were undertaken at two sites. Excavation of Site 21449, a small terrace located in the Astronomy Precinct, was conducted in the hope of retrieving information to aid in the determination of site function. A single 1.0 m by 1.0 m test unit was excavated. The unit was positioned to include a portion of the possible facing and the level area south of the facing in order to determine the presence/absence of subsurface cultural materials, features, and layers. A single test unit (TU-1) was placed at the entrance to Rockshelter 1 at Site 26253 to determine the presence/

absence and vertical extent of any subsurface cultural deposits. TU-1 measured 1.0 m by 0.5 m and was positioned parallel to the long axis of the dripline (see description in Volume 2).

Standard excavation procedures were used in the text excavations at both sites. Excavations were conducted by natural stratigraphic layers and arbitrary 10.0 cm levels within each layer. All excavated material was sifted through a 1/8 inch wire mesh screen. All soils and sediments were documented and described based on standard USDA soil descriptions; including soil color (Munsell 2000), texture, consistency, and plasticity (Schoenenberger et al. 1998). Color photographs were taken before, during, and after excavation.

The excavations are discussed in detail in Volume 2. The flake debitage, charcoal and faunal remains from Site 26253 are analyzed in Section 6.

5.3.8 Survey Limitations

Though the whole 11,288-acre project area was surveyed, it is impossible to claim, as is the common practice in Hawaiian archaeological inventory surveys following on the minimal requirements set forth in HAR 276, that all historic properties were identified and recorded in the Science Reserve. The authors, based on years of cumulative field experience on Mauna Kea, agree with Cowgill that it is a mistake to think that an archaeological survey, surface collection or excavation is ever "total" or complete in terms of, for example, identifying or recovering every single artifact (Cowgill 1986:378; 1989a; 1989b). Cowgill referred to one specific case to make his point:

> Plog et al. (1978) show that although the large and conspicuous sites may be reliably found in open landscapes, no surveys have yet reached the level of intensity at which a still more intensive survey fails to reveal additional inconspicuous but significant occurrences of archaeological data. In order to be able to even begin to compare the results of one survey with another, we must *routinely* describe the exact procedures used, and recognize that more intensive survey would always modify the picture (Cowgill 1986:379).

Cowgill's remarks hold especially true of stone tool quarries of the size and complexity as those found on Mauna Kea. While what is often called "archaeological visibility" is excellent because of the absence of a vegetative cover, the vast size of the project area, combined with a geomorphological regime dominated by slope movement, means that many inconspicuous artifacts (e.g., flakes and even adze preforms) may be alternately exposed and buried. So one survey may observe a small cluster of flakes while a survey of the same intensity conducted at different time would observe no artifacts on the same ground surface. There is, in effect, an inverse relationship between archeological visibility overall and the ability to see or observe small artifacts and even small sites, such as single uprights where the upright may have fallen onto a bedrock surface amongst a mass of other stones.

While the entire 11,288-acre project area was covered, the intensity of coverage was not uniform. This is in part a result of the history of previous archaeological surveys in the Science Reserve. The areas that have been surveyed most intensively are those that have been covered in more than one project. This would include the 1982 and 1984 survey areas which were partially covered again in 1995 for the purpose of obtaining site locations using GPS. The Astronomy Precinct falls within the area of more intensive survey coverage.

The one part of the landscape that was not systematically surveyed was the steep slopes of cinder cones. A systematic, intensive survey of an entire cinder cone would have required a huge expenditure of time and effort. Such an effort would have resulted in extensive scarring of the slopes and the probable disturbance of large areas of *wekiu* bug habitat. In addition, while there is ethnographic evidence to suggest the possible existence of human skeletal remains in buried contexts on the lower flanks of cinder cones, the massive size of these landforms and the instability of their steep-sided slopes effectively precluded survey and subsurface testing as a means of determining the presence or absence of burials or any other possible subsurface features. The survey of cinder cones was limited to the rims.

Another factor that posed a problem in conducting the survey were the effects of high altitude on the field crews. The project area is unlike any other in the Hawaiian Islands in terms of the kinds of physical and mental challenges it presents for fieldworkers. At elevations ranging from roughly 11,800 to over 13,000 ft a person will experience high altitude hypoxia, which is produced by the reduction in partial atmospheric pressure with increasing elevation. The effect is a significant decrease in aerobic working capacity (Grover 1974, 1979). In the project area, the aerobic working capacity varies between 82% and 77% of the value at sea level (Figure 5.3). Sudden changes in weather conditions also occur. Fog and other forms of ground condensation occur with some regularity, typically in the afternoon, and depending on the amount of moisture and temperature change can leave a person at risk of hypothermia. Dense fogs can also cause a person to become disoriented. In addition to the usual effects of high altitude on work performance, day-time temperatures on a number of days remained in the 30s and 40s. It is clear from our own field experiences that the old adage, "night is the winter of the tropics," frequently applies to the day as well. Field conditions were made even more uncomfortable on many days because of high winds. Wind and cold presented problems in terms of mapping and writing field notes and may have contributed to more than the usual amount of mental errors that are virtually impossible to avoid at high elevations.

5.4 SUMMARY OF SURVEY FINDINGS

The 2005-2009 inventory survey recorded a total of 263 sites (Appendix C). This number includes the 95 previously identified sites and 168 new sites. Figure 5.4 shows the general distribution of historic properties, including a few located outside of the Science Reserve boundary. The latter sites have been included in the inventory of historic properties because of the uncertainty of the GPS elevations and accuracy of the USGS quadrangle contour maps. Figure 5.5 is an oversized map showing all of the historic properties with site numbers. It is included in a pocket at the back of the report.

Of the 263 sites 181 (68.82%) are single component of feature sites; the other 82 (31.17%) are multi-component or feature sites. A list of formal and functional categories by site is presented in Appendix D. A brief description of site types is presented below. Detailed site descriptions, including illustrations, are presented in Volume 2. An analysis of the site data is presented in Section 6.

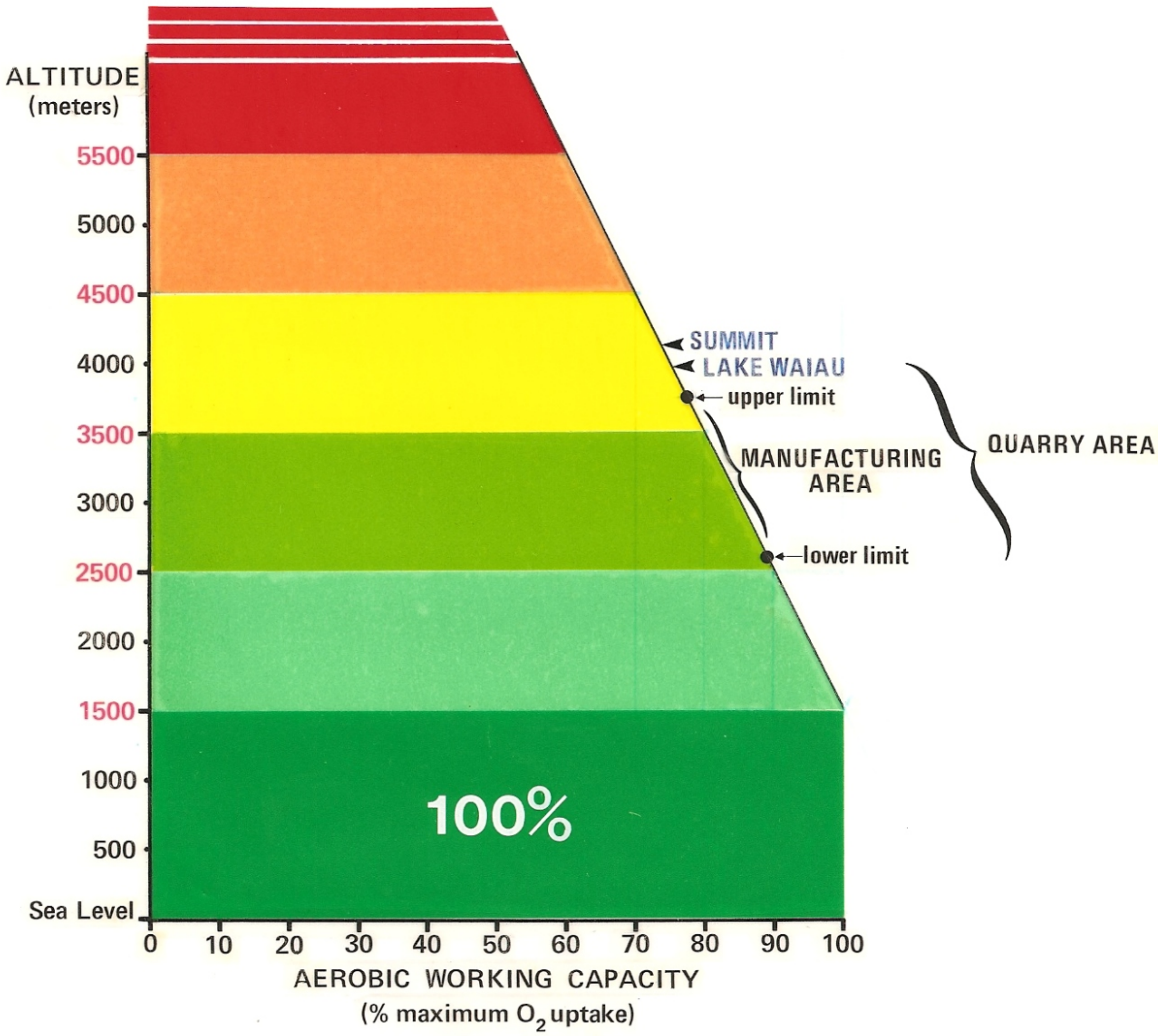


Figure 5.3. Reduction in Aerobic Working Capacity with Increase in Elevation.

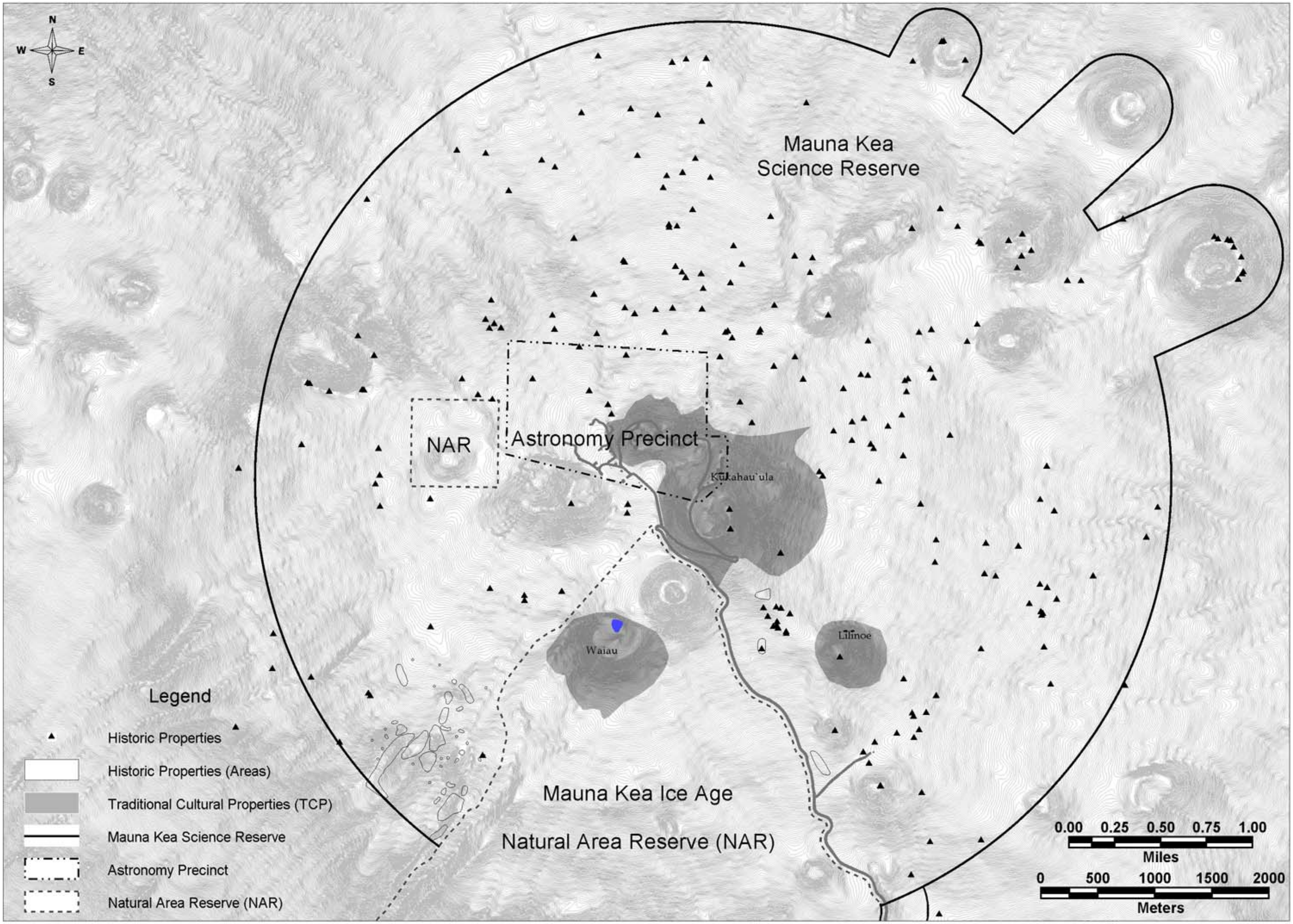


Figure 5.4 Location of Historic Properties Identified in the Mauna Kea Science Reserve.

Note: This Figure is Located in the back pocket of Volume 1

Figure 5.5 Oversized Map Showing Historic Property Locations.

5.4.1 Historic Property Types: Formal and Functional Categories

The convention in Hawaiian archaeology today, due largely to the requirements set forth in Chapter 13-276 of the Hawaii Administrative Rules on archaeological inventory surveys, is to distinguish between formal and functional "types." While sites and features can be easily described in terms of formal attributes, there is in reality no dichotomy between form and function, since function is inferred from form, as argued below for artifacts, but which applies to sites and features as well:

> It must at the same time be recognized that function is an inferential variable... that is, it is an inference made by the archaeologist himself, mostly on the basis of the observable form of the artifact. Consequently, there is no real dichotomy between functional and formal classification …functional classification merely involves the consideration of certain specific attributes of form and not others (Adams and Adams 1991:285).

Functional inferences in this report are based on the environmental and culture-historical context of the project area, formal attributes, locational context, and comparative ethnographic and archaeological data from Hawai`i and other areas of East Polynesia.

Because archaeology is fundamentally an interpretive practice, as argued in Section 4, and because the traces of past practices that archaeologists interpret are often fragmentary and incomplete, there is always an element of ambiguity or uncertainty in the inferences that are made, especially inferences of site function and age. This is especially true of piled and stacked rock features. The problem of determining the age and function of rock features, such as mounds and cairns, is common in Hawaiian archaeology (cf. Reinman and Pantaleo (1998) for a discussion of the problem in the Pohakuloa Training Area).

5.4.1.1 Formal Site and Feature Types in the Project Area

The following list represents the most commonly found formal site and feature types found in the summit region of Mauna Kea. Many of the terms have been used before in earlier reports.

Ahu. According to Pukui and Elbert (1986:8) an *ahu* is a "heap, pile, collection, mass; altar, shrine, cairn; a traplike stone enclosure made by fishermen for fish to enter..." The various meanings, which include cairns and mounds, point to the problem of distinguishing these latter terms.

Cairn. Cairn is a widely used term, which is used to refer to a number of different kinds of stone constructions, however. Linda Hogan, a Native American, has noted that "In its usual, restricted sense, cairn refers only to the (most often) conical pile of stones used to mark boundaries; turning points along routes of travel; caches of food, water, and equipment; areas of danger; sacred sites; and places of private or personal importance" (Hogan 2006:58). In previous archaeological surveys on Mauna Kea cairn has been used to refer to a pile or heap of stones of generally circular to oval shape at the base; there are two varieties in the summit region of Mauna Kea--loosely constructed pyramidal forms with no facings that tend to be of nearly equal in diameter and height, and well-constructed cylindrical piles with facings. The distinction between cairn and mound (see below) is not always easily made, especially in the case of a tumbled cairn which can look like a mound or a simple rock pile.

Cave, Overhang, and Rockshelter. As used in this report and previous reports on the Mauna Kea Adze Quarry Complex, there are no caves utilized by humans in the Science Reserve and NAR. A cave is distinguished from an overhang by a depth (measured from the dripline to the back of the opening) that is greater than the breadth or width of the opening. The areas utilized by Hawaiians for shelter in the summit region are overhangs at the edge of lava flows. These have been called rockshelters, though the term overhang has also been used.

Lithic Scatter. Lithic scatter is a generic term for all of the stone tool residues found at a given locality; these may include tools or implements, unfinished tools, manufacturing waste and hammerstones or some combination of all of these. Lithic scatters represent activity areas where one or more of the following activities may have taken place: tool manufacture, tool use, tool discard.

Prior to the 1980s and an increasing interest in stone tool manufacture, lithic scatter was a rarely used term in Hawaiian archaeology. Indeed, it was not employed in the earlier work in the Mauna Kea Adze Quarry Complex, in 1975-76 (McCoy 1977; Cleghorn 1982) for reasons discussed above. The term lithic scatter does not appear in the literature on the Mauna Kea Adze Quarry Complex until a later date. It was first used and defined in the report on the Pu`u Kalepeamoa Site (McCoy 1991) and later, in a paper on Site 16204 (McCoy 1999b). The lithic debris found at both of these sites differ in important ways from what is typically found in the quarry proper, where manufacture is the only one of the three activities (tool manufacture, tool use, tool discard or some combination of the three) is indicated, with a couple of rare exceptions (e.g. a modified or utilized flake is present, indicating a second function). At the Pu`u Kalepeamoa Site there is evidence of two artifact manufacturing technologies (adzes and octopus lure sinkers), tool use and tool discard (McCoy 1991). At Site 16204, a ritual complex, there are a small number of adze rejects, flakes, and hammerstones. The assemblage was described as a lithic scatter instead of a workshop because:

> This term [*workshop*], though rarely defined in the literature, normally implies in the case of reduction technologies, such as stone tool manufacture, a coherent structure amongst the various by-products of work [cores, waste flakes, rejected tools, etc.] that constitute this category of archaeological remains (McCoy 1999b:25).

Lithic scatter is a more appropriate field designation to use in situations, such as: (1) Site 16204, where the relationship between the various by-products and their behavioral meaning is unclear or ambiguous, and (2) the Pu`u Kalepeamoa Site Complex (16244), where there is evidence of multiple reduction technologies and, thus, different kinds of debitage (McCoy 1991).

In the case of the quarry proper, the alternative would be to describe every single concentration of adze manufacturing debris as a lithic scatter and then explain in every single case why the debris is believed to represent an adze manufacturing workshop. This approach would not only be inefficient, it would also perpetuate the long held, mistaken belief that description and interpretation are separate acts.

Lithic scatter is used in the present report as a blanket term to refer to the isolated artifacts found outside of the quarry proper, where their occurrence and function are ambiguous.

***Flake Scatter*.** The term flake scatter, which occasionally appears in the field notes and site descriptions in Vol. 2, is used interchangeably with lithic scatter. In some contexts it refers to a lithic scatter comprised of just flakes. In other situations it is a more generic term, equivalent in terms of its generality to lithic scatter.

***Chipping Station*.** In the 1975-76 research on the Mauna Kea Adze Quarry Complex, the term "chipping station" was used in reference to small, physically discrete features within a larger workshop (McCoy 1990:96). The term, which appears in some of the site descriptions in Volume 2, refers to a physically discrete workshop area characterized by small flakes that would appear to represent what are often called "finishing flakes."

***Mound*.** A pile or heap of stones that is more irregular in construction and form than a cairn; the linear variety has sloping sides and a generally irregular upper surface.

***Pavement*.** A roughly flat to level surface of placed stones that may vary considerably in size, form and compaction; a term commonly applied to the upper surfaces of platforms and terraces; pavements can occur by themselves as either sites or features of sites.

***Platform*.** Commonly defined in Hawaiian archaeology as a free-standing stone structure two or more courses high and with faced sides; the fill can be made up of stone and/or soil; usually rectangular or square in shape; the term has been applied more loosely in previous reports on the archaeology of the Mauna Kea summit region as any kind of constructed foundation on which upright stones were placed; this more generic definition is also used in this report.

***Terrace*.** A structure similar to a platform, except that one side is not free-standing, but rather abuts a slope or rock outcrop; like a platform, the fill can be made up of stone and/or soil.

***Upright*.** An archaeological term for what are inferred to be god stones that the Hawaiians called *`eho* or *pōhaku `eho*; this same term was also used for stone boundary markers and bird cooking stones (cf. Pukui and Elbert 1971; Buck 1957; Emory 1938; McCoy 1991); because they were set on end (the long axis of the stone is vertical) they are called "uprights."

***Structural remains*.** A general term that refers to what is sometimes called the "built environment" and includes shrines, cairns, and the semi-enclosed structures interpreted as temporary shelters.

***Wall*.** A free-standing linear arrangement of stones that is longer than it is wide and at least two stones high; the sides and top are normally level in contrast to linear mounds.

5.4.1.2 Functional Site and Feature Types in the Project Area

Definitions of the functional site and feature types found in the project area are presented below. Functional inferences are based on a number of factors, including morphology, construction style and materials, locational context and comparison with similar remains of known function. The confidence level in assigning functions to many of the sites and component features varies.

***Burial*.** A deliberate or intentional interment of human remains.

***Stone Marker/Memorial*.** A general term applied to cairns, mounds, or piles of rocks believed to have been built by either Hawaiians during the pre-contact period to mark a trail or land boundaries; modern-day surveyors, or visitors to commemorate the ascent of a cinder cone or another destination, such as Lake Waiau.

***Shrine*.** In common usage a place of worship; the distinction, if one existed in the Hawaiian past, between shrines and temples (*heiau*) is not altogether clear. The present study uses shrine as a generic label for all sites with at least one upright stone. The definition departs slightly from the one used by Sir Peter Buck, who defined a shrine as "a convenient term to designate a simple altar without a prepared court. They were made by individuals or small family groups who conducted a short ritual which required no priest" (Buck 1957:527-528). A small number of shrines have prepared courts and some of these are sufficiently complex to infer that a priesthood was involved in their construction and use.

***Temporary Shelters*.** A small number of semi-enclosed walled structures of various shapes are found in the Science Reserve and have been interpreted as temporary shelters based on their size and form and comparison to similar structures in the coastal lowlands.

***Unknown Function*.** This term is used to refer to remains where the function cannot be determined on available evidence.

***Workshop*.** In sites, such as adze quarries the term workshop is the functional equivalent of a lithic scatter that contains material evidence of tool manufacture and/or use; though rarely defined in the literature, this term normally implies in the case of reduction technologies, such as stone tool manufacture, a coherent structure amongst the various by-products of work [cores, waste flakes, rejected tools, etc.] that constitute this category of archaeological remains. Like quarry, this term or one with the same meaning, such as "working areas," is rarely defined in the literature. Torrence, for example, noted that in her work on the island of Melos, "Well-delimited regions on the density maps can be translated into 'working areas' in behavioral terms, with the density of the surface obsidian as a rough quantitative measure of the amount of use of each location…" (Torrence 1984:51-52).

***Quarry* and *Workshop*.** The archaeological literature evinces a considerable amount of confusion surrounding these terms, particularly the word quarry, which to many people is synonymous with the word mine, where material is excavated and removed from beneath the surface. In many instances the meaning of the term is simply taken for granted (for an exception cf. Kahn et al. 2009) and not defined (e.g., Leach and Witter 1990; Weisler 1990; Torrence 1990). Torrence is one of the few archaeologists to distinguish between quarries and mines:

> In Europe, *quarries*-which can be defined as open sites where material was procured directly from outcrops located on the surface or from relatively shallow pits or trenches-have received much less attention that *mines*-sites where impressive shafts up to ten meters deep were sunk into order to obtain high quality surface rocks (Torrence 1986:164-165).

The most common and easiest method of obtaining raw material is to simply collect it from the surface (loose cobbles and boulders) or to extract it from lava flows or embedded boulders (boulder outcrops). The places where such activity has taken place, where there is a raw material source, are defined quarries. The physically discrete areas within quarries are workshops, but workshops are also commonly found some distance from the *quarry proper* (the source) which means that the raw material and/or incipient tools have been purposively transported and the work resumed in a new location.

***Quarry/Workshop*.** This is a term that appears rather frequently in the archaeological literature (e.g., Leach 1984; Torrence 1990:62). In a discussion of the quarry/workshop distinction at the Pu`u Moiwi adze quarry on Kaho`olawe, it was noted that the number of adze manufacturing sites and features identified in the 1976-1980 survey of the island could not be determined because *quarry* and *workshop* were lumped together in a single class of site--*quarry/workshop*--characterized by the presence of boulders or outcrops. At first glance there is nothing wrong with this definition and in fact it is a good definition of a *quarry* as: (1) comprised of *workshops* and (2) coterminous with the raw material source. The problem is that the confounding of quarry and workshop excludes concentrations of adze manufacturing debris where there is no evidence of a raw material source (McCoy, Sinoto, and Makanani 1993).

***Quarry Complex*.** An aggregation or cluster of quarry sites that are physically separated from other sites. The boundaries of such complexes are in some cases arbitrary. The term is used partly as an heuristic device to facilitate comparisons between parts of the Mauna Kea Adze Quarry Complex, which covers a large area and is comprised of both clustered sites and dispersed sites at different elevations.

5.4.2 Summary Description of Individual Classes of Historic Properties

Four classes of sites were recognized in the earlier surveys in the Science Reserve: (1) shrines; (2) adze manufacturing "workshops"; (3) burials; (4) and probable survey markers. The current survey identified several additional site types. Each class of sites is briefly described below in terms of its defining characteristics. Functional inferences are based on formal attributes, locational context, and comparative ethnographic and archaeological data from Hawai`i and other areas of East Polynesia.

Table 5.1 summarizes the number and variety of historic property types found in the Science Reserve. The inventory includes two previously identified traditional cultural properties, and 261 examples of what are commonly called archaeological sites. Shrines are the most common functional site type. The next most common category are sites located in the Mauna Kea Adze Quarry Complex which consists of: (1) the quarry proper, which is defined as the source areas of tool-quality basalt, and (2) diverse activity remains located outside of the quarry proper as just defined, but which are directly linked to the quarry because of the presence of adze manufacturing by-products (e.g., cores, flakes), hammerstones and unfinished adzes in various stages of completion. Burials and possible burials are another fairly common site type. Two possible burial sites have associated lithic scatters comprised of adze manufacturing by-products that suggest the possibility of adze maker interments. They are included in the list of sites that make up the Mauna Kea Adze Quarry Complex. The remainder of the historic property inventory is represented by small numbers of diverse site types.

5.4.2.1 Traditional Cultural Properties

As noted in Section 3, in 1999-2000 SHPD designated three areas on Mauna Kea as traditional cultural properties. Two of the three, Kūkahau`ula and Pu`u Līlīnoe are located in the Science Reserve, the third, Pu`u Waiau, is located in the NAR (Figure 5.6).

Table 5.1 Historic Property Types in the Science Reserve

Functional Site Type	Number	Percent Total (%)
Traditional Cultural Properties	2	0.76
Shrines	141	53.61
Mauna Kea Adze Quarry Complex Sites	67	25.47
Burials and Possible Burials	29	11.03
Stone Markers/Memorials	15	5.70
Temporary Shelters	3	1.14
Historic Campsites	2	0.76
Historic Transportation Route	1	0.38
Unknown Function	3	1.14
TOTAL	**263**	**99.99**

The cultural significance of Kūkahau`ula (Site 21438) was highlighted in a Chapter 6E-8 and Section 106 review of the proposed Keck Outrigger project by SHPD in 1999 (Hibbard to McLaren 1999). Relevant portions of the review letter (which is included in the CRMP as Appendix B) are presented below, in slightly modified form and without the references that appeared in the letter:

> Several lines of evidence lead us to the conclusion that the cluster of cones is an historic property… The first line of evidence indicating the cultural and historical importance of the summit is that, at a minimum, some portion of the summit cluster bore the name Kukahau`ula who appears as a character in recorded Hawaiian traditions and as a figure in legends about Mauna Kea. As a character in traditional histories and genealogies, he is the husband of Lilinoe and is named as an `*aumakua* (family deity) of fishermen. A descendant, Pae, was known as an exceptional fisherman whose bones were coveted for fishhooks by the paramount chief Umi. In one legend, Kukahau`ula is cast in a more fanciful role as the suitor or husband of Poliahu, the deity of snow and, poetically, his name is said to allude to the pink hue that can be seen reflecting from the snow-covered summit. Lilinoe plays a similar role in the mountain's traditions in that she appears both as a traditional character and a mythical figure. She is, however, even more frequently associated with the summit region of Mauna Kea. In addition to being the wife of Kukahau`ula in some traditions, she is said to have been buried near the summit and is called the "woman of the mountain." One tradition has her being an ancestor of the illustrious Mahi family who served as warriors and attendants to the paramount *ali`i* of Hawaii Island. In legends, Lilinoe becomes the embodiment of fine mist, the literal meaning of her name, and as such is the companion or sister of Poliahu.
>
> While the association between the summit and Kukahau`ula is sufficiently clear, it is not as clear which specific topographic features in the summit the name encompasses. The conclusions drawn here that Kukahau`ula, and thus its association with a significant individual and character, probably applied to the entire summit cluster relies on a couple of arguments. First, use of the name Pu`u o Kukahau`ula in the boundary testimonies and in subsequent notes of field surveys indicates that the name was applied, at a minimum, to the cinder cone (i.e., *pu`u*) as a whole and not just to the highest peak or what would generally be considered the summit in English usage. Second, on the early survey maps (i.e., 1884 to 1891 and 1891), the name Kukahau`ula is written to the east of the

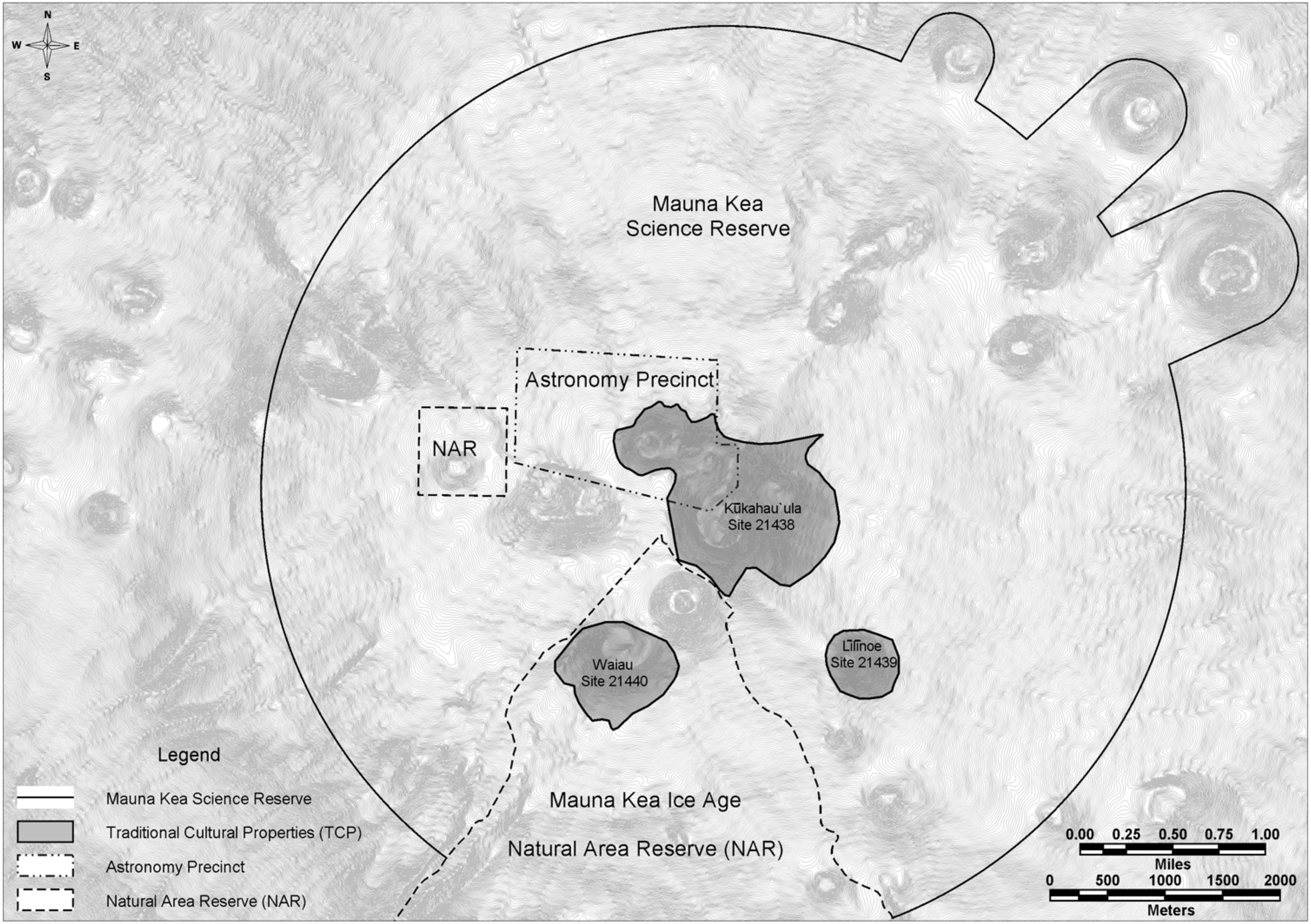


Figure 5.6 Location of SHPD-Designated Traditional Cultural Properties in the Summit Region of Mauna Kea.

> cluster of cones and is not immediately associated with a particular point. In contrast, the highest point on the mountain on these maps is labeled the "summit" and "summit cone" and the triangulation marker on the northeastern peak of the cluster is labeled "Mauna Kea."
>
> At this time, it cannot be known with certainly how Hawaiians during the early historic period and their predecessors would have viewed the cluster or what purposes they may have had to make and name particular distinctions within the cluster. Given the unified appearance of the cluster and the prominence of the name Kukahau`ula, however, it seems reasonable, if not probable, that this name applied to this entire landscape feature, including that which is now called Pu`u Hau Oki.

Pu`u Līlīnoe (Site 21439), as noted above, is from the Hawaiian point of view intimately related to Pu`u Kūkahau`ula since the two personages of the same name were, according to some traditions, husband and wife. Most of what we know about Līlīnoe comes from Kamakau, who called her "the woman of the mountains" and also said that she was an ancestress of Pae, a *kahuna* of `Umi's time (Kamakau 1961:215; McEldowney 1982:A-7). As mentioned above Līlīnoe is also regarded in some traditions as the sister of Poli`ahu. On the summit of Pu`u Līlīnoe is a possible burial site (16195).

Traditional cultural properties, like all historic properties, must have boundaries. As Parker notes, however, "Many, if not most, traditional cultural properties, were and are simply not meant to have lines drawn around them marking where they begin and where they end. Trying to do so can lead to some fairly bizarre and artificial constructs" (Parker 1993:4). Parker goes on to give a hypothetical example of a Native American vision quest site on a mountain top in terms of how the boundaries can be narrowly defined from one point of view and encompass a vast area from the perspective of potential effects on the property. She writes, "The boundaries of a mountain top on which religious practitioners seek visions could be drawn around the toes of a person sitting on it, but the area of potential effect could include everything within that person's viewshed" (Parker 1993:4).

The boundaries of the three TCP's on Mauna Kea were drawn based on geological boundaries of the cinder cones (Wolfe et al. 1997: Plate 2) and in the case of the summit a series of overlapping, contiguous cinder cones which include Pu`u Wekiu, Pu`u Kea, Pu`u Hau Oki and at least one other unnamed cone (see Figure 5.6). In the case of Kūkahau`ula, the boundaries are also based in part on the near total absence of archaeological sites on the summit. The summit thus stands out from the rest of the cultural landscape which is dotted with shrines and other cultural remains as summarized above.

5.4.2.2 Shrines and Possible Shrines

Shrines are by far the most common site type in the UH management areas (see Table 5.1). A total of 141 or 53.62% of the 263 historic properties are shrines that on present evidence are non-occupational religious structures unrelated to the adze quarry. This number includes possible shrines, where some doubt exists about the presence of uprights because none were found in a standing position. It is possible that the construction of some shrines was never completed or the uprights were removed at a later date. There are three sites where there is a confirmed shrine and a second possible shrine. As described below and noted in Table 5.2 and Table 5.3, an additional

12 shrines were found in association with isolated lithic scatters comprised of adze manufacturing by-products transported from the adze quarry. The survey identified another 20 shrines in the quarry, so the total number of shrines in the Science Reserve is 173 (141 non-quarry, 12 shrines with associated lithics outside of the quarry proper and 20 shrines in the Pōhakuloa Gulch area of the quarry).

The quintessential characteristic of all of the sites on Mauna Kea that have been interpreted as shrines is the presence of one or more upright stones that the Hawaiians called *`eho* or *pohaku `eho*, which translates as "god-stone" (cf. Andrews 2003; Pukui and Elbert 1971; Buck 1957; Emory 1938). The conventional view of these and other kinds of Polynesian "god-stones" is that they were "places for the gods to inhabit," or "abodes of the gods," as opposed to icons or actual representations of the gods (Best 1976; Buck 1957; Handy 1927).

The uprights can be regarded as either a special kind of *sign* or *symbol* in the way these terms were defined by Langer:

> Symbols are not proxy for their objects, but are *vehicles for the conception of objects*. To conceive a thing or a situation is not the same thing as to "react toward it" overtly, or to be aware of its presence. In talking *about* things we have conceptions of them, not the things themselves; and *it is the conceptions, not the things, that symbols directly "mean."* Behavior toward conceptions is what words normally evoke; this is the typical process of thinking (Langer 1957:60-61).
>
> In short, images have all the characteristics of symbols. If they were weak sense-experiences, they would confuse the order of nature for us. Our salvation lies in that we do not normally take them for bona fide sensations, but attend to them only in their capacity of *meaning* things, being *images* of things--symbols whereby those things are conceived, remembered, considered, but not encountered (Langer 1957:144-145).

A number of shrines consist of just a single upright, while others are characterized by multiple uprights arranged in different patterns on a variety of different kinds of foundations (Figure 5.7). Kenneth Emory, who was the first one to describe the shrines on Mauna Kea and note their East Polynesian affinities, was of the opinion that the uprights represented or symbolized separate gods. Emory made the following comments about the shrines he saw in the adze quarry, during a brief reconnaissance of the main quarry area in 1937:

> The adze makers, clinging to the ancient form of shrine at which to approach their patron gods, have preserved a most important link with their ancestral home. Each upright stone at a shrine probably stood for a separate god. The Hawaiian dictionary describes *'eho* as "a collection of stone gods" and this is the term which the Tuamotuans, the neighbors of the Tahitians, used to designate the alignment of upright stones on the low and narrow platform at their maraes, or sacred places (Emory 1938:22).

On current evidence there are at the minimum two functional classes of shrines in the Science Reserve: (1) occupational specialist shrines related to adze manufacture, and (2) all the others, which on current evidence appear to be "non-occupational." Morphologically, there is nothing to distinguish these two classes, each of which exhibits considerable variability in groundplan, number of uprights, etc. The Mauna Kea shrines

Figure 5.7. Photographs Showing Examples of Multi-upright Shrines.

are in this regard no different from Hawaiian shrines in general. According to Buck, “Shrines varied considerably in construction, and similar forms were distinguished merely by their function” (Buck 1957:528).

For the so-called occupational shrines Buck added:

> Malo (1951, p. 81) writes that “each man worshipped the *akua* that presided over the occupation or profession he followed...” Thus what may be termed occupational shrines were built to the presiding gods in convenient places, and cultivators, woodsmen, fowlers, and others recited their rituals and laid their offerings upon their particular shrine before engaging in their work. There was nothing to distinguish this form of shrine from others, except, perhaps, the locations of the sites, which were away from the beaches and could not be readily confounded with the shrines of fishermen (Buck 1957:529).

The only thing that distinguishes the occupational shrines from all the others in the Science Reserve are lithic scatters found either on the shrine itself or in close enough proximity to be considered part of a single site. The artifacts found on shrines are interpreted as offerings, while those some distance may denote some other kind of ritual practice (McCoy 1999a).

The report on the 1982 archaeological survey of roughly 1,000 acres of land on the north flank of the mountain (McCoy 1982) followed Buck in referring to the architecturally simpler and generally smaller structures as shrines (*kuahu*), which Buck (1957:527) considered "a convenient term to designate a simple altar without a prepared court." Some of the larger, more complex structures, including those with courts, were called *marae*, following Emory, who had used this term to describe structures on the island of Necker that he believed bore close resemblances to the so-called “inland” type of Tahitian *marae* (Emory 1921, 1928, 1933, 1943, and 1970). Though some of the stone remains in the Hawaiian Islands, including those on Necker and Mauna Kea, do in fact appear to more closely resemble some of the simpler forms of *marae* in Tahiti and the Tuamotus than any known form of Hawaiian *heiau* (see discussion in Section 7) it is probably best to discontinue using the term *marae*, which has no cognate in the Hawaiian language.

The shrines in the Mauna Kea summit region have been previously described as including one or more of the following elements or “parts”: (1) uprights, (2) pavements, and (3) courts. The idea of describing shrines as comprised of parts, instead of features, follows Emory (e.g., Emory 1947:10) who used this terminology in describing East Polynesian *marae* and the structures on Necker Island that he called marae (Emory 1928).

Significant variability exists in the presence/absence of pavements, courts, and artifacts, and in attributes such as, the number of uprights and manner in which they were set and arranged. Whether or not all of the observed variability can or should be subsumed by the term “shrine,” as it is commonly understood, is a thorny issue that needs to be briefly addressed. If one accepts the distinction that Buck (1957) made between shrines and temples, then the sites with prepared courts should be called temples. This report uses the generic term “shrine” to describe all of the religious structures that exist in the summit region of Mauna Kea.

Some may object and argue that they should instead be called *heiau*, but a review of the literature indicates that there is no agreement on what that term included in the past and how it should be used today. According to Buck, “All shrines came under the general term of *kuahu*, except the fishermen’s shrine which received the specific term of *ko`a"* (Buck 1957:528). As noted in Section 2, the term *kuahu* appears to be a more obscure and presumably older term that in modern times has been shortened to *ahu*.

The fact that there were names for different kinds of shrines suggests that shrines and heiau were different. Kamakau (1964:33) said that the *Pohaku o Kane* were family shrines and not a kind of *heiau*, whereas some archaeologists, such as Kirch (1985:260), hold to the view that the *Pohaku o Kane* was a *heiau*. Kolb presented an even broader definition of *heiau* based on the earlier definitions used by McAllister (1933:20) for sites on Oahu, and Bennett (1931:31) for sites on Kauai. They included natural rock outcrops, boulders and other unmodified places as examples of *heiau*. Kolb used this information to define sacred places: "Sacred places thus represent *heiau* possessing little, if any, structural modification" (Kolb 1991:109).

5.4.2.3 Mauna Kea Adze Quarry Complex

The Mauna Kea Adze Quarry Complex consists of two physically discrete but functionally interrelated parts: (1) the quarry proper, which is defined as the source areas of tool-quality basalt, and (2) diverse activity remains located outside of the quarry proper as just defined. The largest number of new sites found in the survey is in the Pōhakuloa Gulch area, which is part of the quarry proper, as is one isolated quarry/workshop. All of the other sites (Table 5.2) are located outside of the quarry proper. These include isolated adze manufacturing by-products (e.g., cores, flakes), hammerstones and unfinished adzes in various stages of completion found by themselves and also found with shrines and possible burials. One of the most important sites is a ritual complex that consists of multiple shrines, enclosures, and a lithic scatter.

Table 5.2 Historic Properties in the Mauna Kea Adze Quarry Complex

Functional Site Type	Number	Percent Total
Pōhakuloa Gulch Adze Quarry/Workshop Complex**	41	61.19
Isolated Quarry/Workshop	1	1.49
Isolated Lithic Scatters and Artifacts of Uncertain Function	12	17.91
Isolated Shrines with lithic offerings and/or associated lithic scatters of uncertain function	12	14.92
Isolated Ritual Complex	1	1.49
Possible Burials with Associated Lithic Scatters	2	2.98
TOTAL	**69**	**99.98%**

5.4.2.3.1 The Pōhakuloa Gulch Quarry/Workshop Complex

Though several adze manufacturing sites had been found on the eastern edge of Pohakuloa Gulch in a 1976 reconnaissance survey (see Section 3), it was not until the end of the 2007 field season that the extent of quarrying and adze manufacture in this area of the Science Reserve was known. Fieldwork conducted in 2008-2009 identified a total of 41 sites (Figure 5.8; see Table 5.2) of varying size and complexity in terms of the number of functional components (workshops, rockshelter habitations, shrines, and burials). The number and variety of components in each of the 41 sites is summarized in Table 5.3.

5.4.2.3.2 Site Components or Activity Remains

As described elsewhere (McCoy 1990), the structure of the quarry industry on Mauna Kea is inferred to have been more complex than any other known Hawaiian adze quarry based on a consideration of the number, diversity, spatial distribution and formal-functional variability within different classes of activity remains which have been called site components. This reflects the view, summarized earlier, that there is a functional relationship between the various activity remains or components. On present evidence the Mauna Kea Adze Quarry Complex is unique amongst Hawaiian adze quarries in the presence of raw material procurement localities (quarries), workshops of various kinds, shrines, temporary habitations (primarily rockshelters), and possible burials. In short, there are site components representing life, work and death as these are normally conceived by anthropologists and archaeologists. The Pōhakuloa Gulch site complex includes the following components:

1) <u>Extraction Areas</u>

A total of 33 extraction areas were identified in the quarry area (see Table 5.3). As defined above (see terminology) there are two kinds of extraction areas: (1) lava flow margins with more or less vertical faces; and (2) bedrock outcrops that may or may not be located on a flow margin. The first type of extraction area is characterized by more or less vertical rock faces exhibiting signs of battering and large negative flake scars, associated with large chunks of broken bedrock. The second type, which are “pits” or depressions that resemble what some archaeologists would call mines, although most mines are characterized by vertical shafts. Nine pits were found in the survey, all of them at Site 27605.

2) <u>Adze Manufacturing Workshops</u>

Investigations in 1984-85 in the Hopukani, Waihu, and Liloe Springs area, which is part of the Pōhakuloa Gulch region of the quarry (McCoy 1986) indicate a number well in excess of the 264 workshops and 1566 constituent features [physically discrete "chipping stations"] identified in the 1975-76 fieldwork (McCoy 1978; Cleghorn 1982). The 2005-2009 survey identified another 459 plus workshops in an area that had never been surveyed (see Table 5.3)

There is considerable variability in the size of individual workshops defined in terms of the area and volume of debitage and the presence/absence of internal features, such as windbreak walls (Figure 5.9). There are two varieties of walled "enclosures" in the quarry that have been classified as open-air shelters. The simplest form is a low windbreak wall. The second variety is a full enclosure. Both varieties are found singly

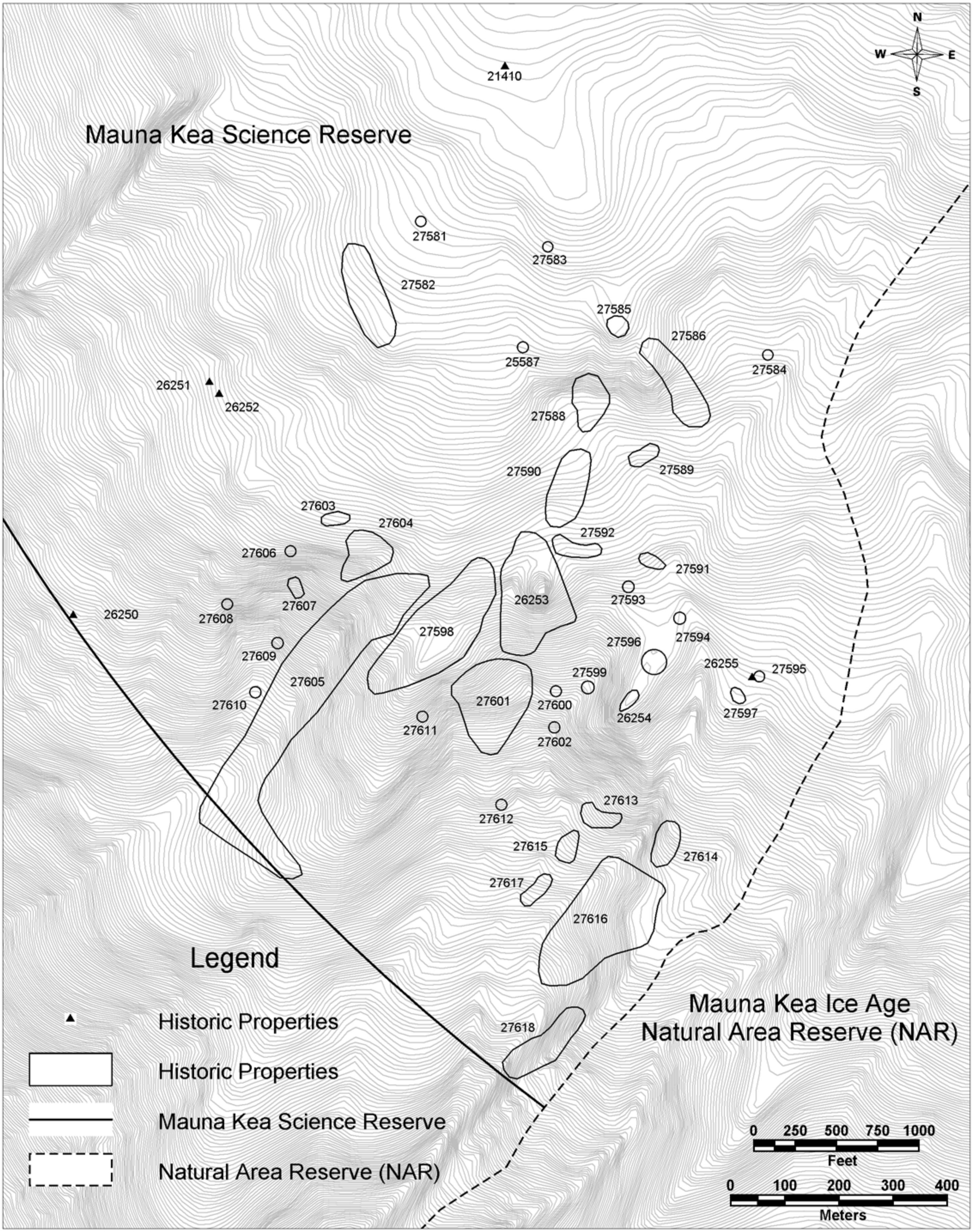


Figure 5.8 Map of the Pōhakuloa Gulch Area of the Mauna Kea Adze Quarry Complex.

Table 5.3. Number and Variety of Components/Features in the Pōhakuloa Gulch Quarry/Workshop Complex.

State Site Number 50-10-23-	Burial/ Possible burial	Shrine	Adze workshop	Flake scatter	Hammerstone workshop	Extraction Area	Temporary habitation	Unknown	Isolated artifacts	Total Number of Components
26253		1	65	6		1	2		4	79
26254		2						2		4
26255		1								1
27581			1							1
27582		1	2					1		4
27583			3							3
27584					1					1
27585			4							4
27586		1	11	1		1				14
27587			1							1
27588		2	4	3		1*				10
27589			5	1						6
27590			9	2					2	13
27591					1	1				2
27592			1	1	1				1	4
27593			1							1
27594					1					1
27595			1		1					2
27596			2		1					3
27597			2		1					3
27598			69	5	1	4			2	81
27599				1						1
27600			1							1
27601			68		2	2	3		3	78
27602									1	1
27603				2						2
27604			14	1						15
27605			74			10		2		86
27606	1		1				1	1		4
27607			2		4					6
27608			1							1
27609					1					1
27610			1							1

Table 5.3. Number and Variety of Components/Features in the Pōhakuloa Gulch Quarry/Workshop Complex.

State Site Number 50-10-23-	Burial/ Possible burial	Shrine	Adze workshop	Flake scatter	Hammerstone workshop	Extraction Area	Temporary habitation	Unknown	Isolated artifacts	Total Number of Components
27611				1						1
27612			1							1
27613			3							3
27614			5			1				6
27615					3	3				6
27616	1	5	97			9		6		118
27617		5	1	1						7
27618		2	10						4	16
Total	2	20	459	25	18	33	6	12	17	587

on workshops and aggregated into clusters where they are associated with shrines in what appear to be religious compounds. Nearly 200 of these structural remains had been recorded in the quarry prior to the start of the current survey (McCoy 1990).

The survey of the new quarry area identified three walls that probably functioned as windbreaks.

3) Hammerstone Quarries-Workshops

On present evidence all of the hammerstones found in the Mauna Kea Adze Quarry Complex are of local origin. A total of 18 hammerstone quarries were found in the Pōhakuloa Gulch area. At each locality there is evidence of extraction and the initial reduction and shaping process. This appears to be one of the largest concentrations of such activity areas in the Mauna Kea Adze Quarry Complex.

4) Flake Scatters

The Pōhakuloa Gulch area, like all areas of the larger quarry complex, are characterized by diffuse scatters of debitage which have been called "flake scatters" though other artifact types are oftentimes found. They are in almost all cases the result of slope movement. A total of 25 such areas were identified, which were undoubtedly originally a part of one or more workshops (see Figure 5.8).

5) Isolated Artifacts

In an area as large as the quarry complex it is not unusual to find isolated artifacts. The earlier surveys in the Mauna Kea Adze Quarry did not record isolated finds as sites, in part because of the difficulty of plotting such small finds on the USGS quadrangle maps due to the lack of technological tools like GPS units.

Figure 5.9. Photoghraphs Showing Examples of Adze Manufacturing Workshops.

The survey found 17 isolated artifacts, mostly adze preforms, in the general area of the quarry, but beyond the boundaries of both workshops and the flake scatters. It is difficult to determine what such isolated objects mean in a quarry context, but the meaning is probably different from the isolated artifacts found outside of the quarry proper (see discussion above).

6) Temporary Habitations

What are believed to have temporary habitations were found at six sites. These include four open-air shelters and two rockshelters with cultural deposits.

In an earlier classification of activity remains in the quarry complex a distinction was made between rockshelters and what were called "overhang shelters" based on differences in surface characteristics of the interior floor area. Rockshelters were noted as containing a variety of residues indicating their use as camps. The "overhang shelters" were described as lacking midden deposits and containing only small quantities of adze manufacturing debitage (McCoy 1977:229). Most of these were presumed to have been used for the storage of food, firewood and other bulky items. A test excavation of one of these "overhang shelters" at Hopukani Spring in 1985 revealed a buried occupation layer with a fire hearth, faunal remains and flake debitage (McCoy 1986). As a result, all natural shelters were combined into one category and the site was renamed Hopukani Rockshelter No. 2 (McCoy 1990).

Two rockshelters were identified in the new quarry complex. Rockshelter 1 of Site 26253 was excavated in 2008. An analysis of the recovered materials is presented in Section 6. The full excavation report is presented in Volume 2.

7) Shrines

A total of 20 shrines were found in the Pōhakuloa Gulch quarry area. This number includes two shrines on top of what was called the “Crag” (Site 26254) in the 1892 mapping of the summit area by Alexander and his assistant, J.M. Muir (Alexander 1892). There is no debitage associated with these shrines. One site (26255) is an isolated shrine, which like the two shrines on the “crag” may have had a special purpose. Debitage was found on all of the other shrines in the quarry area.

8) Possible Burials

Two possible burial locales were found in the survey. One is a platform at Site 27616. The other is a crevice at the back of the rockshelter at Site 27606. Their location in the quarry is unusual, but not totally unexpected based on findings elsewhere in the Science Reserve and the NAR.

9) Unknown Function

There are 12 site components in the quarry of unknown function. They include mounds, walls, and terraces. Further analysis of the data might provide some clues to function, as might excavations in the future.

5.4.2.4 Isolated Quarry/Workshop Site

Site 21437, located outside of the Science Reserve boundary (see Figure 5.5), is a small and apparently isolated quarry and workshop. The raw material source is the edge of a flow of fine-grained, dense basalt at the lower end of a scree deposit. The site, which was found in the SHPD reconnaissance survey in 1997, was not mapped. It covers an area of approximately 8.0-10.0 square meters and consists of six or more cobble-size cores and an estimated 300 to 400 flakes. The flakes are of varying sizes, indicating primary and secondary reduction. One adze preform, made on an angular blocky core, measures 38.0 cm long, 16.0 cm wide, and 14.0 cm thick. The artifact inventory also includes a couple of hammerstones.

Based on the limited time spent at this site, it would appear to be short term, possibly single event workshop. This site may be related to Site 26249 which is an isolated lithic scatter located upslope several hundred meters east-southeast, just inside the Science Reserve boundary. There is more evidence of adze manufacture on this side of the mountain, on the glacial moraines and in the gulches below the Science Reserve.

5.4.2.5 Isolated Lithic Scatters and Artifacts of Uncertain Function

A number of different kinds of isolated lithic artifacts, oftentimes referred to as *find spots* (e.g., McCoy 1984a), as opposed to the admittedly more idiosyncractic use of the term in the current survey, were found in different areas of the Science Reserve and given site designations. A total of 12 sites comprised of isolated lithic scatters or single lithic artifacts were found in the project area outside of the Pōhakuloa Gulch quarry/ workshop complex (Table 5.4; Figure 5.10).

Some of these isolated finds, most of which cover a small area and contain a small number of artifacts, have been previously discussed as a specialized kind of adze manufacturing “workshop” based on the presence of one or more of the following kinds of manufacturing byproducts---flakes, cores, adze preforms, and hammerstones (McCoy 1999a; McCoy and Nees 2009). Others may represent locations where an unfinished adze or several adzes and hammerstones, were lost in transport. In other instances, there is reason to suspect that additional artifacts are located in the immediate vicinity, but were not identified because of factors such as small size, poor lighting conditions, or because they are buried.

Table 5.4. Summary of Isolated Lithic Scatters and Artifacts of Uncertain Function.

State Site Number 50-10-23-	Feature Number	Elevation (feet amsl)	Site Area L x W (in meters)	Description
21204	4	12,800	23.0 x 9.0	Site consists of four (4) features: 1 terrace, 2 mounds, and a lithic scatter
25760	1	11,448	2.0 x 1.0	Approximately 15 flakes and 1 adze preform observed, three (3) flakes collected
25761	1	11,639	1.0 x 1.0	One and possibly two flakes
25762	1	11,829	25.0 x 4.0	Basalt flakes associated with three enclosures; two (2) flakes collected
25767	1	12,240	2.0 x 2.0	Two (2) preforms, both collected
25768	1	12,192	1.0 x 1.0	Single basalt flake
25769	1	12,160	1.0 x 1.0	Basalt flakes two (2) collected
25779	1	11,996	5.0 x 5.0	Three adze preforms, hammerstone and basalt flakes; three (3) preforms collected

Table 5.4. Summary of Isolated Lithic Scatters and Artifacts of Uncertain Function.

State Site Number 50-10-23-	Feature Number	Elevation (feet amsl)	Site Area L x W (in meters)	Description
25796	1	12,627	10.0 x 10.0	Over 15 basalt flakes, several adze preforms, one hammerstone; two (2) preforms collected
25801	1	11,353	1.0 x 1.0	Four (4) basalt flakes, all collected
25828	1	12,712	1.0 x 1.0	Single basalt flake
26249	1	12,077	10.0 x 10.0	Basalt flake scatter

There appears to be a considerable amount of inter-site variability in the number or frequency of different artifact classes found on these sites, unlike the usual workshop. In some cases there seems to be a disproportionate number of unfinished adzes compared to the number of flakes, thus pointing to the high probability that some of the adzes were flaked elsewhere and/or transported to these localities at a later stage in the manufacturing process. At other sites the predominant artifact type is flakes. These characteristics, combined with the small size of most of the artifact assemblages, indicate that these were not ordinary “workshops.” Indeed, the evidence for *in situ* manufacture, as opposed to a place where offerings were made, is in many instances ambiguous.

Four isolated flake scatters were found at Lake Waiau in 2007. A brief analysis of these scatters considered three possible interpretations:

1) the flake scatters mark the locations of small workshops where only one or perhaps two stages of adze manufacture took place;

2) the flake scatters are specialized “workshops” where a small number of flakes were removed as a symbolic act as part of a ritual practice; and

3) the flake scatters represent selected pieces of debitage that were carried from the quarry and offered to the gods of the lake, thus representing a different kind of ritual than what occurred at other places in the summit region.

The first two interpretations are similar in that both involve symbolic acts with similar intentions. They are virtually impossible to test, however. The first theory would require a technological analysis of each assemblage to reconstruct the reduction sequence and determine how many stages of manufacture are represented. On current evidence it is a highly unlikely scenario because of the assemblage characteristics. These characteristics, considered singly and as a whole, are unusual compared to the debitage found on chipping stations in the quarry, where regardless of the size of the blank (either a core or flake) the number and types of flakes removed in the reduction process are more varied. Cleghorn’s replicative experiments, using raw material from the quarry, confirmed this (Cleghorn 1982). For example, the manufacturing process typically produces large and small flakes and shatter throughout the reduction sequence.

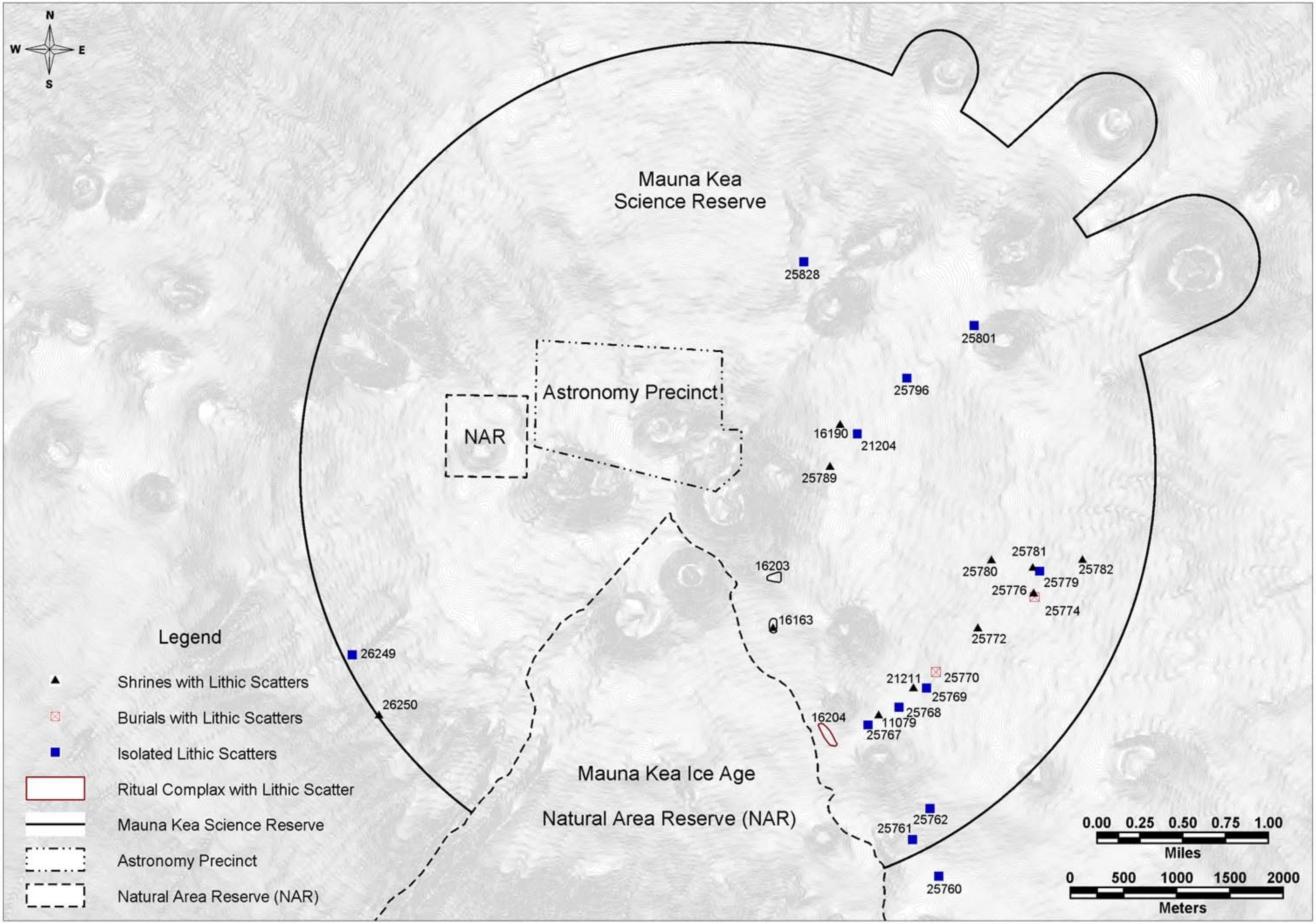


Figure 5.10 Locations of Isolated Sites with Lithic Scatters and Artifacts in the Mauna Kea Science Reserve.

The number of flakes produced in making an adze preform varies enormously (Cleghorn 1982), but a workshop with only 25 or so flakes, all or the majority of them without cortex and of fairly uniform size, is not something that has been observed in the quarry or in replicative experiments (McCoy and Nees 2009).

If adze manufacture did take place at Lake Waiau and the other isolated sites, it would appear to have been an essentially symbolic act as argued in the case of Site 16204, the ritual complex that is part of the quarry complex (McCoy 1999a). It is important to note that symbolic acts can be both expressive and instrumental:

> But as well as expressing something, symbolic activity often (though not always) has an instrumental aspect. People who carry out institutionalized symbolic procedures or rites usually believe that by doing so they are either producing some desired state of affairs or preventing some undesired one (Beattie 1964:202).

Though not common, the location of isolated lithic scatters and artifacts, some associated with shrines, are potentially one of the most important findings of the 2005-2009 survey. Their possible significance is discussed in Section 7.

5.4.2.6 Isolated Shrines with Lithic Scatters

Unfinished adze preforms, flakes and occasionally other manufacturing by-products were found on or near shrines at 12 sites outside of the quarry proper (see Figure 5.10). The intention underlying the presence of lithic artifacts on or near a shrine is less ambiguous than sites consisting of nothing but lithic artifacts because of their locational and functional context. These assemblages, like those found on many shrines in the quarry, are interpreted as offerings to the tutelary gods of adze making (Malo 1951; McCoy 1990, 1999b). The characteristics of the 12 sites are summarized in Table 5.5.

5.4.2.7 Isolated Ritual Complex

Site 50-10-23-16204, first recorded in 1975 during research on the Mauna Kea Adze Quarry (McCoy 1977, 1999b), is one of the most complex and significant sites in the Science Reserve. The site, which is located on a prominent whale-back ridge on the east side of the summit road between the roughly 12,250 and 12,332 ft elevations (full description in Volume 2), consists of 5 shrines, 26 open-air enclosures and a diffuse scatter of adze manufacturing by-products (see Figures 5.5 and 5.10).

There is no other known site like 16204 in either the Science Reserve or the NAR. It has been interpreted as the locus of initiation rites for apprentice adze makers (McCoy 1999b).

5.4.2.8 Possible Burials with Associated Lithic Scatters

As described below, a new form of burial was found in the survey. They are pavements consisting of boulders and cobbles which in some places have a little elevation. The middle tends to be lower than the sides. The two examples found in the survey both have an associated with a lithic scatter (see Figure 5.10). In addition, a small basalt preform was found on one of features at Site 25744. The presence of lithic materials suggests a direct association with the adze quarry (Table 5.6). If these are indeed burial sites, they may contain the remains of adze makers.

Table 5.5. Summary of Isolated Shrines with Associated Lithic Scatters.

State Site Number 50-10-23-	Feature Number	Elevation (feet amsl)	Site area L x W (in meters)	Description
11079	Fe1 (preform) Fe3 (flakes)	12,227	~20.0 x 20.0	Basalt flakes and adze preforms observed with and around Feature 1;Feautre 3 is a lithic scatter
16163	Fe 2	12,755	30.0 x 4.0	Flake scatter
16190	Fe 2	12,856	8.0 x 6.0	Basalt flakes observed (five (5) flakes collected) below shrine
16203	Fe 1, Fe 2, and Fe 3	13,046	150.0 x 100.0	Preforms, cores, and flakes observed at the site
21211	Fe 1 and Fe 2	12,194	10.0 x 10.0	Preform (Fe 1) and basalt flakes (Fe 2) observed
25772	Fe 1 and Fe 4	12,072	50.0 x 50.0	Basalt flakes associated with crude enclosure (Fe 2) and single basalt flakes associated with Fe 3, 4, and 7. Several flakes collected
25776	Fe 2 and Fe 3	11,979	16.0 x 13.0	Associated with both Feature 2 (crude enclosure) and Feature 3 (terrace)
25780	Single upright	12,159	1.0 x 1.0	Single basalt flake
25781	Fe 4	12,032	15.0 x 6.0	Basalt flakes (Fe 4) associated with shrine (Fe 1)
25782	Fe 1	11,834	15.0 x 10.0	Basalt flakes associated with pavement and upright; three (3) flakes collected
25789	Fe 2	12,822	8.0 x 6.0	3-4 flakes
26250	Fe 1	12,053	10.0 x 10.0	Single basalt flake, observed at Feature 1 (shrine)

Table 5.6. Summary of Possible Burials with Associated Lithic Scatters.

State Site Number 50-10-23-	Number of Features	Elevation (feet amsl)	Feature Type	Location	Possible or Confirmed Burial (Number)
25770	2	12,164	pavement	Gelifluction Lobe	Possible (2)
25774	4	11,971	pavement	Gelifluction terrace	Possible (4)

5.4.2.9 Burials and Possible Burials

Prior to the 2005-2009 survey the only positively identified human remains in the Science Reserve were located on the summit of Pu`u Mākanaka (see Figure 2-13). Jerome Kilmartin, a surveyor with the United States Geological Survey, noted the presence of human remains on this prominent cinder cone in 1925. The presence of human remains on the pu`u was confirmed in 1991, as noted in Section 3. In a popular account of his experiences on the mountain, written many years later, Kilmartin noted that the name Pu`u Mākanaka means “Hill crowded with many people” and the grave must have been ancient (Kilmartin 1974:15). The name is indeed accurate; a number of other human remains were found on the rim of the *pu`u* in the survey as noted in Table 5.7.

The survey identified 29 sites with a total of 48 features in the Science Reserve that have been interpreted as burials or possible burials (see Table 5.7). Of the 48 features, five are confirmed burials and 43 are possible burials. For the sites classified as possible burials there are compelling reasons, such as the topographic location and morphological characteristics of the structures, to believe that these sites are indeed burials, but because human remains were not seen at the time they were recorded they are classified as possible burials.

5.4.2.10 Historic Transportation Route

The only direct and in our view unambiguous evidence of the Umi Koa Trail is a single horseshoe that was assigned SIHP number 25800. The horseshoe was found in close proximity to the route shown on the USGS Mauna Kea Quadrangle maps (see Figure 2.13). We believe that this is not a case of mere coincidence. How long the trail was used to transport visitors from the Hāmākua Coast is unknown.

5.4.2.11 Stone Markers/Memorials

One of the more ambiguous classes of sites are piles or stacks of rocks believed to be a marker of some kind or a memorial to some person or event. In all but a couple of cases the actual function is unclear. There are 15 sites that may have been survey markers, piles of stones left by unknown visitors as memorials of their visit to the top of a cinder cone or way-markers along an unmarked trail (Table 5.8). The cairns are quite unlike those which have been interpreted as burials. One of the 13 sites (26244) is the USGS survey marker on Pu`u Wekiu. Another USGS marker was found on Pu`u Poli`ahu and assigned SIHP number 27579. Site 26246 is an example of a cairn interpreted as a marker, perhaps a trail marker in this case (Figure 5.11). The locations of the 15 sites are shown in Figure 5.12).

While there are no dates for any of the cairns, we know from historic accounts that the Rev. Goodrich saw a cairn on the “summit” in 1823 (Goodrich 1826) and that later visitors also observed and built cairns (see Section 2). Jarves (1844:228) described the construction of a cairn to memorialize the ascent of the summit by his companions. It is possible that some of the simple stacked-stone constructions that have been interpreted as modern (see Section 2.4), may be memorials of the kind described by Thomas Thrum in Haleakalā:

> It was a recognized custom of Hawaiians to erect stone piles--pile is one meaning of the word ahu--as way marks, memorials of parties traveling or resting, division points of survey, and also guides to most accessible routes of travel. One such marks the safest of three ridges leading from the rim of the crater to the district of Nuu. That some ahu mark burial places is in accord with the present practice in certain districts of Maui and of Hawaii, and perhaps elsewhere. Most, if not all, of the ahus of three stones, one upon the other, are tributes to the deity of the locality and are designed by travelers to assure safety in their journey (Thrum 1921:259).

The number of markers could thus change with a closer analysis of the survey data.

Table 5.7. Summary of Burial and Possible Burial Sites.

State Site No. (50-10-23-)	Number of Burial Features	Elevation (Ft. amsl)	Burial Feature Types	Location	Confirmed and Possible Burials
16195	2	12,964	Platform, mound	Rim of Pu`u Līlīnoe	Possible (3)
16248	3	12,292	Three mounds	Rim of Pu`u Mākanaka	Confirmed (1); Possible (2)
21209	2	13,714	Mound, alignment	Rim of Pu`u Wekiu	Possible (2)
21413	1	12,626	Platform	Rim of unnamed cinder cone	Possible (1)
21414	1	12,804	Mound	Rim of unnamed cinder cone	Possible (1)
21416	1	12,688	Mound	Rim of unnamed cinder cone	Possible (1)
21452	2	12,541	Platform, mound	Cinder cone	Possible (2)
25765	1	12,416	Platform	Rim of unnamed cinder cone	Possible (1)
25802	2	12,266	Terrace, mound	Rim of Pu`u Mākanaka	Confirmed (1); Possible (1)
25803	1	12,253	Mound	Rim of Pu`u Mākanaka	Possible (1)
25804	1	12,251	Mound	Rim of Pu`u Mākanaka	Possible (1)
25805	1	12,320	Mound	Rim of Pu`u Mākanaka	Possible (1)
25806	3	12,324	Three mounds	Rim of Pu`u Mākanaka	Possible (3)
25807	3	12,349	Three mounds	Rim of Pu`u Mākanaka	Confirmed (1); Possible (2)
25808	7	12,372	Cinder areas, platform, mound, terrace	Rim of Pu`u Mākanaka	Confirmed (1); Possible (6)
25809	1	12,359	Cinder area	Slope of Pu`u Mākanaka	Confirmed (1)
25812	1	12,402	Overhang shelter	Slope of Pu`u Ala	Possible (1)
25813	1	12,560	Mound	Rim of Pu`u Ala	Possible (1)
25814	3	12,544	Three mounds	Rim of Pu`u Ala	Possible (3)
25815	1	12,603	Mound	Rim of Pu`u Ala	Possible (1)
25816	1	12,561	Mound	Rim of Pu`u Ala	Possible (1)
25822	1	11,917	Terrace	Rim of Pu`u Ala	Possible (1)
25823	1	11,882	Mound	Rim of unnamed cinder cone	Possible (1)
25824	1	11,893	Mound	Rim of unnamed cinder cone	Possible (1)

Table 5.7. Summary of Burial and Possible Burial Sites.

State Site No. (50-10-23-)	Number of Burial Features	Elevation (Ft. amsl)	Burial Feature Types	Location	Confirmed and Possible Burials
25829	1	12,780	Mound	Rim of unnamed cinder cone	Possible (1)
25830	1	12,729	Platform	Rim of unnamed cinder cone	Possible (1)
25831	1	12,638	Mound	Rim of unnamed cinder cone	Possible (1)
25832	1	12,510	Mound	Rim of unnamed cinder cone	Possible (1)
26237	1	12,062	Mound	Gelifluction terrace	Possible (1)

Table 5.8. Summary of Markers and Memorial Sites.

State Site Number 50-10-23-	Number of Features	Elevation (ft. amsl)	Location	Feature Type (Feature Number)
21411	1	12,682	Gelifluction terrace	Rock mound (Feature 1)
21412	1	12,511	Glacial moraine	Rock pile (Feature 1)
21415	1	13,050	Ridge crest	Cairn (Feature 1)
21423	1	12,046	Ridge crest	Rock pile on boulder (Feature 1)
21434	1	12,466	Ridge crest	Rock pile on boulder (Feature 1)
21436	1	11,520	Ridge crest	Cairn (Feature 1)
21450	3	13,091	Cinder cone	Two cairns (Features 1-2) and a possible cairn (Feature 3)
25777	1	12,029	Ridge flank	Cairn (Feature 1)
25785	1	12,281	Ridge crest	Cairn (Feature 1)
26224	1	13,796	Pu`u Wekiu	USGS Marker (Feature 1)
26245	1	12,801	Ridge flank	Rock mound (Feature 1)
26246	1	12,805	Ridge crest	Rock mound (Feature 1)
26247	1	12,970	Ridge flank	Rock mound (Feature 1)
26256	1	12,949	Gelifluction terrace	Rock pile (Feature 1)
27579	1	13,610	Pu`u Poli`ahu	USGS Marker (Feature 1)

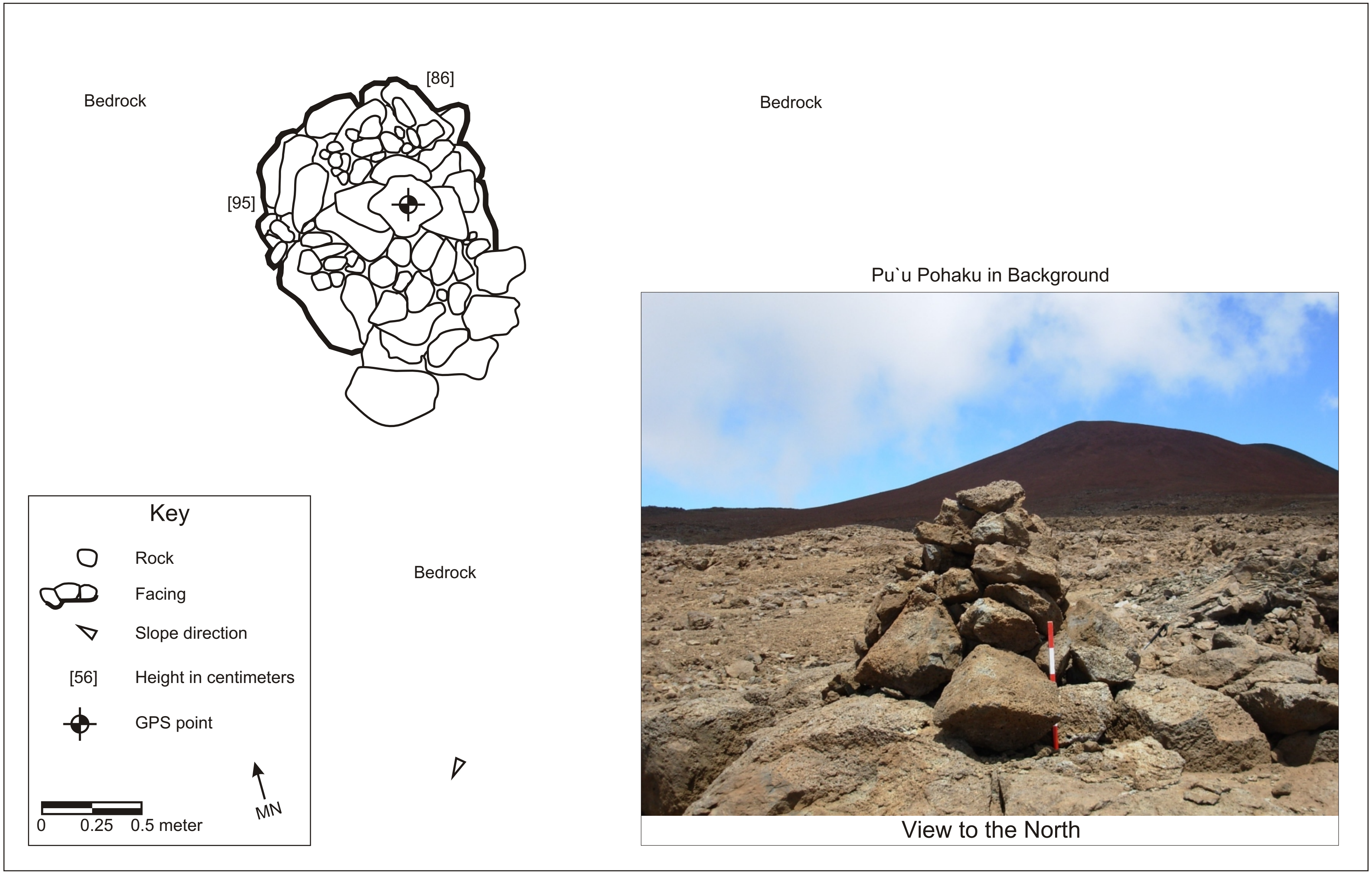


Figure 5.11. Example of a Cairn (Site 26246) Interpreted as a Marker, Plan View and Photograph.

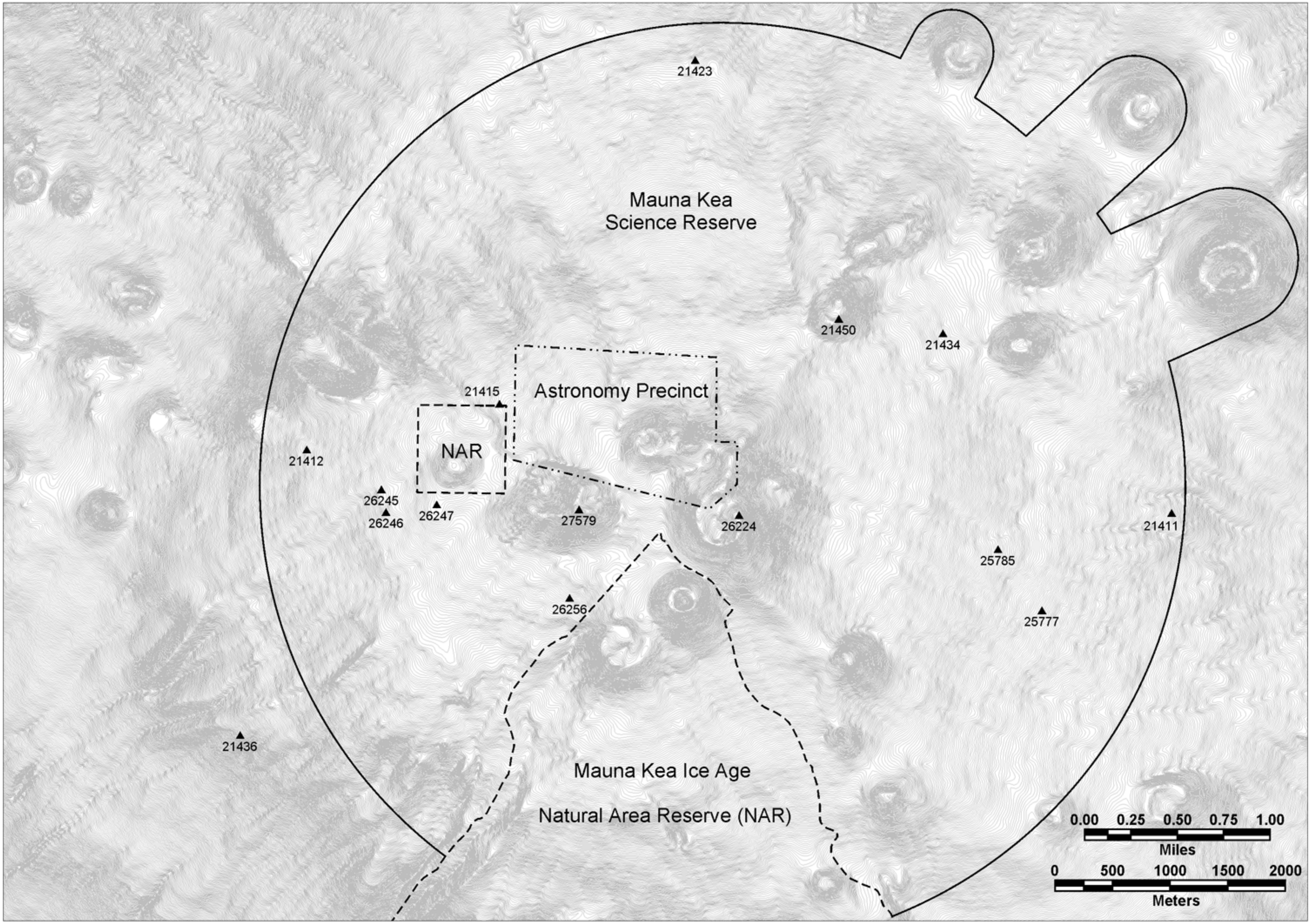


Figure 5.12 Locations of Sites Interpreted as Markers or Memorials.

5.4.2.12 Temporary Shelters

The evidence for "habitation" in the most general sense of the word in the Science Reserve is sketchy. Crude stone walls were found at various localities in the Science Reserve, usually in association with other features, such as lithic scatters. Three sites consist of walls without associated artifacts. Two to a maximum of four walls were found at three sites. Some are linear, while others are roughly C-shape in planview (Figure 5.13). A walled overhang shelter was found directly below a ridge-top shrine at Site 25781. All of these remains are interpreted as temporary shelters based on their morphology and environmental setting.

With the possible exception of the walled rockshelter at Site 25781 there is no evidence that any of the shelters were occupied over night. At least there is no evidence of a fire pit, although the evidence could be buried beneath the surface. With the possible exception of the walled overhang shelter there is no means of dating any of these sites, which are probably either late prehistoric or historic in age.

5.4.2.13 Historic Camp Sites

One and possibly two of the camps occupied by the United States Geological Survey (USGS) survey team in 1925 were found on the northern and northeastern slope of the mountain near Pu`u Māhoe and Pu`u Mākanaka (see Figure 5.5 in back pocket). Site 26218, which corresponds to the location of Camp 3 on a map (MA-1720) of the USGS survey team's camp sites (Figure 5.14), consists of five features, including a boulder concentration with a small constructed cairn (Feature 1), a trash dump (Feature 2), and three alignments (Features 3, 4, and 5). Feature 1 is a boulder concentration with a small constructed cairn located on the northeast side marking an inscription scratched into a flat lying slab. The inscription reads (from top to bottom): "Dec, 6 1925, HIM, USGS." An "arrow" is also present (Figure 5.15). A second inscription is located approximately 4.0 m south of the first, also on a flat lying slab. This inscription is scratched twice in cursive handwriting, and is very difficult to read; it appears to read "Ah Chiung." Upon further investigation it appears that Ah Chiung was the cook for the survey party (Kilmartin 1974:15). Artifacts associated with Feature 4 include a medicine bottle, an aluminum medicine tube, and an aluminum lid with the date of "1921" on it.

What might be Camp 4 was found near Pu`u Mākanaka, just outside of the Science Reserve. Kilmartin noted that "To set up Camp Four at 12,400 feet near Pu`u Mākanaka, we had difficulty finding a small flat area for the tents" (Kilmartin 1974:15). Site 27580 consists of an enclosure located on a small knoll between three pu`u (Pu`u Mākanaka, Pu`u Hoaka, and Pu`u Ala). Originally the enclosure was believed to be outside of the Science Reserve boundary and was only noted as a find spot related to possibly hunters. The enclosure is relatively square in shape with walls constructed of piled cobbles and small boulders and large boulders. It has a relatively level soil interior. No cultural material was observed in the enclosure or immediate vicinity. Whether this is indeed the remains of Camp 4 is an open question.

There is some confusion between the dates on the map and the date inscribed on the boulder at Site 26218. The inscription, as noted, reads Dec. 6, 1925 instead of Nov. 13, which is the date on the map. The Dec. 6 date is on the map but it is next to Camp 4. We suspect that the camp number and dates got switched.

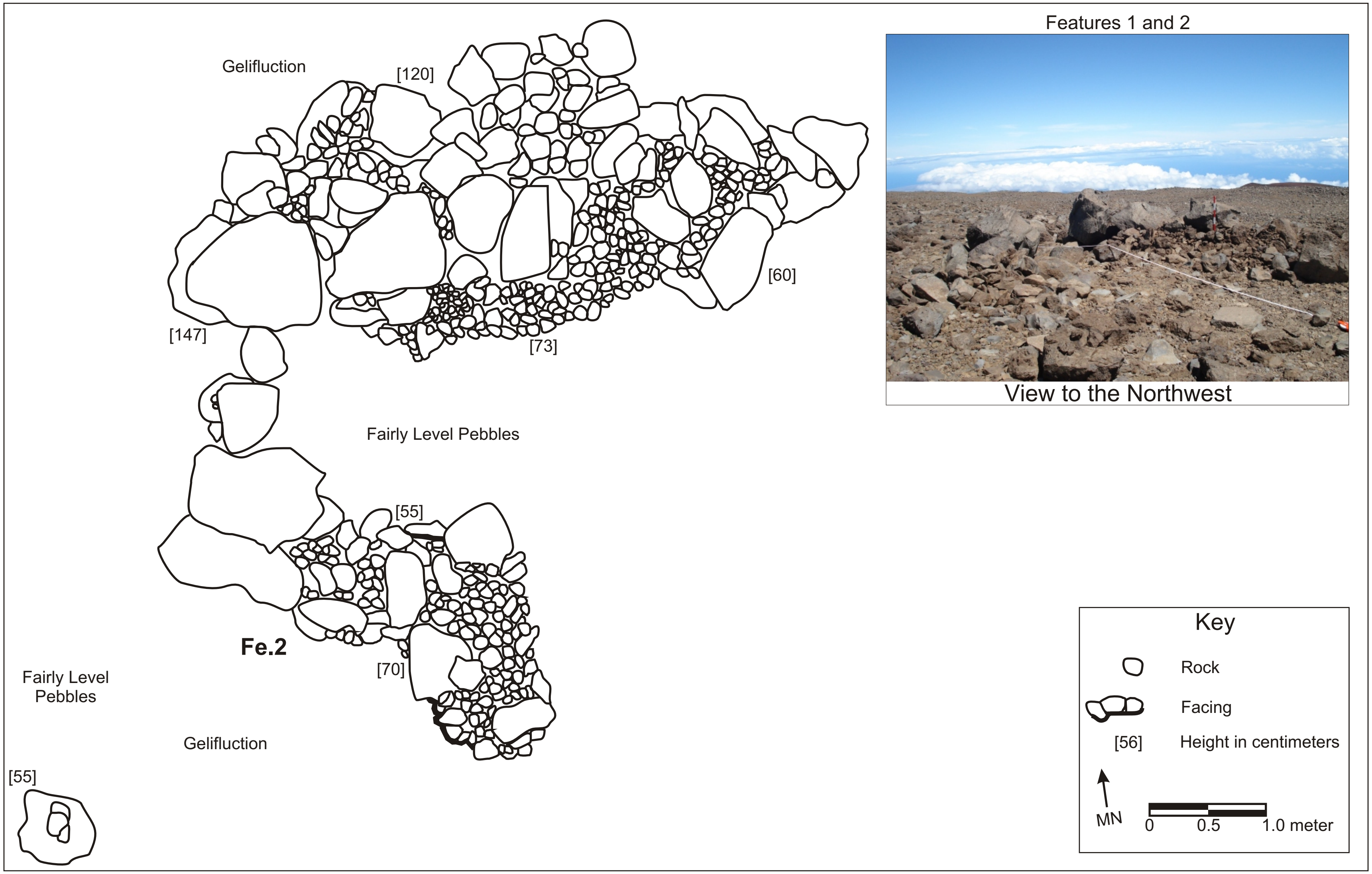


Figure 5.13. Example of a Temporary Shelter at Site 26232, Plan View and Photograph.

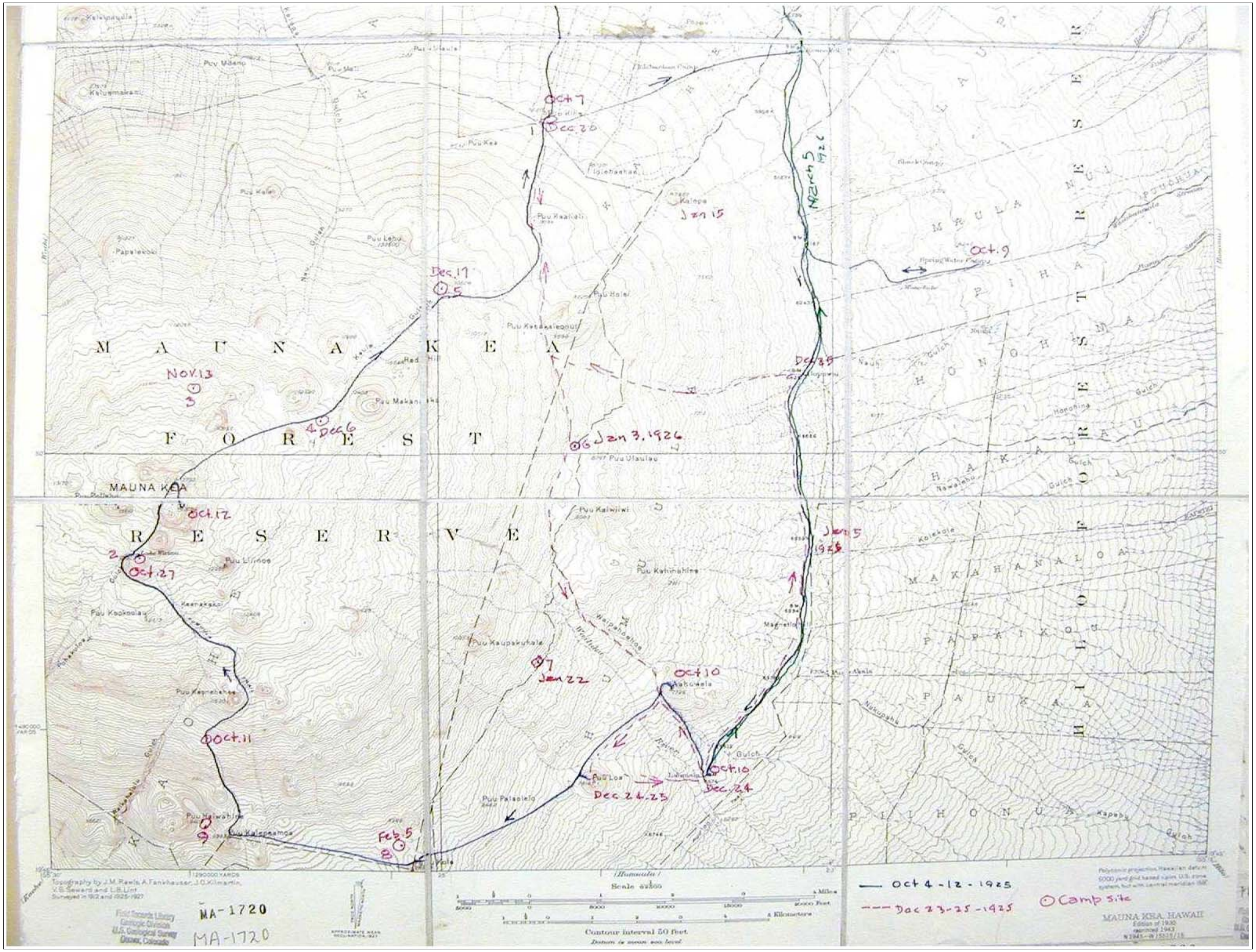


Figure 5.14. Map Showing the Location of the 1925 USGS Survey Party's Camps.

Figure 5.15. Date Inscribed on Boulder at Site 26218 (USGS Camp 3).

5.4.2.14 Unknown Function

There are three sites with a total six features whose function could not be determined (Table 5.9). A large number of these features are stone mounds and rock piles, which is one of the most common formal feature types found in the project area. It illustrates the difficulty in determining the use and meaning of one of the simplest kinds of features, in part because such features continue to be made today.

Table 5.9. Summary of Sites of Unknown Function.

State Site Number 50-10-23-	Number of Features	Elevation (ft. amsl)	Location	Feature Type (Feature Number)
21449	1	13,228	Ridge flank	Terrace (Feature 1)
25776	4	11,979	Rim of unnamed cinder cone	Four stone mounds (Features 1-4)
26230	1	12,199	Gelifluction terrace	Cobble and boulder mound between 2 large boulders (Feature 1)

5.4.3 Other Cultural Resources

Cultural resources in the Science Reserve include a large number of remains that at present cannot be classified as historic properties or sites, as normally defined in State and Federal laws, but which nevertheless need to be considered in developing appropriate management strategies which, according to Tom King (1998:235), need to consider all cultural resources. As noted above in the summary of previous archaeological work in the Science Reserve (Section 3.1), in 1997 SHPD instituted a process of recording what were initially referred to as “locations” but are now being termed “find spots,” although this term generally refers to isolated artifacts (cf. McCoy 1984a). “Find spots” are cultural resources that are either obviously modern features (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder).

A total of 339 find spots were found in the 2005-2009 survey (see Appendix E for descriptions). Their general locations are shown in Figure 5.16.

It is highly likely that some of the simple piles or stacks of rocks are either trail markers, boundary markers, or a simple kind of shrine made to propitiate the gods. Ed Stevens (personal communication) mentioned that when he was little and his family decided to hike a forest trail they would erect a pile of three stones with *ti* leaves between. The purpose was to petition the gods to avoid rain during the hike. It is reasonable to think that this kind of practice, which continues even today, would explain the large number of small stacks of rocks widely dispersed throughout the Science Reserve. It is hard to imagine that such features of the most minimalist kind would necessarily mark trails. They would hardly be visible or not at all during misty or foggy weather, for example. It is easy to see how a simple ritual performed to avoid bad weather could have evolved from earlier practices that were aimed at avoiding danger and insuring safe passage.

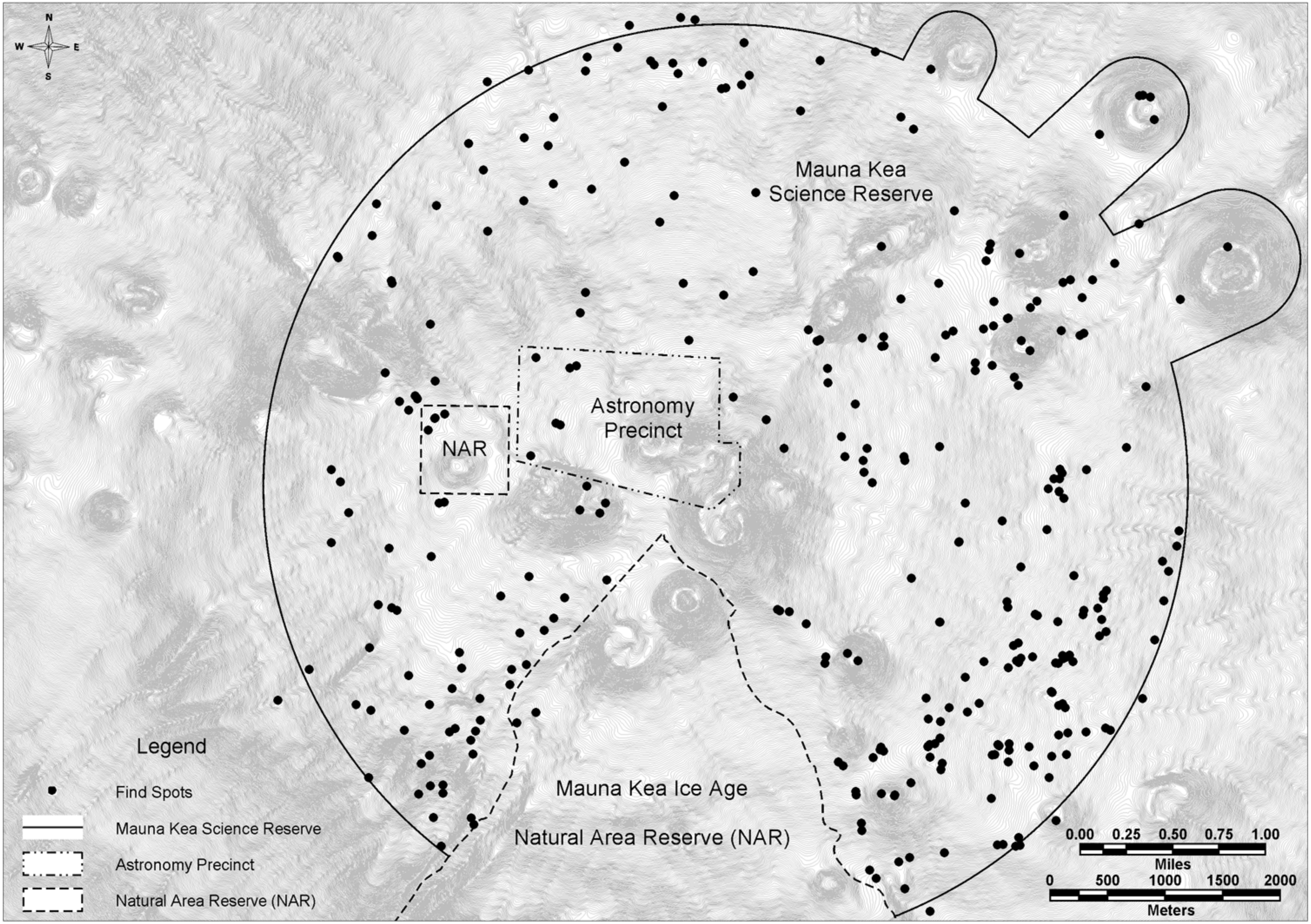


Figure 5.16 General Location of Other Cultural Resources (Find Spots) Identified in the 2005 - 2009 Survey.

McEldowney (1982: A-13) noted that "Such propitiation or petition made to local deities or to those who were personified in natural phenomena (i.e., clouds, mist, rains, winds, falling rocks, stands of trees, etc.) could be made with offerings to "upright stones," "small platforms," simple stones and natural landscape features" (Buck 1957:259).

There are numerous historic accounts that describe such propitiation practices. McEldowney (1982:A-9 to A-10) included two first-hand accounts from Menzies which date to 1793:

> So bigoted are these people to their religion that here and there on the sides of the path they have little maraes or spots consecrated to their deity, which none of them ever pass without leaving something, let it be ever so trifling, to obtain his good will, and they were highly delighted indeed when we followed their example in throwing a nail, a few beads, or a piece of tapa before their deity, which the women were not allowed to pass without uncovering their breasts and shoulders (Menzies 1920:85).
>
> We observed here and there on the path little maraes, pointed out by taboo sticks stuck in the ground round a bush or under a tree. In passing these places the natives always uttered a prayer or hymn, and made some offerings as they said, to their akua, by leaving a piece of fruit, vegetable or something of other at these consecrated spots (Menzies 1920:156-157).

McAllister (1933:19-20) included a quote from a passage in Tyerman and Bennett (1831: 432) that describes in more detail:

> As we proceeded towards an adjacent village, we had to cross, with great difficulty and some peril, a range of black rocks which overhung the dashing surges with precipices of giddy elevation. The path being exceeding rough, there were placed, at intervals small heaps of stones with a large block set upright in the centre of each. The latter, in fact, was a local divinity, tufts of grass and wreaths of leaves being devoutly laid around these sanctuaries by passengers, who thus propitiated his favour that they might be protected from slips and falls by the way…On the summit of this stupendous range, we found a perfect pandemonium, consisting of multitudes of these dumb, shapeless fragments of the rock on which we were treading, set up to receive the honours due to God alone. These seemed to be of a superior order, entitled to inhabit a higher region, than those on the declivities; for, in addition to the grass and leaves that strewed their respective shrines, their tops were wrapped round with native cloth. The savage aspect of nature in this scene of utter loneliness and desolation—where not a tree or plant grew among the innumerable crags, loose or fixed, that lay like the ruins of a mountain shattered to pieces around and below where we stood—was well calculated to affect with superstitious awe an ignorant people.

The Rev. William Ellis observed similar practices aimed at ensuring safe passage at dangerous places along paths or trails, especially those that went up and over cliffs. His account, dating to his travels through the islands in 1823, mentions stone gods at such dangerous places.

> Within a few yards of the upper edge of the pass, under the shade of the surrounding bushes and trees, two rude and shapeless stone idols are fixed, one on each side of the path, which the natives call *Akua no ka Pari*, gods of the precipice; they are usually covered with pieces of white tapa, native cloth; and every native who passes by to the precipice, if he intends to descend, lays a green bough before these idols, encircles them with a garland of flowers, or

wraps a piece of tapa round them, to render them propitious to his descent; all who ascend from the opposite side make a similar acknowledgment for the supposed protection of the deities, whom they imagine to preside over the fearful pass. This practice appears universal, for in our travels among the islands, we have seldom passed any steep or dangerous paths, as the commencement or termination of which we have not seen these images, with heaps of offerings lying before them. Until very recently, it is evident the influence of superstition was strong in the minds of the great mass of the people; for although the natives who accompanied us in our excursions, either from a conviction of the absurdity of the notions of their countrymen, or from mere wantoness, usually overturned the idols, battered them with stones, or rolled them down the precipice or passage which they were supposed to defend; yet on passing the same path only a very short time afterwards, we have invariably found them replaced, or, if broken, their places supplied by fresh ones. The conduct of our native companions was never the consequence of our directions, and seldom received our approbation, for we were not ambitious to become Iconoclasts....(Ellis 1979:15-16).

Eduard Arning, who was collecting ethnographic specimens in the Hawaiian Islands in the 1880s witnessed a variation of same practice as that described earlier by Ellis, on Molokai and Oahu, indicating that what many people today would call superstitious beliefs, continued well after European contact. Instead of tapa and flowers, Arning describes the offerings as stones:

Stone Offerings: In crossing the pali between Kalawao and Waikolo (Molokai) the natives deposited oval lava stones on the dangerous hills. This custom was, during my stay, still rigidly observed. I took such a lava piece (1,20) from one of the rocks; it measures 9 cm. long and 7 cm. wide. Also at the end of a narrow gorge famous for its picturesque waterfall near Punaluu on Oahu (photo 1, 232 and 1, 233) behind the temple of the fish god is Kalaupoko the natives deposited stone offerings. They hoped that these offerings would protect them from falling stones, and they deposited these every four or five steps in little heaps and covered them with leaves of dracaena or Eugenia. They hoped by these tokens of attention to propitiate the gods. They always entered the valley only timidly and with shyness. Here, I was told, the god Kameepua fled from the angry Pele and in sliding down the mountain caused the stripes of erosion beside the waterfall (Arning 1931:79).

5.4.4 Summary of Work and Findings in the Astronomy Precinct

The 525-acre Astronomy Precinct, which was established in 2000 with the approval of the Mauna Kea Science Reserve Master Plan (Group 70 International, Inc.) by the UH Board of Regents, is an area of special concern since this is the only area within the Science Reserve where developments, such as new observatories, will be allowed in the future. A summary of archaeological investigations in the precinct is presented below. Figure 5.17 shows the locations of all known archaeological sites and find spots.

The Astronomy Precinct is one of most intensively surveyed areas in the Science Reserve. Three archaeological surveys have been conducted in the Astronomy Precinct. The first survey, in 1982, identified four sites (Table 5.10; McCoy 1982a). In 1995, SHPD resurveyed a portion of the precinct in the process of relocating previously identified sites which for the first time were accurately located using GPS technology. No new sites were found in that project, which did not cover the whole area, however.

Table 5.10. List of Historic Properties Located in the Astronomy Precinct.

State Site No. 50-10-23-	Site Type	Site Function
Previously Recorded Archaeological Sites		
16166	2 rows of uprights, 8 to possibly 9 total	Shrine
16167	Single row of 2 uprights	Shrine
16169	Single row of 2 uprights	Shrine
16172	Single Upright	Shrine
Newly Recorded Archaeological Sites		
21447	Single Upright	Shrine
21449	Terrace	Unknown

The archaeological inventory survey of the precinct in 2005 found one new shrine (Site 21447) and a small terrace of unknown function (Site 21449; McCoy et al. 2005). Excavation of Site 21449 in 2008 failed to produce any evidence that would aid in the determination of site function (see Volume 2 site descriptions for excavation results). There was no evidence of buried cultural deposits and the only clue of human activity are several large slabs on the surface that are difficult to explain as a natural occurrence. The function of this site thus remains unknown.

In summary, there are six known archaeological sites in the Astronomy Precinct. As shown on Figure 5.17 a portion of Pu`u Kūkahau`ula, a TCP (Site 21438) is also included within the Astronomy Precinct. There are thus seven identified historic properties in the precinct.

The 2005 survey also identified a couple of new find spots in the Astronomy Precinct near the terminus of the "13 North Road." Two single uprights (Find-spots 2005-9 and 2005-9) were found in close proximity to the road and to recently installed test telescope and other equipment (see Figure 5.17). No archaeological sites had ever been found at this location in past surveys or during field inspections by SHPD staff archaeologists in 2004 as part of the compliance process for the installation of the new equipment. The appearance of find-spots 2005-8 and 2005-9 in the short interval between 2004 and 2005 is a good example of why these new cultural features need to be tracked and distinguished from the shrines and other features associated with Mauna Kea's ancient cultural landscape.

Seven find-spots were identified in the Astronomy Precinct in 2005 (Table 5.11; see Figure 5.17), including a previously identified find-spot found during the 1997 SHPD survey (McCoy 1999a).

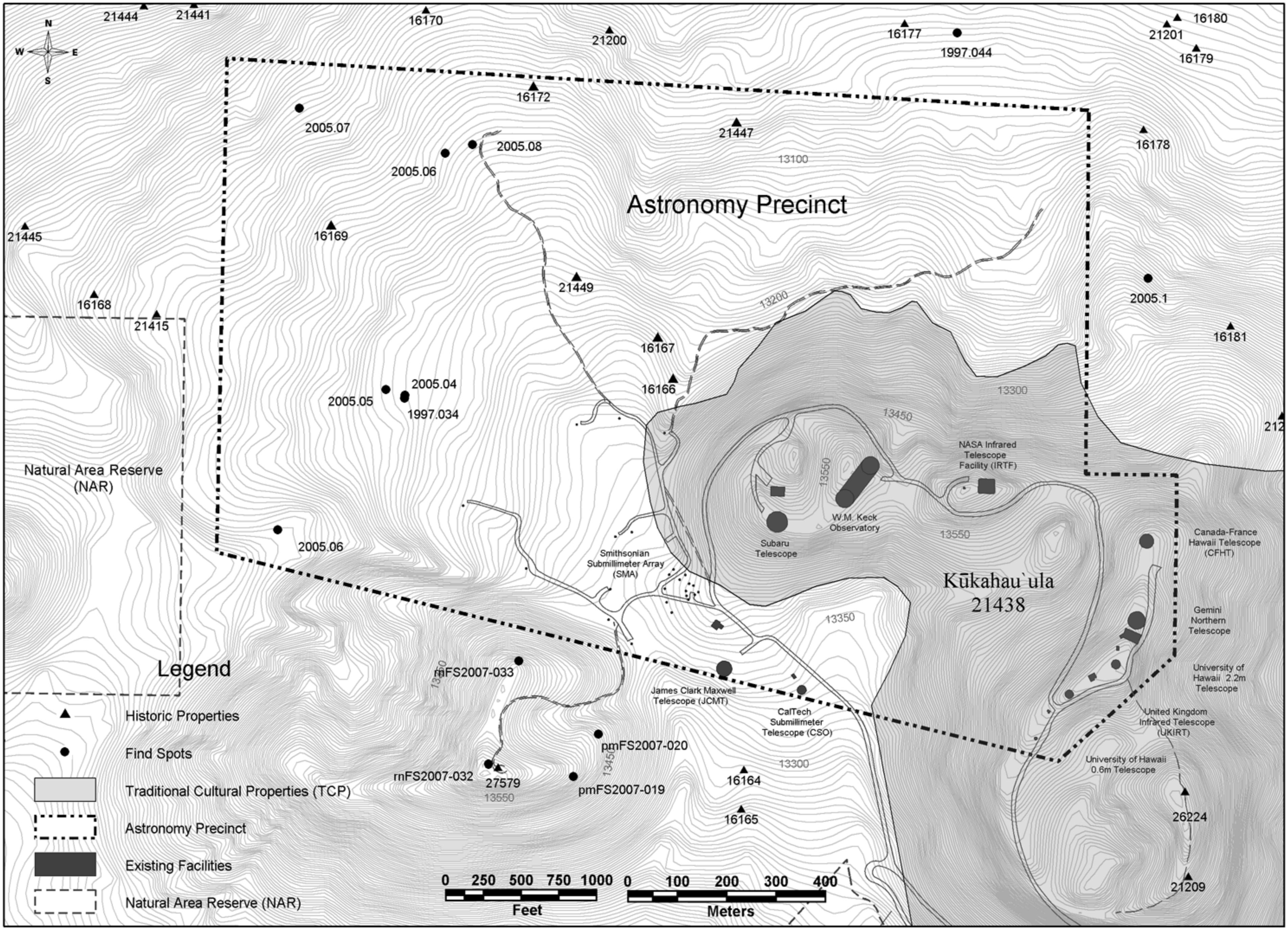


Figure 5.17 Location of Historic Properties and Find Spots in the Astronomy Precinct and Surrounding Area.

Table 5.11. List of Find Spots Located in the Astronomy Precinct.

Year. No.	Approximate Elevation (ft. asl)	Description	Function
Previously Recorded Find-Spots			
1997.07	13,308	Stacked (2) rocks on a boulder	Marker
Newly Recorded Find-Spots			
2005.03	13,271	Stacked (3) rocks	Marker
2005.05	13,220	Stacked rocks	Marker
2005.06	13,202	Possible upright	Unknown
2005.07	13,000	Possible uprights	Unknown
2005.08	13,140	Two uprights near weather station	Shrine
2005.09	13,016	Stacked rocks	Shrine

6.0 DATA ANALYSES AND RESULTS

One of the common criticisms of CRM archaeology is that because little attention tends to be given to methodological and theoretical matters (Watson 1991), it often amounts to little more than data aggregation, and as a result does not contribute significantly to the production of archaeological knowledge. As a generalization it may be true that while CRM-oriented compliance surveys and data recovery projects meet the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation on data analysis, many do so only minimally. It is our impression, moreover, that the data are more commonly under-interpreted and not very often linked to sociocultural theory. In this regard, our view of the place of data analysis in the archaeological process follows Cowgill who has written:

> It is useful to think rather distinctly of three broad categories: archaeological observations, analytical methods, and sociocultural theory. Analytical methods provide the connections between observations and sociocultural theory (Cowgill 1986:369).

The quantity of raw data collected during the survey of the Science Reserve is immense. Time and money constraints prevent exhaustive analyses of all of the field data. The analyses undertaken for this report are focused on the two most common classes of sites and features in the Science Reserve: (1) shrines, and (2) the adze manufacturing quarry complex which is comprised of hundreds of workshops and other components, including shrines, habitation rockshelters and two possible burials.

6.1 Analytical Framework: Concepts and Terminology

The approach to data analysis employed in this report recognizes the importance of scale and the need for multi-scale analyses (Lock and Molyneaux 2006).

> Scale is a slippery concept, one that is sometimes easy to define but often difficult to grasp. In the practice of archaeology, there is much equivocation about scale, as it is at the same time a concept, a lived experience and an analytical framework…In taking scale for granted, archaeologists rarely expose its complexities and therefore overlook its crucial role in the process of representing the past (Lock and Molyneaux 2006:1).

Though shrines and quarry/workshop sites, the two major classes of sites in the Science Reserve, require a different analytical framework, the general approach that is being utilized is based on variables and attributes to identify variability and to develop typologies.

The focus on variables and attributes and the development of typologies is a common archaeological practice that is not without its problems, however, as described below. Paraphrasing Laurent Stern, the general approach is based on the conviction that "we are not finding, stating or describing facts, we are making sense of attributes and actions" (Stern 1990:205-206).

6.1.1 Variables and Attributes

One of the problems in archaeological analysis is that variable and attribute definition and selection are still primarily ad hoc and intuitive. They should be theoretically justified (Hill and Evans 1972:251-252; Dunnell 1986:193). Redman provides one of the clearest statements on the importance of the attribute selection process in archaeological analysis and what it entails:

> *Attribute recognition and selection* is the most crucial step in the analysis of archeological material. It is at this juncture that the archeologist is required to incorporate all available knowledge of similar artifacts, previous classificatory systems, insights on the relevance of particular attributes, and initial observation of the patterning of potential attributes. Attribute recognition is not an automatic process, and the decisions made directly affect the outcome of any subsequent analysis (Redman 1978:163).

We use variable and attribute as defined by Adams and Adams:

> An attribute is a definable aspect of a particular variable; that is, one of the states that it can assume (Adams and Adams 1991:169).
>
> Variables might better be characterized as dimensions of variability. They designate properties that are manifest in one way or another in all of the types in a typology, but not always in the same way or to the same degree (Adams and Adams 1991:170).
>
> Attributes designate recognizably different measurements or aspects within the same field (or along the same dimension) of variability. They differ from variables in several important respects. In each type there can be only one attribute per variable (Adams and Adams 1991:172).

6.1.2 Taxonomy, Classification, and Typology

There is a vast literature on taxonomy, classification and typology in both the natural and social sciences, including archaeology. Stephen Jay Gould noted that "Taxonomies are theories of knowledge, not objective pigeonholes, hatracks, or stamp albums with places preassigned" (Gould 2000:223). Gould recognized that taxonomies, though generally useful in giving order to a body of data, could also be wrong and potentially harmful in some instances. He wrote "A false taxonomy based on a bogus theory of knowledge can lead us badly astray" (Gould 2000:223).

There are significant differences in the way archaeological typologies are developed and used compared to the natural sciences. As Cowgill points out, the "one obvious difference in our data and those of biologists is that our categories are far more problematic" (Cowgill 1989b:132). Adams and Adams (1991) make an important point in emphasizing that classification is just a tool, which means that there is no right and wrong way to classify things, as also argued by Cowgill (1989b:132). Classifications, moreover, are not immutable (i.e., they may require revision):

> We encounter frequently the assertion that typologies should strive for maximum scientific "objectivity." This does not strike us as a relevant or even a meaningful consideration, applied to what are essentially tools of communication. Useful typologies require intersubjective agreement (consistency), which is not the same

> thing as objectivity (correctness). We will never know, in many cases, how closely our type concepts correspond to some external reality, but we can discover and measure how closely the concepts of one person correspond to those of another (cf. especially Fish 1978 and Ziman 1978) (Adams and Adams 1991:4).
>
> There is no right or wrong way to classify anything, but there are better and worse ways of achieving specific purposes, once we have decided what those purposes are. By better we mean not only more precise, but also more communicable and more affordable (Adams and Adams 1991:4-5).

Adams and Adams view typology as a particular kind of classification and describe what the process of developing types involves:

> Scientific literature often does not distinguish between classifications and typologies. To us, this distinction is crucial. In our usage, a typology is a particular kind of classification: one designed not merely for categorizing and labeling things, but for segregating them into discrete groups which correspond to our class categories and labels. This process of segregation we call sorting; the things that are classified and sorted we call entities; the categorical groupings into which they are sorted we call types (Adams and Adams 1991:47).
>
> A typology is a basic set of mutually exclusive categories, at the same level of abstraction, and a taxonomy is a clustering of basic types into large and more inclusive units, or taxa (Adams and Adams 1991:88).

The purpose of classification is not to just organize the data and make them amenable to comparison, but to make comparisons meaningful. What is meaningful is defined in terms of purpose. Adams and Adams (1991: Table 9) define basic, instrumental and multiple purposes. Within the basic purpose category there are three sub-categories--descriptive, comparative, and analytical, which is further subdivided into interpretive and historical. The descriptive function is simply one of economy or convenience. Classifications developed for comparative purposes would be useful at a larger scale of analysis, such as a region. According to Cowgill, whatever the objective, “The essential thing is that, for a given purpose, we must not lump in ways that obscure important differences and we must not split on the basis of differences that are irrelevant for that purpose” (Cowgill 1989b:132).

Based on the earlier, limited analyses of uprights in previous surveys, the senior author’s view is that we cannot even begin to try and understand the meaning and significance of the shrines on Mauna Kea without an analysis of upright shape and the variability in shape on sites with more than one upright. A major focus of the shrine recording process was the systematic recording of the dimensions and what we believe are the most important qualitative attributes of the uprights. Table 6.1 presents a summary of some of the major variables and attributes that are considered at the outset of the analysis. A table with all of the variables and attributes that were recorded is presented in Appendix F.

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
11077	1	1	1	1					x	x	
11079	1		0	0		x					
16163	1	2	14	15					x	x	
16164	2	7	4	6	x				x		
16165	1	2	2	2	x						
16166	2	6	8	9	x					x	
16167	1	2	2	2	x						
16168	1	5	25	25	x			x		x	x
16169	1	3	2	2	x						
16170	2	4	4	4	x		x				
16171	1	1	1	1	x						
16172	1	1	1	1	x						
16173	4	7	7	7	x		x				
16174	4	7	6	8	x	x					
16175	6	7	5	7	x						
16176	1	2	2	2			x				
16177	2	4	4	5	x				x	x	
16178	1	1	1	1	x						
16179	1	2	3	3	x						
16180	1	4	3	3	x						
16181	1	1	1	1	x						
16182	3	7	5	5	x		x			x	
16184	1	5	22	22	x		x				x
16185	1	2	3	3	x						
16186	1	3	2	3	x						
16187	1	2	9	9	x						
16188	1	1	1	1	x						
16189	1	3	4	4	x						

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
16190	1	4	7	11			x				x
16191	1	2	5	5	x						
16192	1	2	17	17	x						
16193	1	1	1	1		x					
16194	1	2	14	14	x						
16196	1	2	2	2	x						
16197	1	1	1	1	x						
16198	1	5	7	15	x				x	x	x
16199	1	4	4	6	x	x	x				
16200	1	7	5	6					x		
16201	1	3	3	3		x	x				
16202	1	1	1	1					x	x	
16203	1	4	3	3			x				
16204	5	various	41	44	x				x	x	x
18682	1	2	3	3	x						
18683	1	2	3	3					x		
21197	2	4	4	5				x			
21198	1	1	1	1					x		
21199	1	1	1	1	x						
21200	1	1	1	1	x						
21201	1	2	2	2	x						
21202	1	2	6	7			x				
21203	1	2	2	2	x						
21205	1	1	1	1	x						
21206	1	1	1	1		x					
21207	1	1	1	1		x					
21208	1	1	1	2		x					
21210	1	1	1	1		x					

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
21211	1	1	0	1					x		
21212	1	2	2	2		x					
21213	1	1	1	1			x				
21214	1	4	8	8			x			x	?
21406	1	1	0	1	x						
21407	1	1	1	1	x						
21408	1	1	1	1	x						
21409	1	1	1	1	x						
21410	1	2	4	5	x		x				
21417	1	1	0	1		x					
21418	1	4	4	4	x	x				x	
21419	1	7	3	3	x						
21420	1	5	12	12			x				x
21421	2	3	1	2			x				
21422	1	1	1	1	x						
21424	1	2	5	5		x	x			?	?
21425	1	1	1	1		x					
21426	1	2	3	3	x					x	
21427	1	1	1	1	x						
21428	1	1	1	1	x						
21429	1	1	1	1	x						
21430	1	3	5	5	x					?	?
21431	1	5	10	10	x		x			?	x
21432	1	1	1	1		x					
21433	1	1	1	1	x						
21435	1	1	0	1		x					
21441	3	4	11	13	x		x				
21442	1	1	1	1	x						

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
21443	1	1	1	1	x						
21444	1	1	1	1	x						
21445	3	3	4	4	x						
21446	3	4	6	11	x						
21447	1	1	1	1	x						
21448	1	2	2	2	x						
21451	1	1	1	1	x						
25763	1	1	1	1		x					
25764	1	5	8	8			x				
25771	1	1	1	1				1			
25772	2	4	4	4		x				x	
25773	1	1	1	1		x					
25775	1	2	2	2		x					
25776	2	3	0	2		x					
25778	1	3	2	2		x					
25780	1	1	1	1			x				
25781	2	6	5	5			x			x	
25782	1	1	1	1		x					
25783	1	2	2	3	x						
25784	1	1	1	1	x						
25786	1	2	1	3	x						
25787	1	4	2	4	x						
25788	1	1	1	1		x					
25789	1	4	15	20	x						
25790	1	2	3	6			x				
25791	1	1	1	1		x					
25792	1		0	0		x					
25793	1	2	4	4	x						

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
25794	1	1	1	1	x						
25795	1	1	1	1		x					
25797	1	1	1	1		x					
25798	1	1	1	1		x					
25799	3	5	3	6	x	x	x				
25810	1	1	0	1			x				
25811	1	1	1	1				x			
25818	1	4	7	7				x			
25819	1	4	15	16	x						
25820	1	2	2	3			x				
25821	1	1	1	1		x					
25825	1	2	2	3			x				
25826	1	2	1	2	x						
25827	1	2	3	4	x						
26217	1	2	3	3			x				
26219	1	2	1	2			x				
26221	1	1	1	1		x					
26222	1	1	1	2			x				
26223	1	1	1	1	x						
26225	1	1	1	1		x					
26226	1		0	0		x					
26227	1	1	1	1			x				
26228	2	4	8	14	x		x				
26229	1	2	2	2		x					
26231	1	2	2	2			x				
26233	1	5	10	12			x			x	
26234	1	1	1	1	x						
26235	1	1	1	1	x						

Table 6.1. Summary of Major Shrine Variables and Attributes

Site Number	Number of Features	Shrine Type	Number of Uprights		Foundation Type*					Pavement	Court
			Minimum	Maximum	Bedrock	Boulder	Mound	Terrace	Platform		
26236	1	1	1	1	x						
26238	1	1	1	1	x						
26239	1	1	1	1	x						
26240	2	4	5	6	x		x				
26242	1	1	1	1			x				
26243	1	1	1	1	x						
26244	1	2	1	2	x						
26248	1	2	4	4	x						
26250	2	4	4	4	x		x				
26251	1	1	1	1	x						
26252	1	2	2	2	x						
26253	1	1	1	1			x				
26254	2	3	2	3			x				
26255	1	1	1	1		x					
27582	1	1	1	1		x					
27586	1	3	3	3	x						
27588	2	4	11	11	x						
27616	5	various	6	13	x		x			x	x
27617	5	various	7	16	x		x		x		
27618	2	various	1	2			x				
Total	208		560	658	91	34	41	4	12	16	8

6.2 Shrine Attributes, Types, Spatial Distribution Patterns, Function and Age

The analysis that follows has several objectives:

(1) identifying and analyzing what we believe are the most important characteristics of the Mauna Kea shrines;

(2) developing a shrine typology for descriptive and comparative purposes; and

(3) examining the spatial distribution of the various attributes and shrine types and the types or styles of uprights found on the shrines in the Science Reserve.

The analyses are by no means definitive or exhaustive in the sense that they do present all that is potentially meaningful about the construction, use and meaning of the shrines. Some of the analyses are, moreover, exploratory.

6.2.1 Methodological Issues

In deciding which of any number of variables and attributes are important to record there is a clear need to consider both qualitative and quantitative attributes. Measurements, such as height, width and thickness, tend to be amongst the most commonly recorded attributes. On the whole little thought is given to the meaning of measurements, however:

> Generating measurements is not difficult; it is far more challenging to assign meaning to these measurements. But measurements themselves do not create meaning; meaning is imposed on the data and this necessitates establishing the context and the priority of questions at the outset. Because we have the ability to take measurements with nearly infinite detail and variety, we are forced to select those measurements that are more appropriate than others. This task *cannot* be separated from the selection and definition of problems (Moore and Keene 1983:16).

While measurements are important in characterizing, for example, the size of a shrine upright and thus making it possible to identify it in future monitoring projects, measurements may not necessarily be the most important attributes. The qualities of a thing, such as a shrine upright, may be more important than physical properties. Maurice Merleau-Ponty recognized long ago that “The qualities of a thing, its colour for example, or its hardness or weight, teach us much more about it than its geometrical properties” (Merleau-Ponty 1962:304). Tilley reiterates what Merleau-Ponty said and emphasizes the importance of taking a phenomenological point of view into consideration in deciding what are the most important variables:

> From an empiricist point of view, objects may be said to possess certain primary characteristics, those that can be measured, and certain secondary characteristics, such as colour or how a thing feels, which cannot. We obtain objective knowledge of the former, but only subjective and thus imprecise knowledge of the latter. From a phenomenological point of view, such a perspective has to be rejected. Just because we can measure the size of a stone does not imply that size is more important than texture or colour. The qualities of a thing, in fact, may tell us fare about it than any number of measurements of its geometrical properties that we might like to take (Tilley 2004:11).

For a variety of reasons, but most importantly, perception, a variable like shape is indeed difficult to record in a regular or systematic way. The approach we have used follows Tilley who describes the need, following Merleau-Ponty, to relate objects to the body:

> The size and shape of objects in a landscape appear to alter as we change our relationship to them. A large stone will appear to be small when seen from far away. As we look at the stone from different angles, its shape will change; so what is its true size and shape? And what size and shape of the stone are illusory? Merleau-Ponty's answer to this problem is to relate the stone to the body: the true size and shape of an object is when it is in reach (and can be measured) (Tilley 2004:11).

In terms of upright recording methodology the most important point made by Tilley is the statement that ***"the true size and shape of an object is when it is in reach (and can be measured)"*** (our emphasis). We are highlighting this statement because there are those who we know have found or would find the recording of upright shape problematical. The problem is the natural tendency to see changes in form based on different perspectives (e.g., from above and below or one side vs. another side), rather than from within a reach close enough to take measurements and record the form or shape of an upright. The same would hold true of any three dimensional object, artifact, building, etc. It is interesting to note how size (defined as height, width and thickness) tend to be regarded as unproblematical in contrast to a qualitative attribute, such as shape. The underlying assumption is that there are determinate sizes but not shapes, which raises the methodological issue of regularity and uniformity (see Cowgill 1989a, 1989b), in addition to the complicated matter of emic and etic types. It is interesting to note that similar concerns are rarely voiced regarding measurements, which would also vary with changes in distance and perspective.

In addition to recognizing how perception can affect observations there is also the matter of experience:

> In ordinary experience, the tendency of the person is to accumulate information randomly, incompletely, and then to order that information into conscious patterns that are specific, yet complicated and unwieldy. Normal perceptions are selectively small; normal concepts are large and weak. It is by constantly reexperiencing the same or similar things that a person's perceptions become adequate and his concepts become efficient, although these concepts remain unconscious and unarticulated (Glassie 1975:13).

Glassie's account of how perception can become more adequate over time, with an increase in experience, is a perfect description of the history of shrine upright recording procedures on Mauna Kea from the mid-1970s on. The recording of shrine upright attributes was initially limited to noting condition (whole or broken) and height, width and thickness measurements. Over time more attention was paid to the form of the uprights in terms of raw material properties (e.g., the recognition that most uprights are tabular and have cross-sections varying from square to triangular). By the time of the 1984 survey, on the east side of the Science Reserve, upright shape was a variable that was beginning to assume significance in the recognition that there were a limited number of recurring forms. The perception of shape was limited, however, to the top of the upright. The observation of pointed and flat-topped uprights led to the preliminary conclusion that the two forms might be symbolic markers of male and female gods (McCoy 1999a; 1999b).

6.2.2 The Component Parts of a Shrine

The Mauna Kea shrines include one or more of the following elements or "parts": (1) uprights, (2) pavements, and (3) courts (Figure 6.1). Significant variability exists in the presence/absence of pavements, courts, and artifacts, and in attributes such as, the number of uprights and manner in which they were set and arranged. In contrast to what Emory called the Necker *marae* and many other *marae* in Eastern Polynesia, few of the Mauna Kea shrines have a raised platform corresponding to what is in many island groups called the *ahu* (Emory 1943:13). The few shrines with defined courts in the Science Reserve are paved, but not clearly demarcated in the way illustrated for the Necker *marae* (see Figure 6.1). The analyses that follow indicate significant variability in the presence/absence of pavements, courts, and artifacts, and in attributes such as, the number of uprights and manner in which they were set and arranged.

6.2.3 Shrine Locations and Orientation

The site location data obtained in earlier surveys showed that the vast majority of shrines are conspicuously sighted in the landscape, either on a ridge top, or at a break in the slope, which generally seems to correspond to either a lava flow margin or a change in the slope of a glacial moraine or glacial drift deposit (McCoy 1999a). The few exceptions are located in an area of low relief, such as the southeast flank of Pu`u Līlīinoe (see Figure 5.5 in back pocket).

6.2.3.1 Topographic Setting

Sites were found in various topographic settings and on different landforms. In some cases more than one of the following categories might apply, such as a site located on the mid-elevation portion of a ridge, on top of which is a gelifluction lobe. A summary of the data is presented in Appendix F. The frequency distribution of the major topographic categories (1-5) is presented in Figure 6.2, which is based on a sample of 145 shrines.

(1) ***Ridge Crest*** **(Summit):** There are 22 shrines (15.17% of the total 145) in this category.

(2) ***Ridge Crest (Mid-Elevation)*****:** There are 34 shrines (23.44% of the total) built on the top or crest of a ridge, but not at the highest point or summit.

(3) ***Ridge Crest*** **(Toe):** The toe of a ridge is the bottom end, where the ridge terminates and another landform begins. There are 30 shrines (20.68% of the total) in this category.

(4) ***Ridge Flank*****:** There are 18 sites (12.41% of the total) located on the edge or flank of a ridge top.

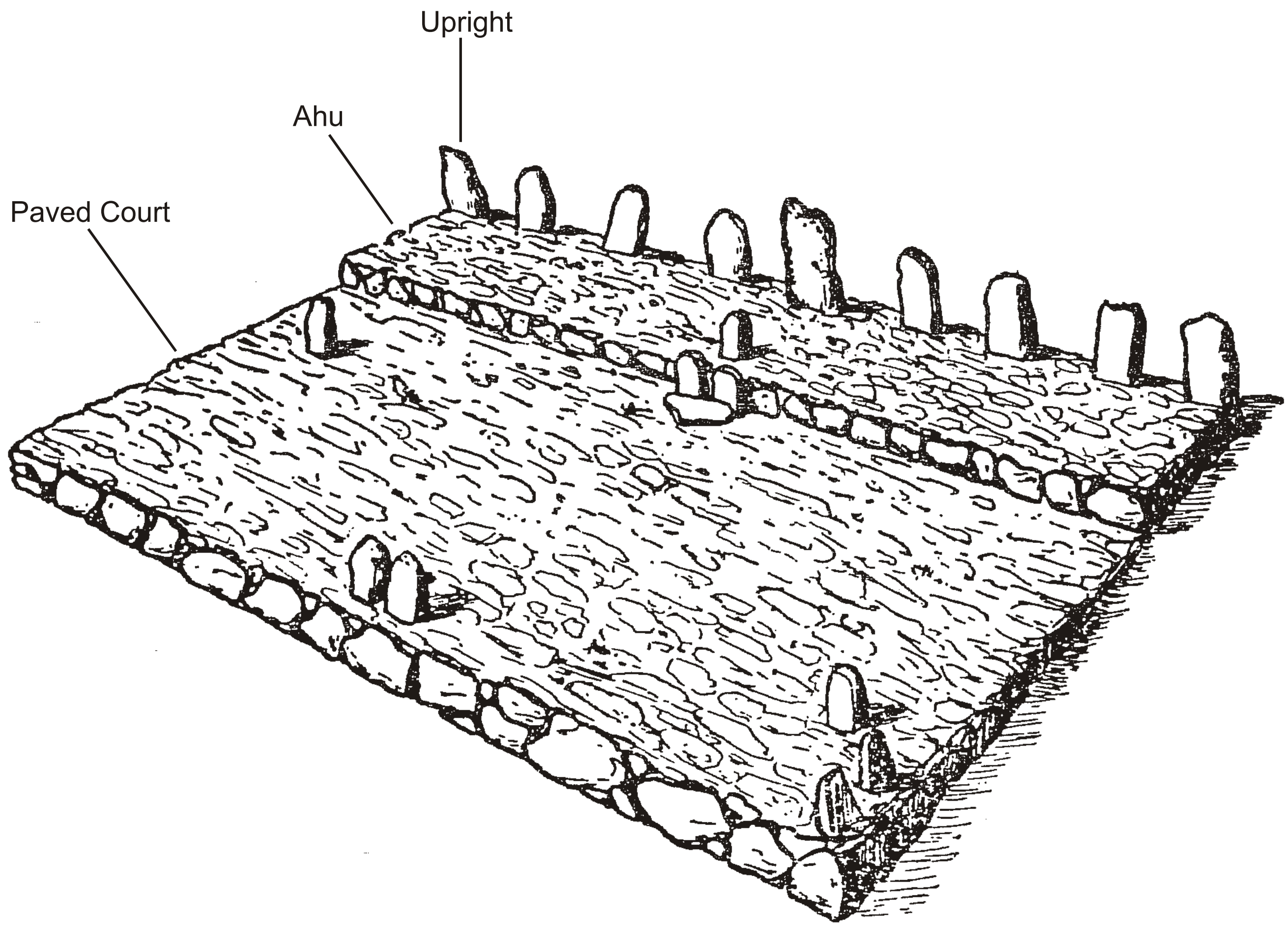
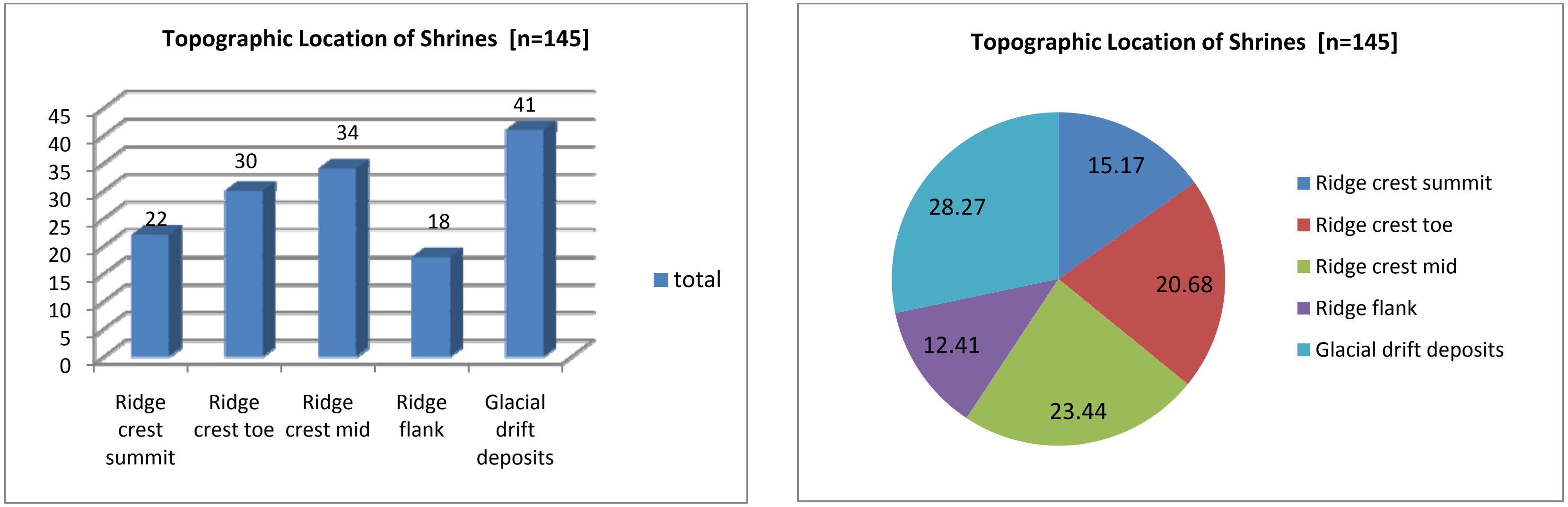
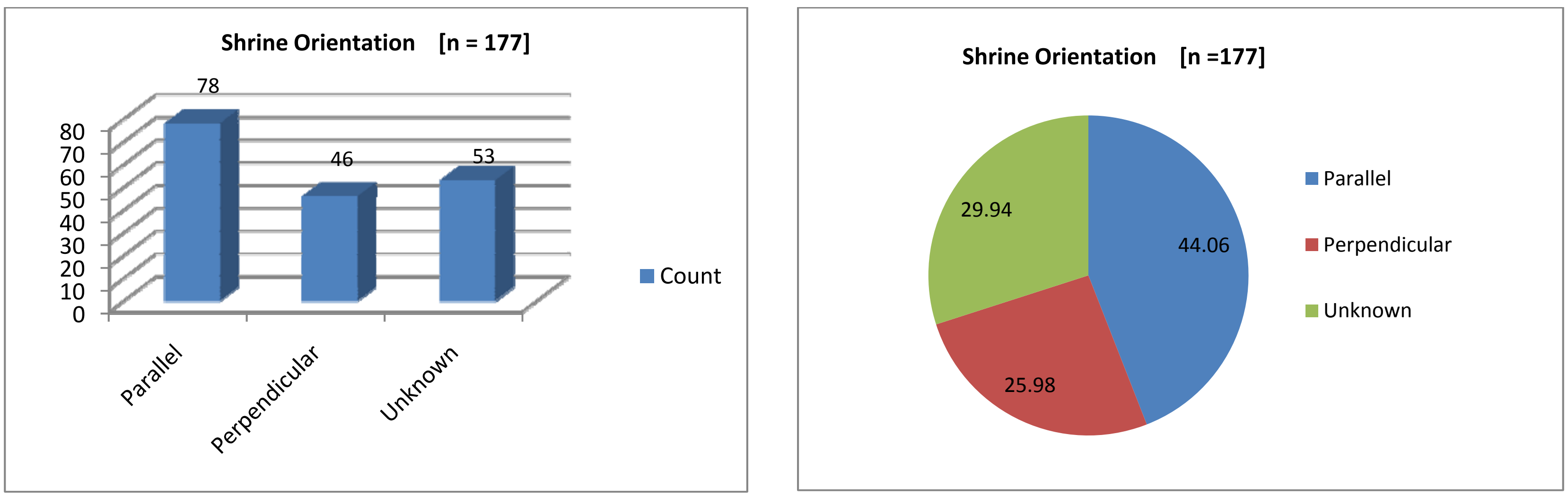


Figure 6.1. The Component Parts of Shrines and Related East Polynesian Religious Structures. (Modified from Emory 1928: Figure 13).



Shrine Topographic Location



Shrine Orientation

Figure 6.2. Frequency Distribution of Site Topographic Location and Orientations.

(5) ***Glacial Moraine-Drift Deposits*:** With exception of large boulders, few shrines were found in the poorly sorted deposits that form glacial moraines and the more generic glacial drift deposits. There are 41 shrines (28.27% of the total) in this category, which is predictably widespread given the broad extent of glacial deposits in the summit area.

(6) ***Gelifluction Lobe or Terrace*:** Gelifluction lobes or terraces, as previously noted, are nearly ubiquitous in the Science Reserve, though many of them are not readily noticeable or recognizable. It depends in part on how well sorted they are and whether or not there is a well developed stone-banked terrace. The number of shrines located on these minor landforms is presented in Appendix F. They have not been included in the calculation of major landform frequencies, however.

(7) ***Cinder Deposit/Surface*:** This is another minor category, which like gelifluction lobes and terraces, has not been used in the calculation of frequencies.

Though the majority of shrines are located on ridges (104 or 76.56% the total 145 in the sample), very few are visible from any great distance. There are several reasons for this. One is the relatively small size of most uprights and the predominance of small shrines comprised of just one or a few uprights. Perspective is another factor, depending on the line of sight and approach taken to a shrine. The most visible shrines are those with rows of more than 4 or 5 uprights. Some shrines, especially those located at the toe of a ridge, are the least visible. So while a preference for highly visible locations is the norm from a statistical point of view, there are exceptions that may signal different beliefs.

The preference for prominent locations with commanding views of the landscape mirrors the pattern described by Gilbert McAllister (1933) and Buck (1957) for *heiau*:

> Heiaus were usually built on some commanding site, such as a hill top, the seaward end of a range, or a promontory of higher land which overlooked valleys, villages, or the sea. According to McAllister (1933a, p. 9) the orientation depended only upon the slope of the land. Heiaus face in all directions of the compass, the only generalization being that most of them face the sea (Buck 1957:516).

While *heiau* may be found on hilltops elsewhere, there are no positively identified shrines in the Science Reserve located on top of a cinder cone. Some could be found in the future, but on current evidence the tops of cinder cones were reserved for burial (see discussion of burial sites below).

McAllister and Buck were not the first to recognize the relationship between topographic location and site orientation in Hawaiian *heiau*. John Stokes came to similar conclusions even earlier, at the turn of the century. His observation about sites that seem to be oriented to cardinal points fits the Mauna Kea shrines perfectly:

> Orientation of the *heiau* platform was controlled by the situation. If situated on the shore, the temple lay parallel or at right angles to the immediate shoreline (not the overall lay of the coast). If slightly inland, the orientation would seem to depend primarily on the contour of the ground and secondarily on the lay of the coast; however, on the account of the form of the volcanic islands, either factor would seem to produce the same result. Farther inland, it would be only the contour of the ground which would be considered. I could find no evidence in the

> foundations of the orientation to cardinal points. It is true that some of them did lie almost true north-south or east-west, but this was because the situation required it (Stokes 1991:35-36).

In the 1982 survey on the north slope several shrines were described as oriented close to north-south and east-west (McCoy 1982a: Table 2.1). How significant this is cannot be determined at the present time.

6.2.3.2 Orientation

The orientation of shrines is potentially one of the most significant variables. For shrines located on ridges, the orientation was recorded as parallel, perpendicular or unknown. The raw data are presented in Appendix F and the frequency distributions in Figure 6.2.

(1) ***Parallel*****:** This orientation means that the long axis of the shrine and the ridge on which they are located are the same. There are 78 sites (44.06% of the total) with this orientation.

(2) ***Perpendicular*****:** 46 sites (25.98% of the total) where a row of uprights is oriented transverse to the long axis of a ridge.

(3) **Unknown:** The orientation of nearly 30.0% of the shrines could not be determined for one reason or another. Many of these are single upright shrines (see Figure 6.2).

6.2.4 Architectural Elements

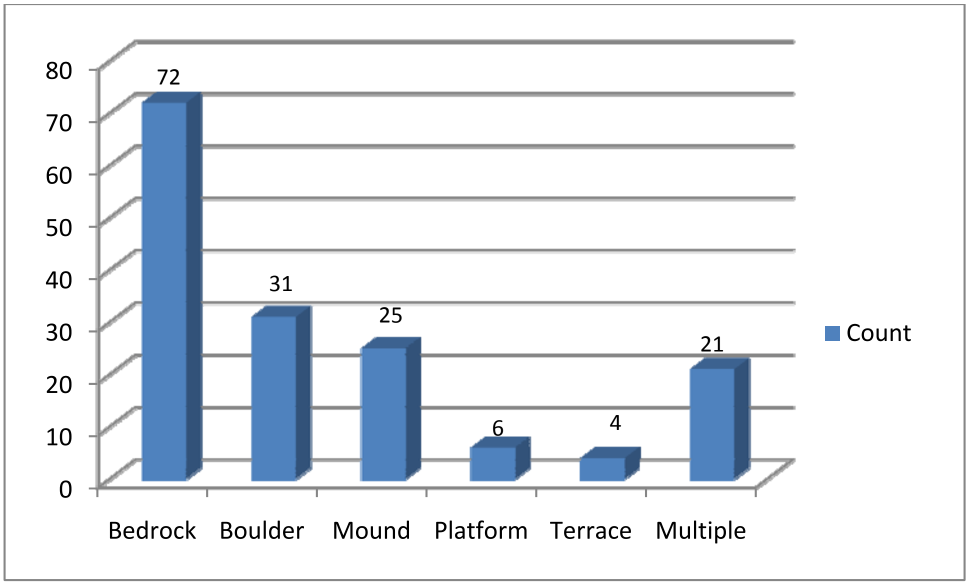
As might be expected based on the environmental context, little time was spent in assembling and arranging the materials needed to build a shrine, with the exception of the uprights which are not considered an architectural element. There are, however, different kinds of foundations. A small number of shrines have pavements and an area identified as a court.

6.2.4.1 Settings or Foundations

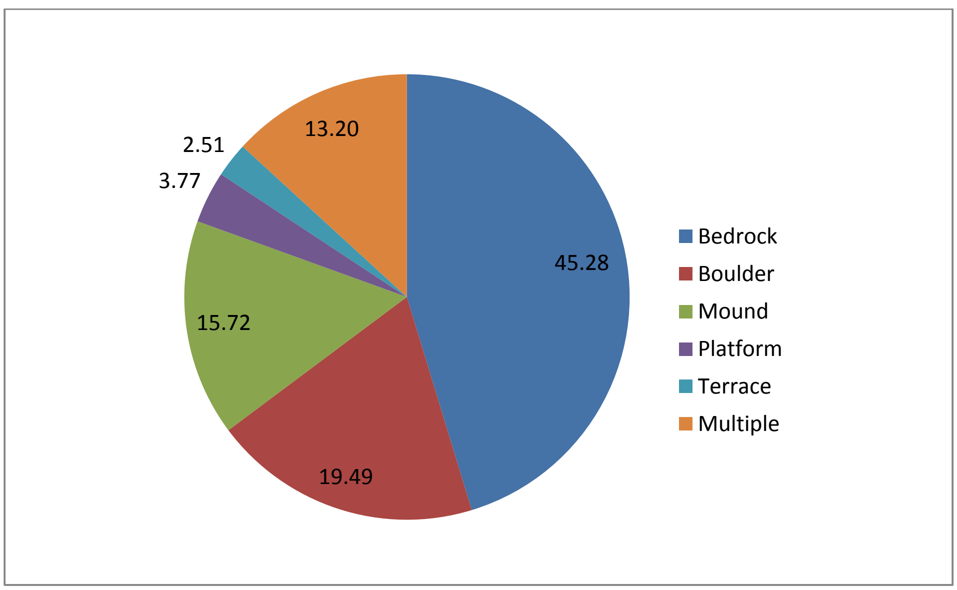
The method or manner in which uprights were set varies considerably, sometimes even within the same site where, for example, some uprights may be found resting on bedrock and others on a platform. Five different kinds of settings or foundations were observed and recorded. They include both natural surfaces (bedrock and boulders) and constructed foundations (mounds, cairns and platforms). The general characteristics, frequency of occurrence, and spatial distribution patterns for each variety is briefly described below, along with the numbers for sites with multiple kinds of foundations (see Table 6.1; Figure 6.3).

(1) ***Bedrock*****:** The most common method was to simply set the uprights on top of an outcrop and brace them with a few stones. In many instances the uprights were set into a crack in the bedrock. There are 72 sites (45.28% of the total) in this category, which is predictably widespread in the Science Reserve.

(2) ***Boulder*****:** The next most common method was to set the uprights on top of a boulder. In some instances the upright was braced by other stones; in other cases it appears that an upright might have been set into a heap of stones. There are 31 shrines (19.49% of the total) where uprights were placed on top of a boulder. The majority of



Count [n=159]



Percentage [n=159]

Figure 6.3. Frequency Distribution of Shrine Foundations within the Mauna Kea Science Reserve.

these are located on the north and east slopes (Figure 6.4) where there appears to be a larger number of naturally occurring boulders of the right size. They constitute a distinctive class of remains that for comparative purposes are being called “boulder shrines.”

(3) ***Mound*:** On 25 shrines (15.72% of the total) the uprights are set into a low rubble heap or pile of stones. In the case of some of the smaller heaps, which are low and circular to oval in shape, it may be that the mound was built up around the uprights. The larger mounds are linear and are found on sites with a larger number of uprights. They correspond in a general way to what would be called the *ahu* on East Polynesian *marae* (see Figure 6.1). Sites in this category occur over a large area on the north, east and south sides of the Science Reserve. Four sites (16170, 16175, 16203, and 21421) are located on a formal cairn, constructed of cobble to small boulder size stones of generally sub-rounded to rounded shape.

(4) ***Terrace*:** There are only four shrines (2.51%) with a terrace foundation and some of these are on sites with more than one kind of foundation (see Table 6.1).

(5) ***Platform*:** There are 6 shrines (3.77% of the total) where a low, rectangular platform was constructed to seat one or more uprights. These are the closest thing to the *ahu* of East Polynesian *marae* (see Figure 6.1). The platforms are made of the same kinds of stones used in the cairns. On some sites there are two platforms and thus two groups of uprights. Shrines with platforms are found in various areas of the Science Reserve, but the only areas with more than one are located: (1) on the south flank of the summit in the midst of a large cluster of sites; (2) in the ritual complex designated Site 16204, and (3) the south side of Pu`u Līlīnoe where there are two sites (11077 and 21213). The latter has adze manufacturing debitage on the surface and like Site 16204 is a part of the adze quarry site complex.

(6) **Multiple Settings:** Of the 159 shrines used in the analysis 21 or 13.20% have more than one kind of foundation or base.

6.2.4.2 Pavements

There are 16 shrines with crude pavements comprised of one to two courses of irregular and poorly fitted stones (see Table 6.1). The upper surface of most of them also tends to be irregular, as does the shape or form of the pavement in plan view. The size (area) is likewise highly variable. The largest pavements are found on shrines with courts (Sites 16168, 16204, 21214, 21420, and 21431), and indeed the pavement is commonly the best indicator of a court. Smaller pavements are a feature of some of the small “boulder shrines” (e.g., Site 21418) which is a category defined by multiple, dispersed uprights located on top of a boulder and on the ground surface below. The ground level uprights in such cases frequently rest on the pavement.

The small number of shrines with pavements indicates that they were not a common feature. They are widely distributed in the Science Reserve but the only places where they occur with any frequency are: (1) on the north flank of the mountain; (2) on the south flank of the summit; and (3) in the ritual complex (Site 16204). This distribution pattern is similar in many respects to the “platform shrines” discussed above.

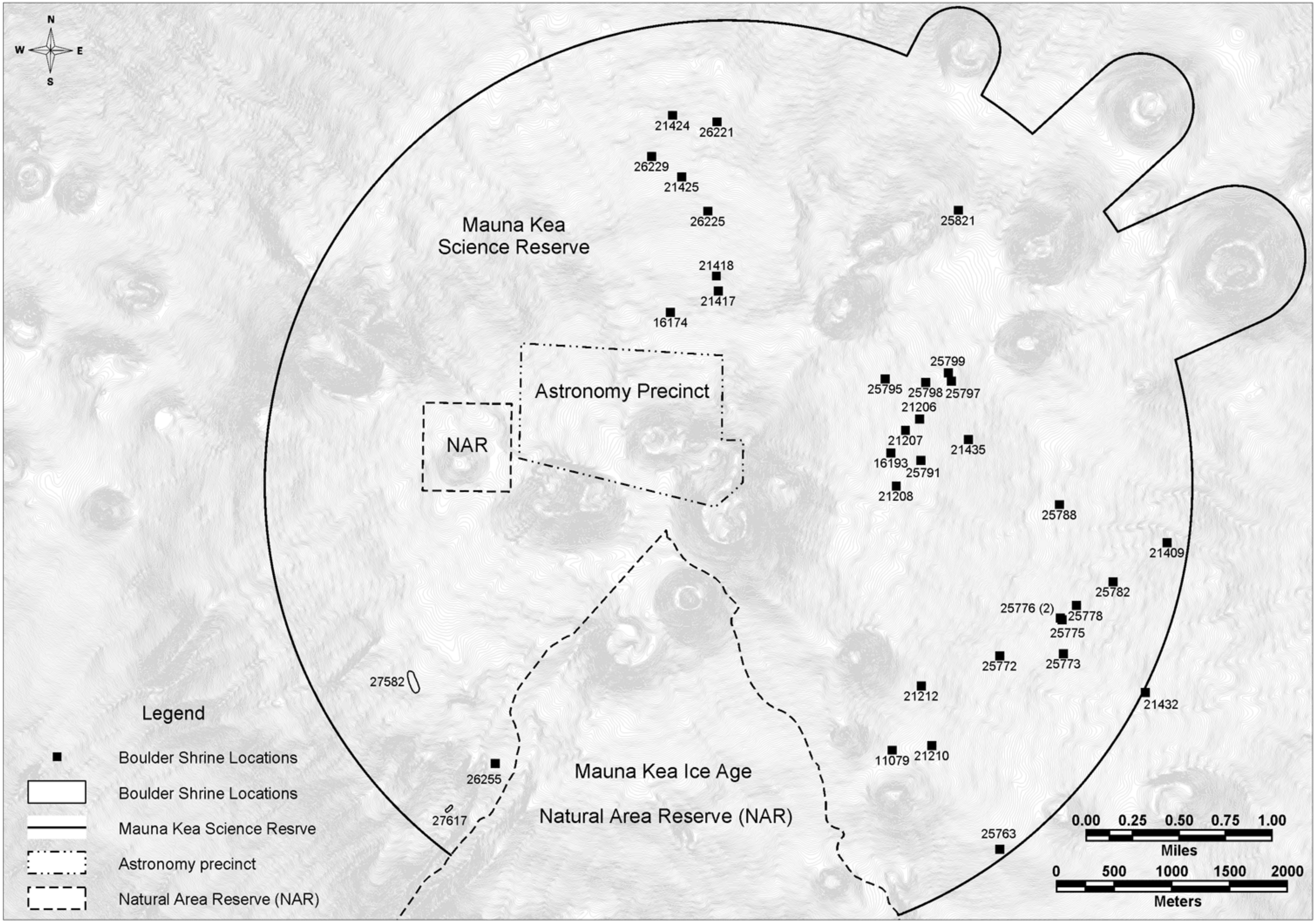


Figure 6.4 Location of “Boulder Shrines”.

The function or uses of these pavements is unknown, but based on what is known about the function of stone pavements found on *heiau* it is reasonable to suggest that they were probably built as a place to lay offerings as indicated in this account by Buck:

> Stone pavements termed *kipapa* were laid in front of the images on the floor of the court...According to Malo (1951, p. 162), the temple offerings (*mohai)* were placed upon the offering pavements temporarily, until the priest was ready to go through the ceremony of presenting them to the gods. Some pavements were made in the space between two images for a similar purpose (Buck 1957:522).

6.2.4.3 Courts

It is the presence of one or more uprights on a flat area opposite a row of "altar" uprights that defines the court. None of the courts on the Mauna Kea shrines, which may have been called *kahua* like those on *heiau* (Buck 1957:516), are enclosed, but in several instances the court area is clearly demarcated by the local topography (lava flow margins or ledges). Some have pavements.

There are only eight sites with clearly demarcated courts (see Table 6.1), which as previously noted are oftentimes identified by the presence of a crude pavement to one side of a row of uprights. Not all of the sites with courts have pavements, however (see Table 6.1). In cases such as this, it is the presence of one or more uprights on a flat area opposite a row of "altar" uprights that defines the court. None of these courts, which may have been called *kahua* like those on *heiau* (Buck 1957:516), are enclosed, but in several instances the court area is clearly demarcated by the local topography (lava flow margins or ledges).

The location of the court at Sites 16168, 16190, 21214, 21420, and 21431 indicates that the approach to the shrine was from the uphill side, so that the back of the celebrants would have been to the mountain. The orientation of these sites thus conforms to the way that lowland *heiau* are oriented. Site 16184, which consists of two parallel rows of uprights and a possible intermediate upright at the uphill end between the rows, is an exception. Another exception is Shrine 4 of Site 16204, where the court is located on the downhill side of a raised platform, so that the celebrants would have been facing toward the top of the mountain when performing rituals. A possible explanation for this unusual orientation is given elsewhere (McCoy 1999b).

Sites with courts occur in all sectors of the Science Reserve. The eight sites with courts are structurally and visually among the most impressive religious structures in the summit region. If one accepts the distinction Buck made between shrines and temples, these eight sites should be classified as small temples, that according to Buck would have been made by a family group or lesser chief (Buck 1957:516). There are several more sites in the NAR with courts, where the functional association is clearly linked to adze manufacture and, thus, occupational specialization.

6.2.5 God-Stones (Uprights)

As noted in the general description of shrines in Section 5, there is good reason to believe on the basis of ethnographic analogy that each upright on a shrine stood for a separate god. Ethnographic information indicates that god-stones or uprights were a place for the gods to inhabit when they were needed. The literature on Hawaiian god-stones indicates the use of both natural and modified stones:

> Gods could be invoked in the abstract or they could be called to natural or fabricated objects, which in turn acquired power and served as suitable places into which the gods might be lured when next needed. These objects retained residual mana and power, which might be passed on from generation to generation (Kaeppler 1982:83).

> In stone sculpture production was limited, the workmanship was less expert than in wood carving, and no significant tradition seems to have been established as it was in the Marquesas, Easter, Society, and Austral Islands. However, stone representations of the great gods, particularly Kane, were very common. Most of these seem to have been natural stones selected for their odd shapes and at most only slightly carved or retouched (Cox and Davenport 1988:25).

If the uprights were not representations of the gods (i.e., images or icons), but merely places for the gods to be called to and inhabit on a temporary basis, and if a piece of unworked stone would suffice, the question arises, why bother recording upright shape? Wouldn't any stone do if the purpose was to simply provide a temporary abode for a god? The answer appears to be no.

While most of the uprights are "unworked" (i.e., they are naturally occurring forms), observations made during the earlier surveys showed that the procurement of slabs to be used as "god stones" was not arbitrary or random, that not just any slab was expediently picked up off the surface (McCoy 1999a). If it had been then the slabs used in shrine construction should be representative of the wide range of shapes and sizes found in the source areas. They are not as a walk through the source areas demonstrates (Figure 6.5). To put a somewhat finer point on it, if there was no contemplation of the natural environment according to some conceptual scheme or belief system the uprights should exhibit no patterning in either size or shape and should be undecipherable to everyone except for the agent that chose stones to be used as "an abode of the gods."

The data demonstrate that the procurement process was deliberative and that the uprights have what can be called a "deliberative history":

> We can mark, as part of the "deliberative history" of an object, the range of objects from which it was chosen, the properties of those objects that were contemplated, and the role these observations played in the eventual decision to use, or not use, them for a purpose (Dipert 1993:29).

> It is one of the severe difficulties in attributing a deliberative history to an artifact that we often have as evidence for this history only the physical, now easily observable, properties of the object. Only some few of the properties represent artifactual features, and then only under a description. Thus, although the designer of the Parthenon undoubtedly had some fairly definite intentions concerning the dimensions and other properties of the building, it would be incorrect (anachronistic) to describe the content of these intentions in terms of feet, meters, comparison of its dimensions with a building that the builder did not know, using special features of our Arabic base-10 number system, and so on (Dipert 1993:55).

Figure 6.5. Photographs Showing Examples of Upright Slab Source Areas.

6.2.5.1 Raw Material Sources and Physical Properties

While we know from historic accounts of at least one wooden image on Mauna Kea (Arning 1931), from a well known rockshelter called Keanakako`i, and several other locations where small wooden images may have existed at one time in the adze quarry, all of the shrine uprights found on Mauna Kea are stone. This may seem on the whole a rather unremarkable fact, especially given the remote location in a sometimes harsh environment, but there are other reasons why stone, rather, than wooden uprights, may have been preferred:

> By reason of its materially lasting qualities no doubt, stone was regarded throughout Polynesia as the most important agency that could be utilized as a medium and container of mana. This is evidenced in many of the religious customs. The most obvious examples of this usage are the carved and natural blocks of stone that served as embodiments for, or mediums of, rapport with patron deities, but other customs illustrate more definitely the native view of the value of stones as mediums of rapport, one is the ceremonial use of stone seats or back rests. This usage is based upon the principle of transference of sacredness through contact: the stone, upon which a man imbued with mana rested, and especially one so employed upon ceremonial occasions, became charged with the man's divine power and would remain so until the tapu was released and the rapport broken between the object and the individual by one of the rites prescribed for the purpose. When a stone slab had served as a seat or back rest for chiefs or priests for generation after generation, it is evident that as it aged it would become more and more sacred and an ever more potent medium of rapport with the spirits of those who had passed on; it sacredness and its mana would be cumulative (Handy 1927:179-180).

The vast majority of uprights are naturally occurring, unaltered slabs of tabular rock of long-narrow shape that were universally set on end (i.e., the long axis of the stone is vertical). The lateral edges of a few of the slab uprights bear flake scars, but with a couple of isolated exceptions these appear to be generally of natural rather than human origin. The use of unmodified or minimally worked stones to represent gods appears to have been more common in Hawaii (Cox and Davenport 1988:25) than some other areas of East Polynesia where stone sculpture was more developed (e.g., Easter Island and the Marquesas). This could vary, though, as Buck noted in this description of Hawaiian stone gods:

> However, stone was used a good deal to represent family or craft gods (`*aumakua*). Some individuals were content to use pieces of unworked stone, whereas others made rough representations of the human figure. It should be remembered that it was not the workmanship but the prayers and offerings which gave a material object power (*mana*) and converted it into a god, no matter what the form (Buck 1957:495).

The origins of these slabs and their abundance in some places are noted in this description of the glaciated areas on Mauna Kea:

> Over the glaciated area of Mauna Kea the wedge-work of ice is conspicuous. The bed rock has been shattered, and spalls and slabs by thousands are strewn over the surface. In addition to the little-weathered, light gray fragments transported by glacial ice, large quantities of broken rock talus lie at the bases of cliff ledges, and, in many places stand in great stacks of flat or curved slabs only little removed from the bedrock itself. Some of the frost slabs are chunky or

> roughly columnar in form. Especially at the sides and downslope ends of thick lava flow or tube masses, the rock has spalled off in straight or slightly curved slabs, one to several inches thick and several square feet in area (Gregory and Wentworth 1937:1738).
>
> Not only are the ledges frost-riven, but many blocks of basalt in the ground moraines and in the talus of cones, some of them only a few inches in diameter, have been split neatly into thin slices which lie stacked near their place of origin. In some such rocks an original or developed fissile structure permitted easy splitting, but joint cracks and incipient fissures produced by moving glacial ice seems to have afforded the most suitable conditions. In general, the shapes and sizes of spalls appear to be due largely to the structures developed in the lava flows during cooling (Pl. 5, fig. 2) (Gregory and Wentworth 1937:1738-1739).

***Raw Material Sources*:** Observations made during earlier surveys indicated that there are some sites where there is no source of tabular slabs in the immediate area, thus indicating that any slab uprights must have been collected elsewhere. An attempt was made for the first time during the current survey to systematically note the presence/absence of a probable raw material source on or near a site, or the approximate distance to a source where none existed in the immediate site area. Figure 6.5 illustrates one of the major source areas on the east flank of the mountain and the multitudinous shapes of slabs found on the surface and along lava flow margins.

***Raw Material Form*:** There are two general classes of uprights: (1) angular slabs and (2) rounded boulders of generally elongated form. The latter are uncommon, occurring on sites where slab material does not seem to have been readily available. The slabs, which are characterized as "tabular" in the attribute analysis, vary in thickness, although most are relatively thin.

> (1) **Tabular:** correspond to the slabs and spalls described by Gregory and Wentworth (see description of the environmental setting above); some slabs are more columnar and, thus, thicker.
>
> (2) **Non-tabular:** more rounded and irregular in overall shape; not as common as the tabular variety.

6.2.5.2 Number, Condition, Position and Location on the Structure

In some cases it is difficult to accurately determine the number of uprights on a shrine because of: (1) the effects of natural processes, such as erosion and perhaps wind shear, that have might have resulted in breakage and the displacement of the stone from its original position, or the deliberate displacement of uprights by humans, and (2) uncertainty regarding whether a particular stone had been utilized as an upright, a bracing stone or a paving stone. Given a situation such as this, where there are different degrees of confidence, a decision was made to present minimum and maximum numbers (see Table 6.1).

***Condition*:** The condition of the stones recorded as uprights was noted as either whole or broken.

> (1) ***whole*:** complete
>
> (2) ***broken*:** fragmentary

Position**:** One would assume that an upright is a standing stone and that calling something a "fallen upright" would be an oxymoron. But to give just one example of why "fallen upright" is a useful, indeed necessary, term, one can think of a flagpole that has toppled over and observed lying flat on the ground. It is still a flagpole. As might be expected, uprights were found in a variety of different positions, ranging from fully erect, to partially erect and fallen. The reports on some of the earlier surveys (e.g., McCoy 1984b) used the term semi-erect, but because of the obvious subjectivity involved in making this finer distinction, the 2005-2009 survey used just two terms to characterize the position of uprights:

(1) ***erect*****:** vertical or nearly vertical; in some of the earlier surveys a distinction was made between erect and semi-erect.

(2) ***fallen*****:** horizontal position on bedrock or ground surface.

Confidence Level**:** The decision to call a fallen stone an upright is not always easy or straightforward and thus involves an element of subjectivity. The decision, which can vary from one individual to another, is dependent in part on experience and such specific criteria as the form or shape of a stone and/or the presence of a depression that could be reasonably inferred to be the "seat" for an upright. The following confidence levels were established for use in the survey:

(1) ***excellent*****:** applies to all standing uprights and fallen stones whose form and location on a site or feature of a site indicates a high degree of probability that the stone was set upright.

(2) ***good*****:** fallen stones that can be regarded with a lower degree of confidence as uprights based on form and location on a site or feature of a site.

(3) ***fair*****:** fallen stones of more problematical function; could correspond to what are being called "possible uprights."

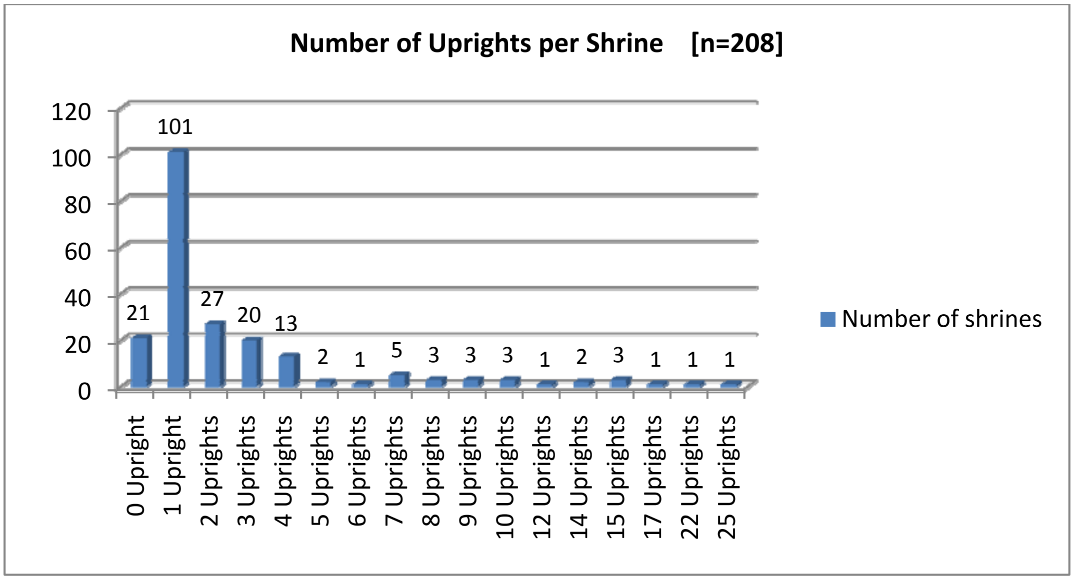
(4) ***poo*****r:** fallen stones resembling one of the several different formal "types" of uprights; corresponds to what are being called "possible uprights."

Minimum Number of Uprights**:** The minimum number reflects higher levels of confidence in the decision-making process (i.e., excellent and good).

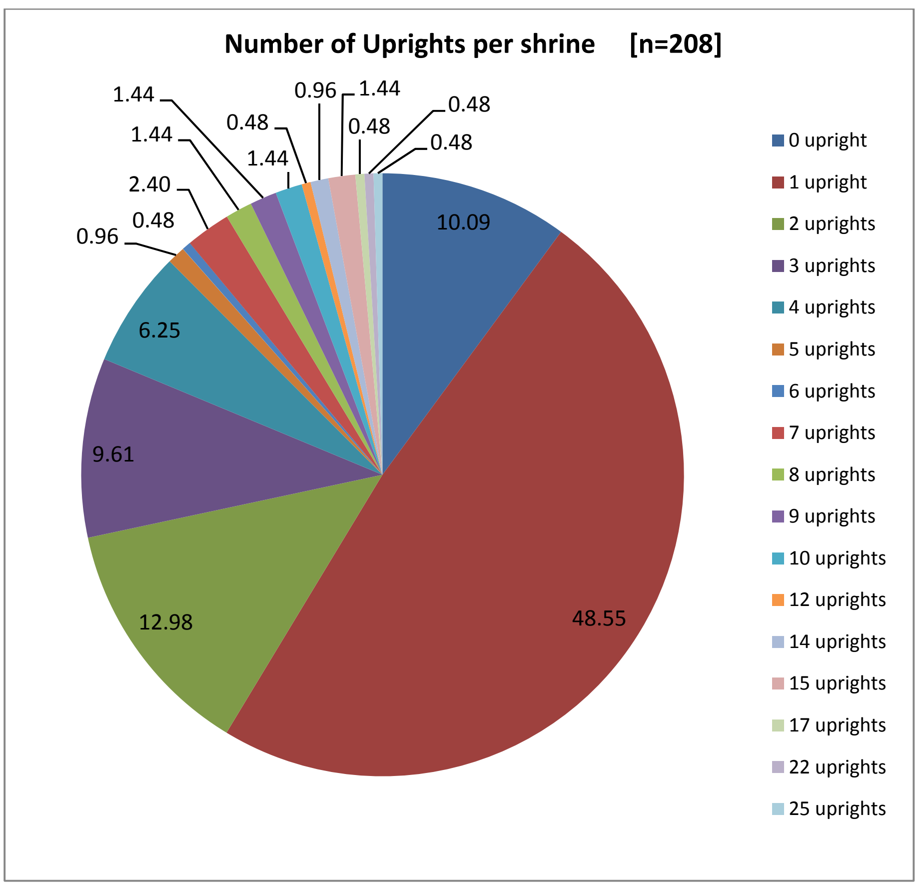
Maximum Number of Uprights**:** The maximum number includes what are called "possible uprights" in the site descriptions in Volume 2. A "possible upright" corresponds to a fair or poor confidence level.

6.2.5.3 Range of Variability in Upright Numbers

The number of uprights on a site that can confidently be called shrine varies from 1 to 25, in contrast to possible shrines where the number is zero (Figure 6.6). Based on a histogram of numerical frequencies using minimum number (see Figure 6.6), the following six groups of shrines were identified. The frequency distribution of the five groups is shown in Figure 6.7 and discussed below:

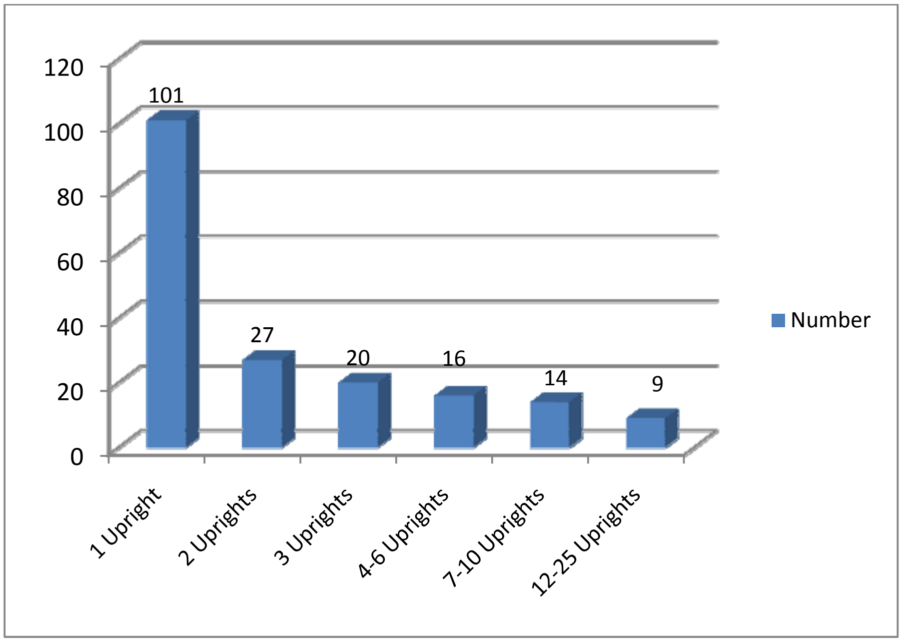


Count

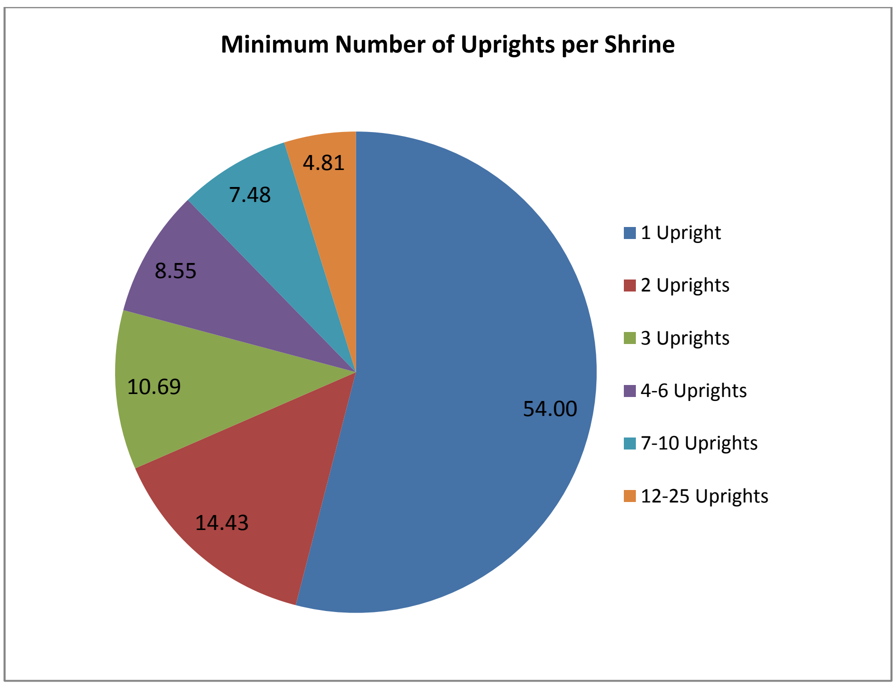


Percentage

Figure 6.6. Frequency Distribution of Uprights per Shrine Based on Minimum Number.



Count [n=187]



Percentage [n=187]

Figure 6.7. Frequency Distribution of Shrine Upright Groupings.

Group 1: 1 Upright

Single upright shrines are the most common (101 or 54% of the total 187 in the sample) and in fact constitute a separate category or type (see discussion of shrine typology following). Single upright shrines are widely distributed throughout the Science Reserve (Figure 6.8).

Group 2: 2 Uprights

Pairs of uprights are quite common, with a total of 27 or 14.43% of the total shrines). They occur in all areas of the Science Reserve (Figure 6.9).

Pairs of uprights appear to be widespread, though not necessarily common, in the Hawaiian Islands. It is possible that they might represent an emic type that heretofore has not been described, though there are numerous ethnographic accounts relating to pairs of gods, such as Ku and Hina, which are widely recognized as symbolizing the male and female principles:

> Leaving the heiau, we passed by a number of smaller temples, principally on the sea-shore, dedicated to *Kuura*, a male, and *Hina*, a female idol, worshipped by fishermen, as they were supposed to preside over the sea, and to conduct or impel, to the shores of Hawaii, the various shoals of fish that visit them at various seasons of the year. The first of any kind of fish, taken in the season, was always presented to them, especially the *operu*, a kind of herring. This custom exactly accords with the former practice of the inhabitants of Maui and the adjacent islands, and of the Society Islanders (Ellis 1969:117).

> Ku and Hina, as well as their varied aspects, function as man and wife in daily rites performed by the populace. With his sister-wife Hina (whose name means “prostrate”), Ku (“upright”) united the people into a single stock, for Ku and Hina represented the male and female reproductive principles. Ku also symbolized the east, sunrise, and the right hand; Hina the west, sunset, and the left. Such antithesis was common (Luomala 1987:217).

This pair of gods (male-female or husband-wife) has in fact been identified archaeologically at least at one location where the stones are of different lithology, color and size:

> Stokes...has recorded two upright stones connected with, though not on, a *koa* at Pearl Harbor, Oahu. One is a dark stone, 4.5 feet high, representing Kuula, a patron of fishermen, the other a coral stone slab 2.5 feet high, representing his wife, Hina (Emory 1928:107).

A pair of rounded upright stones have been identified as the gods Kane and Kanaloa in a photograph included in the revised edition of *Ruling Chiefs* (Kamakau 1992). Pairs of pointed upright stones occur on some of the Mauna Kea shrines and are inferred to symbolize two male gods.

> The structure of the pantheon--like that of the *Kumulipo*--reflects the primacy of the sexual principle. The duality of the sexes is in effect divinized in the couple, Ku (male)/Hina (female). At least in certain representations, this Ku-and-Hina godhead (NK, 2: 122, cf. 147) encompasses all the deities: “Ku is said to preside over all male spirits (gods), Hina over the females” (Beckwith 1940:13). In fact, in this context Ku encompasses all the properties of the masculine gods, Hina (whose name means “prostrated,” “horizontal,” “woman”), all feminine attributes.

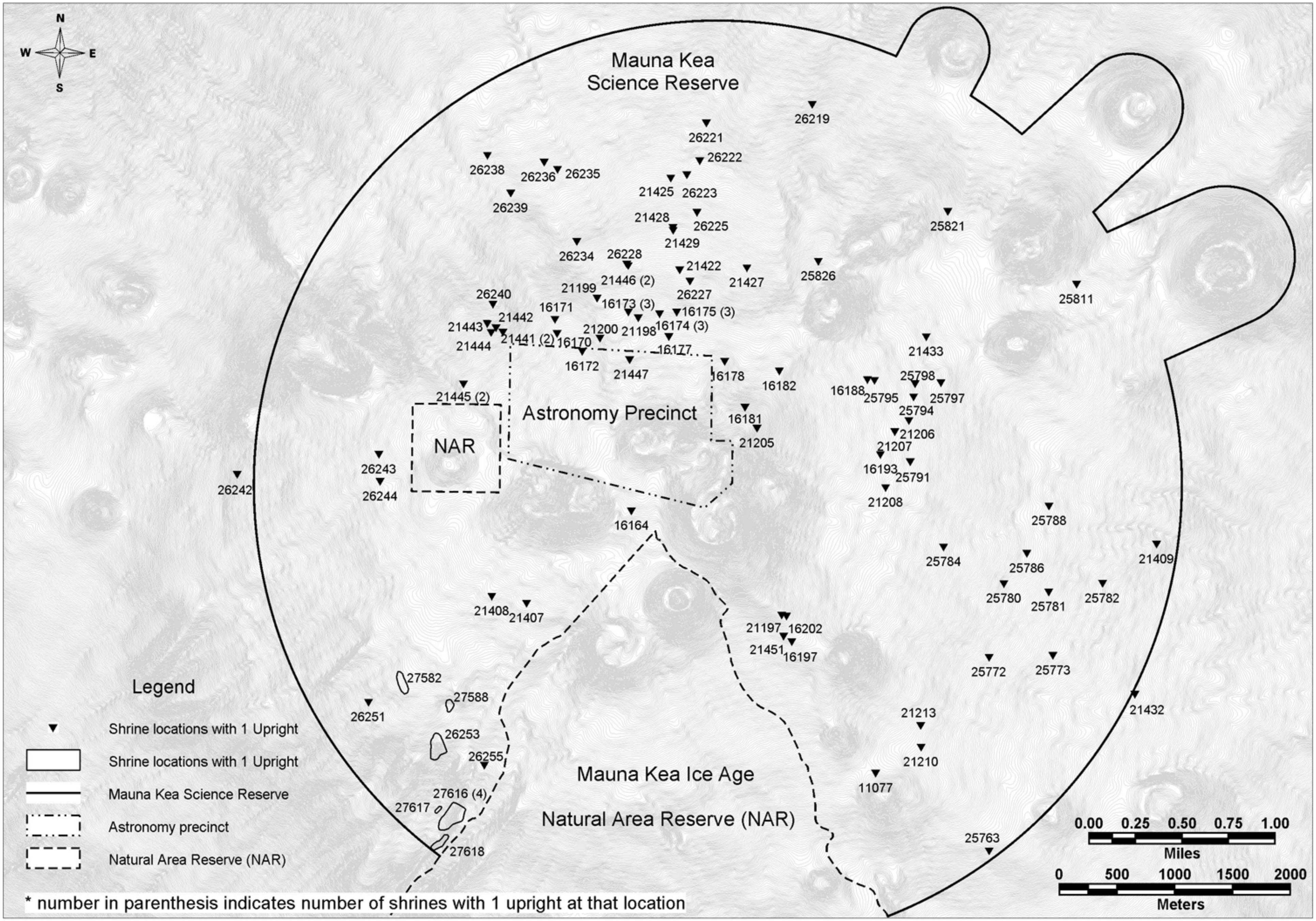


Figure 6.8 Locations of Shrines with 1 Upright.

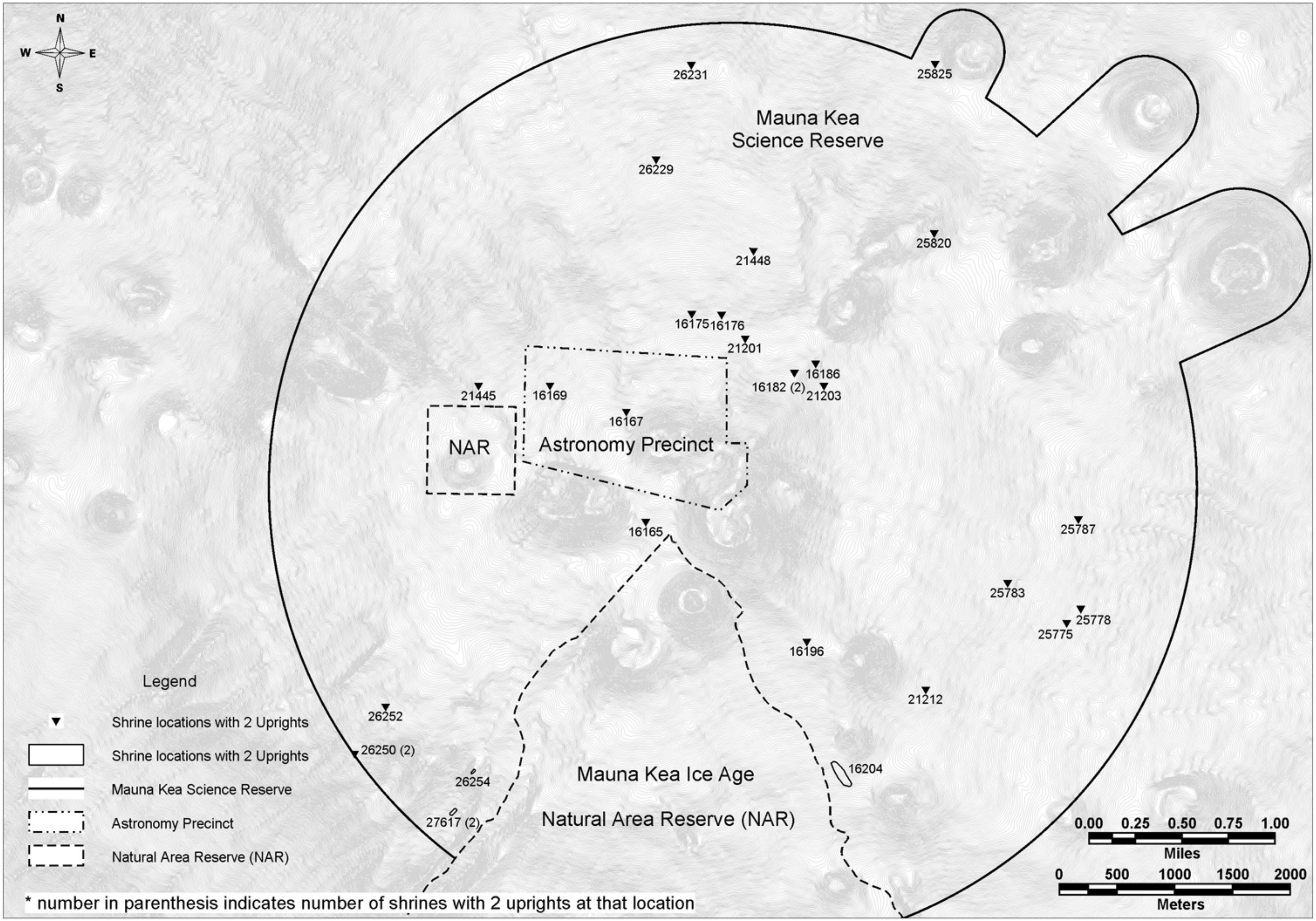


Figure 6.9 Locations of Shrines with 2 Uprights.

> As many myths demonstrate, this divine couple is purely and simply the essence, or type, of the human couple and manifests itself in everything in nature associated with men and women, respectively, as well as with their activities (pp. 12-13) (Valeri 1985:12).

> We can also suppose that the roof, which at least in the mana house is connected with Ku, is masculine, while the lower part of the house is feminine. A similar opposition must exist between the posts, which being erect (*ku*) must be masculine, and the floor, which being horizontal must be feminine. We also know that the head of the family, the ali`i, or the priest is equated with house posts (cf. Apple 1971, 29; Handy and Pukui 1972, 174; Kamakau 1961, 135). This implies that the house as a whole is assimilated to a social group. A commoner's house is equated only with his family, but the house of a chief is equated with the social group he rules. There are indeed indications that different parts of the king's house symbolize different districts of his realm, since each is built by a different *ahupua`a* and thus embodies its work (cf. Ellis 1842, 321; Brigham 1908: 87) (Valeri 1985:302-303).

Victor Turner noted that "One common mode of positioning is binary opposition, the relating of two symbol vehicles whose opposed perceptible qualities or quantities suggest, in terms of the associative rules of the culture, semantic opposition" (Turner 1977:187). The male/female, husband/wife and brother/sister pairings found in Polynesia are examples of binary opposition. The forms used to symbolize each member of the pair are not always recognizable, however, and in the case of the shrines with two uprights, the pairs are not always perceptibly different (e.g., some shrines have two uprights of the same form—parallel-sided with pointed tops). This illustrates yet another point made by Turner "Ritual symbols are multi-vocal---that is, each symbol expresses not one theme but many themes simultaneously by the same perceptible object or activity (symbol vehicle)" (Turner 1977:185).

Group 3: 3 uprights

Shrines with three uprights occur in almost the same numbers as pairs. There are 20 shrines in this group, representing 10.69% of the total. The distribution pattern is much more restricted than paired upright shrines, however. There are in fact only two to three general areas of occurrence--on the north slope at and just below the 13,000 ft elevation, and on the south flank of the summit above Pu`u Līlīnoe (Figure 6.10).

Group 4: 4-6 uprights

The 16 sites that fall into this category (8.55% of the total) are found in all sectors of the Science Reserve (Figure 6.11). A closer examination of the distribution map shows several areas with clusters of these sites, including the north slope, the northeast slope, the south flank of the summit, and the adze workshop-ritual complex (Site 16204).

Group 5: 7-10 uprights

The number of shrines with 7 to 10 uprights is 14. They are just slightly less numerous than the Group 4 shrines (7.48% of the total). They are very widespread, although most of them are located on the eastern and southeastern side of the Science Reserve (Figure 6.12).

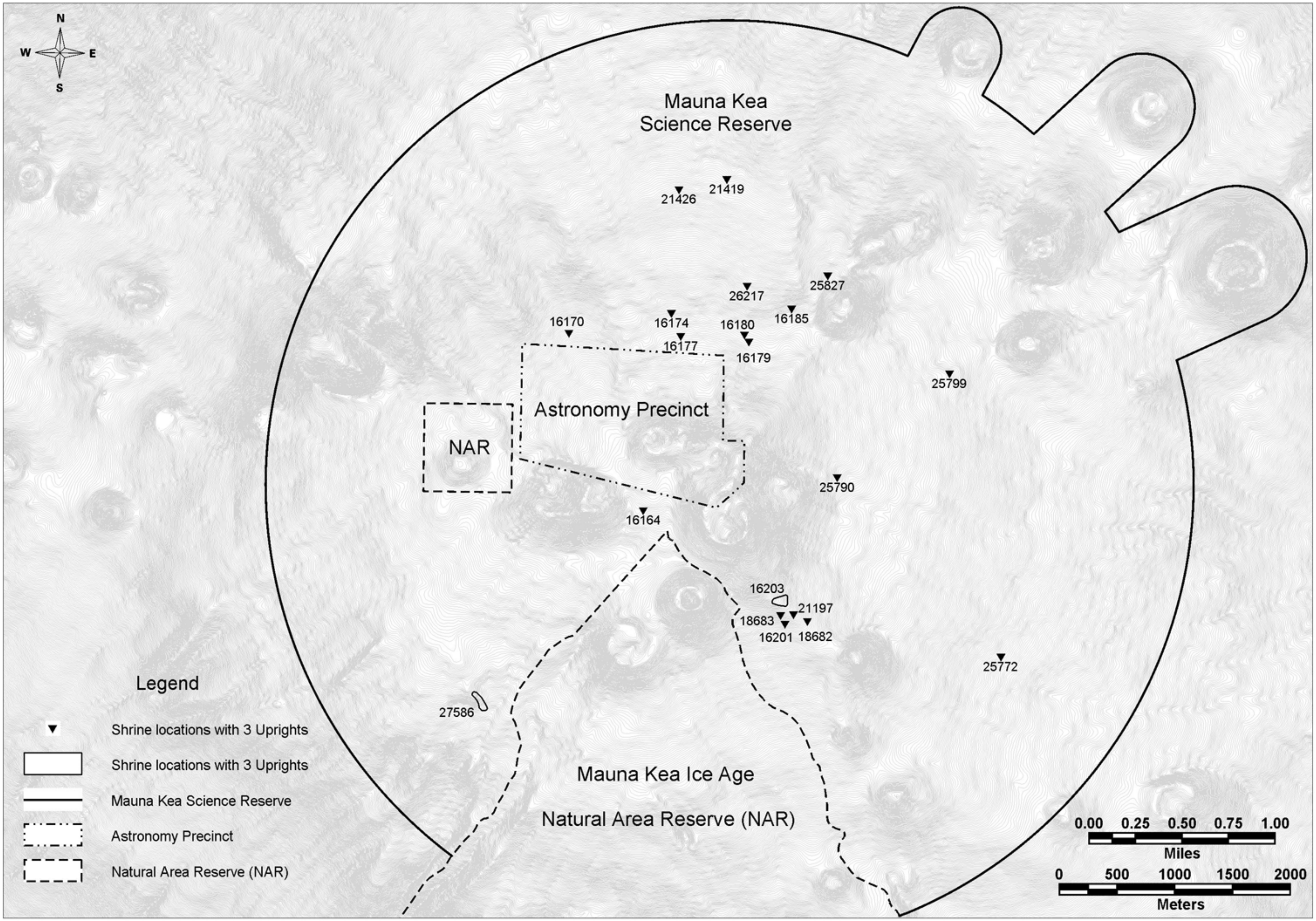


Figure 6.10 Locations of Shrines with 3 Uprights.

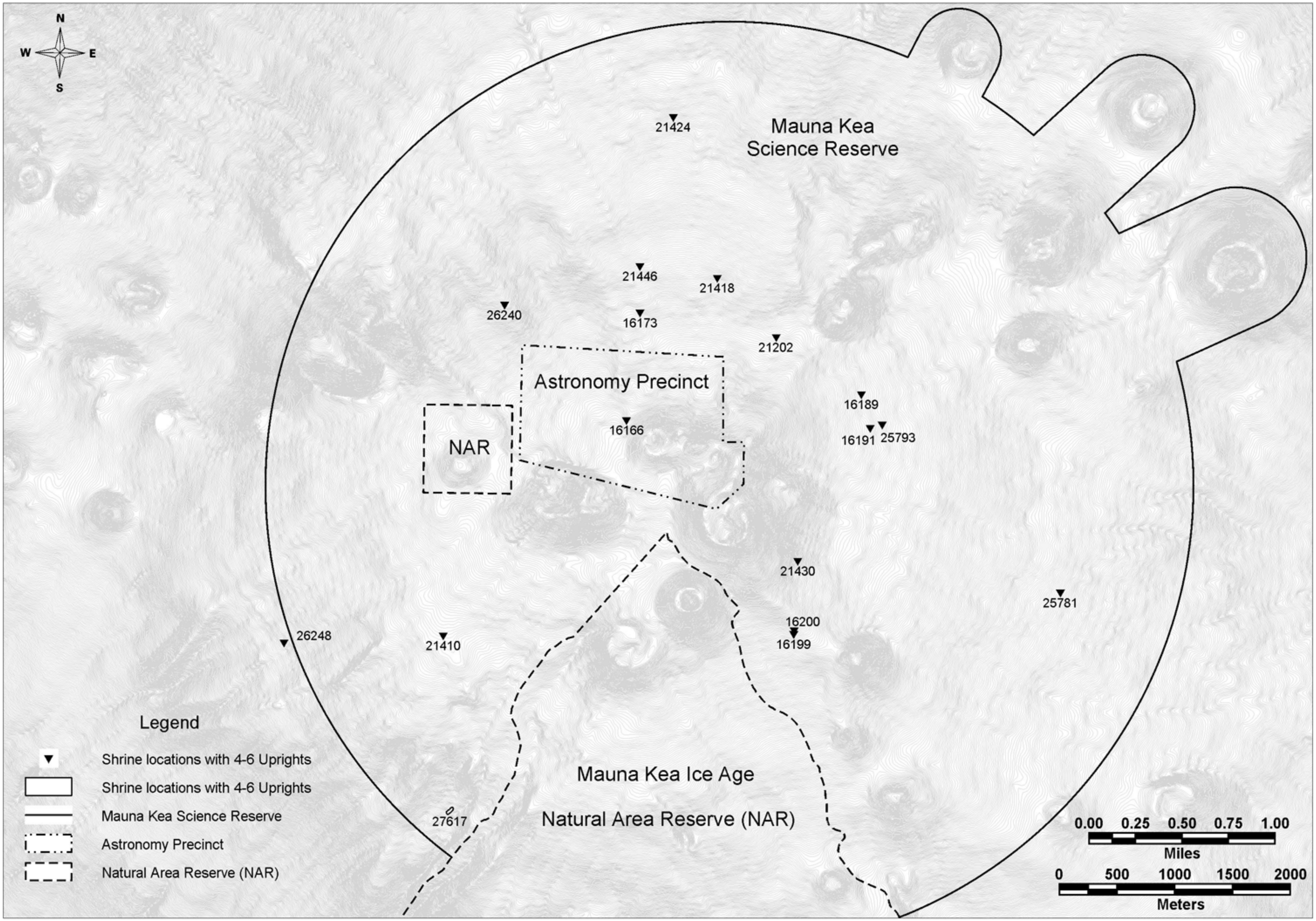


Figure 6.11 Locations of Shrines with 4 - 6 Uprights.

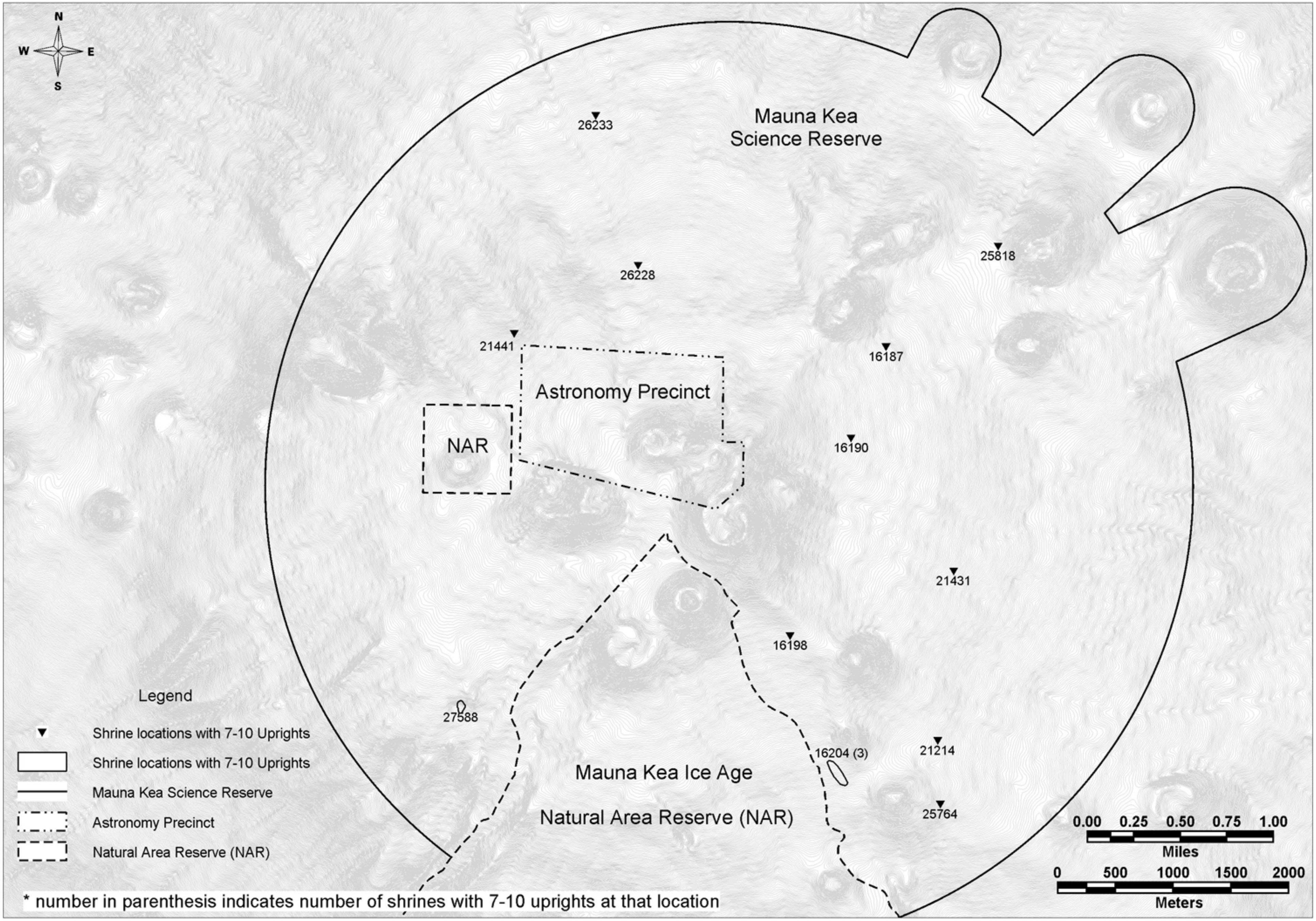


Figure 6.12 Locations of Shrines with 7 - 10 Uprights.

Group 6: 12-25

This grouping is clearly rare as the range in the number of uprights indicates. There are 9 shrines in this group, which like Group 5 is primarily found in the eastern half of the Science Reserve (Figure 6.13).

Of the 187 shrines used in the analysis 148 or 79% have just 1 to 3 uprights (see Figure 6.6). The vast majority of shrines thus tend to be small, which is what one would expect of shrines in contrast to more elaborate religious structures.

6.2.5.4 Size (Height, Width, and Thickness)

Three measurements were taken of each upright—height, width and thickness. All are maximal dimensions. In the case of broken uprights, the height measurement is the sum of the measurements on the individual fragments. An effort was made to take the measurements in the same way, but because the uprights were not individually photographed or drawn, the measurements are not reproducible (i.e., a second set of measurements would probably differ from the first to some varying degree). This is more so with width and thickness, which can sometimes vary considerably along the length of the stone. The difference in most cases would be inconsequential in terms of what the measurements "mean" and the purposes to which they are put. The exception would be uprights of highly irregular form. Like most field measurements, those taken on the uprights are "general." and though giving the impression of objectivity they are not absolute or true in the scientific sense of objectivity. They serve the practical purpose of indicating "norms" and the range of variability within and between sites, which can then be used for comparative purposes.

> ***Height*:** the maximal distance between the top and bottom or two ends (i.e., the long axis).
>
> ***Width*:** the maximal breadth of the stone at or near the mid-point between the top and bottom.
>
> ***Thickness*:** the maximal dimension between the front and back; in most cases this is at or near the base or lower end of the stone, but this can vary with the shape of the stone.

The size data are summarized in Appendix F and in Table 1 of Appendix N which includes minimum, maximum, median and mean for height, width, and thickness by upright type (see discussion below). Gosser's analysis also included an examination of the height, width and thickness ratio (Appendix N, Figure 4). The data indicate little within and between shrine type variability in the three size attributes, except that the larger, more complex shrines (defined as those with larger numbers of uprights, and often, a paved court), are more uniform in terms of upright size (height, width and thickness) than the shrines with fewer uprights. Gosser's analysis shows that shrines with two and three uprights exhibit substantially higher values or parity in the ratio between the tallest and shortest uprights than other shrine types (Appendix N: Figure 9). As Cowgill has said, "Statistical analysis is not a way to arrive at certainty; it is a powerful aid in discerning *what* your data suggest and *how strongly* they suggest it" Cowgill 2005:35). In this instance, the statistical data suggest that shrines with pairs of uprights are indeed a meaningful type as the ethnographic record indicates, and that shrines with three uprights are another meaningful type.

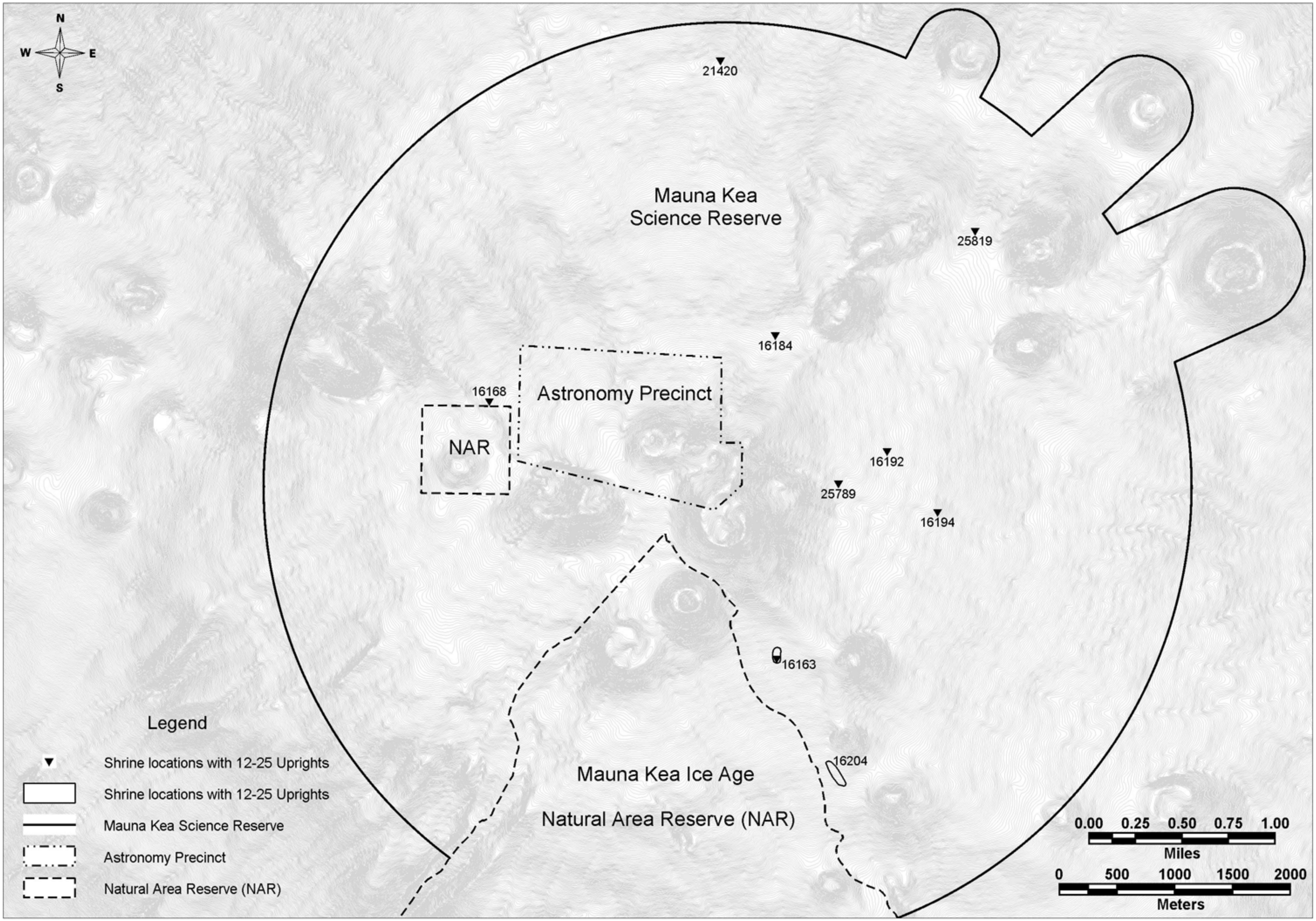


Figure 6.13 Locations of Shrines with 12 - 25 Uprights.

6.2.5.5 Shape or Form

Upright shape or form was inconsistently recorded in the earlier surveys. The emphasis in the earlier work was on recording the shape at the top end or "head" of the upright (e.g., pointed, flat), rather than the shape of the whole stone.

Three different attributes were recorded in the 2005-2009 survey: (1) body shape; (2) top or "head" shape, and (3) "treatment," which refers to natural occurring, or, more rarely, manufactured forms, such as notches and flanges on either the sides or top end of an upright. Figure 6.14 illustrates examples of the three attributes.

Earlier generations of Polynesian archaeologists and ethnologists, such as Emory and Buck, noted the existence on *marae* throughout Central and East Polynesia of unusual forms of uprights, with such distinguishing characteristics as flanges, notches and grooves. Some uprights were described as exhibiting human or animal forms (e.g., Emory 1947:29). In the Tuamotus these were distinguished by the name *tiki* (Emory 1947:13-14). Though sometimes identified as a human or anthropomorphic characteristic, the tendency was to dismiss flanges, notches, grooves and other apparently unusual characteristics as nothing more than "ornamentation" or "embellishment" (Emory 1947:29, 1970:80). The similarities between some of the uprights found on Mauna Kea and *marae* uprights in selected areas of East Polynesia is examined in Section 7.

(1) **body form:** defined as the sides of the upright; the sides can extend the full distance between the top and the base if there is no change in the angle of one or both margins, but such stones are rare; more common are stones with a "shoulder," which is the point at which there is a change in the angle of the sides and the top. Illustrations of the following categories are presented in Figure 6.14 and their frequency distribution in Figure 6.15:

parallel**:** edges are straight and roughly equidistant.

sub-parallel**:** edges are nearly parallel.

divergent**:** stones that are narrower at the top than the bottom or base.

convergent**:** stones that are wider at the top than the bottom or base.

crescent**:** this is a rare form; one the only example appearing at Site 16184; on that site the stone curves from back to front along the long axis of the stone platform on which it rests; in side view it resembles a crescent.

irregular**:** odd shapes that do not fit any of the other categories.

The data indicate a preference for three body shapes—parallel (28.9%), sub-parallel (20.21%) and divergent (24.82%). The parallel and sub-parallel forms taken together (N=277) make up just under 50% of the total 564 uprights. The other forms are much less common (Figure 6.15). The obvious preference for straight-sided forms may indicate that many of the uprights are representations of male gods and possibly Ku in particular. Things in nature that are high and straight, for example, were believed to be manifestations of the god Ku's virility.

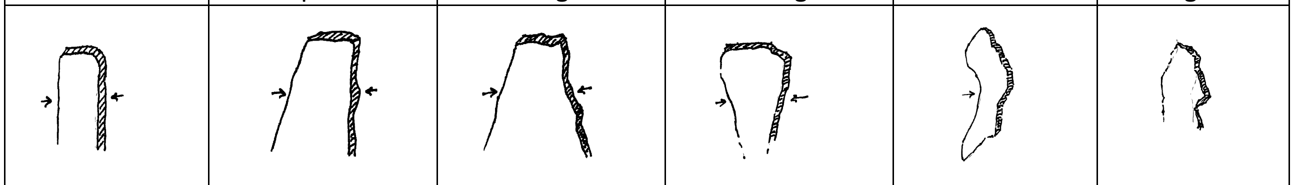
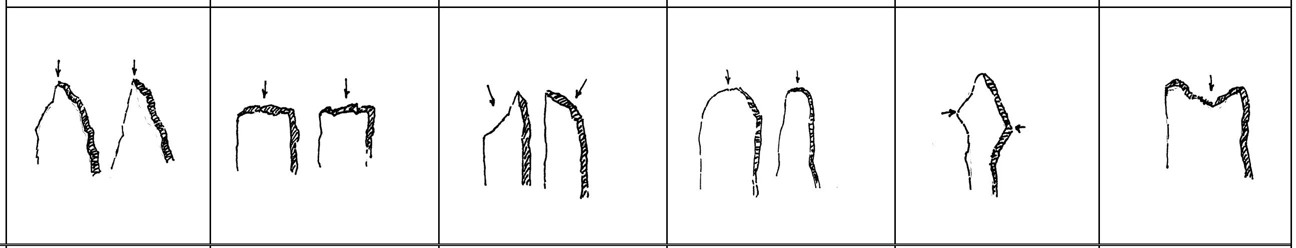
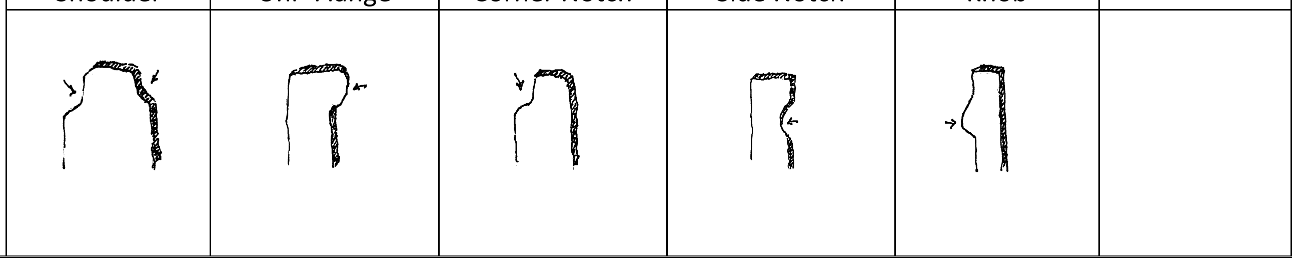
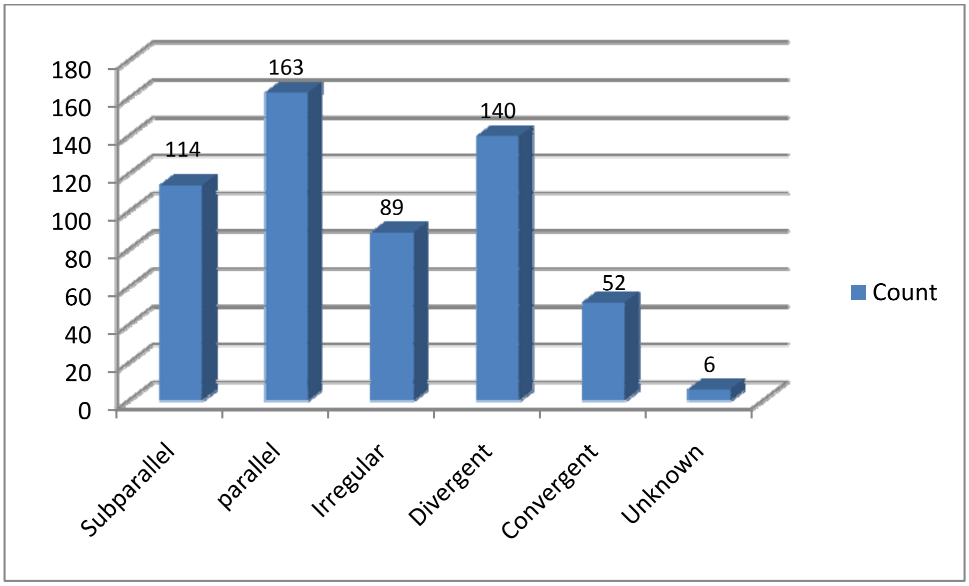
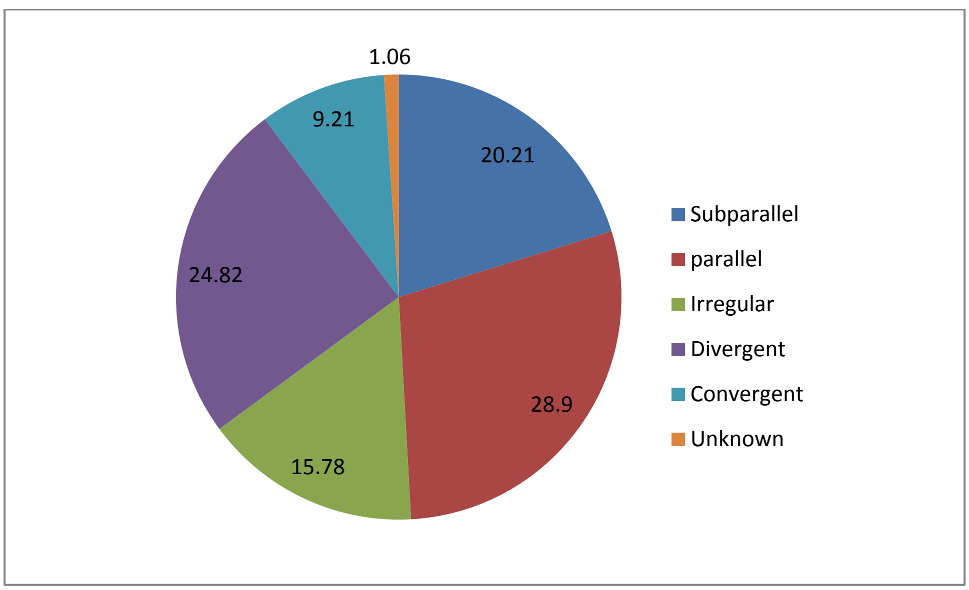
BODY FORM	Parallel	Subparallel	Divergent	Convergent	Crescent	Irregular	
TOP FORM	Pointed	Flat	Beveled	Rounded	Gabled	Mesial Curve	
TREATMENT	Shoulder	Uni- Flange	Corner Notch	Side Notch	Knob		

Figure 6.14. Illustrations of Upright Body, "Head" and "Treatment" Shape Categories.



Counts [n=564]



Percentage [n=564]

Figure 6.15. Frequency Distribution of Upright Body Shape Categories.

(2) **top** (“head’) **form:** the top end of most uprights can be described by a single term, but there are some where it is necessary to use a combination of attributes to adequately characterize the form; there are some uprights, for example, that are beveled above the shoulder and flat or notched on the very top; these are classified in the site tables as beveled/flat. Illustrations of the following categories are presented in Figure 6.14 and their frequency distribution in Figure 6.16.

***pointed*:** a broad category that includes any stone that tapers from the bottom to the top to end in a “point”; the “point” can vary considerably in terms of the degree of angularity or sharpness and the location of the point relative to the sides of the stone (what might be “centeredness”).

***flat*:** there are two variants of this category of uprights, those with parallel or nearly parallel sides and those that are narrow at the bottom and wider at the top; the latter resemble some of the wooden slab images in Hawaii; this form appears to be widespread in Polynesia.

***beveled*:** stones with parallel or nearly parallel sides that like the gabled category also have a shoulder and pointed top end; the difference is in the centering of the point; the direction in which the angle points varies.

***gabled*:** this category is characterized by stones with parallel or nearly parallel sides and a top end that resembles a gabled roof; similar looking uprights, which have clearly anthropomorphic characteristics in the presence of both a lower and upper “body” separated by a “shoulder” are widespread in Polynesia.

***rounded*:** this category is relatively uncommon in the summit region of Mauna Kea; it is generally found where tabular slabs are rare or absent; some of the stones in this category appear to have been derived from the rounded edges of glaciated lava flows.

***mesial notched*:** a concavity in the top of the upright.

irregular: odd shapes that do not fit any of the other categories.

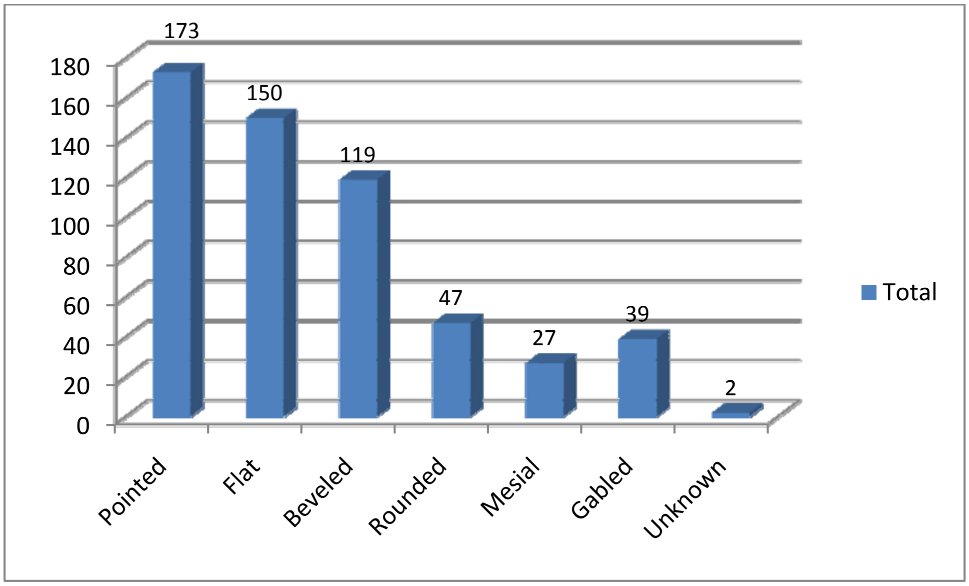
(3) **“Treatment”:** a term commonly used in the analysis of pottery or ceramics; the term is being applied in the current project to other attributes of the “head” and “body” of an upright; most are natural, except for some notches which have been created by flaking. Each of the following categories is illustrated in Figure 6.14 and their frequency distribution in Figure 6.17.

***corner notched*:** a more or less right angle at the juncture (shoulder) between the body and the top.

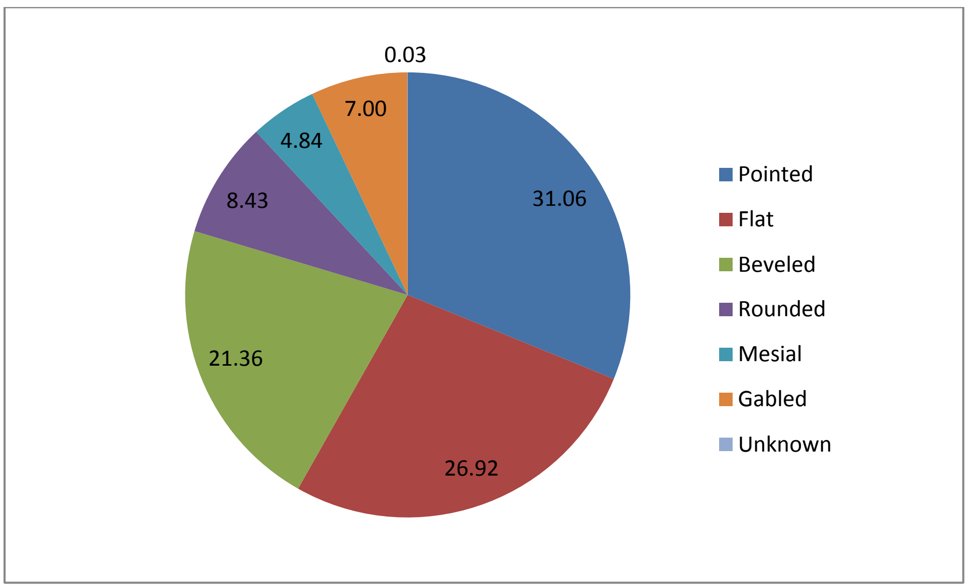
***side notched*:** a concavity in the side of an upright.

***shouldered*:** uprights with what could be described as two corner notches at the the juncture between the “body” and “head”; beveled and corner notched uprights are distinguished by the presence of a single shoulder.

***flanged*:** this term appears in some of the early archaeological literature on East Polynesian marae where it appears to have been used interchangeably with notched (Buck 1932); in some cases it is clear that the flange was used to

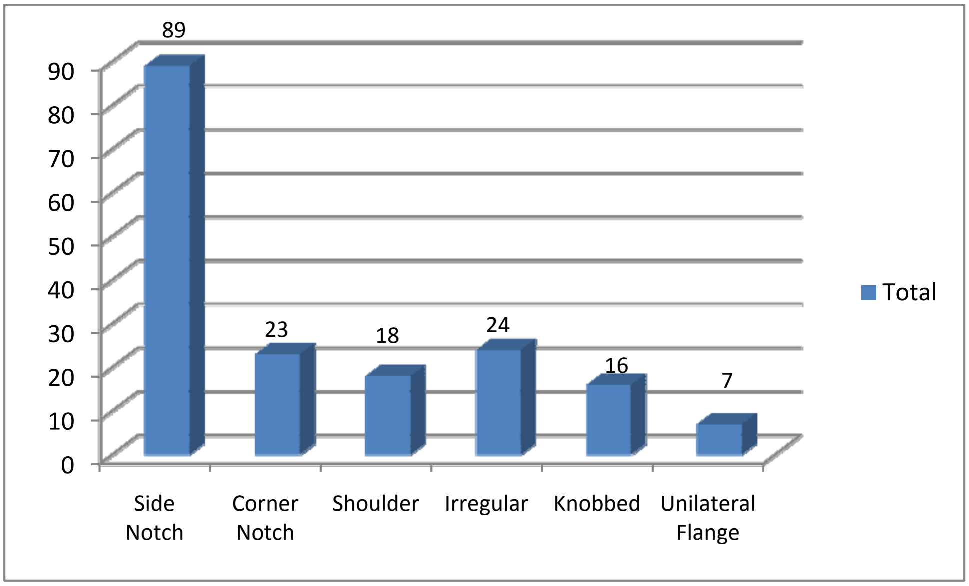


Count [n=557]

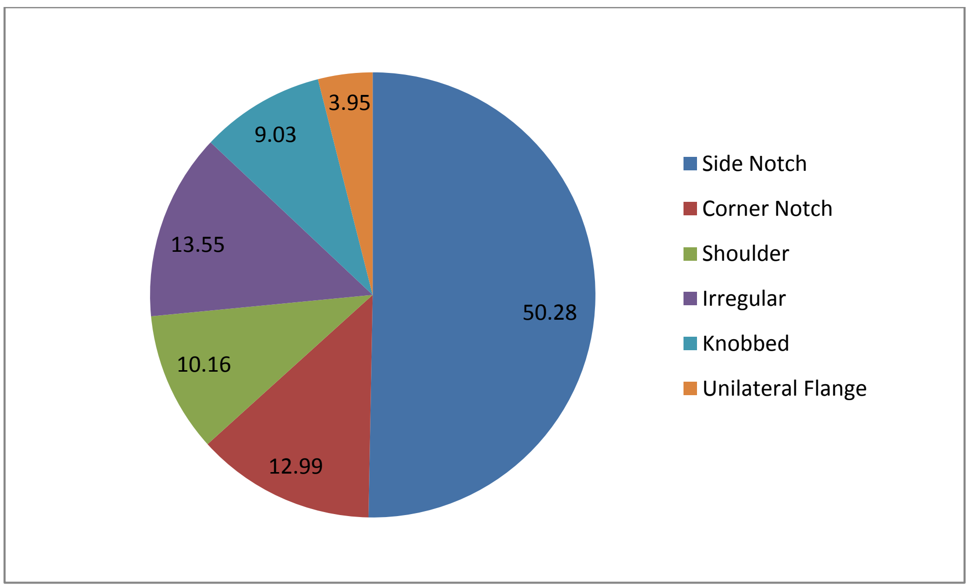


Percentage [n=557]

Figure 6.16. Frequency Distribution of Upright Top or "Head" Shape Categories.



Count [n=177]



Percentage [n=177]

Figure 6.17. Frequency Distribution of Upright Treatment Category.

describe a more or less "right angle" cut or notch; the few examples found to date in the Science Reserve are flanged on just one side and thus referred to in the tables as *unilateral flanged*.

***knobbed*:** a natural protrusion on the side.

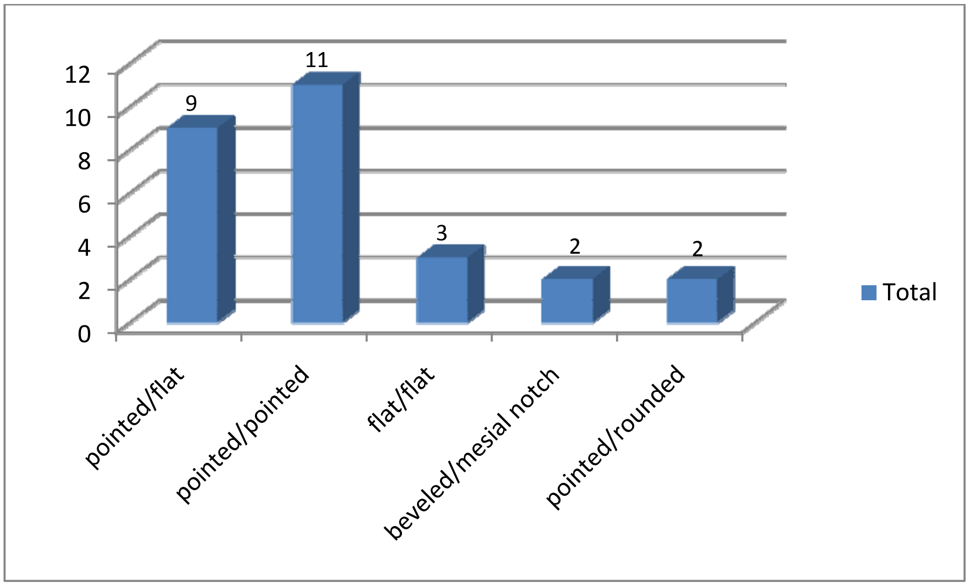
Ethnographic evidence suggests that the different upright forms or shapes are likely to be manifestations of the attributes of different gods or classes of gods, such as male and female. Things in nature that are high and straight, for example, were believed to be manifestations of the god Ku's virility. Sexual symbolism of this kind was widespread throughout Polynesia, including Hawai`i. Martha Beckwith noted, for example, that in Hawai`i:

> A slab-shaped or pointed stone (pohaku) which stands upright is called male, pohaku-o-Kane; a flat (papa) or rounded stone is called female, papa-o-Hina or pohaku-o-Hina, and the two are believed to produce stone children. So the upright breadfruit (ulu) tree is male and is called ulu-ku; the low, spreading tree whose branches lean over is ulu-ha-papa and is regarded as female. These distinctions arise from the analogy, in the shape of the breadfruit blossom and of the rock forms, with the sexual organs, an analogy from which Hawaiian symbolism largely derives and the male expression of which is doubtless to be recognized in the conception of the creator god, Kane" (Beckwith 1970:13).

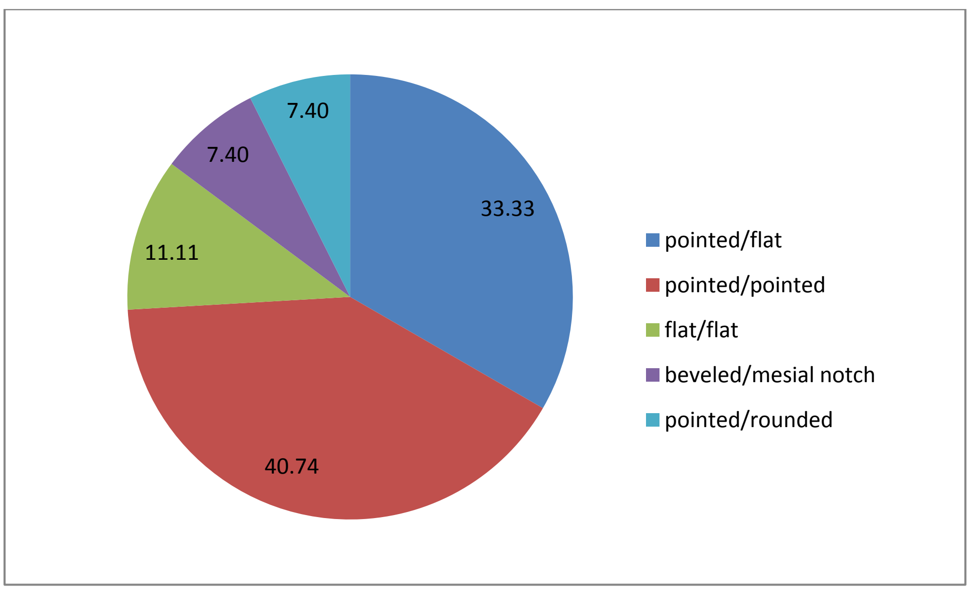
On the basis of ethnographic information the large number of straight-sided uprights and uprights that come to a point indicate a high percentage of male god-stones *(`eho*) on the shrines in the Mauna Kea summit region.

> Rocks have sex: the solid rock, columnar in shape, is male; the porous rock, loaf-shaped or split by a hollow, female. Chiefs and priests worshipped these rocks and poured awa over them as representatives of the god. If a stone of each sex was selected, a small pebble would be found beside them which increased in size and was finally taken to the heiau to be made a god (Beckwith 1970:88).
>
> Ku and Hina, as well as their varied aspects, function as man and wife in daily rites performed by the populace. With his sister-wife Hina (whose name means "prostrate"), Ku ("upright") united the people into a single stock, for Ku and Hina represented the male and female reproductive principles. Ku also symbolized the east, sunrise, and the right hand; Hina the west, sunset, and the left. Such antithesis was common (Luomala 1987:217).

The frequency distribution of head shapes for pairs of uprights is shown in Figure 6.18. It is of interest of those that might be interpreted as male/female, 9 or 33.33% of the total are pointed/ flat and 2 or 7.40% pointed/rounded. The most common pairs are two pointed uprights (11 or 40.74%). The three examples of paired flat-topped uprights is also intriguing in terms of what they might symbolize. In addition to the possibility that upright shapes denote male or female, there are other possible meanings. These are discussed in Section 7.



Count [n=27]



Percentage [n=27]

Figure 6.18. Frequency Distribution of Head Types in Shrines with Two Uprights.

6.2.5.6 Upright Types

Theoretically, a typology of upright forms would be based on the combination of body, top and treatment variables. Such a typology would be unwieldy, however. This is a common and widely recognized problem in the initial stages of developing typologies, as Adams and Adams recognized:

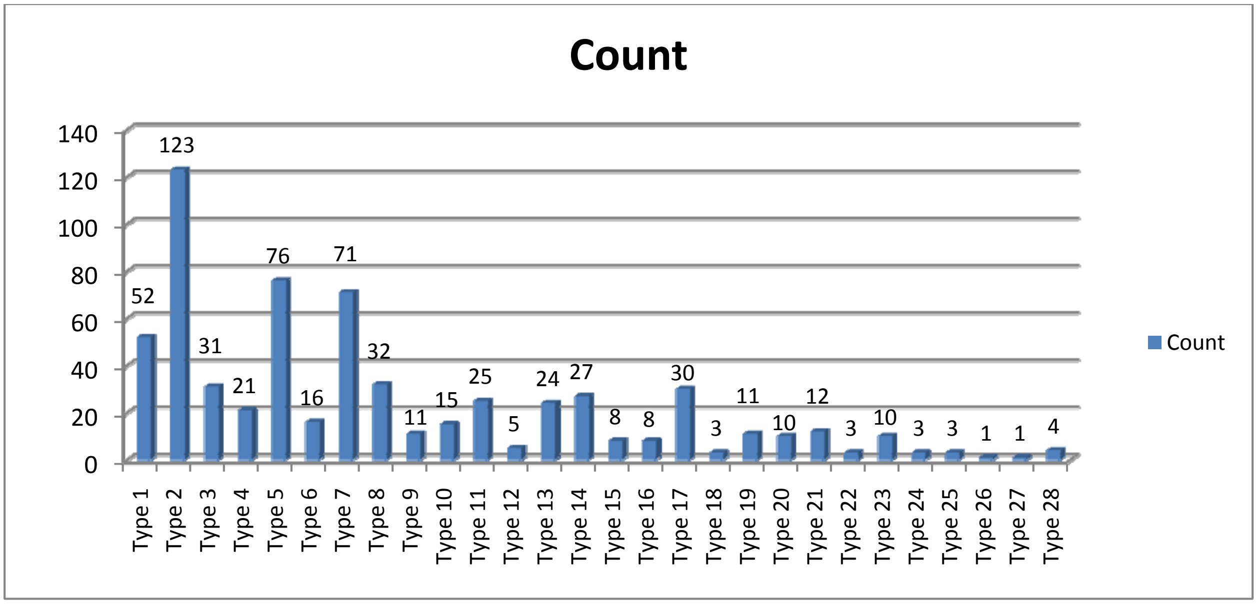
> In the initial search for identifiable types, we will probably have to give some consideration to all of the variables and attributes present in our material, or at least to all those that are readily observable (Adams and Adams 1991:183).
>
> It should be observed that in formulating provisional types we have, in most cases, established only their identity and not their meaning (Adams and Adams 1991:185).

They note that "It is nevertheless true that every identifiable type has an implicit or unstated definition, in that it must possess a unique combination of attributes, present and absent, that distinguish it from all other types. Yet type concepts are constantly changing in the course of use…Some types are redefined, some are split into two or more separate types, and some are combined with other types" (Adams and Adams 1991:184).

In the end we decided to omit the treatment variable since relatively few uprights exhibit it. A classification based on the combination of just body and top attributes yields 28 "types" which is still a large and undoubtedly not totally meaningful number as Table 6.2 and Figure 6.19 demonstrate.

Table 6.2. List of Shrine Upright Types.

Upright Type	Parallel/ Subparallel	Upright Type	Divergent	Upright Type	Irregular	Upright Type	Convergent	Upright Type[1]	Parallel/sub-parallel
1	Pointed	**7**	Pointed	**13**	Pointed	**19**	Pointed	**25**	Pointed
2	Beveled	**8**	Beveled	**14**	Beveled	**20**	Beveled	**26**	Beveled
3	Gabled	**9**	Gabled	**15**	Gabled	**21**	Gabled	**27**	Rounded
4	Rounded	**10**	Rounded	**16**	Rounded	**22**	Rounded	**28**	Flat
5	Flat	**11**	Flat	**17**	Flat	**23**	Flat		
6	Mesial notched	**12**	Mesial notched	**18**	Mesial notched	**24**	Mesial notched		



[n=636]

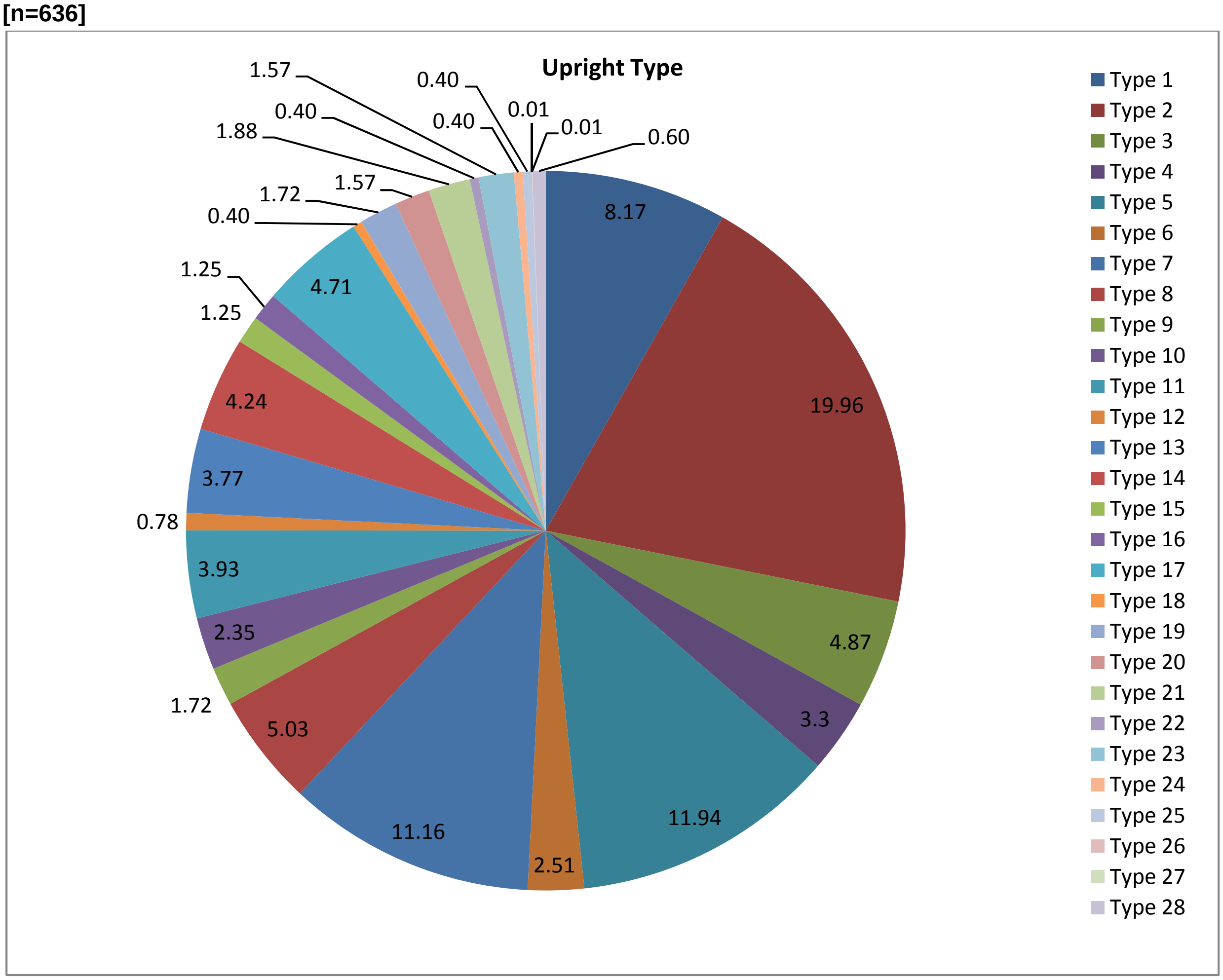


Figure 6.19. Frequency Distribution of Upright "Types."

6.2.5.7 Upright Location

On some of the more complex sites uprights are found in locations that correspond to what are generally referred to as the “altar” (*ahu*) and the “court” in much of the earlier literature on East Polynesian religious structures (e.g., Emory 1933, 1947). Ethnographic information indicates that the meaning of the uprights varied with their location (on the *ahu* vs. on the court). Emory had the following to say about the uprights on Society Island *marae*:

> The *marae* of the Society Islands follow a pattern of a rectangular court with a stone platform (*ahu*) at the head serving as a raised seat for the gods. Stone uprights designate the position of the worshippers on the court. When they occur on the *ahu*, they seem to designate the position of gods invoked (Emory 1970:91).

It is possible that the locations of uprights on the Mauna Kea shrines had the same symbolic significance, although there is no known firsthand knowledge of this and no way to confirm it. The few court uprights that could be considered “backrests” may have occasionally functioned the way Emory described for Tahitian marae, but given the environmental context and remote location, it may be that the court uprights had a primarily symbolic rather than instrumental function or use.

A particularly interesting example of an upright with convergent sides and a roughly flat top is located on Shrine 3 at Site 16204 (McCoy 1999b: Figure 10). Upright 2 is of a form that on current evidence appears to be relatively rare in the shrines on Mauna Kea. The sides diverge toward the top, which though somewhat jagged and irregular is overall rather flat. It resembles in a general way the wooden slab images on the Kauai *heiau* illustrated by Webber (see Emory 1928:108 for a discussion of this *heiau*). Though only a single example, it illustrates that there are some similarities between stone and wooden images.

6.2.6 Shrine Classification, Types, and Spatial Distribution Patterns

There are a number of different classifications of Hawaiian shrines. McAllister (1933:15), for example, divided shrines into three groups: fishing, family, and road shrines. Buck thought it useful, however, to divide McAllister’s family shrines into household and occupational shrines. Buck described occupational shrines as follows:

> Malo (1951, p. 81) writes that “each man worshipped the *akua* that presided over the occupation or profession he followed...” Thus what may be termed occupational shrines were built to the presiding gods in convenient places, and cultivators, woodsmen, fowlers, and others recited their rituals and laid their offerings upon their particular shrine before engaging in their work. There was nothing to distinguish this form of shrine from others, except, perhaps, the locations of the sites, which were away from the beaches and could not be readily confounded with the shrines of fishermen (Buck 1957:529).

Buck’s discussion illustrates the problem of relating form and function and, thus, the tendency to focus on the recognition of functional types.

There is no existing, standard classification or typology of Hawaiian shrines used by archaeologists. Though it makes inter-site and regional comparisons difficult, it must be remembered that site classification is a tool rather than an end it itself (Adams and Adams 1991). To reiterate a point made earlier, the purpose of classification is not to just organize the data and make them amenable to comparison, but to make comparisons meaningful.

6.2.6.1 Classification: Objectives and Methodological Issues

There any number of ways of classifying shrines--e.g., single upright shrines and multiple upright shrines. The second group exhibits significant variability in terms of the arrangement of the uprights and the presence/absence of architectural features, such as pavements. A classification that recognized only two types would be of little use.

Adams and Adams describe the development of types as a two step process—the formulation of provisional types followed by the selection of types that are useful for our specific purposes (Adams and Adams 1991:185):

> …there may at the outset be no rational basis for the selection of attributes; we have no choice but to consider most or all of them, and to formulate a large number of provisional types. Thereafter it is not attributes but types that must be selected on the basis of whether or not they are useful for our purposes (Adams and Adams 1991:185).

We have the followed the lead of Adams and Adams in developing a provisional typology based on the number and arrangement of uprights. Pavements were considered in developing the provisional typology, but they are not defining characteristics of any one group. Shrines with courts, which are some of the largest and most complex structures in the Science Reserve, on the other constitute a type.

6.2.6.2 Previous Classifications

The fact that archaeological classifications are mutable and subject to change is illustrated in the several attempts that have been made to classify the shrines on Mauna Kea. The first attempt to classify the shrines in the Science Reserve was made in 1982 based on the analysis of 21 structures. Three provisional "types" were recognized at that time (Table 6.3): (1) single feature shrines; (2) multiple feature shrines, and (3) *marae* (McCoy 1982:2.9).

Type 1. Single Feature Shrines

The simplest and most common "altars" are those with one to three, and possibly four, juxtaposed and frequently aligned uprights in a small delimited area. The readily apparent dichotomy of one- and three-upright "altars" is the basis for recognizing two provisional subtypes.

Type 2. Multiple Feature Shrines

Structures of this type are distinguished by the presence of two or more physically discrete, but close, structural components with the same or different architectural characteristics.

Type 3. *Marae*

Use of the Eastern Polynesian term, *marae*, follows Emory (1928) who employed it in describing the religious structures on Nihoa and Necker Islands. The two structures in this category bear a general resemblance to the Nihoa and Necker remains in the existence of a "court" area with secondary uprights fronting the main altar. This is the distinguishing feature of this type, which also occurs in the Mauna Kea adze quarry (McCoy 1981) and in Haleakala Crater (Emory 1921, 1970:89).

Table 6.3. 1982 Classification of Shrine Types.

Type	Defining Characteristics	No.	% Total
1	Single feature shrines	11	52.38
2	Multi-feature shrines	8	38.10
3	Primary row of uprights, off-set uprights and a court	2	9.52
Totals		**21**	**100%**

A second classification, developed in 1999 and based on a sample of 84 shrines recognized 5 categories (Table 6.4). There is a general progression in structural complexity from simple to complex in the move from one category to the next. There is no indication, however, that this is necessarily an evolutionary sequence, with the more complex shrines developing from the simpler ones and dating to a later time period. It is highly likely that the various ground plans all existed at the same time, and that the differences are to be explained in social terms. Unlike the 1982 classification, the term "category" was used instead of "type" based on the preliminary nature of the analysis (McCoy 1999a).

Table 6.4. 1999 Classification of Shrine Types.

Category	Defining Characteristics	No.	% Total
1	Single upright	30	36.14
2	Single row of two or more uprights	33	39.76
3	Row of uprights and off-set uprights	10	12.05
4	Multiple rows of uprights	6	7.23
5	Group of dispersed uprights	4	4.82
Totals		**84**	**100%**

6.2.6.3 Revised Classification: Defining Characteristics, Number and Distribution Patterns

The 1982 and 1999 shrine classifications were for a variety of reasons not entirely satisfactory. It illustrates once again that classifications and typologies are not immutable or static. With the completion of the inventory survey of the Science Reserve and a significant increase in the number of shrines there is more variability than previously recognized, thus leading once again to revision of the previous typology.

The revised typology is similar in many respects to the 1999 classification except that the variability noted in the definitions of the Category 2 and Category 3 shrines has been given added importance, resulting in the recognition of two new types (Table 6.5). The Category 2 shrines have been divided into two types. Type 2 shrines are single row shrines comprised of closely spaced uprights. Type 3 shrines are single row uprights where the uprights are physically separated by 50 cm and in some cases several meters. The Category 3 shrines with "courts" are now recognized as Type 5. The decision to treat these more elaborate structures as a separate type represents a return to the original 1982 classification. Figure 6.20 is a schematic diagram illustrating the seven types. The frequency distribution of the seven types is illustrated in Figure 6.21

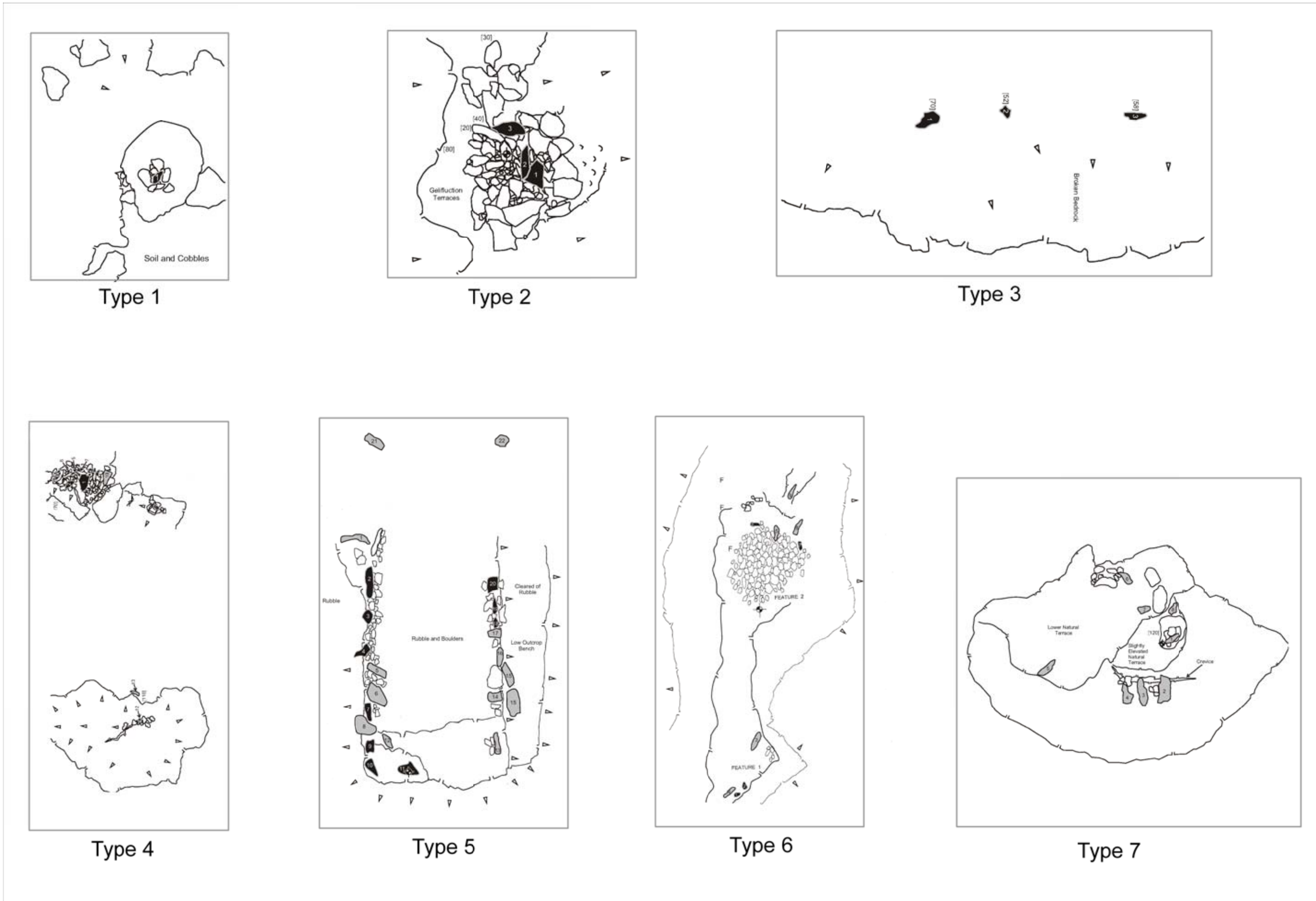
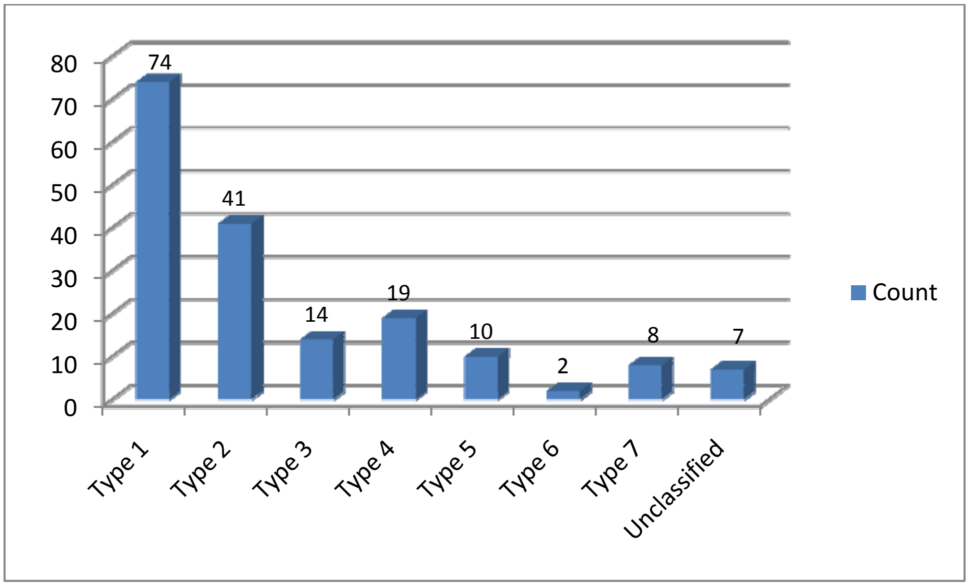
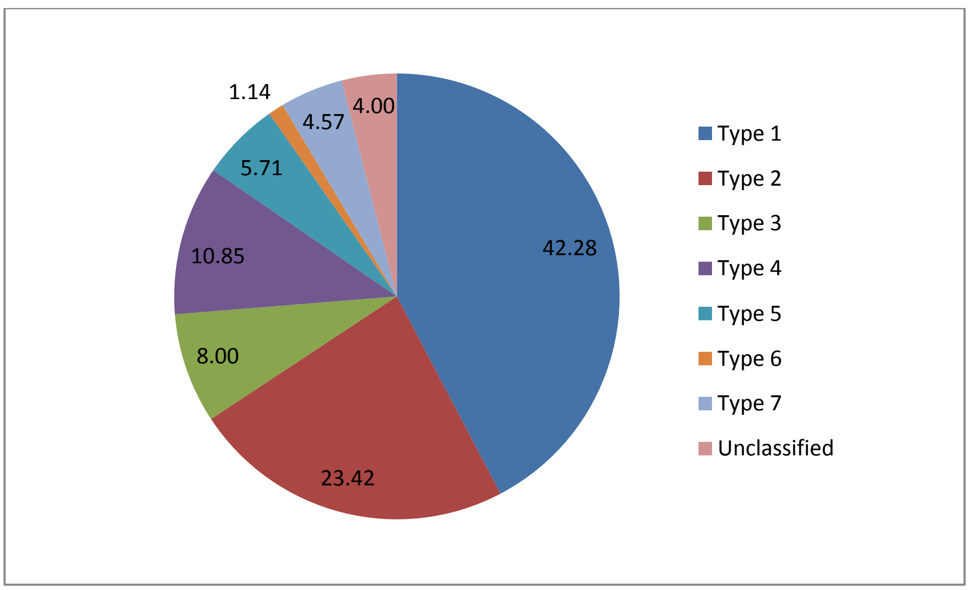


Figure 6.20. Schematic Diagram of Shrine Types.



Count [n=175]



Percentage [n=175]

Figure 6.21. Frequency Distribution of Shrine Types.

and their spatial distribution in Figure 6.22. The number of shrines used in the analysis is 175. Of that number there are 7 that are unclassified because they have characteristics unlike the others (Table 6.5).

Table 6.5. Revised Classification of Shrine Types.

Type	Defining Characteristics	No.	% Total
1	Single upright	74	42.28
2	Row of juxtaposed uprights	41	23.70
3	Row of separated uprights	14	8.00
4	Row of uprights and off-set uprights	19	10.85
5	Multiple uprights with a pavement and defined court	10	5.71
6	Multiple rows of uprights	2	1.14
7	Group of dispersed, non-aligned uprights	8	4,57
Unclassified		7	4.00
TOTAL		**175**	**100%**

There is a general progression in structural complexity from simple to complex in the move from one category to the next. There is no indication, however, that this is necessarily an evolutionary sequence, with the more complex shrines developing from the simpler ones and dating to a later time period. Based on ^{230}Thorium branch coral dates for two shrines in the NAR the different forms are contemporaneous (see Section 7).

Type 1

The simplest or most elementary kind of shrine, but at the same time the most problematical for reasons outlined above, is the single upright stone. A total of 74, or 42.28%, of the shrines in the Science Reserve fall into this category (see Table 6.5; see Figure 6.21). As nothing more than a point, a simple mark on the landscape, shrines such as these clearly have no ground plan. Though small, it is unlikely that the boundaries of these simple shrines were defined by the upright alone. How large of an area would have been regarded as a “sacred precinct” is unknown.

As discussed above, single upright shrines are widespread, but the distribution pattern is uneven. The largest numbers are found on the north slope (see Figure 6.22). A second large grouping of single upright shrines is found on the northeast-east slope, south and east of Pu`u Māhoe and upslope of Pu`u Poepoe.

Type 2

Next to the single upright shrines the most common type of shrine in the Science Reserve are those consisting of a series of uprights aligned in a single row. There are 41 sites in this category which makes up 23.42% of the total (see Table 6.5; see Figure 6.21).

Single row shrines are widely but unevenly distributed. Their distribution is more restricted than the Type 1 shrines. The largest number are found on the north and northeast slopes to the west and south of Pu`u Māhoe. There are several small clusters in this same area, and in the large site complex located upslope of Pu`u Līlīnoe. Two of the shrines at the Site 16204 ritual complex are of this type and there are also a couple present in the Pōhakuloa Gulch quarry area (see Figure 6.22).

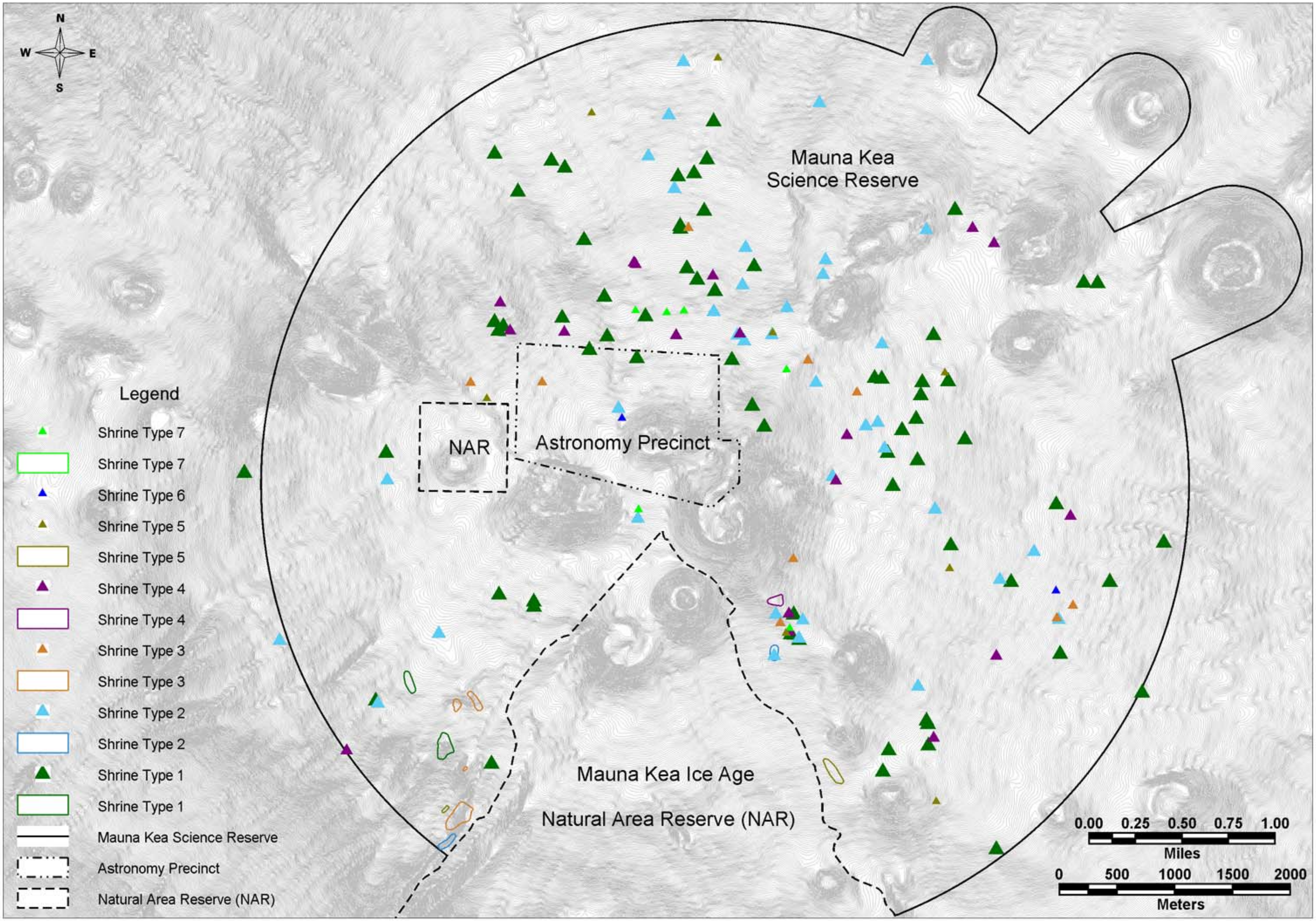


Figure 6.22 Spatial Distribution of Shrine Types.

Type 3

Type 3 shrines are defined as a single row of uprights with a gap of at least 50 cm between stones and in many cases a meter or more. In some cases the individual uprights are located on physically discrete boulders or outcrops. There are 14 Type 3 shrines (8.0% of the total). Their distribution is spotty, with examples occurring over a large expanse of the Science Reserve. A number of them are found in the Pōhakuloa Gulch area (see Figure 6.22).

Type 4

The defining characteristic of this type, which distinguishes it from Types 2 and 3, is the presence of additional uprights located on one side of the primary row. There are 19 sites in this category (10.85% of the total; see Table 6.5). Because the off-set uprights occupy a different space than the main row of uprights, what might be considered the "altar", they may have been essentially the same thing as "court uprights."

Type 4 shrines are widely dispersed. The only grouping of any consequence is found in the site cluster located above Pu`u Līlīnoe (see Figure 6.22).

Type 5

Type 5 shrines are similar to Type 4 shrines except that there is a clearly defined "court" on which are sometimes found more or more offset uprights (see Table 6.5). Following the established practice in describing East Polynesian *marae*, these are called "court uprights." In parts of East Polynesia, such as Tahiti and the Tuamoutu Islands the uprights on the court were used as backrests for persons of honor. Type 5 shrines number 10, representing 5.71% of the total. The 10 known examples are widely scattered (see Figure 6.22).

Some examples of this type, recognized early in the research in the Mauna Kea Adze Quarry, in 1975-76, are U-shaped "enclosures." On Site 21420 the rows intersect to form two sides of a structure that has the general appearance of an enclosure, though the other two sides are natural boulders and cobbles. One example of this type is Site 16198 which is located on the northwest side of Pu`u Līlīnoe. There is one more example in this same general area of the mountain. Shrine 4 at Site 16204, the ritual complex, is a classic example of a shrine with a well-defined, partially paved court (see Figure 6.22).

Type 6

There are only two sites of this type (Sites 16166 and 25781), which is defined as a shrine with more than one row of uprights (Table 6.5). The two sites are on opposite sides of the summit (see Figure 6.22).

Type 7

This is a rare form of shrine with only 8 known examples (4.57% of the total, see Table 6.5). The defining characteristic is a small number of uprights that do not appear to be aligned in any obvious way, but are rather dispersed. Some of the Type 7 shrines consist of one or more uprights located on boulders that form a cluster.

Three of the sites of this type (Sites 16173, 16174, and 16175), are located in a relatively small area on the north flank of the mountain at or near the 13,000 ft elevation (see Figure 6.22). This is an unusual pattern the meaning of which, of course, is unknown. This area may have held some special significance.

6.2.7 Functional Variability and Use

To reiterate a point made earlier, on current evidence there are at the minimum two functional classes of shrines in the Science Reserve: (1) the occupational specialist shrines that are part of the adze quarry complex, and (2) all the others, which on current evidence appear to be "non-occupational." Morphologically, there is nothing to distinguish these two classes, each of which exhibits considerable variability in ground plan, number of uprights, etc. The Mauna Kea shrines are in this regard no different from Hawaiian shrines in general. According to Buck, "Shrines varied considerably in construction, and similar forms were distinguished merely by their function" (Buck 1957:528). The only thing that distinguishes the occupational shrines from all the others are the associated lithic scatters and adze manufacturing by-products (offerings) found on the surfaces of these shrines. There is good reason to believe that the shrines on Mauna Kea had a function similar to the fisherman's shrine. McEldowney (1982:1.11), citing Kamakau, noted that "The dedication by bird catchers of *ko`a* to the increase or maintenance of bird populations may suggest that those seeking *`ua`u,* or any other resource for collection or immediate use, may have built shrines for this purpose" (Kamakau 1976:133).

Apart from a single *`opihi* shell of questionable age on Shrine 2 of Site 16204 and the adze preforms and flakes found on the shrines associated with the adze quarry complex, no discernible offerings were found on any other shrines. It is hard to imagine that nothing was offered to the gods, thus leading to the obvious supposition that the offerings must have all been perishable materials, such as strips of pandanus that might, for example, have been tied around the uprights.

6.2.8 Dating

Unfortunately, none of the shrines in the Science Reserve have been dated. This is due to the absence of datable material, such as organic matter and branch coral. Some of this material could be found concealed in a crack or beneath an upright in the future, but for now the only dates for shrines on Mauna Kea are from two sites in the NAR. These dates are discussed in Section 7.

6.3 PŌHAKULOA GULCH ADZE QUARRY/WORKSHOP COMPLEX ARTIFACT ASSEMBLAGES: SELECTED ANALYSES

The large number of artifacts in the Pōhakuloa Gulch Adze Quarry/Workshop Complex precludes a detailed analysis of every site and workshop assemblage. The focus in this report is on selected adze preform and hammerstone attributes from selected sites. Tables presenting artifact data by site and component are located in Appendix G. The analyses that follow are preceded by a discussion of a number of different kinds of theoretical and methodological issues in stone tool quarry studies and a list of commonly used terms in the field of lithic technology.

6.3.1 Stone Tool Quarry Studies: Theoretical and Methodological Issues

The increasing importance given to lithic tool quarries and workshops in studies of regional exchange systems, craft specialization and the evolution of so-called complex societies (e.g., Arnold 1987; Purdy, 1984; Singer and Ericson 1977; Torrence 1984, 1986; Bayman and Moniz 2000) reflects a primary concern with the socio-cultural consequences of production rather than the technology of production which continues to be described largely in terms of manufacturing stage models of the kind that W.H. Holmes conceptualized nearly a century ago (Holmes 1890). The explication of linear reduction sequences is considered to be both possible and necessary (e.g., Muto 1971; Bradley 1975; Collins 1975; Sheets 1975), but in the absence of experimental replication (e.g., Flenniken 1981) such constructs, as with stage models in general, obviously constitute nothing more than empirical generalizations or, indeed, rather simplistic classifications devoid of explanatory potential. The extent to which an understanding of quarry production systems can contribute to these studies and the most important questions of all, cultural stability and change, is ultimately dependent on defining the organizational properties, internal structure, and developmental history of quarry industries. This goal is clearly dependent in large part on identifying and then explaining in terms of their own dynamics the totality of constraints that account for the range of behavioral variability observed in the archaeological record of the production process (Ericson 1984; Torrence 1986, 1989).

The study of process in many stone tool quarries is unfortunately limited to inferring the dynamics of production based on an analysis of the resultant static by-products, or debitage, that is the quintessential characteristic of quarries. The distributional and techno-morphological attributes of quarry debitage are in themselves one aspect of the organizational dynamics in the sense that they reflect certain material-behavioral and spatial-behavioral relationships of manufacture and discard. Debitage analysis alone is an insufficient basis for elucidating the organizational properties of quarry industries, however, since it does not take into consideration non-material factors, such as possible prescriptive behaviors that may have been codified in some manner, or even the full complexity of material-behavioral relationships.

The distinction between material and non-material dimensions of production indicates the need to isolate both environmental [the "earthly basis"] and social [the "social basis"] constraints (McCoy 1990:87). Each of these delimits certain boundaries within which behavior can be expected to vary, but it is the dynamic relationships between the two, of how nature is mediated, that is of primary concern in terms of the immediate goal of elucidating aspects of organizational variability and the broader interest in culture change and stability.

A widespread problem in lithic analysis is that it is either theoretically sophisticated or methodologically sophisticated but rarely both (see Sullivan and Rozen 1985; Amick and Mauldin 1989; Rozen and Sullivan 1989a). Of the many problems that currently exist one of the most contentious is the manufacturing stage concept or stage analysis (see Rozen and Sullivan 1989b), which tends to be seen as synonymous with technological analysis. A brief introduction to the concept is followed by a summary of its application in the quarry research up to the present time.

The lack of a unified body of theory in lithic analysis means that methodological issues are still the primary concern in this field of study. Chief among these in quarry sites are: (1) the classification of artifacts in terms of the manufacturing stage concept or some alternative; (2) formal and functional typologies; (3) site formation processes, and (4) production estimates. These and other issues underlie the structure of the various analyses that are briefly discussed below.

6.3.2 Artifact Terminology

A brief description of each class and category of artifacts and other relevant terminology is presented below for the purpose of making the site descriptions and preliminary interpretations in the next section of the report more comprehensible. A more detailed analysis of the artifacts that were recorded in the field is presented in the following section.

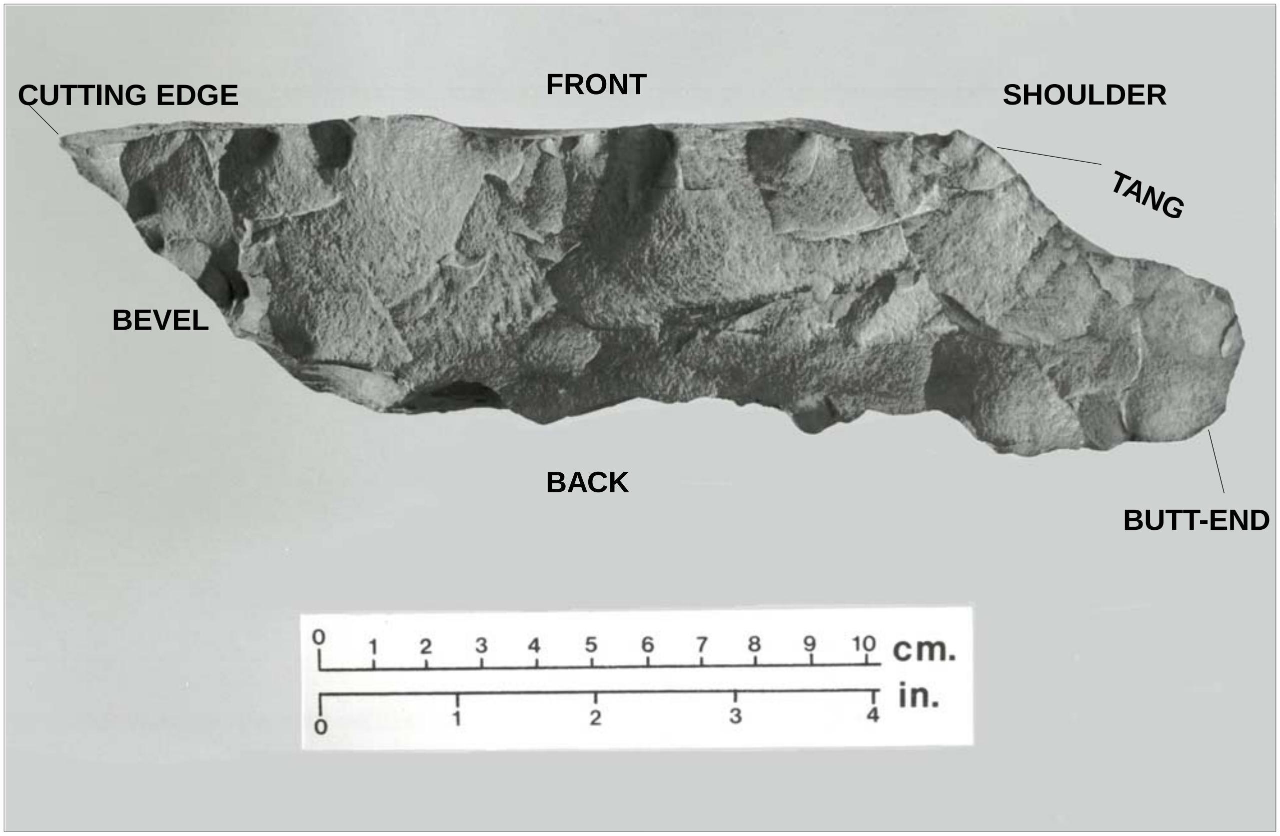
***Adz/Adze and Chisel*.** In a classic methods paper by some of the most distinguished names in Oceanic studies adze, axe and chisel were defined as follows:

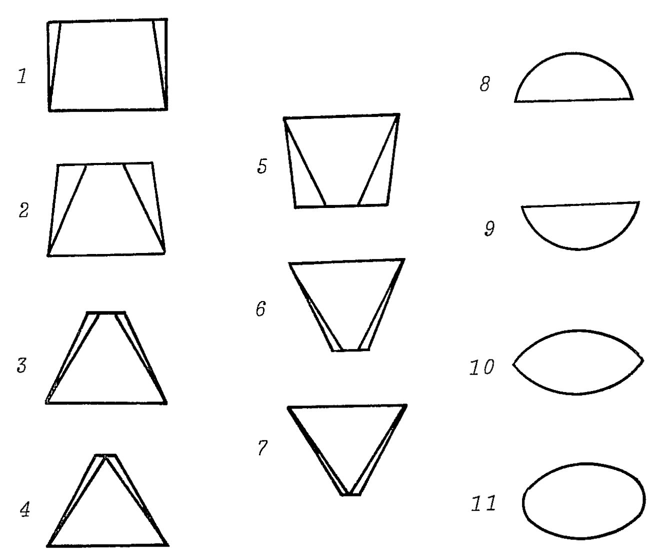
> An adze is a cutting-implement of stone, shell, or other resistant material, with the cutting-edge running transversely to the long axis of the haft. The motive power is supplied by a swinging blow...The term adze is restricted to the implement without the haft and lashings (Fig. 1). When attached to a haft it is referred to as a hafted adze (Fig. 2) (Buck et al. 1930:175).
>
> An axe is a hafted cutting-implement with the edge running parallel or nearly parallel to the long axis of the haft. The power is supplied by a swinging blow (Buck et al. 1930:179).
>
> A chisel is a cutting-implement which is hafted with its long axis continuous with the long axis of the haft. The motive power is supplied sometimes by pressure and sometimes by mallet blows. It is not at present possible to draw a definite line between small adzes and large chisels. It seems probable that some implements were used both as adzes and chisels according to the convenience of the owner (Buck et al. 1930:179).

Though these definitions contain some ambiguities [for example, in assuming that the tool was hafted everywhere in the same manner] and could be improved, they have been adopted and used by generations of Polynesian archaeologists (Figure 6.23). These and the common dictionary definitions which mirror them are not universally applied throughout the Pacific, however. In a recent article titled “The Last Stone Ax Makers” the authors note the conventional method of distinguishing adze and axe, but opt for a definition based on use rather than haft design or method.

An archaeologist would normally classify these implements as adzes, because in side view their ground edges assume an asymmetric, plano-convex shape rather than the symmetric shape typical of axes. Moreover, they are hafted with the working edge at right angles to their handles, whereas ax edges generally lie in the same plane as the handle. But we call them axes because they are used to chop wood and fell trees and because the literature has generally classified such implements according to their use rather than their design. In some other groups, adzes are commonly used not to chop down trees but to shape wood (Toth et al. 1992:88).

The Polynesian literature contradicts their assertion because it consistently refers to adzes classified according to their assumed haft design. The use is variable and in the case of Hawaiian adzes it is clear that they were primarily used to fell trees and shape wood. There are references in the Hawaiian literature to other, perhaps occasional or less regular, uses of stone adzes. The possibility that adzes were used in agriculture was noted by Kamakau (1961:237) who wrote, “With their hands alone, assisted by tools made of hard wood from the mountains and by stone adzes, they tilled large fields...” There is another reference to the use of adzes in digging a well:





Classification of adzes based on form of cross section at shoulder or midway between cutting edge and poll. Cross sections shown base down. 1—Rec. or Quad.; Rectangular or Quadrangular (face width 80-95 percent of base width, or vice versa). 2—Trap.; Trapezoidal (face width 30-79 percent of base width. 3—Subtri.; Subtriangular (face width 15-29 percent of base width). 4—Tri.; Triangular (face width less than 14 percent of base width). 5—Rev. Trap.; Reversed Trapezoidal (base width 30-79 percent of face width). 6—Rev. Subtri.; Reversed Subtriangular (base width 15-29 percent of face width). 7—Rev. Tri.; Reversed Triangular (base width less than 14 percent of face width). 8—Pl-con.; Plano-convex. 9—Rev. Pl-con.; Reversed Plano-convex. 10—Len.; Lenticular. 11—Oval. To these suggested abbreviations can be added "T" for tanged, or "t" for incipiently tanged.

(Adze Classification as Presented in Emory 1968: Figure 1)

Figure 6.23. Hawaiian Adze Preform Terminology and Cross-Section Classification.

> According to Mea Kakau (1902), while Kaiakea was the ruling chief of Molokai (in the time of Kamehameha I), a well was made at Kalaeokala'au; "This well was dug with *pahoa* adzes by the men of Moloka'i until they found water" (Summers 1971:54). *Ko'i pahoa* are also defined as "battle-axes" (Pukui and Elbert 1971:276). Lastly, there are Hawaiian legends that adzes were symbols of power (Beckwith 1970:49).

***Adze reject*.** The term *adze reject* is used in place of *blank* and *preform* given the present confusion surrounding these terms (see discussion of this issue in McCoy 1986, 1991; Williams 1989; Weisler 1990). The use of this term assumes, of course, that all of the adzes that we find in a quarry, with only a few possible exceptions, were rejects that were intentionally discarded because of breakage or design flaws in the shape of the incipient tool. The primary example of the latter is asymmetry in the transverse and/or longitudinal sections or the length:width:thickness ratio. Cleghorn (1982) discussed some other probable reasons for discard.

***Assemblage*.** The word assemblage is used here in two different ways: (1) to refer to the totality of artifacts from a locality [e.g., the Site 26253 artifact assemblage] and (2) to refer to all of the artifacts of a single kind or class [e.g., the adze manufacturing by-product assemblage].

Blank. In the present study the term blank is used to refer to cores and flakes that exhibit more than a few flake scars. Adzes in the quarry were made on tabular blocks from the edges of flows and cobble/small boulders of generally sub-rounded form obtained from glacial drift deposits [***core blanks***], and flakes detached from cores [***flake blanks***] where the ventral surface of the flake was almost invariably utilized as the face or front of the adze.

***Core*.** Crabtree (1972:54, 56) defined a core as a "Nucleus. A mass of material often performed by the worker to the desired shape to allow the removal of a definite type of flake or blade...Cores can be embryonic--such as a piece of natural, unprepared, raw material with scar or scars, reflecting the detachment of one or more flakes." Some of the naturally occurring cores in the quarry are referred to in this report as *boulder cores* or *tabular slab* cores.

***Debitage*.** Crabtree (1972:58) defined debitage as "Residual lithic material resulting from tool manufacture. Useful to determine techniques and for showing technological traits. Represents intentional and unintentional breakage of artifact either through manufacture or functions. Debitage flakes usually represent the various stages of progress of the raw material from the original form to the finished stage." Debitage and by-products are used interchangeably to refer to the exhausted cores, flakes, shatter, and all of the other waste resulting from the manufacturing process.

Extraction areas. These are bedrock exposures from which raw material has been removed (i.e., extracted). The exposures can be along the margin of a lava flow where there is a "face" that can be worked, or the exposure can be a bedrock surface that is mined for subsurface material, resulting in a pit.

***Fabricator*.** Fabricator, as the term has been used elsewhere (McCoy 1986, 1991), is a catchall term for a variety of manufacturing tools or implements. These include, in the instance of the Mauna Kea adze quarry, hammerstones, abraders, and implements with signs of use both as a hammerstone and an abrader.

***Facility or Appliance*.** The one known adjunct to adze manufacture was a stone anvil that was used to support the incipient tool during the flake removal process. Items such as this are variously referred to in the archaeological literature as facilities or appliances.

***Flake*.** Crabtree (1972:64) defined a flake as "Any piece of stone removed from a larger mass by the application of force—either intentional, accidentally or by nature. A portion of isotropic material having a platform and a bulb of force at the proximal end."

***Manufacturing by-products*.** Another term for the residual material left from tool manufacture; commonly used as an alternative for debitage.

***Preform*.** A preform as used in this report is an unfinished adze that has been roughed out from either a core or a flake blank. In contrast to earlier studies, there is no assumption that a preform represents the final form of the adze blade.

***Shatter*.** This term refers to material removed in the reduction process that does not possess any of the landmark characteristics of flakes, such as a striking platform or bulb of force.

***Test areas*.** Archaeologists frequently refer to small lithic scatters consisting of a core and a few flakes as test areas. Their material characteristics suggest that the material was found unsuitable for whatever reason.

***Utilized/modified flakes*.** The collection includes a small number of adze waste flakes with edge and surface alterations that were probably utilized as scraping or cutting tools.

6.3.3 Artifact Description and Classification

The description and classification of artifacts can no longer be regarded as a totally objective and purely methodological undertaking given the fact that description is interpretation. The purpose of classification, moreover, is not to just organize the data and make them amenable to comparison, but to make comparisons meaningful. What is required then is theory to structure and organize classification. Shanks and Tilley write:

> Now, as all archaeologists know, or should know, there are a multitude of possible competing descriptions of an artifact, an assemblage, or any set of remains encountered in the archaeological record. The choice involved in the description of these remains is related to the theories used to understand them (Shanks and Tilley 1987:109).
>
> As regards to artefact classification, it has begun to be recognized that classification is not independent of theory ...and there is no such thing as a `best' classification. All classifications are partial and selected from observed features of the data set (Shanks and Tilley 1988:83-84).

6.3.4 Artifact Analysis: Basic Concepts and Approaches

The artifact analysis is based on the use of both an assemblage approach and an attribute approach. The word assemblage is used here in two different ways: (1) to refer to the totality of artifacts from a site and its constituent components (workshops, habitation shelters and shrines) and (2) to refer to all of the artifacts of a single kind or class [e.g., the adze manufacturing by-product assemblage]. Our interest is in both similarities and differences and more particularly in the variability within and between assemblages. We agree with Cowgill (1989) and Conkey (1989) that more attention should be given to explaining and interpreting diversity rather than just measuring it.

Data are presented in terms of both raw counts and percentages. Measurements were made with dial calipers and rounded off to the nearest millimeter and weights to whole grams.

The primary objective of the analysis that follows is to provide a general characterization of the assemblages in terms of technological, functional and stylistic properties for the purpose of achieving an understanding of the manufacturing technology in terms of the skills, knowledge, and procedures that are the defining characteristics of all technologies (Merrill 1968:576). The major emphasis in the present analysis has been the recording of attributes deemed to have technological, functional and/or stylistic significance. We hold to the common view that technology, function, and style are all integrally related. As Isaac noted in regard to the shape of a stone tool:

> On logical grounds it would appear that the morphology of a stone tool is governed by the interaction of (1) the *physical properties* of the stone being employed, and (2) the *'intentions'* (design concepts) and the *motor habits* of the craftsman. The design concepts themselves are presumably related in turn to two kinds of determining influences: firstly, the *functional requirements* of the tool will place limits on the range of forms that would be effective; secondly, systems of *transmission of traditions* provide a craftsman with a set of technical and morphological patterns that are functionally adequate and socially acceptable (Isaac 1972:176).
>
> It can be seen that in trying to make inferences about the specific 'design norms', or 'traditions', manifest in a set of artefacts, it is necessary to resolve and subtract other factors, such as those than can be attributed to the physics of conchoidal fracture or to the primary form of the raw material. Now, for complex artefacts such as refined hand-axes or tanged points, each involving a great many technical acts (e.g. flake removals), the role of a specific tradition in determining form may be quite clear. However, the shorter the sequence of technical acts, the more decisive will be those aspects of form imposed by 'physics' and 'geology' rather than by design. Thus, there is a limited range of forms than can result from the simple sharpening of common, naturally occurring, stone fragments. This situation creates difficulties in the study of early tool-kits: it is hard to distinguish separate 'intentions' or 'traditions' from opportunism, and there is a continual danger of over-interpreting the material (Isaac 1977:40).

The primary frame of reference in the present analysis is technological. The initial concern is with the relatively straightforward but by no means simple task of describing the salient aspects of the manufacturing technology, including: (1) a description of manufacturing techniques and tools and (2) an explication of the stages of manufacture, beginning with the raw material procurement process, and consideration of more specific behaviors and causal relationships, such as: (a) the effect of raw material form and abundance on the frequency of manufacturing by-product categories and variability; (b) stockpiling behavior; (c) materials testing, and (d) other non-technological behaviors.

The attributes selected for study include a combination of qualitative and quantitative variables. They are specific to each artifact class, though there are a number of individual attributes that all artifacts share in common and which have been judged important enough to record. In using the attribute approach it is important to remember that:

> To define or describe an artifact according to immediately given attributes is not enough because an object always has a surplus of meaning over and above any

> definition or description. A definition or description can never be identical with or sufficiently summarize the complexity of the overlapping relational aspects of an object. Any single definition or description applies to only a particular frame of reference which is necessarily value-laden. The particular perspective from which an object or event is viewed is an integral part of the object of study. Concepts and categories of analysis are internal to, they constitute the object of study; they are not separate from what they are categories of. So there can be no formal and general method separate from the structure of the object of study... (Shanks and Tilley 1987:66).

6.3.5 Technological Analysis and the Manufacturing Stage Concept

Technological analysis, which is primarily concerned with how artifacts are made, is fundamentally a behavioral study, founded on the assumption that an artisan's behavior is recorded on tools and manufacturing debris (Sheets 1975). The objectives and assumptions on which this kind of analysis rest are described by Sheets:

> A technological analysis attempts, among other things, to determine the procedures used to manufacture implements through the examination of both the implements and the manufacturing debitage. Lithic analysis of manufacturing procedures is based on two assumptions. First, manufacturing behavior is recorded on the implements and on the wastage of the lithic industry. Second, we as archaeologists can train ourselves to read that record-to recognize the procedures used in the past which resulted in the various morphological attributes in the collections. Our objective is to translate, with as high a degree of accuracy as possible, the attributes observed into past actions, and then to place those actions in a hierarchy of procedures and products which represents the original organization of that industry (Sheets 1975:371-372).

> Because technological analysis is interpretive, and not purely descriptive, it must be based on a foundation of theory. As Phagan (1973:2) comments, the basis of a technological analysis is the "establishment of a theoretical framework or system within which various traits of flakes or implements can be seen to have technological significance" (Sheets 1975:372).

The focus of technological analysis is the lithic reduction strategy which has been operationally defined by Muto (1971) and others (e.g., Sheets 1975; Bradley 1975) as a continuum or sequence of manufacturing stages. The stage concept is applied and/or is thought by many to be applicable to the study of stone tool manufacture. It is regarded by many lithic technologists as the main analytical concept and by others as highly problematical and of limited utility. On one important point there is a general consensus: that stone tool manufacture is a continuum and that because it is a reduction technology the parent material becomes smaller and at the same time there is a decreasing amount of cortex. The chief complaint against the use of the concept is the artificiality of dividing a continuum into arbitrary parts.

What seems to have gone largely unnoticed in the debate over the utility of the manufacturing stage concept is the effect that the use of stage typologies has on interpretation and the realization of both particularistic and generalizing goals in view of the fact that the manufacturing stage concept, like all stage concepts, is descriptive and non-explanatory, as well as inherently reductionistic. Stage typologies clearly sacrifice detail for generalization. The stage concept, moreover, is incapable of answering the question "why this particular sequence or number of stages and not some other"?

Apart from the debatable efficacy of the stage concept, what is missing in this area of lithic analysis is a theory that establishes the relevance of stage analysis to an understanding of social processes. There is clearly a need to move beyond re-description in the reconstruction of reduction sequences and strategies to interpreting reduction sequences and strategies in meaningful ways –as illustrations of or, indeed, evidence of social processes, such as the development of institutions like craft specialization and the possibly changing relationship between social constraints and individual freedom. For example, do the reduction sequences become more complicated [in the number of techniques used] and/or more standardized as has been hypothesized? This is the fundamental problem in applying a generalized model, of proceeding, for example, by simply applying Muto's (1971) three stage model rather than working out a stage sequence that fits the particular case and in relation to some general theory linking stages to other cultural and social variables.

There is a clear need to rethink the stage concept in terms of its definition, and application or utility. It is not an end in itself but rather a means to an end, a precursor (a classification) to the explanation of varied aspects of the manufacturing technology. Part of the definition problem is the lack of standardized terminology (e.g., technique, method, etc.), but there are other difficulties as well, such as the complexity of the manufacturing process. For example, is there a change in tools and/or techniques, and if so, how is it reflected in the archaeological record, if at all? In the case of Hawaiian adze manufacture, that from any perspective or standard of comparison surely qualifies as one of the most complex stone tool manufacturing technologies in the world in terms of the number of technical actions, it would appear that there were only two techniques – percussion flaking and grinding/polishing in the final stage, which took place outside the quarry. There is some evidence to suggest that pecking/abrading was employed as a "secondary technique" prior to grinding and polishing. On current evidence the stage products in the quarry cannot be distinguished on the basis of "techniques." In the end the only useful stage classification scheme is one that relates the two classes of residues–tool rejects and debitage –in terms of their techno-morphological attributes that are widely held to reflect certain behaviors.

One of the primary methodological issues in manufacturing stage analysis is the use of size and cortex variables in the definitions of stages. Neither one is by itself, or in combination, a clear or unambiguous signature of a specific stage. Size and cortex are both related in part to raw material form [cores and flakes and morphological variations within each of these two categories], but if size and cortex are omitted from study then there is little or no opportunity to determine raw material form and hence to say anything about raw material procurement–the first stage in the manufacturing process.

6.3.6 Manufacturing Reduction Strategies and Sequences: A Review of the Use of the Stage Concept in Research on the Mauna Kea Adze Quarry Complex and the Pu`u Moiwi Adze Quarry

The first systematic attempt to conduct an attribute analysis of Hawaiian adze quarry tool rejects and debitage for the purposed of developing a manufacturing stage sequence was based on an attribute list compiled by the senior author and Paul Cleghorn in 1975-76 (McCoy 1981; Cleghorn 1982:113). Subsequent studies have resulted in a number of modifications to the original classification, including a reevaluation of the attribute selection criteria and rationale (McCoy 1986, 1991, 1993; Williams 1989). The revision process is unfinished, however, for two related reasons. First, typologies are "mutable and always to some extent experimental" (Adams and Adams 1991:61). Second, because typologies are imposed constructs "they must be held open to continuous revision as new material accumulates" (Wylie 1992:487).

All of the existing classifications of Hawaiian adze preforms discussed in this report are based on the different parts of the adze as defined by Buck et al. (1930) and the cross-section following the classification established by Emory (1968: Figure 1). Figure 6.23 above illustrates the terms used in this study.

1982 Classification (Cleghorn)

The blank and preform analysis follows on earlier studies by McCoy (1981) and Cleghorn (1982) who jointly developed the analytical framework used in the study of this one class of quarry products.

Cleghorn's study postulated a four step manufacturing sequence for tanged rectangular and trapezoidal preforms that was then compared to the sequence that resulted from his replicative experiments. The two sequences are similar in terms of the serial order of actions and resultant products, except a fifth step, final side straightening step was recognized in the replicative sequence (Cleghorn 1982:328). These steps are defined in Table 6.6 below.

Table 6.6. 1982 Adze Reduction Sequences.

Step	Archaeological Sequence	Replicative Sequence
1	Basic cross-section formation	Initial width reduction
2	Bevel creation	Bevel creation
3	Tang formation	Poll straightening
4	Final trimming	Tang formation
5	N/A	Final side straightening

In both sequences, Step 1 results in a preform. A preform was defined, following (Crabtree 1972:85), as "an unfinished adze whose general final form is evident, but which has not been ground" (Cleghorn 1982:40). Where the final form, which was defined as the cross-section, could not be determined the object was classified as a blank.

1986 Classification (McCoy)

An analysis of collections recovered in data recovery work conducted the Hopukani and Liloe Springs area, in 1985, departed from previous analyses in the use of a new and different stage classification scheme in which greater importance was placed on the isolation of techno-morphological changes throughout the manufacturing sequence (McCoy 1986). Prior to this time adze rejects had been classified as either a blank or a preform. One major problem with this classification is that it fails to recognize significant variability within and between these two groups which have been normally defined, moreover, in terms of form or morphology alone, rather than a combination of formal and technological attributes. A second, related problem is the widely held notion that the form (cross-section) of the emerging tool and, thus, intent of the tool-maker, is only apparent at the preform stage. The result has been a long-standing preoccupation with the classification of preforms in terms of formal adze types to the exclusion of blanks which have been essentially defined as a product group lacking standardized forms.

The new scheme reflects a growing dissatisfaction with the old system and the basic assumptions on which it and many other stage classifications are based. The new stage classification is based on the premise, held by the late Glynn Isaac and others, that there is a direct relationship between the complexity of tool form and the complexity of the manufacturing technology in terms of the number of technical acts or stages. Four stages of manufacture have been defined in the present study. The word "blank" is retained provisionally to refer to the first three stages that are defined as follows:

Table 6.7. 1986 Adze Reduction Sequence.

Stage	Defining Characteristics
Blank 1	Front/back and sides not yet distinguishable. The longitudinal and transverse sections are by definition irregular.
Blank 2	The front/back can be distinguished from the sides but the front cannot yet be distinguished from the back. Both profiles are more regular than the previous stage.
Blank 3	The front and back and sides are all clearly distinguishable from one another. The profiles are more regular but the cross section does not yet fit an ideal geometric form.
Preform	The front and back and sides are all clearly distinguishable from one another. The cross section fits an ideal geometric form.

The Blank 1 to Preform reduction sequence characterizes what may be called a "core series" in contrast to adzes made on flakes wherein the flat ventral surface of the flake becomes the front of the adze. The "flake series" is by definition a truncated reduction sequence in which the first stage product can be classified as a Blank 2 tool type.

1989 Classification (Williams)

Williams developed a revised stage classification in 1989 based on an analysis of debitage from one of the major habitation rockshelters in the quarry. His classification recognized problems with both Cleghorn's study (1982), which he noted "only proposed general manufacturing steps, not true reduction stages" (Williams 1989:22) and McCoy's (1986) analysis. He noted that "McCoy could not link his flake attributes to the reduction stages he proposed, both because the attributes he chose to analyze were heavily dependent on raw material form and the stages he proposed required highly subjective classification" (Williams 1989:22-23).

Williams proposed a five stage reduction stage model of Hawaiian adze manufacture. The model he developed also included raw material selection, which was not included as a reduction stage, however (Williams 1989: Fig. 3.1). His five stages are defined in Table 6.8 below.

The focus of Williams' analysis was the primary and secondary reduction stages since these are the stages that produce the bulk of the debitage and from what is known, all of the debitage in the quarry. Primary reduction, as defined by Williams (1982:53), results in what he calls a blank that is defined as a piece of raw material that has been flaked enough to create a "regular shape" (Williams 1989:53). Secondary reduction

Table 6.8. 1989 Adze Reduction Sequence

Stage	Description
1	Primary reduction
2	Secondary reduction
3	Grinding
4	Polishing
5	Rejuvenation

results in a preform (Williams 1989:55). His reduction model, though based on a different approach, is clearly similar to the original blank to preform continuum.

Williams was careful to note that although his model is relatively "simple" this does not imply that the manufacturing technology was correspondingly "simple." He also noted that his reduction sequence model was not the only possible model and that it was developed, moreover, for just quadrangular adzes (Williams 1989:51).

1991 Classification (McCoy)

The original blank-preform stage typology employed in the quarry research (Cleghorn 1982; McCoy 1977, 1981) and Williams' more recent debitage based typology (1989) are similar in recognizing only two stages of manufacture–early and late. In the first instance the use of stages was nothing more than a heuristic device for characterizing the manufacturing technology. In 1986 a four stage sequence was developed, which though far from perfect, represented what the senior author believed was an improvement over the other stage models (McCoy 1986 and below). Williams' model has certain merits but it is flawed in because it recognizes only two stages of manufacture, which means that there is a beginning and an end with nothing in between. A second problem with his and many other stage typologies is that procurement has been separated out and/or simply taken for granted as a logical first stage or step in the manufacturing process. Because no analyses of attributes, such as size and cortex, are undertaken the dynamics of the procurement process remains unaccounted for in the model, which means that there is no basis for inferring raw material form and its influence on the reduction strategy.

There are, in the very simplest of terms, two adze manufacturing reduction strategies and sequences: (1) a core reduction sequence and (2) a flake reduction sequence which I have earlier referred to as a ***core series*** and a ***flake series*** to reflect what is in the senior author's opinion significant techno-morphological variability within the two "ideal types"(McCoy 1986:12). There is, for example, a significant difference in tabular and non-tabular core shapes and in lamellar flakes and side-struck flake blanks, so that there would be a lamellar flake blank reduction sequence and associated production code or grammar differing in some respects with adzes made on other flake types in the sense that the two produce different kinds of debitage assemblages. This same approach has been used elsewhere in Polynesia (e.g., New Zealand cf. Leach and Leach 1980:112). Figure 6.24 illustrates examples of adzes made on flake blanks and cores.

The core and flake reduction sequence contrast is a useful analytical construct because it exists independent of "type" or "style", in addition to the fact that it helps to clarify the present confusion surrounding the widely used blank-preform stage terminology [see also Dye et al. 1985] if we follow the lead of Crabtree (1972) and others (Shafer 1985) in using the term *blank* to refer to what is in fact raw material form [a boulder core or cobble vs. a flake] so that we have only *adze preforms* rather than a

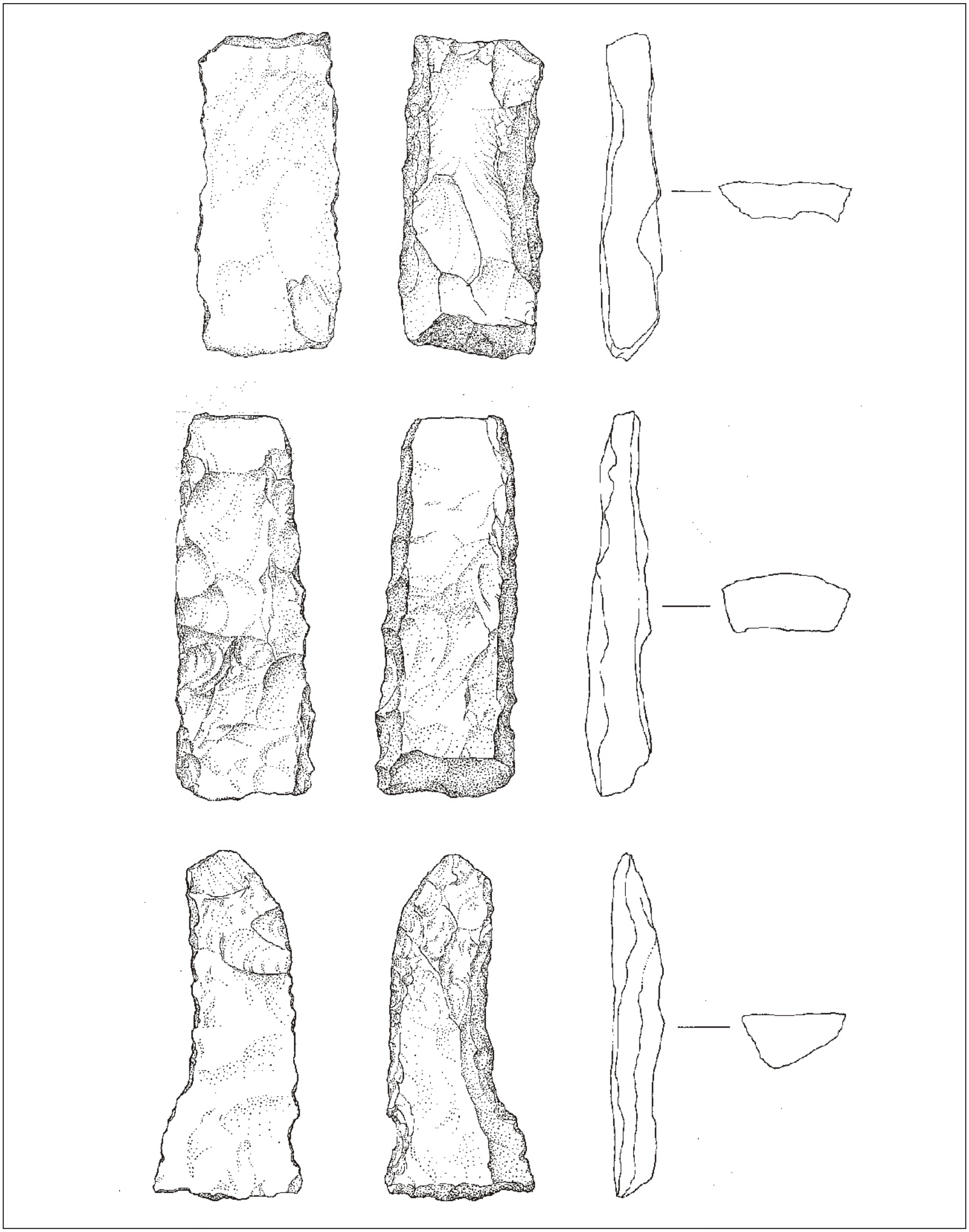


Figure 6.24. Examples of Adze Preforms Made on Flake Blanks (Top and Bottom) and Core Blanks (Middle) (70% Natural Size).

continuum comprised of adze blanks and adze preforms --a distinction that was both simplifying and obfuscating with respect to the "type" concept.

If we employ the term blank as a convenient short-hand for “raw material type or form” and the term preform for anything that is clearly an adze in the making then technological and morphological [“type”] dimensions or properties are clearly separated or disentangled [stage and “type” are two separate variables or attributes] which means that all specimens can thus be described in terms of both their position or place in the continuum [e.g., stage 1 preform and their “type” or cross-section [e.g., reverse triangular] in addition to other salient attributes.

The alternative is to do away with the blank and preform terminology and replace it with a less biased terminology like “product group” 1, 2, 3, Etc. Another way to avoid the blank to preform sequence terminology is to simply refer to Stage 1 [early], Stage 2 [middle] and Stage 3 [late]. The definitions that follow are those used in used in the 1991 report. They are similar to those employed in the 1986 report except that *blank* and *preform* have been replaced with *stage*:

Table 6.9. 1991 Adze Reduction Sequence.

Stage	Defining Characteristics
1	Front/back and sides not yet distinguishable. The longitudinal and transverse sections are by definition irregular.
2	The front/back can be distinguished from the sides but the front cannot yet be distinguished from the back. Both profiles are more regular than the previous stage.
3	The front and back and sides are all clearly distinguishable from one another. The profiles are more regular but the cross section does not yet fit an ideal geometric form and there is always some identifiable flaw or imperfection in the shape to explain why the incipient tool was left unfinished to enter the archaeological record as a tool reject.
4	The front and back and sides are all clearly distinguishable from one another. The cross section fits an ideal geometric form and there is no obvious reason why the incipient tool would not have been ground and polished and then used. Such specimens are understandably rare in most quarry/workshop contexts.

Stage 4 adzes are the objects that, saving breakage in the final finishing process, loss, or deliberate secreting away in caches as unfinished implements (see Weisler 1988) ultimately enter the archaeological record in a number of different contexts other that quarries and workshops where they are understandably rare or absent. The first three stages of manufacture by contrast are common in quarry/workshop sites.

1993 Classification (McCoy et al.)

Yet another different classification was used in the analysis of four site assemblages from the Pu`u Moiwi Adze Quarry on Kaho`olawe in 1993. Stage was replaced by what was called Techno-Morphological Type. Four types were recognized (McCoy et al. 1993:123-124):

Table 6.10. Pu`u Moiwi Adze Quarry Classification Based on Techno-Morphological Types.

Type	Defining Characteristics
Type 1	Front/back and sides not yet distinguishable. The longitudinal and transverse sections are by definition irregular.
Type 2	The front/back can be distinguished from the sides but the front cannot yet be distinguished from the back. Both profiles are more regular than the previous stage.
Type 3	The front and back and sides are all clearly distinguishable from one another. The profiles are more regular but the cross section does not yet fit an ideal geometric form and there is always some identifiable flaw or imperfection in the shape to explain why the incipient tool was left unfinished to enter the archaeological record as a tool reject.
Type 4	The front and back and sides are all clearly distinguishable from one another. The cross section fits an ideal geometric form and there is no obvious reason why the incipient tool would not have been ground and polished and then used. Such specimens are understandably rare in most quarry/workshop contexts.

Type 4 adzes are the objects that, saving breakage in the final finishing process, loss, or deliberate secreting away in caches as unfinished implements (see Weisler 1988), ultimately enter the archaeological record in a number of different contexts other than quarries and workshops where they are understandably rare or absent. The first three types by contrast are common in quarry/workshop sites.

6.3.3.6 Summary

All of the classifications summarized above have strengths and weaknesses and none, therefore, are totally satisfactory. One of the problems is the assumption that there is a single reduction sequence. As noted in the discussion of the 1986 classification (McCoy 1986:12), the Stage 1 to Stage 4 reduction sequence applies only to adzes made on core blanks. The flake blank reduction sequence is by comparison a shorter and simpler sequence because the first stage that can be recognized as an incipient adze is a Stage 3 product as defined above. The core and flake blank sequences are thus not directly comparable in terms of the number of manufacturing stages as presently defined.

A second problem is although raw material procurement has been normally been taken for granted as the beginning of the tool manufacturing sequence, it has not been included as a stage of reduction. Another issue is the tendency amongst some archaeologists (e.g., Williams 1989; Mintmier 2007) to develop reduction sequences that are really “life history” sequences and based on evidence that is not evident in a quarry setting, at least not in the Mauna Kea Adze Quarry Complex (e.g., grinding, polishing and cutting edge rejuvenation).

Cleghorn (1982) found that the degree of bidirectional flaking is a good stage indicator based on the number of surfaces that exhibit the negative flake scars of this technique (see also Weisler 1990:38). Figure 6.25 shows an example of a square preform that has extensive bidirectional flake scars. This attribute was not recorded in the field because of the amount of time and expertise it would have required. This illustrates once again the value of collections that can be studied over and over again.

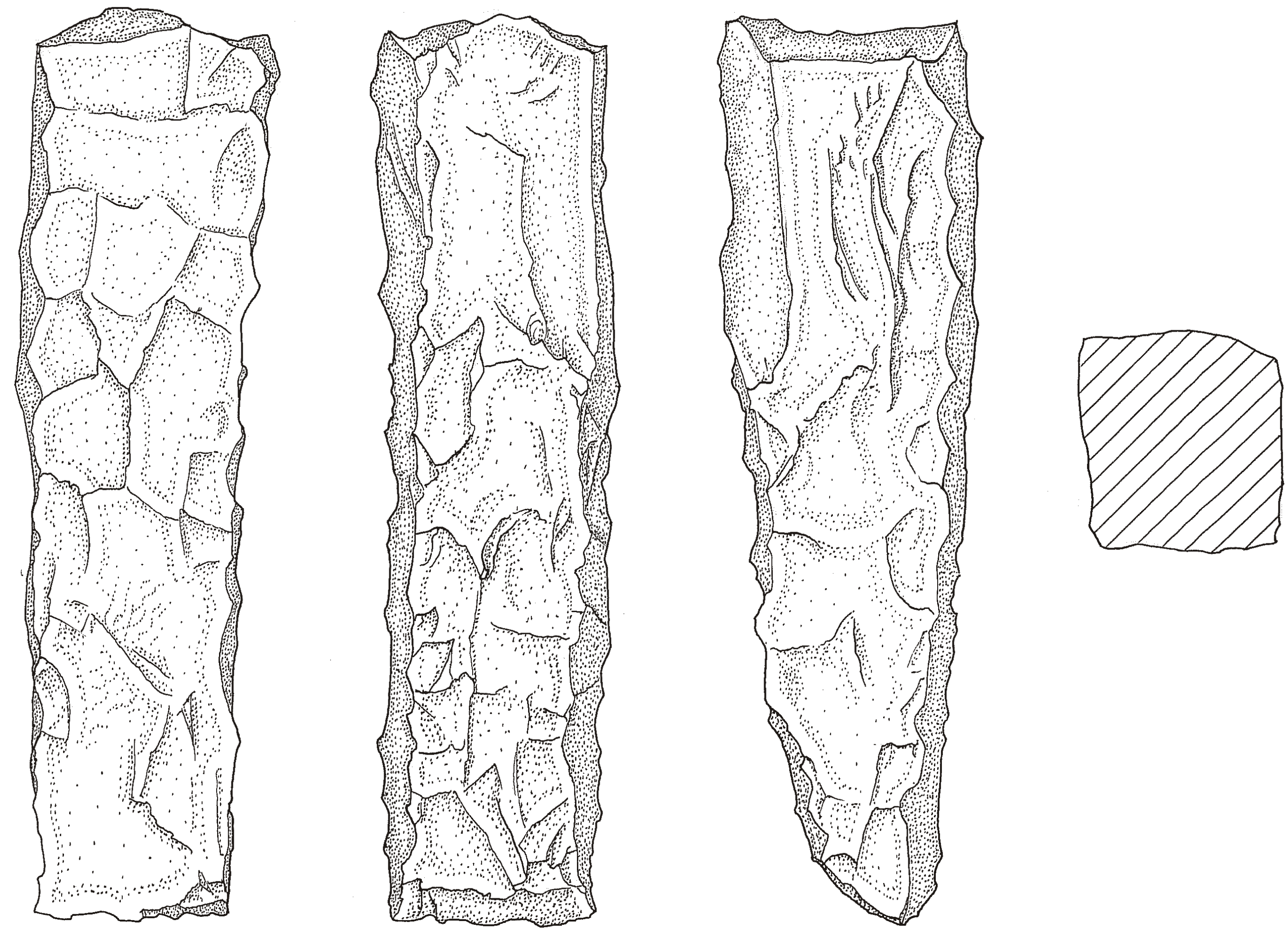


Figure 6.25. Adze Preform with a Square Cross-section Showing Extensive Bidirectional Flake Scars.

6.3.7 Analysis of Selected Adze Preform Attributes

The adze preform recording form used in the field had both metric and non-metric attributes. The attribute selection criteria and rationale are briefly described below for each attribute. The preform analysis presented in this report is based on selected non-metric attributes due to time constraints. Table 6.11 summarizes selected non-metric data for 536 preforms from 13 sites in the Pōhakuloa Gulch quarry complex. This sample and another sample, representing two rockshelters and 12 workshops at six sites (Table 6.12) are used in the following the intra-site and inter-site comparisons that follow in Section 6.5.

(1) **Condition:** Specimens from archaeological sites are obviously found in either a whole or broken condition. In quarry sites there is a predominance of either broken and/or rejected tools. One of the primary reasons that tools are rejected in the manufacturing process is breakage due to such factors as flaws in the material and human error in the calculation of the flaking angle and insufficient skill to solve technological problems.

Adze fragments include three diagnostic parts --butt end, mid-section, and bevel end (see Figure 6.23). The recording of section frequencies was done to facilitate the calculation of minimum numbers of incipient tools and to examine the relationship between part frequency and manufacturing stage as a means of testing the hypothesis that there is a higher incidence of breakage later in the manufacturing sequence.

The use of part frequencies is similar to the method used by Foss Leach to calculate minimum numbers based on avian limb bone fragments (Leach 1979: Fig. 8.1). There is, of course, nothing inherent in the relative numbers or frequencies of whole and broken specimens. Breakage, for example, occurs during manufacture, but except for very small thin adzes few whole adzes would be expected to have been broken after they were discarded.

(2) ***Blank Type*:** Data for this attribute, which to reiterate is a term applied to cores and flakes that exhibit more than a few flake scars, is limited to the sample of collected artifacts studied in the lab (Appendix J). The data are not discussed any further, however.

(3) **Cross-section:** Polynesian adze typologies are based almost exclusively on the cross-section at the shoulder of tanged adzes (see Figure 6.23) or the mid-section of untanged adzes (Buck et al. 1930). The importance given to this one attribute in Polynesian adze studies is highlighted by Emory:

> For Polynesian adzes as a whole, the shape of the cross-section at the middle, or where the division between butt and blade is discernible, has proven essential to type designation. It has been equally important to note the presence or absence of a grip or tang, that is, the modification of the butt by reduction of its face or sides or both.
>
> If we sort Polynesian adzes according to the shape of this cross-section and separate the tanged from the untanged, we have gone a long way toward their useful classification. The associated features can then be described and those adzes which have such features in common may be grouped according to our needs in comparative studies (Fig. 1) (Emory 1968:153).

Table 6.11. Summary of Selected Adze Preform Non-Metric Attributes from 13 Sites.

ATTRIBUTE	Site 26253 [n=32]		Site 26581 [n=3]		Site 27583 [n=2]		Site 27586 [n=11]		Site 27588 [n=10]		Site 27596 [n=1]		Site 27598 [=107]	
	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total
Condition														
Whole	20	62.50	1	33.33	2	100.00	6	54.54	7	70.00	1	100.00	65	60.74
Butt End	7	21.87	1	33.33	0	0.00	2	18.18	2	20.00	0	0.00	10	9.34
Mid-Section	0	0.00	1	33.33	0	0.00	1	9.00	0	0.00	0	0.00	8	7.47
Bevel End	5	15.62	0	0.00	0	0.00	0	0.00	1	10.00	0	0.00	24	22.42
Indeterminate	0	0.00	0	0.00	0	0.00	2	18.18	0	0.00	0	0.00	0	0.00
Cross-Section														
Rectangular	16	50.00	3	100.00	2	100.00	9	81.81	6	60.00	0	0.00	63	58.87
Reverse Triangular	1	3.12	0	0.00	0	0.00	1	9.09	0	0.00	0	0.00	9	8.40
Reverse Trapezoidal	3	9.37	0	0.00	0	0.00	0	0.00	2	20.00	0	0.00	18	16.82
Square	12	37.50	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00	13	12.14
Lenticular	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Reverse Plano-Convex	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.93
Unknown	0	0.00	0	0.00	0	0.00	1	9.09	2	20.00	0	0.00	3	2.80
Longitudinal Profile														
Tang	18	56.25	2	66.66	1	50.00	1	9.09	0	0.00	1	100.00	17	15.88
Untanged	9	28.12	0	0.00	1	50.00	8	72.72	5	50.00	0	0.00	49	45.79
Indeterminate	5	16.62	1	33.33	0	0.00	2	18.18	5	50.00	0	0.00	41	38.31

Table 6.11. Summary of Selected Adze Preform Non-Metric Attributes from 13 Sites.

ATTRIBUTE	Site 27601 [n=34]		Site 27604 [n=1]		Site 27605 [n=39]		Site 27606 [n=21]		Site 27616 [n=262]		Site 27618 [n=13]		ALL SITES [n=536]	
	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total
Condition														
Whole	24	70.58	1	100.00	25	64.10	14	66.66	195	74.42	10	76.92	371	69.21
Butt End	6	17.64	0	0.00	2	5.12	7	33.33	35	13.35	3	23.07	75	13.99
Mid-Section	3	8.82	0	0.00	12	30.76	0	0.00	12	4.58	0	0.00	37	6.90
Bevel End	1	2.94	0	0.00	0	0.00	0	0.00	18	6.87	0	0.00	49	9.14
Indeterminate	0	0.00	0	0.00	0	0.00	0	0.00	2	0.76	0	0.00	4	0.74
Cross-Section														
Rectangular	17	50.00	0	0.00	24	61.53	14	66.66	166	63.35	11	84.61	331	61.75
Reverse Triangular	3	8.80	0	0.00	3	7.69	2	9.52	28	10.68	0	0.00	47	8.76
Reverse Trapezoidal	6	17.64	0	0.00	7	17.94	0	0.00	30	11.45	1	7.60	67	12.50
Square	6	17.64	1	100.00	5	12.82	0	0.00	4	1.52	0	0.00	42	7.83
Lenticular	0	0.00	0	0.00	0	0.00	0	0.00	3	1.14	0	0.00	3	0.55
Reverse Plano-Convex	0	0.00	0	0.00	0	0.00	1	4.70	1	0.03	1	7.60	4	0.74
Unknown	2	5.88	0	0.00	0	0.00	4	19.04	30	11.45	0	0.00	42	7.83
Longitudinal Profile														
Tang	11	32.35	0	0.00	8	20.51	10	47.61	87	33.20	6	46.15	162	30.22
Untanged	11	32.35	1	100.00	18	46.15	8	38.09	158	60.30	7	53.84	275	51.30
Indeterminate	12	35.29	0	0.00	13	33.33	3	14.28	17	6.48	0	0.00	99	18.47

Table 6.12. Summary of Adze Preform Non-Metric Attributes from 12 Workshops at Six Sites

	Site 26253		Site 27588		Site 27598									
ATTRIBUTE	R1 [n= 36]		WS1 [n= 10]		WS1 [n= 20]		WS2 [n= 14]		WS7 [n= 15]		WS23 [n= 14]		WS24 [n= 12]	
	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total
Condition														
Whole	25	69.44	7	70.00	15	75.00	6	42.85	9	60.00	9	64.28	9	75.00
Butt End	6	16.66	2	20.00	0	0.00	2	14.28	1	6.66	3	21.42	1	8.33
Mid-Section	1	2.77	0	0.00	3	15.00	6	42.85	0	0.00	1	7.14	1	8.33
Bevel End	4	11.11	1	10.00	2	10.00	0	0.00	5	33.33	1	7.14	1	8.33
Indeterminate	0	0.00	0	0.00	0	0.00	0	0	0	0.00	0	0.00	0	0.00
Cross-Section														
Rectangular	20	55.55	7	70.00	6	30.00	1	7.14	3	20.00	4	28.57	6	50.00
Reverse Triangular	0	0.00	0	0.00	5	25.00	1	7.14	2	13.33	0	0.00	1	8.33
Reverse Trapezoidal	3	8.33	2	20.00	3	15.00	6	42.85	4	26.66	6	42.85	4	33.33
Square	11	30.55	0	0.00	6	30.00	6	42.85	5	33.33	2	14.28	1	8.33
Lenticular	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Reverse Plano-Convex	1	2.77	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Unknown	1	2.77	1	10.00	0	0.00	0	0.00	1	6.66	2	14.28	0	0.00
Longitudinal Profile														
Tang	20	55.55	0	0.00	1	5.00	3	21.42	2	13.33	3	21.42	3	25.00
Untanged	14	38.88	9	90.00	9	45.00	4	28.57	8	53.33	9	64.28	5	41.66
Indeterminate	2	5.55	1	10.00	10	50.00	7	50.00	5	33.33	2	14.28	4	33.33

SUMMARY OF ADZE PREFORM REJECT NON-METRIC ATTRIBUTES FROM SITES WITH MORE THAN 10 ADZE PREFORMS SAMPLED

	Site 27598		Site 27605		Site 27606		Site 27616									
ATTRIBUTE	WS41 [n= 11]		WS4 [n= 14]		R1 [n= 21]		WS2_4 [n= 25]		WS5 [n= 25]		WS6 [n= 16]		WS10 [n= 22]		**TOTAL n=255**	
	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total
Condition																
Whole	8	72.72	6	42.85	13	61.90	13	52.00	19	76.00	13	81.25	14	63.63	166	65.09
Butt End	0	0.00	1	7.14	7	33.33	1	4.00	5	20.00	2	12.50	3	13.63	34	13.33
Mid-Section	0	0.00	7	50.00	0	0	5	20.00	1	4.00	1	6.25	3	13.63	29	11.37
Bevel End	3	27.27	0	0.00	0	0.00	5	20.00	0	0.00	0	0.00	1	4.54	23	9.01
Indeterminate	0	0.00	0	0.00	1	4.76	1	4.00	0	0.00	0	0.00	1	4.54	3	1.17
Cross-Section																
Rectangular	5	45.45	5	35.71	14	66.66	20	80.00	16	64.00	1	6.25	15	68.18	123	48.23
Reverse Triangular	1	9.09	1	7.14	2	9.52	2	8.00	4	16.00	5	31.25	0	0.00	24	9.41
Reverse Trapezoidal	3	27.27	4	28.57	0	0.00	2	8.00	1	4.00	5	31.25	3	13.63	46	18.03
Square	2	18.18	4	28.57	0	0.00	0	0.00	0	0.00	1	6.25	2	9.09	40	15.68
Lenticular	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	6.25	0	0.00	1	0.30
Reverse Plano-Convex	0	0.00	0	0.00	1	4.76	0	0.00	0	0.00	0	0.00	0	0.00	2	0.70
Unknown	0	0.00	0	0.00	4	19.04	1	4.00	4	16.00	3	18.75	2	9.09	19	7.45
Longitudinal Profile																
Tang	0	0.00	2	14.28	11	52.38	2	8.00	5	20.00	0	0.00	6	27.27	58	22.74
Untanged	7	63.63	5	35.71	8	38.09	18	72.00	19	76.00	15	93.75	11	50.00	141	55.29
Indeterminate	4	36.36	7	50.00	2	9.52	5	20.00	1	4.00	1	6.25	5	22.72	56	21.96

The established convention for describing the cross-section rests on what is known regarding the orientation of the few hafted adzes that were collected prior to the replacement of stone adzes with metal counterparts. The established procedure is to orient the adze with the front or face always up and the back down (see Figure 6.23); this explains the difference between a triangular and a reverse-triangular adze (see Figure 6.23). Strict adherence to this convention imposes obvious constraints on classifying unfinished adzes and especially fragments of broken adze rejects. Other difficulties are encountered in adhering to the established procedure for determining cross-section. For example, the cross-sections of early stage adzes are more irregular for the most part except in the case of some tabular cores where the cross-section is inherently rectangular, so that even though the front and back may not be distinguishable the cross-section is nevertheless very regular.

The classification employed here follows Emory (1968: Figure 1) but because we took only one width measurement--the maximum width at the middle of both whole adzes and fragments--rather than the width of both the front and back, there are some specimens that should be properly classified as reversed subtriangular. In the case of reversed trapezoidal and reversed triangular adzes, the maximum width is the front width. Back width measurements would be necessary to make the quarry types conform to Emory's criteria, which were of course developed for finished adzes and are in any case arbitrarily imposed distinctions. Emory's classification is in some ways too rigid for use in the analysis of quarry assemblages, yet we agree that we should continue to classify adzes in terms of the cross-sections and to distinguish, for example, thick and thin, square, rectangular and trapezoidal.

(4) **Longitudinal Profile:** This attribute (see Cleghorn 1982:171 for a fuller discussion) was recorded as (1) tanged (see Figure 6.23), (2) untanged, or (3) indeterminant in the case of some of the fragments.

(5) **Cortex:** Cortex, a term employed by mainly archaeologists to refer to the exterior weathered surface of rocks, is the result of natural processes that produces what geologists call a rind (Crabtree 1972:56). Cortex is an important attribute for determining blank type. Cores collected from the surface of the landscape or removed from the upper surface of lava flows are completely covered with cortex in contrast to flakes which by definition [a piece of a core] have cortex only on the outer or dorsal surface. In the present study the recording of this attribute was limited to recording presence/absence rather than the more involved and time consuming quantification of the actual amount of cortex in terms of, for example, the percentage of the surface with cortex. In the lab analysis of the collected preforms the location was recorded as follows: front, back, 1 side, 2 sides.

(6-8) **Length, Width and Thickness:** Size measurements recorded in the field include length, width, and thickness. Measurements were taken on all specimens, whole and broken as follows:

Length: maximal distance between the cutting edge and the butt end.

Width: maximal dimension taken at the mid-section of untanged adzes and at the shoulder of tanged adzes.

Thickness: maximal dimension between the front and back.

(9) **Cutting Edge Width:** the width or breadth of the cutting edge measured from side to side.

(10) **Weight:** weight, which is a size variable, is limited to the sample that was collected and brought back to the lab (Appendix J).

6.3.8 The Need for a New Adze Preform Typology

Previous analyses of the preforms from the Mauna Kea Adze Quarry Complex have followed the established practice in Hawaiian archaeology of talking about types in terms of cross-section (at the tang or mid-section of untanged adzes). Thus, there are descriptions of quadrangular, trapezoidal, reverse trapezoidal, triangular, reverse-triangular, and other less common types.

Cross-section is clearly an important attribute, but it is both limited and limiting in terms of addressing the significance of morphological variability in Hawaiian adzes. Earlier studies by Bennett (1931) and others demonstrated on the basis of small samples of adzes from various islands that there are differences in the form of the butt end and the blade. Some are parallel-sided from the butt end to the cutting edge. Others have a parallel-sided tang, but a blade that "flares" outward at the cutting edge. Yet others, but probably a small number compared to the former, have a "tapered blade" that is narrower at the cutting edge than at the butt end (see Figueroa and Sanchez 1965 for discussion of tapered and flared blade forms). In the case of the Mauna Kea Adze Quarry Complex, there is also a wide range of variability in preform thickness (at the mid-section of untanged adzes and shoulder of tanged adzes).

Weisler's study of the Kapohaku Adze Quarry on Lana`i is one of few studies that have attempted to go beyond Emory's long-used typology based on cross-section in recognizing a distinction between broad thin forms and forms that are more square in cross-section (Weisler 1990:41-42). His work points to the need for a new adze preform typology. We believe that what is needed is a typology based on a consideration of blank type (core or flake), cross-section, longitudinal profile (tanged vs untanged), the shape of the sides and the blade, and relative thickness. Thickness and overall mass (weight) is probably one of the best potential indicators of gross function and use. Three thickness intervals were used in a trial and regrettably unfinished analysis of the preforms collected in the survey: (1) thin [<4 cm], (2) medium [4.1-5.0 cm], and (3) thick [>5.1 cm]. These intervals may change when examining a larger number of specimens.

The core reduction and flake blank reduction sequences are in our view key to the development of a more complete and satisfactory typology. The provisional types we have established so far correspond fairly closely to the difference between adzes made on tabular slabs and large boulders (cores) and those made on flake blanks. As with any analysis there is a degree of subjectivity involved in determining whether a preform was made on a core or a flake, particularly when there are no landmark features, such as a bulb of percussion and striking platform in the case of flake blanks. While it is not uncommon to observe flakes in the quarry that are 15-20 cm or greater in length, the thickness is usually less than 5-8 cm. The trimming of a flake this large would result in a preform that would not only be shorter, but also thinner.

6.3.9 Analysis of Selected Hammerstone Attributes

A form was used in the field in recording selected hammerstone attributes based on samples, which were often 100% because hammerstones generally occur in small numbers at most workshops. The selected attributes are described below. The complete data set for hammerstones is presented in Appendix K. The data are summarized in Table 6.13.

(1) **Condition.** This attribute was recorded as either whole or broken. Many of the fragments are sheared or split, often into half sections that exhibit an extremely flat ventral surface. Most of these fragments are undoubtedly the unintended consequence of use, rather than post-depositional breakage. The frequency of sheared fragments is of great interest in terms of providing possible clues to raw material constraints and/or use. Some appear to have been used as anvils. The frequency distribution of whole and broken hammerstones by shape is presented in Figure 6.26.

(2) **Shape.** Hammerstone shapes in the sample analyzed in this report include: (1) discoidal; (2) spherical, and (3) irregular.

(3) **Raw Material Form.** The materials utilized for hammerstones include (1) vesicular pieces of basalt; (2) dense and fine-grained pieces of basalt, usually cobbles and (3) recycled adze rejects

(4) **Raw Material Source.** Unlike the other attributes or tool properties, raw material source must always be inferred and the inference is based primarily on raw material form and, more specifically, the rounding and texture, especially the surface finish. On current evidence, which consists of field observations made over a number of years and EDXRF analyses of a small sample, all of the hammerstones in the quarry, indeed everywhere in the summit region, are local volcanics. In contrast to other stone tool quarries, where hammerstones had to be imported, the lavas flows on Mauna Kea provided a readily available source of hammerstone material. The most commonly used material is a vesicular basalt, although some hammerstones are non-porous and dense.

Howard Powers brief description of the hammerstones found in the adze manufacturing sites on Haleakala is of considerable interest with regard to their origins and the selection for specific properties, such as porosity and shape. He noted that:

> ...the stones used for hammers in shaping the adzes are always of tough, porous rock which shatters less readily. Most of the hammerstones were carried in by the workmen; some from deposits of stream gravel lower on the mountain; and some even from the sea beaches, as many of the hammers show remnants of the smooth rounded surface typical only of wave-rounded cobble stones (Powers 1939:24).

(5) **Maximal Dimensions.** Because measurements are shape dependent and the shapes of the hammerstones so variable, we have resorted to maximal measurements (Table 6.13). The maximal dimensions give a good and indeed better indication of the general shape of the tool.

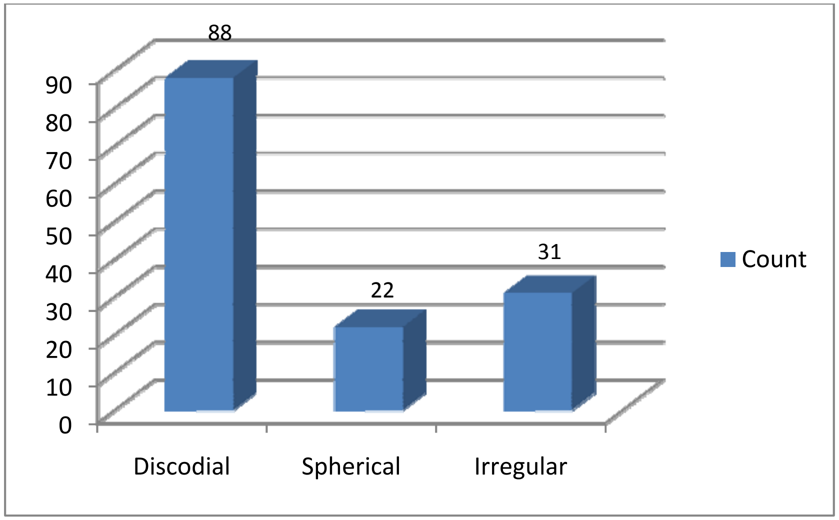
In the lab the samples that had been collected were measured to the nearest tenth of a centimeter. Diameter was recorded for all hammerstones and thickness was recorded for discoidal hammerstones.

6.3.10 Modified/Utilized Flakes

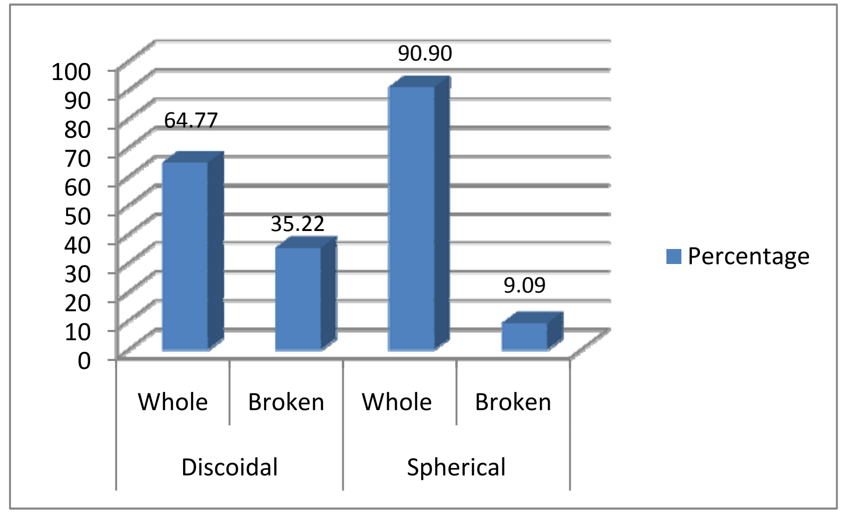
This class is a catchall for a variety of artifacts which based on the current study and previous studies in the Mauna Kea Adze Quarry Complex are not common. One possible broken flake tool was recovered in the excavations of Site 26253, Rockshelter 1. It is impossible to say what it might have been used for and whether it was made in the quarry.

Table 6.13. Summary of Hammerstone Type Frequencies by Site and Workshop.

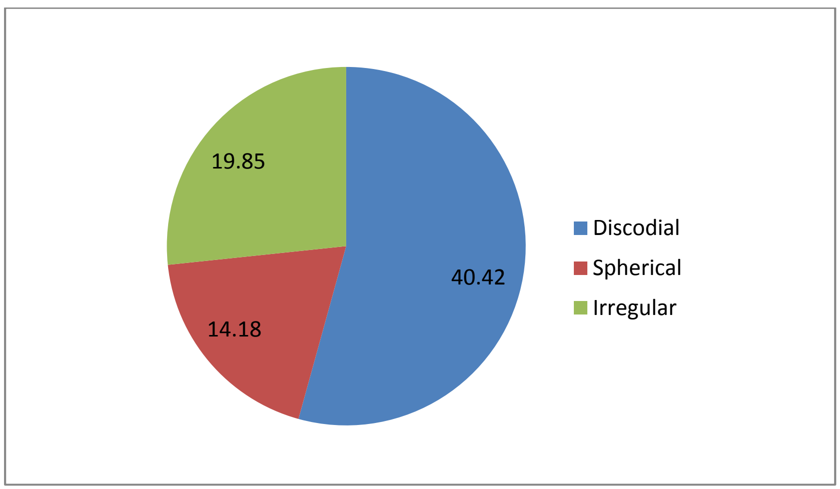
ATTRIBUTE	Site 26253				Site 27581		Site 27588		Site 27598		Site 27601		Site 27604		Site 27605		Site 27616		TOTAL [n=141]	
	R1 [n= 3]		WS [n= 5]		WS [n= 4]		WS [n= 2]		WS [n= 18]		WS [n= 12]		WS [n= 1]		WS [n= 15]		WS [n= 81]			
	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total	Number	% Total
Condition																				
Whole	3	100.00	4	80.00	4	100.00	0	0.00	7	38.88	8	66.66	1	100.00	8	53.33	70	86.41	105	74.46
Broken	0	0.00	1	20.00	0	0.00	2	100.00	11	61.11	4	33.33	0	0.00	7	46.66	11	13.58	36	25.53
Cross-Section																				
Discoidal	2	66.66	3	60.00	3	75.00	1	50.00	14	77.77	7	58.33	0	0.00	12	80.00	47	58.02	89	63.12
Spherical	1	33.33	1	20.00	1	25.00	0	0.00	2	11.11	5	41.66	1	100.00	3	20.00	7	8.64	21	14.89
Irregular	0	0.00	1	20.00	0	0.00	1	50.00	2	11.11	0	0.00	0	0.00	0	0.00	27	33.33	31	21.98



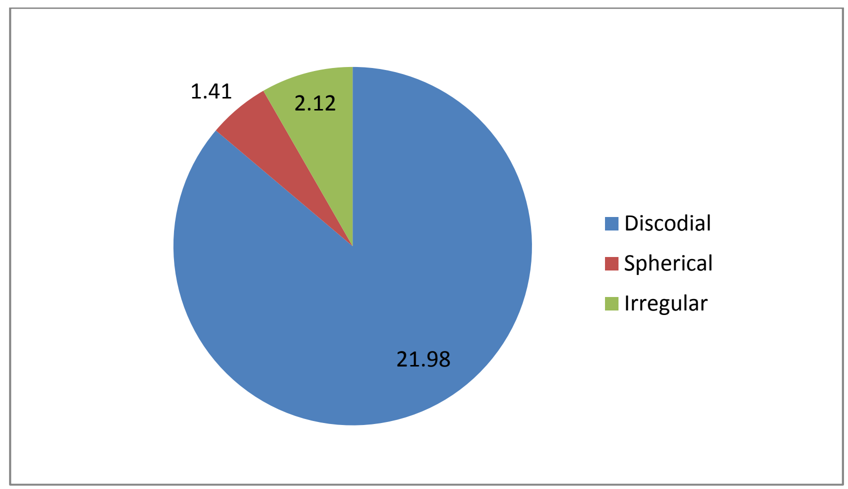
Count



Percentage



Whole Hammerstones



Broken Hammerstones

Figure 6.26. Frequency Distribution of Whole and Broken Hammerstones and Hammerstone Shapes [n=141].

6.4 Laboratory Analyses

Laboratory analyses were undertaken of the artifacts collected in the field for sourcing and the processing of unsorted bags of sediment, artifacts and faunal/floral remains recovered in the excavation of Site 26253, Rockshelter 1. Cultural materials recovered in the test excavation include over 10,000 basalt flakes and shatter, one piece of fragmented marine shell, one possible broken basalt tool, and one piece of volcanic glass. The debitage includes adze flakes and shatter and hammerstone flakes and shatter (Table 6.14). The 76 artifacts from the Mauna Kea Science Reserve were analyzed in the PCSI archaeology Lab. The list of artifacts is presented in Appendix H.

6.4.1 General Methods and Procedures

Collected material from was processed as follows. Dried charcoal and organic material was placed in foil pouches. Weight in grams was recorded on the pouch and returned to original field collection bags. One wood charcoal sample was delivered to Gail Murakami at IARII for radiocarbon screening. A sample identified by Gail was then mailed to BETA Analytic for radiocarbon dating. Dried collections of flakes to sort, flakes of hammerstone material, and collections to screen were placed in re-sealable plastic bags and returned to original field bags. All "to screen" collections were screened through a 1/4" screen and separated in bags labeled "to sort from 1/4" screen and "remaining after 1/4" screen.

The materials recovered in the test excavation of Site 26253, Rockshelter 1 were washed prior to screening and sorting. A flotation bucket was used for the purpose of removing charcoal and cleaning lithic material to facilitate sorting and identification of cortex. The entire contents of a bag were placed in a 5 gallon bucket of water. The bucket is outfitted with a 1" diameter PVC pipe attached to the side and used as a drain. As more water was added charcoal and organic material floating to the surface, was collected with a window screen attached to the drain and air dried on white paper. Additional water was added to the bucket and remaining material gently agitated by hand until all charcoal and organic material surfaced and was collected. Water was emptied from the bucket through a window screen and the remaining contents of the bucket removed by hand onto multiple layers of white paper to air dry.

Dried charcoal and organic material was placed in foil pouches and weighed in grams. *Kukui* (*Aleurites moluccaca*) nutshell fragments were placed in separate foil pouches. All charcoal and *kukui* pouches were placed in new Ziploc bags with the original field bag added. With the exception of Layer I/surface, and Layer II/1, remaining dried collections were gently (not much shaking) screened through a 1/4" screen. The purpose of screening was to remove remaining non-cultural ash and facilitate sorting by size. Material falling through the screen was placed in re-sealable plastic bags and labeled "remaining after 1/4" screen". Layer I/surface collections were not screened because they contained mostly large artifacts.

Dried collections from the 1/4" screen size fraction were then placed in gallon Ziplocs by provenience, combining multiple bags collected from the same Layer and level while keeping the two collection areas, western 1/2 and eastern 1/2 of Layer I, separate [combined field bags include Bags 1 & 2 from Layer I/surface and Bags 3, 4, & 5 from Layer I/1 western 1/2].

Unscreened and 1/4" screened collections were sorted into the following: complete flakes, complete flakes with cortex, fragments and shatter, hammerstone

Table 6-14. Summary of Basalt Flake Size from Site 26253 Rockshelter 1 Excavation

Provenience: Site 26253 Rockshelter 1					Flake Attributes											Other	
Bag No(s)	Test Unit	Layer/ level	Depth cmbd	Location	Total Flakes < 2 cm	Cortex present	Total Flakes 2 - 4 cm	Cortex present	Total Flakes 4 - 6 cm	Cortex present	Total Flakes 6 - 8 cm	Cortex present	Total Flakes > 8 cm	Cortex present	Broken Flakes & shatter	Hammerstone material	Volcanic glass
1, 2	1	I/ surface	20 - 24		61	8	183	28	68	15	20	5	3	1	134	5	0
3, 4, 5	1	I / 1	21 - 30	west half	2,681	321	478	86	31	9	1	1	0	0	2,015	355	0
12	1	I / 1	21 - 30	east half	1,076	94	168	21	8	4	0	0	1	0	1,485	111	0
13	1	Ash lens	24 - 30		192	36	49	17	3	1	3	1	1	0	605	118	0
10	1	II / 1	28 - 34		74	10	6	2	1	0	0	0	0	0	156	22	1
			Total count:		4084	469	884	154	111	29	24	6	5	1	4395	611	1
			Total flakes:		5,108												

material, natural material (non-cultural), and other. The category ‘other” included rare pieces of volcanic glass and a basalt tool fragment. The sort was aided by use of a 10x magnifying lens lit with a florescent tube. Count was recorded on each bag by provenience for fragments and shatter, hammerstone material, and other artifacts. Remaining natural material was bagged by provenience. See the flake analysis section below for processing of flakes.

Photographs were taken of the collected adze preforms and hammerstones using a Canon PowerShoot A590 digital camera. The camera was attached to a tripod and the following settings were used: indoors, close-up, no flash, and manual set light exposure of 0.1 to 2+ depending on the darkness of the basalt raw material. Light sources included fluorescent room light, outdoor sidelight semi-permanently masked with thick plastic sheeting behind open blinds, and a three inch theatre fresnel mounted above the tripod. Background material was white felt. A 5.0 cm scale was used in all photographs, accompanied by a 30.0 cm ruler for larger artifacts.

Photographs were recorded on a photo record form with the provenience of each artifact noted. The orientation for photographs of adzes included: front, two sides, and occasionally back. Each adze was numbered in sequence beginning with #1 (one): #.Front, #.Side.1, #.Side.2., #.Back. Hammerstone photographs were based on shape with one or two photos for face and side views. Each hammerstone was numbered in sequence beginning with H#1 (one): H#.Face or H#.Face.1, H#.Face.2 and H#.Side or H#.Side.1 and H#.Side.2. Additional codes used for photographs of artifacts being sourced include: “LW” Lake Waiau, and “K” Kau.

6.4.2 Debitage Analysis

Over 10,000 flakes and pieces of shatter were recovered in the excavation of Site 26253, Rockshelter 1. The debitage from the excavation includes both adze manufacturing waste flakes and shatter, and fragments of hammerstones, which are vesicular and easily distinguished from adze flakes, except for very small pieces.

The large volume of material has precluded a technological analysis of attributes that would contribute to an understanding of reduction strategies and sequences. The current analysis was limited to just two attributes—size and cortex. The analysis represents a compromise between a detailed attribute study of every specimen and what some lithic analysts refer to as a "mass analysis" (Ahler 1986, 1989).

Complete flakes from TU-1 were first sorted within each provenience by presence/absence of cortex. Lengths of complete flakes were measured using a size chart to facilitate the division into size classes. Complete flakes were then bagged by size and the presence/absence of cortex with length determined as the distance between the proximal and distal ends as shown in Figure 6.27. The results of the flake analysis are presented in Table 6.14.

6.4.2.1 Flake Attributes

(1) Condition. Whole and broken flakes are distinguishable by the presence/ absence of a proximal and/or distal end. Breakage occurs during and after manufacture and as a consequence there is no inherent meaning in this variable. The relative frequencies of whole and broken flakes is contingent on a number of factors, such as

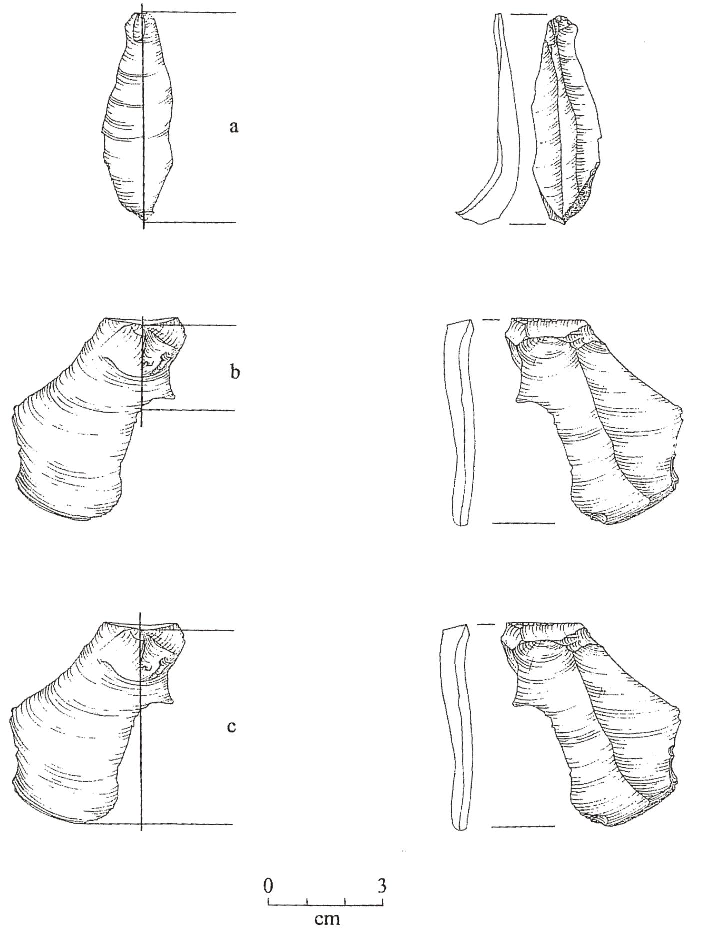


Figure 5.8 Flake length measurements: (a) length corresponding to a line perpendicular to striking platform width; (b) length taken on an irregular shaped flake where the line perpendicular to striking platform width is less than 3 cm; (c) length measured as the maximum distance from the proximal to distal end along a line perpendicular to striking platform width.

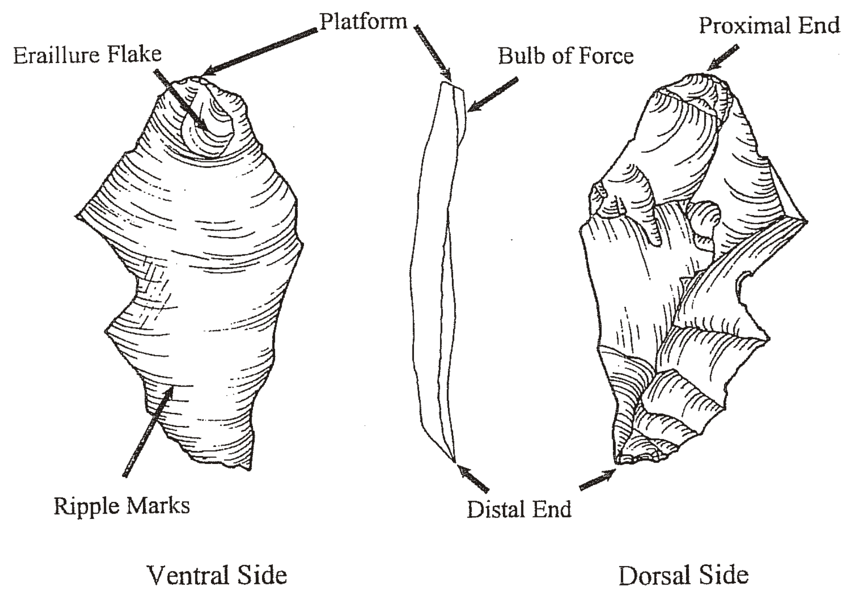


Figure 2.7 Conchoidal flake showing common elements and terminology.

Figure 6.27. Flake Terminology and Flake Length Measurement Methods (after Andrefsky, Jr. 1998).

raw material properties, skill, and the potential for post-manufacture breakage due to such processes as trampling and erosion (Sullivan and Rozen 1985).

The senior author finds it useful to partition assemblages into two populations--whole and broken flakes--and though I think that most archaeologists would agree that the focus should be on the whole flake population, I think it is important nevertheless to at least include counts and weights for the broken material. One reason is that such data are necessary to production output estimates based on the total volume of waste.

(2) Size. Size measurements, as already mentioned, were limited to length (defined as the straight line distance between the striking platform and the distal end of the flake; see Figure 6.27). Length was recorded in terms of five class intervals: 0-20 mm, 21-40 mm, 41-60 mm, 61-80 mm, >81mm. The choice of regular intervals was done to facilitate comparison within and between assemblages. The results are presented in Table 6.14 and Figure 6.28.

(3) Cortex. The weathering rind or cortex is commonly recorded attribute. In the present study analysis was limited to sorting out and then counting the number of flakes with cortex by the five size class intervals. The results are presented in Table 6.14.

The number of pieces of debitage recovered in the test excavation is rather astonishing, particularly the amount of material that represents fragments of hammerstones. The attrition rate in the progressive reduction in the size of hammerstones is undoubtedly highly variable, but the recovery of 611 fragments in the small excavation unit is surprising, especially since the primary activity at this location appears to have been shaping of semi-finished adze preforms based on the flake size data (see Table 6.14).

6.4.3 Wood Charcoal Identification

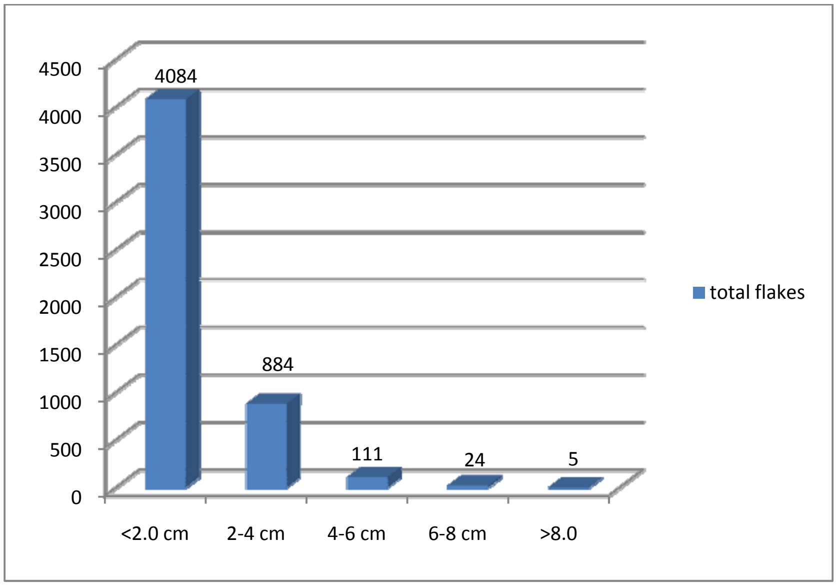
Though not yet a standard practice, many archaeologists in Hawaii submit samples of wood charcoal for identification prior to selecting species suitable for radiocarbon dating. There are two benefits to identifying wood charcoal. It is one way of eliminating long-lived species from being submitted for dating and it also provides useful information on vegetation patterns.

6.4.3.1 Sample Selection and Preparation

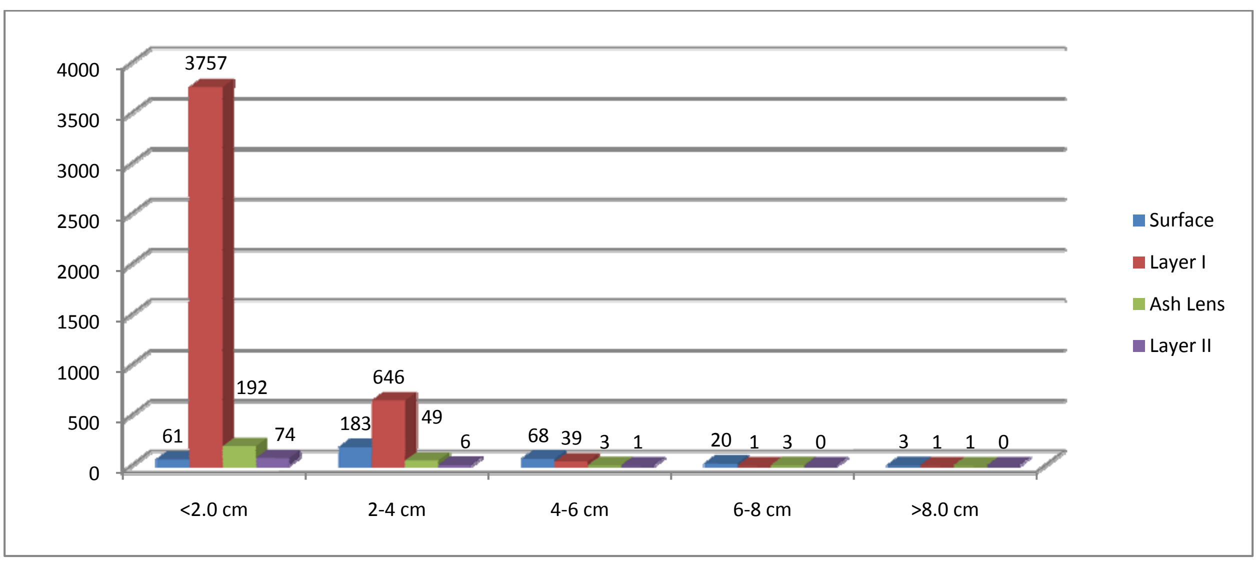
Dried charcoal and organic material was placed in foil pouches. Weight in grams was recorded on the pouch and returned to original field collection bags. Two charcoal samples from the TU1 excavation at Site 26253, Rockshelter 1 (OMKM-1 and OMKM-2) were submitted for wood charcoal identification. Sample OMKM-1 was submitted to Beta Analytic for dating.

6.4.3.2 Results

The samples that could be identified included *Sophora chrysophylla* (*mamane*); *Dubautia* sp. (*na`ena`e, kupaoa*), *Coprosma* sp. (*pilo*) and *Perrottetia sandwicensis* (*olomea*). Murakami noted that most Dubautia in this area of the island are shrubs, but one species is a tree, *Dubautia arborea*, found at about the 9,000 ft elevation. The results are similar to those obtained in an earlier study (Murakami 1986) of eight charcoal samples from Site 16238 (BPBM Site 50-Ha-G29-34) that was given the name



Basalt Flake Count Based on Size [n=5,108]



Basalt Flake Count Based on Stratigraphic Location.

Figure 6.28. Frequency Distribution of Flake Sizes by Stratigraphic Layer From Site 27253, Rockshelter 1, TU-1.

Hopukani Rockshelter and two samples from Site 16239 (BPBM Site 50-Ha-G28-63), originally called Hopukani Springs Overhang Shelter (McCoy 1986, 1990). In that study Murakami identified *Sophora chrysophylla, Coprosma* sp, and Railliardia sp. Two thin-sections could not be identified and were listed as Unknown A and Unknown B (Murakami 1986).

Sophora chrysophylla (Hawaiian *mamane*) and *Myoporum sandwicense* (Hawaiian *naio*) are the dominant species of the treeline vegetation on the southwest flank of the mountain. Herbaceous fog-drip communities comprised of mostlyintroduced species occur beneath the larger, scattered *mamane* trees which form a distinctive mountain parkland (Mueller-Dombois and Krajina 1968). There are clear indications that this dryland forest at one time contained many more species, such as *Santalum ellipticum*, *Euphorbia olowaluana* and *Dubautia arborea*, which are presently confined to small pockets or refugia away from the reach of feral goats and sheep (Allen 1981:46; Van Riper 1980:288-290). *Perrottetia sandwicensis* ranges in size from a shrub to small tree. The wood was used in conjunction with *hau* (*Hibiscus tiliaceous*) to start fires. It was the `*aulima*, held in hands & rubbed against the `*aunaki* (Abbott 1992:93; Krauss 1993:17; Malo 1951:21).

Table 6.15, prepared by Gail Murakami of IARII, presents the results of wood charcoal identifications made during sorting of wood charcoal samples for radiocarbon dating. The samples were obtained from TU1 excavations at Site 26253, Rockshelter 1.

Table 6.15. Site 26253, Rockshelter 1 Wood Charcoal Identifications.

PCSI Sample No.	WIDL No.	Taxon	Common/Hawaiian Name	Origin/Habit	Part	Count	Weight, in grams
OMKM-1	0907-1	*Sophora chrysophylla*	*Māmane*	Native/Tree	Wood	11	0.63
	0907-2	cf. *Dubautia* sp.*	*Na'ena'e, kūpaoa*	Native/Shrub or Tree	Wood	31	0.96
	0907-3	Unknown**			Stem?	3	0.05
OMKM-2	0907-4	cf. *Perrottetia sandwicensis*	*Olomea*	Native/Tree	Wood	1	0.02
	0907-5	cf. *Dubautia* sp.	*Na'ena'e, kūpaoa*	Native/Shrub or Tree	Wood	44	2.65
	0907-6	*Sophora chrysophylla*	*Māmane*	Native/Tree	Wood	8	0.51
	0907-7	cf. *Coprosma* sp.	*Pilo*	Native/Shrub	Wood	5	0.25
	0907-8	Not identified			cf. tuber	5	0.15

*Although most *Dubautia* in the area are shrubs, there is one that is a tree, *Dubautia arborea*, at about 9,000 ft elevation.
**This possible stem is not from a shrub or tree.

6.4.4 Radiocarbon Dating

PCSI Sample No. OMKM-1, WIDL No. 0907-5, was sent to Beta Analytic for radiocarbon dating (^{14}C) using the AMS dating technique (Accelerator Mass Spectrometer). The sample (Beta-256935) yielded a conventional radiocarbon age of 450 +/- 40 B.P. (Before Present) with a 13C/12C ratio of -22.9. At two sigma (95% probability) the sample yielded a calibration age of CAL AD 1420-1480 (cal BP 540-470). Table 6.16 summarizes the data for this dated sample. The report prepared by Beta Analytic is contained in Appendix L.

Table 6.16. Results of a Radiocarbon Age Determination for Site 26253, Rockshelter 1.

PCSI Sample No.	Beta Lab No.	Provenience	Sample Wt (g)	14 C Age (B.P.)	13C/12C Correction (o/oo)	Conventional 14C Age (B.P.)	Calibrated Date Ranges 1 Sigma Relative Probability (.68)*	Calibrated Date Ranges 2 Sigma Relative Probability (.95)
OMKM-1	256935	TU1; L.I/1; 23-26 cmbs	1.8	420 ± 40	-22.9	450 ± 40	A.D.1430 - 1450	A.D.1420-1480

* 1 and 2-sigma calibrated age ranges from Pretoria Software (Stuiver and van der Plicht 1998; Stuiver et al. 1998; Talma and Vogel 1993)

6.4.5 Artifact Sourcing Analysis

A number of artifacts were collected during the survey for sourcing analysis and comparison with the data obtained in previous studies. Figure 6.29 shows the locations where the collections were made. Analyses of Mauna Kea basalts and hawaiite have been undertaken by a number of researchers, both geologists and archaeologists (e.g., Cleghorn et al. 1985). The latest and most ambitious study was undertaken by Peter Mills and Steve Lundblad at the University of Hawaii at Hilo (Mills and Lundblad 2006; Mills et al. 2008; Lundblad et al. 2008). In contrast to most other studies, they obtained samples from bedrock exposures at multiple locations within the Mauna Kea Adze Quarry complex (Figure 6.30) which were subsequently compared to flakes from four excavated rockshelters (Mills et al. 2008).

6.4.5.1 Sample Size and Proveniences

A total of 64 basalt and volcanic glass artifacts (e.g., adze preforms, hammerstones, tools, bird cooking stones, and volcanic glass flakes) collected from various sites in the Science Reserve and from Lake Waiau in the NAR, the Pu`u Kalepeamoa Site at Hale Pōhaku, and a site in North Kona were sent to the University of Hawaii, Hilo for geochemical analysis using a non-destructive method that is briefly described below. The list of samples and results are presented in full in Appendix M.

6.4.5.2 Methods

An Energy-dispersive X-ray Fluorescence (EDXRF) spectrometer was used which can rapidly generate broad-spectrum geochemical analyses with levels of precision in the parts per million range. The analyses were completed on a ThermoNoran QuanX EDXRF spectrometer with an extended sample chamber, using a rhodium (stable-isotope) X-ray tube, thermoelectrically cooled detector, and supporting Edmunds vacuum pump, with data processed on Wintrace™ software, version 4.1, build 16.

The specimens were analyzed by placing the flattest interior surface on the specimen over the X-Ray beam. Each sample run also included the analysis of a known geological standard prepared by the USGS from a basalt source in Kilauea Caldera (BHVO-2; Wilson 1997).

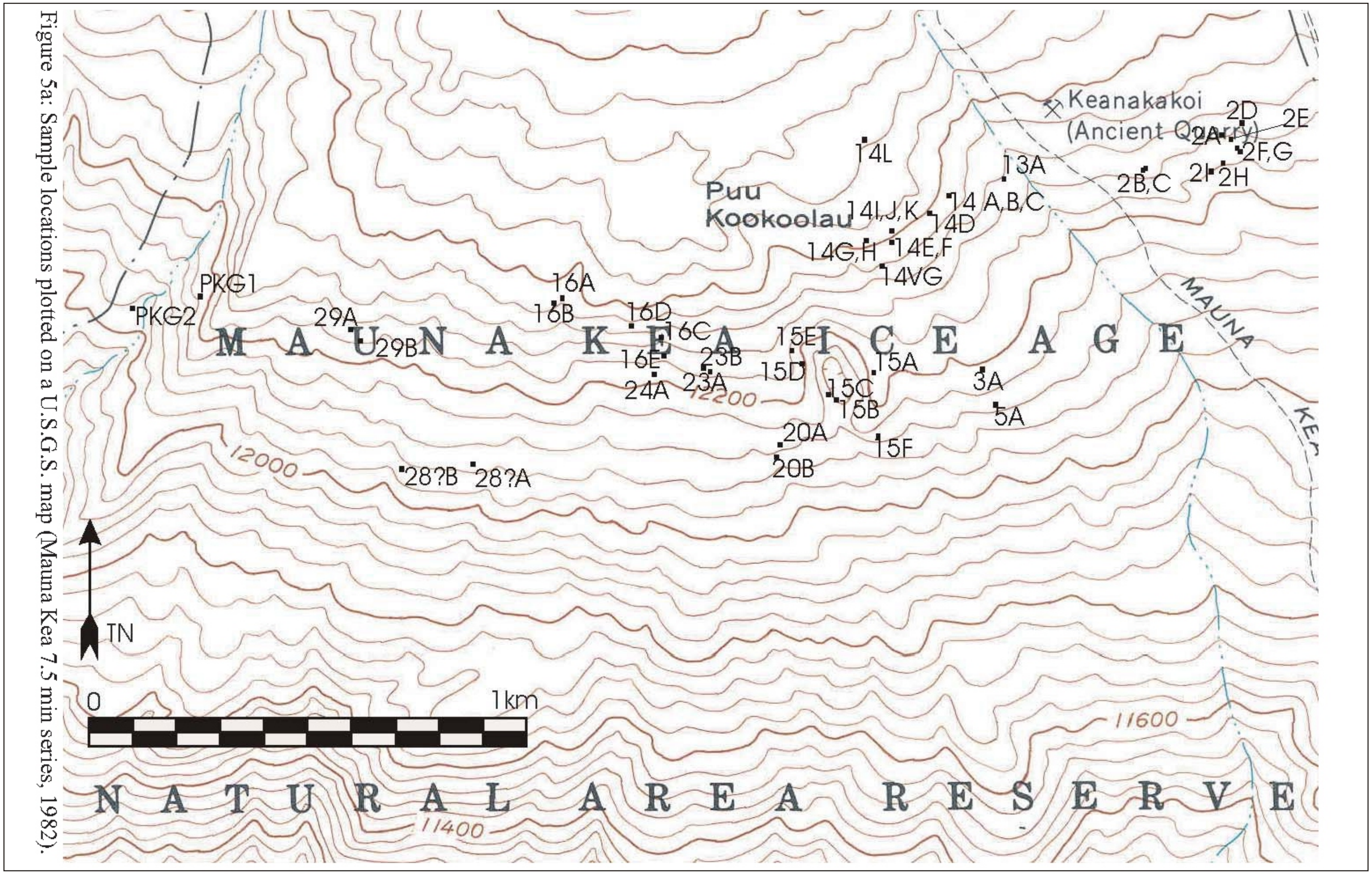


Figure 5a: Sample locations plotted on a U.S.G.S. map (Mauna Kea 7.5 min series, 1982).

Figure 6.29. Geological Sampling Locations for EDXRF Analysis (Figure from Mills and Lundblad 2006).

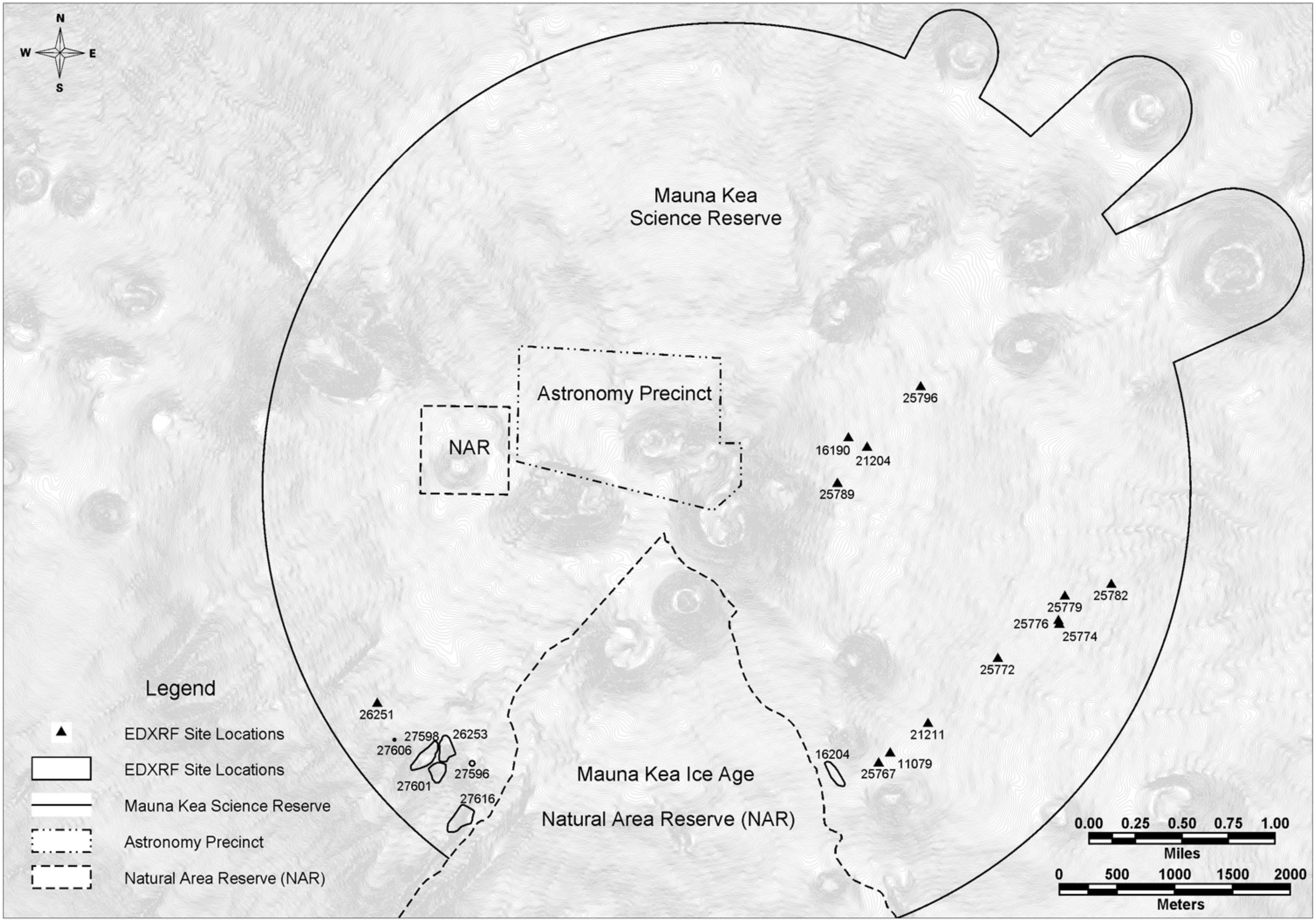


Figure 6.30 Location of Sites with Aritfacts Submitted for EDXRF Analysis.

In order for EDXRF spectrometers to yield precise measurements, the spectrometers must be calibrated by analyzing similar geological reference standards that contain well-established concentrations of elements. The UH Hilo spectrometer has been calibrated for the analysis of basalt with 27 geological standards, including 12 USGS standards (AGV-2, BCR-1, BCR-2, BHVO-1, BHVO-2, BIR-1, DNC-1, DTS-2, GSP-2, QLO-1, STM-1, W-2), 12 Geological Survey of Canada standards (LKSD 1-4, FER 1-4, TILL 1-4), two basalt standards from the Geological Survey of Japan (JB-2, JB-3), and one Geological Survey of China basalt standard (NCS DC 73303). Some trace elements found in Pacific basalts exhibit better analytical precision with EDXRF than others, namely rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb), while data for major elements are less precise. The reader is referred to Lundblad et al. (2008) for further technical information.

6.4.5.3 Results and Discussion

The results of the analyses included quantitative data for 19 elements, of which two Strontium (Sr) and Zirconium (Zr) values were used. The use of the Sr element helps separate the dense fine-grained rocks from Kilauea and Mauna Loa. The results of the analyses are presented in Figure 6.31 and Table 6.17. Appendix M contains data for 1,300 comparative samples from the island of Hawai`i.

The results of the Pōhakuloa Gulch Quarry samples were compared with a set of over 1,300 other Big Island samples, including over 900 from the Mauna Kea Adze Quarry Complex (Mills and Lundblad 2006; Mills et al. 2008)

Based on the results and the comparison of Sr and Zr eight adze preforms from Pōhakuloa Adze Quarry are good geochemical matches with the MKAQ, as are three of the hammerstones (the fourth is on the edge of the cluster, and may still be from the same source) and one of the worked flakes. Three of the adzes from North Kona are also good matches with MKAQ. Another group of Pōhakuloa Adze Quarry samples (PCSI 4, 5, 7, 13, 17, 23, 29, 35) still fall well within the range of the Hamakua volcanic series in general, but they are on the periphery of, or well removed from, the range of variation in samples from the MKAQ (see Figure 6.31). The lab director is fairly certain that most, if not all, of these samples are not from the Ko`oko`olau escarpments, where the MKAQ is located.

One adze preform (PCSI 10), most of the cobbles (PCSI 19, 20, 21, 22, and 24), and one of the flakes (PCSI 24) match well with the later Laupāhoehoe volcanic series that predominates around Lake Waiau and other portions of the summit (Figure 6.32).

One basalt cobble (PCSI 18), one volcanic glass sample (PCSI 25), and two adzes from North Kona (PCSI 31 and 33) match well with Kilauea and Mauna Loa volcanics. The lab doesn't have a large database to separate Kilauea from Mauna Loa but these samples match well with Kilauea.

None of the Pōhakuloa Adze Quarry samples match well with the Pololū Quarry or most of the Kohala volcanic series.

As mentioned above, the elements chosen for comparative purposes were selected due to their ability to separate the dense fine-grained basalt of the major quarries on the Island of Hawai`i. It is clear that the "other group" (PCSI 4, 5, 7, 13, 17, 23, 29, 35) reflects the new quarry (see Figure 6.31). With this in mind, and knowing the location of the samples sent for analysis are from Mauna Kea, other elements were explored to see

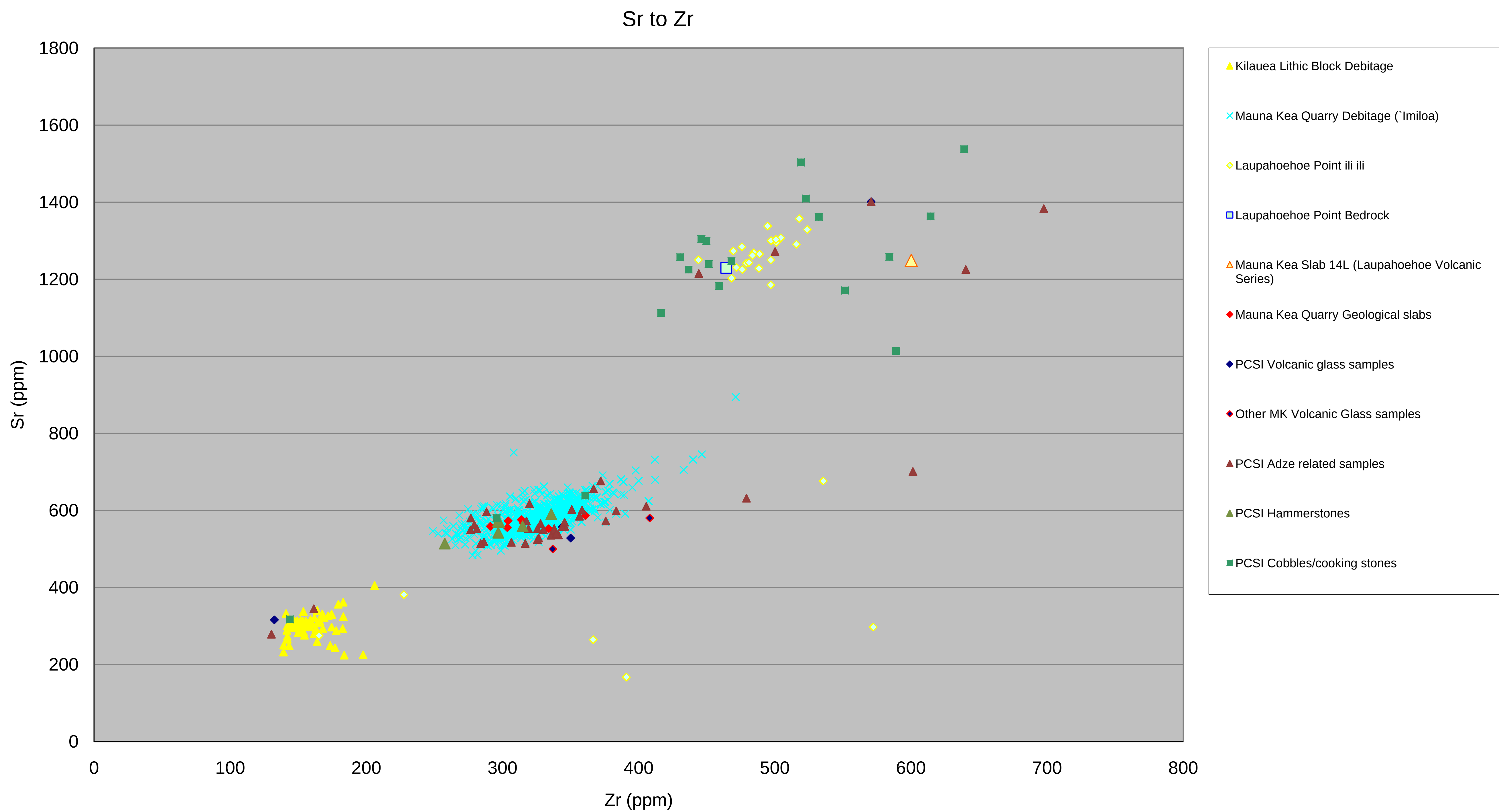


Figure 6.31. Scatterplot Diagram of EDXRF Analyses of Volcanics from Various Localities Including the Science Reserve.

Table 6.17. Results of EDXRF

Pohakuloa Gulch Adze Quarry Complex

SIHP Number	Sourcing ID PCSI #	Artifact Type	XRF Results Indicating Geological Series
26253	4	Adze preform	Hamakua Volcanic Series
26253	5	Adze preform	Hamakua Volcanic Series
26253	6	Adze preform	Mauna Kea Quarry
26253	7	Adze preform	Hamakua Volcanic Series
26253	8	Adze preform	Mauna Kea Quarry
26253	15	Hammerstone	Mauna Kea Quarry
26253	35	Flake tool	Hamakua Volcanic Series
26253	53	Adze preform	Mauna Kea Quarry
	54	Adze preform	Mauna Kea Quarry
27596	13	Adze preform	Hamakua Volcanic Series
27598	9	Adze preform	Mauna Kea Quarry
27598	10	Adze preform	Laupahoehoe Volcanic Series, around Lake Waiau
27598	17	Hammerstone	Hamakua Volcanic Series
27601	16	Hammerstone	Mauna Kea Quarry
27606	11	Adze preform	Mauna Kea Quarry
27606	12	Adze preform	Mauna Kea Quarry
27616	1	Adze preform	Mauna Kea Quarry
27616	2	Adze preform	Mauna Kea Quarry
27616	3	Adze preform	Mauna Kea Quarry
27616	14	Hammerstone	Mauna Kea Quarry

Mauna Kea Science Reserve

11079	36	Adze preform	Mauna Kea Quarry
11079	37	Basalt flake	Mauna Kea Quarry
16190	38	Basalt flake	Mauna Kea Quarry
21204	39	Basalt flake	Mauna Kea Quarry
21211	40	Basalt flake	Mauna Kea Quarry
25767	41	Adze preform	Mauna Kea Quarry
25772	42	Adze preform	Mauna Kea Quarry
25772	43	Adze preform	Laupahoehoe Volcanic Series, around Lake Waiau
25772	44	Adze preform	Laupahoehoe Volcanic Series, around Lake Waiau
25774	45	Adze preform	Mauna Kea Quarry
25776	46	Basalt flake	Mauna Kea Quarry
25779	47	Adze preform	Mauna Kea Quarry
25779	48	Hammerstone	Mauna Kea Quarry
25782	49	Basalt flake	Mauna Kea Quarry
25789	50	Basalt flake	Mauna Kea Quarry
25796	51	Adze preform	Laupahoehoe Volcanic Series, around Lake Waiau
26251	52	Basalt flake	Mauna Kea Quarry

Hale Pohaku

SIHP Number	Sourcing ID PCSI #	Artifact Type	XRF Results Indicating Geological Series*
16244	18	Bird cooking stone	Kilauea Volcanic Series
16244	19	Waterworn pebble	Laupahoehoe Volcanic Series, around Lake Waiau
16244	20	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	21	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	22	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	23	Adze preform	Hamakua Volcanic Series
16244	24	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	25	Basalt core	Kilauea Volcanic Series
16244	26	Volcanic glass	Mauna Kea Adze Quarry
16244	58	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	59	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	60	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	61	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	62	Bird cooking stone	Mauna Kea Adze Quarry
16244	63	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau
16244	64	Bird cooking stone	Laupahoehoe Volcanic Series, around Lake Waiau

Mauna Kea Adze Quarry

16204	55	Adze preform	Mauna Kea Quarry
16204	56	Hammerstone	Mauna Kea Quarry
16204	57	Adze preform	Mauna Kea Quarry

Lake Waiau Artifacts

26126	27	Modified flake	Mauna Kea Quarry
26129	28	Basalt flake	Laupahoehoe Volcanic Series, around Lake Waiau
26135	29	Basalt flake	Hamakua Volcanic Series

Reference Artifacts

14292	30	Adze preform	Mauna Kea Quarry
14292	31	Adze preform	Kilauea Volcanic Series
14313	32	Basalt tool	Mauna Kea Quarry
N/A	33	Adze preform	Kilauea Volcanic Series
N/A	34	Adze preform	Mauna Kea Quarry [Large adze]

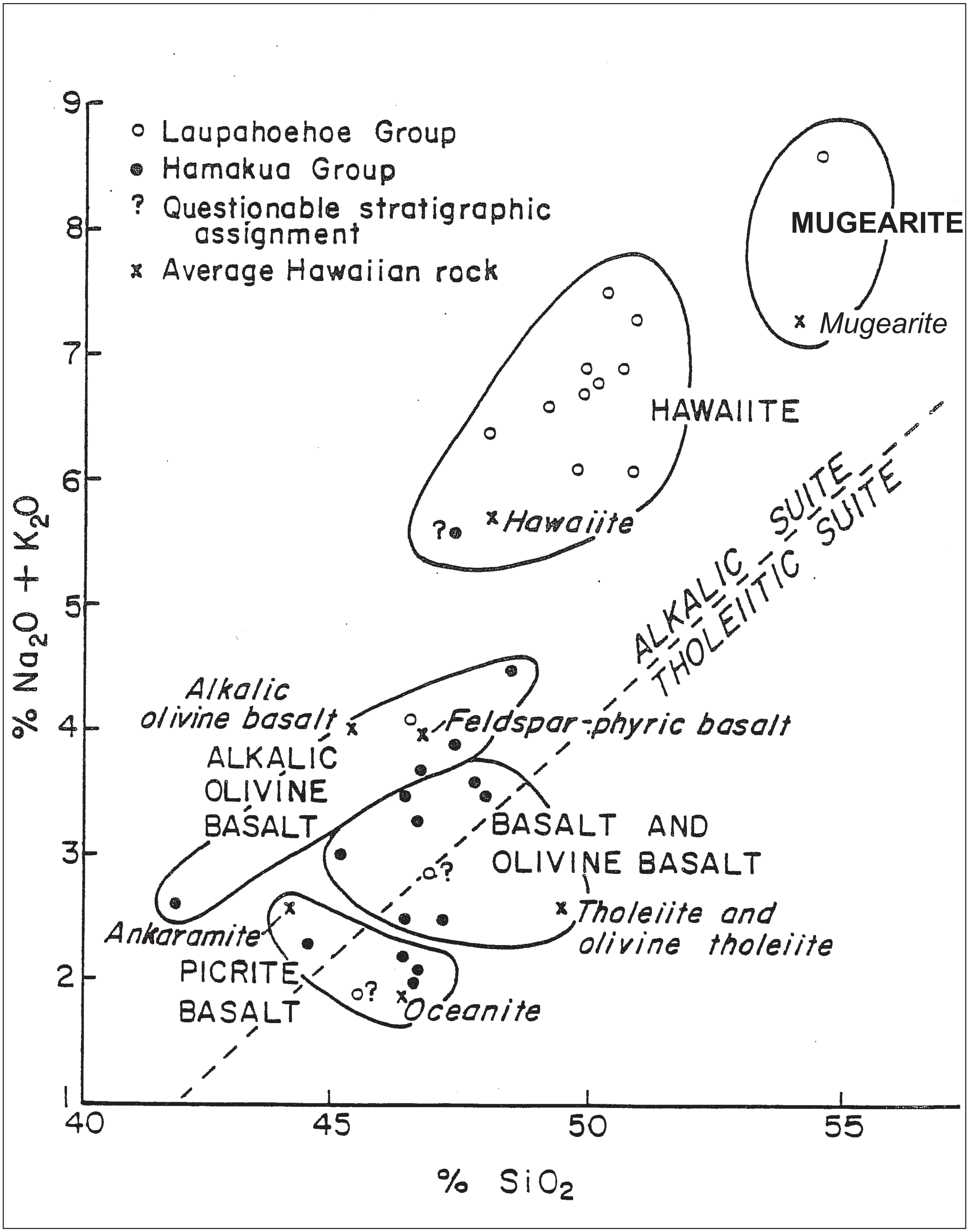


Figure 6.32. Alkalai-Silica Diagram for Mauna Kea Lavas (after Porter 1979c:Figure 5).

if it is possible to distinguish between the two quarry areas (Pōhakuloa Gulch and the previously studied area referred to here as MKAQ). The results are intriguing. Using several different elements and comparing them with the UH sample of over 900 samples from MKAQ the Pōhakuloa Gulch samples consistently separate out from the MKAQ. In some cases there are a few samples that overlap with MKAQ (see Figure 6.31). In addition, the samples closely matching Kilauea volcanics were rerun using several different elements and compared with samples collected at Pohakuloa Training Area (PTA) located south of the Pōhakuloa Adze Quarry. The samples appear to match closely with geological samples from PTA (see Figure 6.29).

6.5 The Pōhakuloa Gulch Area Of The Mauna Kea Adze Quarry Complex; A Summary and Discussion

6.5.1 Raw Material Sources and Procurement

As described in an earlier paper (McCoy 1990) significant variability exists within each of the two "sources" [lava flows and glacial deposits] in terms of the quantity and density of "tool-quality material", defined here as the combination of major raw material properties: (1) grain-size or texture, (2) form [shape, sphericity, and rounding] and (3) size.

What exists in fact are a large number of variable size "patches" (Winterhalder 1981:23) of tool-quality material unevenly distributed over a large area of the southwest flank of Mauna Kea. There are large "patches" which have been called "production zones". These include in descending order of probable importance:

(1) the escarpment (see Figure 7.3),

(2) a "middle-ground" of whaleback ridges covered with a thin mantle of glacial drift and, in the same area, Late Makanaka glacial moraines, and

(3) lower elevation slopes discontinuously covered with Early and Late Makanaka and Waihu glacial moraine and outwash deposits. Within each of these zones are smaller "patches" of differential quality material (McCoy 1990:93, 96).

As discussed elsewhere (McCoy 1990:93-94), the extent to which "patchiness" is a predictable source of behavioral variability (Kirch 1980:124) is evidenced in procurement strategy variability in space and over time. An optimal, mixed strategy of initial surface collecting and later bedrock extraction (mining) characterizes the long-term, continuous exploitation of the primary source along the escarpment. This is in sharp contrast to the almost pure collecting strategy employed in the somewhat later exploitation of the glacial drift deposits in Zones 1 and 2, which on current evidence was coeval with the former between ca. AD 1300-1600 and possibly as early as AD 1000. The material correlates of this spatio-temporal sequence are similar, yet contrastive, adze preform assemblages given the inherent limitations of raw material form and size on the shape and dimensions of the final product (Isaac 1972, 1977a), which in this particular quarry context is inferred to have meant not only differential exchange-value, but the differential potential to build a personal reputation (see Shanks and Tilley 1987:95; McCoy 1990).

6.5.2 Inter-Site Variability in Preform Assemblages

As described above, the Mauna Kea Adze Quarry is not a monolithic whole exhibiting uniformity in raw material procurement methods, reduction strategies and sequences, and preform types. The following comparisons demonstrate variability in preform assemblages within and between sites and workshops, as well as between the workshops found at the two rockshelters in the Pōhakuloa Gulch area. The data used in the comparisons are from Tables 6.11 and 6.12.

A comparison of tanged and untanged preforms from a sample of 12 workshops and the 2 rockshelters shows some potentially significant differences (Figure 6.33). The smaller number of tanged adzes from the 12 workshops (n=198) is consistent with earlier findings and interpretations that tangs are one, if not the last, part of the adze to be formed. The rockshelter assemblages, though smaller (n=57) show that more than half (52.54%) of the preforms are tanged. This is a pattern that has been observed previously at some of the rockshelters/workshops located in the NAR (Cleghorn 1982).

When the cross-sections of preforms found at workshops and rockshelters are compared using the same data set as in the previous analysis, the one thing that stands out is the high percentage of rectangular preforms in both (Figure 6.34). Square preforms are likewise fairly common at workshops and rockshelters (14.64% vs. 19.29% respectively). Rectangular and square cross-sections combined represent 79% of the total at the two rockshelters and 60% at the 12 workshops. In addition to these common forms, there is a wide variety of other cross-sections represented in both populations (see Figure 6.34).

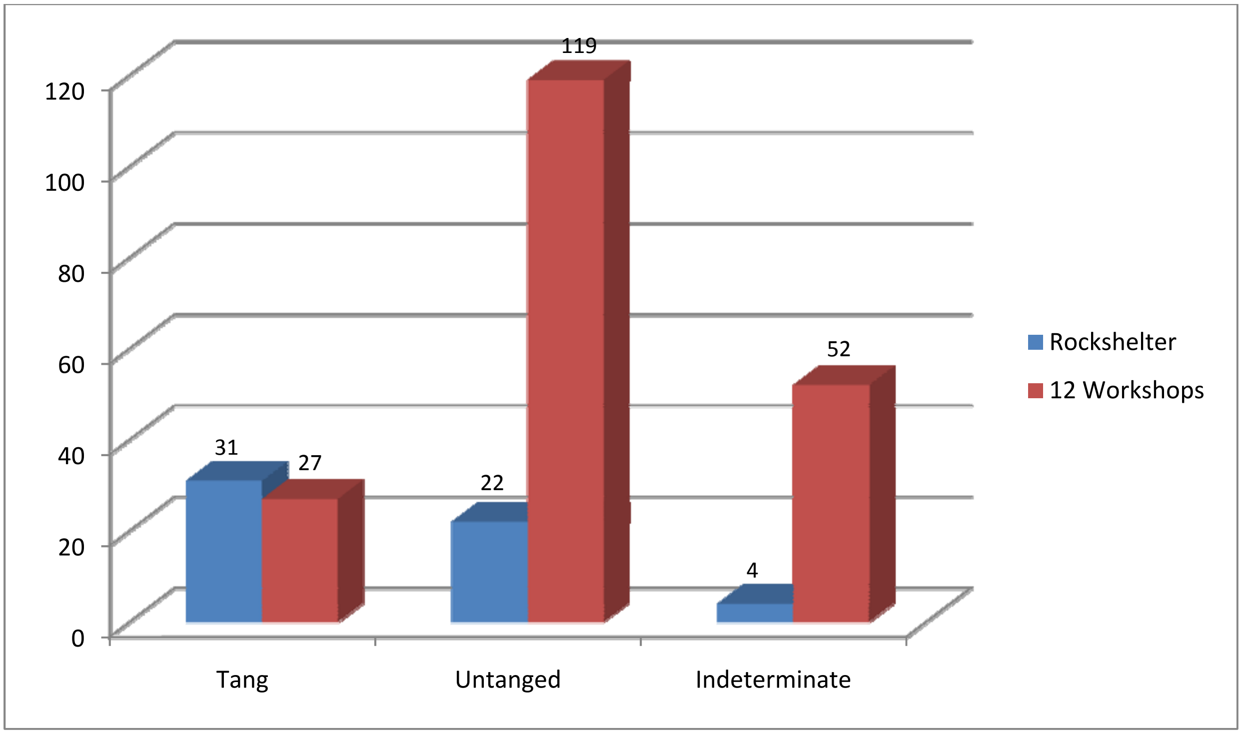
Using the same sample of 12 workshops and 2 rockshelters, there is an interesting between intra-site and inter-site contrast in the frequencies of rectangular (n=123) and reverse triangular (n=33) preforms (Figure 6.35). In each case there are three to four workshops and/or rockshelters where the majority of each preform type is found, in contrast to the remainder of the population that is represented by frequencies of 4 to 6%.

A comparison of the single rockshelters at Sites 26253 and 27606 shows in both cases a predominance of rectangular preforms (55.55% at 26253 vs. 66.66% at Site 27606. What is of more interest, perhaps, is the occurrence of a fairly large number of square preforms (30.55%) at Site 26253 and the absence of this type at Site 27606 (Figure 6.36).

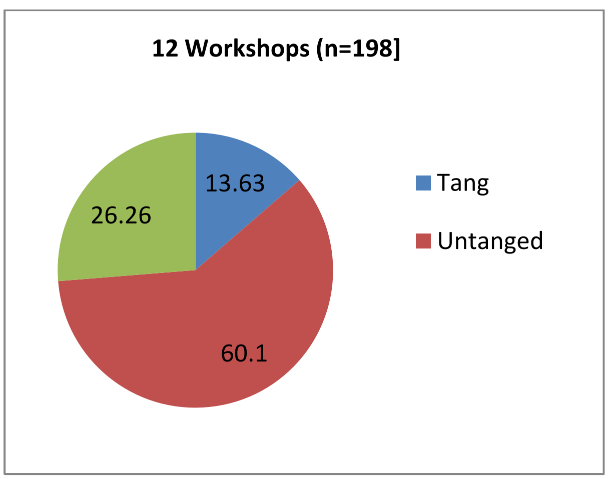
At the inter-site level there is an interesting contrast between the frequency of rectangular preforms at Sites 27598 (n=34) and 27616 (n=52). While the number of workshops used in the comparison differ, the relative percentages of rectangular preforms at the four workshops that are part of Site 27616 all contain high percentages, except for one (WS6). A similar distribution is seen at the workshops at Site 26253, but there are several of these assemblages where rectangular preforms represent less than 30% of the total (Figure 6.37).

6.5.3 Production Strategies and Chronology

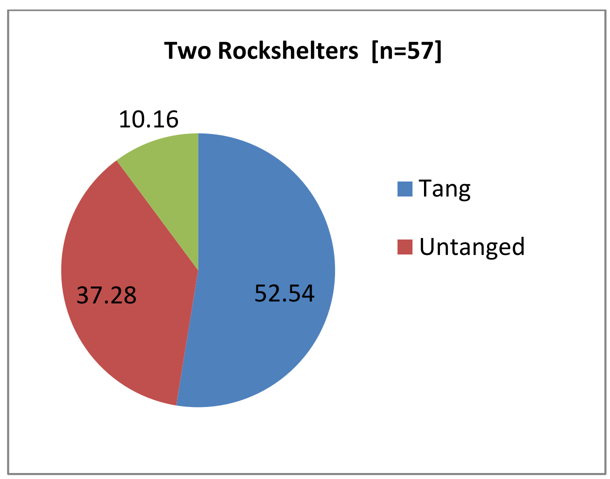
The single radiocarbon date of AD 1420-1480 (Beta-256935) for Site 26253 does not allow a detailed discussion of the history of adze manufacture in the Pōhakuloa Gulch area and production strategies over time. The mid- to late-15th century date for the cultural deposit at Site 26253 falls within the period of peak production in the Mauna



Counts: Rockshelters [n=57] 12 Workshops [n=198]

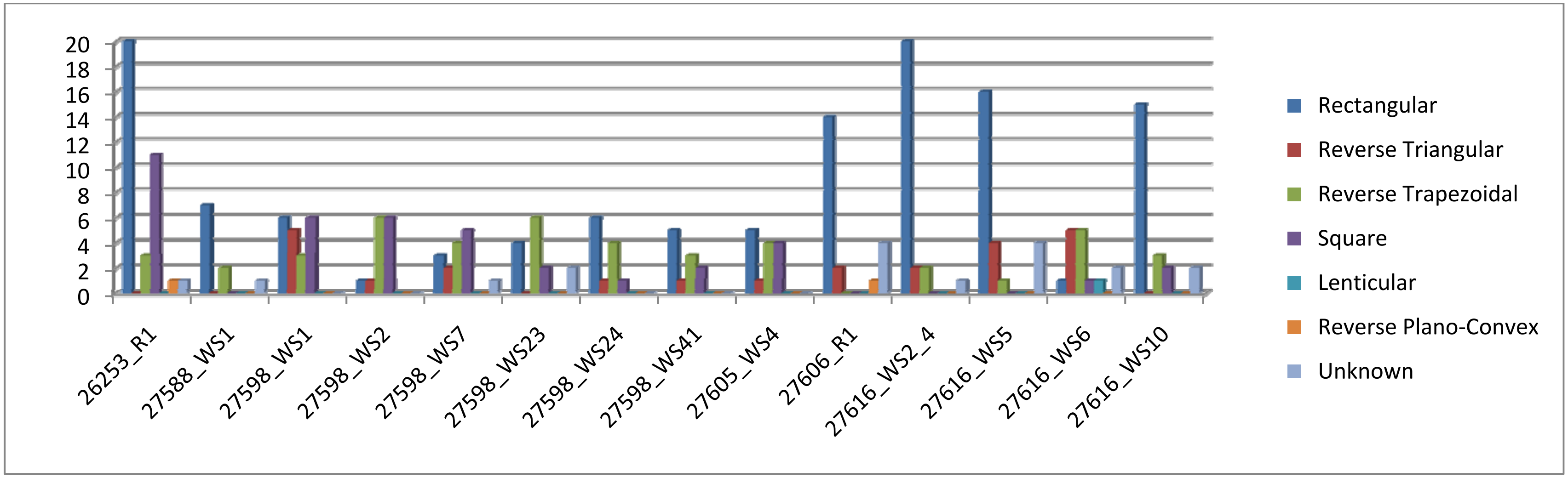


12 Workshops at PGAQC [n=198]

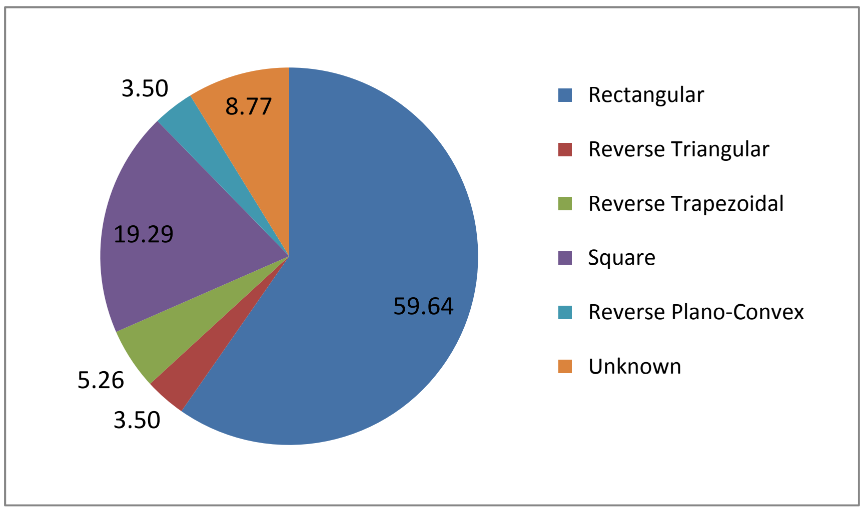


Sites 26253 and 27606 Rockshelters [n=57]

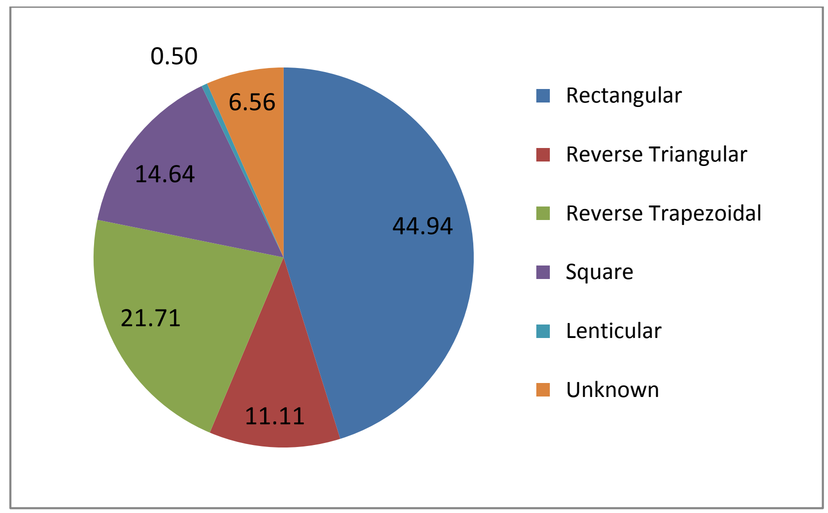
Figure 6.33. Comparison of Tanged and Untanged Preform Frequencies for Rockshelters and Workshops.



12 Workshops at 5 Sites and two rockshelters at 2 Sites

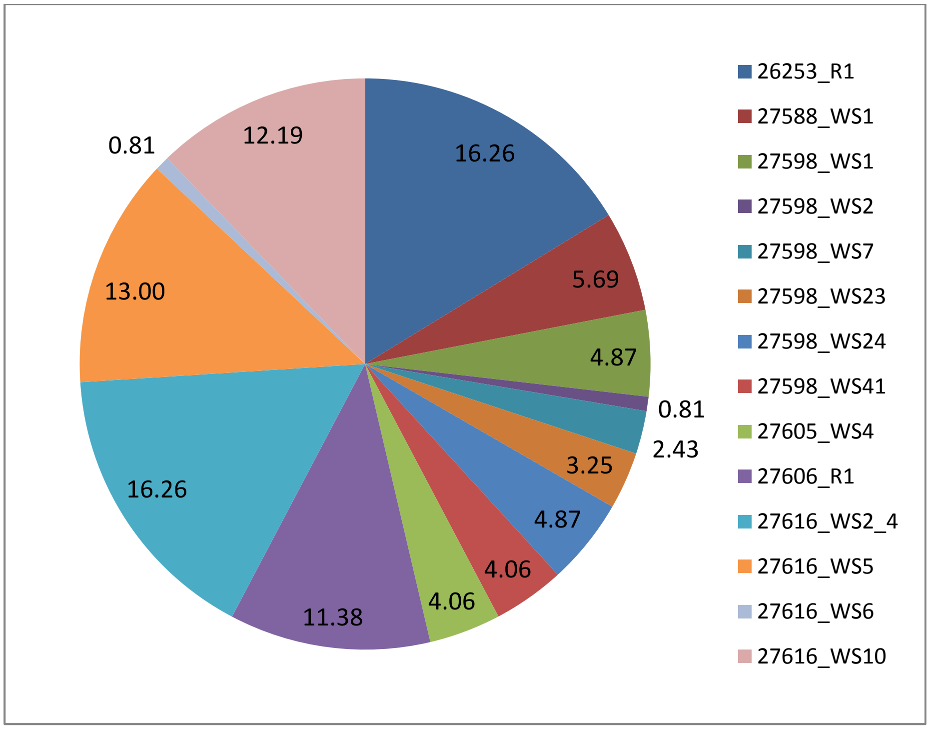


Site 26253 and 27616 Rockshelters [n=57]

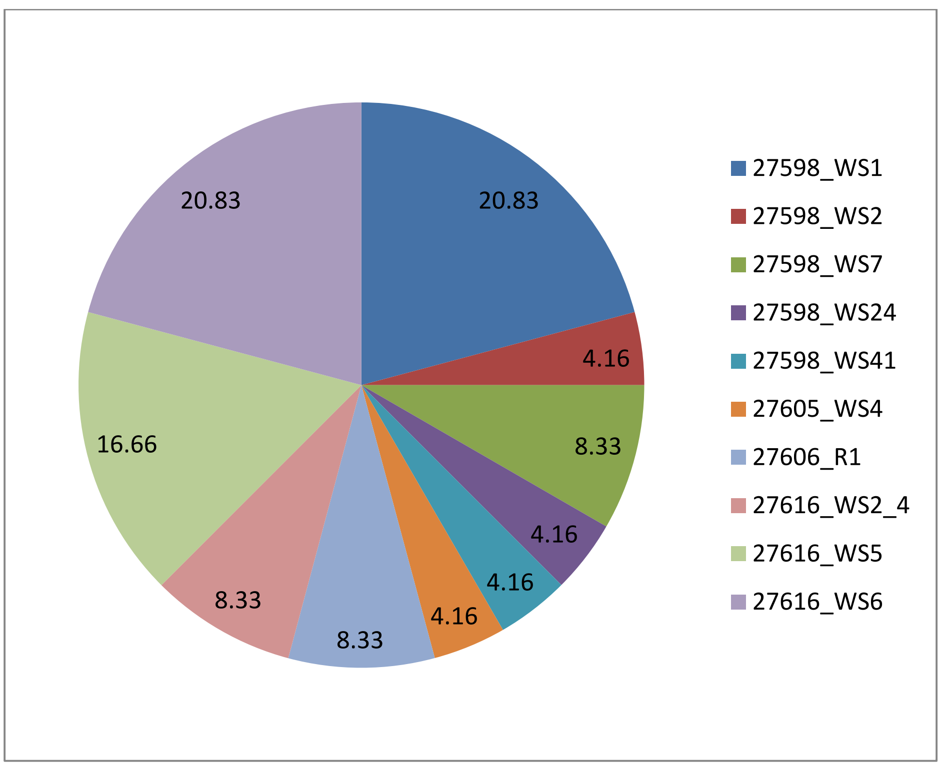


12 Workshops at 5 Sites [n=198]

Figure 6.34. Comparison of Adze Preform Type Frequencies at Two Rockshelters and Twelve Workshops.

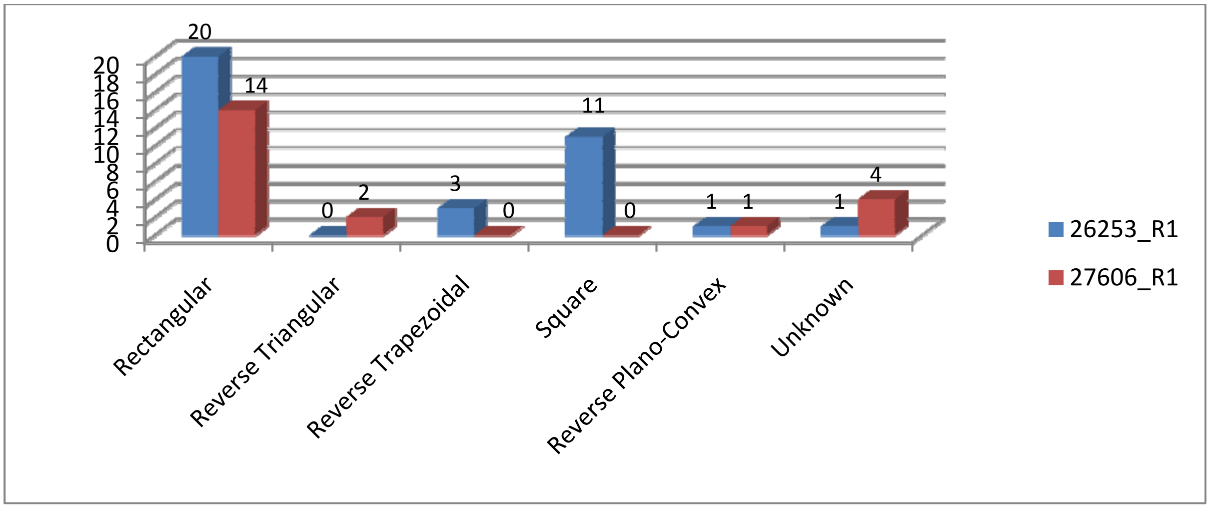


Rectangular Adze Preforms [n=123]

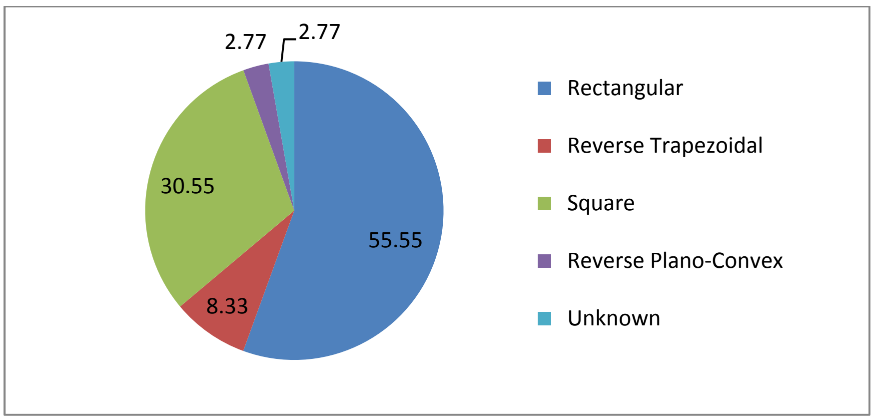


Reverse Triangular Adze Preforms [n=24]

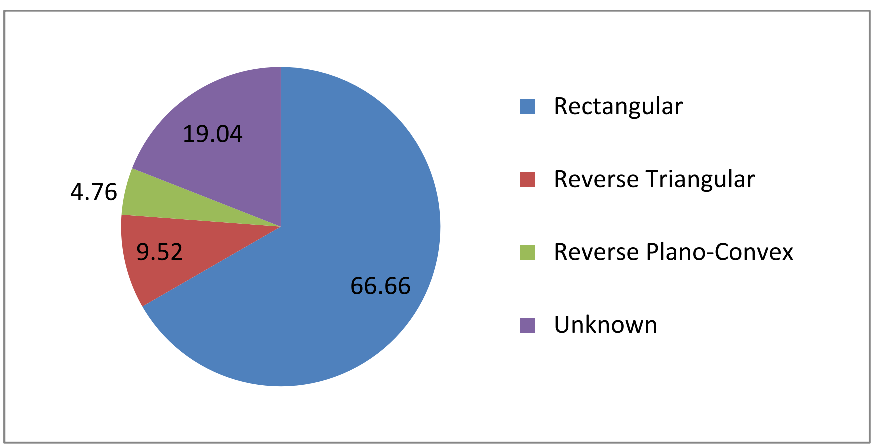
Figure 6.35. Comparison of the Frequencies of Rectangular and Reverse-Triangular Preforms from Selected Workshops and Two Rockshelters.



Site 26253 [n=36] Site 27606 [n=21]

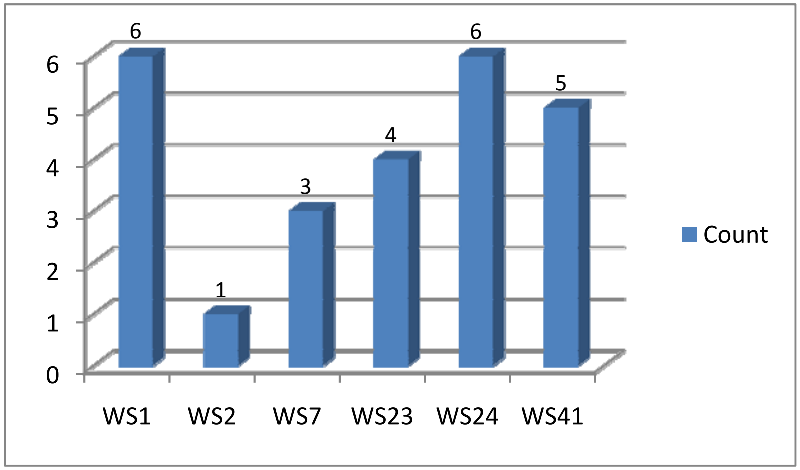


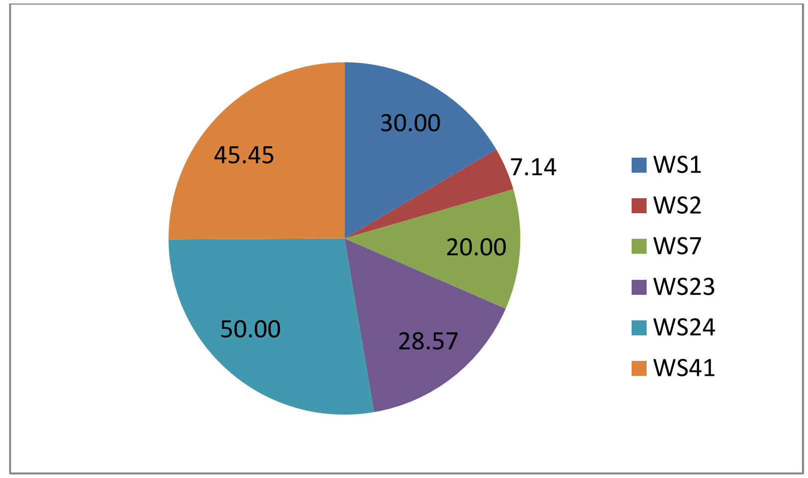
Site 26253 Rockshelter 1 [n=36]



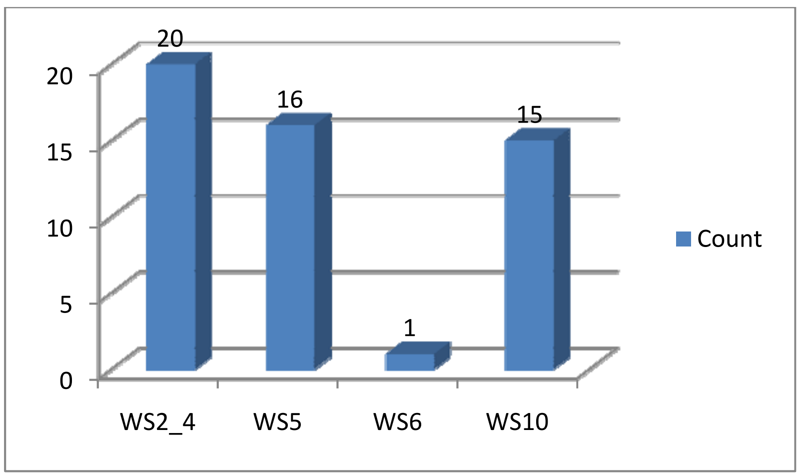
Site 27606 Rockshelter 1 [n=21]

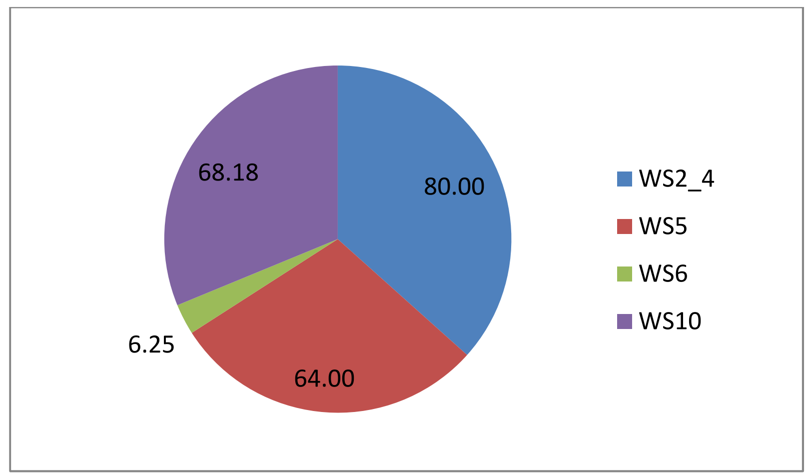
Figure 6.36. Comparison of the Percent Frequencies of Adze Preform Types from Site 26253, Rockshelter 1 and Site 27606, Rockshelter 1.





Count **Site 27598 [n=25]** **Percentage**





Count **Site 27616 [n=52]** **Percentage**

Figure 6.37. Comparison of the Percent Frequencies of Rectangular Adze Preforms from Site 27598 and Site 27616.

Kea Adze Quarry Complex. This period has been variously set as ranging from 200 to 300 or so years between AD 1400-1750 (McCoy 1977, 1990, 1991).

On current evidence the Pōhakuloa Gulch area was not used over a lengthy period of time. There are no large piles or mounds of manufacturing waste at any of the sites located within the Science Reserve, even allowing for the flattening out effect of long-term erosion. The cultural deposit in the excavation of Site 26253, Rockshelter 1 was very shallow. The chronological sequence in this quarry is thus clearly horizontal rather than vertical. The available dates from other areas of the Mauna Kea Adze Quarry Complex suggest, moreover, that the several different source areas, each differing in the quantity of material available, were most likely exploited simultaneously, rather than exhausting a one source before moving on to a new one.

Based on the sample artifact data collected in the field, the primary production strategy or goal was the manufacture of the large, thick quadrangular or square cross-sectioned variety of adze. Large preforms are comparatively rare in most Hawaiian adze quarries (McCoy et al. 1993; Weisler 1990; Dye et al. 1985). There are several possible explanations. Helen Leach, in an important study of New Zealand adzes, concluded that thick quadrangular and large triangular adzes were underrepresented in the surviving sample because of two factors: (1) a higher success rate compared to other types, and (2) the purposeful reworking of broken specimens, which is not generally possible in the case of thin adzes made on blades or flakes (Leach 1984:113). If anything is underrepresented in the Mauna Kea Adze Quarry Complex, it is the smaller preforms made on flake blanks. We know, for example, that flake blanks were being removed to what are being interpreted as logistical camps situated at or below treeline east of Waikahalulu Gulch (McCoy 1990, 1991) and below the terminus of Pōhakuloa Gulch (Welch 1991; Bayman and Moniz 2000).

As argued in an earlier paper (McCoy 1990:96), the large and more massive adzes are inferred to have had more value, in part because of the raw material constraints at other sources on the island and throughout the island chain. The source material at most, if not all of the major known adze quarries, would not have allowed the manufacture of many adzes more than 25.0 cm in length.

7. 0 SUMMARY, SYNTHESIS AND CONCLUSIONS

The primary aim of this final section of the report is to summarize and synthesize the data collected during the survey and to discuss their relevance to selected topics and issues in Hawaiian archaeology. In some places the senior author has taken the liberty of deliberately pushing the interpretations to a point reaching the "razor's edge." In a discussion of the issue of under and over interpretation that seems to be at the center of the scientific versus humanist debate in archaeology, Watson and Fotiadis made the point that "There is often a rather thin line between archaeological inference and the writing of fiction because archaeology is, by nature, an underdetermined kind of scholarship" (Watson and Fotiadis 1990:621). It is the senior author's view that the archaeological record is more commonly under-interpreted, that inferences are in many cases not extended far enough and that we are left, as a result, with shallow, uninteresting accounts of the past. This was the chief problem with much of the New Archaeology, which effectively "took the soul out of archaeology and out of the cultural past by denying or at any rate ignoring, the basic humanity of those who created the archaeological record" (Watson and Fotiadis 1990:621).

In deciding how the results of the survey were going to be presented and discussed there was recognition of the fact that one of the major problems with how archaeology is generally practiced is the manner in which data are collected, interpreted and presented. Jones has addressed this problem, which he calls *fragmentation* (Jones 2002:42), using as an example what he calls "exploding excavations" (Jones 2002: Figure 3.1). What happens is that during the course of an excavation and even more so in the post-excavation phase of a project, is that the material remains are separated from one another and in some cases handled by a number of specialists (e.g., faunal analysts and lithic technologists) who write up the results of their analyses. Final excavation reports thus often end up being compartmentalized representations of a site rather than holistic. The same can hold true of survey reports that contain different data sets, such as this report which includes a statistical summary and analysis of selected shrine attributes by Dennis Gosser (Appendix N). To avoid this problem we have included a discussion of most of his findings in Section 6. A discussion of Gosser's cluster analysis is presented below.

In the discussion of theoretical and methodological issues in Section 4 it was argued that archaeology is inherently interpretive and that interpretations can vary depending on a whole host of factors, including theoretical presuppositions and context. In addition, "Different theories help us to understand alternative aspects of the mosaic. All simplify and none is adequate to an understanding of the totality" (Tilley 1995:339-340). Archaeological fieldwork itself is an interpretive practice in deciding, for example, not only what is cultural, as opposed to natural, but whether a pile of stones is old or recent and whether it might mark a trail, a boundary or something else. A classic example of this dilemma is how to prove that a cairn was a trail marker:

> A decayed cairn differs not at all from a couple of rocks accidentally and naturally clustered. Such reasoning is thus either probabilistic, in which the threshold for acceptance and action "on the trail" is very low, or even mere abductive or prima facie reasoning (Dipert 1993:82).

Lacking the means to prove that a cairn was a trail marker interpretations are in Tweed's words "more or less acceptable, where acceptable means internally coherent and contextually useful" (Tweed 2006:17). Tweed recognizes at the same time that "an acceptable interpretation is always contested and contestable and is always a matter of offering a plausible account within an accepted categorical scheme and within a particularly professional setting, with its scholarly idiom and role-specific obligations" (Tweed 2006:17).

Finally, as a preface to the discussions that follow, we want to note our agreement with what we regard as a fundamental principle in archaeological practice: that the "The interpretive practice that is archaeology is an ongoing process: there is no final and definitive account of the past as it was" (Shanks and Hodder 1995:5). In a similar vein we also note our agreement with Tilley, who has written "Just as there is no one monolithic present in which we all live, there is no one single immutable past to be resurrected in our discourses" (Tilley 1995:339-340).

7.1 NUMBER, FUNCTIONAL DIVERSITY AND SITE DISTRIBUTION PATTERNS

A summary of the number, functional diversity and spatial distribution patterns in the Science Reserve is complicated by what were loosely referred to earlier as "simple sites," such as shrines and "complex" sites, namely the adze quarry complex. While the shrines were easy to identify as discrete entities, the opposite held true of the quarry complex where boundaries are exceedingly difficult to establish because of natural and cultural factors. The numbers of each of these two broad categories are not comparable, and thus have little or no meaning.

7.1.1 Site Numbers and Functional Diversity

Prior to the 2005-2009 archaeological inventory survey a total of 97 historic properties had been identified in the Mauna Kea Science Reserve. This included 95 archaeological sites found in reconnaissance surveys conducted between 1975 and 1999 (Appendix A), and two SHPD designated traditional cultural properties. The current project identified another 166 historic properties, thus bringing the total to 263. To reiterate a point made earlier, although the entire 11,288-acre Science Reserve has finally been surveyed in its entirety and some areas more than once, there is always a chance that additional historic properties will be found in the future.

At the most general level of analysis the diversity of functional site types in the Science Reserve is low. There are two ways of measuring diversity:

> First, of course, is *richness*, the number of categories present. Second, is *evenness*, which expresses the extent to which the categories are represented by similar quantities of objects (Cowgill 1989b:135).

Without performing an actual statistical test it is still possible to say state that richness, defined as the number of functional site types in the Science Reserve, is low. Indeed, the vast majority of sites are related to just two kinds of social practices—adze manufacture and ritual, which includes mortuary practices and the performance of rituals at shrines located below the summit of the mountain. There is at the same time little evenness in the relative numbers of different site types. Of the 263 sites recorded in the survey 141 or 54 % are classified as shrines. The Mauna Kea Adze Quarry Complex, and related sites, including a ritual site, isolated lithic scatters and isolated artifacts (N=69) make up 26% of the total. Burials are the next most common class of sites, but they make up only 11% of the total sites in the Science Reserve (see Table 5.1).

A pattern of some significance is the rarity of temporary habitation shelters in the Science Reserve. The few that were identified appear in almost every instance to have been utilized by adze makers on their departure from the quarry and return to their homes on the coast. While there are hundreds of natural rock overhangs that could and probably were used as temporary shelters to get out of the wind or a passing rain shower, there is no physical evidence of such behavior. The test probes of several overhangs in 2005 did not yield evidence of human use, but this is hardly an adequate sample. It is possible that some natural overhangs contain buried cultural deposits, including fire places, but that these have been covered over by aeolian sediments. The near total absence of temporary shelters suggests that the people who built all of the non-quarry related shrines most likely did not spend much time at high elevation and probably returned to camps located in the upper forest zone.

Trails are another kind of site that is curiously absent or at least unconfirmed. The archaeological evidence for trails in the Science Reserve, as noted in Section 2, is circumstantial. In the case of the Umi Koa Trail (see Figure 2.13) there is no beaten down path or prepared surface that marks the trail. The inability to identify the Umi Koa Trail on the ground is undoubtedly due in part to infrequent use of the trail, its eventual abandonment with coming of roads to the summit and the active slope movement that has probably obscured whatever trace of the route that might have existed. As opposed to well-defined linear paths or trails, there is evidence of general routes or what we are calling ascent-descent routes marked by the isolated lithic scatters and isolated artifacts that are a part of the Mauna Kea Adze Quarry Complex and in some places, perhaps, a series of ground level cairns and mounds on top of large boulders (see further discussion below).

7.1.2 Macro-Level Site Distribution Patterns

Pattern-recognition is always the first step in attempting to comprehend the archaeological record. The importance of context in pattern recognition has been highlighted by Richard Gould:

> Pattern recognition is an essential step in all archaeological analysis, but the problem we must deal with is really a kind of selective pattern recognition, with selection based on the prior expectations of the archaeologist rather than on an organized approach that considers the widest possible range of relevant context and seeks to control for contextual variables (Gould 1990:40).

Glassie notes that "Many possible patterns will appear, and the task becomes the separation of the "patterns" that are merely coincidences from those that might have been structures in the thought of the artifacts' makers" (Glassie 1975:116). In the syntheses that follow an effort has been made wherever possible to go beyond pattern recognition to a consideration of pattern-generation processes.

The fact that archaeological practice is by nature multi-scalar means that there is no single way of analyzing data. It is puzzling that Tilley, who otherwise believes in the need for different analytical approaches and theories (Tilley 1993), is not in favor of analyzing distribution maps, at least in the case of European megaliths:

> In an oblique manner, to use another visual metaphor, the point I am trying to make is that if we are to try and understand the relationship between megalith and landscape the focus of our attention must be on modes of visual perception and experience on the human scale. Little is to be gained from the analytical

> gaze at the distribution map in which megaliths are merely dots in an abstracted containing space (Tilley 1993:56).

While we agree that there is much to be gained from a phenomenological analysis based on perception (cf. McCoy 1999b), we also believe that there is a great deal to be gained in what Tilley somewhat contemptuously calls the "analytical gaze at the distribution map."

In the last summary of the archaeological site data collected in the Science Reserve prior to the start of the inventory survey in 2005 (McCoy 1999a), it was noted that archaeological sites had been found in all areas that have been surveyed up to that time, but that there were significant differences in the number, types, and density of sites in given areas and on different landforms. Examination of Figures 7.1 and 7.2 and Figure 5.5 (in pocket) shows this same macro level pattern still holds true after completing the survey of the entire Science Reserve. Figure 7.1 shows the locations of both historic properties and find spots. As discussed earlier, there is a significant overlap in many areas of the two, suggesting once again that some of what have been called find spots may be more than 50 years old and should thus be classified as historic properties.

Figure 7.2 illustrates the relationship between the geology and the site distribution pattern. The geology base map illustrates rock-stratigraphic units, so it is the only the latest in a long series of geologic events that are shown. Thus, while the map shows large areas on the northern and eastern sides of the Science Reserve covered by glacial till, there are also numerous lava flows pre-dating the last period of glaciation in the same area. There is much that can be gleaned from a close examination of this figure. For the time being we simply want to point out how few sites are located on cinder cones and the large number of sites, primarily shrines, located on the glacial till deposits that mantle, but only partially, a whole series of lava flows which is where the vast majority of shrines are found.

The 1999 overview report (McCoy 1999a) noted that burials and possible burial sites had been found nowhere else than on the tops of cinder cones. The results of the 2005-2009 survey indicate that there are a couple of exceptions to this pattern, but of the 29 confirmed and possible burial sites located outside of the adze quarry there are only two that are not located on the rim of a cinder cone. Shrines, in contrast had never been found on cinder cones in the earlier surveys in the Science Reserve and never in association with burials. There is still no clear-cut evidence of a shrine-burial association. Two sites with pavements and low mounds that have been interpreted as possible burial site contain associated adze manufacturing debitage.

With the exception of the possible adze maker interments, the apparent restriction of the higher elevation burials to the apex of cinder cones is in sharp contrast to many of the burials found at Kanakaleonui, a well-known burial center located not too far outside of the Science Reserve, just below Pu`u Mākanaka and the summit plateau. Reconnaissance of this area indicates that there are an indeed a great number of structural remains at this locality. There are platforms on the top of the cone and a great number of smaller cairns at the base. On current evidence there are more burials in the general environs of Kanakaleonui than probably exist higher on the mountain, possibly on all of the summit plateau. The disproportionate number of burials in the environs of Kanakaleonui suggests that the edge of the plateau might have been a major social boundary, with the area below reserved for commoners and the plateau for persons of

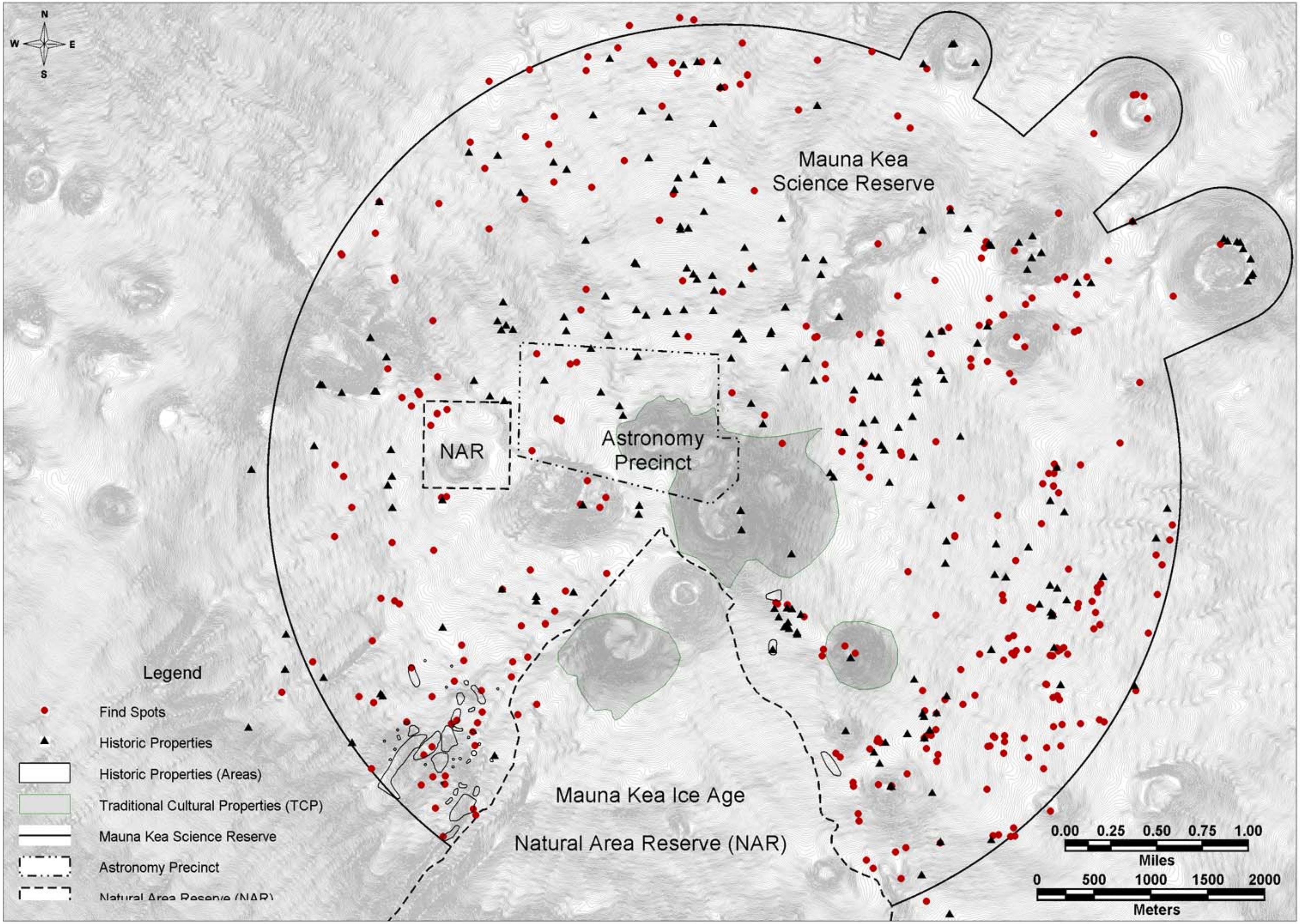


Figure 7.1 Macro-Level Site and Find Spot Distribution Patterns.

Figure 7.2 Location of Historic Properties in Relation to Geological Rock-Stratigraphic Units.

higher social status (chiefs and priests). If the very top of the cones were reserved for higher status individuals and the ground below for commoners, then Kanakaleonui must have both (McCoy 1999a:28).

The primary concentrations of sites in the Science Reserve are found on the northern and eastern slopes just above and below the 13,000 ft elevation (see Figure 7.1). This pattern, which was discussed at some length in the report on the 1982 survey (McCoy 1982) and again in 1999 (McCoy 1999a), suggests that most of those who journeyed to the summit area came from the Hāmākua and Hilo sides of the mountain.

The 1982 report contained a brief analysis of the site distribution pattern and discussion of the inferred socio-behavioral correlates of locational and formal (typological) dimensions of site variability. The site distribution map (McCoy 1982a: Figure 2.3) shows a broad but manifestly uneven site distribution pattern, with the largest concentration of sites on the north slope below the summit cones. The area of greatest interest is the north slope where all but two of the total 21 sites found in the 1982 survey are located (McCoy 1982a: Fig. 2.3). Of particular interest is the fact that 13, or 65%, of the sites are located within a narrow 200-ft contour interval, between the 12,900 and 13,100 ft elevations, that coincides with a topographic change in slope gradient. The 13,000 +/-100-ft contour, between Pu`u Māhoe and Pu`u Pōhaku, is the downslope margin of a gently sloping plateau (McCoy 1982a: Figs. 2.2 and 2.3). The edge of this small plateau, when viewed from either the base of the steep, inclined slope directly below, or from the base of the summit cones above, is a relatively flat horizon on which the shrine uprights are silhouetted and therefore visible from some distance. The possible significance of this horizon and, thus, at least a partial explanation for the clearly defined vertical zonation site pattern was discussed in the context of several multiple working "hypotheses" which are essentially untestable, however. The text that follows is from the 1982 reconnaissance survey report (McCoy 1982a).

> <u>"Hypothesis" 1</u>: The high density site area on the edge of the plateau is the lower, northern boundary of an upper mountain god/ spirit zone.

The posited relationship of shrines in the study area to mountain gods and spirits in, for example, the request for permission to ascend and pass over the summit, implies that the approach was from the northern, windward side of the island, a view wholly consistent with the inclusion of this land in the Hāmākua District and generally accepted *ahupua`a* model of traditional Hawaiian land tenure. Apart from the knowledge that gods and spirits presided over different districts (Buck 1957:529), the extent and physical boundaries of their domains in the Hawaiian land tenure system is unknown. The data obtained in the present survey suggest that the cluster of religious sites on the edge of the 13,000 +/- 100 ft plateau demarcates the lower boundary of an upper mountain god/spirit zone or domain, and that a sanction existed requiring the performance of ritual prior to entering this domain. Evidence in support of this zonal concept hypothesis would include the localized occurrence of religious sites at similar elevations elsewhere on the mountain.

It is tempting to relate some, if not a large number, of the shrines to the mythological snow goddess, Poli`ahu, and, thus, to the winter season of the year. While it would add a good measure of specificity to the above hypothesis, there is clearly no means of testing this proposition and the validity of the mythological data base on which it rests. It is difficult to imagine, however, that snow, a non-existent phenomenon in the ancestral Eastern Polynesian homeland, did not give rise to some associated rituals and pilgrimages in Hawaii. Though purely speculative, the broader site distribution pattern on the upper north flank of Mauna Kea might well reflect the construction of shrines at the lower margins of snow fields which, perhaps, normally extend down to the circa 13,000 ft elevation. Over a period of time, fluctuations in the snow line would be manifested archaeologically in a more variable site distribution pattern. This conjecture is offered in part to account for the greater altitudinal dispersion of sites than allowed by the above hypothesis, as formulated.

> <u>“Hypothesis” 2</u>: Astronomical phenomena were integral factors in the topographic location, orientation, and function of the larger, more complex structures.

The Hawaiian ethnographic literature alludes to a class of people with a specialized knowledge of astronomical phenomena, and while there are no known Hawaiian archaeological sites with an unequivocally demonstrated astronomical orientation or function, it is reasonable to predict such sites on the higher elevation slopes of Mauna Kea. That some of the structures recorded in this survey might reflect some astronomical concept(s) is vaguely suggested by the north-south orientation of the two structures labeled *marae* and other multi-feature shrines (see McCoy 1982a:Table 2.1). The isolated *marae* on the western edge of the 13,000 ft plateau (Site 16168) is especially noteworthy with regard to its orientation and possible function. The approach to this structure (i.e., the court) is on the east, looking down onto the Hāmākua coast, Waimea plains, Kohala mountains and across to Haleakalā on Maui. The placement of offerings and whatever other ritual took place here appear to have been intentionally directed away from Mauna Kea. The impression that many sites were purposefully situated with respect to the earlier described plateau horizon needs to be investigated. Further research is obviously required to test the multitudinous aspects of this hypothesis.

Additional support for the conclusions reached in 1982 is presented in Gosser’s analysis of shrine and upright data by 240 ft elevation bands and geographical area (Appendix N). Some will undoubtedly criticize the ideas presented above as nothing more than mere speculation, or as an example of “just so stories.” Though the “hypotheses” are really just propositions, they are, according to Bunge, like all others in that “Every concept and every proposition makes sense only in some context---that is, in relation to other bits of knowledge” (Bunge 1996:132). Tweed notes that for philosopher Hilary Putnam “truth does not entail “proof” or “justification,”; it aims for—to use John Dewey’s term—“warranted assertability” (Tweed 2006:16). If we accept the Hawaiian oral traditions that there was a snow goddess called Poli`ahu, the idea that Hawaiians would have traveled long distances to get a closer glimpse of her home has in our view a degree of “warranted assertability.”

7.1.3 Site Clusters of Varying Size and Function

An earlier report on the sites in the Mauna Kea Science Reserve included a preliminary and purely intuitive analysis of site clusters and their possible social significance (McCoy 1999a). For this report Gosser analyzed shrine locations using K-means nonhierarchical cluster analysis. The reader will note that there are some differences of opinion regarding his cluster analysis and our own discussion of site clusters that follows. All of us agree with what Kintigh has said regarding the analysis of archaeological data:

> Doing analysis is an inherently messy business. Most analyses (and certainly all of mine) involve lots of trial-and-error, sidetracks, and deadends. I’ve never keep

track of the numbers, but it would not surprise me if I discarded 100 analyses for every one that appears in an article (Kintigh 2005:33)

Gosser's K-means analysis indicates that the optimal number of clusters is four. He notes, however, that "while most of the cluster groups are intuitively reasonable, Cluster 2 appears to contain, minimally, three "sub-clusters" (Appendix N: Figure 13). He notes that these are not recognized, however, until an eight cluster solution is reached.

Gosser's Cluster 2 is located in the eastern-southeastern part of the Science Reserve and includes sites that are part of the Mauna Kea Adze Quarry Complex. Though his sub-clusters are not identified on a map, it is clear that one is located above Pu`u Lilinoe and one below (see the oversize site distribution map (see Figure 5.5 in back pocket). Both of these "sub-clusters" were previously identified based on a purely visual examination of a site distribution map. Both contain shrines with adze preforms and manufacturing waste and mark what we believe are ascent-descent routes used by adze makers from the Hamakua coast (see discussion below).

While we tend to agree with Clarke that intuitive analysis, "by inspection" or "eyeballing" is no longer sufficient nor an end in itself" (Clarke 1977:5), statistical analysis in our opinion is not the final answer to our problem of making sense of point patterns, in this case site locations. One problem with statistical approaches, such as K-means analysis and nearest-neighbor analysis, is that the underlying assumptions on which the methods are based are rarely described and analyzed to see if they are valid. One common assumption is topographic homogeneity:

> point pattern analysis implicitly assumes spatial isotropy (i.e., invariance by rotation) and homogeneity despite the fact that actual human landscapes offer both topographically dependent movement environments and spatially heterogeneous natural resources (waters, soils, etc.) (Bevan and Conolly 2006:218).

We believe that one of the problems that Bevan and Connolly identified with nearest neighbor analysis also applies to K-means analysis, that both are "influenced by the size of the area to be analyzed, with regular, random, or clustered distributions arising being dependent on the amount of surrounding areas included in the analysis (Hodder and Orton 1976:41)" (Bevan and Conolly 2006:218).

The discussion that follows is based on the belief that there are more than four meaningful shrine clusters and three "sub-clusters" in the Science Reserve, and that what is required is a recognition that spatial patterning is dependent on area and varies according to the size or scale (Lock and Molyneaux 2006). In proceeding with what is clearly an intuitive approach we have heeded the advice of Cowgill who has written:

> *Look* at your data first, through simple tables and pictures. Often this tells you everything important. If not, it will tell you what is sensible or not sensible to do next. Do not rush to apply advanced techniques while overlooking the messages of simple methods (Cowgill 2005:35).

7.1.3.1 Shrine Clusters

The smallest clusters, consisting of two sites located within 200 meters (m) or less of each other, are fairly common and widespread. The distance separating sites may seem exceedingly large and it would be by most standards, but 200 m in an open landscape covering over 11,000 acres has to be viewed using a different scale than what might be used elsewhere. The most obvious pairs of sites are listed below. Some of these tend to be more isolated, such as the following paired sites. Two of these paired site complexes (16164-16165 and 16166-16167) are located in the center of the Science Reserve. The first pair is in the saddle area between the summit cones and Pu`u Poli`ahu. The second is on the northwest flank of Pu`u Hau Oki.

16164-16165	16202-21197
16166-16167	21211-21213
21406-21407	21210-21214
16180-21201	26251-26252
16184-21202	21446-26228
16192-16193	25775-25776

There is a hierarchy of shrines defined in terms of the number of uprights and other attributes, such as courts and pavements. As might be expected given the remote location in a high altitude, and frequently inhospitable environment, there are few larger, architecturally complex sites, though such sites could have been built over a period of time with repeated visits if that was the intent.

The most significant fact about the more complex sites, defined as those with more than 12 uprights and courts, is their relatively isolated location and separation from the larger, denser clusters of smaller, less complex sites. Some are not as isolated as previously thought, however, (McCoy 1999a). The marginal locations of a number of them relative to the main clusters of shrines suggest a possible political element in their locations. The number and location of the few complex shrines suggests a possible correspondence to political districts. Whatever their political affinities might have been, there is a hint of a hierarchy of power according to one model:

> Straightforwardly, the more superhuman agents there are in a religious model, the greater is the number of figures whose activities are capable of entitling rituals and the number of figures who are capable of altering the arrangement of entities within the religious world. Since it is, by definition, difficult to maintain more than one most powerful superhuman agent, let alone lots of them, whenever a religious model includes many different superhuman agents, it is inevitable than they fit into a hierarchy of power. All such agents are capable of doing some ritual jobs. However, some jobs require powers reserved for but a few (Lawson and McCauley 1990:163).

It may have been that the rituals conducted at the complex shrines were ones that reaffirmed and reproduced the broader world-view, as opposed to what might have been simple prayers or chants at the more common, simple shrines.

To expand on and refine the earlier speculations, it now seems likely that the simple shrines were built and used by small family groups as originally thought, but that the larger, more complex structures were built and maintained by a priesthood. There are two initial reasons for thinking this may be the case. First, on the assumption that each upright stands for a separate god, the larger number of uprights on these sites points to a larger pantheon of gods (major and minor gods) that probably most Hawaiians would not have known. Second, many of the sites in this category are isolated from the main areas of worship (see Figure 6.16). The separation has to have been deliberate. It implies, as physical separation often does, a meaningful social boundary and, in this case, status differences.

7.1.3.2 Burial Clusters

The 29 burial and possible burial sites found in the survey are on current evidence localized to just a few locations in the Science Reserve. Of the 29 sites 27 or 93% were found on just four of the 15 or so major cinder cones located in the Science Reserve. Two possible burial sites are located on a plain in close proximity to a site with adze manufacturing debitage (see Table 5.2). The structural remains at these two sites are rectangular pavements/low mounds that are architecturally different from the burial mounds found on the cinder cones, but similar to ones found at Lake Waiau where adze manufacturing waste material was also found (McCoy and Nees 2009). The distinctive architectural characteristics and presence of adze manufacturing by-products suggests that if the sites are indeed burials they may contain the remains of adze makers, in contrast to the cinder cone burial sites where no such association is evident.

Wherever they have been found burial sites, like a number of the shrines, tend to occur in clusters of two to sometimes three mounds, platforms or terraces. The recognition of shrine clusters comprised of two sites and similar sized burial site clusters is a pattern that would seem to reinforce the notion of family units staking out a piece of land to be used over a number of generations. This interpretation, if true, indicates that it is perhaps wrong to view the burials in the Science Reserve as simply reflecting high status and that we should take Hodder's advice and view burial patterns as "meaningful transformations of social differentiation" (Hodder 1982:150). In short, it is possible that the burial patterns in the summit region are the result of a social practice that recognized graded statuses and that the underlying principles or rules changed through time.

Examination of Figure 5.5 (in back pocket) shows a total of six paired burial sites. Three are on Pu`u Mākanaka (Sites 25803-25804, 25806-25807, and 25808-25809), one on an unnamed cinder cone (Sites 25823-25824), and two on a large cinder cone with no known name located on the western edge of the summit plateau (Sites 21413-25831 and 21414-25829).

7.1.3.3 Mixed Function Site Clusters

The largest and inferentially most important cluster of sites located outside of the adze quarry proper is directly below the summit, which is not visible from this locality, however. The number of sites at this one locality, which is situated upslope of Pu`u Līlīnoe (see Figure 7.1; see Figure 5.5 in back pocket) suggests that it was a specific destination point for large numbers of people over a lengthy period of time, and in fact this location is about as close as one can get to the summit without actually climbing the side of the cinder cone. Contained within this cluster is a shrine that when first recorded in 1984 had adze preforms at the base of the upright and a larger than usual lithic scatter for a site located outside of the quarry proper. This site (16203) suggests that some of the other shrines in this area, though lacking artifacts, may also have been built by adze makers.

A second cluster of mixed function sites occurs below Pu`u Līlīnoe in the general vicinity of the Very Long Base Array observatory. This is a smaller and more dispersed cluster than the one above Pu`u Līlīnoe (see Figure 7.1; see Figure 5.5 in back pocket). It too contains isolated lithic scatters and artifacts transported from the adze quarry.

The third obvious cluster, which is well separated from all the others, is Site 16204 which was described in Section 5 as a ritual complex and part of the Mauna Kea Adze Quarry Complex (see Figure 7.1; see Figure 5.5 in back pocket).

7.2 THE DEVELOPMENT OF PLACES IN THE MAUNA KEA SUMMIT REGION: AN HISTORICAL PERSPECTIVE

There is accumulating archaeological evidence that the high elevation "wilderness" on Mauna Kea was the locus of a number of special purpose activities, including tool manufacture, burial and the worship of gods and spirits. There is a suggestion in all of these activities of a direct link to the exercise of political power in the person of a ranking chief, and more particularly of what Sahlins has called the "general cultural practice of heroic history" (Sahlins 1985:34). Dates for the quarry suggest that each of these practices has considerable time depth and continuity.

In a report on an archaeological inventory survey of Lake Waiau (McCoy and Nees 2009), we noted that the number and types of historic properties and other cultural resources found in the Science Reserve, combined with ethnohistoric and ethnographic data regarding cultural practices, points to the lake having developed as a *place* within a *region*, as the two terms are used by cultural geographers and philosophers of space and time (McCoy and Nees 2009). The discussion that follows is a synthesis of information regarding the development of places within the Mauna Kea summit area. It is based on our view that a non-site oriented approach is essential to understanding the long-term history of Mauna Kea.

7.2.1 Analytical Constructs: Region, Place and Landscape

With the completion of the archaeological inventory survey of the Science Reserve and Lake Waiau (McCoy and Nees 2009) there is new evidence that the summit region of Mauna Kea was comprised of several different places, each with its own defining characteristics, but also exhibiting evidence of inter-connections. The phrase "Mauna Kea summit region" has been used repeatedly throughout this and other recent reports (e.g., McCoy 1999a), without being clearly defined, however. The geographer Edward Relph provides a useful definition of region:

> A geographical region is defined as a part of the earth that is distinctive from other areas and which extends as far as that distinction extends. It is characterized by internal similarities of landforms, cultural history, settlement forms, climate, or a combination of all of these (Relph 1985:21).

The higher elevations of Mauna Kea have all of the defining characteristics of a region as defined by Relph: similar landforms, climate and a locally unique set of land use practices.

Beyond the simple definition of what makes up a geographical region, there are numerous other definitions of region, as well as place and landscape. Some of the definitions that the senior author have found most useful are those presented in Edward S. Casey's book, *Getting Back into Place: Toward a Renewed Understanding of the*

Place-World (Casey 1993). Casey, who is a philosopher, goes beyond simple definitions to consider the relationships between the different terms:

> A region, let it be noted, exceeds a given discrete place…But in what does the excess consist? If we consider the term *region* to designate a collection or gathering of places, *place* retains the particularity essential to its description…For places are the particular parts or portions of regions. But this is not to say that regions are abstract totalizations of places. Regions possess their own concreteness, as we realize when we consider the specificity of a regional landscape with which we are thoroughly familiar. (A landscape can be considered the phenomenal or sensuous manifestation of a region). On the other hand, if regions do act to collect or gather places, this is not because they serve as mere containers, as "the first unchangeable limit of that which contains." Regions are no more containerlike *things* than places are bare *positions*. Regions are forms of gathering, and in this capacity they have powers and virtues of their own, which are not foreign to the dynamism of lived bodies that make possible the configuration of places (Casey 1993:73).

Casey's view that "Regions are no more container like *things* than places are bare *positions*" (Casey 1993:73) is one that is also now held by a number of anthropologists and archaeologists. Rodman, for example, argues that "Places are not inert containers. They are politicized, culturally relative, historically specific, local and multiple constructions" (Rodman 1992:641). Knapp and Ashmore note a change in the way many archeologists now view landscape:

> In minimalist terms, a landscape is the backdrop against which archaeological remains are plotted. From economic and political perspectives, landscapes provide resources, refuge, and risks that both impel and impact on human actions and situations. Today, however, the most prominent notions of landscape emphasize its socio-symbolic dimensions: landscape is an entity that exists by virtue of its being perceived, experienced, and contextualized by people (Knapp and Ashmore 1999:1).

The manner in which landscapes are experienced is highlighted in this passage from one of Casey's several books on place:

> …the spatiality of the places between which we move in landscape is at once inconstant and variant, unsystematic and open: as anyone can attest from an afternoon's hike in the low foothills of the California Sierras. Even when there are marked trails, these follow the irregular lay of the land, converge and diverge unpredictably, vary in width and in regard to how cleared they are, and in still other ways they resist charting in strictly geographic terms. When we are in a landscape setting, in other words, we are very much in the presence of place in its most encompassing and exfoliated format, a format in which we are sensuously attuned to its intrinsic spatial properties rather than imposing on it our own site-specifying proclivities (Casey 2000:197-198).

The new emphasis on perception, experience and context in landscape and place echoes what Casey has been arguing for some time:

> Place as we experience it is not altogether natural. If it were, it could not play the animating, decisive role it plays in our lives. Place, already cultural as experienced, insinuates itself into a collectivity, altering as well as constituting that collectivity. Place becomes social because it is already cultural. It is also, for the same reason, historical. It is by the mediation of culture that places gain historical depth (Casey 1993:31-32).

The recognition that places are historical requires that they be viewed from an historical perspective if they are to be properly understood. In the words of the anthropologist Eric Wolf:

> What attention to history allows you to do is look at processes unfolding, intertwining, spreading out, and dissipating over time. This means rethinking the units of our inquiries--households, localities, regions, national entities--seeing them not as fixed entities, but as problematic: shaped, reshaped, and changing over time. Attention to processes unfolding over time foregrounds organization--the structuring arrangements of social life--but requires us to see these in process and change (Wolf 1990:590).

The focus on process and change draws attention to the fact that natural places, such as the summit of Mauna Kea and Lake Waiau, are to some extent also "socially constructed" places. There are obviously many different kinds of places. As the late Clifford Geertz so aptly put it for cultural anthropologists, "The ethnography of place is, if anything, more critical for those who are apt to imagine that all places are alike than for those who, listening to forests or experiencing stones, know better" (Geertz 1996:262).

The boundaries of places, and sacred places in particular, are not always easily defined. Tilley has noted that, "Places nest in landscapes, and their borders cannot usually be strictly defined" (Tilley 2004:25). This is true of the adze quarry, the boundaries of which have become less clear over time as more of the southern flank of Mauna Kea has been surveyed. Lake Waiau and the summit are exceptions. In contrast to the summit, which is surrounded with shrines and a few other kinds of sites, the base of Pu`u Waiau is an essentially open landscape. The site distribution pattern is the inverse of the summit, which shows little evidence of having been modified by Hawaiians in the past. The boundaries that define Lake Waiau as a place are the string of discontinuous sites around the rim of the cinder cone and margin of the lava flow that overlies the rim on the north side of the lake.

From the perspective of the people that were engaged in the various practices that made the various definable places in the summit regions, the boundaries of each place are essentially unmappable because of all of the "invisibilities that can never be made visible", which means that maps of such places "are by definition incomplete" (Caron 1995:126). As Caron notes, "The performance of the practice is itself the map" (Caron 1995:126).

Boundaries of sacred places also change through time. Lake Waiau and the summit have both become polymorphous spaces (Caron 1995) claimed by people of different religions. At different times it is possible that one may encounter at the lake such things as Native American prayer sticks and arrowheads, Tibetan prayer flags and various "New Age" objects such as crystals and other rocks and minerals. Similar objects have been placed on the summit *lele*.

7.2.2 The "Sacred Center": Pilgrimages to the Mountaintop (Kūkahau`ula)

In many religions mountains are considered sacred places and in many areas of the world they are the focus of pilgrimages to communicate and make offerings to local gods.

> ...sacred places are places of communication with divinity, places where people go to meet the gods. This function is often indicated by symbols that represent a link between the world of humans and transcendent realms. Such symbols might be vertical objects that reach from earth toward heaven, such as mountains, trees, ropes, pillars, and poles (Brereton 1987:528).

Contrary to the generalizations of Eliade and others, not all mountains became sacred places, however (Robson 1995:121).

Mauna Kea, believed to be the firstborn of Papa and Wakea and regarded by Native Hawaiians as the "center" or *piko* of the island, has all the hallmarks of what Mircea Eliade, a distinguished historian of religions, referred to as a "sacred center" (Eliade 1987) and others have called a "cosmic mountain" (Eck 1987:130-131). Eliade, who followed Emile Durkheim (1912/1995) in distinguishing between the sacred and the profane, saw "a correlation between this distinction and distinctions in space and time" and argued that "These distinctions owe their existence to some non-human other, often termed "the sacred" (Gill 1998:302). Eliade thus concluded, in the words of Sam Gill, that "Human beings do not construct their world so much as they discover or recognize the distinctions, the sacred places that supernatural beings introduced into the world" (Gill 1998:302). Gill goes on to note that:

> Such spatial distinctions invariably correlate with the points of entry into the world of the supernatural creators. These places continue to function as the locations where humans may communicate with the gods. In Eliade's analysis the strongest place, the place giving orientation to all space, is the center. Structurally the center can have no other valuation than sacredness since it is the locus of all creative and thereby religious activity, both divine and human. Thus "sacred space" is focused upon and oriented by the "the sacred center" (Gill 1998:303).

Eliade's approach to the study of world religions was thus based on "territorial distinctions made significant by sacred events, "the center" (or "the sacred center") in spatial terms and "the beginning" in temporal terms" (Gill 1998:304). While Eliade's approach continues to be used, there are critics, such as Jonathan Z. Smith, who "sees humans as constructing their worlds of meaning" and for whom there is "no objective territory" (Gill 1998:305). Smith, the author of a much cited paper, "*Map is Not Territory*," (Smith 1978:289-309) argues that the data used to study religions are like "maps" and because "there are endless ways to map a territory and to use maps to negotiate a territory, there are endless ways to perform rites and apply myths in the effort to construct meaning in life" (Gill 1998:307).

Though the sacred is clearly a contested concept and might only be useful as a heuristic device (Colpe 1987:511), archaeological evidence indicates that the summit region of Mauna Kea is quite unlike other mountain peaks and "sacred places" in Hawai`i, The large number of shrines in the summit region have been interpreted as the remains of an historically undocumented and apparently unknown pattern of pilgrimage to worship the snow goddess, Poli`ahu, and other mountain gods and goddesses such as Kūkahau`ula, Līlīnoe, and Waiau (McCoy 1982, 1990).

While there is no reason to expect that Mauna Kea would conform exactly to the idea of a modern pilgrimage center associated with one of historic religions (Turner 1974), and of the so-called "salvation" religions in particular, it does share some of the same general characteristics of all pilgrimages:

> At the heart of pilgrimage lies the notion of a journey (see, e.g., Morinis 1984). A journey involves two important dimensions--time and space. What distinguishes pilgrimage from other journeys is that its time and space are not ordinary time and space. Moreover, pilgrimage is both a "real" journey and a symbolic or metaphoric one in which spiritual and/or social transformation takes place (Dubisch 1995:35).
>
> Pilgrimage is based on the belief that certain places are different from other places, specifically, that they are in some sense more powerful and extraordinary--what Preston (1992) calls "spiritual magnetism." This power can not only be experienced by the pilgrim who visits such places; it can also be taken home in one form or another--whether as a feeling of spiritual renewal, as a healed illness, as a physical object imbued with the sacred power of the pilgrimage site, or as a transformation in one's social status (Dubisch 1995:35).

The probable origins of the pilgrimage process were earlier linked to one of Mauna Kea's most distinctive and unusual characteristics, the mantle of snow that often covers the top of the mountain (McCoy 1990:113-114):

> A large shrine complex located above the quarry suggests that the earliest activity on the top of the mountain was related to the worship of local gods and goddesses. This complex, which is interpreted as a 'pilgrimage center', is inferred to have had its origins in what would have been for the first colonists from east Polynesia a natural history anomaly--snow--which because it was 'matter out of place' must have been regarded as mystically dangerous. As Lewis (1976:109) points out, 'anomalies are always situational and relative, never or very rarely absolute.' The shrine complex, though undated, suggests that this anomaly was not avoided, but rather than it was quickly given a place in the local cosmology (Douglas 1966:38).

Reference was made earlier to chants that relate that because the island of Hawai`i was the firstborn of Papa and Wakea it was considered the older sibling or *hiapo* of all Native Hawaiians and that Mauna Kea was the origin point or *piko* of the island (Langlas 1999:7). The ascent of Mauna Kea has been described elsewhere as "a walk upward and backward in time to cosmological origins" (McCoy 1990:114).

Based on the large number of shrines in the summit area it is clear that Hawaiians went to the top of the mountain with a sacred purpose in mind, but it is doubtful that large numbers were involved at any one time. The ritual landscape that exists today is almost certainly the result of journeys by a number of families and adze makers over many generations.

The cluster of overlapping cinder cones that forms the "summit" of Mauna Kea, including those now called Pu`u Wekiu, Pu`u Kea, Pu`u Hau Oki and others that are not easily distinguished as discrete landforms (Porter 1979), has been designated an historic property (Site 21438) based on ethnographic information and archaeological data. Ethnographic information suggests that the "summit," as just defined, was most probably known in the past by a single name, Kūkahau`ula, that on present evidence referred to both a legendary figure and to a character in traditional histories and genealogies. The latter includes references to Kūkahau`ula as the husband of Līlīnoe and as an *`aumakua* (family deity) of fishermen. The place name evidence thus indicates that the "summit" was at the very least a legendary place (*wahi pana* Pukui and Elbert 1971, 1986). The archaeological evidence indicates that it was much more than that. While there is little archaeological evidence of human activity on the "summit" itself, the large numbers of shrines that encircle the mountain, just below (see Figure 7.1; see Figure 5.5 in back pocket), indicate that the top of the mountain was the focal point of ritual practices. There is no knowledge of what these practices entailed, but it is reasonable to infer that they were centered on the worship of local mountain gods and goddesses, such as Poli`ahu and Līlīnoe, and presumably Kūkahau`ula as well. The summit is thus interpreted to have been the focal point of a major pilgrimage site or center.

Though no archaeological surveys were conducted prior to the construction of the summit road, which was completed in the mid-1960s, there is no indication that any archaeological sites on the "summit" were destroyed at that time, or at any time thereafter in the construction of the existing observatories. In 1998 Kepa Maly interviewed two Hawaiian men, Theodore "Teddy" Bell, who had worked for Morrsion-Knudsen on the road to the summit, and Alika Lancater, who had worked on the construction of the first observatories in the 1960s. Neither one had seen or heard of any human bones uncovered along the road, or on the summit (Maly 1999 Appendix A:123, A-232).

The most important observation to be made about the summit (Kūkahau`ula) is the meager evidence of human activity prior to the historic period. Indeed, with the exception of Site 21209, which is comprised of two features, a small rock outline and mound on the southeast rim of Pu`u Wekiu, there are no other known sites of probable pre-contact age on the summit. The virtual absence of archaeological sites on the very top of the mountain may mean different things and is potentially open to a number of different interpretations. In the early to mid-19th century the opinion seems to have been that Hawaiians avoided the top of the mountain because of the cold environment and superstitious beliefs. The following accounts provide an indication of the thinking at that time:

> The natives have no passion for high mountains, or cold weather (Jarves 1844:222).
>
> It is very unlikely that any native had reached the top of the terminal cones on the summit, owing to being unprovided with warm clothing to resist the great cold and also to the fact that the natives had a superstitious dread of the mountain spirits or gods. About six months after the date of the first ascent of Mauna Kea by Mr. Goodrich the peak was scaled by Dr. Abraham Blatchley and Mr. Samuel Ruggle, both connected with the American Mission (Macrae 1922:55).
>
> The snow on the summit of the mountain, in all probability, induced the natives to call it Mouna-Kea, (mountain white), or, as we should say, white mountain. They have numerous fabulous tales relative to its being the abode of the gods, and none ever approach the summit---as, they say, some who have gone there have been turned to stone. We do not know that any have been frozen to death; but neither Mr. Goodrich, nor Dr. Blatchely and his companion, could persuade the natives, whom they engaged as guides up the side of the mountain, to go near its summit (Ellis 1979:292).

The lack of warm clothing was clearly not a deterrent to reaching the top of the mountain, as the numerous shrines located only a few hundred feet below the summit demonstrate. The repeated references to the top of the mountain being the "abode of the gods" and to the fear of the gods indicate why the early expeditions could not persuade their Hawaiian guides to go all the way to the summit. The top of the mountain was clearly a sacred precinct that must, moreover, have been under a *kapu* and accessible to only the highest chiefs or priests. The virtual absence of sites on the summit cones suggests that the same belief system had been adhered to and strictly enforced in the more remote past.

While the small number of shrines on the west and southwest side of the mountain suggest the possibility of people coming from the Kona and South Kohala districts, the number would appear to have never been high. The implications are quite interesting. It suggests that while the mountain may have been viewed from a distance by people from everywhere on the island as a sacred mountain, in practice those who made the journey and worshipped there did not represent an even cross-section of the island populace. The implication is that access to the summit region was under the political control of the east Hawai`i chiefdoms, a conclusion that is consistent with the ethnographic and historic evidence that the summit region of Mauna Kea was located in the Hāmākua District. A possible exception to this pattern, discussed below, is the adze quarry which may have been accessed from a number of different districts. In any case, most of the shrines in the southwest sector of the Science Reserve are part of the adze quarry complex.

Skeptics of the pilgrimage interpretation will probably argue that the scanty evidence of pre-contact Hawaiian activity on the summit is due to the destruction of sites during the road building in the 1960s and the construction of astronomical observatories that followed. Even if they are willing to accept that the near absence of structural remains on the summit is real, they might still say that the argument put forth is a case of special pleading. Anticipating such skepticism, it is important to note that Mauna Kea was not the only "high place" in Hawai`i where the common people were prohibited from entering. Another example is a hill named Pu`upane at Keokea in the Kula District, Maui that was described by Moses Manu in the late 19th century:

> This was a hill decreed by the ruling chiefs of Maui to be sacred; no commoner ascended this hill; for it was a *heiau* for the high chiefs of Maui from ancient times until Kihapi`ilani's arrival on the hill of Pu`upane, and that was the reason that this kahuna lived at `A`apueo, to watch out for it (Manu 1884:4, quoted in Kolb 1991:109).

On Hawaii Island there is another reference to the marking of boundaries on a hill in the Waimea area that involved a High Chiefess named Wao. The information is from the Edgar Henriques Collection:

> The servants of Wao would roll a stone down the hill to a flat land and wherever the stone would stop, that would be the tabu line, and no one would be allowed to pass. Especially would it be a sign for the people who lived below the hill called Pekepekelani who were a class known as Kauas or low born (Haun et al. 2002:12).

Whether a boundary is set by some practice, such as that described at Pekepekelani on Maui, or prescribed by some edict transmitted verbally, the scholar Van Gennep "saw that rites of transition treat all marginal or ill-defined social states as dangerous...Not only marginal social states, but all margins, the edges of all boundaries which are used in ordering the social experience, are treated as dangerous and polluting" (Douglas 1975:56). We believe that it is significant that, in contrast to the summit, there are no clusters of shrines at the base of any of the other cinder cones in the summit region, such as Pu`u Mākanaka, Pu`u Līlīnoe, Pu`u Poepoe, Poli`ahu and Pu`u Waiau. This implies a pattern akin to what Douglas called "graduated holiness," with the very top of the mountain or *piko* representing the holiest place in the Hawaiian world and accessible to only a special few.

The apparent absence, or at the very least, minimal evidence of human activity on Kūkahau`ula before European contact and written accounts is an example of "a larger pattern of presence-within-absence" (Herzfeld 1992:67). Though difficult to describe, it is the absence of human residues that points to the presence of spirits and gods on the mountain top.

7.2.3 Lake Waiau: A Central Place for Rites of Passage

In contrast to the summit, where there is little physical evidence of pre-contact use, archaeological data and traditional evidence indicate that Lake Waiau was a center for a number of activities (McCoy and Nees 2009) that included:

> 1) communication with the gods and goddesses of the lake;
>
> 2) a place where rituals associated with two of life's primary rites of passage, birth and death, took place; and
>
> 3) a place used by adze makers, some of whom may have been buried at the lake.

Based on the oral traditions relating to the placement of umbilical cords (*piko*) in the lake and the archaeological evidence of numerous human burials (see McCoy and Nees 2009 for a summary), Lake Waiau at some point in time became a central place for rites of passage related to both birth and death. Rites of passage are rituals that:

> mark the passages of an individual through the life cycle, from one stage to another, integrating the human and cultural experiences with biological destiny: birth, reproduction, and death (Myerhoff 1982:109).

Though no dates are available for either of the two rituals, it is likely that the lake was discovered relatively early after colonization of the island and that it became a *wahi pana* (storied place), at least for persons of high rank.

In the case of the *piko* we know that it was a practice that existed at the time of first known European contact in 1778. Sahlins (1981:41) cites an interesting example of *piko* being placed on board one of Capt. Cook's ships:

> ..and while the women remained alongside, the men, following their instructions, went on board and deposited the navel cords of newborn children into the cracks of the decks. Commenting on the incident, a modern Hawaiian authority on traditional custom observed: "Cook was first thought to be the god Lono, and the ship his "floating island." What woman wouldn't want her baby's *piko* [umbilical cord] there" (Pukui et al. 1972:184).

As a place inhabited by the gods the concealment of *piko* at Lake Waiau is of the same general pattern as that which occurred on Cook's arrival since he was regarded, according to Sahlins, as a god (Sahlins 1981, 1995). As noted earlier, the concealment of *piko* was a practice aimed at ensuring a long life and preventing a person from becoming a thief if the piko should have been taken before it was cared for in the proper way.

Given the occurrence of similar practices elsewhere in Polynesia (e.g., Easter Island or Rapa Nui where the umbilical cord was called *pito* Fuentes 1960) and other information, such as that collected by Thomas Thrum on Maui, the practice is undoubtedly an old one:

> Reference to the place of deposit of the "umbilical cords of Kaupo babies" (page 16), and to the superstitions relating to the practice illustrates the strong hold of ancient customs on Hawaiians. The practice may be traced back a thousand years or more, and throws light on the name chants of Puna-imua, Hema, Kahai, and others, which mention not only the place of deposit of the *piko* (umbilical cord) but other evidence of birth, hid in different locations, an ancient method, it may be, of birth registration. Whatever may have been the original design in the custom, the facts recorded in name chants may be used as a means of identification of proof, of Hawaiian birth, particularizing it to locality (Thrum 1921:259 in Emory).

Ethnographic data indicate that Lake Waiau was home to a number of gods and goddesses. There are references to the lake as the home of the goddess Waiau and the goddess Mo`o-i-nanea, the water-form of a *mo`o* (Maly and Maly 2005:vi). The one-time used name, Pond Poli`ahu, suggests that Poli`ahu may have also called the lake home. There are also references to the lake as the home of the gods Kane and Kanaloa and the place "from which the "ka wai kapu o Kane" (the sacred water of Kane) was collected" (Maly and Maly 2005:vi). On current evidence the lake would appear to have functioned something like both a female and male "earth shrine." The sacred water, whether female or male, was apparently used for healing purposes and the making of *awa* (Maly and Maly 2005:42). The consumption of *awa* may have been part of the rituals conducted at the lake and also in the adze quarry, where it was found in the cave called Keanakako`i by Eduard Arning in the 1880s (Arning 1931).

Many of the activities that took place at Lake Waiau involved hiding or concealment. According to Caron (1995:130), "hiding places and hiding practices are integral to the fabrication of sacred places." The evidence for this can be seen in the rites of passage that were performed at the lake.

To complicate matters, it now appears that there were two *piko* or centers on Mauna Kea, the summit (Kūkahau`ula) and Lake Waiau. According to some accounts the lake was named Ka piko o Waiau after the goddess Waiau (Maly and Maly 2005:vi), while the summit was also called Piko o Wakea according to Queen Emma's poets (de Silva and de Silva 2007). Though close spatially, the two centers were quite different places. Ethnographic accounts indicate that the summit region of Mauna Kea was located in the *wao akua*, a sacred region (Malo 1951:16-18). Like all sacred places, there were restrictions or *kapu* on what kinds of activities could occur. As argued above, the shrine distribution pattern indicates that the summit of the mountain was the focal point of the inferred pilgrimage process and that it was probably under a *kapu* that prevented all but the highest chiefs or priests from ascending the top or *piko* (McCoy 1999a).

7.2.4 Keanakako`i: A Central Place in Hawaiian Adze Manufacture

There is little doubt that what archaeologists today call the Mauna Kea Adze Quarry Complex, but which may have been known to native Hawaiians in the past as Keanakāko`i or Kaluaakāko`i (McEldowney 1982:1.7), was a central place in traditional Hawaiian stone adze manufacture. The vast area encompassed by the quarry complex and long-term chronology are in themselves indicators of a central place. Following the initial research, in 1975-76, and partial publication of the results of that earlier work, the quarry has gained more recognition and with it has come new and different interpretations. Some of this information is presented below, together with a brief discussion of some of the key debates that have arisen about some of the interpretations.

7.2.4.1 Quarry Boundaries: A Container View vs. A Practice View

In previous papers the statement has been made that the Mauna Kea Adze Quarry Complex covers more area and contains a larger volume of debitage than all of the other known adze quarries in the Hawaiian Islands combined (McCoy 1990:92). Following the 1975-76 fieldwork, frequent mention has also been made of the fact that the boundaries of the quarry complex have become increasingly blurred over time with the discovery of new sites (McCoy 1990:92). The current survey and a 10-week long survey in the NAR, in 2008-2009 (McCoy et al. in prep), indicate that the boundaries of the quarry complex extend below the Science Reserve and NAR boundaries onto Mauna Kea Forest Reserve lands, but how far is still unknown.

The boundaries of the quarry complex have become increasingly blurred over time with the discovery of not only new sites, but different perspective on how the boundaries should be conceived. Streck's (1992) comparison of the radiocarbon-based chronologies for the Mauna Kea Adze Quarry Complex and archaeological sites at the Pohakuloa Training Area (PTA) is one example of a different perspective. Streck separated the quarry complex from what he called the mid-elevation slope workshops. This split between the higher elevation quarry and lower elevation workshops reflects the age-old quarry/workshop definition problem. It implies, for example, the absence of raw material sources in the lower region of the quarry complex, which is not the case. The difference is between the more traditional and orthodox view of quarries as containers, the limits of which are defined by the local geology and a practice theory view that quarry boundaries are more diffuse by virtue of the practices that took place outside of the "container" which can be described as the *quarry proper*.

In the simplest terms, the Mauna Kea Adze Quarry Complex is a site complex comprised of the *quarry proper* (sites on or adjacent to a raw material source that contain cores, flakes, adze rejects and manufacturing tools), and isolated sites both similar to and different from those found in the quarry proper in terms of the size and variety of the artifact assemblages which are not of local origin but have instead been transported to their present location. Some, like the Pu`u Kalepeamoa Site (McCoy 1985b, 1991), contain adze manufacturing by-products but are located well beyond the source of raw material.

A previous discussion of the quarry (McCoy 1990) noted that the most obvious materialistic "explanation" for the vast areal extent of this quarry and chronology of long-term repeated use is the quality and quantity of the raw material. The boundaries of the quarry when defined using the "container view" coincide with the occurrence of a fine-grained rock called hawaiite, which is the dominant lithology in all of the younger lavas on Mauna Kea (Porter 1979c). The primary source of this material is what Porter (1979c; 1987) believes to be the front margin of a subglacially erupted flow (see Wolfe 1987:30 for a different interpretation) that forms an escarpment at the 3,720 to 3,780 m elevation in the vicinity of Pu`u Ko'oko'olau. Porter has described this flow, referred to as the Pu`u Waiau flow in his 1987 paper, as follows:

> Its downslope margin forms a discontinuous but abrupt cliff, locally embayed and commonly 15 to 25 m high (Fig. 15). The flow consists of a dark-gray dense

> nonporphyritic and nonvesicular hawaiite with well-developed intersecting joint planes that result in distinctive and rather symmetrical blocks of various sizes. The early Hawaiians quarried this flow extensively for adze blanks, because the dense aphanitic nature of the rock and its prominent jointing were ideally suited for their lithic industry (Fig. 4, loc. 10, Table 1). The large concentration of quarry sites along the steep flow margin suggests that the special properties of the rock that the Hawaiians found so desirable may be due, in part, to the unique eruptive conditions and cooling history of the flows (Porter 1979c:1034).

> The flow, which is very fine-grained and hard, fractures into slabs appropriate for such artifacts [adzes] and apparently was ideal for stone working. Its glassy groundmass contains randomly oriented microlites of plagioclase, rather than fully developed crystals, making the rock tougher than other flows and therefore easier to shape (Porter 1987:592).

The quarry is not localized to the escarpment, however contra the impression given in Porter's descriptions and maps (Porter 1979c, 1987:592 and Fig. 2.3). Secondary sources of tool-quality hawaiite are found in other flows and in glacial drift deposits below the escarpment (McCoy 1985, 1986; Wolfe 1987). The large area of the quarry is in fact directly related to the distribution of these glacial drift deposits which include moraines and outwash deposits of different ages. The older drift, labeled the Waihu Glacial Member, is exposed mainly below the 3,350 m elevation. The younger Makanaka Glacial Member is comprised of two bodies of drift which as a whole is less indurated than the Waihu deposits (Porter 1987:588-589). All three drifts contain hawaiite clasts of predominantly sub-angular to sub-rounded shape. The failure to consider the glacial till and glacial outwash deposits as part of the quarry and the confusion it causes is evident in Streck's (1992) analysis of radiocarbon dates for Mauna Kea and PTA (see discussion of the quarry chronology below).

As previously suggested, it is possible that the lower quarry boundaries are demarcated in a general way by the boundaries of the earlier glacial outwash deposits on Mauna Kea (McCoy 1990: Figure 5, 1991; see Figure 7.2; Figure 7.3). Though the geology is helpful in predicting where the boundaries might lie, we believe that the quarry industry is more profitably viewed as a *process* --a three-part process of ascent, production, and descent--that involved a series of changes in the social persona, thus, emphasizing the "being" and "becoming" aspects of social life (Turner 1967; McCoy 1990).

In the case of a quarry complex like that on Mauna Kea, the container view is an impoverished view that leaves out of account important social and ritual activities undertaken before entering and upon departing from the quarry. A better but more difficult way of determining appropriate boundaries is to adopt a practice theory approach that seeks to explain "the configuration of cultural forms, social relations, and historical processes that move people to act in ways that produce the effects in question" (Ortner 1989:12).

7.2.4.2 Chronology

Not only does the Mauna Kea Adze Quarry Complex cover a larger area than all of the other known stone adze quarries in Hawai`i, but it also has what is probably one of the longest chronologies of any single place in Hawai`i. Buried B2 horizon soils in the excavated rockshelters suggest that there were hiatuses or breaks in the production

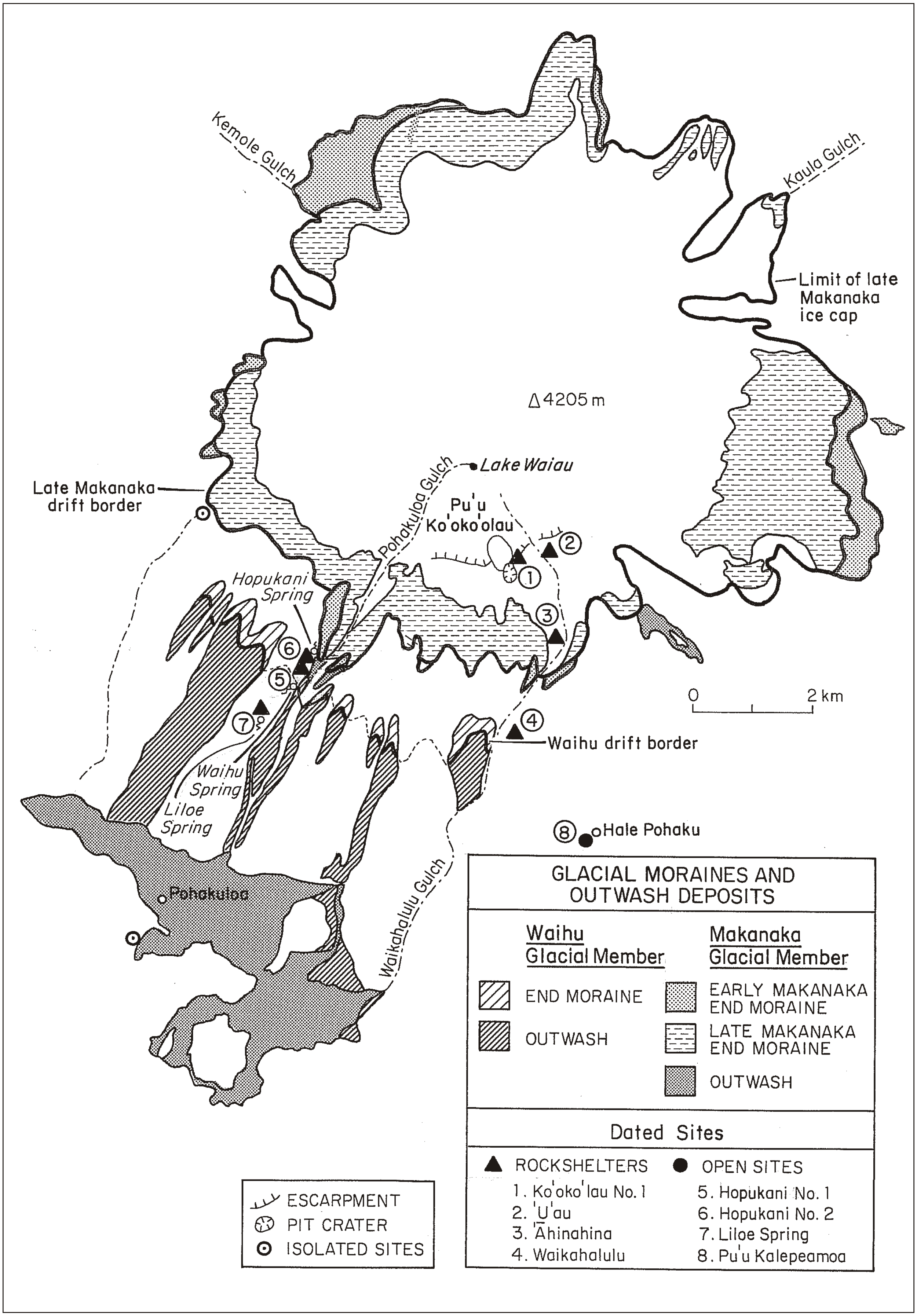


Figure 7.3. Locations of Previously Dated Sites in Relation to Glacial Moraines and Outwash Deposits.

process. The soils, which should perhaps instead be called sediments, are probably of aeolian origin given the short chronology of quarry use and slow development of soils in an alpine desert environment (Ugolini n.d.).

With the dating of the rockshelter at Site 26253 there are now 26 radiocarbon dates from nine excavated sites indicate that the quarry "industry" spanned a period of approximately 700 years, between ca. AD 1100-1800 (McCoy 1990: 92-93), although a shorter chronology now seems more likely based on recently obtained radiocarbon age-determinations for the settlement of the Hawaiian Islands. On current evidence, the period of peak production was ca. AD 1400-1700. This is a conclusion Streck reached in an analysis of radiocarbon dates from Mauna Kea and PTA:

> The annual frequency distributions suggest that prehistoric cultural activity in the uplands of Hawai`i Island may have been most intense from A.D. 1400 to 1450. The curves derived from samples from the Mauna Kea Adze Quarry Complex and the middle slope workshops differ slightly in that the workshop curve appears strongly unimodal with a sharp peak around A.D. 1425 (Fig. 1). There appears to be relatively infrequent use of the middle slopes before this time. The adze quarry curve suggests more intensive use over a longer period. The most intensive use seems to have occurred around A.D. 1440, with significant use between A.D. 1300 and 1650. Prehistoric use of Mauna Kea covers a maximum of around 700 years until the nineteenth century (Streck 1992:103).
>
> The available radiocarbon dates suggest that the main prehistoric use of the Mauna Kea Adze Quarry Complex was during a relatively short period of around 300 years. This covers the period when the development of class stratified societies and the formalization of traditional land tenure systems are thought to have occurred (Streck 1992:106).

When the quarry was abandoned is unknown and may never be known with any certainty, but there is some evidence that it may have occurred prior to European contact in 1778 or shortly thereafter (Welch 1993:31). Historic accounts indicate the rapid adoption of Western tools, clothing and other items in the major trading centres, initially by the chiefs and then the common people. By 1793-94, the chiefs in some areas were apparently no longer interested in trading for iron tools, such as adzes, because of a surplus of metal (McCoy 1990:93; Sahlins 1981:44). That some people, including craft specialists such as canoe makers, continued to use stone adzes for selected tasks into the historic period is well documented (Brigham 1902), but the extent to which stone tool adzes continued to be manufactured is open to debate. Remote quarries, such as the complex on Mauna Kea, may have been the first to be abandoned, although the manufacture of a small number of adze blades may have continued for a while given what is assumed to have been the high value of the adzes from this particular quarry.

The terminal date for adze manufacture on Mauna Kea has become a subject of debate. In an earlier paper the senior author wrote the following regarding the abandonment of the Mauna Kea quarry (McCoy 1990:92-93):

> With regard to an upper limiting or terminal date, there is archaeological as well as ethnohistoric evidence (McEldowney ms:7) suggesting that the quarry may have been abandoned prior to first known European contact in 1778 and the ensuing rapid replacement of stone tools with metal counterparts. In any event, by 1793-94 there was a surplus of metal and the chiefs were apparently no longer interested in trading for iron tools such as adzes (Sahlins 1981:44).

Bayman (2003, 2007) has taken issue with this passage and used it to suggest that:

> The tendency to overlook evidence for the persistence of stone adze economies in the Hawaiian islands may reflect the view of some archaeologists (e.g., McCoy 1990:92-93) that stone adzes were quickly replaced by metal adzes after European contact (Bayman 2003:95).
>
> Some researchers (e.g., McCoy 1990:92-93) have concluded that stone adzes were quickly replaced by metal adzes after contact, and that large quarries like Mauna Kea were abandoned (Bayman 2003:98).
>
> This lack of attention to post-contact stone adze economies in the Hawaiian Islands clearly contributes to the "rapid replacement" view of some archaeologists (e.g., McCoy 1990:92-93)…that metal adzes were more efficient tools than stone adzes (Bayman 2007:5).

Bayman has deliberately distorted McCoy's argument by not discussing it in full. He did not take into consideration the context of the statement which was made in a paper on the Mauna Kea Adze Quarry Complex and, thus, the manufacturing component of the production process. The statement regarding rapid replacement of stone adzes by metal counterparts did not specify an actual date or period of time and was, moreover, qualified with the following words: "In any event, by 1793-94 there was a surplus of metal and the chiefs were apparently no longer interested in trading for iron tools such as adzes" (Sahlins 1981:44). And nowhere has McCoy attributed the replacement of stone adzes with metal ones to efficiency. In continuing to single out one individual as an exemplar of a larger problem he has committed what is commonly called the "straw-man fallacy."

Bayman does not seem to be aware, moreover, of the ethnohistoric evidence that was cited by McCoy (1990:92) and the extent to which it might actually bolster his argument for continued stone adze manufacture after contact. The evidence in question was presented in a report by McEldowney:

> The only native Hawaiian mention of this resource, or its use on Mauna Kea, found thus far is the testimony in the 1873 boundary dispute between Humuula and Kaohe *ahupua'a* (Bound. Comm. Bk., Vol. B:28-59, Haiki). In reciting noteworthy landmarks along the boundary, which he claimed crossed the summit, Haiki mentioned first "Kaluakaakoi a cave there they used to get stone adzes out" and later reiterated, "My parents told me Humuula went to Kaluakaakoi and Poliahu. We used to go there after adzes for Humuula people." If these statements are valid, and if his knowledge of the boundaries came from his "father," "grandfather," and "father of my wife" as he claims and considering that he was born "after the battle of Kekuakalani" (i.e. 1819; Barrere, pers. Comm..), then the knowledge and use of the quarry as implied from these statements potentially stretch from the 1770s to the 1840s. A complicating factor in using these statements is that Haiki's overall testimony and placement of the boundary was rejected by the commission (McEldowney 1982:1.7).

If there is any fault to be had with archaeologists overlooking continuity in stone adze manufacture and use, part of it would seem to lie with the uncritical use of the ethnohistoric literature. Bayman's use of this literature is of interest in the larger debate, since in his 2003 paper he cites with approval Brigham's comments regarding the apparent cessation of large-scale stone adze manufacture after contact, but does not refer to Brigham's comments on the efficiency of the traditional adze:

> Of course the making of stone adzes ceased soon after the introduction of iron and I have never seen them made, nor have I talked directly with any of the surviving makers, but I have seen them used and sharpened, and I have been astonished at the dexterity of the man and the efficiency of the tool. In watching the shaping of a canoe I have seen the old canoe-maker use for the rough shaping and excavating an ordinary foreign steel adze, but for the finishing touches he dropped the foreign tool and returned to the tool of his ancestors, and the blunt looking stone cut off a delicate shaving from the very hard koa wood and never seemed to take too much wood as the foreign adze was apt to do. That skill was an important element in the use I was convinced, for with all the teaching of the native I could only make a dent where I tried to raise a shaving (Brigham 1902: 408-410).

Brigham's remarks, contra Bayman's conclusion in his 2007 paper of why Hawaiians stopped making stone adzes after contact (Bayman 2007:3), indicate that efficiency was *not* the reason for the replacement of stone adzes with metal ones, that the small stone adze was in fact preferred by a canoe maker in making the finishing touches.

Finally, the continued use of stone adzes after contact does not necessarily imply continued manufacture, especially in such isolated localities as Mauna Kea. Smaller adzes, if properly maintained, can have a long life history, and if they do enter the archaeological record they are examples of "curation."

The following article, which appeared in *The Pacific Commercial Advertiser*--Notes of the Week, in October 28, 1862, lends support to Brigham's and the senior author's conclusion that work in the Mauna Kea adze quarry ceased shortly before or just after European contact:

> Hawaiian Antiquities---On a recent tour around Hawaii, Dr. Wm. Hillbrnd ascended to the summit of Mauna Kea, in company with Charles Hall and Capt. Cummings. About 1500 feet below the top on a side of the mountain seldom visited by either foreigners or natives, they discovered an ancient manufactory of stone implements. It consists of a cave, in front of which was a pile of stone chips 25 feet high, which had evidently accumulated from the manufacture of stone adzes, maika balls, etc., and which lay scattered about in an unfinished state. In front of the cave a wooden idol, in good preservation, which, with the pedestal attached to it, measures nearly five feet high. In form the image very much resembles that pictured in Jarves' History, page 27. Bones of pigs and dogs, kapa, pieces of coconut shells, fragments of hewn wooden implements, sea shells, and many other curiosities were also found. The party loaded their guide and themselves with as many of these curiosities as they could carry, and returned to Waimea. On reaching Rev. Mr. Lyons' residence the discovery soon became noised abroad among the natives, who flocked to the mission premises to learn the truth of the report. On inquiry among them, no person appears ever to have heard of the existence of the manufactory, even the oldest natives were ignorant of it. From this it is inferred that its antiquity must date back beyond the present generation. On reaching Kona, Dr. H. learned from Capt. Cummings that an old native was living there, who in his younger days had heard the place spoken of by his fathers, but nothing definite can be learned regarding it. The discovery forms an interesting incident in Hawaiian history, and may lead to further searches and perhaps discoveries regarding the ancient customs of this people.

7.2.4.3 A Consecrated Industry of Craft Specialists: Ethnographic and Archaeological Evidence

As noted elsewhere (McCoy 1990:96), the number of shrines and other ritual remains in the Mauna Kea Adze Quarry Complex indicate that work in the quarry, like the building of a Hawaiian canoe, was an "affair of religion" (Malo 1951:126). According to Handy this was true of all of the major crafts throughout Polynesia. Handy (1927:282) used the term "consecrated industry" to highlight the pervasiveness of ritual in Polynesian crafts:

> The main features of all kinds of consecrated enterprise were everywhere fundamentally the same. These were: organization and direction under master craftsmen or adepts, and priests; worship of patron deities, who were commonly deified men, by means of prayer and the presentation of offerings; tapu and purificatory rites designed to insulate the work, the workers, and the product, from evil; the taking of omens relative to the outcome of the enterprise; empowering workers, places, instruments, and the products by using conductors of mana, and endowing them directly with mana through spells; consecrating the finished product by means of ritual; and finally, feasting and general merrymaking to mark the end of the consecrated period, to enjoy the product, and to render thanks to the gods (Handy 1927:282).
>
> Consecrational worship before, during, and after, all labor was regarded as the prerequisite of successful accomplishment...What Malo wrote with regard to the making of canoes in Hawaii was true in ancient times of all industry throughout all Polynesia: "The building of a canoe was an affair of religion" (99, p. 168) (Handy 1927:282).

Information on Hawaiian craft specialization (see Lass 1998 for a useful summary) is on the whole rather meager and for adze manufacture almost non-existent. Malo (1951) noted that adze makers, who were called *po`e ka-koi*, were a "greatly esteemed class" and that "each man worshipped the *akua* that presided over the occupation of profession he followed" (Malo 1951:51). According to Sahlins "craftsmen and priests did not constitute a separate class (contra Malo) or status level. Their position in the social hierarchy was instead determined by their inherited rank which varied along a continuum from low to high" (Sahlins 1958:14). According to Goldman (1970) the common craftsman was known only by his specific occupation--"one who makes adzes, or, if an acknowledged expert, as a "skilled person" (*malalaioa*)" (Goldman 1970:223). It is unclear as to whether or not craftsmen of commoner status were granted the title of *kahuna* after an apprenticeship (like priests of the commoner class), but Goldman's analysis of status led him to conclude that the technical statuses (i.e., craft specialists) were not a shadow aristocracy, but rather an elevated class of commoners (Goldman 1970:537).

Buck noted that "Chiefs, warriors, craftsmen, and commoners had their own particular deities. The commoners conducted their simple ritual without any special setting, but craftsmen made simple shrines upon which to deposit their offerings" (Buck 1957:465). Ethnographic data indicate that amongst groups of craft specialists, one of them assumed the temporary role of a "priest" in conducting ritual activities. According to Goldman (1970:223), "Kahuna, a title for both professional priests and craftsmen, implied in both fields a ritual office. The crafts kahuna was its religious leader." Handy noted that there were several ways of becoming a craft priest:

> The system of professional craftmanship was such that the adepts or master craftsmen (kahuna, tohunga) may properly be called craft priests. A man who became an adept at some profession through heredity, aptitude and apprenticeship, was not only master of the technique of his profession, but was also master of the ceremonial requirements of his trade, understood the auguries and omens that were significant... Likewise in Hawaii the master canoe-maker presented offerings to the gods of the forest; he uttered the appropriate prayers; and then he himself did the preliminary manual work in trimming the log for the canoe body before it was shaped out (99, p. 168). Under the direction of the adept in charge there always worked a body of consecrated workers, some of them also adepts, others assistants or apprentices (Handy 1927:282-283).

In contrast to everyday work, the places where consecrated work took place had to be purified, as did the people involved in such work. According to the information gathered by Handy:

> Numerous tapu protected consecrated enterprise from evil influences. Those engaged in the work had to be purified before they began their labors in order that they might be freed from evil that had attached itself to them and be made physically pure to work as instruments of mana (Handy 1927:284).
>
> The localities used in connection with sacred labor had to be consecrated, as did the workers. It has already been pointed out that the precincts of the professional fishermen in both Hawaii and the Marquesas were tapu, that is protected against the intrusion of outsiders (Handy 1927:285).

Archaeological evidence of the kinds of consecrational acts described ethnographically have been tentatively identified at several sites on Mauna Kea. There are two sites, both located outside of the quarry proper, that have been interpreted as places where rites of passage may have taken place. One is the Pu`u Kalepeamoa Site (50-10-23-16244), a treeline campsite that on present evidence was occupied by adze makers on the ascent to and descent from the quarry complex (McCoy 1991; McCoy et al. 2009). A piece of chill glass from this site has been recently sourced to either Mauna Loa or Kilauea (Peter Mills, written communication), with the most likely source being the Pohakuloa Chill Glass Quarry Complex in the Pohakuloa Training Area (Williams 2002). This artifact suggests a southerly ascent route, while the presence of adze preforms and manufacturing waste indicate material transported downslope from the quarry. This transitional site contains evidence suggesting that it was the locus of rites of passage involving a change in social status from *noa* to *kapu*, Hawaiian terms that are commonly but, according to Shore (1989), not adequately glossed as sacred and profane. According to Shore, *kapu* and *noa* represent the relations possible between the divine and the human, with *kapu* being “a state of contact with the divine” and *noa*, “an unbounded state of separation from the divine” (Shore 1989:164-165). A variety of artifactual evidence suggests that the Pu`u Kalepeamoa Site point was a logistical support camp occupied by people engaged in a number of different activities.

As noted in a data recovery report on the Pu`u Kalepeamoa Site (McCoy 1991), there is good reason to expect that the ascent and descent phases of the quarry operation were important social occasions based on ethnographic information relating to Hawaiian beliefs and the generalization that "The crossing of frontiers and thresholds is always hedged about with ritual, so also is the transition from one social status to another" (Leach 1976:35). Elsewhere (McCoy 1990:114) it was inferred that the ascent to the quarry must have involved a serious of religious rites in the process of passing through and across the boundaries of a number of different environmental zones perceived in cultural terms as wildernesses and known by the general term *wao* (Malo 1951:17).

Located on the margins of the quarry complex is the second site where a different kind of rites of passage ritual is believed to have occurred. This is the Site 16204 ritual complex described in the summary of site types in Section 5. Site 16204, which consists of a group of ridge top shrines, two clusters of small rock outlines below the shrines, and a diffuse scatter of flakes, unfinished adze blades and hammerstones associated with the shrines and the rock outlines, is quite unlike any other found in the quarry. As noted earlier, it has been interpreted as a place where the initiation of apprentice adze makers may have taken place (McCoy 1999b).

7.3 The Mauna Kea Adze Quarry Complex and Its Relevance to Selected Topics and Issues in Hawaiian Archaeology

The study of isolated, so-called "special purpose" sites and site complexes located outside of the permanently occupied coastal-inland zone, such as the Mauna Kea Adze Quarry Complex and the ritual landscape located in the summit region of Mauna Kea, hold great potential to contribute to an understanding of cultural process at the regional level. Such site complexes and landscapes also require a regional perspective if they are to be properly understood in terms of their various relationships, which are fundamentally political, socio-economic and religious, rather than purely technological in the case of the adze quarry.

In talking about social action in non-Western societies it is important to remember that:

> ...any social action is simultaneously economic, political, and religious, although not necessarily to an interesting extent...If religion, politics, and economics are analytical rather than empirical categories, it follows that the vexed question of causal relations or determinism among them is a theoretical one, a function of the way in which these entities are conceived. Social science has not yet produced a generally accepted theoretical statement of these relations because the three categories themselves are not logically necessary but merely emanations of the organization of Western society into church, state and market (MacGaffey 1986:2-3).

7.3.1 Craft Specialization, Social Complexity and the Related Issues of Trade and Exchange

It is now widely accepted that the emergence of craft specialization is not correlated with social complexity, at least with social complexity viewed as a linear series of evolutionary stages (e.g., tribe to chiefdom to state). Goldschmidt noted, for example, that the Nomlaki, a tribe located in Northern California, had a number of specialists (Goldschmidt 1951). The discussion of Keanakako`i as the locus of a consecrated tool manufacturing “industry” has already introduced the concept of craft specialization. Based on ethnographic evidence, the consecrated industries of Polynesia were all forms of craft specialization (Handy 1927). The discussions that follow considers the origins of Polynesian craft specialization and archaeological approaches to studying it.

7.3.1.1 Ethnographic Perspectives on the Origins of Polynesian Craft Specialization

The origins of craft specialization and its relationship to social complexity in Polynesia has been a subject of interest to both ethnographers and archaeologists. Goldman presented an interesting and insightful theory on the origins of specialization in Polynesia:

> The significance of specialization lies in its role of diversifying the economy, giving it more interactive agents and more complexity with respect both to the organization of production and the system of exchange. General economic theory holds specialization to be a by-product of high productivity, on the one hand, and of the diversification of social needs, on the other. The assumption is logical enough that an economy will not have specialists until it can afford them and wants them, but since the theory does not claim that specialization <u>must</u> arise with an economic "surplus," it is uninformative on the very question of greatest interest, namely: how does specialization arise? With its wide range of forms of specialization, Polynesia can illuminate some of the factors in their evolution. In the history of specialization, Polynesia is not at the lowest level. All share in the common respect for the expert, the tohunga. Respect for skill is surely a basic human trait. But the Polynesian concept of tohunga is more than general respect. By conferring the title, the Polynesians have converted a general human concept into a specific system of status, drawing the expert into the orbit of aristocracy. Thus, viewing the forms of variation and the historical elaboration of specialization from the perspective of Polynesia, we see in the honoring of the expert the source of the whole development. The concept of expertness does have its roots in the actual nature of skills, as in the exceptional skill required to fashion a seaworthy canoe. It is the elaboration of the system of skills, the formation of professions, of guilds, and the incorporation of the tohunga into the order of statuses--in short, the growth of specialization--that we must attribute to the basic concept of honoring the expert. This, however, remains to be proven (Goldman 1970:491-492).

The importance of skill and knowledge is repeatedly emphasized in the ethnographic literature. Shore elaborates on their interrelationship and why craft specialization was universally regarded as a *tapu* activity:

> Knowledge and skill have frequently been pointed to as exemplifying *mana*. Those with specialized skill and knowledge, who Polynesians variously call *tohunga* (Maori), *tufuga* (Samoan), *kahuna* (Hawaiian), and *tahu`a* (Tahitian), among others exhibit *mana*...What all of these specialists share is the capacity to to externalize intellectual power (knowledge) as concrete, coherent products such as boats, houses, victory in warfare, and healed bodies. Knowledge embodied in organized, generative activity, whether words or deeds, replicates the work of the gods for Polynesians, and is thus *tapu* activity (Shore 1989:149-150).

Just how important the gods were to craftsmen was noted by Malo (1951) and others. The role that ancestral spirits and deities played in traditional crafts was summarized by McEldowney (1982: A-14) who noted that “Numerous ancestral spirits and deities who were attributes of other gods presided over occupational groups and individual professions in every aspect of their work. Craftsmen relied on these religious entities to provide inspiration, to enhance skills, and to insure the quality and availability of material used” (Malo 1951:81; Barrere 1962:23).

7.3.1.2 Archaeological Approaches to the Study of Craft Specialization and the Importance of Quarries

Torrence noted some years ago that "Craft specialization and control over resources both present very knotty problems for archaeology because the terms embrace such a wide variety of different types of behaviour whose relationship to exchange do not appear to be necessarily straightforward" (Torrence 1986:233). Questions of resource ownership, access, and control, on which the interpretations of tool acquisition (direct access or exchange) are based, are especially difficult to investigate, however, as Torrence herself discovered in her investigations of Bronze Age obsidian exchange on the Aegean island of Melos (Torrence 1984, 1986).

One of the problems in studying craft specialization is related to the matter of variability in the forms and levels of production and the different terms used to characterize this variability. Costin (1991) and Clark (1995) provide a good summary of the problem:

> For example, the term "attached specialization," as first suggested by Earle [1981] and then developed by him and others [Brumfiel and Earle 1987; Costin 1986; Gero 1983; Hagstrum 1985, 1989; Russell 1988], was defined as production on command for elites and the social and political institutions they control. The key was the reference to a situation in which elites sponsor the productive process in order to control the distribution and consumption of high-value, high-status goods…This has implications for explanation, since central to Earle's work is the theme that attached specialization develops as part of a political processes, while independent specialization evolves to meet utilitarian, economic needs [Brumfiel and Earle 1987] (Costin 1991:7).
>
> Recognition of different types of specialized craft production sent investigators scrambling to devise typologies of craft specialization and to determine the archaeological signature of each type (see Costin 1991 for a summary)...The current confusion of categories makes comparative analysis difficult (cf. Halperin 1994:1-11) and calls into question the usefulness of craft specialization as a descriptive, analytical, or explanatory category (Clark 1995:270).

According to Torrence (1984:50; 1986:164), quarries should assume a privileged position in the study of stone tool production and exchange systems because of the direct link to consumers. A well designed analysis should make it possible, for example, to determine whether tools were obtained by what Colin Renfrew (1975:43) has called "direct access," or through some form of exchange. In the latter case, quarries should theoretically provide a better indication of the kind of exchange than settlement sites, where inferences based on the study of consumption patterns are always faced with equifinality problems caused by such factors as tool reuse or recycling, variable discard patterns, and post-depositional processes. In practice, stone tool quarries are not easily interpreted in social terms, however.

In Hawai`i, the Mauna Kea Adze Quarry Complex has assumed a special place in an on-going dialogue regarding the origins and antiquity of craft specialization. One reason for the focus on Mauna Kea, discussed elsewhere (McCoy 1990:110), is that Mauna Kea is the only known tool-quality basalt source in the Hawaiian Islands with the inherent potential to sustain over a period of more than perhaps a few centuries an institutional practice such as the legitimation of chiefly authority and power based on the production for exchange by a group of attached specialists (Brumfiel and Earle 1987:5-6).

Following on the 1975-76 research project there have been efforts to identify craft specialization in the Mauna Kea Adze Quarry Complex based on: (1) the scale of production (McCoy 1977, 1981, 1990); (2) standardization of adze forms (Cleghorn 1982; Kirch 1990); (3) standardization of manufacturing techniques and indications of apprenticeship based on measures of differential skill (Cleghorn 1982, 1986), and the degree of ritual investment in the manufacturing process (McCoy 1977, 1981, 1990, 1991). A brief review of some of the key arguments is presented below.

In the neo-evolutionary writings that are part of the increasingly diversified literature on Hawaiian archaeology (e.g., Kirch 1984, Hommon 1986) there are explicit and implicit references to the "evolution" of tool types and the appearance of craft specialization as an index of social complexity. Kirch provides a good illustration of this viewpoint:

> In contrast to the early adze variation, for example, later Hawaiian basalt adzes display a *monotonous* uniformity…..The increasing standardization of portable artifact morphology in the Expansion and especially Proto-Historic Periods thus implies increasing craft specialization, as well as the control of certain raw material resources (e.g. adz quarry sites) by particular social groups. Elite control of unevenly distributed resources (such as fine-grained basalt for adzes, pearly shell for fishhooks, or large *Acacia koa* trees for canoes) would imply some form of exchange between sociopolitical units (Kirch 1990a:327, our emphasis).

McCoy (1990:100-101) has criticized the normative view linking craft specialization to standardization. He has challenged the conclusions of Cleghorn and others (e.g., Arnold 1987; Kirch 1990) who use standardization of tool form and manufacturing procedures as unambiguous signatures of craft specialization. While quadrangular cross-section adze blades are the most common "type" in the quarry and in collections of finished adzes (Emory 1968: 162-164; Kirch 1990), there is also evidence for a multiplicity of reduction strategies and tool forms throughout the history of the quarry complex (McCoy 1990:101) and, indeed, at other Hawaiian quarries as well (Dye et al*.* 1985; Weisler 1990:35-36). Some of the variability is undoubtedly due to predictable failures and departures from norms, which are to be expected in quarry sites (Isaac 1977:9, footnote 1) despite the level of skill that is evidenced in the debitage and unfinished adze blades.

Some of the diversity of adze forms in the Mauna Kea Adze Quarry Complex and other Hawaiian adze quarries (e.g., Dye et al. 1985; McCoy et al. 1993; Weisler 1990) is related to variability in raw material properties. Mauna Kea is unlike any other Hawaiian adze quarry in the presence of massive bedrock exposures, unconsolidated glacial drift deposits containing rounded cobbles and boulders, and an abundance of thick tabular slabs of minimally weathered basalt resting on the surface or embedded in a lava flow. Indeed, the thick tabular slabs facilitate the manufacture of quadrangular-sectioned adze blades and probably contribute to the predominance of these types in the complex. In contrast to the areas containing bedrock exposures and slabs, where there is a preponderance of larger and thicker quadrangular adze preforms, smaller, more diverse adze forms are found more commonly in the glacial drift deposits.

The predominance of thick rectangular and square cross-sectioned blanks preforms (Cleghorn 1982, this report) supports the unstated assumption that a higher value was placed on tabular material, which is virtually localized to the escarpment and nearby flows. It is here that the vast majority of the larger adzes used in felling trees for canoes and land clearance would have been made. Maximization of raw material form is obvious, yet there is also clear evidence throughout the history of the quarry of multiple reduction strategies in the manufacture of a range of adze types and sizes from core blanks and flake blanks (McCoy 1977, 1981, 1986; Cleghorn 1982).

7.3.1.3 Variability in Hawaiian Stone Adze Manufacture: Different Forms of Craft Specialization and Scales of Production

Lass, who agrees that standardization of Hawaiian adze forms is a problematical marker of craft specialization (Lass 1998:25), has challenged the view that the adze makers on Mauna Kea were “attached specialists” rather than “independent specialists” as defined by Brumfiel and Earle (1987:5-6). Lass believes that the quarry complex was used on an occasional basis by “independent specialists,” defined by her as specialists that were neither sponsored nor supported by chiefs (Lass 1994:47). This conclusion is at odds with the ethnographic record. According to Sahlins, craftsmen were engaged and subsidized by high chiefs and local leaders of intermediate status (Sahlins 1958:15-16).

Bayman and Moniz (2000), who are in agreement with McCoy regarding a high degree of specialization and elite sponsorship in the Mauna Kea Adze Quarry Complex, have presented a different interpretation of three isolated adze manufacturing sites located near the bottom of Pōhakuloa Gulch. In their view the assemblage of lithic artifacts from Sites 5003, 12251, and 14638 represent an expedient form of adze production on a smaller scale than what is evidenced higher on Mauna Kea in the quarry proper. While providing yet another demonstration of variability in Hawaiian adze manufacture, they came to the questionable conclusion that manufacture at the Pōhakuloa sites was “non-specialized” and “outside of the direct purview of elite control” (Bayman and Moniz 2000:249):

> Expedient adze production at Pohakuloa and Pololu was on a much smaller scale, it was non-specialized, and it was outside the direct purview of elite control. The adze rejects on the interior saddle were evidently intended for different functions than the larger ones made on Mauna Kea (Bayman and Moniz 2000:249).
>
> Detailed study of the Pohakuloa adze production system also revealed that it was markedly different in terms of its organization than the main quarry at Mauna Kea. Simply put, there is strong evidence that adze production (and use) at Pohakuloa was embedded in a broader economy of resource extraction that included bird catching and other activities. Moreover, this system of adze production operated independently of the highly specialized, large-scale production that was practiced at the main quarry of Mauna Kea. These findings have important implications for general models (e.g., Kirch 2000) of traditional Hawaiian economic organization (Bayman et al. 2004:85).

The conclusion that adze production at Pōhakuloa was embedded in a broader economy of resource extraction and operated independently of the highly specialized adze manufacturing industry higher on Mauna Kea is similar in some respects to the Lass model discussed above. The Bayman and Moniz-Nakamura model is based on several unfounded assumptions, including: (1) that the Pōhakuloa sites were occupied by a different group of adze makers than those working in the adze quarry and the sites therefore were not a part of the quarry industry or production system; (2) that manufacture was expedient, and (3) that the adzes made at this site, which they claim are smaller than those found in the quarry probably had a different intended function.

One problem with both Lass' (1988) and especially Bayman and Moniz's (2000) interpretation of independent specialists, is the underlying assumption that specialists of this class were manufacturing a tool to meet strictly utilitarian, economic needs in contrast to the attached specialists who were part of a political process because of chiefly sponsorship. This is the Brumfiel and Earle model (1987:5), which fails to take into consideration a point emphasized by Kirch based on an earlier remark by Goldman:

> Polynesian political systems cannot be understood separately from cosmology and religion, nor for that matter can their economic systems be divorced from their political and ritual contexts. As Goldman put it, 'whether we start with politics to explain the economy or with economics to explain the polity, we are involved in the same equation' (1970:509) (Kirch 1984:37).

The idea that the smaller adzes found at the Pōhakuloa sites might have been used for different purposes than the larger adze preforms found wherever the raw material form allows them to be made is a commonsense kind of argument, but it is difficult to apply for reasons noted by Sahlins:

> In order to frame an answer, to give a cultural account of production, it is critical to note that the social meaning of an object that makes it useful to a certain category of persons is no more apparent from its physical properties than is the value it may be assigned in exchange. Use-value is not less symbolic or less arbitrary than commodity-value. For "utility" is not a quality of the object but a significance of the objective qualities" (Sahlins 1976:169).

Based on evidence from a number of adze manufacturing sites on the south flank of Mauna Kea, we believe that the authors have misinterpreted the Pōhakuloa sites and because of this reached spurious conclusions regarding the scale of production and sponsorship. The artifact assemblage at Site 14638 resembles the Pu`u Kalepeamoa Site assemblage in the presence of bird cooking stones, small adze preforms, small flake debitage, volcanic glass nodules, abrading tools, and utilized basalt flakes (Bayman and Moniz 2000:243-244). The similarities between the two site assemblages suggest that a variety of activities took place at both sites. In our view the two sites were logistical support camps for the adze makers working in the quarry.

Use of the term "expedient" to characterize the discarded, unfinished adze preforms at the Pōhakuloa sites does not purport with the widely accepted definition of expedient tools and technology:

> In a continuum of production effort formal tools are at one end and informal tools are at the opposite end. Informal tools may be viewed as unstandardized or casual with regard to form. They include expediently manufactured tools that are made, used, and discarded over a relatively short period of time. Binford (1979) characterizes such tools at situational gear, or gear that is put to use in response to conditions rather than in anticipation of events or situations. This kind of technology is wasteful with regard to lithic raw materials: it tends to produce tools that are simpler and have less formal patterning, shape, or design (Andresfky 1998:213).

The illustrated adze preforms from the three Pōhakuloa sites (Bayman and Moniz 2000: Figure 4) indicate that more than a little effort was expended in their manufacture and that unlike the utilized basalt and volcanic glass flakes at these sites, the adze makers must have had some form in mind. Another description of the contrast between formal and informal tools emphasizes the differences between the two:

> Formal tools are defined as artifacts that require energy and skill to manufacture, such as endblades, sideblades, burins, microblades, and bifaces (Andresfky 1994b, 1998). They are tools in standardized form, shaped for hafting, which require a preconception, or a "mental template" prior to manufacture. They are distinguished from "expedient" tools, such as flake knives and retouched flakes, which can be manufactured spontaneously with minimal preparation (Wenzel and Shelley 2001:115).

Part of the effort required in making any stone tool is obtaining the raw material. Even if tool-quality basalt occurred nearby in the glacial outwash deposits at the bottom of Pōhakuloa Gulch (Porter 1979a, 1987; McCoy 1991:Figure 3; see Figure 7.1), the effort in finding, testing and transporting a partially reduced cobble or other piece of material is inconsistent with the notion of an expedient technology.

In a discussion of the volcanic glass quarry complex at PTA Williams cautions against the unqualified use of such terms as simple and expedient in describing stone tool manufacture:

> Using the term "simple" or "expedient" to describe a reduction technology often has unfortunate negative connotations to it, as few technologies are ever really "simple." The definition of expedient as 'suitable for achieving a particular end' is appropriate to describe the volcanic glass reduction technology at PTA: sharp edges suitable for unhafted cutting tools were produced from multi-platform, multi-directional cores (Williams 2002:95).

When the adze preforms from the Pōhakuloa sites are compared to those from Hopukani Springs and the Pu`u Kalepeamoa Site there are notable similarities in size and cross-section frequencies (McCoy 1991; Bayman et al. 2001; Bayman and Moniz 2000).  The Pu`u Kalepeamoa site adze rejects appear to be more similar to those from other lower elevation sites, such as the Waikahalulu and the two Hopukani rockshelters , than to those from the higher elevation sites in terms of the relative proportions of flake and core blanks, small size, and cross-section category frequencies (McCoy 1986). The typological variability that is evident in the Hopukani Springs sites, the Waikahalulu Rockshelter, and the Pu`u Kalepeamoa Site assemblages assumes major importance with regard to several research problems. This is yet one more instance from the Mauna Kea Adze Quarry of significant typological diversity refuting (1) frequent assertions of typological monotony in late prehistoric Hawaiian adzes (Kirch 1985, 1990) and (2) the putative link between craft specialization and standardization/homogeneity (Cleghorn 1982, 1986; Kirch 1990; McCoy 1981, 1986, 1990).

With regard to the importance that Bayman and Moniz give to differences in preform size as an indicator of a different mode and scale of production, it is true that large preforms are comparatively rare in many Hawaiian adze quarries (McCoy et al. 1993; Weisler 1990; Dye et al. 1985). There are several possible explanations. Helen Leach, in an important study of New Zealand adzes, concluded that thick quadrangular and large triangular adzes were underrepresented in the surviving sample because of two factors: (1) a higher success rate compared to other types, and (2) the purposeful reworking of broken specimens, [which is not generally possible in the case of thin adzes made on blades or flakes] (Leach 1984:113).

The discussion of production strategies in Section 6 noted the effect of raw material form on preform size and how this is related to the different kinds of sources.

With regard to the question of preform type representation raised by Leach, there are at least two possible, but not necessarily mutually exclusive, explanations for the large number of semi-finished preforms in the Mauna Kea Adze Quarry. One is the abundance of raw material which would suggest that the adze makers could afford to discard performs at a higher rate than would have been possible at many other quarries where there were limited quantities of source material. A more likely explanation is that, as craft specialists working in area of special cultural significance (the *piko* of the island) there was a higher standard of performance and valuation of the final product. This is yet one more another example of the importance of context in archaeological interpretation.

It is perhaps not too far fetched to think that if a particular adze was intended to be used in carving a wooden deity to be placed on a *heiau* that any small defect may have led to its abandonment of the in the quarry, although it might have been technically possible to correct the error. In contrast to everyday life, an error made by a craftsman working under a *kapu* and in a *kapu* environment would have been a serious matter and could have resulted in large numbers of discarded adzes, some with only minor or perceptible flaws, over time:

> Errors in craftmanship were likewise indicative of the presence of maleficent influences, or foreboded evil. In Tahiti in ancient times a small technical error might lead to the abandonment of the work in hand; while in Hawaii a diviner might point out some defect in the construction of a house, predicting misfortune for its inmates if the error was not corrected (54, Vol. VI, p. 82). In the Marquesas the ancient craftsmen discarded defective products as worthless. Obviously there is a point of view arising out of religious concepts, which must have had very far reaching practical effects in producing painstaking and accurate craftmanship, such as was typical of ancient Polynesia (Handy 1927:287).

In summary, the quarry evidence, while agreeing with the results of Lass' adze sourcing study that there was no centralized redistribution of adzes on the island of Hawaii, presents a wholly different perspective on this issue that also raises questions about some of her supporting data. The evidence is at odds, for example, with her view that the Mauna Kea quarry was exploited on an occasional basis by independent craft specialists.

The Pu`u Moiwi Adze Quarry on Kaho`olawe has also assumed importance in the debates over standardization in Hawaiian adze manufacture, beginning with the observations of Hommon (1979) at Site 108. Hommon was struck with how different the types of adze rejects at this site were compared to the finished adzes found on sites elsewhere on the island which were quadrangular in cross-section. This led Hommon to develop three working hypotheses:

> 1) The non-quadrangular adzes may have been earlier forms, produced before the quadrangular form achieved its later overwhelming popularity. This would suggest that site 108 was abandoned before such a shift took place.
>
> 2) The non-quadrangular adz may have been introduced from outside Hawaii. Alternately, the quadrangular adz may have been the introduced form. (The latter statement could be combined with number 1 above).
>
> 3) The non-quadrangular adzes may have been manufactured for export to Maui or some other island (Hommon 1979).

In developing these hypotheses Hommon was careful to note that "none of the arguments can be supported with solid evidence and further research is clearly needed" (Hommon 1979).

Hommon's hypotheses regarding the seemingly anomalous typological characteristics of the site 108 adze rejects and the possibility that the non-quadrangular adzes were produced for exchange were re-evaluated based on data collected in a preliminary re-survey of the Pu`u Moiwi Adze Quarry in 1992. Hommon's (1979) and others' (e.g., Kirch 1990) statements regarding the predominance of the quadrangular form in Hawaii is supported by the results of an important study by Emory (1968) who examined a sample of 265 Hawaiian adzes [165 from various localities in the Bishop Museum collection and 100 from Maui in the Wong collection]. Emory concluded that:

> No place in East Polynesia exhibits such a steadfast adherence to one form of adz as Hawaii. Hawaiian adzes are usually quadrangular (or rectangular) in cross-section, and except for some small specimens and a few of medium size, are tanged. They range from wide and thin to narrow and thick with most of them of intermediate proportions. In profile the great majority are curved longitudinally along the base and the butt meets the blade at an angle. None show shaping by pecking (Emory 1968:162-163).
>
> Our study of Hawaiian adzes has revealed the early existence of an islandwide uniformity in adzes. There is no reason to believe that there ever was a time in Hawaiian history when the tanged, quadrangular adz was not known. Therefore, the first settlers introduced this adz form. They may also have brought the plano-convex, the triangular, and reversed triangular at the same time, but only the quadrangular form survived (Emory 1968:164).

When Emory's data on the frequency of Hawaiian adze types is examined (Emory 1968: Table 6) one of the first things that is noticed is that there are no trapezoidal or reversed trapezoidal adzes. The Pu`u Moiwi assemblages thus appear to be anomalous in the presence of a new and previously unknown adze type in Hawaii. Once known, Emory would probably have argued that the assemblages exemplified an evolutionary sequence which he had already described. He wrote that "The reversed trapezoidal tanged adz marks a transition in form from the quadrangular tanged adz to the reversed triangular" (Emory 1968:159).

The Pu`u Moiwi assemblages do not appear anomalous given what we now know of other quarry assemblages, but there are several questions that are raised in interpreting the meaning of the reversed trapezoidal adze. First, the comparison of quarry types and finished tool types from non-quarry contexts raises questions about the representativeness or bias in quarry assemblages because quarry assemblages are comprised of intended and unintended by-products. It is natural to expect more variety or diversity in a quarry context because of predictable failures and departures from norms. Isaac (1977:9, footnote 1) noted that quarry sites commonly deviate from what he called "regional-phase norms." Second, it is highly likely that a significant proportion of the reversed trapezoidal rejects are early stage rectangular adzes (see Cleghorn 1982). Third, given the occurrence of this adze type in habitation sites from other islands (e.g., Kirch 1975), it is necessary to assume that some proportion of the reversed trapezoidal rejects were intentional and/or acceptable tool types.

Emory's conclusion that only the quadrangular form survived to the end of the Hawaiian cultural sequence implies that all of the non-quadrangular adzes must date to the settlement period. A similar conclusion was drawn by Kirch based on Cleghorn's earlier conclusions regarding the evidence for craft specialization in the form of standardization in adze forms and the manufacturing technology as a whole:

> A temporal pattern of some significance is the morphological variability evident in various artifact classes from assemblages dating to the Colonization and Developmental Periods. This is especially notable in basalt adzes, but also in fishhooks and various ornaments. In part, such variability reflects attempts to adapt technomic artifacts to local environmental constraints and conditions. Equally important, however, such variability may signal an early lack of technical specialization (Kirch 1990a:327).

Emory's and Kirch's conclusions regarding the homogeneity of late Hawaiian adzes is contradicted by recent evidence from several different sites. The one relatively early radiocarbon date from the Pu`u Moiwi quarry of ca. AD 1250-1400 is in line with existing arguments regarding the antiquity of non-quadrangular adze types (e.g., Kirch 1985), but the reversed trapezoidal and reversed triangular types are known to have been made over a much longer time period at the Mauna Kea adze quarry (McCoy 1986, 1991) and probably elsewhere (Dye et al. 1985). It is doubtful that the manufacture of non-quadrangular adzes was restricted to just the early part of the Pu`u Moiwi quarry sequence.

If Kirch's claims have any truth value to them it seems odd that while adzes were becoming increasingly standardized other items were beginning to exhibit significant regional variability in style (Kirch 1990b). The literature indicates that Hawaiian adzes, though predominantly quadrangular in cross-section, were not all alike and hardly *monotonous*, although Kirch would probably claim that such matters are in the eye of the beholder. Brigham's and Bennett's descriptions of Hawaiian adzes are instructive in pointing to other aspects of variability that have been largely overlooked because of the preoccupation with cross-section:

> The Hawaiian peculiarity consists in the parallel sides and angular tang, but it is not to one definite shape that all Hawaiian adzes conform. For instance, the plates show that parallelism of the sides is not constant and in the larger specimens there is a wide departure, but all the while there is a strong family resemblance among them all (Brigham 1902:74-75).

> As shown by Emory...tanged adzes fall into three main classes...1. Broad, heavy adzes, with the width of the cutting edge more than 25 per cent of the length and the tang at a marked angle to the blade. 2. Narrow, heavy adzes, with the width of the cutting edge less than 25 per cent of the length. 3. Thin bladed adzes with tang at a slight angle. In class 1 the sides diverge towards the cutting edge, in class 2 they are parallel, or converge, and in 3 they diverge markedly. In Kauai thick bladed adzes, classes 1 and 2, are far more numerous than the thin bladed, or class 3 (Bennett 1931:58).

What is clearly in need of clarification in the study of Hawaiian craft specialization in stone tool manufacture is the concept of standardization and its putative relationship to social complexity. Cowgill's discussion of the various issues surrounding standardization and its misuse is worth quoting at length:

> Finally, I offer some suggestions about further concepts related to diversity...First, of course, is *richness*, the number of categories present. Second, is *evenness*, which expresses the extent to which the categories are represented by similar quantities of objects. A third concept is *range*, by which I mean the amount of difference between the most different categories...A fourth concept is *standardization*. This has been used too loosely, to mean several

> different things, including relatively low richness. I suggest that we distinguish between richness and standardization, and use the latter term to refer to low variation within categories. Fifthly, since some categories in a data set may show high standardization while other categories show low standardization, it seem worth defining *uniformity of standardization* as the extent to which some categories are more standardized than others (Cowgill 1989b:135).

> Low standardization, in contrast, as I urge we define it, means that there is considerable variation between different examples of a given category. There are at least three plausible reasons for low standardization. One is that there is simply little value placed on standardization by the culture. A second is relatively low skill, and/or conditions not conducive to uniformity of products or raw materials. A third is relatively high skill and control over techniques, which can be taken advantage of to vary monotony. Greater skill and greater control over materials and techniques doubtless appear when producers spend a higher proportion of their time in making ceramics (or lithics, or whatever), but low standardization, *per se*, may reflect low skill, high skill, or have little to do with skill. Even distinguishing richness and range from standardization is not enough. Studies of artifact production must take explicit account of more than this, such as sensitive indicators of skill. Unfortunately, many attempts to deal with craft production and specialization...have been seriously flawed by vagueness about some of the distinctions I have discussed (Cowgill 1989b:135).

Some of the problems that Cowgill has identified in attempts to interpret skill are evident in Kirch's characterization of the temporal changes in Hawaiian adze morphology. In saying that low standardization may signal the lack of technical specialization he is implying the lack of knowledge of local materials and requisite skill to control and thus "dominate" the raw material. Thus, for the first roughly 1,100 years of Hawaiian prehistory [Kirch's Colonization and Developmental Periods] adze makers were dominated by the material and unable to produce standardized forms. One of the difficulties with this adaptationist argument is the underlying assumption that the raw material used for adze manufacture in Hawai'i was significantly different from that in the homeland to require a millennium of experimentation.

Instead of increasing homogeneity through time--the evolutionist hypothesis linking craft specialization to standardization (Kirch 1985, 1990)--there is instead evidence for more diversity and, thus, meaningful variability at both group and individual levels, the latter of which is left out of account in the generalizing or evolutionist interpretations. What distinguishes the individual and collective site assemblages as the work of specialists in the Mauna Kea Adze Quarry Complex is not the quality of the work or, more specifically, the skill and success rate alone --a variable that is too contingent--but rather the degree of embellishment in the ritual dimension of production (McCoy 1991). As Cowgill noted, low standardization may have little or nothing to do with skill. Conversely, craft specialization is too complex an institution to be explained or identified archaeologically in terms of skill alone.

7.3.2 Socio-political Processes at the Regional Level

With a few notable exceptions (e.g., Cordy 1994) there is a common tendency in Hawaiian archaeology to take the boundaries of the community, the *ahupua`a*, as the main focus of study, but in so-called "complex" societies it is readily apparent that many of the most important cultural processes transcend a specific locale or community. One result of the narrow focus on the *ahupua`a* is that many of the most important questions regarding socio-economic and political processes are yet to be addressed with empirical data. This is fundamentally a problem of research perspectives and theoretical orientation, more particularly of not having a regional research design. At the present time archaeological data are largely conceptualized as relevant to the boundaries of sites and communities rather than larger territories. A second result of the narrow focus on the community is the proclivity to accept it as a self-sufficient socio-economic unit which is clearly not true or universally true. This normative view reduces the community to a redundant unit wherein variability within and between communities is minimized.

When the research on the quarry began, in 1975, it was assumed that the scale of production was a clear indication of production for trade or exchange, and that the prevailing and widely accepted ethnographic model of Hawaiian land tenure, with its emphasis on proprietary rights to resources within the boundaries of the community territory (*the ahupua`a*) was applicable (McCoy 1977). The large volume of material available for exchange implied wide-ranging political and social relationships with a number of communities. As the research progressed the initial assumptions began to be questioned. There was the realization, for example, that although there was a potentially large quantity of adzes available for exchange, something other than exchange value or economics per se was involved. As Sahlins noted, "an economic basis" is a symbolic scheme of practical activity not just the practical scheme in symbolic activity. It is the realization of a given meaningful order in the relations and finalities of production, in valuations of goods and determinations of resources" (Sahlins 1976:371).

There is accumulating evidence that the Mauna Kea Adze Quarry Complex had developed at some point in its long history into a pan-island production center exploited by small groups of attached craft specialists from all six of the political districts on the island of Hawai`i (McCoy 1990). The evidence includes, but is not limited to, a constellation of upright stones in the Pu`u Ko`oko`olau area of the adze quarry area that is interpreted as a "territorial map" of the island political organization, and rockshelter base camps/workshops characterized by roof-top shrines and large debitage mounds interpreted as district level work centers. This interpretation of the quarry socio-political structure has a number of important implications. It suggests, for example, that the prevailing and generally accepted ethnographic model of Hawaiian land tenure, in which a community had exclusive rights to the resources within its territorial boundaries, does not apply. The added implication is that because more than one community had direct access to the quarry there was no monopoly of the raw material source and, thus, no production for trade or exchange as the ethnographic model would suggest and is commonly concluded for such large quarries where production clearly exceeded local needs (Kirch 1979; Williams 1994).

The quarry sequence spans the putative transformation/change in the 15th and 16th centuries from what Hommon (1986:58) has termed the archaic *maka`ainana* society of multi-community non-egalitarian corporate kinship groups to the economically and socially self-sufficient communities comprised of ego-based bilateral kindreds called *ahupua`a* that displayed strong tendencies toward endogamy. According to Hommon, this transformation was accompanied by or resulted in the erosion of kinship ties between communities coeval with the growth of even more status levels amongst the chiefly class. If this is true then it raises questions about the relationship between the rise of supposed self-sufficient communities and the death of kinship ties amongst the commoners. It seems to us that the recruitment of lower level chiefs to organize and supervise production at the community level is a contradiction, that there is instead good evidence for the maintenance of inter-community ties through large scale enterprises involving labor recruitment and circulation of a surplus to support the so-called public economy.

Evidence in support of the pan-island production system theory includes the isolated lithic sites, some associated with shrines and possible burials, located outside of the adze quarry proper. The locations of these different sites are arranged in a number of essentially linear pathways or corridors emanating from the quarry and going off in multiple directions are interpreted as ascent-descent routes utilized by adze makers (Figure 7.4). The best defined of these are on the east side of the mountain. There are two and possibly three pathways leading out from the quarry toward the Hāmākua coast. One of these appears to follow the route of the historic Umi Koa trail. A continuation of one of these is suggested by the occurrence of an isolated basalt lithic scatter near Red Hill below Pu`u Mākanaka (Stephanie Nagata, personal communication). The evidence is less clear on the south side of the mountain, but we believe there is reason to believe that Pōhakuloa Gulch and Waikahalulu Gulch were corridors used not only by the elite adze makers working in the quarry, but also their retinue of supporters. We believe that the latter used the Pu`u Kalepeamoa Site and the area around Sites 14638 and 5003 at the bottom of Pōhakuloa Gulch as camps. Isolated sites with basalt sourced to Mauna Kea located further south in PTA suggest other stops and a continuation of the travel back to a home on the Kona coast. Several isolated lithic sites located on the southeastern side of the Science Reserve hint at yet another corridor following a glacial moraine and outwash deposit and perhaps leading to another camp site near Pu`u Kole (McCoy 1991:Figure 2).

In a cultural landscape made temporarily “sacred” by rites that made adze makers and their work environment *kapu*, there were, as Barrett would argue, a series of paths accessible to some and foreclosed to others (Barrett 2001:159-160). Barrett notes the importance of time or what others would call space-time, in the movement of humans from one place to another:

> Many places are simply passed through, others represent 'stations' where time is consumed. These 'stations' or locales are thus distributed serially and are interspersed by periods which are required by the individual both to separate those locales and to move between them. As a process of constituting social reality, the significance of each locale is determined not only by what takes place there and then, but by what has gone before and what comes after. In other words, it is determined by the memories and the expectations of the participants. Thus an understanding of 'place' depends upon its context within time, a time-context built up from a number of differing trajectories as people meet and then part (Barrett 1994:73-74).

However the isolated scatters, shrines and even possible burials located in the Science Reserve and elsewhere in the summit region are interpreted, it is clear that at least some adze makers spent some time at “stations” along a route or pathway that is marked by the lithic artifacts they left behind. The occurrence of semi-finished adze preforms outside of the quarry has always presented an interpretive challenge. The issue was discussed in a report on the Pu`u Kalepeamoa Site:

> Hypothesis 1 stated that the predominant activity at this site was the "finishing" of late stage adzes imported from the Mauna Kea Adze Quarry. This hypothesis, which denotes a major spatio-temporal discontinuity in the manufacturing process, contradicts earlier assumptions regarding two interrelated aspects of efficiency in this particular quarry industry based on a consideration of its isolated location: (1) the removal from the quarry of adzes ready for grinding and

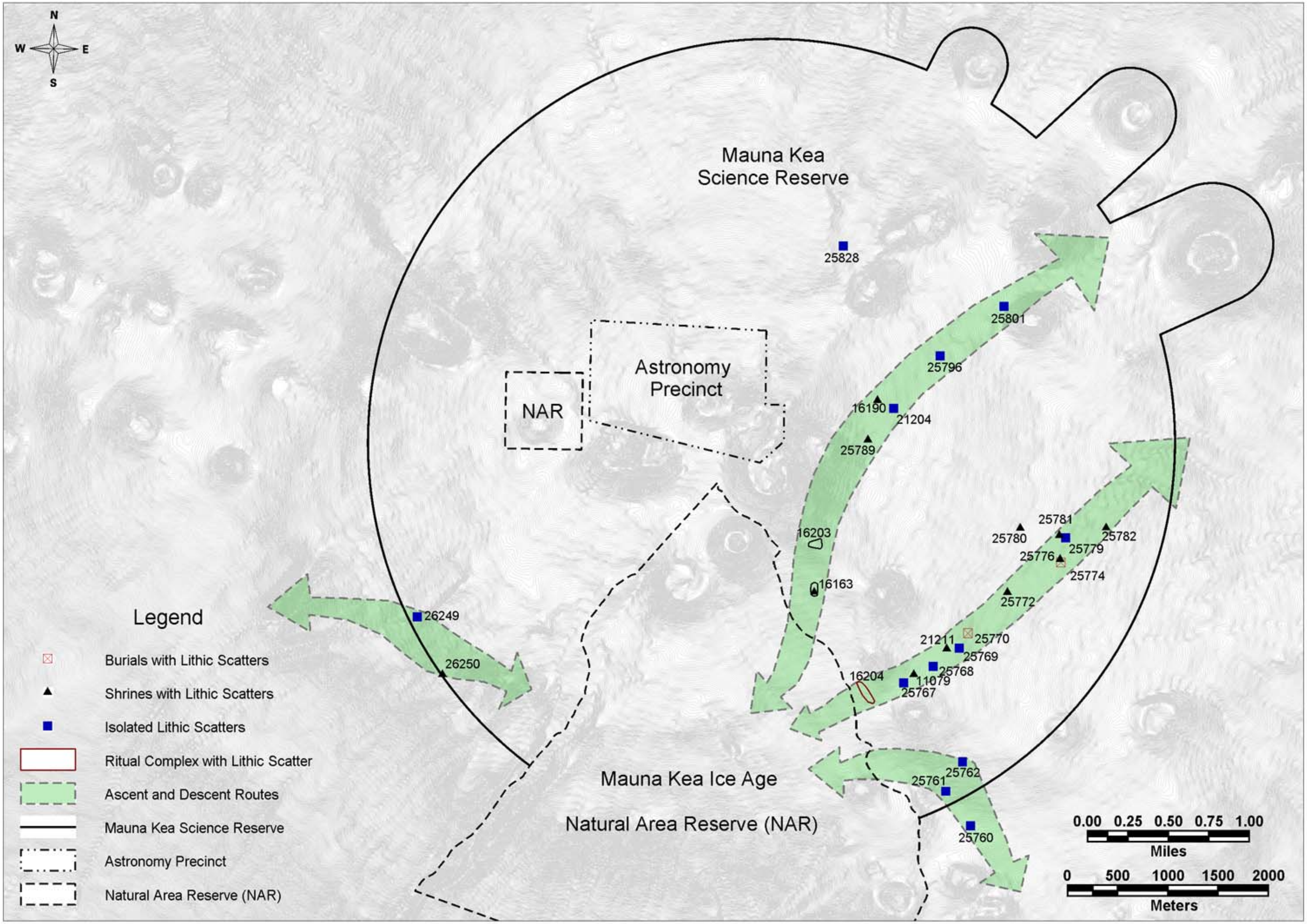


Figure 7.4 Adze Quarry Complex Ascent and Descent Routes.

> polishing rather than crudely flaked adzes to minimize the discard rate due to breakage and other factors in the resumption of work at a different place and time and (2) the minimization of weight in the transport phase of the manufacturing process (McCoy and Gould 1977). The transport phase is assumed to have been conditioned by a number of factors, the most important of which are two positively correlated variables, bulk properties and distance from the source. If this distance decay model is correct then the relative proportions of cores, early stage tool rejects and large flakes should decrease with distance from the source.
>
> Neither of the two assumptions regarding the removal of unfinished adzes from the quarry has ever been evaluated to determine if the assumptions are indeed warranted or under what conditions there might be predictable exceptions. The Pu'u Kalepeamoa site would seem to be an anomaly or deviation from the predicted behavior, but it is an anomaly only if the underlying premise is correct. In this case I think the underlying efficiency argument is essentially correct, but that the risk minimization and labor-saving aspects of the theory do not provide a completely satisfactory explanation for the existence of this site. The hypothesis of a late stage "finishing" camp is not supported by the various analyses, which point instead to a camp occupied by craftsmen who made a few adzes on small cobbles and flake blanks imported from at least two different source areas. Of particular relevance is the apparent late date of this site and evidence that it was probably occupied only a few times, which means that whatever theory is used to account for this site it must be seen in specifically historical terms rather than in general economic terms (McCoy 1991:169-170).

7.3.3 Territoriality and Property Rights/Use Rights

The number and location of the subalpine forest “outlier sites” is a subject of great interest with regard to the social relations of production, what Wolf (1990:587) later called structural power which was defined as “the power to deploy and allocate social labor”. These sites, which include the Pu`u Kalepeamoa site, the Pu`u Kole site and sites located near what is now an old section of the Saddle Road (Welch 1991) were clearly occupied on the descent from the quarry and are thus inferred to mark routes back home for one or more leeward groups. More specifically, these sites are interpreted as evidence that the quarry was a "common resource" exploited by groups from every region and political district on the island from at least AD 1400 on (McCoy 1990). Supporting evidence for the "common resource" hypothesis and attached as opposed to independent specialists (cf. Earle 1982; Clark and Parry 1990; Withrow 1991) is presented elsewhere (McCoy 1990).

In the traditional Hawaiian system of land tenure, individuals did not own resources. Rather they had use rights to property and resources which were expropriated from the gods. When the quarry research first began it was assumed that the scale of production was a clear indication of production for exchange or trade and that the ethnographic model of Hawaiian land with its emphasis on proprietary rights to resources within the boundaries of the *ahupua'a* was applicable (McCoy 1977). Some fundamental problems with this long-held assumption (see also Withrow 1990, 1991), were noted after the 1975-76 fieldwork in the quarry, leading to an alternative view, that the Mauna Kea quarry, like Kamoku in the Hāmākua District, was a *common resource* exploited by all of the chiefdoms on the island (McCoy 1990:112, 1992; for other views on this matter see Withrow 1990, 1991). Unlike the *ahupua’a*, where there were proprietary rights to resources, “common lands” were open to exploitation by the masses. This alternative system of land tenure does not necessarily imply uncontrolled access or the lack of competition and conflict over access to the best quality material.

7.3.4 Non-agricultural Production Systems

Polynesian archaeology evinces an understandable preoccupation with food production and agricultural systems in particular. In contrast to the long history of research on food production relatively little attention has been given to the study of non-agricultural production systems, such as stone tool manufacture, which tend to be viewed in purely technological terms rather than production systems in their own right (Kirch 1984, 1989, 1990).

One consequence of this bias is a partial understanding of life as fully constituted and lived in time and space. In the case of more so-called "complex" societies, such as Hawaii, there is, moreover, a general lack of knowledge regarding the "other economy"-- the so-called "political" or "public" economy -- that supported social institutions larger than the family (Sahlins 1972:101) and involved the management and mobilization of resources, such as food surpluses and labor, for economic and political purposes-- honor, prestige, legitimation, and domination. Just how little is known of this other economy and more particularly of the interaction between chiefs and commoners prior to European contact, is clear in some of the overviews of Hawaiian prehistory (Cordy 1981; Hommon 1976, 1986; Kirch 1984, 1985, 1990).

As noted elsewhere, non-agricultural production systems, such as the Mauna Kea adze quarry industry, were an integral part of the social construction of reality (McCoy 1990:114). There is, perhaps, no other single archaeological site complex in Hawaii that holds such great potential for understanding how that reality was actually made and changed over time than the Mauna Kea Adze Quarry.

7.3.5 Annual Subsistence Region

Because of the existence of agriculture Hawaiian settlement was fundamentally permanent and sedentary, although there was obviously some movement between coastal and more upland areas. The exploitation of land beyond the limits of agriculture and, thus, permanent habitation, in pre-contact Hawai'i constituted the functional equivalent of an annual range in mobile hunter-gatherer societies.

The evidence relating to the quarry and other upland activities suggest that this annual range was to a large extent a polity catchment area or territorial range that was for the most part economic, but also frequently included "sacred" lands on the highest mountains above treeline (McCoy 1990). In this view there was both an annual economic range and a non-economic territory. The treeline location of the Pu'u Kalepeamoa site provides the first real opportunity to investigate the sociocultural significance of this natural boundary and its place in the hierarchy of Hawaiian wilderness zones (Malo 1951:17; Handy and Pukui 1972:22; McCoy 1990:114).

7.4 The Mauna Kea Shrines: Linguistic, Architectural, and Temporal Relationships to Religious Structures Elsewhere in Hawai`i and East Polynesia

Soon after his trip to Mauna Kea, in 1937, Emory published several papers in which he noted both linguistic affinities and architectural similarities to religious structures elsewhere in Hawaii and East Polynesia (Emory 1938, 1947, 1970). Emory's pioneering effort was, of course, in many ways limited. In some cases the comparisons were based on incomplete data and unwarranted assumptions of uniformity. In the absence of absolute dates Emory, Buck and others working in 1920s-1940s, were forced to make a number of assumptions based on architectural characteristics.

The discussion that follows summarizes some of Emory's comparisons and presents a critique of some of the conclusions he made regarding the antiquity of what were assumed to be archaic forms and their probable replacement by more advanced or complex structures. Because the subject matter is religious structures, we have included a brief and far from complete synopsis of what is covered under the rubric of religion. Not long ago it was common practice to define religion as involving a belief in supernatural beings. Katherine Luomala, who summarized some of the most important characteristics of traditional Hawaiian religion, including the existence of major gods and another class of gods called `*aumakua*, used the term supernatural beings:

> Believing the supernatural forces filled sea, sky, and earth, the Hawaiians personified them in countless named and individualized deities, who controlled nature and mankind through their *mana*, or supernatural power. The people retained cosmogonic gods from the homeland, such as Kane, Kanaloa, Ku, Lono, and Wakea, and goddesses like Hina, Papa, Haumea, but they added aspects of these gods and included the deified dead, beings like the volcano goddess Pele, and touchy local spirits in their pantheon of supernatural beings. This pantheon provided the inherited or acquired guardian gods, or aumakuas, of each individual, family, occupation, and profession (Luomala 1987:215).

Over time, some anthropologists, such as Mary Douglas, refrained from using the term supernatural in recognition of the fact that in many cultures gods were part of nature, not above or outside of it. Oral traditions indicate that this was definitely the case in pre-contact Hawaii.

Guthrie developed what he believes is a new theory of religion based on a closer analysis of the concept of anthropomorphism (Guthrie1993). He has continued to elaborate his theory (2007a, 2007b) thusly:

> In the case of the term religion, for example, cognitive science supports defining it, broadly yet substantively, as a system of thought and action for interpreting and influencing the world, built on anthropomorphic premises. Anthropomorphism, in turn, may be theorized as the inevitable consequence of a strategy of perception for an ambiguous world: namely, guess first at what matters most (Guthrie 2007b:58).

Guthrie employs to good effect the concept of "family resemblances" made famous by the philosopher Ludwig Wittgenstein:

> Religion', for example, may be used to corral a particular family of human ideas and actions. One such family appears cross-culturally, though it is, like other families (Wittgenstein 1974), not bounded but open-ended. Specifically, the family I have in mind is one of ideas and actions relating to (among other things) important, often-invisible, human-like agents—'spirits', for example—who have interests in and influence on human affairs, and with whom humans can interact symbolically (as by prayer and offerings) (Guthrie 2007b:59).

The term "family resemblances" is in our opinion an apropos term for our purposes. While it denotes obvious similarities in, for example, the form of a structure and the placement of upright stones, it does not assume direct contact between the people who built the shrines on Mauna Kea and a group of people in the Tuamotus, Tahiti, Tongareva, or wherever the same or similar trait is found. One obstacle to establishing direct links is the absence of a firm chronology for the shrines on Mauna Kea and the religious structures with which they are being compared.

7.4.1 Linguistic Affinities

Kenneth Emory, as previously noted, was the first archaeologist to describe the shrines on Mauna Kea and note their East Polynesian affinities. Emory made the following comments about the shrines he saw during his brief visit in 1937:

> The adze makers, clinging to the ancient form of shrine at which to approach their patron gods, have preserved a most important link with their ancestral home. Each upright stone at a shrine probably stood for a separate god. The Hawaiian dictionary describes `*eho* as "a collection of stone gods" and this is the term which the Tuamotuans, the neighbors of the Tahitians, used to designate the alignment of upright stones on the low and narrow platform at their maraes, or sacred places (Emory 1938:22).

As Emory pointed out, the word `*eho* is *keho* and possibly *aho* in various parts of East Polynesia:

> The upright stone slabs on the ahu and out on the court are called *pohatu* at Vahitahi and Napuka and probably many other islands. At Anaa, Fagatau, Fakahina, Tatakoto, Reao, and undoubtedly at other islands they are called *keho*. *Keho* in the Marquesas is a term applied to a "basalt column planted in the ground to serve as a backrest" (32, p. 351). In the Society Islands an *aho* (`*aho?*) is a certain stone set up in a marae where the priest set up his *tapa`au* (coconut leaf twisted to represent a man). Henry (13, pp. 134, 399) records that these *aho* of Tahiti were only certain small uprights in the rear part of the court. It is probable, however, that the word *aho* is related to the Marquesan and Tuamotuan word *keho*, meaning a backrest in the Marquesas and a marae memorial stone or backrest in the Tuamotus. In Hawaii, `*eho* means a stone god representing Lonokaeho, a collection of stone gods, or a stone pillar set up as a monument (Emory 1934:10).

The word *keho* is also found in the language of Rapa Nui (Easter Island) where it is may have also referred at one time to ancestral god-stones predating the famous statues called *moai* (McCoy 1993).

Emory's saw similarities in the design of religious structures throughout East Polynesia and presented evidence indicating that in several island groups they were probably called *ahu* in the beginning, prior to the appearance of the word *marae*:

> In New Zealand the *tu-ahu* with a row of upright stones planted across one end of the open space is apparently the Tahitian inland marae reduced to its simplest in form and function (24). The name itself carries with it memory of the most conspicuous feature of a Society Island marae. Elsewhere (p. 41) I have given facts which indicate that in the Society Islands and in the Tuamotus the ancient maraes were once called "ahu" (Emory 1933:51).

The word `*eho* has various other meanings, some of which point to the need to exercise some caution in assuming that all upright stones were shrines. According to Mary Kawena Pukui and Samuel H. Elbert (1971:35) `*eho* is a term for a single stone image as well as a stone pile, particularly of the kind used to mark land boundaries. The latter information may have come from Samuel M. Kamakau, who noted that "Boundary markers (*kukulu `eho`eho*) of tall stones (*oeoe pohaku*) were set up to identify the boundaries" (Kamakau 1976:7). The use of a stone to represent a god and mark a land boundary are not necessarily incompatible, however, since the construction of religious structures in Polynesia was a common way of making a claim to a piece of land (Handy 1927; Emory 1947:10). Handy described examples from the Society Islands and New Zealand:

> Another instance of the use of stones as mediums of mana is exhibited in the custom typical of the Society Islands and New Zealand, and doubtless of other islands also, of employing them as signs of ownership of land. In the Society Islands the limits of land belonging to families were marked by corner stones, small upright columns of rock some of which were dressed and some rough, set up at the corners of the property. These markers, which have been in the ground from ancestral times, are regarded as very sacred even today...In New Zealand the same practice is exhibited in the "boundary stones" (*pou-paenga*) which were set up to mark the limits of the plantations...Now, it is evident that this ceremonial use of stones to seal a land claim is closely related to the building of stone marae for the purpose, among others, of establishing land rights (Handy 1927:180).
>
> The maraes, as the property of kindred, were material symbols of them, and formed a visible connection with the past. Always standing on the land occupied by the kindred, observable by any who might pass, they came to be a seal of ownership. They bound the ancestral spirits and gods of the kindred to the land, putting it under their eternal guardianship (Emory 1947:10).

7.4.2 Architectural Design Comparisons

The shrines of the Mauna Kea summit region, including those in the adze quarry, are morphologically both similar to and different from most of the religious structures found in the main Hawaiian Islands. The single upright shrines most closely resemble the small family shrines called *Pohaku o Kane* ("Stone of Kane"), the defining characteristic of which was a single upright stone that symbolized the male organ. There are numerous descriptions of the Pohaku o Kane and their uses (Kamakau 1964:32; Luomala 1987:216; Beckwith 1970). The description that follows is from Beckwith:

> A family altar called Pohaku-o-Kane (Stone of Kane) was set up to Kane in the shape of a single conical stone from a foot to eight feet in height, plain or with slight carving, and planted about with ti plant, where members of a family went to pray to their aumakua and ask forgiveness for the broken tapu to which they ascribed any trouble that had come upon them. Here they sought protection from their family god with offerings and prayer. They came early in the morning, chewed awa while a pig was baking, and, when all was ready, ate under tapu, leaving no remnants and clearing away all rubbish. The place for setting up the stone and the offering to be made were revealed in a dream to the kahuna they consulted. The stone itself was sprinkled with water or with coconut oil and covered with a piece of bark cloth during the ceremony. It is possible, since the Kane stone is generally regarded as an emblem of the male organ of generation, that this covering is similar to the reported practice, before worshipping an image in which sex organs were displayed, of covering those parts with tapa cloth (Beckwith 1970:46-47).

Though similar, it is doubtful because of the context in which they are found that the single upright shrines on Mauna Kea were Pohaku o Kane, or at the very least, functioned in the same way.

One of the first comparisons Emory made that included the Mauna Kea shrines was in a paper published in 1943. Without giving any details, Emory interpreted the Mauna Kea structures as “crude replicas” of the Necker structures which he called *marae*:

> The Necker maraes, with their continuous row of uprights along the back of the platform, are most like the maraes of the more isolated eastern end of the vast Tuamotuan Archipelago. Although Necker was unknown to the historic Hawaiians, its ancient visitors certainly came from the main Hawaiian group, as the squid-lure sinkers and adzes found on the island are Hawaiian. Crude replicas of the Necker maraes were discovered by the writer in 1937 at the quarries of the adze-makers on the 12,500 foot contour of Mauna Kea, the highest mountain on the island of Hawaii. At Puu o Umi on the slopes of neighboring Mauna Loa, a low, narrow platform, bearing uprights similar to the Necker marae has been photographed (See pl. V, fig. 1). But the Necker type of marae has been all but obliterated in Hawaii (Emory 1943:13).

Though Emory saw obvious similarities in widely dispersed religious structures in the Hawaiian Island, the Necker marae as described by him were in some ways distinctive. Emory noted, for example, a pattern of odd numbers of uprights and alternation between flat and pointed shapes:

> The central rear upright, that is, the upright having an equal number of uprights on each side, is conspicuously larger than the others in 7 out of the 12 maraes where it could be noted. In the remaining 5 maraes it is of equal size or even smaller. In Marae 26 and Marae 34, the central rear upright, which measures 4 feet high, 2 feet wide, and 2 feet thick, shows a deep front-to-back groove at the top, possibly an artificial notch (fig. 26). Of the other central rear uprights as many are almost flat on top as are definitely pointed (Emory 1928:63).

Emory did not comment on what the pointed and flat shapes might mean. The senior author has suggested on the basis of ethnographic evidence (Beckwith 1970; Luomala 1987) that the two shapes represent male and female (McCoy 1999b). East Polynesian societies, such as Hawaii, where there is a clear indication of sexual symbolism in pointed and flat stones.

Emory’s description of the Necker marae suggests that as a group they are more homogeneous than the Mauna Kea shrines in terms of the presence of a substantial platform and associated terrace or “court”; the regularity in the occurrence of odd numbers of uprights on the platform, and the frequent occurrence of uprights on the court. There are undoubtedly a number of different reasons for these differences even if we assume that the Necker and Mauna Kea structures are of the same cultural origin. There are social and environmental factors as well as regional variation in design and construction that would have to be considered.

> The marae ruins of Necker belong to one fixed type from which only 5 out of the 33 maraes vary in any noteworthy degree. The type form is a low, narrow, rectangular platform which faces on a paved rectangular terrace (fig. 25). Along the full length of the rear of the platform an odd number of upright slabs which average 2 1/2 feet in height, 1 1/2 feet in width, and 8 inches in thickness, are set at equal intervals. On the front of the platform a smaller upright stands opposite the central upright. Directly in line with these two, a pair of small uprights are planted on the pavement of the terrace and against the platform, at their base a flat slab. Opposite this pair of uprights another pair, or a single upright, stands on the front of the pavement. All these uprights face parallel to the platform.

> Viewed from the front, one, two, or three small uprights stand near the right corner of the pavement. Near the left edge of the terrace, about one-third of the way from the platform to the front edge of the pavement, stand one or two small uprights. The right and left terrace uprights face parallel the platform or at right angles to it (Emory 1928:60-61).

There are some fairly striking similarities between the Necker marae and some of the Mauna Kea shrines in, for example, the locations of court uprights, but the number of sites on Mauna Kea that exhibit these characteristics are very limited in number. One site that exhibits a similar pattern of court uprights is Site 16168 (Figure 7.5).

In noting that the Mauna Kea shrines exhibited similarities to other rarely found forms in Hawaii, such as those he had recorded on Necker, Emory was assuming or perhaps simply implying that the Mauna Kea shrines were of a single type. It is true that the shrines on Mauna Kea are on the whole more homogeneous in design compared to Hawaiian *heiau*, but what Stokes had to say on the matter of *heiau* plans applies equally well to the Mauna Kea shrines:

> After examining about 150 *heaiu* sites on the island of Hawai`i, about 70 on Moloka`i, and several on the islands of Kaua`i, O`ahu, and Kaho`olawe, it seems to me that a man would be very unwise to attempt to draw a plan of *the* Hawaiian *heiau* (Stokes 1991:21).

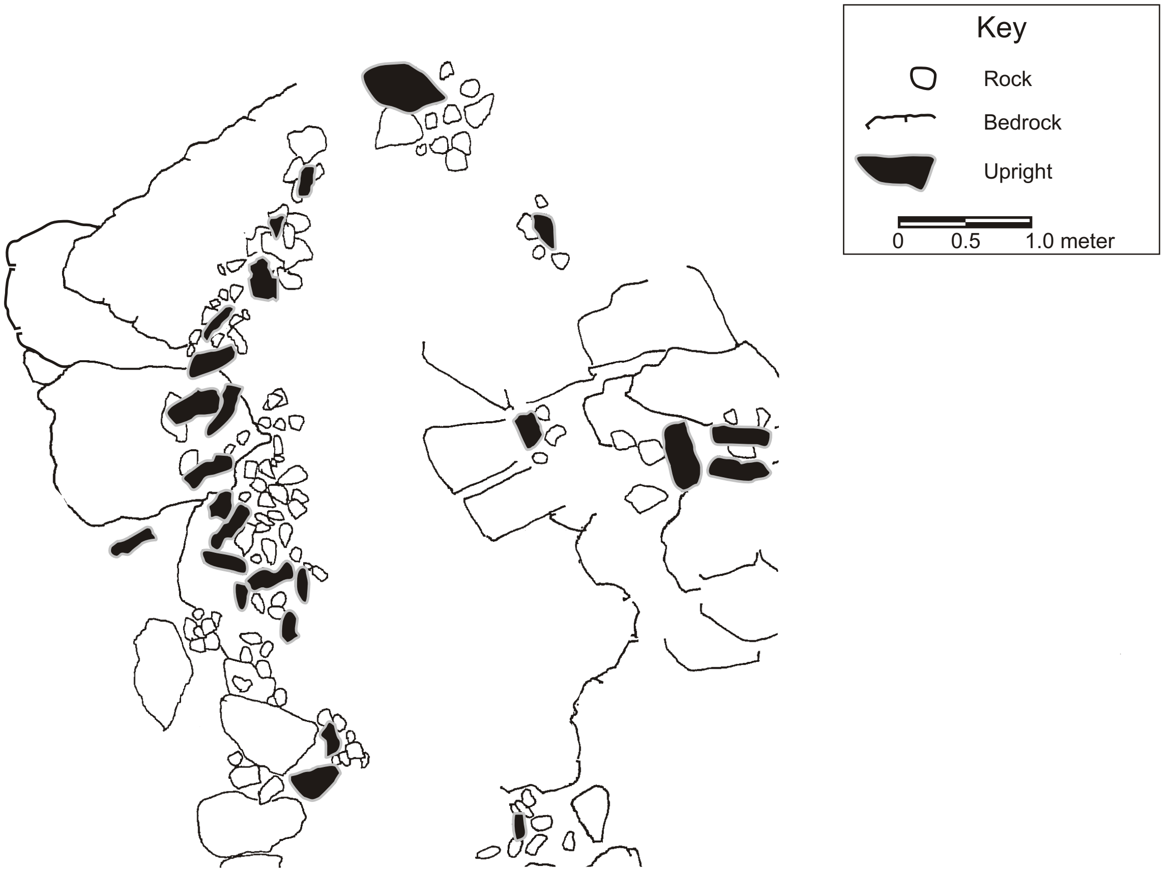
As illustrated in the analysis of shrine planviews in Section 6, what Stokes had to say about *heiau* also applies to the shrines on Mauna Kea: there is no such thing as *the Mauna Kea shrine*.

Emory's comparative studies were, of course, not limited to Hawaiian structures, but also included Tahitian and Tuamotuan *marae.* Emory (1933, 1947) saw both similarities and differences in the Necker *marae* and the *marae* he had seen and recorded in Tahiti and the Tuamotus:

> What the *marae* of Necker have in common with Tahitian and Tuamotuan is a long narrow, raised platform facing on a rectangular court. Along the back of the platform stand an uneven number of stone uprights, and on the court there is an arrangement of uprights, including one, or a pair centrally placed against the platform and another single or pair away from the platform (Fig. 13). In some *marae*, as in the Society Islands, the platform is absent, and the uprights at the head of the court are planted directly in the pavement. A tiny platform abuts the central or pair of uprights against the platform. Such were seen as many of the Tuamotuan *marae* (Emory 1970:87).
>
> Where the Necker *marae* depart from the Tahitian-Tuamotuan type, is the increase in number of uprights on the platform. Instead of three, theirs ranged from 5 to 21, but always an uneven number (Emory 1970:87).

The Type 4 shrines---a row with additional or supplementary uprights to one side--- are similar to central and western Tuamotuan marae. In contrast to the Type 5 shrine, the off-set uprights define the court area which is normally unpaved and unenclosed. Figure 7.6 shows several examples of Tuamotuan marae that resemble some of the

Plan View of Site 16168



Sketch of Necker Marae

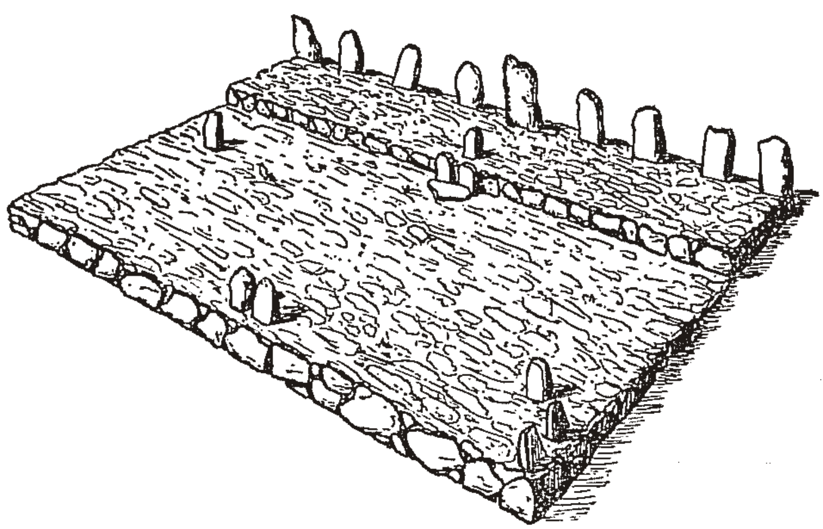


Figure 7.5. Necker Island Marae and Mauna Kea Shrine (Site 16168) (after Emory 1928).

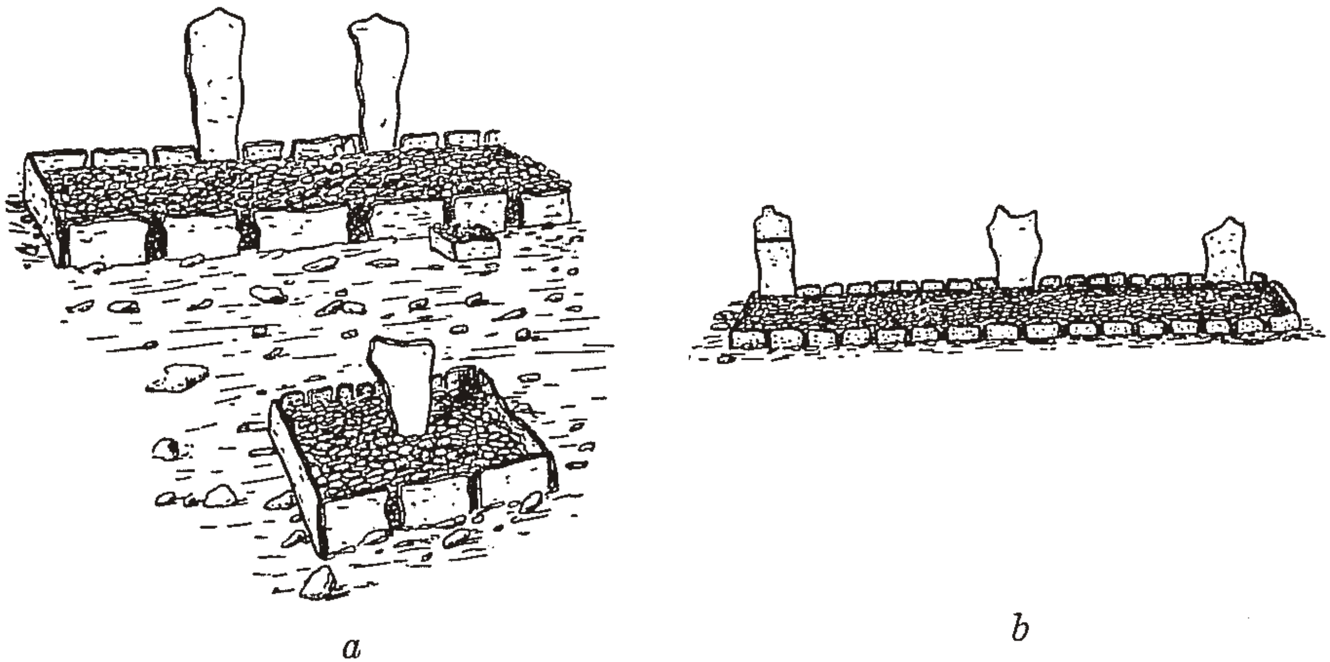


FIGURE 69.—Sketches of maraes in the Tuamotu archipelago: *a*, one end of the Marae Katipa, Fakahina Island, showing the sacred stone uprights, a small altar before one of the uprights, and a small platform supporting an upright; *b*, Marae Ramapohia, Fagatau Island, Tuamotu archipelago, platform about 3 feet wide, 60 feet long, the upright slabs of limestone about 6 feet high, the carving on left slab representing the human form is called *ofai tiki* or representation of a deity.

(Reproduced by permission from a drawing by Seurat.)

Figure 7.6. Examples of Tuamotuan Marae (after Emory 1928).

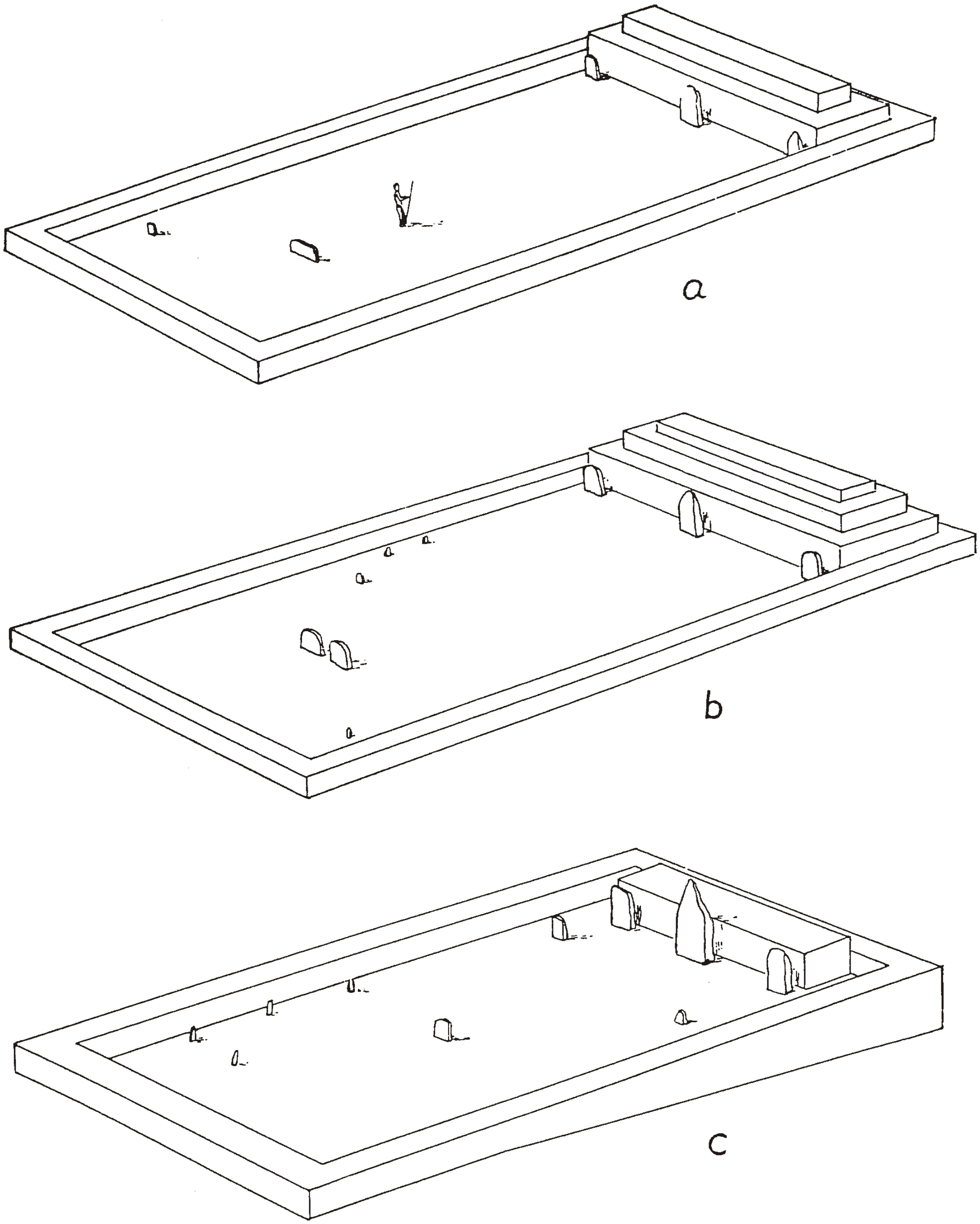


Figure 2. Tahitian *marae*: *a*, coastal type with *ahu* of two inner and three outer steps, sketch based on *marae* in Hitiaa; *b*, coastal type with *ahu* of three inner and four outer steps, sketch based on *marae* Arahurahu, Paea; *c*, intermediate between inland and coastal types, sketch based on *marae* Teroro inland at Afareaitu, Moorea.

Figure 7.7. Examples of Tahitian *Marae* (after Emory 1970: Figure 2).

Mauna Kea shrines. Many of the Tahitian marae that Emory recorded are considerably more elaborate than any known religious structures on Mauna Kea (Figure 7.7).

The large number of uprights that characterize the Necker *marae* is something seen in some of the Mauna Kea shrines, but only rarely. Emory's observations on the uneven number of uprights on the Necker *marae* are of great interest in terms of the uniformity, which would suggest strict adherence to a rule or code. This same pattern is not found on Mauna Kea, although there are a number of shrines with odd numbers of uprights.

One of the puzzling characteristics of the Mauna Kea shrines, with a couple of exceptions, is the absence of anything that could be readily interpreted as an offering. An account of a shrine dedicated to Pele at a place called Pu`u o `Umi (on some USGS maps it is marked as `Umi Caverns/Alika Cone) at the roughly 7,800 ft elevation on Mauna Loa (see Emory 1943, 1970) indicates that the uprights themselves should perhaps be considered offerings:

> An old road of Umi's from his heiau between the mountains in Kona to Kau, is mentioned in the article "Ahua a Umi" in the 1917 Annual. A most interesting discovery of another section of this road was made by Professor Jaggar on visiting the source of the 1919 lava low. Near the source of the flow were many small horse-shoe shaped stone shelters at different parts of the trail, and one large stone platform with long stones erected at the back, and further along a smaller stone platform. It has been learned from the Hawaiians that these platforms were for the priests, and the upright stones were offerings erected whenever there was a flow in this especially Pele-ridden section of Mauna Loa, to avert disaster. The shelters were against the prevailing wind, and would hold from one to several men, sheltering quite a company in all (Baker 1920:85).

It may never be possible to corroborate all of the details in this account, but the idea that a stone erected for the purpose of averting a disaster was regarded as an offering to the god Pele makes sense and is not inconsistent with the generally accepted view that uprights and other material objects were places for the gods to inhabit when they were needed. The alleged function is also consistent with the wealth of ethnohistoric accounts of rituals aimed at avoiding danger. If a new upright was placed on the platform each time there was a crisis this would indicate an accretional history, as opposed to a single event structure with many uprights placed all at once.

The Mauna Loa site, which consists of a shrine and temporary shelters occupied according to available information by priests, has no known counterpart on Mauna Kea. It is possible that the priests had a retinue of followers or helpers who constructed the shelters. The absence of such shelters at some of the larger shrines on Mauna Kea is hard to explain if, based on our earlier assumption, that priests were involved in the construction and use of the larger, more complex shrines.

There are a number of places on the island of Hawaii that are attached to Umi, including one described by Beckwith:

> On the slope of the mountain just back of the hill Hale-pohaha were to be seen, before the lava flows of 1887 and 1907 covered them, the stone structures of "Umi's camp." Seventy-five huts were counted, all facing away from the wind and built of three slabs of pahoehoe lava rock, two set together at an angle and a third forming the back, each hut large enough to hold two men. Larger huts,

> perhaps designed for chiefs, were supported by slabs within and built up outside with stone walls shaped into a dome. The place on Kauiki is still pointed out where the image stood which was later commemorated by Kamehameha as the god Kawalaki`i (Beckwith1970:391-392).

Shrines exhibiting family resemblances to those on Mauna Kea have also been found in the Pohakuloa Training Area. Some are large platforms with one or more upright stones. Others are low structures like Site 21289 (Figure 7.8). The uprights at this site consist of a single row of fairly evenly spaced stones of variable shapes. A profile drawing of the uprights shows what appear to be pointed, flat-topped, mesial notched and corner-notched forms (Figure 7.8). The plan is similar in some respects to the Type 3 and Type 4 shrines on Mauna Kea.

7.4.3 Upright Shape Similarities and Differences

Reference was made earlier to the fact that several of the pioneers in Polynesian archaeology and anthropology, such as Emory and Buck, had noted the existence on *marae* throughout Central and East Polynesia of unusual forms of uprights, with such distinguishing characteristics as flanges, notches and grooves. Some uprights were described as exhibiting human or animal forms (e.g., Emory 1947:29). In the Tuamotus these were distinguished by the name *tiki* (Emory 1947:13-14). Though sometimes identified as a human or anthropomorphic characteristic, the tendency was to dismiss flanges, notches, grooves and other apparently unsual characteristics as nothing more than "ornamentation" or "embellishment." The following descriptions give some idea of how these odd or unusual uprights were regarded by Emory and Buck:

> Montiton (35, p. 366) and others assumed that the great upright slabs on the marae platform, a few of which were shaped crudely in semblance of the human form, were "idols," but this shaping is little more than embellishment and the uprights themselves simply mark the place of the gods when they were thought to be at the marae (Emory 1947:29).

> Presumably, therefore, the slabs along the back of the ahu functioned to mark the position of ancestral gods attending the service. These stones did not serve as material embodiments of their ancestral gods, although the ones which in shape suggested the human form were called *tiki* (that is, shaped in human or animal form), a term which we are likely to associate with the representation of a god. Montiton calls them "idols" (35, p. 366). Some of the backrests on the court were also shaped in the same way, and this shaping can hardly be other than embellishment (Emory 1947:13-14).

> These Tongarevan *marae* share in common with Tuamotuan and Society Island *marae* a raised platform at one end of a quadrangular court and uprights along the back of this platform. In the Tuamotus, at Fagatau, Fakahina, and Tatakoto we saw the same kind of flange and notched ornamentation on *marae* uprights (Emory 1934a: fig. 5) (Emory 1970:80).

> A few of the slabs were ornamented at the top by horizontal flanges or by lateral notches (Buck 1932:155, fig. 22). Buck considered all the slabs on Tongareva *marae* as purely ornamental "placed there to add dignity and impressiveness to the structure" (Buck 1932:179) (Emory 1970:80).

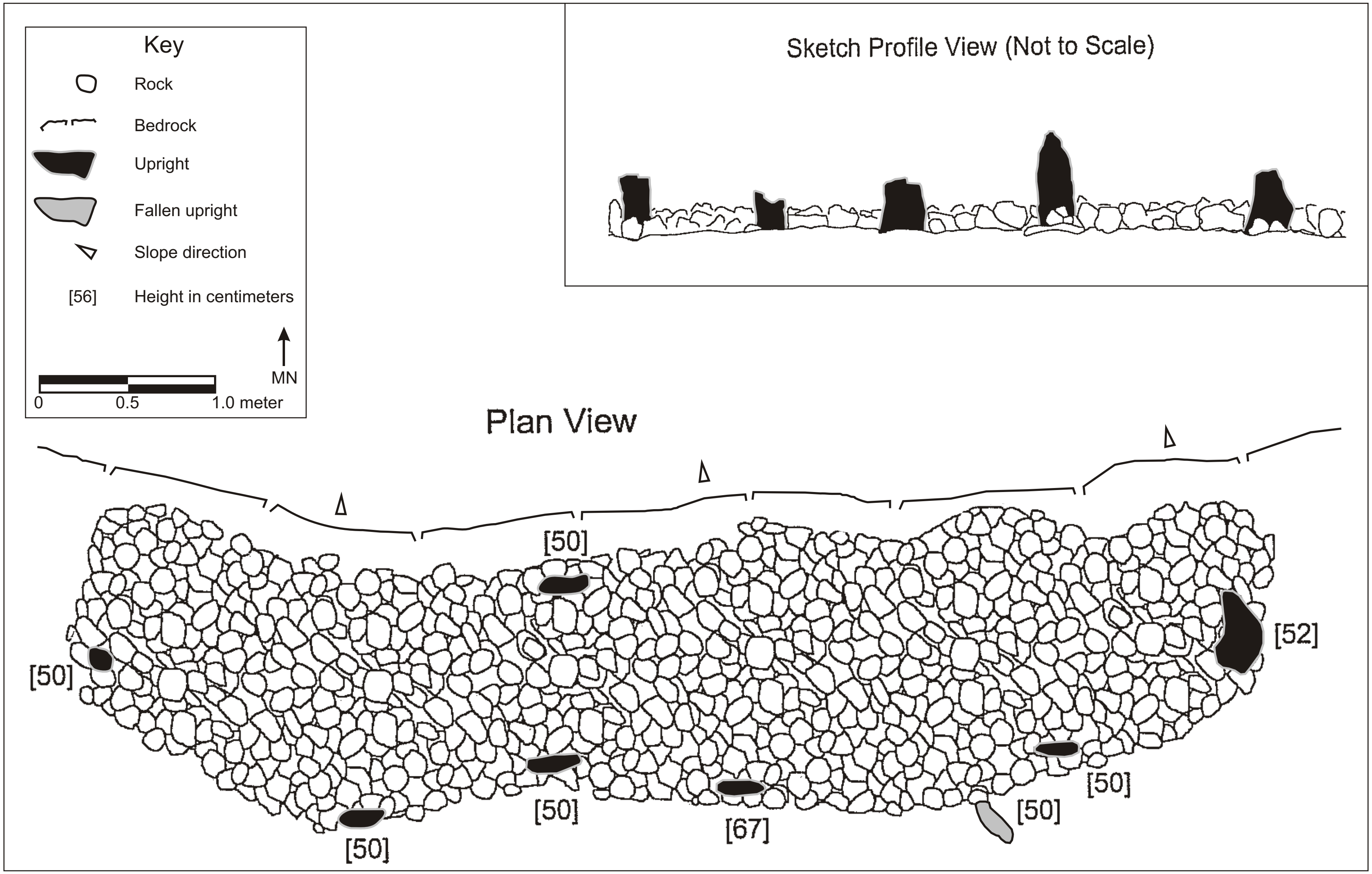


Figure 7.8. Plan View and Profile of Shrine (Site 21289) in the Pohakuloa Training Area. (Modified from Williams, 2002, Figure III-12)

A comparison of the uprights found on the shrines in the Mauna Kea summit region to the examples described above indicates commonalities in the presence of small numbers of slabs with flanges, side-notches and mesial notches. Though there is a difference in raw materials (limestone vs. basalt) and the limestone slabs were often shaped as opposed to the natural forms on Mauna Kea, the occurrence of similar forms is of interest, even if we cannot rule out chance and the fact that it may be only a case of fortuitous resemblance. Buck (1932:153) noted in the case of Tongareva that the sides of the limestone slabs were also shaped. He noted that though the Tongarevan slabs are generally rectangular, the widths at the top and bottom varied. Buck illustrated examples of what we have called "divergent: and "convergent" sided uprights with flat tops (Buck 1932: Figure 21). Examples of Tongarevan marae uprights are illustrated in Figures 7.9 and 7.10.

While Emory consistently dismissed unusual upright shapes as nothing more than ornamentation, he did recognize, however, how such forms could have evolved over time into images:

> It can readily be seen that if these slabs were set up originally as back-rests for the gods, they might easily be taken to represent the gods as much as images would. At the island of Fagatau and Tatakoto in the Tuamotus some slabs were shaped crudely in the outline of the human form. While the object of this was embellishment, as indicated by the fact that the chief's leaning slab was similarly shaped, it does illustrate how a back-rest reserved for a departed ancestor might converted into a representation of him. In the *heiau* on Kauai in the Hawaiian Islands, sketched by Captain Cook's artist, the wooden slabs which are arranged after the fashion of the stone slabs of Necker maraes are carved with a human face. On the island of Hawaii, in place of the straight lines of slab images, we have descriptions of a semi-circle of wooden images in the round placed at one end of the court. The transition of the upright slabs of the early Polynesian marae into images seems actually to have taken place whatever their original intent (Emory 1943:17).

What Emory, Buck and others failed to appreciate is that material culture is meaningfully constituted, which means "there are ideas and concepts embedded in social life which influence the way material culture is used, embellished and discarded" (Hodder 1992:12). Embellishment can denote different things. In a paper on different kinds of value in the Eastern Solomon Islands, Davenport, noted, for example, that " aesthetically embellished objects signal ritual contexts and ritual utilization" and "An embellished object is separated from the economic domain of purchase and exchange" (Davenport 1986:106-107).

7.4.4 A Re-Assessment of the Form and Meaning of East Polynesian God-Stones

As remarked earlier, the conventional view of Polynesian 'god-stones' is that they were 'vehicles', 'places for the gods to inhabit,' abodes of the gods,' or 'temporary shrines' as opposed to icons or actual representations of the gods. While there is no reason to question the function of most of these stones, the whole matter of 'representation' is badly in need of re-examination. For example, are uprights embodiments of gods or simply mediums for communication—i.e., a vehicle as commonly described? Differences in form and repeated forms argue for something more meaningful.

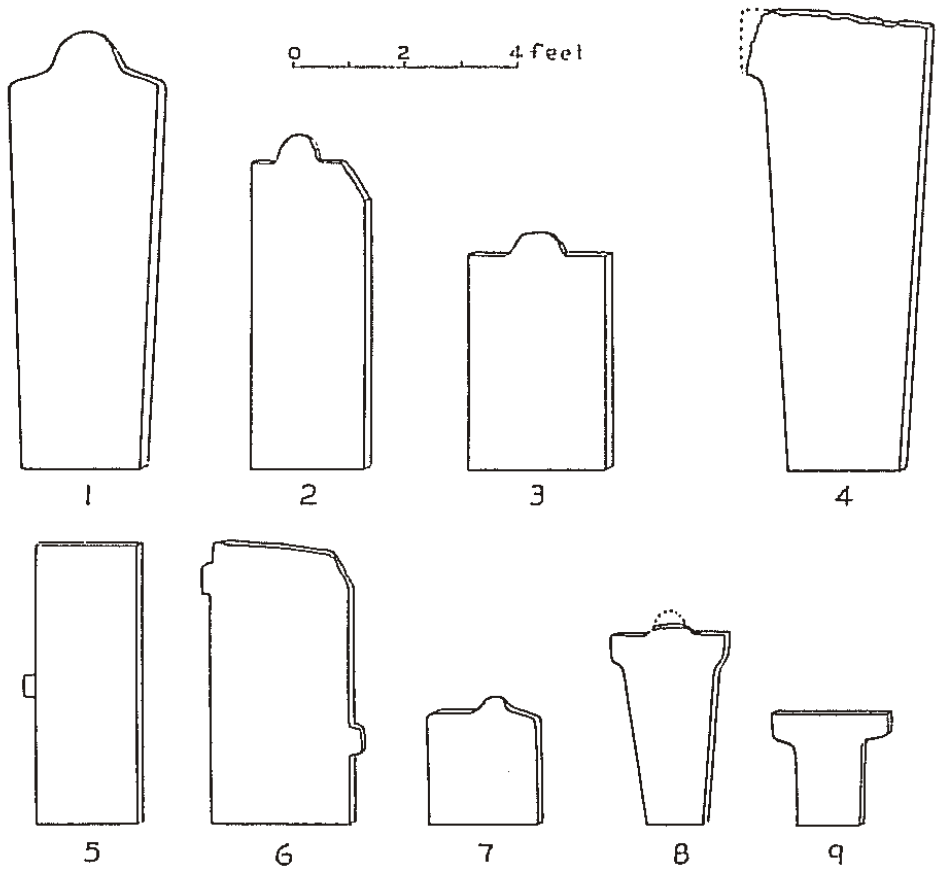


FIGURE 5.—Limestone marae uprights: 1-5, from marae Ramapohia, Fagatau: 3, a court upright; 5, a lateral *ahu* upright; the others *ahu* uprights; 6, *ahu* upright from marae Punakau, Tatakoto; 7, court upright from marae Ahutu, Fagatau; 8, upright from marae Katipa, Fakahina; 9, court upright from marae Ahutu, Tatakoto.

Figure 7.9. Tuamotuan *Marae* Upright Forms (after Emory 1934: Figure 5).

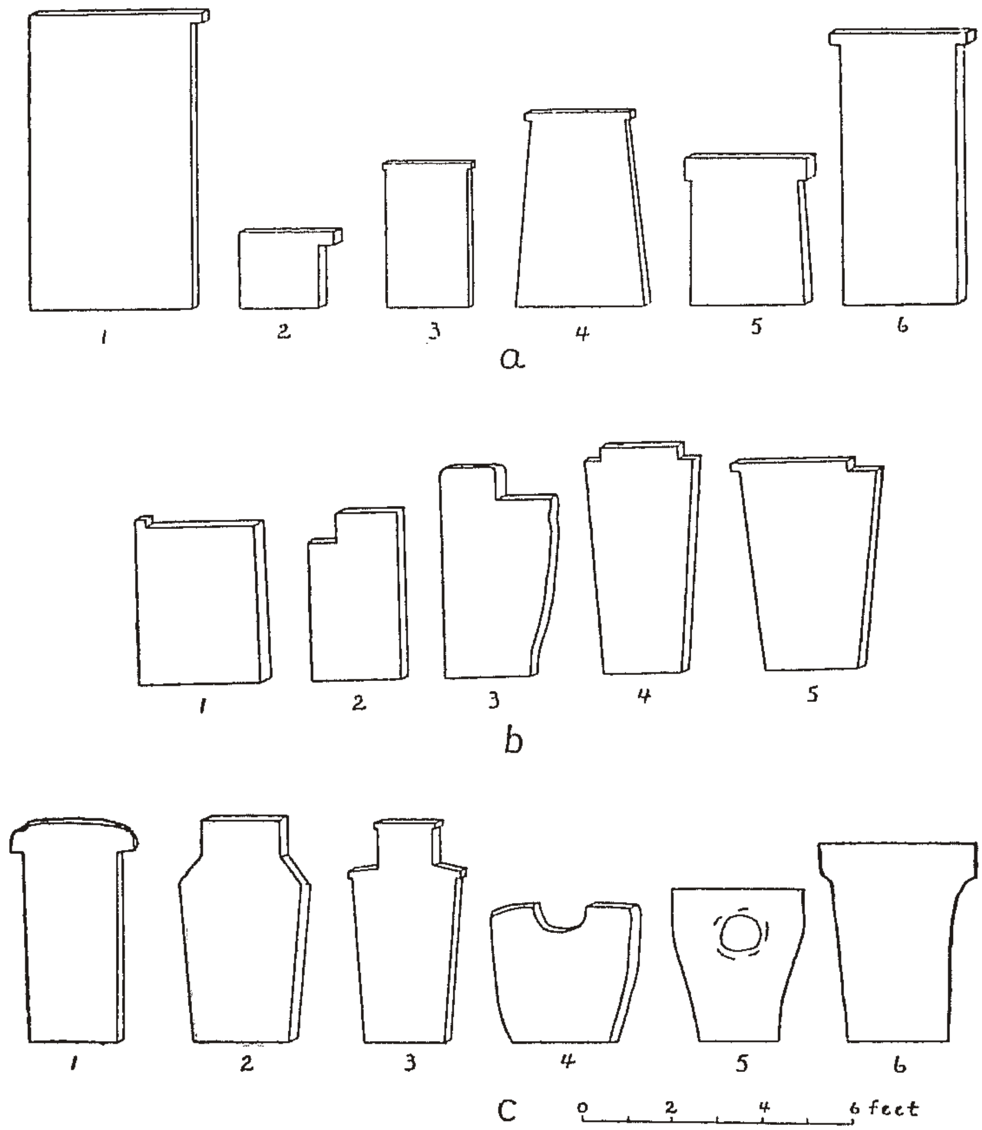


FIGURE 22. Marae pillars. *a*, pillars with horizontal flanges: 1, 2, unilateral flanges; 3-6, bilateral flanges. 1, Rauhara pillar from back line; 2, Te Reinga, right line; 3, Rakahanga, front line; 4, Rakahanga, left line; 5, Rauhara, right line; 6, Te Tohi, back line. *b*, pillars with corner notches: 1-4, back line pillars; 5, pillar of left line. 1, Te Tohi pillar with vertical flange; 2, Te Reinga, even unilateral notch; 3, Te Reinga, deep unilateral notch; 4, Te Tohi, bilateral notches; 5, Rakahanga, shallow notch and flange. *c*, worked pillars: 1, Mahue pillar from back line, bilateral projections; 2, Rakahanga, left, two sloping shoulders; 3, Rakahanga, left, bilateral squared shoulders and bilateral horizontal flanges at shoulders and top; 4, Te Reinga, left, mesial curved notch; 5, Te Reinga, right, perforation evidently a natural flaw and not worked; 6, Te Hara, back, bilateral projections or deep flanges.

Figure 7.10. Tongarevan Marae Upright Forms (after Buck 1932: Figure 22).

The ability of the gods to take different forms appears to have been widespread in Polynesia. Handy noted that "Most of the gods who received actual worship and those who figured in the myths and legends were thought of usually as having human form. It must be remembered, however, that gods were accredited with the power of assuming various forms at their pleasure. All through Polynesia there are legends which recount the exploits of the mythical hero gods who were regarded as embodying and expressing all the attributes of human beings, but at the same time possessing godlike powers and qualities" (Handy 1927:90-91).

The Maori, who did not engage in the construction of large religious structures of stone like other groups in East Polynesia, did manufacture small god sticks of variable forms to represent different gods:

> Some of the diminutive Maori "god sticks," called *toko*, show an interesting symbolism. A set described by White (156, Vol. I, p. 2) consisted of small sticks only a few inches high, each with a knob on top, and each having a characteristic shape of shaft. The stick representing Tu, the war god, was straight, standing erect "as Tu did at the deluge." The symbol representing Tawhiri, the god of the tempest, was "not unlike a corkscrew, to represent the whirling of the winds and clouds when Rangi attached Tu at the time of the deluge." The lord of the sea, Tangaroa, was symbolized by "a zigzag form, not unlike the teeth of a saw, to represent the waves of the sea." The stick representing Tane, the forest lord, "had a semicircular bend at half its length, on either side of which it was straight. This bend represented the swelling and growth of bulbs, shrubs and trees." The stick of Rongo, the god of the sweet potato, "was in rounded wave-lines along its whole length, to represent the growth of the tuberous *kumara* as it raised the earth in little mounds." Lastly, the *toko* (stick) of Haumia, the god of the fern root "had three half-circles bending in one direction" which represented the "irregular and twisted form of the fern-root when newly dug up" (Handy 1927:124).

The Maori god stick figures suggests that in addition to or, perhaps, in place of the commonplace male/female dichotomy there are physical characteristics of the uprights that are specific to one god or goddess or class of gods or personal spirits. In the Maori example, it is interesting that it was the shape of the shaft, which is equivalent to what we are calling the body of the upright that was the distinguishing characteristic.

There were obviously many different forms of representation in Polynesian god-stones and wooden images and this is the problem for analysts and interpreters. The stone uprights on Mauna Kea are an example of what Gell called 'aniconic representations':

> Meanwhile, there are indexes which refer to other entities (such as gods, again) which (*a*) are visible, but which (*b*) do not permit abductions as to the visual appearance of the entity (god) because they lack any visual recognition cues. Sometimes gods are 'represented' by stones, but the god does not 'look like' a stone in anybody's estimation, believer or non-believer alike. The anthropology of art has to consider such instances of 'aniconic' representation, as well as the ones involving more or less overt visual cues as to the appearance of the entity being represented. There are many forms of 'representation' in other words, only one of which is the representation of *visual form*. Approximately, the aniconic image of the god in the form of a stone is an index of the god's spatio-temporal presence, but not his appearance. But in this case, the spatial location of the god is not 'arbitrarily' or 'conventionally' associated with the spatial location of the god; the stone functions as a 'natural sign' of the god's location just as smoke is a natural sign of the spatial location of fire (Gell 1998:26).

The problem with Gell's formulation, with the simple dichotomous distinction between 'iconic representations' and 'aniconic representations", is that while it may be true that natural stones do not represent the appearance of the god (the Hawaiians did not know what the gods looked like) 'god-stones' of the kind widely found throughout Polynesia can or did represent some quality or aspect of a god or class of gods, who were in many instances indistinguishable from humans (Sahlins 1995; Valeri 1985). Sahlins describes the similarities and overlap:

> In the event, all sorts of resemblances and differences, temporalities, and contiguities connect features of nature and elements of culture to one or another of the great *akua*. As previously noted, the hawk, the dog, and certain game fish are bodies of Ku, since this god is the ideal male and these species evoke the warrior's qualities. Plants used in men's technical activities are likewise particularlizations of Ku, such as the *koa* tree, from which canoes are made. Forest birds whose feathers adorn warriors and chiefs' capes are again realizations of Ku. Ku: the term also means 'straight' or 'erect,' hence things high and straight in nature are manifestations of Ku's virility. The coconut tree is a kino of Ku; it is a man with his head in the ground and his testicles in the air (Sahlins 1995:168-169).

It is highly unlikely that we will never know what kinds of rites were conducted at any of the shrines, the names of the gods that were invoked or the underlying beliefs because of the absence of verbal and written accounts (cf. Trigger1998:18). Trigger (1998) and Davis (1993) are very explicit about the limits of our interpretations:

> I reluctantly conclude that specific beliefs cannot be inferred from material culture alone. To infer the meaning of symbols, it is necessary to have verbal information in the form of written records or oral traditions either from the same culture or from cultures that are historically related to the one being studied (Trigger 1998:18).
>
> To understand what an image signifies, an interpreter must know exactly in what way the properties of a visual display were produced for seeing-as. Because of the possibility of ambiguity and of fortuitous resemblance, no amount of inspecting the display itself, 'empirically' recording its 'attributes,' can possibly provide this information. The interpreter must have what I called 'archaeological' knowledge about the replication of seeing-as (Davis 1993:129).

The uprights on the larger, more complex shrines (Types 4 and 5), those which are inferred to have been possibly built and used by priests instead of the heads of small family groups, may have possibly functioned in a way similar to that described by Raymond Firth for the stone symbols on the *marae* of Tikopia:

> The material symbols also gave a kind of chart for navigation in ritual behaviour. The ritual of Marae Lasi in Uta had an intricate ground plan, and by reference to the stone symbols of the gods the performers could constantly orient themselves for assembly and individual action. The stones were also of great importance as mnemonics, serving to remind generation after generation of what had to be done, where and for whom (Firth 1970:126).

7.4.5 Cultural Origins and Chronology: A Review of the Replacement and Cultural Survivals Theory

Not long after they were first described in 1938, Emory compared the Mauna Kea shrines to the *marae* on Necker and to a platform with uprights on the slopes of Mauna Loa. Emory expressed a commonly held opinion of the time—that simple shrines with East Polynesian architectural and iconic characteristics were once common throughout the main Hawaiian Islands, but had been replaced by the *heiau* just about everywhere except for Necker and other isolated localities such as higher elevation slopes of Mauna Kea and Mauna Loa. This viewpoint, which is a classic example of the "archaic survival theory," was a prevalent theory in anthropology at the time Emory and Buck were working. Another example of such thinking is found in Buck's description of the introduction of a new form of religious structure with Paao. Buck wrote that "He [Paao] introduced the form of temple then vogue in Tahiti, and it was adopted either peacefully or after hostilities. The new form based on the later Tahitian type was locally named heiau instead of marae. The early temples were destroyed or altered in all the inhabited islands, but a few escaped destruction in isolated localities such as the mountain slopes of Mauna Kea and Mauna Loa on Hawaii " (Buck 1957:531). One important aspect of the diffusionist model was left out of account—the origin of the term *heiau* which to our knowledge has never been adequately explained (conversation with Julie Taomia). If Paao did in fact introduce a new form of *marae* to Hawaii, why didn't the term *marae* follow?

The cultural survivals theory was untenable even at the time Emory and Buck were writing on the subject of Polynesian religious structure variety and change. The *ahu* of Easter Island, which Emory compared to Tuamotuan *marae*, and the *tuahu* in New Zealand clearly indicate an early widespread form of a "primitive" or "archaic" type. The validity of the assumptions underlying the "replacement and survivals theory" have been questioned before (McCoy 1999b). The view that the shrines on Mauna Kea and in other remote places in Hawai`i must necessarily be "early" because of their "archaic" form is an old idea, which I think is still mistakenly held to by some archaeologists even today. This appears to be a classic example of the fallacy of reading antiquity into simple forms (i.e., of wrongly inferring age based on formal and spatial attributes).

Until recently none of the shrines on Mauna Kea had been dated and it appeared unlikely that the age of any would ever be determined, except by comparison to the shrines in the adze quarry where similar forms are found in association with workshops and dated rockshelters (McCoy 1999a). It was believed that some of the shrines might be potentially quite early based on the assumption that pilgrimages to the snow-topped may have occurred soon after human colonization of the Hawaiian Islands. Two shrines in the NAR were recently dated using the ^{230}Thorium method. The first shrine, which was destroyed and not recognized until a few years ago, is located above the entrance to Keanakako`i (literally "cave of the adze"). Keanakako`i is a habitation rockshelter (Bishop Museum site no. 50-Ha-G28-2-R2; State of Hawaii site no. 50-10-23-16205) with a large mound of debitage in front of the entrance located at the ca. 3,780 m elevation on a modern section of the Humu`ula Trail. The dated sample, which was collected from the surface of the debitage mound below the remains of the shrine, yielded an age-determination of AD 1398 +/- 13. The second sample, which has a secure provenance, is from a shrine (Bishop Museum Site No. 50-Ha-G28-3-S1; State Site No. 50-10-23-16206) located at the ca. 3,675 m elevation, approximately 500 m south of Keanakako`i. This shrine, which is one, if not the most elaborate of all the shrines on Mauna Kea was dated to AD 1441 +/- 3 (McCoy et al. 2009).

While a few shrines could date to perhaps as early as AD 800-1000, most were probably constructed at a later time, coinciding with the rise in population and intensification of adze manufacture in the adze quarry circa AD 1400-1600. It is important to note in this regard that the shrines in the Science Reserve and those in the adze quarry are stylistically indistinguishable. A good number of shrines are therefore probably coeval with the quarry industry, which is roughly dated to circa AD 1100 to AD 1800 (McCoy 1990).

It is clear from ethnographic accounts and recent archaeological dating that simple forms of Hawaiian shrines, such as *the Pohaku o Kane* and *koa*, and more elaborate religious structures (*heiau*) were coeval. In the case of Tahiti, Emory was cognizant of the fact that a variety of forms, both simple and complex, existed at the time of European contact:

> The types, from the simplest to the most elaborate apparently were in use at the time of European contact, so that on form alone one cannot say that any given ruin is earlier than another. But we are fully justified in regarding the stepped-*ahu marae* and those embellished with dressed stone, as well as the *ahu* faced with megalithic slabs, as belonging to the final period of Tahitian culture and as evolving from the smaller, simpler types of *marae* (Emory 1970:77).

7.4.6 Life Histories of Shrines: The Cycle of Respect and Disrespect

One of the newer concepts borrowed by archaeologists from anthropology, is the "life history" concept. The basic argument is that objects, like people, have a "life history" and that an understanding of life histories provides a richer account of material culture items which often tend to be interpreted in strictly utilitarian or functionalist terms.

The life history of uprights obviously started with the selection of particular stones within a "field" of stones that in some cases would number in the thousands and exhibit a bewildering variety of shapes. In Section 6 it was argued that uprights have a "deliberative history" based on some conceptual scheme or belief system in their selection.

Ethnographic data indicate that the relation between man and his gods is a form of accountability in the sense that both are dependent on one another. Durkheim noted that in this regard that "The gods also have need of man; without offerings and sacrifice they would die" (Durkheim 1965:53; quoted in Murphy 1971:149).

The consecration of a shrine was not a once in a life-time event. They had to be renewed or re-consecrated. Victor Turner had an apt phrase for this- "the seemingly fixed is really the continuously renewed" (Turner 1985:155). Handy described the process as follows:

> Such representations of deity were for the most part, merely temporary shrines into which gods could be induced to enter when their services were required for purposes of divination or for dispensing mana. At such times these objects or instruments were made new or refurbished, and consecrated, as were the places of worship. They were revered with all the awe that the visible presence of the god himself would have inspired but at other times the only sanctity accorded to the object was that which pertained to any paraphernalia devoted to the service of the gods (Handy 1927:122).

Sahlins (1995: 271) noted the same pattern or cycle of respect and disrespect:

> It is true that such images were receptacles of the gods. But then, they would be so when and as they were ritually consecrated, a condition that would not obtain during the Makahiki, as ordinary rites were then in abeyance. Hence the indifference to images reported as a general rule by Lieutenant King in his resume of observations at Hawaii (Cook and King 1784, 3:160). Samwell had remarked the like in his own journal:
>
> Tho' they look upon these idols as their Gods they pay no great reverence to them, for when any of us laughed at them & treated with Contempt even those we supposed the most sacred among them, the Indians instead of being offended, would join with us in ridiculing them & seemed to think as lightly of them as we did, and there was none of them they would not sell even for trifles (Beaglehole 1967:1185; n.b.: the last was not true of the Ku image).

The cycle of respect and disrespect that Capt. Cook's party observed is evident on some of the shrines in the Science Reserve. The life-history of some shrines ended with what can only be characterized as deliberative destruction of some of the god-stones. There is no way to date this kind of event. Some of the destruction is undoubtedly post-contact and even recent. In other cases, such as Sites 16189 (Figure 7.11) and Site 16163 (Figure 7.12), many of uprights at these sites were not just knocked over; they were deliberately broken. In the case of Site 16189, some of the broken pieces are 10 cm or so thick. The breaks, moreover, are clean and the fragments, which must weigh 100 lbs or more, are found several meters below where they originally stood (see Figure 7.11).

It is interesting to note that as late as the late 19th century on Easter Island (Rapa Nui), when all of the stone statues (*moai*) had been toppled; those that were still intact were viewed as still alive while those that had been broken were dead. Wilhelm Geiseler collected the following information in the 1880:

> The honoring of the idols must have been wide spread because even today every older Rapanui man knows well the name of each of the many statues, regardless whether these are still standing or have already fallen down, and displays great respect toward them. Even though present inhabitants claim to be Christians, the idols are still considered to have some special attributes and to possess great powers. Furthermore, they view the tipped over statues as being still alive; only the broken idols are thought of as dead and without any powers whatsoever (Geiseler 1995, trans. by Ayres and Ayres).

This same belief system might explain the deliberate breakage of some uprights. The breaking of objects appears to be a widespread practice in traditional cultures (e.g., the breaking of mortars and pestles, which was called "killing" amongst various Native American Groups. The idea that different statuses or ranks can pollute one another is part of the complex Hawaiian ideology of pollution beliefs (Valeri 1985), and the Maori of New Zealand as well. There are descriptions of Maori chiefs in the early contact period breaking tea cups after the beverage had been consumed, much to the consternation of their European visitors. The reason "was to ensure that their tapu, which had entered the cup by contact with their lips, spread no further to the possible detriment of both themselves and any future user" (Hanson and Hanson 1983:53).

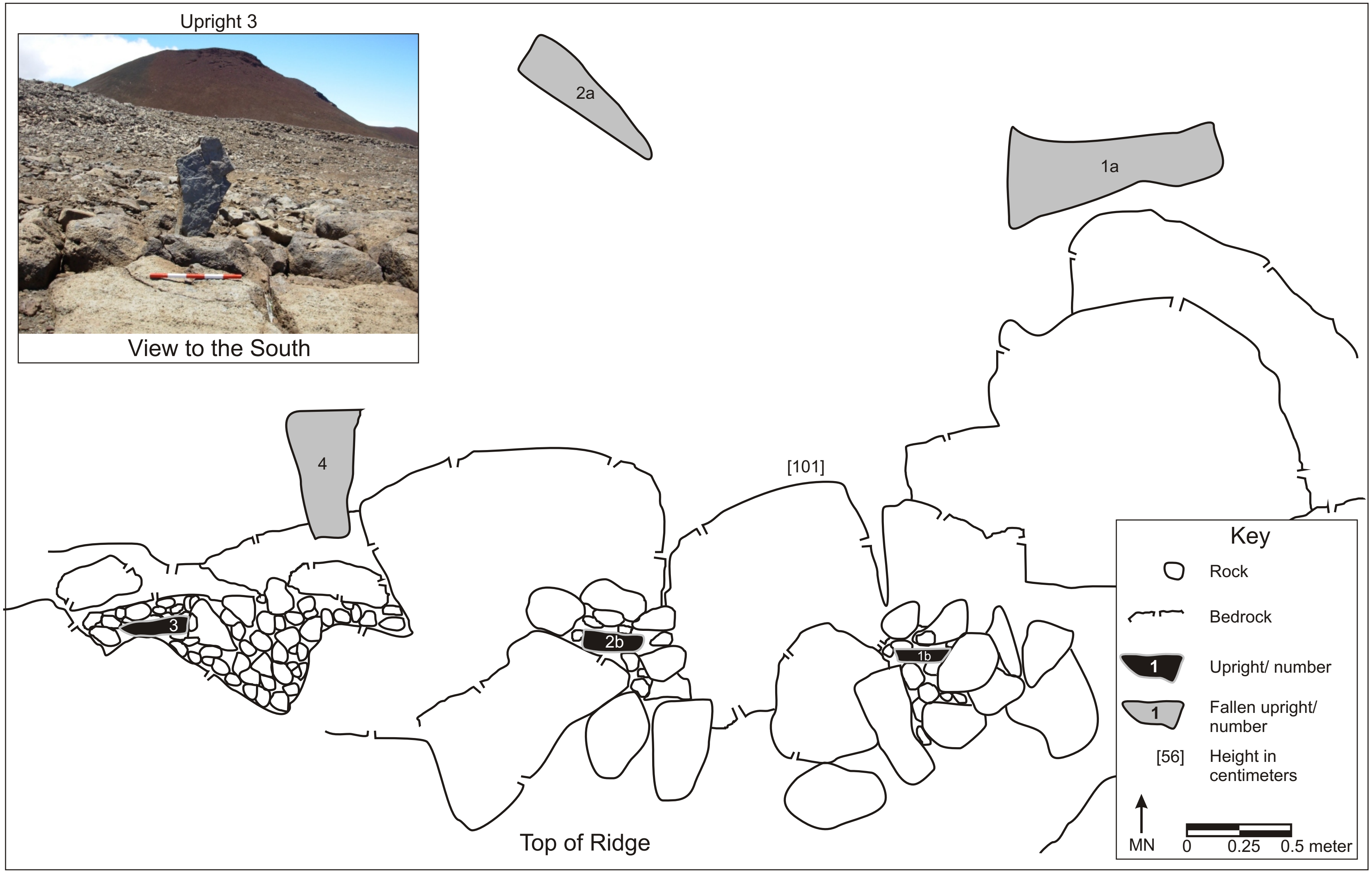


Figure 7.11. Deliberately Broken and Displaced Uprights at Site 16189, Plan View and Photograph.

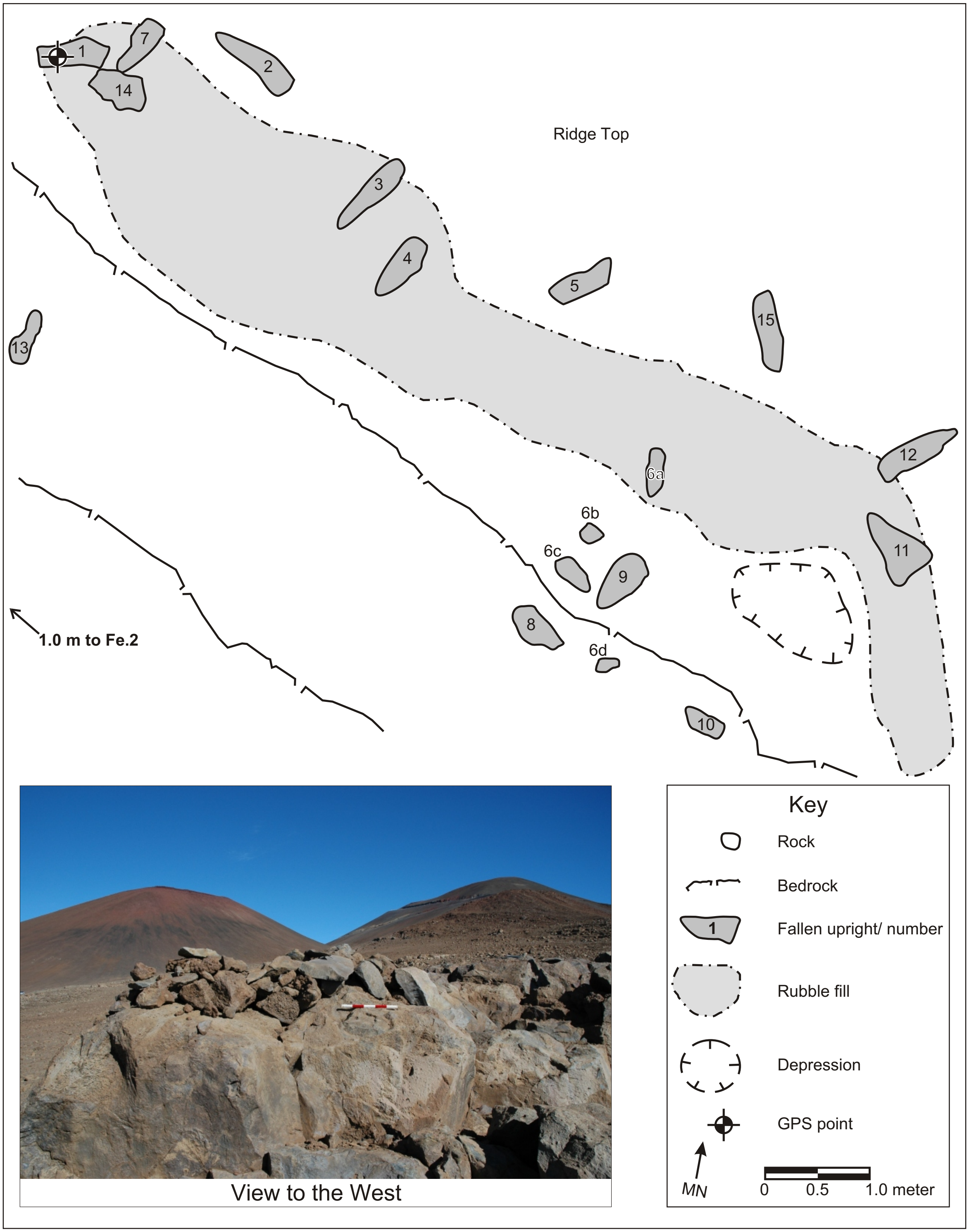


Figure 7.12. Deliberately Broken and Displaced Uprights at Site16163, Feature 1, Plan View and Photograph.

7.5 CONCLUDING REMARKS

The recent history of archaeological research in the summit region of Mauna Kea is a classic example of the emergence of new and different questions as well as new perspectives that are gained in a multi-stage research program carried out over a period of time. The 2005-2009 survey provided ample opportunity to re-assess earlier ideas and conclusions and to revise or formulate new ones. As an example, one long-standing research question concerned the function and meaning of Site 16204 which is located outside of the adze quarry proper because of the absence of locally available tool-quality basalt, but is regarded as a part of the quarry in terms of the social and religious processes that were an integral part of the production process. The most recent interpretation of this site (McCoy 1999b) differs greatly from ideas held only a few years earlier as a result of the opportunity to go back to this site again and again.

During the survey and even before, in the 1975-76 research project, we came to the conclusion that the site oriented approach to recording and interpreting the archaeological landscape of a quarry complex like that on Mauna Kea presents a number of problems and is in many ways unworkable. A better approach is to view the quarry as a cultural landscape comprised of diverse kinds of activity remains, all related to work and livelihood and probably the burial of esteemed adze makers in the quarry. There is, moreover, no basis for thinking that however the Mauna Kea Adze Quarry Complex is perceived and recorded that the same approach could be extended automatically to other Hawaiian adze quarries.

The Mauna Kea Adze Quarry Complex should not be viewed as a monolithic whole in comparative studies. Generalizations about preform types, reduction sequences, craft specialization, standardization, etc. are not only unwarranted, they often lead to spurious conclusions, such as the conclusion that flake blanks are the predominant blank type in the Mauna Kea Adze Quarry Complex and cobble blanks in the minority (Mintmier 2007: Figure 5). Comparisons with other adze quarries in Hawai`i need to specify what part of the quarry complex or what specific site assemblages are being used in the comparison. They also need to take into account that while there are commonalities between Hawaiian adze quarries, in for example the manufacturing technology and resultant by-products, the organization or social structure (Hodder 1982:150) of the quarry operation on Mauna Kea exhibits characteristics that on present evidence are believed to be local and particular.

Finally, we hope to have demonstrated that the isolated lithic assemblages and artifacts in the Science Reserve, though small and seemingly insignificant compared to the massive debitage deposits in the adze quarry, assume a special kind of importance in archaeological practice. They demonstrate that “work” and more precisely, consecrated work, is a far broader, more elusive phenomenon than is generally recognized, thus pointing to the need to continue developing appropriate theory and methods for interpreting the residues of work, such as adze manufacture.

8.0 SIGNIFICANCE EVALUATIONS

Evaluating the significance of sites or historic properties is a requirement for state projects under Chapter 6E-8 and its implementing regulation (Chapter §13-275-6). Site significance in American archaeology tends to be evaluated using standard criteria, such as those set out in the National Park Service's National Register regulations at 36CFR 60.4. Significant historic properties, using the National Register criteria, are those:

> a) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> b) That are associated with the lives of persons significant in our past; or
>
> c) That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or possess high artistic values, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> d) That have yielded, or may be likely to yield, information important in prehistory or history.

One other criteria (e) has been added to the list in Hawai`i. Historic properties evaluated as significant under Criterion "e":

> Have an important value to the native Hawaiian people or other another ethnic group with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity (Chapter §13-275-6).

Site significance tends to be viewed as fixed and unchanging, but in reality it is "both dynamic and relative" (Moratto and Kelly 1978:2). Bowdler (1977:2) and others have noted how archaeological significance is anything but static. Charles McGimsey and Hester Davis emphasize the importance of having a frame of reference in making significance evaluations and why they are always at the minimum relative:

> The fact that archaeological sites and the information they contain are our only clues to much of human life in the past makes every site potentially significant. It is generally recognized, however, that defining significance implies some frame of reference, problem orientation, geographic, temporal or other context, against which an archaeological phenomenon is to be evaluated. A site is therefore more or less significant relative to some criterion or criteria (McGimsey and Davis 1977:31).

As noted earlier in this report, during the preparation of the Master Plan, in 1999, SHPD proposed that the cultural landscape on the top of Mauna Kea be recognized as the Mauna Kea Summit Region Historic District. The historic district proposal was summarized in the cultural impact assessment for the Master Plan (PHRI 1999:30-32) and discussed in more depth in the early planning process for the proposed Keck Outrigger project (Hibbard 1999; NASA 2005). The IfA, NASA, and other parties agreed that the proposed district, which on current thinking would include all of the Science Reserve, the Natural Area Reserve, and additional areas at selected locations lower on the mountain, meets the eligibility criteria for inclusion on the

National Register of Historic Places. The district is now listed in the Statewide Inventory of Historic Places as Site 50-10-23-26869.

With the recognition of the Mauna Kea Summit Region Historic District as eligible for the National Register there is now a single frame of reference that can be used in evaluating site significance for all of the historic properties in the summit region. All of the sites in the Astronomy Precinct are contained within the proposed boundaries of the Historic District. They are considered to be contributing properties in the National Register.

> A **contributing** building, site, structure or object adds to the historic architectural qualities, historic associations, or archaeological values for which a property is significant because a) it was present during the period of significance, and possesses historic integrity reflecting its character at that time or is capable of yielding important information about the period, or b) it independently meets the National Register criteria (National Register Bulletin 24:45).

The historic district is significant under all four National Register criteria and criterion "e" of the Hawaii Administrative Rules, Chapter §13-275-6. The district is significant under criterion "a" because of the presence of the Mauna Kea Adze Quarry Complex (a National Historic Landmark), which was used over a period of 500 years or more and the hundreds of shrines in and outside of the quarry. Both the quarry and the shrines are associated with broad patterns and events in Hawaiian prehistory. The district is significant under criterion "b" because of the association with several gods who may have been deified ancestors. These include Kūkahau`ula, Līlīnoe and Waiau. The sites in the adze quarry and many of the shrines embody distinctive characteristics of traditional Hawaiian stone tool manufacture by craft specialists and a distinctive type of shrine construction found in only a few other places in the Hawaiian Islands. These make the district significant under criterion "c." Studies of the Mauna Kea Adze Quarry Complex and the on-going archaeological survey of the Mauna Kea Science Reserve have already made a significant contribution to our understanding of Hawaiian prehistory and history, and hold the potential to make even more contributions. The district is thus significant under criterion "d." Finally, the district is significant under criterion "e" because of the presence of numerous burials and the hundreds of shrines which have been interpreted as evidence of a previously unknown land use practice in the form of pilgrimages to the summit of Mauna Kea to worship the gods and goddesses. As noted earlier**,** Pu`u Kūkahau'ula, Pu`u Waiau and Pu`u Līlīnoe were deemed Traditional Cultural Properties (TCPs) by SHPD in 1999 based on legendary information and continuity of cultural practices (Hibbard 1999; SHPD 2000). There are people, both Hawaiian and non-Hawaiian, who believe that more of the mountain, if not the entire mountain, is sacred and should be recognized as one large TCP.

9.0 RECOMMENDATIONS

One of the recommendations that would have been made if it had not been done so earlier, in the 2000 Mauna Kea Science Reserve Master Plan (Group 70 International, Inc. 2000), would have been to preserve as much of the cultural landscape in the 11,288-acre Science Reserve as possible. The Master Plan, which was approved by the UH Board of Regents (BOR), established a 10,760-acre Natural/Cultural Preserve, and a 525-acre Astronomy Precinct, which is the only area than can be developed in the future.

All of the historic properties in the Natural/Cultural Preserve will be preserved. It should also be possible to preserve the few sites in the Astronomy Precinct through avoidance. A number of mitigation measures aimed at preserving, protecting and enhancing the importance of the historic properties in the Science Reserve have been outlined in a draft CRMP (CRMP; McCoy et al. 2009). Brief summaries of the proposed management actions in the CRMP are presented below.

1) ***Develop a policy to assure that Kahu Kū Mauna council is consulted on individual development projects.*** As the primary Native Hawaiian advisory group associated with Mauna Kea, the Kahu Kū Mauna Council will be consulted on individual development projects, in a timely and appropriate manner. The consultation policy will include mechanisms for addressing any recommendations or concerns raised by the Council.

2) ***Continue to prohibit the use of vehicles off of established roads.*** Unauthorized off-road vehicle use has caused serious damage to the fragile alpine environment of the summit and is therefore prohibited. Direct and indirect damage to historic properties, as well as to the cultural landscape of Mauna Kea, can also occur through unauthorized off-road vehicle use. OMKM's policy will continue this ban and strengthen measures to deter off-road use.

3) ***Prepare a Burial Treatment Plan.*** Once the final AIS report is reviewed and approved, a BTP will be prepared for all of the confirmed and possible burial sites documented for the three UH Management Areas using guidelines set forth in the CRMP. The BTP will detail how the burials will be preserved and protected (including any site stabilization measures), suggest the enforcement responsibilities OMKM Rangers will have, and describe any provisions for visitation by recognized descendants.

4) ***Develop an archaeological monitoring program.*** Once the final AIS report is completed and submitted, the archaeological monitoring program can begin. The CRMP contains a conceptual AMP and program on which this program can be built. The program will be guided by a final AMP, to be prepared and submitted to OMKM and DLNR. The AMP will include guidelines for monitoring the condition of historic properties in order to identify patterns in the alteration of historic properties. In addition, the plan will include steps for maintaining and updating the catalogue of historic properties, as documented in the AIS, and record their current condition for comparative impact assessments.

5) ***Develop guidelines regarding the use of ancient shrines and protocols for offerings.*** The AIS fieldwork has documented alterations made to shrines and other historic sites in the UH Management Areas; some of the alterations appear to be related to modern cultural and religious practices. Guidelines will be developed in consultation with the Kahu Kū Mauna Council to prevent alterations that affect the integrity of historic properties, such as the removal or addition of new upright stones.

6) ***Develop a list of individuals, families or organizations who will be consulted when individual development projects are proposed or when other issues arise that may be a concern.*** A list of parties to be consulted will be developed and expanded from those who participated in consultations over the CRMP, Natural Resource Management Plan (NRMP), and CMP. Development of the list will include procedures for updating it, and for ensuring prompt and accurate communications between OMKM and all parties.

7) ***Develop a policy for the construction of new Hawaiian cultural features and the long-term management of these features.*** The AIS has documented many small stone features of presumably recent origin that may or may not be ceremonial or religious in nature. The policy will address the construction of additional new features, and include protocols (developed by the Kahu Kū Mauna in consultation with other Native Hawaiian organizations) for how, where, and when such construction may occur.

8) ***Retain commercial permitting process.*** Currently, the OMKM reviews and approves commercial permit applications made by such businesses as tour operators or film companies; permit approvals may include conditions on uses or activities. These procedures will continue and be supplemented by requiring cultural orientation training for all tour operators and key personnel, on-going monitoring of commercial activities, and controlling visits.

9) ***Prepare a debris control and removal plan that incorporates protective measures for historic properties.*** This plan will include provisions for monitoring the distribution of debris and minimizing its escape from the observatories and during maintenance and construction work. The plan will also include measures for debris collection in publicly accessed areas and safe removal practices that will not cause damage to historic properties. Public education and positive reinforcement of public behavior (e.g., strategic placement of rubbish containers) will form a part of the plan.

10) ***Develop a staff training program.*** A staff training program will include basic information from the AIS on site locations and descriptions, including site and artifact recognition. Primary elements of other plans or policies – prevention of off-road vehicle use, debris control and removal, public access management – will form the basis of staff training. The program will also integrate all regulations, restrictions, and polices in a single document to aid management staff.

11) ***Implement archaeological monitoring program.*** Once the AMP is approved by OMKM and DLNR, the monitoring program can be implemented. The primary purpose of the monitoring program is to determine what uses, if any, are affecting

historic properties, the degree and frequency of these effects, and ways to prevent or minimize their occurrence. Implementation of the monitoring plan will require the presence of trained OMKM staff, or a qualified archaeological consultant, who will conduct site visits to all relevant locations within the UH Management Areas in order to monitor uses and conditions of historic properties, as well as document and describe any impacts to these properties.

12) ***Coordinate hunting policies with DLNR to ensure that historic properties are protected.*** The policies will include measures for advising the public of sensitive areas, the enforcement of prohibitions on off-road vehicle driving or parking, and controlling debris. Coordination with DLNR may include a Cooperative Agreement with DOFAW.

13) ***Develop research guidelines that incorporate protective measures for historic properties.*** Research on Mauna Kea, for example, geological, botanical, and zoological research activities, can range from relatively low-impact efforts, such as those in which researchers hike to specific areas to record information, to more intrusive efforts such as setting up instruments to record data over time or collecting samples. Research guidelines will specify which kinds of research require permits, which agency reviews are necessary, and how permit conditions will be enforced. Information on historic properties and the need to avoid any alteration of them will also be provided to research permit applicants.

14) ***Implement debris control and removal plan.*** Take steps to ensure that appropriate OMKM personnel, including Rangers, are aware of the plan's measures for protecting historic properties.

15) ***Implement staff training program.*** Take steps to ensure that the training program includes a comprehensive review of the relevant documents pertaining to the archaeological and other cultural resources in the UH Management Areas as well as field trips to various site types present. Rangers will receive training in recording damage to historic properties.

16) ***Develop an educational and interpretive program that minimizes the impact of visitation to historic properties.*** As part of the development of this program, an educational and interpretive plan will be prepared in coordination with DLNR. The educational and interpretive plan will include educational themes, signage (if deemed appropriate), content of the sign text, guidelines for implementation of the program, and measures that will ensure protection and preservation of any historic sites involved in the program, as well as protection and preservation of Mauna Kea's cultural landscape. The program will designate historic properties suitable for public visitation through guided or self-guided tours. The program can also include development of educational brochures, displays, and materials for supporting staff presentations to the public. The development of such programs will be coordinated with OMKM, the Kahu Kū Mauna Council, and DLNR.

17) ***Implement the educational and interpretive programs.*** Implementation of these programs will follow steps and guidelines in the educational and

interpretive plan, and will be coordinated with DLNR, and the Kahu Kū Mauna Council.

18) ***Develop a plan to mitigate off-road vehicle tracks.*** The plan will recommend additional barriers, provide language for signage and public information, and contain recommendations for restoring areas damaged previously by off-road vehicular activity. OMKM Rangers will be involved in the development and implementation of this plan.

19) ***Implement the mitigation plan for off-road vehicle tracks.*** Initially, a survey to document the location of existing off-road vehicle tracks will be conducted to ensure that mitigation efforts will not impact any historic properties.

20) ***Develop and maintain an integrated GIS database for cultural resources to include guidelines for access and use.*** The existing database from the AIS of the three UH Management Areas will be the foundation on which the integrated GIS database will be developed. Using data from the AIS and the results of periodic monitoring of the condition of historic properties, the GIS database should prove to be an effective and efficient cultural resources management tool. Guidelines regarding public access to the database and use of historic and cultural resources information will be developed.

21) ***Prepare a curation plan for archaeological collections.*** The curation plan will detail temporary and long-term measures for the storage of archaeological collections and associated records, in accordance with Hawaii State and Federal standards. It is anticipated that OMKM staff will need to consult with a qualified archaeological consultant or collections management specialist to develop the curation plan. The plan will specify the location(s) for curation facility, materials to be used (acid-free paper, files, and storage bags), and provisions for access and use.

22) ***Prepare an emergency plan that includes measures to avoid and protect historic properties.*** The plan will include anticipated situations and recommend contingency measures for each one, such as maps showing appropriate access routes and measures to avoid impact to historic sites or surrounding landscape. The plan will be prepared in coordination and consultation with OMKM Rangers and local safety officials (Fire Department, Police Department).

23) ***Implement the curation plan.*** Initially, steps need to be taken to locate an adequate curation facility for the archaeological collections and hard copies of the archaeological records (notes, forms, drawings and maps, etc.). Implementation of the curation plan will follow the guidelines that were developed and approved.

24) ***Implement the emergency plan.*** Steps need to be taken to ensure that the OMKM Rangers as well as local safety officials are aware of implementation of the emergency plan and the protective measures that need to be taken for historic properties.

25) ***Review the CRMP periodically to ensure all historic preservation regulations, restrictions, and policies are updated and revised as***

appropriate and to evaluate existing management policies and the implementation of management actions. Periodic review will rely partly on the results of the monitoring program to be carried out as well as any changes in applicable statutes, regulations or policies. Review of the CRMP will be conducted by the OMKM, the Mauna Kea Management Board and other interested parties and stakeholders (for example, the Kahu Kū Mauna Council). Should it be decided that amendments to the CRMP are desired, the CRMP will be amended in consultation with DLNR.

26) ***Develop a management policy for the scattering of cremated human remains.*** A management policy on the scattering of cremated human remains could be patterned after the policy recently instituted at Hawai'i Volcanoes National Park. This type of policy will be developed and implemented for the Science Reserve.

Finally, it is recommended that SHPD and the Hawaii Historic Places Review Board encourage the National Park Service to establish boundaries for the Mauna Kea Adze Quarry Complex National Historic Landmark. The NHL presently has no official boundaries. This recommendation is based on the assumption that although the NHL now falls within the boundaries of the Mauna Kea Summit Region Historic District, the NHL will continue to exist as a specially designated place within the larger region. A boundary recommendation for the NHL was made in 1977 based on evidence available at the time (see McCoy 1977, Figure 2; Figure 9.1). This was followed by on-site consultation with NPS staff, but boundaries were never established by that agency. Completion of an archaeological inventory of the Mauna Kea Ice Age Natural Area Reserve (NAR) in 2009 indicates that the earlier proposed boundaries need to be expanded (McCoy and Nees in prep.). The actual boundaries of the NHL may never be known with absolute certainty, but certainly not until a survey has been conducted of the Mauna Kea Forest Reserve lands below the Science Reserve and the NAR.

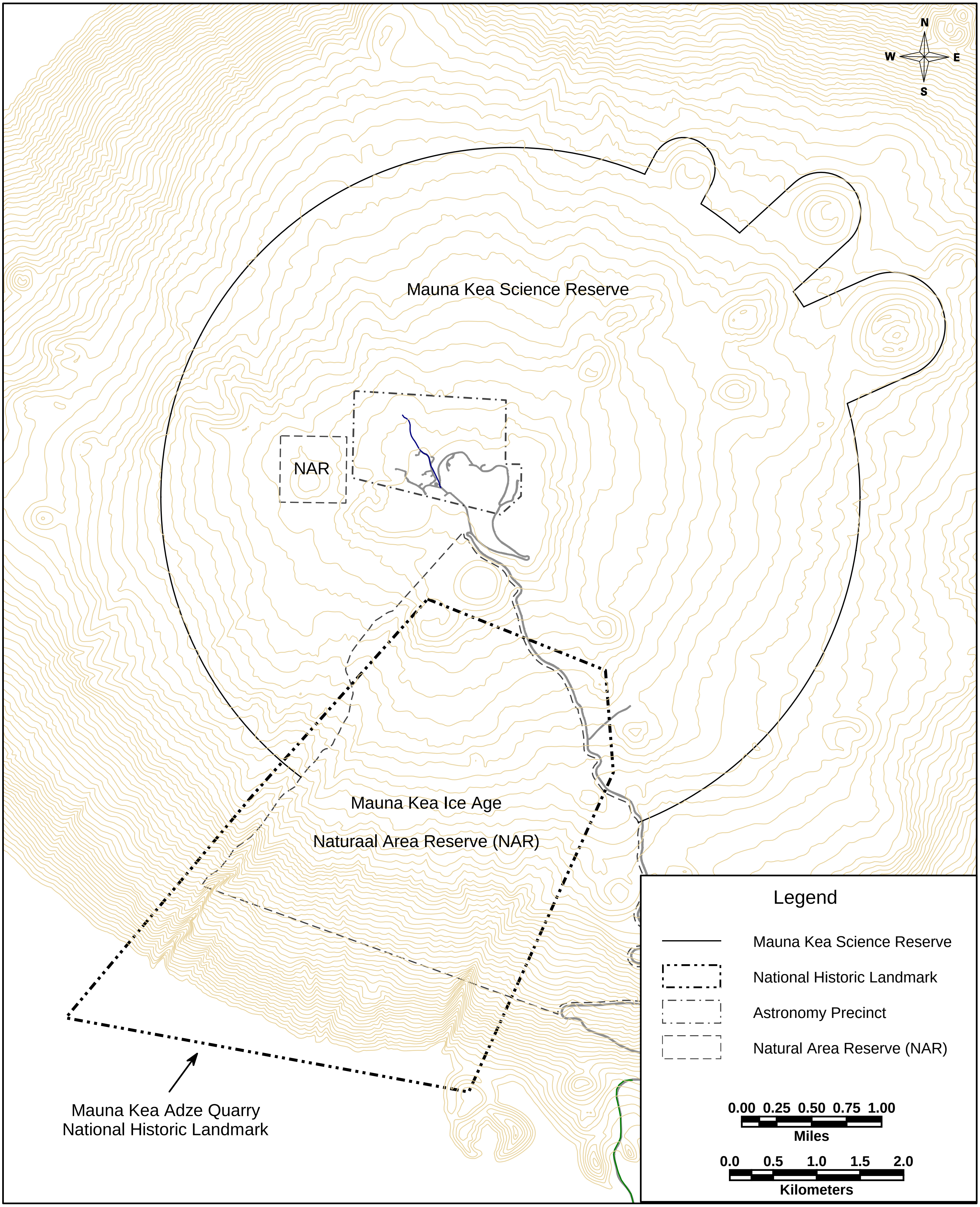


Figure 9.1. Proposed Boundary of the Mauna Kea Adze Quarry National Historic Landmark (Adapted from McCoy 1977, Figure 2).

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APPENDIX A: List of Sites Recorded Between 1975 and 1999 in the Mauna Kea Science Reserve

APPENDIX B: Site Number Concordance Table for Historic Properties in the Hale Pōhaku Area

APPENDIX C: List of Historic Properties in the Mauna Kea Science Reserve

APPENDIX D: Summary of Site Components.

APPENDIX E List of Other Cultural Resources (Find Spots) in the Mauna Kea Science Reserve

APPENDIX F: Metric and Non-Metric Data for Shrines in the Mauna Kea Science Reserve.

APPENDIX G: Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex

APPENDIX H: List of Artifacts Collected during Inventory Survey of the Mauna Kea Science Reserve.

Appendix I: Metric and Non-Metric Data Collected in the Field for Adze Preforms.

APPENDIX J: Metric and Non-Metric Data for Collected Adze Preforms.

APPENDIX K: Metric and Non-Metric Data Collected in the Field for Hammerstones.

APPENDIX L: Radiocarbon Data from Beta Analytic, Inc.

APPENDIX M: List of Samples and Results of EDXRF Analysis.

APPENDIX N: A Statistical Summary and Analysis of Selected Shrine Attributes from the Mauna Kea Science Reserve

APPENDIX A

List of Sites Recorded Between 1975 and 1999 in the Mauna Kea Science Reserve

List of Archaeological Sites Recorded in the Mauna Kea Science Reserve Between 1975 and 1999

State Site No.	Elevation (ft. amsl)	Description	Function
11077	12,254	single upright	shrine
11079	12,240	lithic scatter of adze manufacturing byproducts and 2 associated cairns	“workshop” and possible shrine
16163	12,746	platform/pavement with 14 uprights	shrine
16164	13,287	3 to 5 uprights on platform and 1 isolated upright	shrine
16165	13,317	single row of 2 uprights	shrine
16166	13,268	2 rows of uprights, 8 to possibly 9 total	shrine
16167	13,258	single row of 2 uprights	shrine
16168	13,002	semi-enclosure with 21 to possibly 25 uprights	shrine
16169	13,120	single row of 2 uprights	shrine
16170	13,041	2 cairns with 3 to possibly 4 uprights	shrine
16171	12,982	single upright	shrine
16172	13,110	single upright	shrine
16173	12,894	7 dispersed uprights	shrine
16174	12,933	boulder with 1 to possibly 8 uprights on the side	shrine
16175	12,923	5 cairns with 1 upright each	shrine
16176	12,943	single row of 3 uprights	shrine
16177	13,022	platform with 3 uprights	shrine
16178	13,110	single upright	shrine
16179	12,995	single row of 3 uprights	shrine
16180	12,982	boulder with 3 uprights	shrine
16181	13,307	single upright	shrine
16182	13,081	3 to 5 uprights	shrine
16184	12,963	semi-enclosure with 24 uprights	shrine
16185	12,884	single row of 3 uprights	shrine
16186	12,990	single row of 2 and possibly 3 uprights	shrine
16187	12,687	single row of 9 uprights	shrine
16188	12,746	single upright	shrine
16189	12,805	single row of 3 and possibly 4 uprights	shrine
16190	12,854	single row of 10 uprights and off-set uprights	shrine
16191	12,805	single row of 4 uprights	shrine
16192	12,746	2 sets of uprights, 6 total	shrine
16193	12,736	single upright	shrine
16194	12,569	single row of 12-14 uprights	shrine
16195	12,987	2 cairns	possible burial
16196	12,835	single row of 2 uprights	shrine

List of Archaeological Sites Recorded in the Mauna Kea Science Reserve Between 1975 and 1999

State Site No.	Elevation (ft. amsl)	Description	Function
16197	12,828	single upright	shrine
16198	12,831	2-tiered platform with 7 uprights	shrine
16199	12,854	1 and possibly 4 uprights	shrine
16200	12,874	single row of 5 and possibly 6 uprights	shrine
16201	12,884	single row of 3 uprights	shrine
16202	12,940	single upright	shrine
16203	13,045	single row of 2 and possibly 3 uprights and a lithic scatter of adze manufacturing byproducts	adze “workshop” and shrine
16204	12,274	5 shrines, 26 stone-walled enclosures and a lithic scatter of adze manufacturing byproducts	adze “workshop” and shrine complex
16248	12,414	series of cairns on rim of Pu`u Makanaka	burial
18682	12,887	single row of 3 uprights	shrine
18683	12,953	single row of 2 uprights	shrine
21197	12,959	2 platforms with a total of 5 uprights	shrine
21198	12,933	single upright	shrine
21199	12,815	single upright	shrine
21200	12,870	single upright	shrine
21201	12,989	single row of 2 uprights	shrine
21202	12,963	single row of 6 to possibly 7 uprights	shrine
21203	12,933	single row of 2 uprights	shrine
21204	12,800	3 areas of stacked rock	unknown
21205	13,376	single upright	shrine
21206	12,657	single upright	shrine
21207	12,697	single upright	shrine
21208	12,697	1 to 2 uprights on a boulder	shrine
21209	13,790	cairn on summit cone	marker?
21210	12,165	single upright	shrine
21211	12,195	single row of 2 uprights on a platform and a lithic scatter of adze manufacturing byproducts	adze “workshop” and shrine
21212	12,313	single row of 2 uprights	shrine
21213	12,185	3 piles of rocks with 1 upright	shrine
21214	12,146	single row of 5 and possibly 7 uprights	shrine
21406	12,884	single upright	shrine
21407	12,894	single row of 2 uprights	shrine
21408	12,874	single upright	shrine
21409	11,693	single upright	shrine
21410	12,746	single row of 5 uprights	shrine

List of Archaeological Sites Recorded in the Mauna Kea Science Reserve Between 1975 and 1999

State Site No.	Elevation (ft. amsl)	Description	Function
21411	12,682	Cairn	marker?
21412	12,511	Cairn	marker?
21413	12,626	cairn	possible burial
21414	12,804	cairn	possible burial
21415	13,050	cairn on a boulder	unknown
21416	12,688	cairn	possible burial
21417	12,854	cairn	unknown
21418	12,776	3, possibly 4, uprights on top and to the side of a boulder	shrine
21419	12,776	single upright	shrine
21420	12,077	enclosure with 11 and possibly 12 uprights and a nearby stone platform	shrine
21421	12,638	2 cairns, one with a possible upright and an isolated upright	shrine
21422	12,756	single upright	shrine
21423	12,046	stones on boulder	marker?
21424	12,234	4 to 5 uprights on a platform and boulder	shrine
21425	12,441	single upright	shrine
21426	12,490	single row of 4 uprights	shrine
21427	12,667	terrace with possible upright	unknown
21428	12,638	single upright	shrine
21429	12,648	single upright	shrine
21430	12,992	single row of 3 uprights	shrine
21431	12,421	semi-enclosure with 7 to 10 uprights	shrine
21432	11,604	single row of 2 uprights	shrine
21433	12,510	single upright	shrine
21434	12,466	8 stones on a boulder	unknown
21435	12,480	cairn and boulder with 1 upright	shrine
21436	12,520	cairn	marker
21437	11,864	isolated quarry/workshop	adze manufacturing

APPENDIX B

Site Number Concordance Table for Historic Properties in the Hale Pōhaku Area

LIST OF HISTORIC PROPERTIES LOCATED IN THE HALE POHAKU AREA (SITE 50-10-23-16244)**

State Site No.	BPBM Site No. 50-Ha-G28-87-	Description	Functional Interpretation
10310	Locality 1	Lithic scatter	Adze and octopus sinker manufacturing workshop
10311	Locality 2	Lithic scatter	Adze and octopus sinker manufacturing workshop
10312	Localities 3 and 4	Lithic scatter	adze and octopus sinker manufacturing workshop
10313	Shrine 1	3-5 uprights and octopus sinker manufacture offerings	Octopus sinker manufacturing ritual
10314	Locality 5	Lithic scatter	Adze and octopus sinker manufacturing workshop
10315	Shrine 2	1 upright	ritual
10316	Locality 6	Lithic scatter	Adze and octopus sinker manufacturing workshop
10317	Locality 7	Lithic scatter and firepit	Possible temporary camp and adze and octopus sinker manufacturing workshop
10318	Locality 9	Lithic scatter	Adze and octopus sinker manufacturing workshop
10319	Locality 10	Lithic scatter	Octopus sinker manufacturing workshop
10320	Locality 8	Lithic scatter and firepit	Temporary camp and adze and octopus sinker manufacturing workshop
10321	Locality 11	Lithic scatter	Adze and octopus sinker manufacturing workshop
10322	Locality 12	Lithic scatter	Octopus sinker manufacturing workshop
10323	Locality 4	Lithic scatter	Adze and sinker manufacturing workshop
16245	Locality 13	Lithic scatter	Adze and octopus sinker manufacturing workshop
16246	Locality 14	Lithic scatter	Adze and octopus sinker manufacturing workshop

**The State site numbers were arbitrarily assigned by Cordy (1994:Table 28) before the 1991 site report was submitted to SHPD. Cordy assigned numbers to each of the 14 remains identified in the survey and also gave a number (50-10-23-16244) to the whole site complex (BPBM Site No. 50-Ha-G28-87), which was called the Pu`u Kalepeamoa Site by McCoy (1985, 1991)

APPENDIX C

List of Historic Properties in the Mauna Kea Science Reserve

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
11077	*N/A*	A-5	4	Upright, wall, terraces	Shrine, temporary habitation
11079	*N/A*	A-5	3	Lithic scatter, cairns	Adze manufacturing, possible shrine, markers
16163	*BPBM G28-38*	A-5	2	Platform with uprights, lithic scatter	Shrine, adze manufacturing
16164	*5222 / BPBM G28-40*	A-5	2	Platform with uprights	Shrine
16165	*5223 / BPBM G28-41*	A-5	1	Uprights	Shrine
16166	*5224 / BPBM G28-42*	A-2	2	Uprights	Shrine
16167	*5225 / BPBM G28-43*	A-2	1	Uprights	Shrine
16168	*5226 / BPBM G28-44*	A-1	1	U-shaped structure with uprights	Shrine
16169	*5227 / BPBM G28-45*	A-1	1	Uprights	Shrine
16170	*5228 / BPBM G28-46*	A-1	2	Cairns with possible uprights	Shrines
16171	*5229 / BPBM G28-47*	A-1	1	Upright	Shrine
16172	*5230 / BPBM G28-48*	A-2	1	Upright	Shrine
16173	*5231 / BPBM G28-49*	A-2	4	Uprights	Shrine
16174	*5232 / BPBM G28-50*	A-2	4	Uprights	Shrine
16175	*5233 / BPBM G28-51*	A-2	6	Cairns with uprights	Shrines
16176	*5234 / BPBM G28-52*	A-2	1	Uprights	Shrine
16177	*5235 / BPBM G28-53*	A-2	2	Terrace with uprights, overhang	Shrine, temporary habitation?
16178	*5236 / BPBM G28-54*	A-2	1	Upright	Shrine
16179	*5237 / BPBM G28-55*	A-2	1	Uprights	Shrine
16180	*5238 / BPBM G28-56*	A-2	1	Uprights	Shrine
16181	*5239 / BPBM G28-57*	A-2	1	Upright	Shrine
16182	*5240 / BPBM G28-58*	A-2	3	Uprights	Shrines
16184	*5242 / BPBM G28-60*	A-2	1	U-shaped structure with uprights	Shrine
16185	*5243 / BPBM G28-61*	A-2	1	Uprights	Shrine
16186	*BPBM G28-67*	A-2	1	Uprights	Shrine
16187	*BPBM G28-68*	A-2	1	Uprights	Shrine
16188	*BPBM G28-69*	A-2	1	Upright	Shrine

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
16189	*BPBM G28-70*	A-2	1	Uprights	Shrine
16190	*BPBM G28-71*	A-5	2	Lithic scatter, uprights	Adze manufacturing, shrine
16191	*BPBM G28-72*	A-2	1	Uprights	Shrine
16192	*BPBM G28-73*	A-2	1	Uprights	Shrine
16193	*BPBM G28-74*	A-2	1	Upright	Shrine
16194	*BPBM G28-75*	A-5	1	Uprights	Shrine
16195	*BPBM G28-76*	A-5	2	Mounds	Burial, marker
16196	*BPBM G28-77*	A-5	1	Uprights	Shrine
16197	*BPBM G28-78*	A-5	1	Upright	Shrine
16198	*BPBM G28-79*	A-5	1	Platform with uprights	Shrine
16199	*BPBM G28-80*	A-5	1	Uprights	Shrine
16200	*BPBM G28-81*	A-5	1	Uprights	Shrine
16201	*BPBM G28-83*	A-5	1	Uprights	Shrine
16202	*BPBM G28-84*	A-5	1	Upright	Shrine
16203	*BPBM G28-86*	A-5	5	Lithic scatter, uprights, cairn	Adze manufacturing, shrine, marker
16204	*BPBM G28-1*	A-5	32	Complex	Adze manufacturing, shrines, temporary habitation
16248		A-3	3	Mounds	Burials
18682	*BPBM G28-82*	A-5	1	Uprights	Shrine
18683	*BPBM G28-85*	A-5	1	Uprights	Shrine
21197		A-5	2	Platforms with uprights	Shrines
21198		A-2	1	Upright	Shrine
21199		A-2	1	Upright	Shrine
21200		A-2	1	Upright	Shrine
21201		A-2	1	Uprights	Shrine
21202		A-2	1	Uprights	Shrine
21203		A-2	1	Uprights	Shrine
21204		A-2	4	Lithic scatter, mounds, terrace	Adze manufacturing, possible shrines
21205		A-2	1	Upright	Shrine

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
21206		A-2	1	Upright	Shrine
21207		A-2	1	Upright	Shrine
21208		A-5	1	Uprights	Shrine
21209		A-5	2	Mounds	Markers
21210		A-5	1	Upright	Shrine
21211		A-5	2	Lithic scatter, uprights	Adze manufacturing, shrine
21212		A-5	1	Uprights	Shrine
21213		A-5	4	Rock pile, mounds, pavement	Unknown
21214		A-5	1	Uprights	Shrine
21406		A-4	1	Upright	Shrine
21407		A-4	1	Upright	Shrine
21408		A-4	1	Upright	Shrine
21409		A-6	1	Upright	Shrine
21410		A-4	1	Uprights	Shrine
21411		A-6	1	Cairns	Markers
21412		A-1	1	Cairn	Marker
21413		A-1	1	Platform	Burial
21414		A-1	1	Mound	Burial
21415		A-1	1	Cairn	Marker
21416		A-1	1	Mound	Burial
21417		A-2	1	Cairn	Shrine
21418		A-2	1	Uprights	Shrine
21419		A-2	1	Uprights	Shrine
21420		A-2	4	Enclosure with uprights	Shrine
21421		A-2	3	Cairns	Shrine
21422		A-2	1	Upright	Shrine
21423		A-2	1	Cobble scatter	Marker
21424		A-2	1	Platform	Shrine
21425		A-2	1	Upright	Shrine

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
21426		A-2	1	Uprights	Shrine
21427		A-2	1	Terrace with possible upright	Shrine
21428		A-2	1	Upright	Shrine
21429		A-2	1	Upright	Shrine
21430		A-5	2	Uprights, mound	Shrines
21431		A-5	1	U-shaped structure with uprights	Shrine
21432		A-6	1	Uprights	Shrine
21433		A-2	1	Upright	Shrine
21434		A-2	1	Rock pile	Marker
21435		A-5	2	Upright, rock pile	Shrine, marker
21436		A-4	1	Cairn	Shrine
21437		A-4	1	Lithic scatter	Adze manufacturing
21438		N/A	1	Cinder cone	Traditional Cultural Property
21439		N/A	1	Cinder cone	Traditional Cultural Property
21441		A-1	3	Mound with upright, rock pile with upright, upright	Shrine
21442		A-1	1	Upright	Shrine
21443		A-1	1	Upright	Shrine
21444		A-1	1	Upright	Shrine
21445		A-1	3	Mound with upright, uprights	Shrines
21446		A-2	3	Mound with upright, uprights	Shrines
21447		A-2	1	Upright	Shrine
21448		A-2	1	Uprights	Shrine
21449		A-2	1	Terrace	excavated, determined not to be a site
21450		A-2	3	Cairns	Markers
21451		A-5	1	Upright	Shrine
21452		A-5	2	Platform, mound	Burials
25760		A-5	1	Lithic scatter	Adze manufacturing

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
25761		A-5	1	Lithic scatter	Adze manufacturing
25762		A-5	4	Lithic scatter, enclosures	Adze manufacturing, temporary habitation
25763		A-6	1	Upright	Shrine
25764		A-6	1	Uprights	Shrine
25765		A-5	1	Platform	Burial
25766		A-5	4	Mounds	Unknown
25767		A-5	1	Adze preforms	Isolated artifacts
25768		A-5	1	Basalt flake	Isolated artifacts
25769		A-5	1	Lithic scatter	Adze manufacturing
25770		A-5	4	Lithic scatter, mound, enclosure, filled crack	Adze manufacturing, temporary habitation, possible burials
25771		A-6	1	Upright	Shrine
25772		A-6	4	Mound with upright, upright, cairn, lithic scatter	Shrine complex, marker and, adze manufacturing
25773		A-6	1	Upright	Shrine
25774		A-6	5	Lithic scatter, mounds	Adze manufacturing or offering, burials
25775		A-6	1	Upright	Shrine
25776		A-6	8	Site Complex	Adze manufacturing, shrines, temporary habitation, marker
25777		A-6	1	Mound	Marker
25778		A-6	1	Upright	Shrine
25779		A-6	1	Lithic scatter	Adze manufacturing
25780		A-6	1	Upright	Shrine
25781		A-6	4	Lithic scatter, uprights, rockshelter	Adze manufacturing, shrine, temporary habitation
25782		A-6	3	Lithic material, enclosed area with upright, enclosure, rock pile	Adze manfacturing, temporary habitation, shrine
25783		A-6	1	Upright	Shrine
25784		A-6	1	Upright	Shrine
25785		A-6	1	Rock pile	Marker

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
25786		A-6	1	Uprights	Shrine
25787		A-6	1	Uprights	Shrine
25788		A-6	1	Upright	Shrine
25789		A-5	2	Lithic scatter, uprights	Adze manufacturing, shrine
25790		A-5	1	Mound with uprights	Shrine
25791		A-5	1	Upright	Shrine
25792		A-6	1	Rock pile	Shrine
25793		A-2	1	Uprights	Shrine
25794		A-2	1	Upright	Shrine
25795		A-2	1	Upright	Shrine
25796		A-2	1	Lithic scatter	Adze manufacturing
25797		A-2	1	Upright	Shrine
25798		A-2	1	Upright	Shrine
25799		A-2	5	Terrace with upright, platform, pavement, uprights	Shrines
25800		A-3	1	Horseshoe	Isolated artifact
25801		A-3	1	Lithic scatter	Adze manufacturing
25802		A-3	2	Terrace, mound	Burials, one confirmed
25803		A-3	1	Mound	Burial
25804		A-3	1	Mound	Burial
25805		A-3	1	Mound	Burial
25806		A-3	3	Mounds	Burials
25807		A-3	3	Mounds	Burials, one confirmed
25808		A-3	7	Site complex	Burials, one confirmed
25809		A-3	1	Human remains	Burial(s), confirmed
25810		A-3	4	Mounds	Possible shrine, markers
25811		A-3	1	Upright	Shrine
25812		A-3	1	Overhang	Burial
25813		A-3	1	Mound with uprights	Burial or shrine

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
25814		A-3	3	Mounds	Burials
25815		A-3	1	Mound	Burial
25816		A-3	1	Mound	Burial
25817		A-3	2	Enclosed areas	Temporary habitation
25818		A-3	1	Terrace with uprights	Shrine
25819		A-3	1	Uprights	Shrines
25820		A-2	1	Mound	Burial or shrine
25821		A-3	1	Upright	Shrine
25822		A-3	1	Terrace with uprights	Shrine
25823		A-3	1	Mound	Burial
25824		A-3	1	Mound	Burial
25825		A-2	1	Mound with uprights	Shrine
25826		A-2	1	Uprights	Shrine
25827		A-2	1	Uprights	Shrine
25828		A-2	1	Lithic scatter	Adze manufacturing
25829		A-1	1	Mound	Burial
25830		A-1	1	Platform	Burial
25831		A-1	1	Rock pile	Burial
25832		A-1	1	Mound	Burial
26217		A-2	1	Mound with uprights	Shrine
26218		A-2	5	Rock piles, rock alignments	Camp site
26219		A-2	1	Mound with uprights	Shrine
26220		A-2	4	Rock walls	Temporary habitation
26221		A-2	1	Upright	Shrine
26222		A-2	1	Mound with uprights	Shrine
26223		A-2	1	Upright	Shrine
26224		A-5	1	Brass plate	USGS Marker
26225		A-2	1	Upright	Shrine
26226		A-2	1	Mound	Shrine

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
26227		A-2	2	Mound with upright, lava tube	Shrine, temporary habitation
26228		A-2	2	Mound, rock pile	Shrines
26229		A-2	1	Upright	Shrine
26230		A-2	1	Mound	Unknown
26231		A-2	1	Mound with upright	Shrine
26232		A-2	2	Walls	Temporary habitation
26233		A-2	1	U-shaped structure with uprights	Shrine
26234		A-1	1	Upright	Shrine
26235		A-1	1	Upright	Shrine
26236		A-1	1	Upright	Shrine
26237		A-1	1	Mound	Burial
26238		A-1	1	Upright	Shrine
26239		A-1	1	Upright	Shrine
26240		A-1	2	Mound with uprights, overhang with upright	Shrines
26241		A-1	1	Mound	Shrine
26242		A-1	2	Mound, cairn	Shrines
26243		A-1	2	Upright, cairn	Shrine, marker
26244		A-1	1	Upright	Shrine
26245		A-4	1	Cairn	Marker
26246		A-4	1	Cairn	Marker
26247		A-4	1	Cairn	Marker
26248		A-4	1	Uprights	Shrine
26249		A-4	1	Lithic scatter	Adze manufacturing
26250		A-4	3	Uprights, trash	Shrine, dump
26251		A-4	1	Upright	Shrine
26252		A-4	1	Uprights	Shrine
26253		A-4	79	Site complex	Extraction, shelter, shrine, adze manufacturing
26254		A-4	4	Mounds	Shrines, markers

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
26255		A-4	1	Upright	Shrine
26256		A-4	1	Cairn	Marker
27579		A-5	1	Marker	USGS marker
27580		A-3	1	Camp	USGS Camp
27581		A-4	1	Lithic scatter	Adze manufacturing
27582		A-4	4	Lithic scatter, upright, marker	Adze manufacturing, shrine, marker
27583		A-4	3	Lithic scatter	Adze manufacturing
27584		A-4	1	Lithic scatter	Hammerstone manufacturing
27585		A-4	4	Lithic scatter	Adze manufacturing
27586		A-4	14	Lithic scatter	Extraction, adze manufacturing
27587		A-4	1	Lithic scatter	Adze manufacturing
27588		A-4	10	Lithic scatter, uprights	Adze and hammerstone manufacturing, shrines
27589		A-4	6	Lithic scatter	Adze manufacturing
27590		A-4	13	Lithic scatter	Adze manufacturing
27591		A-4	2	Lithic scatter	Hammerstone manufacturing
27592		A-4	4	Lithic scatter	Adze manufacturing
27593		A-4	1	Cores	Hammerstone manufacturing
27594		A-4	1	Lithic scatter	Hammerstone manufacturing
27595		A-4	2	Lithic scatter	Adze and hammerstone manufacturing
27596		A-4	3	Lithic scatter	Adze and hammerstone manufacturing
27597		A-4	3	Lithic scatter	Adze and hammerstone manufacturing
27598		A-4	81	Lithic scatter, rockshelter	Adze and hammerstone manufacturing
27599		A-4	1	Lithic scatter	Adze manufacturing
27600		A-4	1	Lithic scatter	Adze manufacturing
27601		A-4	78	Site complex	Adze manufacturing
27602		A-4	1	Adze preform	Isolated artifact
27603		A-4	2	Lithic scatter	Adze manufacturing
27604		A-4	15	Lithic scatter	Adze manufacturing
27605		A-4	86	Site complex	Extraction, adze manufacturing

Appendix C. List of Historic Properties in the Mauna Kea Science Reserve

State Site Number 50-10-23-	Other State Site Numbers/ or Bishop Museum Numbers (BPBM)	Section Map Reference Number	Total number of Features/ Components	Formal Site Type	Functional Interpretation
27606		A-4	4	Lithic scatter, rockshelter	Adze manufacturing, shelte
27607		A-4	6	Lithic scatter	Hammerstone and adze manufacturing
27608		A-4	1	Lithic scatter	Adze manufacturing
27609		A-4	1	Lithic scatter	Hammerstone manufacturing
27610		A-4	1	Lithic scatter	Adze manufacturing
27611		A-4	1	Lithic scatter	Adze manufacturing
27612		A-4	1	Lithic scatter	Adze manufacturing
27613		A-4	3	Lithic scatter	Adze manufacturing
27614		A-4	6	Lithic scatter	Extraction, adze manufacturing
27615		A-4	6	Lithic scatter	Extraction, hammerstone manufacturing
27616		A-4	118	Site complex	Extraction, adze manufacturing, shrines, possible burial
27617		A-4	7	Site complex	Adze manufacturing, shrines
27618		A-4	12	Site complex	Adze manufacturing, shrines

APPENDIX D

Summary of Site Components

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
11077			1					1	2		4
11079			1	1	1						3
16163			1		1						2
16164			2								2
16165			1								1
16166			2								2
16167			1								1
16168			1								1
16169			1								1
16170			2								2
16171			1								1
16172			1								1
16173			4								4
16174			4								4
16175			6								6
16176			1								1
16177			2								2
16178			1								1
16179			1								1
16180			1								1
16181			1								1
16182			3								3
16184			1								1
16185			1								1
16186			1								1
16187			1								1
16188			1								1
16189			1								1
16190			1		1						2
16191			1								1

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
16192			1								1
16193			1								1
16194			1								1
16195	2										2
16196			1								1
16197			1								1
16198			1								1
16199			1								1
16200			1								1
16201			1								1
16202			1								1
16203			1	1	2	1					5
16204			5			1		26			32
16248	3										3
18682			1								1
18683			1								1
21197			2								2
21198			1								1
21199			1								1
21200			1								1
21201			1								1
21202			1								1
21203			1								1
21204					1				3		4
21205			1								1
21206			1								1
21207			1								1
21208			1								1
21209	2										2
21210			1								1

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
21211		1			1						2
21212			1								1
21213		1							3		4
21214			1								1
21406		1									1
21407			1								1
21408			1								1
21409			1								1
21410			1								1
21411				1							1
21412				1							1
21413	1										1
21414	1										1
21415				1							1
21416	1										1
21417		1									1
21418			1								1
21419			1								1
21420			1	2					1		4
21421		1	1						1		3
21422			1								1
21423				1							1
21424			1								1
21425			1								1
21426			1								1
21427			1								1
21428			1								1
21429			1								1
21430			1						1		2
21431			1								1

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
21432			1								1
21433			1								1
21434				1							1
21435			1	1							2
21436				1							1
21437					1						1
21438											1
21439											1
21441			3								3
21442			1								1
21443			1								1
21444			1								1
21445			3								3
21446			3								3
21447			1								1
21448			1								1
21449									1		1
21450				3							3
21451			1								1
21452	2										2
25760					1						1
25761					1						1
25762					1			3			4
25763			1								1
25764			1								1
25765	1										1
25766									4		4
25767										1	1
25768										1	1
25769					1						1

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
25770	2					1		1			4
25771		1									1
25772			2	1		1					4
25773			1								1
25774	4					1					5
25775			1								1
25776			2	1		*		2	3		8
25777				1							1
25778			1								1
25779					1						1
25780			1								1
25781		1	1			1		1			4
25782			1			*		1	1		3
25783			1								1
25784			1								1
25785				1							1
25786			1								1
25787			1								1
25788			1								1
25789			1			1					2
25790			1								1
25791			1								1
25792		1									1
25793			1								1
25794			1								1
25795			1								1
25796					1						1
25797			1								1
25798			1								1
25799		2	1						2		5

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
25800										1	1
25801					1						1
25802	2										2
25803	1										1
25804	1										1
25805	1										1
25806	3										3
25807	3										3
25808	7										7
25809	1										1
25810		1		3							4
25811			1								1
25812	1										1
25813	1										1
25814	3										3
25815	1										1
25816	1										1
25817								2			2
25818			1								1
25819			1								1
25820			1								1
25821			1								1
25822	1										1
25823	1										1
25824	1										1
25825			1								1
25826			1								1
25827			1								1
25828					1						1
25829	1										1

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
25830	1										1
25831	1										1
25832	1										1
26217			1								1
26218				1				3		1	5
26219			1								1
26220								4			4
26221			1								1
26222			1								1
26223			1								1
26224				1							1
26225			1								1
26226		1									1
26227			1					1			2
26228			2								2
26229			1								1
26230									1		1
26231			1								1
26232								2			2
26233			1								1
26234			1								1
26235			1								1
26236			1								1
26237	1										1
26238			1								1
26239			1								1
26240			2								2
26241		1									1
26242			1	1							2
26243			1	1							2

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
26244			1								1
26245				1							1
26246				1							1
26247				1							1
26248			1								1
26249					1						1
26250			2							1	3
26251			1								1
26252			1								1
26253			1		66	6		2		4	79
26254			2	2							4
26255			1								1
26256				1							1
27579				1							1
27580								1			1
27581					1						1
27582			1	1	2						4
27583					3						3
27584							1				1
27585					4						4
27586			1		12	1					14
27587					1						1
27588			2		4	3				1	10
27589					5	1					6
27590					9	2				2	13
27591							2				2
27592					1	1	1			1	4
27593					1						1
27594							1				1
27595							2				2

Appendix D. Summary of Site Components within the Mauna Kea Science Reserve.

State Site Number 50-10-23-	Burial/ Possible burial	Possible shrine	Shrine	Marker/ memorial	Adze workshop	Flake scatter	Hammerstone workshop	Temporary habitation	Unknown	Isolated artifacts	Total number of Components
27596					2		1				3
27597					2		1				3
27598					73	5	1			2	81
27599						1					1
27600					1						1
27601	1				68		2	3		3	78
27602										1	1
27603						2					2
27604					14	1					15
27605					**84**			2			86
27606					1			1	1		4
27607					2		4				6
27608					1						1
27609							1				1
27610					1						1
27611						1					1
27612					1						1
27613					3						3
27614					6						6
27615							6				6
27616	1		5	1	**107**				5		119
27617			5		1	1					7
27618			2		10						12
Total	55	13	196	34	501	32*	26	56	29	19	951

BOLD includes extraction area * indicates that basalt flakes are part of a feature and not included in total

** includes a battered boulder - test area

APPENDIX E

List of Other Cultural Resources (Find Spots) in the Mauna Kea Science Reserve

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
1997.04	*B-1*	*12,883*	*Two (2) rocks*	*Marker/PM2006.05*
1996.06	*B-1*	*12,977*	*Single upright leaning on boulder*	*Modern Shrine/PM2006.02*
1997.07	*B-1*	*13,212*	*Stacked (2) rocks on a boulder*	*Marker*
1997.11	*B-2*	*12,795*	*Stacked (2) rocks on an outcrop*	*Unknown*
1997.12	*B-2*	*12,917*	*Leaning stone*	*Unknown*
1997.13	*B-2*	*13,027*	*Stone slabs on outcrop*	*Unknown*
1997.15	*B-2*	*12,894*	*Stacked (2) rocks on outcrop*	*Marker*
1997.17	*B-2*	*12,415*	*Stacked (4) rock on boulder*	*Marker/RN2006.06*
1997.18	*B-5*	*12,375*	*Single rock on boulder*	*Marker/RN2006.068*
1997.19	*B-5*	*12,282*	*Stacked (9) rocks on a boulder*	*Marker*
1997.20	*B-5*	*12,969*	*Filled areas (2) on outcrop*	*Unknown*
1997.21	*B-5*	*12,991*	*Overhang with stacked rock wall*	*Temporary shelter*
2005.01	B-2	13,264	C-shape at Site 21209	Temporary shelter
2005.02	B-1	12,965	Stacked rocks	Marker
2005.03	B-2	13,247	Stacked (3) rocks	Marker
2005.04	B-2	13,213	*Same as 1997.07, Stacked rocks*	Marker
2005.05	B-1	13,205	Stacked rocks	Marker
2005.06	B-1	13,132	Possible upright	Unknown
2005.07	B-1	13,010	Possible uprights	Unknown
2005.08	B-1	13,144	Two uprights near weather station	Unknown
2005.09	B-1	12,875	Stacked rocks	Marker
2005.10	B-2	13,264	Air Force drone	Surveillance plane?
2005.11	B-2	12,703	Stacked (3) rocks on ridge toe	Marker, same as PM2007.01?
2005.12	B-2	13,332	Stacked boulders on whaleback ridge	Marker
2005.13	B-2	12,930	Stacked (4) rocks on a boulder	Marker
2005.14	B-2	12,923	Stacked (4) rocks on a boulder	Marker
2005.15	B-2	12,947	Stacked (2) rocks	Marker
2005.16	B-2	13,094	Stacked (3) rocks	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
2005.17	B-2	12,974	Stacked (8) rocks on a boulder/piled rock against a boulder, over shallow overhang	Marker
2005.18	B-2	12,975	Piled rock	Marker
2005.19	B-5	12,529	Stacked (4) rocks on a boulder and 2 rocks on an outcrop	Marker
2005.20	B-5	12,286	Stacked (2) rocks on a boulder	Marker
2005.21	B-5	13,009	Stacked rocks	Marker
2005.22	B-5	12,938	Stacked rocks	Marker
2005.23	B-5	12,863	Stacked rocks	Marker
2005.24	B-5	12,826	Stacked rocks	Marker
2005.25	B-5	12,793	Stacked (4) rocks on a boulder	Marker
2005.26	-	12,000	Stacked (2) rocks on a boulder	Marker
2005.27	-	12,000	Stacked linear mound	Unknown
2005.28	-	12,000	Stacked rocks	Marker
2005.29	-	12,000	Stacked rocks	Marker
2005.30	-	12,000	Stacked rocks on a boulder	Marker
2005.31	B-5	12,769	Stacked (5) rocks with orange spray paint on one	Marker
2005.32	B-5	12,776	Single upright abutting a boulder	Unknown
2005.33	-	12,000	Single upright	Unknown
2005.34	B-5	12,839	Stacked (3) rocks	Marker
2005.35	B-5	12,505	Stacked (5) rocks on a boulder	Marker
2005.36	B-5	12,534	Rock placed upright on a boulder	Marker
PM2006.01	B-1	13,073	Two (2) stacked rock on boulder	Marker
PM2006.02	*B-1*	*12,977*	*Single upright leaning on boulder*	*Modern shrine?/1997.06. Located within the Natural Area Reserve(NAR) boundary*
PM2006.03	B-1	12,848	Single rock on boulder	Marker
PM2006.04	B-1	12,731	Support rocks and wood	Surveyor’s marker
PM2006.05	*B-1*	*12,883*	*Two (2) rocks*	*1997.04*
PM2006.06	B-1	11,795	Six (6) rocks next to boulder	Unknown

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
PM2006.07	B-1	11,792	Three (3) rocks on boulder	Marker
PM2006.08	B-1	12,493	Four (4) rocks	Marker
PM2006.09	B-5	12,102	Upright on soil	Unknown
PM2006.10	B-6	11,895	Seven (7) piled rocks on boulder	Marker
PM2006.11	B-6	11,908	Two (2) rocks on boulder	Marker
PM2006.12	B-5	12,159	Single rock on boulder	Marker
PM2006.13	B-5	12,159	Three (3) rocks on boulder	Marker
PM2006.14	B-5	12,134	Single rock on boulder	Marker
PM2006.15	B-5	12,126	Single rock on boulder	Marker?
PM2006.16	B-6	11,931	Single rock on boulder	Marker?
PM2006.17	B-6	11,926	Single rock on boulder	Marker?
PM2006.18	B-6	11,902	Single rock on boulder	Marker?
PM2006.19	B-6	11,909	Single rock on boulder	Marker??
PM2006.20	B-6	11,863	Single rock on boulder	Marker?
PM2006.21	B-6	11,800	Seven (7) rocks on two boulders	Marker
PM2006.22	B-6	11,808	Two (2) rocks on boulder	Marker
PM2006.23	B-6	11,792	Six (6) rocks on boulder	Marker
PM2006.24	B-6	11,810	Two (2) rocks on boulder	Marker
PM2006.25	B-6	11,811	Single rock on each boulder(2)	Marker?
PM2006.26	B-6	11,880	Single rock on boulder	Marker?
PM2006.27	B-6	11,883	Single rock on boulder	Marker?
PM2006.28	B-6	11,940	Four (4) rocks on boulder	Marker
PM2006.29	B-6	12,036	Cluster of Find Spots	Marker?
PM2006.30	B-5	12,073	Cluster of Find Spots on a ridge below Pu'u Lilinoe	Marker?
PM2006.31	B-5	12,160	Single Rock on boulder adjacent to Site PM2006-02 (lithic scatter)	Modern site marker?
PM2006.32	B-2	12,421	Single rock on boulder	Marker?
PM2006.33		12,415	Single rock on boulder	Marker?
PM2006.34		12,453	Stacked rock on boulder	Marker/Cairn

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
PM2006.35		12,129	Three (3) rocks on boulder	Marker
PM2006.36		11,957	Four (4) rocks on boulder	Marker
PM2006.37	B-6	11,993	Single rock on boulder	Marker
PM2006.38	B-6	12,052	Three (3) rocks on boulder	Marker
PM2006.39	B-6	12,108	Two (2) rocks on boulder	Marker/same as RN2006.024
PM2006.40	B-6	12,049	Three (3) rocks on boulder	Marker
PM2006.41	B-2	12,788	Two (2) rocks on boulder	Marker
PM2006.42	B-6	11,970	Seven (7) rocks on boulder	Marker
PM2006.43	B-5	12,793	Four (4) rocks on boulder	Marker
PM2006.44	B-5	12,754	Nine (9) rocks on boulder	Marker
PM2006.45	B-5	12,754	Four (4) rocks on boulder	Marker
PM2006.46	B-5	12,256	Two (2) rocks on boulder with roses, ti leaf, a crystal, and a heart-shaped piece of coral	Modern shrine
PM2006.47	B-2	12,869	Three (3) rocks on boulder	Marker
PM2006.48	B-2	12,679	Six (6) rocks, two (2) stacked on boulder	Marker
PM2006.49	B-2	12,870	Single upright, no support stones	Unknown
PM2006.50	B-5	12,744	Single rock on boulder with three (3) stacked rocks next to boulder	Unknown
PM2006.51	B-5	12,191	Vertically oriented stone on boulder	Modern shrine
PM2006.52	B-6	11,949	Cluster of four (4) find spots, including one (1) with a rounded stone boulder	Markers?
PM2006.53	B-6	11,891	Two (2) stacked rocks on boulder	Marker
PM2006.54	B-6	11,829	Single rock on boulder	Marker
PM2006.55	B-6	11,845	Single Rock on boulder	Marker
PM2006.56	B-6	11,818	Two (2) rocks on boulder	Marker
PM2006.57	B-6	11,814	Two (2) stacked rocks on boulder	Marker
PM2006.58	B-5	12,276	Two (2) stacked rocks and three to four (3-4) piled rocks on outcrop	Marker?
PM2006.59	B-6	11,829	Seven (7) stacked rocks on ridgetop	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
PM2006.60	B-5	12,179	Two (2) boulders, one with two (2) stones on top, the second with seven (7) stones	Marker
PM2006.61	B-5	12,035	Four (4) stacked rocks on ridgetop	Marker?
PM2006.62	B-5	11,825	Two (2) stacked rocks on boulder	Marker
PM2006.63	B-5	11,757	Two (2) rocks on boulder	Marker
PM2006.64	B-5	12,416	Ten (10) piled rocks on glacial outwash plain ca. 5 m north of Site PM2006-15	Modern site marker?
PM2006.65	B-5	12,390	Three (3) mounds of piled rocks, two to three (2-3) meters	Markers
PM2006.66	B-5	12,417	name “Adam” spelled out with rocks on summit of cinder cone	Memorial marker
PM2006.67	B-2	12,333	Two (2) adjacent boulders with two (2) piled rocks on one and four (4) on the other	Marker
PM2006.68	B-2	12,323	Two (2) adjacent boulders with two (2) rocks on one and four (4) on the other	Marker
PM2006.69	B-2	12,284	Six (6) piled rocks on boulder	Marker
PM2006.70	B-3	12,214	Five (5) piled stones on boulder	Marker
RN2006.01	B-1	12,975	Single rock on boulder	Marker? Located within the NAR
RN2006.02	B-1	12,821	Wood and metal	Surveyors marker
RN2006.03	B-1	12,009	Rock alignment	Hunters blind?
RN2006.04	B-1	12,002	Rock alignment	Hunter blind?
RN2006.05	B-5	12,867	Single rock on boulder	Marker
RN2006.06	*B-5*	*12,416*	*Four (4) stacked rock on small boulder*	*Marker/ 1997.017*
RN2006.07	B-3	12,268	Seven (7) piled rock on boulder	Marker
RN2006.08	B-3	12,092	Three (3) features: 1= single rock on boulder 2 = Three (3) rock on boulder one is upright with the other two on top 3= four (4) rock on boulder	Recent shrine or marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.09	B-3	12,089	Three (3) rocks next to boulder (rock are light grey in color)	Unknown
RN2006.10	B-3	12,078	Fifteen plus (15+) slabs and rock on boulder; one aluminum can present	Disturbed shrine?
RN2006.11	B-3	11,943	Two (2) rock on boulder	Marker
RN2006.12	B-3	12,101	Two rock on boulder	Marker
RN2006.13	B-5	12,557	Single rock on boulder	Marker
RN2006.14	B-5	12,159	Three (3) rocks on boulder	Marker
RN2006.15	B-5	12,134	Two (2) rocks on boulder	Marker
RN2006.16	B-5	12,095	Eleven (11) rocks on boulder	Marker?
RN2006.17	B-6	11,903	Three (3) mounds with wood and metal	Surveyors markers
RN2006.18	B-6	11,818	Single rock on boulder	Marker
RN2006.19	B-6	11,805	Single rock on boulder	Marker?
RN2006.20	B-6	11,832	Two (2) rocks on boulder	Marker
RN2006.21	B-6	11,855	Three (3) rocks on boulder; two additional spots N and NE	Marker
RN2006.22	B-6	11,838	Four (4) features: 1= 13 rocks on boulder [6 are slabs] 2= single rock on boulder 3 = four rocks on boulder and 4 = 11 rocks on boulder [7 are light grey in color]	Unknown
RN2006.23	B-6	11,846	Single rock on boulder	Marker
RN2006.24	B-6	12,000	Two (2) stacked rocks on boulder	Marker
RN2006.25	B-6	12,044	Two (2) stacked rocks on boulder (another spot west ~25 m)	Marker
RN2006.26	B-6	12,028	Thirty plus (30+) rocks on boulder	Marker
RN2006.27	B-6	12,044	Six plus (6+) single cobble on boulder spots in this area	Unknown
RN2006.28	B-5	12,090	Single rock on boulder (another spot downslope [SE])	Marker
RN2006.29	B-5	12,124	One (1) cobble on boulder	Marker
RN2006.30	B-5	12,159	Three (3) rocks on boulder	Marker?

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.31	B-6	12,098	Single rock on boulder	Marker?
RN2006.32	B-6	11,945	Single rock on boulder	Marker?
RN2006.33	B-6	11,936	Thirteen plus (13+) pebbles and cobbles and boulder	Unknown
RN2006.34	B-6	11,901	Two rocks on outcrop	Unknown
RN2006.35	B-6	11,852	Two (2) stacked rock on boulder	Marker
RN2006.36	B-6	11,814	Three (3) rocks on boulder; two (2) are stacked	Marker
RN2006.37	B-6	11,755	Single rock on boulder	Marker
RN2006.38	B-6	11,797	Single rock on boulder	Marker
RN2006.39	B-6	11,774	Four features: three are single rocks on boulder and one has 25 pebbles and cobbles on a boulder	Modern marker?
RN2006.40	B-6	11,776	Three (3) rocks and a slab on boulder: another spot is E/NE (15 m) and is a single rock on boulder	Marker, possibly a shrine
RN2006.41	B-6	11,861	Two (2) rocks on boulder; Adze blank found here. Another spot is 30 m downslope and looked like a single on boulder	Marker
RN2006.42	B-6	11,886	Single rock on boulder	Marker
RN2006.43	B-6	11,881	Two (2) stacked rocks on boulder	Marker
RN2006.44	B-6	11,883	Single rock on boulder	Marker
RN2006.45	B-6	11,891	Two (2) rocks on boulder; two additional spots S and N. Each has 2-3 rocks on a boulder	Marker
RN2006.46	B-6	11,975	Single light grey slab on boulder	Unknown
RN2006.47	B-6	11,199	Single rock on outcrop	Unknown
RN2006.48	B-6	11,995	Two (2) stacked cobbles on gelifluction terrace	Unknown
RN2006.49	B-6	12,002	Single rock on boulder and four (4) rocks on second boulder	Markers
RN2006.50	B-6	12,015	Single rock on boulder	Marker?
RN2006.51	B-5	12,160	Single rock on boulder	Marker?

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.52	B-2	12,429	Several single rocks on whaleback ridge	Markers?
RN2006.53	B-3	12,382	Two (2) rocks on outcrop	Unknown
RN2006.54	B-3	12,350	Two (2) stacked rocks on boulder	Marker
RN2006.55	B-3	12,300	Two (2) stacked rocks on boulder	Marker
RN2006.56	B-3	12,070	Two single rocks on boulders with rusted cans (sardine and pork and beans – key openers for the bean cans. Stick wedged between boulder and rocks	Historic markers?
RN2006.57	B-6	12,067	Six (6) pebbles and cobbles on small boulder	Unknown
RN2006.58	B-6	12,114	Two (2) stacked small boulders	Unknown
RN2006.59	B-6	12,188	Two (2) stacked rocks on boulder	Marker
RN2006.60	B-6	12,145	Single rock on boulder	Marker?
RN2006.61	B-6	12,145	Single rock on boulder	Marker?
RN2006.62	-	12,250	Single rock on boulder and 2-3 rocks on second boulder	Unknown/No GPS data
RN2006.63	B-2	13,176	Two (2) stacked rocks on boulder	Marker
RN2006.64	B-2	12,856	Nine (9) rocks on boulder, second boulder has three (3) rocks	Markers?
RN2006.65	B-2	12,796	Two (2) stacked rocks on boulder	Marker
RN2006.66	B-2	12,684	Single (large) tabular slab broken into three pieces	Unknown
RN2006.67	B-2	12,686	Single rock on small boulder	Unknown
RN2006.68	*B-5*	*12,375*	*Single rock on boulder*	*Unknown/Same 1997.018*
RN2006.69	B-5	12,315	Multiple find spots – rocks on boulders	Markers
RN2006.70	B-5	12,303	Eleven (11) rocks on boulder, three additional find spots with 1-2 rocks on boulders nearby	Markers
RN2006.71	B-2	12,752	Eight (8) rocks on red-colored boulder	Marker
RN2006.72	B-2	12,645	Ten (10) piled rocks on outcrop	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.73	B-2	12,673	Six (6) rocks (three cobbles and three pebbles) on boulder	Unknown
RN2006.74	B-2	12,808	Two (2) stacked rocks on outcrop	Unknown
RN2006.75	B-2	12,574	Two (2) stacked rocks on small boulder	Unknown
RN2006.76	B-6	11,842	Piled rock on boulder	Marker
RN2006.77	B-6	11,842	One (1) rock on boulder	Marker
RN2006.78	B-5	11,848	Piled rock on boulder	Marker
RN2006.79	B-5	11,524	Piled rock on boulder	Marker
RN2006.80	B-5	12,192	Two (2) rocks on boulder	Marker
RN2006.81	B-5	11,993	Stacked rock on boulder	Marker
RN2006.82	B-5	11,837	Two (2) rocks on boulder	Marker
RN2006.83	B-5	11,809	Piled rock on boulder	Recent marker?
RN2006.84	B-5	12,237	Seven (7) FS of recent construction	Reported to be a site used currently by cultural practioners
RN2006.85	-	12,335	Changed to Site RN2006.44	Adze preform
RN2006.86	B-5	12,260	Piled rock on boulder	Marker
RN2006.87	B-5	12,974	Two (2) rocks on boulder	Marker
RN2006.88	B-5	12,918	1 (1) rock on boulder	Marker
RN2006.89	B-3	12,406	Cairn, stake, pins, stakes, and wire	Survey marker
RN2006.90	B-2	12,352	U-shaped enclosure w/ rusted cans	Historic temporary shelter
RN2006.91	B-3	12,339	Boulder with four (4) cobbles on top with a wooden pole placed against the boulder	Marker
RN2006.92	B-3	12,234	Boulder with four (4) cobbles on top	Marker
RN2006.93	B-2	12,364	Wall with cleared area east of wall	Temporary shelter
RN2006.94	B-3	12,649	Cairn with pole in center	Marker
RN2006.95	B-3	12,645	Cairn with pole in center	Marker
RN2006.96	B-2	12,335	Boulder with scattered cobbles	Marker
RN2006.97	B-3	12,590	Mound	Unknown

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.98	B-2	12,524	Four (4) cobbles holding down a piece of aluminum	Marker
RN2006.99	B-3	12,131	Piled rock on boulder	Marker
RN2006.100	B-3	12,196	Boulder with two (2) cobbles stacked on top	Marker
RN2006.101	B-3	11,976	Boulder with five (5) cobbles on top and a possible fallen upright at the base of the boulder	Marker
RN2006.102	B-3	12,215	Boulder with two (2) cobbles stacked on top	Marker
RN2006.103	B-3	12,235	Boulder with 13 cobbles on top	Marker
RN2006.104	B-3	12,283	Enclosure	Temporary shelter
RN2006.105	B-2	12,441	Two (2) rocks on boulder	Marker
RN2006.106	B-3	12,043	Two (2) FS: 1) is a boulder with five (5) cobbles on top 2) a split boulder with seven (7) cobbles piled in crack	Markers
RN2006.107	B-3	11,963	Stacked rocks on boulder	Marker
RN2006.108	B-3	12,162	Boulder with five (5) cobbles on top	Marker
RN2006.109	B-2	12,802	Rock pile with two (2) sticks	Marker
RN2006.110	B-2	12,488	Small boulder with four (4) stacked cobbles on top	Marker
RN2006.111	B-2	12,406	Boulder with seven (7) cobbles on top	Marker
RN2006.112	B-2	12,346	Boulder with two (2) cobbles on top	Marker
RN2006.113	B-3	11,745	Boulder with two (2) cobbles on top	Marker
RN2006.114	B-3	12,005	Rock pile with lava bomb on top	Marker
RN2006.115	B-3	11,997	Mound	Unknown
RN2006.116	B-3	11,990	Mound with two (2) sticks	Unknown
RN2006.117	B-3	12,034	Rock pile	Unknown
RN2006.118	B-3	12,327	Boulder with two (2) cobbles on top	Marker
RN2006.119	B-2	11,766	Two rock mounds	Unknown
RN2006.120	B-2	11,968	Mound with cobbles on top	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2006.121	B-2	11,761	Boulder with three (3) cobbles on top. Possible flake on north side of boulder	Marker
RN2006.122	B-2	12,014	Boulder with two (2) cobbles on top	Marker
RN2006.123	B-5	13,009	Cairn with slab on end on top	Recent marker
RN2006.124	B-2	12,465	Eight (8) cobbles stacked on boulder	Marker
RN2006.125	-	11,963	Enclosure	Temporary shelter. After review made into a site (Site 27580)
PM2007.01	B-2	12,416	Upright-like cobble supported by two cobbles	Marker
PM2007.02	B-2	12,099	Two cobbles on low angular boulder	Marker
PM2007.03	B-2	11,867	Two cobbles on small boulder	Unknown
PM2007.04	B-2	11,748	Two large cobbles and three medium cobbles on flat, low boulder	Unknown
PM2007.05	B-2	12,055	Two flat cobbles and one angular cobble on boulder	Unknown
PM2007.06	B-2	12,042	Two large cobbles on flat boulder	Unknown
PM2007.07	B-2	12,060	Five medium cobbles on medium boulder	Marker
PM2007.08	B-2	12,035	Four cobbles/small boulders on large boulders	Marker
PM2007.09	B-2	11,969	Four cobbles and a few pebbles on large boulder	Unknown
PM2007.10	B-2	11,939	Two large cobbles on outcropping	Unknown
PM2007.11	B-1	12,628	Three cobbles on boulder	Marker
PM2007.12	B-1	12,970	Two sets of stacked cobbles on outcropping	Unknown
PM2007.13	B-1	12,972	Three cobbles on small boulders	Marker
PM2007.14	B-4	12,954	Eight to ten cobbles stacked on boulder	Marker
PM2007.15	B-4	12,816	Six cobbles stacked on outcropping	Marker
PM2007.16	B-4	12,727	Seventeen cobbles piled on outcropping	Marker
PM2007.17	B-4	12,434	Two find spots: cobbles on boulders	Markers

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
PM2007.18	B-4	12,946	Two large cobbles stacked on boulder	Marker
PM2007.19	B-2	13,525	Five cobbles on boulder	Marker
PM2007.20	B-2	13,472	Seven cobbles piled on outcropping	Unknown
PM2007.21	B-4	12,764	Five cobbles stacked on boulder	Marker
PM2007.22	B-4	12,720	Three cobbles stacked on outcropping	Marker
PM2007.23	B-4	12,655	Four cobbles stacked on outcropping	Marker
PM2007.24	B-4	12,561	Three cobbles stacked on boulder	Marker
PM2007.25	B-4	11,602	Three cobbles stacked on outcropping	Marker
PM2007.26	B-4	12,484	Three cobbles stacked on outcropping	Marker. Located within the NAR
PM2007.27	B-4	11,766	Three cobbles on boulder	Marker
PM2007.28	B-4	11,966	Two cobbles stacked on boulder	Marker
PM2007.29	B-4	11,959	Two find spots: cobbles stacked on two boulders	Marker
PM2007.30	B-4	11,975	Three cobbles stacked on boulder	Marker
PM2007.31	B-4	11,911	Three cobbles stacked on boulder	Marker
PM2007.32	B-4	12,045	Seven cobbles on boulder	Marker
PM2007.33	B-4	12,346	Two cobbles on boulder	Marker
PM2007.34	B-4	12,289	Fifteen cobbles piled on boulder	Marker
PM2007.35	B-4	12,621	Two cobbles piled on outcropping	Unknown
PM2007.36	B-4	12,533	Six cobbles piled on boulder	Marker
PM2007.37	B-2	12,793	Four cobbles stacked on boulder	Marker
RN2007.01	B-2	12,830	Cobbles scattered on boulder	Marker?
RN2007.02	B-2	11,997	Four cobbles, one small boulder, and one slab on boulder	Marker
RN2007.03	B-2	12,802	Two cobbles stacked on flat slab	Marker
RN2007.04	B-2	11,809	Wall-like structure	Shelter
RN2007.05	B-2	11,857	Four cobbles piled on boulder	Marker
RN2007.06	B-2	12,052	Six cobbles piled on boulder	Marker
RN2007.07	B-2	12,033	Two cobbles on boulder	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2007.08	B-2	12,015	Two cobbles stacked on boulder	Marker
RN2007.09	B-2	11,923	Camping gear: tent, sleeping mat, sleeping bag, and one plastic bottle	Recent activity: Camp site
RN2007.10	B-2	12,160	Two cobbles piled on boulder	Unknown
RN2007.11	B-2	12,341	Two cobbles on boulder with a tabular slab on the ground	Unknown
RN2007.12	B-2	12,318	Seventeen cobbles piled on boulder	Marker
RN2007.13	B-2	12,588	Single cobble on boulder visible from a distance	Marker
RN2007.14	B-2	12,670	Eight cobbles piled on boulder	Marker
RN2007.15	B-1	11,815	90-100 cobbles piled	Marker
RN2007.16	B-1	11,877	Two cobbles piled on boulder	Unknown
RN2007.17	B-1	11,930	Three cobbles stacked on boulder	Marker
RN2007.18	B-1	12,043	Two cobbles piled small boulder	Marker
RN2007.19	B-1	11,858	Two cobbles on large boulder	Marker
RN2007.20	B-1	12,160	Five cobbles piled on large boulder	Marker
RN2007.21	B-1	12,093	Fifteen cobbles piled on medium boulder	Marker
RN2007.22	B-1	12,088	Seven cobbles stacked on large boulder. A 2nd FS nearby	Markers
RN2007.23	B-1	12,052	Eight cobbles piled on small boulder	Marker
RN2007.24	B-1	12,121	Seven cobbles piled on outcropping	Marker
RN2007.25	B-1	12,266	Five cobbles stacked on outcropping	Marker
RN2007.26	B-1	12,331	Four cobbles piled on large boulder	Marker
RN2007.27	B-1	12,330	Eleven cobbles piled on large boulder	Marker
RN2007.28	B-1	12,605	Two cobbles on outcropping	Unknown
RN2007.29	B-1	12,598	Five slabs stacked on low flat boulder	Marker
RN2007.30	B-5	13,120	Eleven cobbles piled on outcropping	Marker
RN2007.31	B-4	12,883	Two cobbles stacked on outcropping	Marker
RN2007.32	B-1	13,610	Thirty+ cobbles and small boulders piled on cinder (recent offering present)	Recent activities

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2007.33	B-1	13,551	Alignment of cobbles forming an enclosure	Activity area?
RN2007.34	B-4	12,877	Two cobbles stacked on small boulder	Marker
RN2007.35	B-4	12,797	Two cobbles stacked on small boulder	Marker
RN2007.36	B-4	12,697	Three flat slabs stacked on outcropping	Marker
RN2007.37	B-4	12,672	Six cobbles dispersed on outcropping	Unknown
RN2007.38	B-4	12,603	Three cobbles piled on medium boulder	Marker
RN2007.39	B-4	12,562	Two find spots: stacked cobbles on outcropping	Markers
RN2007.40	B-4	12,707	Five slabs stacked on outcropping	Marker
RN2007.41	B-4	12,610	Six cobbles piled on small boulder	Marker
RN2007.42	B-4	12,448	Two cobbles stacked on small boulder	Marker. Located within the NAR
RN2007.43	B-4	11,967	Three cobbles piled on large boulder. Two other FS nearby. One pair of Army issued boots observed	Recent use of area
RN2007.44	B-4	11,971	Eight cobbles stacked on small boulder	Marker
RN2007.45	B-4	11,887	Three cobbles piled on large boulder	Marker
RN2007.46	B-4	12,408	Seven cobbles stacked on large boulder. A stick is placed in the center	Recent activity
RN2007.47	B-4	12,288	Two find spots: cobbles stacked on boulders	Probably recent
RN2007.48	B-4	12,270	Thirty six cobbles stacked on large boulder. A towel is placed on south side with 12 cobbles holding the towel in place	Recent activity
RN2007.49	B-4	12,278	Three cobbles piled on boulder	Marker
RN2007.50	B-4	12,372	Three cobbles stacked on boulder	Marker
RN2007.51	B-4	12,340	Three cobbles stacked on boulder	Marker
RN2007.52	B-4	12,407	Four cobbles piled on boulder	Marker
RN2007.53	B-4	12,390	Five cobbles stacked on boulder	Marker

Appendix E. Find Spots Recorded in the Mauna Kea Science Reserve.

Find Spot No.	Map Number	Elevation (Ft. AMSL)	Description	Function
RN2007.54	B-4	12,558	Two cobbles on boulder	Unknown
RN2007.55	B-4	12,617	Eight cobbled piled on outcropping. Rusted can nearby	Recent activity
RN2007.56	B-4	12,419	Four cobbles stacked on small boulder	Marker
RN2007.57	B-6	11,704	Five cobbles piled on large boulder	Marker
RN2007.58	B-6	11,686	Three cobbles piled on medium boulder	Marker
RN2007.59	B-6	11,595	Three cobbles piled on boulder	Marker
RN2007.60	B-6	11,602	Three cobbles piled on boulder	Marker
RN2007.61	B-6	11,598	Four cobbles on boulder	Marker
RN2007.62	B-6	11,603	Two cobbles stacked on large boulder	Marker
RN2007.63	B-6	11,660	Four cobbles piled on large boulder	Marker
RN2007.64	B-6	11,597	Seven cobbles piled on boulder	Marker
RN2007.65	B-6	11,631	Two find spots: cobbles piled on two large boulder	Marker
RN2008.01	B-4	11,849	Enclosure measuring 3.3 by 3.2 m	Temporary habitation

Due to a GPS malfunction data was lost for Find Spots 2005.26 through 2005.30 and 2005.33. Because of this their locations do not appear on the maps.
Italicized find spots were recorded in 1997

APPENDIX F

Metric and Non-Metric Data for Shrines in the Mauna Kea Science Reserve

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
11077	Perpendicular	1	1	1	1	1	Mound	N	S		Gabled	3	50	30	17	1,1	
11079		1	1	0	0	0	Boulder									0,0	Adze preform on boulder and a flake scatter nearby
16163	Parallel		1	14	15	1	Platform	T	P	SN	Flat/ beveled	2	70	26	16	14,15	
						2	Platform	T	P	CN	Pointed	1	76	20	11		
						3	Platform	T	P		Rounded	4	90	20	20		
						4	Platform	T	S		Flat/ gabled	3	75	30	13		
						5	Platform	T	P		Flat	5	80	25	17		
						6	Platform	T	P	SN	Flat	5	121	12	8		Basalt flake scatter area is roughly 30.0 m by 4.0 m
						7	Platform	T	IR		Flat	13	65	24	11		
		2				8	Platform	T	S		Flat/ gabled	3	68	31	13		
						9	Platform	T	D		Pointed	7	68	27	15		
						10	Platform	T	S		Pointed	1	44	15	8		
						11	Platform	T	D		Pointed	7	75	42	12		
						12	Platform	T	S	SN	Rounded	4	100	30	17		
						13	Platform	T	IR		Beveled	14	60	15	12		
						14	Platform	T	S		Rounded	4	49	15	8		
						15	**Platform**	**T**	**P**		**Flat**	5	**77**	**20**	**15**		
16164	Perpendicular		1	3	5	1	Bedrock/platform	T	P		Beveled	2	69	27	10	4,6	
						2	Bedrock/platform	T	D		Pointed	7	40	34	15		
		7				3	Bedrock/platform	T	C		Beveled	20	78	40	20		
						4	**Bedrock/platform**	**T**	**C**	**CN**	**Pointed**	19	**52**	**25**	**11**		
						5	**Bedrock/platform**	**T**	**P**		**Beveled**	2	**45**	**13**	**8**		
			2	1	1	6	Bedrock/platform	T	S		Rounded	4	46	18	8		
16165	Perpendicular	2	1	2	2	1	Bedrock crack	N	S		Flat	5	90	70	23	2,2	
						2	Bedrock surface	N	D		Pointed	7	60	40	25		
16166	Parallel		1	4	4	1	Bedrock crack	T	S		Beveled	2	40	20	6	8,9	
						2	Bedrock crack	T	D		Pointed	7	34	20	12		
						3	Bedrock crack	N	IR		Pointed	13	53	20	15		
		6				4	Bedrock surface	N	P		Rounded	4	48	16	17		
			2	4	5	5	**Bedrock surface**	**T**	**P**		**Beveled**	2	**34**	**13**	**12**		Basalt flakes near Fe.2 less than 1.0 m away
						6	Bedrock crack	T	D		Pointed	7	23	25	10		
						7	Bedrock crack	T	P	CN	Beveled	2	39	26	10		
						8	Bedrock surface	T	P		Beveled	2	49	18	14		
						9	Bedrock surface	T	P		Pointed	1	56	10	15		
16167	Parallel	2	1	2	2	1	Bedrock crack	N	S		Gabled	3	55	25	14	2,2	
						2	Bedrock crack	N	IR		Pointed	13	54	21	14		
16168	Perpendicular		1	25	25	1	Bedrock surface	N	P		Beveled	2	65	43	17	25,25	
						2	Bedrock surface	T	D		Beveled	8	35	23	7		
						3	Bedrock surface	T	D		Pointed	7	35	25	15		
						4	Bedrock surface	T	D		Pointed	7	45	15	7		
						5	Bedrock surface	N	P	SN	Beveled	2	62	26	15		
						6	Bedrock surface	T	D		Beveled	8	62	38	9		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

				Number of Uprights				Upright Form					Upright Dimensions (cm)				
Site Number	Topographic Orientation	Shrine Type	Feature Number	Minimum	Maximum	Upright Number	Foundation	Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness	Summary Min,Max	Comments
16168		5				7	Bedrock surface	N	P		Pointed	1	60	21	17		
						8	Bedrock surface	T	S	SN	Beveled	2	50	25	8		
						9	Bedrock surface	T	S		Rounded	4	50	14	6		
						10	Terrace	T	P		Flat/ beveled	2	55	19	18		
						11	Terrace	T	P		Flat/ beveled	2	65	28	12		
						12	Terrace	T	P	SN	Beveled	2	50	16	5		
						13	Terrace	T	P		Flat/ beveled	2	41	13	8		
						14	Terrace	T	P		Beveled	2	40	15	7		
						15	Terrace	T	IR	SN	Pointed	13	40	15	6		
						16	Terrace	T	P		Pointed	1	35	15	8		
						17	Terrace	T	IR		Beveled	14	57	18	7		
						18	Terrace	N	IR		Beveled	14	45	17	15		
						19	Bedrock surface	T	D		Pointed	7	51	31	9		
						20	Bedrock crack	T	D		Pointed	7	40	28	10		
						21	Bedrock crack	T	P	SN	Gabled	3	56	26	10		
						22	Bedrock surface	T	P		Flat	5	43	17	7		
						23	Bedrock surface	N	D		Flat/ beveled	8	25	20	11		
						24	Terrace	T	D		Flat/ beveled	8	48	28	7		
						25	Bedrock surface	T	P		Flat	5	30	20	5		
16169	Parallel	3	1	2	2	1	Bedrock surface	N	P		Beveled	2	71	30	21	2,2	
						2	Bedrock crack	T	D	SN	Pointed	7	62	28	12		
16170	Parallel	4	1	3	3	1	Mound	T	IR		Beveled	14	66	25	15	4,4	
						2	Mound	T	P		Beveled	2	58	22	11		
						3	Mound	T	P		Beveled	2	40	20	12		
			2	1	1	4	Bedrock surface	T	P		Rounded	4	40	30	16		
16171	Perpendicular	1	1	1	1	1	Bedrock surface	T	S	CN	Gabled	3	60	27	12	1,1	
16172	Unknown	1	1	1	1	1	Bedrock	N	P		Gabled	3	60	40	25	1,1	
16173	Parallel	7	1	1	1	4	Mound	N	D		Pointed	7	66	17	16	7,7	
			2	4	4	1	Bedrock crack	T	S		Flat	5	88	32	9		
						2	Bedrock crack	T	S	SH	Beveled	2	74	25	5		
						6	Bedrock crack	T	IR	SH	Pointed	13	61	18	5		
						7	Bedrock crack	N	D		Flat	11	62	10	6		
			3	1	1	3	Bedrock surface	T	C	SN	Gabled	15	79	41	6		
			4	1	1	5	Mound	N	P	SH	Pointed	1	56	14	13		
16174	Parallel	7	1	1	3	1	Boulder	T	D	IR	Pointed	7	44	18	10	6,8	
						7	**Bedrock surface**	**T**	**S**	**IR**	**Beveled**	2	**46**	**23**	**6**		
						8	**Bedrock surface**	**T**	**S**	**SN**	**Pointed**	1	**45**	**19**	**4**		
			2	3	3	2	Bedrock crack	T	P	SN	Flat	5	74	34	11		
						3	Bedrock crack	T	C	SN	Beveled/ mesial notched	24	80	30	8		
						4	Bedrock surface	T	P	SN	Beveled	2	59	26	14		
			3	1	1	5	Bedrock surface	T	P	SN	Gabled	3	83	23	11		
			4	1	1	6	Bedrock surface	T	IR	SN	Pointed	13	60	25	10		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights: Minimum	Number of Uprights: Maximum	Upright Number	Foundation	Upright Form: Material	Upright Form: Body	Upright Form: Treatment	Upright Form: Top	Upright Form: Upright Type	Upright Dimensions (cm): Height	Upright Dimensions (cm): Width	Upright Dimensions (cm): Thickness	Summary Min,Max	Comments
16175	Parallel	7	1	1	1	1	Bedrock surface	T	D		Pointed	7	46	20	7	5,7	
			2	1	1	2	Bedrock surface	T	P		Flat	5	95	25	10		
			3	0	1	3	**Bedrock surface**	**T**	**P**		**Flat**	5	**50**	**20**	**6**		
			4	1	1	4	Bedrock surface	N	D		Beveled	8	53	31	12		
			5	0	1	5	**Bedrock surface**	**T**	**P**		**Flat/ mesial notched**	6	**60**	**34**	**7**		
			6	2	2	6	Bedrock surface	T	S		Flat/ Beveled	2	58	15	9		
						7	Bedrock surface	T	S	SN	Gabled	3	50	20	5		
16176	Perpendicular	2	1	2	2	1	Mound	T	P		Pointed	1	103	32	4	2,2	
						2	Mound	T	IR	CN	Pointed	13	80	18	15		
16177	Perpendicular	4	1	3	4	1	Platform	T	S		Pointed	1	65	22	5	4,5	
						2	Platform	T	S	SN	Gabled	3	50	25	10		
						4	Platform	N	S		Mesial notched	6	34	16	11		
						5	**Bedrock surface**	**T**	**S**	**CN**	**Flat**	**5**	**59**	**30**	**12**		
	Parallel		2	1	1	3	Bedrock surface	T	D		Pointed	7	60	18	18		
16178	Parallel	1	1	1	1	1	Bedrock	T	S	SN	Flat	5	56	22	7	1,1	
16179	Perpendicular	2	1	3	3	1	Bedrock surface	T	S		Pointed	1	51	19	9	3,3	
						2	Bedrock surface	T	D	SN	Beveled	8	61	25	4		
						3	Bedrock surface	T	P	SN	Beveled	2	60	18	14		
16180	Unknown	4	1	3	3	1	Bedrock surface	T	S	SN	Pointed	2	57	28	14	3,3	
						2	Bedrock surface	T	D	SN	Flat	11	40	33	9		
						3	Bedrock Surface	T	IR		Beveled	14	51	15	7		
16181	Unknown	1	1	1	1	1	Bedrock	T	P		Gabled	3	64	16	10	1,1	
16182	Parallel	7	1	1	1	1	Bedrock surface	T	P	SN	Beveled	2	88	60	24	5,5	
			2	2	2	2	Bedrock surface	T	P	SN	Flat	5	50	26	10		
						3	Mound	T	P		Flat/ gabled	3	66	30	20		
			3	2	2	4	Bedrock surface	N	P		Pointed	1	56	24	15		
						5	Mound	N	P		Beveled	2	47	30	10		
16184	Parallel	5	1	22	22	1	Bedrock surface	T	IR		Crescent shaped/ flat	28	49	13	5	22,22	
						2	Mound	T	IR		Mesial notched	18	71	56	7		
						3	Mound	T	C	KN	Beveled	14	50	22	5		
						4	Mound	T	IR		Crescent shaped/ pointed	25	50	17	7		
						5	Mound	T	P		Beveled	2	46	11	10		
						6	Mound	T	D		Crescent shaped/ pointed	25	46	28	5		
						7	Mound	T	IR	SN	Beveled	14	56	22	7		
						8	Bedrock Surface	T	S	SN	Flat	5	54	47	7		
						9	Mound	T	S		Beveled	2	52	28	17		
						10	Bedrock surface	T	C		Flat	17	47	40	10		
						11	Bedrock crack	T	P		Flat	5	56	28	10		
						12	Bedrock surface	T	D		Gabled	9	40	15	9		
						13	Bedrock surface	T	P		Beveled	2	38	40	6		
						14	Bedrock surface	T	S		Gabled	3	32	26	6		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
16184						15	Bedrock surface	T	P	CN	Flat	5	54	42	13		
						16	Bedrock surface	T	C		Gabled	21	55	47	10		
						17	Bedrock surface	N	S		Flat	5	36	16	13		
						18	Bedrock surface	N	C	SH	Pointed	19	43	22	15		
						19	Bedrock surface	T	P	CN	Flat	5	42	23	6		
						20	Bedrock surface	T	P	UNIL F	Pointed/ beveled	2	40	30	12		
						21	Mound	T	S		Beveled	2	59	19	8		
						22	Bedrock surface	T	S	CN	Pointed	2	51	24	8		
16185	Parallel	2	1	3	3	1	Bedrock surface	T	P		Pointed	1	60	18	12	3,3	
						2	Bedrock surface	T	P		Beveled	2	67	28	5		
						3	Bedrock surface	T	P		Flat/ Beveled	2	48	19	6		
16186	Parallel	3	1	2	3	1	Bedrock surface	T	P	SN	Pointed/ beveled	2	44	15	7	2,3	
						2	Bedrock surface	N	P	SN	Pointed/ beveled	2	43	12	12		
						3	**Bedrock surface**	**T**	**S**	**SN**	**Flat**	5	**45**	**15**	**6**		
16187	Parallel	2	1	9	9	1	Bedrock crack	T	D	SN	Pointed	7	71	29	8	9,9	
						2	Bedrock crack	T	D		Pointed	7	62	15	6		
						3	Bedrock crack	T	C		Pointed	19	47	16	4		
						4	Bedrock crack	T	S		Flat	5	52	12	3		
						5	Bedrock crack	T	D		Flat	11	66	17	6		
						6	Bedrock crack	T	S		Beveled	2	75	9	9		
						7	Bedrock crack	T	S		Rounded	4	44	16	3		
						8	Bedrock crack	T	C		Gabled	21	60	19	11		
						9	Bedrock crack	T	C		Flat/ beveled	20	55	25	4		
16188	Parallel	1	1	1	1	1	Bedrock crack	T	IR		Flat/ gabled	15	66	43	7	1,1	
16189	Parallel	3	1	4	4	1	Bedrock crack	T	IR		Flat	17	118	50	10	4,4	
						2	Bedrock crack	T	D		Flat	11	110	30	10		
						3	Bedrock crack	T	D	SN	Gabled	9	90	30	12		
						4	Bedrock crack	T	IR		Flat	17	90	30	12		
16190	Parallel	4	1	7	11	1	Mound	T	S		Beveled	2	84	27	9	7,11	
						2	Mound	T	S		Pointed	1	53	24	6		
						3	Mound	T	P		Flat	5	54	26	6		
						4	Mound	T	D	SH	Pointed/ gabled	9	60	35	3		
						5	Mound	T	D		Pointed	7	60	25	7		
						6	Mound	T	C	SH	Gabled	21	96	34	8		
						7	**Mound**	**T**	**D**	**SN**	**Beveled**	**8**	**130**	**34**	**7**		
						8	**Mound**	**T**	**S**	**SH**	**Beveled**	**2**	**45**	**18**	**6**		
						9	**Mound**	**T**	**S**	**SN**	**Pointed/ beveled**	2	**55**	**35**	**3**		
						10	Mound	T	D	SN	Pointed	7	72	22	7		
						11	**Mound**	**T**	**P**	**SN**	**Beveled**	**2**	**45**	**11**	**4**		
16191	Perpendicular	2	1	5	5	1	Bedrock crack	T	IR	SN	Pointed	13	80	45	3	5,5	
						2	Bedrock crack	T	IR	SN	Beveled	14	70	30	6		
						3	Bedrock crack	T	IR		Beveled	14	77	18	3		
						4	Bedrock crack	T	IR	SN	Beveled	14	77	45	3		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights: Minimum	Number of Uprights: Maximum	Upright Number	Foundation	Upright Form: Material	Upright Form: Body	Upright Form: Treatment	Upright Form: Top	Upright Type	Upright Dimensions (cm): Height	Upright Dimensions (cm): Width	Upright Dimensions (cm): Thickness	Summary Min,Max	Comments
16191						5	Bedrock surface	T	IR		Beveled	14	65	13	5		
16192	Parallel	2	1	17	17	1	Bedrock	T	D		Round	10	93	39	5	17,17	
						2	Bedrock	T	S		Gabled	3	50	35	5		
						3	Bedrock	T	C		Beveled	20	53	20	7		
						4	Bedrock	T	P		Beveled	2	40	24	5		
						5	Bedrock	T	D		Beveled	8	40	12	3		
						6	Bedrock	T	P		Beveled	2	65	13	7		
						7	Bedrock	T	P		Flat	5	53	22	6		
						8	Bedrock	T	D	SN	Pointed/ beveled	7	79	21	9		
						9	Bedrock	T	P		Flat/ beveled	2	68	24	10		
						10	Bedrock	T	P	SN	Flat	5	50	17	11		
						11	Bedrock	T	D		Flat	11	53	24	14		
						12	Bedrock	T	D		Pointed	7	40	10	7		
						13	Bedrock	T	P		Flat/ beveled	2	50	28	7		
						14	Bedrock	T	S		Beveled	2	64	31	7		
						15	Bedrock	T	C		Flat	23	47	28	6		
						16	Bedrock	T	IR		Flat	17	44	18	12		
						17	Bedrock	T	S	SN	Flat	5	84	38	6		
16193	Other	1	1	1	1	1	Boulder	T	C	SN	Pointed/ gabled	21	47	15	11	1,1	
16194	Perpendicular	2	1	14	14	1	Bedrock surface	T	C		Beveled	20	80	40	6	14,14	
						2	Bedrock surface	T	C	SN	Flat	23	37	25	4		
						3	Bedrock surface	T	IR	SN	Beveled	14	51	30	5		
						4	Bedrock surface	T	C		Rounded/ gabled	21	86	44	5		
						5	Bedrock surface	T	P		Beveled	2	115	46	12		
						6	Bedrock surface	T	S		Beveled	2	59	26	6		
						7	Bedrock surface	T	IR	SN	Flat	17	58	38	4		
						8	Bedrock surface	T	D		Mesial curve	12	65	39	7		
						9	Bedrock surface	T	D		Mesial curve	12	58	38	5		
						10	Bedrock surface	T	P		Rounded/ gabled	3	65	38	5		
						11	Bedrock surface	T	S		Rounded	4	93	25	10		
						12	Bedrock surface	T	D	SN	Pointed	7	67	50	6		
						13	Bedrock surface	T	P		Pointed/ gabled	3	55	33	6		
						14	Bedrock surface	T	D	SN	Flat/ beveled	8	44	12	5		
16196	Parallel	2	1	2	2	1	Bedrock crack	T	S		Flat	5	37	16	11	2,2	
						2	Bedrock crack	T	S		Pointed	1	46	19	11		
16197	Perpendicular	1	1	1	1	1	Bedrock	T	S		Pointed	1	45	20	15	1,1	
16198	Perpendicular		1	7	15	1	Bedrock surface	N	IR	SN	Rounded	16	60	44	17	7,15	
						2	Platform	T	IR	-	Rounded/ gabled	15	71	25	9		
						3	Bedrock surface	T	P	SN	Flat	5	85	18	13		
						4	Platform	T	S	CN	Pointed	1	73	22	8		
						5	Platform	T	S		Mesial notched	6	70	32	10		
						6	Platform	T	S	SN	Flat	5	79	26	16		one

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
16198						7	Platform	T	IR		Crescent shaped/ flat	28	66	26	8		basalt
		5				8	**Platform**	**T**	**S**		**Mesial notched**	6	**53**	**51**	**5**		flake
						9	**Platform**	**T**	**IR**		**Mesial notched**	18	**47**	**33**	**9**		
						10	**Platform**	**T**	**IR**		**Gabled**	15	**62**	**27**	**8**		
						11	**Platform**	**T**	**S**		**Flat**	5	**65**	**26**	**9**		
						12	**Platform**	**T**	**D**		**Mesial notched**	12	**60**	**51**	**5**		
						13	**Platform**	**T**	**C**		**Gabled**	21	**70**	**32**	**10**		
						14	**Platform**	**T**	**P**		**Pointed**	1	**66**	**15**	**15**		
						15	**Platform**	**T**	**IR**	**CN,SN**	**Crescent shaped/ flat**	28	**78**	**19**	**9**		
16199	Parallel		1	4	6	1	Platform	T	D		Pointed	7	90	55	8	4,6	
						2	Platform	T	S		Flat/ Beveled	2	62	22	8		
		4				3	Platform	T	S/IR	SN	Pointed	1	96	37	12		
						4	Bedrock crack	N	IR		Pointed	13	80	24	20		
						5	**Boulder**	**T**	**P**		**Flat**	5	**49**	**16**	**8**		
						6	**Mound**	**T**	**S**		**Rounded**	4	**47**	**22**	**12**		
16200	Parallel		1	5	6	1	Platform	T	S	SN	Beveled	2	60	25	25	5,6	
						2	Platform	T	P		Flat	5	55	10	15		
		7				3	Platform	T	IR	SN	Crescent shaped/ flat	28	90	25	5		
						4	Platform	T	P	SN	Beveled	2	55	25	7		
						5	Platform	T	D		Flat	11	55	25	15		
						6	**Platform**	**T**	**P**		**Gabled**	3	**61**	**23**	**10**		
16201	Parallel		1	3	3	1	Mound	N	S		Flat	5	60	44	20	3,3	
		3				2	Boulder	T	S	IR	Pointed/ Beveled	2	50	25	15		
						3	Boulder	T	S	SN	Mesial notched/ flat	6	44	47	12		
16202	Parallel	1	1	1	1	1	Platform	T	D	SH	Pointed	7	90	45	15	1,1	
16203	Parallel		1	3	3	1	Mound	N	IR		Flat	17	37	29	10	3,3	
		4				2	Mound	T	P		Beveled	2	40	15	11		Basalt flakes
						3	Mound	T	P	CN	Rounded	4	68	22	10		preforms
16204	Parallel		1	9	9	1	Bedrock	T	IR		Pointed	13	47	24	20	41,44	Basalt flakes and
						2	Bedrock	T	P	CN	Pointed	1	50	28	9		adze preforms at 16204
						3	Bedrock	T	S	UNL F	Flat	5	55	25	13		
						4	Bedrock	T	IR	SN	Pointed	13	59	35	15		
		4				5	Bedrock	T	D		Pointed	7	49	18	16		
						6	Bedrock	T	P	UNL F	Pointed	1	55	14	14		
						7	Bedrock	N	IR		Flat	17	43	24	18		
						8	Bedrock	T	S		Flat	5	61	22	18		
						9	Bedrock	N	D		Pointed/	7	60	30	24		
	Perpendicular		2	8	8	1	Platform	T			Rounded		36	22	12		
						2	Platform	T			Pointed		50	21	15		
						3	Platform	T	D		Rounded	10	43	24	9		
		2				4	Platform	T	P		Mesial curve	6	50	20	7		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
16204						5	Platform	T	P		Beveled	2	44	15	9		
						6	Platform	T	IR		Flat		42	17	11		
						7	Platform	T			Flat		75	27	17		
						8	Platform	T	IR		Round	16	66	28	20		
	Perpendicular	7	3	7	10	1	Bedrock surface	N	P		Flat	5	45	20	15		
						2	Platform	T	C		Flat	23	50	72	9		
						3	Platform	T	D		Gabled	9	75	44	7		
						4	Platform	T	P		Flat	5	52	22	9		
						5	Platform	T	D		Pointed	7	47	19	10		
						6	Platform	T	S		Beveled	22	49	22	8		
						7	Platform	T	S		Beveled		40	20	10		
						8	**Bedrock surface**	**T**			**Pointed**		**42**	**20**	**14**		
						9	**Bedrock surface**	**T**			**Pointed**		**57**	**33**	**9**		
						10	**Bedrock surface**	**T**			**Pointed**		**34**	**30**	**9**		
	Perpendicular	5	4	15	15	1	Platform	T	S		Beveled	2	55	20	10		
						2	Platform	T	P	SN	Beveled	2	64	32	8		
						3	Platform	T	S		Mesial curve	6	60	26	16		
						4	Platform	T	P		Flat/ beveled	2	76	29	20		
						5	Platform	T	D		Pointed/ beveled	8	58	30	11		
						6	Platform	T	D		Pointed	7	45	27	5		
						7	Platform	T	S		Pointed	1	46	20	4		
						8	Platform	T			Pointed		57	30	7		
						9	Platform	T	IR	SN	Rounded	16	77	26	6		
						10	Platform	T	IR		Pointed/ beveled	14	47	23	4		
						11	Platform	T	D		Pointed	7	58	29	6		
						12	Bedrock surface	T	D		Pointed	7	95	29	14		
						13	Bedrock surface	T	S	SN	Pointed	1	69	25	10		
						14	Bedrock surface	T	S		Flat	5	72	26	16		
						15	Bedrock surface	T	S		Beveled	2	61	29	7		
	Perpendicular	2	5	2	2	1	Bedrock	T	D		Flat	11	44	18	10		
						2	Bedrock	T	D		Pointed	7	34	20	10		
18682	Parallel	2	1	3	3	1	Bedrock crack	N	D		Pointed	7	76	50	18	3,3	
						2	Bedrock crack	T	IR		Beveled	14	73	26	9		
						3	Bedrock crack	N	S		Flat	5	42	15	15		
18683	Perpendicular	2	1	3	3	1	Platform	T	S		Pointed	1	30	56	8	3,3	
						2	Platform	T	C	UNL F	Flat	17	28	68	15		
						3	Platform	N	S	IR	Pointed	1	35	17	11		
21197	Parallel	4	1	1	1	5	Terrace/mound	T	D		Pointed	7	45	30	10	4,5	
			2	3	4	1	Terrace/mound	T	D		Pointed	7	60	25	15		
						2	**Terrace/mound**	**N**	**D**		**Gabled**	9	**40**	**40**	**10**		
						3	Terrace/mound	T	D		Pointed	7	50	20	13		
						4	Terrace/mound	T	P	SN	Pointed	1	40	15	11		
21198	Perpendicular	1	1	1	1	1	Bedrock surface	T	D	SN	Pointed	7	90	45	15	1,1	

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

				Number of Uprights				Upright Form					Upright Dimensions (cm)				
Site Number	Topographic Orientation	Shrine Type	Feature Number	Minimum	Maximum	Upright Number	Foundation	Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness	Summary Min,Max	Comments
21199	Other	1	1	1	1	1	Bedrock surface	T	P	SH	Flat	5	48	29	7	1,1	
21200	Parallel	1	1	1	1	1	Bedrock crack	N	P		Pointed	1	43	22	17	1,1	
21201	Perpendicular	2	1	2	2	1	Bedrock crack	T	D	SN	Pointed/ beveled	8	80	26	5	2,2	
						2	Bedrock crack	T	S	SN	Flat	5	84	24	10		
21202	Parallel	2	1	6	7	1	Mound	T	S		Mesial notched	6	23	14	6	6,7	
						2	Mound	T	P	CN	Pointed	1	45	12	10		
						3	Mound	T	IR		Pointed	13	44	20	6		
						4	Mound	T	IR	UNL F,CN	Flat	17	37	27	7		
						5	Mound	T	IR	SN	Flat	17	34	15	8		
						6	Mound	T	IR	SN	Beveled	14	52	25	9		
						7	**Mound**	**N**	**S**	**CN**	**Flat**	5	**62**	**15**	**12**		
21203	Parallel	2	1	2	2	1	Bedrock crack	N	D		Beveled	8	36	13	10	1,2	
						2	Bedrock crack	N	D		Round	10	46	15	5		
21205	Perpendicular	1	1	1	1	1	Bedrock crack	T	IR	SH	Flat	17	60	24	10	1,1	
21206	Other	1	1	1	1	1	Boulder	T	IR	SN	Beveled	14	58	15	12	1,1	
21207	Other	1	1	1	1	1	Boulder	T	P	SN	Gabled	3	38	20	3.5	1,1	
21208	Other	1	1	1	2	1	Boulder	N	IR		Pointed	13	44	20	10	1,2	
						2	**Boulder**	**T**	**D**		**Pointed/ beveled**	8	**72**	**20**	**18**		
21210	Other	1	1	1	1	1	Boulder	T	D		Pointed	7	46	27	17	1,1	
21211	Other	1	1	0	1	1	**Platform**	**T**	**S**		**Flat/ beveled**	2	**60**	**26**	**10**	0,1	Basalt flakes present
21212	Other	2	1	2	2	1	Boulder	T	P		Mesial curve	6	45	26	5	2,2	
						2	Boulder	T	D	SN	Beveled	8	47	17	5		
21213	Unknown	1	1	0	1	1	**Mound**	**T**			**Pointed**		**40**	**15**	**11**	1,1	
21214	Perpendicular	4	1	8	8	1	Pavement	T	S	SN	Flat	5	53	26	9	8,8	
						2	Pavement	T	C	SN	Gabled	21	60	30	5		
						3	Pavement	T	P	SN	Crescent/ rounded	27	70	30	9		
						4	Mound	T	S		Flat/Beveled	2	65	33	8		
						5	Mound	T	IR		Pointed	13	110	35	20		
						6	Mound	T	D		Gabled	9	50	20	7		
						7	Pavement	T	IR	SN	Flat	17	61	30	9		
						8	Mound	T	IR	SN	Flat/Beveled	14	67	22	9		
21406	Parallel	1	1	0	1	1	**Bedrock surface**	**T**	**IR**	**CN**	**Pointed/ beveled**	14	**58**	**49**	**22**	0,1	
21407	Perpendicular	1	1	1	1	1	Bedrock surface	T	P	SH	Flat	5	67	29	17	1,1	
21408	Parallel	1	1	1	1	1	Bedrock crack	T	P		Rounded	4	63	30	16	1,1	
21409	Other	1	1	1	1	1	Boulder	T	IR	IR	Beveled	14	84	35	20	1,1	
21410	Perpendicular	2	1	4	5	1	Mound	T	C		Pointed	19	70	20	13	4,5	
						2	Mound	T	P	CN	Pointed	1	36	27	11		
						3	Mound	N	D		Flat	11	50	18	11		
						4	**Mound**	**T**			**Flat**		**36**	**10**	**6**		
						5	Bedrock	N			Flat		46	17	16		
21417	Unknown	1	1	0	1	1	**Boulder**	**N**	**S**		**Flat**	5	**44**	**23**	**9**	0,1	

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
21418	Other	4	1	4	4	1	Boulder	T	P		Beveled	2	76	21	4	4,4	
						2	Bedrock surface	N	P		Flat/ beveled	2	56	23	14		
						3	Pavement	N	IR		Beveled	14	74	19	12		
						4	Pavement	N	P		Beveled	2	72	22	17		
21419	Perpendicular	0	1	3	3	1	Bedrock crack	T	CR		Flat		45	13	5	3,3	
						2	Bedrock crack	T	CR		Unknown		43	24	5		
						3	Bedrock crack	T	S		Gabled		42	20	8		
21420	Perpendicular	5	1	12	12	1	Wall	T	D		Pointed	7	37	19	8	12,12	
						2	Wall	T	D		Pointed	7	67	42	18		
						3	Wall	T	S	KN	Beveled	2	60	29	15		
						4	Wall	T	IR		Pointed/ gabled	15	53	33	15		
						5	Wall	T	C		Pointed/ gabled	21	60	35	17		
						6	Wall	T	S	CN	Pointed	1	61	33	10		
						7	Wall	T	P		Flat	5	48	28	8		
						8	Wall	T	P		Mesial curve	6	46	26	8		
						9	Wall	T	C		Pointed/ gabled	21	52	38	9		
						10	Pavement	T	P		Flat	5	60	37	7		
						11	Wall	T	D		Pointed	7	54	42	8		
						12	Wall	T	P		Pointed	1	55	27	7		
21421	Parallel	3	2	0	1	1	**Mound**	**T**	**D**		**Flat**	**11**	**43**	**21**	**8**	1,2	
			3	1	1	2	Mound	T	C		Rounded	23	53	30	17		
21422	Unknown	1	1	1	1	1	Bedrock crack	N	D		Gabled	9	90	62	18	1,1	
21424	Parallel	2	1	5	5	1	Boulder	T	P		Beveled	2	66	33	18	5,5	
						2	Boulder	T	D		Pointed	7	52	18	17		
						3	Mound	T	P		Beveled	2	53	24	11		
						4	Mound	T	D	KN	Rounded	10	57	42	5		
						5	Mound	T	IR		Pointed	13	68	37	17		
21425	Other	1	1	1	1	1	Boulder	T	C	CN	Pointed	19	72	27	15	1,1	
21426	Perpendicular	2	1	3	3	1	Pavement	T	S	IR	Pointed	1	59	28	5	3,3	
						2	Pavement	T	S	IR	Pointed	1	49	21	10		
						3	Pavement	T	P	IR	Beveled	2	42	24	6		
21427	Parallel	1	1	1	1	1	Bedrock surface	T	P	CN	Flat	5	34	25	12	1,1	
21428	Perpendicular	1	1	1	1	1	Bedrock crack	T	IR	IR	Gabled	15	72	52	4	1,1	
21429	Parallel	1	1	1	1	1	Bedrock crack	T	C	SH	Gabled	21	52	37	3	1,1	
21430	Perpendicular	3	1	5	5	1	Bedrock surface	N	P	CN	Flat	5	39	31	12	5,5	
						2	Bedrock surface	N	C	CN	Pointed	19	49	31	8		
						3	Bedrock surface	N	P	SN	Pointed	1	76	37	12		
						4	Bedrock surface	N	D		Pointed	7	42	29	15		
						5	Bedrock surface	N	D		Beveled	8	43	21	8		
21431	Parallel		1	10	10	1	Bedrock crack	N	D		Rounded	10	45	20	18	10,10	
						2	Mound	T	S	SN	Beveled	2	48	30	6		
						3	Bedrock crack	N			Rounded		55	25	18		
						4	Bedrock crack	T	D		Gabled	9	53	30	15		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
21431						5	Other	T	D		Gabled	9	47	25	11		
		5				6	Bedrock crack	T	IR	SN	Rounded/ gabled	15	48	14	8		
						7	Bedrock crack	T	S		Flat	5	48	23	17		
						8	Other	T	S	SN	Rounded	4	38	24	16		
						9	Other	T	C		Mesial curve	24	48	35	10		
						10	Other	T	IR		Gabled	15	44	32	10		
21432	Other	1	1	1	1	1	Boulder	N	IR		Rounded	16	35	25	18	1,1	
21433	Perpendicular	1	1	1	1	1	Bedrock crack	T	P		Beveled	6	50	31	13	1,1	
21435	Other	1	1	0	1	1	Boulder	T	D	SN	Pointed	7	31	10	8	0,1	
21441	Parallel?		1	9	10	1	Mound	T	P	SN	Gabled	3	89	39	22	11,13	
						2	Mound	T	P		Gabled	3	65	24	22		
						3	Bedrock surface	T	D		Pointed	7	51	23	15		
						4	Bedrock surface	T	D		Flat	11	48	30	12		
						5	Bedrock surface	T	S	SN	Flat	5	42	25	8		
		4				6	Bedrock surface	T	P		Gabled	3	60	30	6		UR 3 is flaked
						7	Bedrock surface	T	D		Mesial notched/ pointed	12	53	35	13		
						8	Bedrock surface	T	C	SN	Gabled	21	51	39	8		
						9	Bedrock surface	T	C		Rounded	22	47	29	18		
						10	**Bedrock surface**	**T**	**D**	**SN**	**Pointed**	7	**63**	**28**	**9**		
			2	1	1	11	Bedrock surface	T	P	CN	Gabled	3	78	18	25		
			3	1	2	12	Bedrock crack	T	D		Rounded	10	40	15	10		
						13	**Bedrock surface**	**T**	**D**	**SN**	**Pointed**	7	**38**	**11**	**5**		
21442	Unknown	1	1	1	1	1	Bedrock surface	T	D	IR	Beveled	8	39	32	24	1,1	
21443	Unknown	1	1	1	1	1	Bedrock crack	T	S	IR	Pointed	1	80	31	9	1,1	
21444	Perpendicular	1	1	1	1	1	Bedrock surface	T	S	IR	Rounded	16	52	24	10	1,1	
21445	Perpendicular		1	2	2	1	Bedrock surface	T	P		Gabled	3	62	28	14	4,4	
		3				2	Bedrock surface	T	D	SN	Pointed/ beveled	8	51	40	14		
			2	1	1	3	Bedrock surface	T	S		Flat	5	84	30	13		
			3	1	1	4	Bedrock surface	T	P		Beveled	2	70	25	13		
21446	Perpendicular		1	4	9	1	**Bedrock surface**	**T**	**S**		**Beveled**	2	**44**	**11**	**10**	6,11	
						2	**Bedrock crack**	**T**	**D**	**SN**	**Beveled**	8	**51**	**22**	**26**		
						3	Bedrock crack	T	P		Flat	5	39	16	19		
						4	Bedrock surface	T	D		Flat	11	72	29	14		
						5	Bedrock surface	T	S		Rounded	4	73	34	9		
		4				6	Bedrock crack	T	S		Gabled	3	46	29	11		
						7	**Bedrock surface**	**T**	**D**		**Flat/ rounded**	10	**70**	**23**	**7**		
						8	**Bedrock surface**	**T**	**IR**	**SN**	**Flat**	17	**61**	**23**	**17**		
						9	**Bedrock surface**	**T**	**D**		**Flat**	11	**63**	**30**	**7**		
			2	1	1	10	Bedrock surface	T	S		Beveled	2	54	20	6		
			3	1	1	11	Bedrock surface	T	P	SN	Gabled	3	75	22	14		
21447	Unknown	1	1	1	1	1	Bedrock crack	T	P		Pointed	1	33	11	8	1,1	

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights: Minimum	Number of Uprights: Maximum	Upright Number	Foundation	Upright Form: Material	Upright Form: Body	Upright Form: Treatment	Upright Form: Top	Upright Form: Upright Type	Upright Dimensions (cm): Height	Upright Dimensions (cm): Width	Upright Dimensions (cm): Thickness	Summary Min,Max	Comments
21448	Parallel	2	1	2	2	1	Bedrock crack	T	S		Flat	5	59	24	7	2,2	
						2	Bedrock crack	T	IR		Flat	17	54	19	10		
21451	Unknown	1	1	1	1	1	Bedrock crack	T	S	SN	Beveled	2	46	15	15	1,1	
25763		1	1	1	1	1	Boulder	T	C		Flat	23	51	45	8	1,1	
25764	Parallel	5	1	8	8	1	Mound	T	C/IR		Gabled	21	49	28	12	8,8	
						2	Mound	T	D		Pointed	7	31	29	14		
						3	Mound	T	P	SN	Flat	5	35	14	13		
						4	Mound	T	P	SH	Rounded	4	34	16	12		
						5	Mound	N	P		Beveled	2	43	19	10		
						6	Mound	T	D		Pointed	7	40	27	6		
						7	Mound	T	P		Beveled	2	48	20	10		
						8	Mound	T	D		Pointed	7	44	29	8		
25771	Other	1	1	1	1	1	Gelifluction terrace	T	S		Pointed	1	25	18	6	1,1	
25772	Perpendicular	4	1	3	3	1	Pavement	T	S	SN	Mesial curve	6	67	26	5	4,4	Basalt flakes
						2	Pavement	T	S		Flat	5	75	30	28		
						3	Pavement	N	IR		Rounded	16	76	37	18		
	Other		2	1	1	4	Boulder	N	S		Beveled	2	60	20	15		
25773	Other	1	1	1	1	1	Boulder	T	IR	SN	Unknown		48	20	12	1,1	
25775		2	1	2	2	1	Boulder	T	D		Rounded					2,2	
						2	Boulder	T		DATA	MISSING						
25776	Parallel	3	5	0	1	1	Boulder	T	IR	IR	Flat	17	79	46	6	0,2	Basalt flakes
			6	0	1	2	Boulder	N	D		Pointed	7	33	17	13		
25778	Other	3	1	2	2	1	Boulder	T	D	SN	Rounded	10	43	23	13	2,2	
						2	Boulder	T	D		Beveled	8	51	19	11		
25780	Parallel	1	1	1	1	1	Mound	T	D	SN	Pointed	7	68	31	15	1,1	One basalt flake
25781	Parallel	6	1	4	4	1	Pavement	N	D	IR	Flat	11	46	18	15	5,5	Basalt flakes performs and hammerstones nearby
						2	Pavement	T	S	IR	Flat	5	92	42	10		
						3	Pavement	T	P	IR	Beveled	2	111	50	17		
						4	Pavement	T	D		Pointed	7	58	24	7		
			2	0	1	5	Mound	T	P	IR	Flat	5	49	15	10		
25782	Other	1	1	1	1	1	Boulder	T	C		Beveled	20	69	17	8	1,1	Basalt flakes
25783	Parallel	2	1	2	3	1	Bedrock crack	T	D		Pointed	7	52	37	9	2,3	UR#3 looks flaked
						2	Bedrock crack	T	D		Pointed	7	78	30	9		
						3	Bedrock crack	T	D		Beveled	8	42	24	7		
25784	Parallel	1	1	1	1	1	Bedrock	T	D		Pointed/ gabled	9	45	62	9	1,1	
25786	Perpendicular	2		1	3	1	Bedrock	T	C		Pointed	19	59	29	10	1,3	
						2	Bedrock	T	S	SN	Flat/ beveled	2	82	29	13		
						3	Bedrock	T	S		Beveled	2	75	34	21		
25787			1	2	4	1	Bedrock crack	T	D		Beveled	8	43	34	4	2,4	
						2	Bedrock	T	IR	IR	Flat	17	46	30	3		
						3	Bedrock crack	T	C	SH	Flat	23	52	26	5		
						4	Bedrock crack	T	P	SH	Flat	5	32	19	5		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights: Minimum	Number of Uprights: Maximum	Upright Number	Foundation	Upright Form: Material	Upright Form: Body	Upright Form: Treatment	Upright Form: Top	Upright Form: Upright Type	Upright Dimensions (cm): Height	Upright Dimensions (cm): Width	Upright Dimensions (cm): Thickness	Summary Min,Max	Comments
25788	Other	1	1	1	1	1	Boulder	T	P		Rounded	4	29	14	9	1,1	
25789	Perpendicular	4	1	15	20	1	Bedrock surface	T	IR		Beveled	14	64	27	10	15,20	Basalt flakes present
						2	Bedrock surface	T	D		Flat	11	50	19	12		
						3	Bedrock surface	T	D		Pointed	7	70	28	10		
						4	Bedrock surface	T	IR	SN	Beveled	14	100	40	10		
						5	Bedrock surface	T	D		Flat	11	65	30	10		
						6	Bedrock surface	T	IR	SN	Pointed/ beveled	13	46	25	3		
						7	Bedrock surface	T	C		Flat	23	68	30	13		
						8	Bedrock surface	T	S		Beveled	2	68	22	16		
						9	**Bedrock surface**	**T**	**IR**	**SN**	**Flat**	17	**64**	**52**	**18**		
						10	Bedrock crack	T	D		Pointed/ beveled	8	70	33	9		
						11	Bedrock surface	T	D		Beveled	8	48	21	6		
						12	Bedrock surface	T	IR		Flat/ beveled	17	38	26	8		
						13	Bedrock surface	T	D		Flat	11	66	45	11		
						14	**Bedrock surface**	**T**	**D**		**Beveled**	8	**65**	**35**	**7**		
						15	**Bedrock surface**	**T**	**D**		**Beveled**	8	**41**	**18**	**10**		
						16	**Bedrock surface**	**T**	**S**		**Beveled**	2	**44**	**25**	**4**		
						17	**Bedrock crack**	**T**	**D**		**Rounded**	10	**37**	**18**	**7**		
						18	Bedrock crack	T	S		Flat	5	40	20	4		
						19	Bedrock crack	T	IR		Flat	17	52	20	17		
						20	Bedrock crack	T	IR	SN	Flat	17	60	18	15		
25790	Perpendicular	2	1	3	6	1	Mound	T	IR	UNL F	Flat	17	68	33	8	3,6	
						2	Mound	T	P	SN	Pointed	1	47	13	7		
						3	**Mound**	**T**	**S**		**Beveled**	2	**47**	**26**	**3**		
						4	**Mound**	**T**	**P**		**Flat**	5	**48**	**12**	**5**		
						5	**Mound**	**T**	**S**		**Flat**	5	**41**	**13**	**5**		
						6	Mound	T	C	SN	Beveled	20	45	25	11		
25791	Other	1	1	1	1	1	Boulder	N	D		Pointed / gabled	9	47	24	19	1,1	
25792	Unknown		1	0	0		Boulder	**No upright observed**								0,0	
25793	Parallel	2	1	4	4	1	Bedrock surface	T	C	UNL F	Flat/ beveled	20	39	23	8	4,4	
						2	Bedrock surface	T	IR	SH,CN	Flat	17	45	21	5		
						3	Bedrock surface	T	S	SN	Rounded/ gabled	3	68	37	4		
						4	Bedrock surface	N	P		Mesial curve	6	51	18	14		
25794	Parallel	1	1	1	1	1	Bedrock crack	T	IR	CN	Flat	17	90	57	9	1,1	
25795	Other	1	1	1	1	1	Boulder	T	IR	IR	Pointed	13	62	27	13	1,1	
25797	Other	1	1	1	1	1	Boulder	T	S	SN	Round	4	48	37	23	1,1	
25798	Other	1	1	1	1	1	Boulder	T	P	SN	Rounded / gabled	3	42	21	6	1,1	
25799	Parallel	5	1	3	4	1	Mound	T	P	SN	Beveled	2	50	18	7	2,6	
						2	Mound	T	IR	IR	Beveled	14	74	35	15		
						3	Mound	T	P		Pointed/ beveled	2	73	22	13		
						4	**Mound**	**T**	**D**		**Round**	10	**54**	**38**	**4**		
			4	0	1	5	**Boulder**	**T**	**P**		**Gabled**	3	**66**	**32**	**12**		
			5	0	1	6	**Bedrock crack**	**T**	**P**		**Beveled/ flat**	2	**84**	**33**	**14**		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights: Minimum	Number of Uprights: Maximum	Upright Number	Foundation	Upright Form: Material	Upright Form: Body	Upright Form: Treatment	Upright Form: Top	Upright Form: Upright Type	Upright Dimensions (cm): Height	Upright Dimensions (cm): Width	Upright Dimensions (cm): Thickness	Summary Min,Max	Comments
25810	Parallel	1	1	0	1	1	**Mound**	**T**	**C/IR**	**SN**	**Round**	22	**63**	**25**	**10**	0,1	
25811	Unknown	1	1	1	1	1	Terrace	T	P	KN	Beveled	2	84	43	17	1,1	
25818	Perpendicular	4	1	7	7	1	Terrace	T	D	IR	Beveled	8	75	34	19	7,7	
						2	Terrace	N	S		Beveled	2	82	25	17		
						3	Terrace	T	P	KN	Beveled	2	65	35	7		
						4	Terrace	T	P		Beveled	2	65	23	4		
						5	Terrace	T	P	SN	Round	4	65	28	11		
						6	Terrace	T	S	SN	Round	4	78	34	4		
						7	Terrace	T	P		Beveled	2	76	32	8		
25819	Parallel	4	1	15	16	1	Bedrock surface	T	S	SH	Pointed	1	78	30	17	15,16	
						2	Bedrock surface	N	C		Beveled	20	61	18	17		
						3	Bedrock surface	T	P		Beveled	2	38	22	11		
						4	Bedrock surface	T	D		Flat	11	46	39	26		
						5	Bedrock surface	T	S		Beveled	2	57	39	11		
						6	Bedrock surface	T	P		Flat	5	93	37	8		
						7	Bedrock surface	T	S		Beveled	2	52	36	6		
						8	Bedrock surface	N	S		Beveled	2	82	16	14		
						9	Bedrock surface	T	P		Beveled	2	68	37	5		
						10	Bedrock surface	N	D		Beveled	8	77	24	19		
						11	**Bedrock surface**	**T**	**P**		**Pointed**	1	**72**	**20**	**14**		
						12	Bedrock surface	T	S		Beveled	2	87	31	7		
						13	Bedrock surface	T	P		Beveled	2	58	27	7		
						14	Bedrock surface	N	D		Flat	11	57	23	13		
						15	Bedrock surface	T	D		Pointed	7	57	28	7		
						16	Bedrock surface	T	C		Flat	23	44	19	4		
25820	Parallel		1	2	3	1	Mound	T	D		Pointed	7	40	17	5	2,3	
		2				2	Mound	T	P	IR	Flat	5	41	11	8		
						3	Mound	N	P	CN	Rounded	2	67	44	15		
25821	Other	1	1	1	1	1	Boulder	T	S	SN	Beveled	2	57	28	6	1,1	
25825	Parallel	2	1	2	3	1	Mound	T	S		Flat/beveled	2	57	27	9	2,3	
						2	Mound	T	D		Pointed	7	40	22	14		
						3	**Mound**	**N**	**IR**	**SN**	**Pointed**	13	**35**	**14**	**5**		
25826	Unknown	2	1	1	2	1	Bedrock crack	T	C		Pointed	19	30	20	5	1,2	
						2	**Bedrock crack**	**T**	**C**		**Mesial notched**	24	**43**	**25**	**16**		
25827	Parallel	2	1	3	4	1	Bedrock surface	T	P		Pointed	1	50	21	16	2,4	
						2	Bedrock surface	T	D	SN	Pointed	7	43	25	16		
						3	Bedrock surface	T	P		Flat	5	39	16	5		
						4	**Bedrock crack**	**T**					**57**	**29**	**5**		
26217	Parallel	2	1	3	3	1	Mound	T	D		Flat	11	100	55	15	3,3	
						2	Mound	T	IR	SN	Flat	17	77	50	15		
						3	Mound	T	C		Flat	23	80	35	20		
26219	Parallel	2	1	1	2	1	Mound	T	P		Flat/ beveled	2	61	25	6	1,2	
						2	**Mound**	**T**	**P**		**Flat**	**5**	**56**	**34**	**14**		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
26221	Other	1	1	1	1	1	Boulder	T	C		Pointed	19	45	22	11	1,1	
26222	Parallel	1	1	1	2	1	Mound	T	IR	KN	Mesial curve	18	44	20	7	1,2	
						2	**Mound**	**T**	**D**		**Rounded**	**10**	**28**	**26**	**4**		
26223	Perpendicular	1	1	1	1	1	Bedrock crack	N	P		Beveled	2	49	26	23	1,1	
26225	Other	1	1	1	1	1	Boulder	T	P		Beveled	2	34	14	9	1,1	
26226	Unknown	1		0	0		Boulder	**No upright observed but believed to be a shrine**									
26227	Unknown	1	1	1	1	1	Mound	T	S		Gabled	3	45	15	12	1,1	
26228	Perpendicular		1	7	13	1	**Bedrock surface**	**T**	**IR**		**Beveled**	**14**	**44**	**12**	**8**	8,14	Appears to be
						2	**Bedrock crack**	**T**	**IR**		**Flat**	**17**	**45**	**39**	**9**		dismantled or
						3	**Bedrock crack**	**T**	**CR**		**Pointed**	**25**	**46**	**22**	**10**		in the process
						4	**Bedrock surface**	**T**	**D**	**SH**	**Flat**	**11**	**50**	**24**	**9**		of being
						5	Bedrock crack	T	D		Pointed	7	46	19	18		constructed
						6	Bedrock surface	T	P		Flat	5	71	24	12		
		4				7	Bedrock surface	T	S	KN	Pointed	1	68	36	10		
						8	**Bedrock surface**	**N**	**D**		**Pointed**	**7**	**64**	**22**	**20**		
						9	Bedrock surface	T	D		Rounded	10	60	22	7		
						10	Mound	T	D	KN	Flat	11	79	62	15		
						11	**Bedrock surface**	**N**	**P**		**Pointed**	**1**	**53**	**16**	**16**		
						12	Bedrock surface	N	D		Poinited	7	71	42	27		
						13	Bedrock surface	T	C		Unknown		71	41	11		
			2	1	1	14	Bedrock surface	T			Broken		52	20	7		
26229	Other	2	1	2	2	1	Boulder	N	P	IR	Flat	5	62	22	22	2,2	
						2	Boulder	T	S		Flat/ beveled	2	61	30	12		
26231	Parallel	2	1	2	2	1	Mound	T	S	IR	Beveled	2	50	23	12	2,2	
						2	Mound	T	D	SH	Flat	11	65	30	15		
26233	Perpendicular		1	10	12	1	**Mound**	**T**	**P**		**Flat**	**5**	**50**	**28**	**5**	10,12	
						2	Mound	T	S	IR	Flat/ beveled	2	52	41	4		
						3	Mound	T	S		Pointed/ beveled	2	74	37	13		
						4	**Mound**	**T**	**D**		**Flat**	**11**	**47**	**27**	**9**		
						5	Mound	T	P		Pointed	1	79	32	6		
		5				6	Mound	T	D		Pointed	7	58	43	9		
						7	Mound	T	D		Beveled	8	78	38	8		
						8	Mound	T	P		Pointed	1	62	25	13		
						9	Mound	T	P		Pointed	1	68	28	16		
						10	Mound	T	C		Rounded	22	55	25	8		
						11	Mound	T	P	IR	Rounded	4	60	40	4		
						12	Mound	T	S		Flat	5	48	34	6		
26234	Parallel	1	1	1	1	1	Bedrock surface	T	C		Beveled	20	85	37	7	1,1	
26235	Parallel	1	1	1	1	1	Bedrock surface	T	P	IR	Flat	5	24	16	10	1,1	
26236	Parallel	1	1	1	1	1	Bedrock surface	T	C	IR	Pointed	19	41	17	5	1,1	
26238	Parallel	1	1	1	1	1	Bedrock surface	T	IR	IR	Pointed	13	47	21	20	1,1	
26239	Parallel	1	1	1	1	1	Bedrock surface	T	D	IR	Pointed	7	40	20	11	1,1	

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
26240	Parallel		1	4	5	1	Mound	T	P		Mesial curve	6	52	15	6	5,6	
						2	Mound	T	P		Flat	5	42	15	9		
						3	Mound	T	P		Beveled	2	43	17	15		
		4				4	Mound	T	P	CN	Pointed	1	48	18	10		
						5	**Bedrock surface**	**T**	**P**		**Pointed**	**1**	**42**	**20**	**10**		
			2	1	1	6	Slabs	T	D	IR	Beveled	8	58	24	13		
26241	Other		1	0	0	0	No upright on mound, does not appear to be burial										
26242	Other	1	1	1	1	1	Mound	T	D		Flat	11	46	32	8	1,1	
26243	Parallel	1	1	1	1	1	Bedrock surface	T	P		Pointed/ beveled	2	48	15	12	1,1	
26244	Perpendicular	2	1	1	2	1	Bedrock surface	T	S	IR	Pointed	1	70	51	10	1,2	
						2	**Bedrock surface**	**N**	**IR**	**IR**	**Rounded**	**16**	**34**	**18**	**15**		
26248	Parallel		1	4	4	1	Bedrock surface	T	C		Beveled	20	63	25	4	4,4	
		2				2	Bedrock surface	T	P		Flat/ beveled	2	42	22	6		
						3	Bedrock surface	T	P		Pointed	1	47	16	6		
						4	Bedrock surface	T	P		Flat	5	32	17	6		
26250	Perpendicular		1	2	2	1	Bedrock surface	T	P	CN	Beveled	2	93	48	20	4,4	
		4				2	Mound	T	D		Pointed	7	54	35	8		
			2	2	2	3	Mound	T	D		Pointed	7	92	38	18		
						4	Bedrock crack	T	P		Beveled	2	80	30	16		
26251	Perpendicular	1	1	1	1	1	Bedrock	T	P		Flat/ mesial curve	6	45	21	10	1,1	
26252	Parallel	2	1	2	2	1	Bedrock crack	T	IR		Pointed	13	70	41	9		
						2	Bedrock surface	T	D		Beveled	8	39	28	14		
26253	Parallel	1	Shrine 1	1	1	1	Mound	T	S		Flat/beveled	2	50	18	10	1,1	
26254	Parallel	3	Shrine 1	2	2	1	Mound	T	D		Pointed	7	80	40	11	2,3	
						2	Mound	T	IR		Pointed	13	60	19	12		
			Shrine 2	0	1	**3**	**Mound**	**N**	**IR**		**Flat**	**17**	**45**	**24**	**16**		
26255	Parallel	1	Shrine 1	1	1	1	Boulder	N	D		Pointed	7	57	23	13	1,1	
27582	Other	1	Shrine 1	1	1	1	Boulder	T	S		Flat/ beveled	2	60	18	10	1,1	
27586	Parallel		Shrine 1	3	3	1	Bedrock surface	T	D		Bevel	8	90	50	30	3,3	
		3				2	Bedrock surface	T	P		Pointed	1	50	27	17		
						3	Bedrock surface	T	D		Pointed	7	57	44	8		
27588	Parallel		Shrine1	10	10	1	Bedrock surface	T	P	CN	Beveled	2	63	37	13.5	11,11	
						2	Bedrock surface	T	P		Flat	5	39.5	10	8		
						3	Bedrock surface	T	IR		Pointed	13	70	30	24		
						4	Bedrock crack	T	S		Pointed	1	42	32	8		
		3				5	Bedrock surface	T	P		Pointed	1	58	24	12		Three workshops
						6	Bedrock surface	T	IR		Pointed	13	47	35	6		
						7	Bedrock surface	T	S		Flat	5	55	25	7		
						8	Bedrock surface	T	S	SH	Rounded	4	64	17	14.5		
						9	Bedrock surface	T	D		Pointed	7	58	32	14		
						10	Bedrock surface	T	P		Flat	5	51	14	5.5		
		1	Shrine 2	1	1	11	Bedrock surface	T	D		Pointed	8	52	19	18.5		

Appendix F. Metric and Non-Metric Data for Shrine Located within the Mauna Kea Science Reserve.

Site Number	Topographic Orientation	Shrine Type	Feature Number	Number of Uprights		Upright Number	Foundation	Upright Form					Upright Dimensions (cm)			Summary Min,Max	Comments
				Minimum	Maximum			Material	Body	Treatment	Top	Upright Type	Height	Width	Thickness		
27616	Parallel	1	Shrine 1	1	3	1	Mound	T	S	IR	Beveled	2	64	28	20		
						2	Mound	T	D	IR	Flat	11	52	18	9		
						3	Mound	T	IR	IR	Beveled	14	50	23	12		
	Parallel	3	Shrine 2	1	3	4	Bedrock	T	D		Mesial curve	12	55	33	15	3,6	
						5	Bedrock	T	P		Beveled	2	26	10	7		
						6	Bedrock	T	D		Beveled	8	28	19	9		
	Perpendicular	1	Shrine 3	1	1	7	Mound	T	IR		Pointed/ beveled	13	41	23	12		
	Parallel	7	Shrine 5	1	6	1	Mound	T	D		Rounded	10	51	31	20	1,6	
						2	Mound	T	C		Flat	23	59	22	14		
						3	Mound	T	P		Beveled	2	55	12	5		
						4	Mound	T	P		broken		53	17	5		
						5	Mound	T	P		Flat	5	59	29	13		
						6	Other	T	D		Rounded	10	51	40	11		
	Parallel		Shrine 4		No upright on mound but has offering of an adze preform, does not appear to be burial												
27617	Perpendicular	5	Shrine 1	2	9	1	Mound	T	IR		Flat	17	62	49	18		
						2	Mound	T	IR		Pointed	13	40	24	4		
						3	Mound	T	C		Pointed	19	64	29	14		
						4	Mound	T	IR		Flat	17	56	35	13		
						5	Mound	T	P		Beveled	2	63	29	14		
						6	Mound	T	S		Pointed	1	52	29	13		
						7	Mound	T	S		Mesial curve	6	57	25	11		
						8	Mound	T	IR		Pointed	13	57	31	37		
						9	Mound	T	P		Beveled	2	61	30	9	9,17	
	Parallel	3	Shrine 2	2	3	1	Bedrock	T	IR		Flat	17	45	24	7		
						2	Bedrock	T	IR		Pointed	13	41	29	15		
						3	Bedrock	T	P		Flat	5	48	16	13		
	Parallel	2	Shrine 3	4	4	1	Platform	T	IR		Pointed	13	54	51	12		
						2	Platform	T	P		Rounded	4	27	21	14		
						3	Platform	T	P		Flat	5	35	21	9		
						4	Platform	T	D		Rounded	10	29	38	16		
			Shrine 4				No upright on feature but has possible offerings										
		1	Shrine 5	1	1	1	Boulder	T	P		Flat	5	30	20	3		
27618	Perpendicular	2	Shrine 1	1	2	1	Mound	T	C		Beveled	20	47	28	9	1,2	
						2	Mound	T	C		Rounded	22	54	26	6		
			Shrine 2				No upright on mound but has offering of basalt flakes, does not appear to be burial										

Upright Treatment SN = Side notch SH = Shoulder UNIL F = Unilateral Flange CN = Corner notch KN = Knobbed IR = Irregular
Upright Body P = Parallel S = Subparallel D = Divergent C = Convergent IR = Irregular

APPENDIX G

Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
26253	1	RS1 ridge slope	15.0 x 8.0	x	x	x	x	76+	32	14	3	3
26253	2	ridge slope	35.0 x 35.0		x	x	x	5	0	0	1	0
26253	3	ridge slope	5.0 x 2.0			x	x	0	0	0	0	0
26253	4	ridge slope	1.0 x 1.0		x	x	x	1	1	0	0	0
26253	5	ridge slope	3.0 x 3.0	x	x	x	x	1	1	0	0	0
26253	6	ridge slope	1.0 x 1.0			x	x	1	0	0	0	0
26253	7	ridge slope	3.0 x 2.6		x	x	x	0	0	0	0	0
26253	8	ridge slope	3.5 x 1.5	x	x	x	x	4	0	0	0	0
26253	9	ridge slope	2.5 x 2.0	x	x	x	x	0	0	0	0	0
26253	10	ridge slope	3.5 x 2.5	x	x	x	x	0	0	0	0	0
26253	11	ridge slope	1.0 x 1.0	x	x	x	x	2	0	0	0	0
26253	12	ridge slope	3.5 x 2.0	x	x	x	x	1	1	0	0	0
26253	13	ridge slope	2.0 x 2.0		x	x	x	0	0	0	0	0
26253	14	ridge slope	2.0 x 2.0		x	x	x	1	1	0	0	0
26253	15	ridge slope	5.0 x 4.0	x	x	x	x	0	0	0	0	0
26253	16	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
26253	17	ridge slope	4.0 x 2.0	x	x	x	x	8	0	0	0	0
26253	18	ridge slope	4.0 x 1.5		x	x	x	0	0	0	0	0
26253	19	ridge slope	5.5 x 2.0					0	0	0	1	0
26253	20	ridge slope	2.5 x 2.0	x	x	x	x	2	0	0	0	0
26253	21	ridge slope	2.5 x 2.0	x	x	x	x	1	0	0	0	0
26253	22	ridge slope	6.0 x 3.0		x	x	x	5	0	0	1	0
26253	23	ridge slope	3.0 x 2.0	x	x	x	x	1	1	0	1	1
26253	24	ridge slope	3.5 x 3.0	x	x	x	x	0	0	0	1	0
26253	25	ridge slope	10.0 x 3.0	x	x	x	x	4	0	0	0	0
26253	26	ridge slope	1.5 x 1.0			x	x	0	0	0	0	0
26253	27	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
26253	28	ridge slope	1.5 x 1.5		x	x	x	0	0	0	0	0
26253	29	ridge slope	10.0 x 5.0		x	x	x	4+	0	0	1	0
26253	30	ridge slope	4.0 x 4.0	x	x	x	x	0	0	0	0	0
26253	31	ridge slope	2.5 x 2.0	x	x	x	x	1	0	0	1	0
26253	32	ridge slope	2.0 x 1.5		x	x	x	0	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
26253	33	ridge slope	2.5 x 2.0		x	x	x	0	0	0	0	0
26253	34	ridge slope	4.0 x 3.0	x	x	x	x	0	0	0	0	0
26253	35	ridge slope	3.0 x 1.5		x	x	x	0	0	0	0	0
26253	36	ridge slope	2.5 x 1.0		x	x	x	0	0	0	0	0
26253	37	ridge slope	2.5 x 2.0		x	x		0	0	0	0	0
26253	38	ridge slope	4.0 x 4.0			x	x	0	0	0	0	0
26253	39	ridge slope	1.5 x 1.0		x	x	x	2	0	0	0	0
26253	40	ridge slope	3.0 x 2.5		x	x	x	1	1	0	0	0
26253	41	ridge slope	5.0 x 4.0	x	x	x	x	4+	0	0	1	0
26253	42	ridge slope	7.5 x 5.0	x	x	x	x	0	0	0	0	0
26253	43	ridge slope	2.0 x 2.0				x	0	0	0	0	0
26253	44	ridge slope	3.0 x 3.0	x	x	x	x	1	1	0	0	0
26253	45	ridge slope	5.0 x 3.0		x	x	x	1	1	0	0	0
26253	46	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
26253	47	ridge slope	1.5 x 1.0		x	x		0	0	0	0	0
26253	48	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
26253	49	ridge slope	2.0 x 2.0			x	x	0	0	0	0	0
26253	50	ridge slope	2.0 x 1.5	x	x	x	x	0	0	0	0	0
26253	51	ridge slope	2.8 x 1.7	x	x			2	0	0	1	0
26253	52	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
26253	53	ridge slope	2.0 x 1.0		x	x		1	0	0	0	0
26253	54	ridge slope	2.1 x 1.7		x	x		0	0	0	0	0
26253	55	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	1	0
26253	56	ridge slope	1.0 x 1.0		x	x		0	0	0	0	0
26253	57	ridge slope	3.0 x 1.8			x	x	0	0	0	0	0
26253	58	ridge slope	2.8 x 2.2		x	x		0	0	0	0	0
26253	59	ridge slope	2.3 x 1.6		x	x		1	0	0	2	0
26253	60	ridge slope	1.0 x 1.0		x	x		0	0	0	1	0
26253	61	ridge slope	1.8 x 1.0	x	x	x	x	0	0	0	0	0
26253	62	ridge slope	1.0 x 1.0	x	x	x		0	0	0	0	0
26253	63	ridge slope	3.0 x 1.0		x	x	x	0	0	0	0	0
26253	64	ridge slope	2.0 x 1.0		x	x	x	0	0	0	0	0
26253	65	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
27591	1	ridge slope	2.0 x 2.0	x	x	x		0	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27591	EA1	ridge slope	10.0 x 10.0	x	x			0	0	0	0	0
27592	1	ridge slope	1.0 x 1.0	x	x	x		0	0	0	0	0
27592	2	ridge slope	3.0 x 3.0	x	x	x		0	0	0	0	0
27593	1	ridge slope	15.0 x 15.0	x	x	x	x	0	0	0	0	0
27594	1	ridge slope	12.0 x 6.0	x	x	x		0	0	0	0	0
27595	1	ridge slope	3.0 x 3.0	x	x			0	0	0	0	0
27596	1	ridge slope	4.0 x 4.0	x	x	x	x	2	0	0	0	0
27596	2	ridge slope	7.0 x 3.0	x	x	x	x		0	0	0	0
27596	3	ridge slope	3.0 x 1.0				x	1	0	0	0	0
27597	1	ridge slope	1.0 x 1.0	x	x			0	0	0	0	0
27597	2	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27597	3	ridge slope	1.0 x 1.0	x	x	x	x	1	0	0	0	0
27598	1	ridge top	10.0 x 10.0	x	x	x	x	40	20	0	10	5
27598	2	ridge crest	3.0 x 3.0	x	x	x	x	3+	0	0	0	0
27598	3	gelifluction terrace	7.0 x 6.0	x	x	x	x	4	2	0	1	1
27598	4	gelifluction terrace	12.0 x 8.0	x	x	x	x	5	3	0	2	1
27598	5	gelifluction terrace	3.5 x 1.5	x	x	x	x	1	0	0	1	1
27598	6	gelifluction terrace	7.0 x 5.5	x	x	x	x	12	6	0	0	0
27598	7	gelifluction terrace	8.0 x 6.0	x	x	x	x	29	15	1	5	2
27598	8	gelifluction terrace	3.0 x 2.0		x	x		0	0	0	0	0
27598	9	gelifluction terrace	4.0 x 3.0			x	x	1	1	0	0	0
27598	10	gelifluction terrace	5.0 x 5.0			x	x	0	0	0	0	0
27598	11	gelifluction terrace	2.0 x 2.0			x	x	0	0	0	1	0
27598	12	gelifluction terrace	4.0 x 4.0		x	x		0	0	0	0	0
27598	13	gelifluction terrace	4.0 x 2.0	x	x	x	x	0	0	0	0	0
27598	14	gelifluction terrace	8.0 x 8.0			x	x	0	0	0	0	0
27598	15	gelifluction terrace	3.0 x 3.0	x	x	x	x	0	0	0	0	0
27598	16	gelifluction terrace	2.0 x 2.0	x	x	x	x	0	0	0	0	0
27598	17	gelifluction terrace	1.0 x 1.0			x	x	0	0	0	0	0
27598	18	gelifluction terrace	2.0 x 2.0			x	x	0	0	0	1	0
27598	19	gelifluction terrace	2.0 x 2.0			x	x	0	0	0	0	0
27598	20	gelifluction terrace	3.0 x 1.0			x	x	0	0	0	0	0
27598	21	gelifluction terrace	1.0 x 1.0			x	x	1	1	0	0	0
27598	22	gelifluction terrace	4.0 x 3.0	x	x	x	x	5	3	0	1	1

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27598	23	gelifluction terrace	7.0 x 7.0	x	x	x	x	29	14	1	2	1
27598	24	gelifluction terrace	6.0 x 6.0	x	x	x	x	51	12	0	2	1
27598	25	gelifluction terrace	1.5 x 1.5	x	x	x	x	3	0	0	3	0
27598	26	gelifluction terrace	1.0 x 1.0		x	x		0	0	0	0	0
27598	27	gelifluction terrace	3.0 x 1.3		x			0	0	0	1	0
27598	28	gelifluction terrace	1.0 x 1.0					0	0	0	0	0
27598	29	gelifluction terrace	1.0 x 1.0		x			0	0	0	0	0
27598	30	gelifluction terrace	1.5 x 1.0	x	x			0	0	0	0	0
27598	31	gelifluction terrace	3.0 x 2.0	x	x	x	x	1	0	0	0	0
27598	32	gelifluction terrace	2.5 x 1.2	x	x	x		0	0	0	1	0
27598	33	gelifluction terrace	1.0 x 1.0	x	x			0	0	0	0	0
27598	34	gelifluction terrace	3.0 x 2.5	x	x			1	0	0	0	0
27598	35	gelifluction terrace	5.5 x 2.0	x	x	x		0	0	0	0	0
27598	36	gelifluction terrace	1.6 x 1.5	x	x			0	0	0	0	0
27598	37	gelifluction terrace	9.0 x 4.0					1	0	0	0	0
27598	38	gelifluction terrace	4.0 x 3.0		x	x		1	0	0	3	0
27598	39	gelifluction terrace	1.7 x 1.4					1	0	0	0	0
27598	40	gelifluction terrace	6.5 x 4.0	x	x	x		2	0	0	1	0
27598	41	gelifluction terrace	9.0 x 8.5	x	x	x	x	21	11	0	2	1
27598	42	gelifluction terrace	10.0 x 5.7	x	x	x	x	10	5	0	2	1
27598	43	gelifluction terrace	7.3 x 6.0	x	x	x		4	2	0	1	1
27598	44	gelifluction terrace	3.5 x 3.3	x	x	x		2	0	0	0	0
27598	45	gelifluction terrace	13.0 x 6.0		x	x		6	3	0	0	0
27598	46	gelifluction terrace	24.0 x 11.0		x	x	x	3	0	0	1	0
27598	47	gelifluction terrace	7.0 x 5.0		x	x	x	9	5	0	1	1
27598	48	gelifluction terrace	13.5 x 8.8	x	x	x	x	5	3	0	0	0
27598	49	gelifluction terrace	3.2 x 2.5					4	0	0	0	0
27598	50	gelifluction terrace	1.6 x 1.5		x	x		1	0	0	0	0
27598	51	gelifluction terrace	5.4 x 5.0					1	0	0	0	0
27598	52	gelifluction terrace	3.0 x 2.8	x	x	x	x	3	0	0	1	0
27598	53	gelifluction terrace	4.9 x 4.2	x	x	x	x	7	3	0	0	0
27598	54	gelifluction terrace	3.5 x 2.0		x	x	x	0	0	0	0	0
27598	55	gelifluction terrace	4.5 x 3.5	x	x	x	x	3	0	0	0	0
27598	56	gelifluction terrace	3.2 x 3.2		x	x	x	1	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27598	57	gelifluction terrace	4.0 x 3.0		x	x	x	0	0	0	0	0
27598	58	gelifluction terrace	3.0 x 3.0		x	x	x	0	0	0	0	0
27598	59	gelifluction terrace	3.0 x 3.0		x	x	x	0	0	0	0	0
27598	60	gelifluction terrace	4.5 x 2.5	x	x	x	x	3	0	0	0	0
27598	61	gelifluction terrace	5.0 x 4.0		x	x	x	0	0	0	0	0
27598	62	gelifluction terrace	4.0 x 3.5		x	x	x	3	0	0	0	0
27598	63	gelifluction terrace	2.0 x 2.0			x	x	0	0	0	0	0
27598	64	gelifluction terrace	2.0 x 2.0		x	x	x	1	0	0	0	0
27598	65	gelifluction terrace	1.0 x 1.0		x	x	x	1	0	0	0	0
27598	66	gelifluction terrace	4.0 x 2.0		x	x	x	3	0	0	0	0
27598	67	gelifluction terrace	1.0 x 1.0		x	x	x	0	0	0	0	0
27598	68	gelifluction terrace	1.0 x 1.0		x	x	x	0	0	0	0	0
27598	69	gelifluction terrace	2.0 x 1.0		x	x		0	0	0	0	0
27598	70	gelifluction terrace	1.0 x 1.0	x	x			0	0	0	0	0
27600	1	glacial moraine	5.0 x 3.0	x	x	x	x	1	0	0	0	0
27601	1	glacial moraine	3.5 x 1.6		x	x	x	1	0	0	0	0
27601	2	glacial moraine	4.2 x 3.2	x	x	x		0	0	0	0	0
27601	3	glacial moraine	7.0 x 4.0	x	x	x	x	3	0	0	1	0
27601	4	glacial moraine	2.0 x 1.0	x	x	x	x	3	0	0	0	0
27601	5	glacial moraine	3.0 x 2.0	x	x	x	x	2	0	0	0	0
27601	6	glacial moraine	2.0 x 1.5	x	x	x	x	0	0	0	0	0
27601	7	glacial moraine	2.0 x 1.0	x	x	x	x	0	0	0	1	0
27601	8	glacial moraine	2.0 x 2.0	x	x	x	x	1	0	0	4	0
27601	9	glacial moraine	2.5 x 1.0	x	x	x	x	0	0	0	0	0
27601	10	glacial moraine	1.0 x 1.0		x	x	x	1	0	0	0	0
27601	11	glacial moraine	1.0 x 1.0		x	x		0	0	0	0	0
27601	12	glacial moraine	2.5 x 1.8	x	x	x	x	3	0	0	0	0
27601	13	glacial moraine	2.0 x 1.0	x	x	x		0	0	0	0	0
27601	14	glacial moraine	2.0 x 2.0		x	x	x	0	0	0	2	0
27601	15	glacial moraine	1.0 x 1.0		x	x	x	0	0	0	0	0
27601	16	glacial moraine	1.0 x 1.0		x	x	x	0	0	0	0	0
27601	17	glacial moraine	5.0 x 1.5	x	x	x	x	4	0	0	1	0
27601	18	glacial moraine	8.0 x 4.0	x	x	x	x	0	0	0	0	0
27601	19	glacial moraine	6.5 x 3.0	x	x	x	x	0	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27601	20	glacial moraine	3.0 x 2.0		x	x	x	0	0	0	0	0
27601	21	glacial moraine	4.7 x 3.0	x	x	x	x	0	0	0	0	0
27601	22	glacial moraine	5.0 x 2.5	x	x	x	x	1	0	0	0	0
27601	23	glacial moraine	7.5 x 4.0	x	x	x	x	3	0	0	0	0
27601	24	glacial moraine	5.0 x 2.0	x	x	x	x	1	0	0	0	0
27601	25	glacial moraine	4.5 x 3.0	x	x	x	x	1	0	0	2	1
27601	26	glacial moraine	4.5 x 4.4	x	x	x	x	2	0	0	0	0
27601	27	glacial moraine	4.0 x 2.5	x	x	x	x	0	0	0	0	0
27601	28	glacial moraine	3.0 x 2.6	x	x	x	x	3	0	0	0	0
27601	29	glacial moraine	5.0 x 3.8	x	x	x	x	4	0	0	0	0
27601	30	glacial moraine	3.5 x 3.5	x	x	x	x	3	0	0	0	0
27601	31	glacial moraine	3.7 x 2.0	x	x	x	x	2	0	0	0	0
27601	32	glacial moraine	3.0 x 2.5	x	x	x	x	4	0	0	3	0
27601	33	glacial moraine	2.7 x 2.5	x	x	x	x	0	0	0	0	0
27601	34	glacial moraine	4.0 x 2.0	x	x	x	x	4	1	0	0	0
27601	35	glacial moraine	5.0 x 4.0	x	x	x	x	8	2	0	1	0
27601	36	glacial moraine	4.0 x 4.0	x	x	x	x	3	0	0	1	0
27601	37	glacial moraine	1.8 x 1.8	x	x	x	x	2	0	0	0	0
27601	38	glacial moraine	3.3 x 2.3	x	x	x	x	3	1	0	0	0
27601	39	glacial moraine	4.0 x 2.7	x	x	x	x	6	0	0	0	0
27601	40	glacial moraine	3.3 x 2.2	x	x	x	x	0	0	0	1	0
27601	41	glacial moraine	3.0 x 2.0	x	x	x	x	3	0	0	4	0
27601	42	glacial moraine	3.8 x 3.6		x	x	x	1	0	0	1	0
27601	43	glacial moraine	1.7 x 1.5	x	x	x	x	2	1	0	1	1
27601	44	glacial moraine	6.0 x 2.7	x	x	x	x	1	0	0	0	0
27601	45	glacial moraine	2.7 x 2.1	x	x	x	x	2	0	0	1	0
27601	46	glacial moraine	10.5 x 3.5	x	x	x	x	5	0	0	1	0
27601	47	glacial moraine	3.4 x 3.0		x	x	x	4	0	0	1	0
27601	48	glacial moraine	3.6 x 2.5			x	x	0	0	0	2	0
27601	49	glacial moraine	4.5 x 2.5	x	x	x	x	2	1	1	0	0
27601	50	glacial moraine	2.0 x 1.2		x	x		1	0	0	0	0
27601	51	glacial moraine	2.0 x 1.0		x	x		0	0	0	1	1
27601	52	glacial moraine	2.5 x 1.0		x	x		0	0	0	0	0
27601	53	glacial moraine	5.0 x 1.5		x	x		1	0	0	0	0

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				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27601	54	glacial moraine	4.7 x 3.0		x	x		3	1	0	1	1
27601	55	glacial moraine	6.5 x 5.5	x	x	x	x	10	5	0	0	0
27601	56	glacial moraine	9.5 x 6.0	x	x	x	x	8	4	0	0	0
27601	57	glacial moraine	3.4 x 2.3	x	x	x		2	0	0	0	0
27601	58	glacial moraine	1.0 x 1.0		x	x		0	0	0	0	0
27601	59	glacial moraine	4.3 x 2.2		x	x	x	0	0	0	0	0
27601	60	glacial moraine	1.0 x 1.0		x	x		0	0	0	0	0
27601	61	glacial moraine	6.0 x 4.4	x	x	x	x	14	7	0	6	3
27601	62	glacial moraine	1.4 x 1.2		x	x		2	0	0	0	0
27601	63	glacial moraine	3.5 x 2.0		x	x		1	0	0	0	0
27601	64	glacial moraine	3.5 x 2.2		x	x		0	0	0	0	0
27601	65	glacial moraine	4.7 x 1.4			x		0	0	0	0	0
27601	66	glacial moraine	1.0 x 1.0		x	x	x	0	0	0	0	0
27601	67	glacial moraine	2.8 x 1.7		x	x		1	0	0	0	0
27601	68	glacial moraine	1.0 x 1.0		x	x		0	0	0	0	0
27601	69	glacial moraine	2.0 x 2.0	x	x	x		0	0	0	0	0
27601	70	glacial moraine	2.0 x 1.6	x	x	x	x	1	0	0	0	0
27604	1	glacial moraine	3.0 x 3.0	x	x	x		0	0	0	0	0
27604	2	glacial moraine	3.0 x 3.0	x	x	x		0	0	0	0	0
27604	3	glacial moraine	3.0 x 3.0	x	x	x		0	0	0	0	0
27604	4	glacial moraine	1.0 x 1.0			x	x	1	0	0	0	0
27604	5	glacial moraine	3.5 x 3.5	x	x	x	x	0	0	0	4	0
27604	6	glacial moraine	6.2 x 3.0	x	x	x	x	1	0	0	0	0
27604	7	glacial moraine	2.0 x 1.2	x	x	x		0	0	0	2	0
27604	8	glacial moraine	1.0 x 1.0			x	x	0	0	0	0	0
27604	9	glacial moraine	1.0 x 1.0			x	x	0	0	0	0	0
27604	10	glacial moraine	1.0 x 1.0			x	x	1	1	0	0	0
27604	11	glacial moraine	1.0 x 1.0	x	x	x	x	1	0	0	0	0
27604	12	glacial moraine	1.0 x 1.0	x	x	x		0	0	0	0	0
27604	13	glacial moraine	5.0 x 5.0	x	x	x	x	5	0	0	2	0
27604	14	glacial moraine	3.0 x 2.0	x	x	x		2	0	0	0	0
27605	1	ridge slope	2.0 x 1.0	x	x	x	x	2	0	0	0	0
27605	2	ridge slope	3.0 x 2.0	x	x	x	x	5	0	0	0	0
27605	3	ridge slope	3.0 x 3.0	x	x	x	x	0	0	0	0	0

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				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27605	4	ridge slope	10.0 x 7.0	x	x	x	x	14	14	2	9	9
27605	5	ridge slope	2.0 x 2.0	x	x	x		0	0	0	3	0
27605	6	ridge slope	3.0 x 3.0	x	x	x	x	2+	0	0	0	0
27605	7	ridge slope	2.0 x 2.0	x	x	x	x	0	0	0	0	0
27605	8	ridge slope	5.0 x 2.0	x	x	x	x	0	0	0	0	0
27605	9	ridge slope	2.0 x 2.0	x	x	x	x	2+	0	0	0	0
27605	10	ridge slope	3.0 x 1.5	x	x	x	x	1	0	0	0	0
27605	11	ridge slope	4.0 x 1.0	x	x	x	x	0	0	0	0	0
27605	12	ridge slope	2.0 x 2.0	x	x	x	x	1	0	0	0	0
27605	13	ridge slope	2.0 x 2.0	x	x	x	x	0	0	0	0	0
27605	14	ridge slope	1.0 x 1.0		x	x	x	1	0	0	0	0
27605	15	ridge slope	3.0 x 3.0	x	x	x	x	2+	1	0	0	0
27605	16	ridge slope	1.0 x 1.0	x	x			0	0	0	0	0
27605	17	ridge slope	1.0 x 1.0	x	x	x	x	1	0	0	0	0
27605	18	ridge slope	2.0 x 2.0	x	x	x	x	4	0	0	0	0
27605	19	ridge slope	1.5 x 1.5	x	x	x	x	3	2	0	1	1
27605	20	ridge slope	2.5 x 2.0	x	x	x	x	2	0	0	2	0
27605	21	ridge slope	3.0 x 1.5	x	x	x	x	8	4	0	0	0
27605	22	ridge slope	2.0 x 2.0	x	x	x	x	6	3	0	1	1
27605	23	ridge slope	3.0 x 1.5	x	x	x	x	4+	2	0	1	1
27605	24	ridge slope	3.0 x 2.0	x	x	x	x	0	0	0	0	0
27605	25	ridge slope	2.0 x 1.0			x	x	0	0	0	0	0
27605	26	ridge slope	2.0 x 1.0	x	x			1	0	0	0	0
27605	27	ridge slope	2.0 x 2.0	x	x	x		3	0	0	1	0
27605	28	ridge slope	1.0 x 1.0	x	x	x	x	1	0	0	0	0
27605	29	ridge slope	2.0 x 2.0		x	x	x	0	0	0	0	0
27605	30	ridge slope	1.0 x 1.0				x	0	0	0	0	0
27605	31	ridge slope	2.0 x 2.0	x	x	x	x	0	0	0	0	0
27605	32	ridge slope	3.0 x 3.0	x	x	x	x	0	0	0	1	0
27605	33	ridge slope	4.0 x 2.0	x	x	x	x	1	0	0	0	0
27605	34	ridge slope	2.0 x 1.5		x	x	x	0	0	0	0	0
27605	35	ridge slope	3.0 x 3.0		x	x	x	0	0	0	0	0
27605	36	ridge slope	1.7 x 1.0		x	x	x	0	0	0	0	0
27605	37	ridge slope	4.0 x 2.0		x	x	x	0	0	0	0	0

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27605	38	ridge slope	2.0 x 1.5	x	x	x	x	0	0	0	0	0
27605	39	ridge slope	5.0 x 4.0	x	x	x	x	2	0	0	1	0
27605	40	ridge slope	4.0 x 2.3		x	x	x	0	0	0	0	0
27605	41	ridge slope	2.0 x 1.5		x	x	x	1	0	0	0	0
27605	42	ridge slope	1.0 x 1.0		x	x	x	1	0	0	0	0
27605	43	ridge slope	5.0 x 2.0		x	x	x	0	0	0	0	0
27605	44	ridge slope	2.5 x 2.0		x	x	x	0	0	0	0	0
27605	45	ridge slope	4.0 x 2.5		x	x	x	0	0	0	0	0
27605	46	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27605	47	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27605	48	ridge slope	2.0 x 1.5		x	x	x	2	0	0	0	0
27605	49	ridge slope	4.0 x 4.0		x	x	x	1	0	0	0	0
27605	50	ridge slope	5.0 x 3.0			x	x	0	0	0	0	0
27605	51	ridge slope	2.0 x 1.5		x	x	x	0	0	0	0	0
27605	52	ridge slope	2.0 x 2.0		x	x	x	0	0	0	0	0
27605	53	ridge slope	2.0 x 1.5		x	x	x	0	0	0	0	0
27605	54	ridge slope	2.0 x 2.0		x	x	x	1	0	0	1	0
27605	55	ridge slope	2.0 x 2.0		x	x	x	0	0	0	0	0
27605	56	ridge slope	1.0 x 1.0		x	x	x	0	0	0	1	0
27605	57	ridge slope	2.0 x 2.0	x	x	x	x	1	0	0	0	0
27605	58	ridge slope	3.0 x 3.0		x	x	x	0	0	0	0	0
27605	59	ridge slope	5.0 x 3.0	x	x	x	x	3	0	0	0	0
27605	60	ridge slope	1.0 x 1.0			x	x	1	0	0	0	0
27605	61	ridge slope	2.0 x 2.0		x	x	x	1	0	0	0	0
27605	62	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27605	63	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27605	64	ridge slope	1.0 x 1.0		x	x	x	1	0	0	0	0
27605	65	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27605	66	ridge slope	2.0 x 1.0	x	x	x	x	4	0	0	1	0
27605	67	ridge slope	7.0 x 4.0	x	x	x	x	2	0	0	0	0
27605	68	ridge slope	1.0 x 1.0	x	x			0	0	0	0	0
27605	69	ridge slope	2.0 x 1.0		x	x	x	0	0	0	0	0
27605	70	ridge slope	2.5 x 1.0		x	x	x	1	0	0	0	0
27605	71	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0

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				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27605	72	ridge slope	5.0 x 4.0	x	x			0	0	0	0	0
27605	73	ridge slope	2.0 x 2.0		x	x	x	0	0	0	0	0
27605	74	ridge slope	6.0 x 6.0	x	x	x	x	0	0	0	0	0
27606	RS1/WS1	ridge slope	20.0 x 20.0	x	x	x	x	21	21	5	0	0
27607	1	ridge slope	2.5 x 1.5		x	x	x	0	0	0	0	0
27607	2	ridge slope	2.0 x 1.5	x	x	x	x	0	0	0	0	0
27607	3	ridge slope	2.5 x 2.0		x	x	x	0	0	0	0	0
27607	4	ridge slope	3.0 x 2.0			x	x	0	0	0	0	0
27607	5	ridge slope	2.0 x 2.0			x	x	0	0	0	0	0
27607	6	ridge slope	3.0 x 2.0	x	x	x	x	0	0	0	0	0
27608	1	ridge slope	2.0 x 1.0		x	x	x	0	0	0	0	0
27609	EA1	ridge slope	10.0 x 10.0	x	x	x	x	0	0	0	0	0
27610	1	ridge slope	1.5 x 1.5	x	x	x	x	0	0	0	0	0
27612	1	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27613	1	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27613	2	ridge slope	2.0 x 2.0	x	x	x	x	0	0	0	0	0
27613	3	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27614	1	ridge slope	5.0 x 2.3	x	x	x	x	5	0	0	0	0
27614	2	ridge slope	4.5 x 2.8	x	x	x	x	3	0	0	1	0
27614	3	ridge slope	3.5 x 3.5	x	x	x	x	0	0	0	0	0
27614	4	ridge slope	2.5 x 2.0	x	x	x	x	0	0	0	0	0
27614	5	ridge slope	2.0 x 2.0		x	x	x	1	0	0	0	0
27614	EA1	ridge slope	70.0 x 40.0	x	x	x	x	0	0	0	0	0
27615	EA1/WS1	ridge base		x	x	x	x	0	0	0	0	0
27615	EA2/WS2	ridge base		x	x	x	x	0	0	0	0	0
27615	EA3/WS3	ridge base		x	x	x	x	0	0	0	0	0
27616	1	ridge crest	1.7 x 1.0		x	x	x	0	0	0	0	0
27616	2	ridge slope	3.5 x 2.5	x	x	x	x	4	4	0	1	0
27616	3	ridge slope	2.5 x 2.5	x	x	x	x	10	10	0	1	0
27616	4	ridge slope	2.7 x 1.5	x	x	x	x	11	11	0	1	0
27616	5	ridge slope	8.0 x 8.0	x	x	x	x	25	25	0	7	7
27616	6	ridge slope	10.0 x 9.0	x	x	x	x	16	16	0	1	0
27616	7	ridge slope	3.8 x 1.4	x	x	x	x	11	5	0	2	0
27616	8	ridge slope	2.5 x 2.5	x	x	x	x	4	2	0	1	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27616	9	ridge slope	2.7 x 1.9	x	x	x	x	4	2	0	2	1
27616	10	ridge slope	12.0 x 9.0	x	x	x	x	41	20	3	8	4
27616	11	ridge slope	2.3 x 1.9	x	x	x	x	9	4	0	0	0
27616	12	ridge slope	6.0 x 5.0	x	x		x	1	1	0	1	1
27616	13	ridge slope	1.5 x 1.5	x	x		x	0	0	0	1	1
27616	14	ridge slope	4.0 x 2.2	x	x		x	4	2	0	4	2
27616	15	ridge slope	2.4 x 2.0	x	x		x	0	0	0	2	2
27616	16	ridge slope	3.0 x 2.5	x	x		x	0	0	0	1	1
27616	17	ridge slope	6.0 x 5.0	x	x		x	9	4	0	3	2
27616	18	ridge slope	6.8 x 2.9	x	x		x	2	1	0	1	1
27616	19	ridge slope	2.1 x 1.8	x	x		x	4	2	0	1	1
27616	20	ridge slope	4.5 x 2.8	x	x		x	4	2	0	3	2
27616	21	ridge slope	2.1 x 2.0	x	x		x	4	2	0	0	0
27616	22	ridge slope	1.9 x 1.1	x	x	x	x	0	0	0	0	0
27616	23	ridge slope	1.7 x 0.6	x	x	x	x	0	0	0	0	0
27616	24	ridge slope	3.2 x 2.2	x	x	x	x	0	0	0	0	0
27616	25	ridge slope	5.3 x 2.9	x	x	x	x	1	1	0	1	1
27616	26	ridge slope	3.3 x 3.1	x	x	x	x	6	3	0	0	0
27616	27	ridge slope	3.2 x 2.9	x	x	x	x	2	1	0	1	1
27616	28	ridge slope	2.8 x 1.2	x	x	x	x	3	1	0	0	0
27616	29	ridge slope	2.5 x 1.6	x	x	x	x	2	1	0	1	1
27616	30	ridge slope	2.0 x 1.6	x	x	x	x	2	1	0	0	0
27616	31	ridge slope	9.1 x 5.7	x	x	x	x	6	3	0	2	2
27616	32	ridge slope	1.7 x 1.4	x	x	x	x	2	1	0	1	1
27616	33	ridge slope	2.1 x 1.9	x	x	x	x	0	0	0	0	0
27616	34	ridge slope	2.2 x 1.8	x	x	x	x	4	2	0	1	1
27616	35	ridge slope	8.0 x 7.6	x	x	x	x	11	6	0	9	5
27616	36	ridge slope	3.7 x 3.4	x	x	x	x	2	1	0	2	1
27616	37	ridge slope	2.5 x 1.9	x	x	x	x	2	1	0	1	1
27616	38	ridge slope base	6.0 x 4.5	x	x	x	x	7	3	0	2	1
27616	39	ridge slope base	2.7 x 1.8	x	x	x	x	4	1	0	0	0
27616	40	ridge slope base	1.8 x 1.3	x	x	x	x	1	1	0	0	0
27616	41	ridge slope	5.0 x 3.5	x	x	x	x	7	1	0	0	0
27616	42	ridge slope	1.0 x 1.0	x	x	x		0	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27616	43	ridge slope	3.2 x 2.8	x	x	x	x	5	1	0	1	1
27616	44	ridge slope	2.5 x 2.0	x	x	x	x	6	3	0	1	1
27616	45	ridge slope	2.4 x 1.2	x	x	x	x	1	1	0	0	0
27616	46	ridge slope	4.5 x 3.2	x	x	x	x	1	1	0	6	3
27616	47	ridge slope	3.6 x 2.8	x	x	x	x	5	2	0	0	0
27616	48	ridge slope	3.3 x 2.2	x	x	x	x	6	3	0	2	1
27616	49	ridge slope	2.2 x 1.9	x	x	x	x	3	2	0	0	0
27616	50	ridge slope	1.6 x 1.4	x	x	x	x	1	1	0	2	1
27616	51	ridge slope	1.0 x 1.0	x	x	x	x	1	1	0	0	0
27616	52	ridge slope	4.0 x 3.6	x	x	x	x	6	3	0	0	0
27616	53	ridge slope	3.8 x 3.4	x	x	x	x	10	3	0	8	4
27616	54	ridge slope	3.0 x 2.8	x	x	x	x	6	3	0	1	1
27616	55	ridge slope	1.0 x 1.0			x	x	0	0	0	0	0
27616	56	gelifluction terrace in gulch	7.0 x 6.0	x	x	x	x	9	5	0	3	2
27616	57	gelifluction terrace in gulch	4.1 x 3.0	x	x	x	x	9	4	0	1	1
27616	58	gelifluction terrace in gulch	5.0 x 3.5	x	x	x	x	4	2	0	0	0
27616	59	gelifluction terrace in gulch	3.5 x 2.0	x	x	x	x	4	2	1	1	1
27616	60	gelifluction terrace in gulch	2.7 x 2.4		x	x	x	0	0	0	0	0
27616	61	gelifluction terrace in gulch	2.8 x 2.1		x	x	x	0	0	0	0	0
27616	62	gelifluction terrace in gulch	4.7 x 3.6	x	x	x	x	3	3	0	3	3
27616	63	gelifluction terrace in gulch	15.0 x 13.0	x	x	x	x	21	9	0	6	2
27616	64	gelifluction terrace in gulch	4.0 x 3.5	x	x	x	x	2	0	0	0	0
27616	65	gelifluction terrace in gulch	5.0 x 3.0	x	x	x	x	1	1	0	1	1
27616	66	gelifluction terrace in gulch	3.0 x 3.0	x	x	x	x	3	2	0	1	1
27616	67	gelifluction terrace in gulch	8.0 x 5.5	x	x	x	x	6+	3	0	3	1
27616	68	gelifluction terrace in gulch	3.2 x 3.2	x	x	x	x	3	2	0	1	1

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27616	69	gelifluction terrace in gulch	5.0 x 3.6	x	x	x	x	11	5	0	7	1
27616	70	gelifluction terrace in gulch	4.3 x 3.3	x	x	x	x	4	2	0	2	1
27616	71	gelifluction terrace in gulch	3.0 x 2.5	x	x	x	x	0	0	0	0	0
27616	72	gelifluction terrace in gulch	5.0 x 4.0	x	x	x	x	11	5	0	2	1
27616	73	gelifluction terrace in gulch	4.0 x 3.5	x	x	x	x	3	3	0	1	1
27616	74	gelifluction terrace in gulch	8.0 x 5.0	x	x	x	x	14	7	0	2	1
27616	75	gelifluction terrace in gulch	12.0 x 7.5	x	x	x	x	40	12	0	3	0
27616	76	gelifluction terrace in gulch	5.5 x 3.8	x	x	x	x	3	0	0	2	0
27616	77	gelifluction terrace in gulch	4.0 x 3.0	x	x	x	x	0	0	0	0	0
27616	78	gelifluction terrace in gulch	1.5 x 1.5			x	x	5	5	0	0	0
27616	79	gelifluction terrace in gulch	2.0 x 1.0		x	x	x	3	3	0	0	0
27616	80	gelifluction terrace in gulch	2.0 x 1.0	x	x	x	x	3	3	0	0	0
27616	81	gelifluction terrace in gulch	2.0 x 1.0		x	x	x	3	3	0	0	0
27616	82	gelifluction terrace in gulch	7.0 x 5.0		x	x	x	0	0	0	0	0
27616	83	gelifluction terrace in gulch	5.0 x 5.0			x	x	0	0	0	0	0
27616	84	gelifluction terrace in gulch	2.0 x 2.0		x	x	x	0	0	0	0	0
27616	85	gelifluction terrace in gulch	3.0 x 2.0	x	x	x	x	0	0	0	0	0
27616	86	gelifluction terrace in gulch	1.0 x 1.0	x	x	x	x	1	0	0	0	0
27616	87	ridge slope	3.0 x 3.0	x	x	x	x	1	0	0	0	0
27616	88	ridge slope	4.0 x 2.0	x	x	x		1	0	0	0	0
27616	89	ridge slope	1.0 x 1.0		x	x	x	0	0	0	0	0
27616	90	ridge slope	11.0 x 5.5	x	x	x	x	1	1	0	0	0
27616	91	ridge slope	2.0 x 2.0	x	x	x	x	3	0	0	0	0
27616	92	ridge slope	4.0 x 3.0	x	x	x	x	4	0	0	0	0

Appendix G. Summary of Metric and Non-Metric Data for Workshops in the Pōhakuloa Quarry/Workshop Complex.

				Basalt Flake Size				Adze Preform			Hammerstones	
Site Number	Workshop Number	Location	Workshop Dimensions Length x Width in meters	5 cm or less	6 cm - 10 cm	11.0 -14.0 cm	15.0 cm and greater	Estimated Number	Number Sampled	Number Collected	Estimated Number	Number Sampled
27616	93	ridge slope	6.0 x 6.0	x	x	x	x	12	0	0	0	0
27616	94	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27616	95	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27616	96	ridge slope	1.0 x 1.0	x	x	x	x	0	0	0	0	0
27618	1	gelifluction terrace in gulch	8.5 x 3.5	x	x	x	x	8	4	0	0	0
27618	2	gelifluction terrace in gulch	7.6 x 6.0	x	x	x	x	6	3	0	3	2
27618	3	gelifluction terrace in gulch	12.0 x 8.0	x	x	x	x	11	6	0	1	1
27618	4	ridge slope	unknown	x	x	x	x	0	0	0	0	0
27618	5	ridge slope	unknown	x	x	x	x	1	0	0	0	0
27618	6	ridge slope	unknown	x	x	x	x	0	0	0	0	0
27618	7	ridge slope	unknown	x	x	x	x	10+	0	0	0	0
27618	8	ridge slope	unknown	x	x	x	x	0	0	0	0	0
27618	9	ridge slope	unknown	x	x	x	x	0	0	0	0	0
27618	10	ridge slope	unknown	x	x	x	x	0	0	0	0	0

APPENDIX H

List of Artifacts Collected during Inventory Survey of the Mauna Kea Science Reserve

Appendix H. List of Artifacts

Bag No.	Date	Site	Contents	Comments
	2006	Site 11079, Fe3	adze preform	Adze 1
	2006	Site 11079, Fe3	adze preform	Adze 2
	2006	Site 16204	adze preform	
	2006	Site 16204	adze preform	
	2006	Site 25767	adze preform	Adze 1
	2006	Site 25767	adze preform	Adze 2
	2006	Site 25779	adze preform	Adze 1
	2006	Site 25779	adze preform	Adze 2
	2006	Site 25779	adze preform	Adze 3
	2006	Site 25796	adze preform	Adze 1
	2006	Site 25796	adze preform	Adze 2
	2006	Site 25774	adze preform	
	2006	Site 25772	adze preform	Adze 1
	2006	Site 25772	adze preform	Adze 2
	2006	Site 25772	adze preform	Adze 3
01	08.29.08	Site 27616, Workshop 5	adze preform	Adze #12
02	08.29.08	Site 27616, Workshop 5	hammerstone	
03	09.02.08	Site 27616, Workshop 8	adze preform	
04	09.02.08	Site 27616, Workshop 8	adze preform	Adze #5
05	08.29.08	Site 27616, Workshop 4	hammerstone	
06	09.03.08	Site 27616, IO1	adze preform	
07	09.05.08	Site 27616, IO2	hammerstone	
01	09.25.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
02	09.25.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
03	09.25.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
04	09.25.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
05	09.25.08	Site 26253 Rockshelter 1	marine shell	Excavation
06	09.25.08	Site 26253 Rockshelter 1	charcoal	Excavation
07	09.25.08	Site 26253 Rockshelter 1	charcoal	Excavation
08	09.25.08	Site 26253 Rockshelter 1	charcoal	Excavation
09	09.25.08	Site 26253 Rockshelter 1	charcoal	Excavation
10	09.25.08	Site 26253 Rockshelter 1	flakes & charcoal (2 bags)	Excavation
11	09.26.08	Site 26253 Rockshelter 1	marine shell	Excavation
12	09.26.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
13	09.26.08	Site 26253 Rockshelter 1	basalt flakes	Excavation
14	09.26.08	Site 26253 Rockshelter 1	soil sample, ash	Excavation
15	09.26.08	Site 26253 Rockshelter 1	charcoal	Excavation
16	09.22.08	Site 27616, Workshop 59	adze preform	

Appendix H. List of Artifacts

Bag No.	Date	Site	Contents	Comments
17	09.24.08	Site 26253 Rockshelter 1	hammerstone	
18	09.26.08	Site 26253 Rockshelter 1	adze preform	
19	09.24.08	Site 26253 Rockshelter 1	adze preform	
20	09.26.08	Site 26253 Rockshelter 1	adze preform	
21	09.26.08	Site 26253 Rockshelter 1	adze preform	
22	09.24.08	Site 26253 Rockshelter 1	adze preform	
23	09.24.08	Site 26253 Rockshelter 1	adze preform	
24	09.24.08	Site 26253 Rockshelter 1	adze preform	
25	09.24.08	Site 26253 Rockshelter 1	adze preform	
26	09.24.08	Site 26253 Rockshelter 1	adze preform	
27	09.24.08	Site 26253 Rockshelter 1	adze preform	
28	09.26.08	Site 26253 Rockshelter 1	adze preform	
29	09.26.08	Site 26253 Rockshelter 1	adze preform	
30	09.26.08	Site 26253 Rockshelter 1	adze preform	
31	09.24.08	Site 26253 Rockshelter 1	adze preform	
32	09.24.08	Site 26253 Rockshelter 1	adze preform	
33	09.24.08	Site 26253 Rockshelter 1	adze preform	
34	09.25.08	Site 26253 Rockshelter 1	adze preform	
35	09.30.08	Site 27601, Workshop 34	adze preform	
36	09.29.08	Site 27601, Workshop 49	adze preform	
37	09.29.08	Site 27601, Workshop 43	hammerstone	
38	09.25.08	Site 27598, Workshop 2	adze preform	
39	09.25.08	Site 27598, Workshop 2	adze preform	
40	09.25.08	Site 27598, Workshop 2	adze preform	
41	09.25.08	Site 27598, Workshop 2	hammerstone	
42	09.26.08	Site 27598, Workshop 2	hammerstone	
43	09.25.08	Site 27598, Workshop 7	adze preform	
44	09.26.08	Site 27598, Workshop 23	adze preform	
45	10.01.08	Site 27606	adze preform	
46	10.01.08	Site 27606	adze preform	
47	10.01.08	Site 27606	adze preform	
48	10.01.08	Site 27606	adze preform	
49	10.01.08	Site 27606	adze preform	
50	10.01.08	Site 27596	adze preform	
51	10.02.08	Site 27596	adze preform	
52	09.24.09	Site 27586	adze preform	
53	09.24.09	Site 27588	adze preform	
54	09.24.09	Site 27588	adze preform	

APPENDIX I

Metric and Non-Metric Data Collected in the Field for Adze Preforms

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
26253	**R1**	1	27.0 x 6.2 x 5.2	Core	Square	x				5.5	x			8.5 x 6.5
		3	15.4 x 6.3 x 6.7		Square			x	x	6.3		x		
		5	19.4 x 7.8 x 6.3		Square		x	x		N/A		x		
		7	13.4 x 6.5 x 6.5		Square			x		N/A		x		
		15	15.5 x 6.7 x 3.4	Core	Rectangular	x				6.5		x		
		19	34.0 x 10.0 x 8.2		Rectangular	x				8.0	x			12.7 x 9.8
		20	10.7 x 6.5 x 6.4		Rectangular			x	x	7.0		x		
		24	17.8 x 7.4 x 6.6		Square		x	x		N/A	x			8.5 x 7.4
		26	9.4 x 4.1 x 3.6		Rectangular			x	x	4.3		x		
		28	13.0 x 5.4 x 6.0		Square		x	x		N/A	x			9.0 x 4.8
		29	19.6 x 4.5 x 2.8		Rectangular	x				4.8		x		
		31	7.9 x 5.3 x 2.5		Rectangular			x	x	6.4		x		
		33	17.5 x 8.2 x 5.0		Rectangular	x				8	x			7.0 x 7.9
		36	14.2 x 5.2 x 4.0	Core	Reverse Trapezoidal		x	x		N/A	x			8.9 x 5.0
		37	18.3 x 3.2 x 3.3	Core	Square	x				3	x			5.1 x 3.2
		40	23.0 x 6.2 x 7.6		Rectangular	x				5.6	x			8.1 x 6.0
		41	12.0 x 5.8 x 3.3		Rectangular	x				5.9		x		
		45	23.0 x 7.8 x 8.3		Square	x				6.4	x			8.0 x 7.5
		46	13.5 x 4.0 x 2.5	Core	Reverse Trapezoidal		x	x		N/A		x		
		48	12.4 x 4.6 x 3.5	Core	Rectangular	x				4.4		x		
		49	29.7 x 8.1 x 7.4	Core	Rectangular	x				7	x			8.0 x 8.1

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
26253		53	17.2 x 4.0 x 4.2		Square	x				3.1		x		
		54	28.4 x 7.5 x 5.0	Core	Rectangular	x				8	x			6.9 x 6.9
		55	27.4 x 7.6 x 6.0	Core	Rectangular	x				9	x			6.0 x 7.6
		56	23.0 x 8.5 x 7.4		Rectangular	x				9.6	x			7.0 x 8.0
		58	26.0 x 7.0 x 6.4		Rectangular	x				6.5	x			5.9 x 6.7
		59	30.9 x 12.0 x 7.5		Quadrangular	x				13.2	x			4.5 x 11.2
		61	226.0 x 6.5 x 6.0		Square	x				6.1		x		
		63	27.7 x 7.4 x 6.5		Square		x	x	x	6.5	x			6.0 x 5.7
		64	24.9 x 5.7 x 6.3	Core	Rectangular	x				7.7	x			7.2 x 5.7
		65	24.8 x 7.9 x 6.6	Core	Rectangular	x				8.9	x			11.5 x 7.7
		67	22.3 x 4.8 x 3.5	Core	Rectangular	x				5.3	x			7.5 x 4.4
		69	20.7 x 8.4 x 5.9		Rectangular	x				10		x		
		70	13.8 x 5.7 x 2.7		Plano-convex	x								
		71	13.0 x 4.7 x 4.9		Indeterminate	x								
		76	7.7 x 3.7 x 2.6	Core	Reverse Trapezoid	x				3.4	x			2.2 x 3.7
	2	1	41.2 x 16.0 x 9.5		Rectangular	x				10.2		x		
	4	1	32.1 x 13.5 x 8.0		Rectangular	x				13.2		x		
	6	1	37.1 x 14.0 x 14.0		Square	x				N/A			x	
	13	1	13.2 x 5.0 x 3.2		Rectangular	x				6.2	x			3.2 x 3.3
	15	1	31.5 x 11.0 x 11.0		Square	x				N/A			x	
	23	1	28.5 x 8.5 x 9.5		Square	x				6.0	x			10.0 x 8.0

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
26253	**24**	1	17.0 x 9.5 x 6.8		Rectangular		x	x		N/A		x		
	25	1	20.8 x 8.5 x 5.2		Rectangular	x				8.8		x		
	40	1	30.1 x 10.6 x 7.8		Rectangular	x				7.0		x		
	45	1	28.0 x 13.5 x 11.1		Indeterminate					N/A			x	
	53	1	26.2 x 7.0 x 7.0		Square	x				6.6		x		
	IO	1	20.6 x 7.1 x 6.7		Square	x				6.3	x			10.1 x 7.1
	IO	1	15.3 x 5.5 x 4.7		Reverse Triangular	x				5.4	x			4.8 x 5.6
27581	**1**	1	31.4 x 10.0 x 11.8		Rectangular	x				N/A	x			No data
		2	26.2 x 13.6 x 5.0		Rectangular			x		N/A			x	
		3	17.8 x 6.8 x 8.5		Rectangular		x	x		N/A	x			No data
27583	**3**	1	28.0 x 5.4 x 6.2	core	Rectangular	x				6.7		x		
		2	31.6 x 6.9 x 8.4	core	Rectangular	x				4	x			9.3 x 6.6
27586	**1**	1	33.0 x 10.0 x 8.5		Rectangular	X				N/A	x			N/A
		2	45.0 x 18.0 x 10.0		Rectangular	X				N/A			x	
	4	1	30.0 x 11.9 x 11.4		Reverse Triangular	x				N/A		x		
	5	1	22.0 x 7.5 x 7.5		Rectangular		x	x		N/A		x		
	6	1	37.6 x 11.2 x 9.6		Rectangular	x				N/A		x		
	8	1	23.8 x 8.5 x 8.7		Rectangular			x		N/A		x		
		2	23.9 x 10.0 x 9.0		Rectangular		x	x		N/A			x	
		3	33.5 x 11.7 x 12.2		Indeterminate					N/A			x	
	10	1	29.4 x 12.9 x 9.7		Rectangular	x				N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

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							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
		2	28.2 x 9.9 x 6.7		Indeterminate					N/A			x	
	11	11	18.0 x 11.6 x 8.8		Rectangular	x				N/A		x		
27588	**1**	1	28.2 x 14.3 x 12.9	core	Rectangular	x				10.0		x		
		2	12.9 x 7.4 x 2.5	flake	Rectangular	x				6.1		x		
		3	19.1 x 7.7 x 6.8	flake	Rectangular	x				6.5		x		
		4	34.3 x 9.8 x 7.6	core	Rectangular	x				N/A		x		
		5	8.3 x 4.6 x 3.3	flake	Reverse Trapezoid			x	x	4.3			x	
		6	29.5 x 13.0 x 11.5	core	Rectangular	x				N/A		x		
		7	33.5 x 12.0 x 9.5	core	Indeterminate	x				N/A		x		
		8	15.0 x 4.0 x 3.5	core	Rectangular	x				N/A		x		
		9	11.0 x 4.0 x 3.5	flake	Reverse Trapezoid		x	x		N/A		x		
		10	13.8 x 5.3 x 5.0	core	Rectangular		x	x		N/A		x		
27596	**1**	1	34.0 x 7.0 x 7.5	core	Square	x				7.8	x			12.2 x 7.0
27598	**1**	2	24.0 x 8.3 x 6.8		Square	x				8.2		x		
		4	18.4 x 5.3 x 5.3		Reverse Trapezoid			x		N/A			x	
		6	17.7 x 12.1 x 3.8		Reverse Trapezoid			x	x	15.0			x	
		8	27.6 x 12.5 x 7.4		Reverse Trapezoid	x				9.4		x		
		10	24.6 x 6.9 x 5.6		Rectangular	x				6.6	x			10.4 x 7.1
		12	29.9 x 8.2 x 7.3		Square	x				5.9		x		
		14	15.8 x 12.5 x 7.8		Rectangular					12.2			x	
		16	28.1 x 11.6 x 8.4		Reverse Triangular	x				7.5		x		

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State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27598		18	29.0 x 13.0 x 6.6		Rectangular	x				11.4		x		
		20	18.7 x 12.5 x 8.8		Reverse Triangular			x		N/A			x	
		22	14.8 x 6.8 x 3.3		Rectangular	x				6.0		x		
		24	16.9 x 5.5 x 3.9		Square	x				N/A			x	
		26	18.6 x 7.3 x 6.7		Square	x				9.3		x		
		28	28.4 x 13.9 x 11.7		Square	x				N/A			x	
		30	18.5 x 6.6 x 6.6		Reverse Triangular	x				4.9		x		
		32	19.6 x 7.8 x 5.7		Rectangular	x				N/A			x	
		34	9.5 x 7.5 x 4.1		Reverse Triangular			x		N/A			x	
		36	20.2 x 8.0 x 8.6		Rectangular	x				9.0		x		
		38	34.2 x 9.6 x 8.4		Reverse Triangular	x				N/A			x	
		40	20.9 x 9.6 x 7.6		Square	x				N/A			x	
	2	1	17.5 x 2.9 x 2.0		Reverse Trapezoid	x				N/A			x	
		2	20.0 x 4.3 x 5.1		Reverse Triangular			x		N/A			x	
		3	24.3 x 9.4 x 8.4		Reverse Trapezoid			x		N/A			x	
		4	16.9 x 5.0 x 5.3		Square		x	x		N/A	x			8.5 x 4.5
		5	22.1 x 6.5 x 6.0		Square			x		N/A			x	
		6	15.5 x 6.5 x 4.7		Square			x		N/A			x	
		7	25.0 x 7.5 x 7.0		Square	x				6.6	x			10.0 x 6.8
		9	12.8 x 9.7 x 5.2		Trapezoid			x		N/A			x	
		10	19.0 x 8.0 x 4.3		Rectangular	x				6.6		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Integrity: Whole	Integrity: Broken: Butt End	Integrity: Broken: Mid-section	Integrity: Broken: Bevel	Cutting edge in cm	Tang: Present	Tang: Absent	Tang: Indeterminate	Tang: Dimensions Length x Width in centimeters
27598		11	13.7 x 5.9 x 6.5		Square			x		N/A			x	
		12	10.8 x 4.6 x 4.6		Square		x	x		N/A	x			4.9 x 3.4
		13	18.8 x 7.1 x 6.2		Reverse Trapezoid	x				6.3		x		
		14	27.1 x 10.7 x 7.1		Reverse Trapezoid	x				5.1		x		
		15	25.1 x 11.2 x 6.1		Reverse Trapezoid	x				9.1		x		
	3	1	14.0 x 6.5 x 5.5		Rectangular			x		N/A			x	
		3	17.8 x 8.0 x 4.5		Trapezoid			x	x	10.0			x	
	4	1	46.1 x 19.0 x 17.0		Square	x				18.5		x		
		3	41.5 x 13.0 x 10.5		Plano-convex	x				8.2	x			12.0 x 9.0
		5	36.0 x 16.0 x 12.0		Plano-convex			x		N/A				
	6	2	46.5 x 16.0 x 13.0		Reverse Triangular				x	10.0			x	
		4	22.0 x 9.0 x 4.4		Trapezoid		x	x	x	6.3			x	
		6	39.0 x 13.0 x 7.5		Rectangular		x	x	x	12.0			x	
		8	12.7 x 4.6 x 3.5		Rectangular			x	x	4.1			x	
		10	15.0 x 5.1 x 4.7		Rectangular				x	5.2			x	
		12	17.1 x 8.0 x 7.4		Rectangular				x	7.4			x	
	7	1	13.1 x 2.6 x 2.2		Square	x				1.9	x			3.9 x 2.6
		3	14.6 x 7.0 x 6.3		Reverse Trapezoid			x	x	7.2			x	
		5	24.8 x 9.6 x 10.0		Square			x	x	7.7			x	
		7	32.5 x 13.1 x 9.4		Trapezoid	x				5.3		x		
		9	8.2 x 2.6 x 1.0		Rectangular			x	x	5.0			x	

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						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27598		11	28.4 x 10.7 x 7.8		Reverse Triangular	x				7.2		x		
		13	8.8 x 3.1 x 2.6		Reverse Triangular	x				3.9		x		
		15	17.5 x 7.8 x 6.0		Rectangular			x	x	6.7			x	
		17	29.4 x 10.3 x 7.7			x				6.9		x		
		19	13.5 x 4.4 x 3.0		Rectangular		x	x		N/A	x			7.2 x 4.3
		21	28.8 x 10.9 x 9.9		Reverse Trapezoid	x				9.2		x		
		23	16.2 x 5.8 x 5.2		Square	x				7.3		x		
		25	30.3 x 10.2 x 7.8		Reverse Trapezoid	x				6.7		x		
		27	10.8 x 5.6 x 3.1		Square	x				2.2		x		
		29	16.0 x 6.1 x 6.0		Square			x	x	6.0			x	
	9	1	23.0 x 10.0 x 8.6		Rectangular	x				10.4			x	
	18	1	8.5 x 5.9 x 5.0		Square	x				N/A		x		
	21	1	20.8 x 8.5 x 5.2		Rectangular	x				8.8		x		
	22	1	20.0 x 9.4 x 5.1		Trapezoid			x		N/A			x	
		3	27.8 x 6.8 x 7.5		Trapezoid	x				7.8	x			9.4 x 5.8
		5	23.5 x 9.5 x 10.5		Trapezoid			x	x	11.2			x	
	23	2	14.8 x 6.2 x 4.8		Square			x					x	
		4	15.2 x 5.4 x 3.5		Rectangular	x				4.7	x			6.1 x 5.1
		6	15.6 x 10.8 x 6.9		Reverse Trapezoid		x	x				x		
		8	27.8 x 12.8 x 11.0		Reverse Trapezoid	x				5.8		x		
		10	18.4 x 7.5 x 4.6		Rectangular	x				6.4		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

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State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27598		12	17.2 x 6.1 x 6.2		Reverse Trapezoid	x				4.9		x		
		14	21.5 x 6.5 x 5.8		Unknown	x				5.0		x		
		16	17.7 x 6.9 x 7.3		Rectangular	x				8.2	x			5.2 x 5.5
		18	11.2 x 7.2 x 2.9		Rectangular			x	x	8.0			x	
		20	25.5 x 7.0 x 6.5		Reverse Trapezoid		x	x	x	5.8		x		
		22	9.0 x 4.1 x 3.3		Reverse Trapezoid	x				4.2		x		
		24	17.4 x 7.9 x 6.6		Square		x	x				x		
		26	9.4 x 4.2 x 2.6		Indeterminate	x				3.9	x			3.9 x 4.3
		28	26.5 x 12.3 x 8.7		Reverse Trapezoid	x				7.9		x		
	24	4	23.8 x 10.1 x 10.2		Reverse Trapezoid	x				6.8		x		
		8	24.6 x 6.5 x 6.2		Rectangular	x							x	
		12	18.1 x 6.2 x 6.7		Reverse Trapezoid	x				6.1	x			8.1 x 6.1
		16	9.4 x 5.0 x 3.2		Reverse Triangular		x	x				x		
		20	17.8 x 6.9 x 5.4		Rectangular	x				6.1		x		
		24	13.4 x 5.5 x 5.0		Reverse Trapezoid	x				4.2	x			6.5 x 4.8
		28	20.9 x 8.3 x 5.5		Rectangular	x				6.7		x		
		32	13.7 x 5.8 x 3.2		Rectangular	x							x	
		36	18.2 x 9.0 x 7.9		Trapezoid			x	x	6.1			x	
		40	16.0 x 8.0 x 6.1		Rectangular			x					x	
		44	23.9 x 8.0 x 7.1		Square	x				4.9		x		
		48	38.8 x 14.2 x 15.1		Rectangular	x				7.7	x			11.2 x 5.9

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State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Integrity: Whole	Integrity: Broken: Butt End	Integrity: Broken: Mid-section	Integrity: Broken: Bevel	Cutting edge in cm	Tang: Present	Tang: Absent	Tang: Indeterminate	Tang: Dimensions Length x Width in centimeters
27598	**41**	1	7.9 x 4.9 x 2.9		Rectangular			x	x	5.0			x	
		3	29.2 x 10.2 x 7.7		Rectangular	x				6.9		x		
		5	16.3 x 9.1 x 6.3		Rectangular			x	x	8.0			x	
		7	24.2 x 8.5 x 7.4		Rectangular	x				5.6		x		
		9	35.3 x 11.8 x 12.4		Square	x				N/A			x	
		11	10.4 x 5.3 x 4.0		Reverse Trapezoid	x				3.3		x		
		13	11.9 x 4.8 x 2.6		Reverse Trapezoid	x				5.1		x		
		15	33.4 x 9.9 x 5.0		Square	x				N/A		x		
		17	21.5 x 8.6 x 5.9		Reverse Triangular	x				N/A		x		
		19	12.2 x 4.2 x 2.8		Rectangular	x				2.5		x		
		21	10.1 x 4.2 x 2.5		Reverse Trapezoid			x	x	5.2			x	
	42	1	23.6 x 7.7 x 8.0		Square	x				N/A		x		
		3	10.2 x 6.2 x 3.4		Rectangular			x	x	6.5			x	
		5	14.8 x 5.6 x 6.1		Rectangular			x	x	8.5			x	
		7	15.8 x 6.0 x 3.5		Reverse Trapezoid	x				N/A		x		
		9	24.7 x 10.3 x 7.6		Rectangular	x				10.3		x		
	43	2	18.6 x 5.2 x 6.8		Rectangular	x				N/A		x		
		4	10.3 x 5.8 x 5.6		Square			x	x	4.9			x	
	45	2	38.5 x 12.4 x 16.3		Reverse Trapezoid	x				10.9		x		
		4	21.7 x 10.4 x 10.2		Reverse Trapezoid	x				11.3		x		
		6	14.9 x 7.2 x 5.2		Reverse Triangular			x	x	6.3			x	

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State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27598	47	1	20.3 x 5.2 x 6.1		Square	x				5.7	x			7.7 x 5.6
		3	14.5 x 9.6 x 6.3		Rectangular			x	x				x	
		5	23.3 x 7.1 x 5.4		Reverse Trapezoid		x	x			x			9.4 x 7.0
		7	19.6 x 7.3 x 4.4		Reverse Trapezoid	x				7.5	x			7.5 x 6.5
		9	11.1 x 5.7 x 4.3		Rectangular			x	x				x	
	48	1	22.1 x 7.8 x 6.9		Rectangular			x	x	7.4			x	
		3	27.5 x 7.7 x 6.5		Square	x				8.6		x		
		5	24.6 x 7.6 x 8.7		Rectangular	x				7.9	x			7.5 x 7.0
	53	2	26.9 x 12.1 x 8.4		Reverse Trapezoid	x				9.3		x		
		4	26.5 x 6.6 x 3.7		Rectangular	x				4.6	x			8.6 x 6.0
		6	24.6 x 5.6 x 6.3		Square	x				4.5	x			6.8 x 3.9
27601	**2**	1	41.2 x 16.0 x 9.5		Rectangular	x				10.2		x		
	Fe1	1	29.7 x 9.6 x 11.4		Square	x				N/A			x	
	4	3	27.7 x 7.9 x 9.4		Rectangular		x	x	x	6.7	x			4.7 x 5.6
	8	5	20.3 x 7.3 x 9.1		Rectangular	x				6.3		x		
		7	18.1 x 9.1 x 6.9		Square			x		N/A			x	
	9	9	40.3 x 14.3 x 8.6		Reverse Triangular		x	x	x	N/A		x		
		11	31.4 x 9.2 x 9.7		Square	x				8.1			x	
	12	1	33.0 x 9.0 x 10.5		Reverse Trapezoid	x						x		
		3	33.0 x 14.0 x 10.5		Indeterminate	x						x		
	19	1	22.5 x 7.4 x 7.3		Reverse Triangular	x				6.5	x			5.9 x 6.0

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							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27601	**34**	1	29.0 x 6.2 x 5.5		Quadrangular	x				8.0	x			4.0 x 7.0
		4	28.8 x 25.8 x 25.2		Rectangular	x				7.8	x			3.5 x 6.0
	35	1	23.0 x 8.8 x 6.7		Rectangular	x				8.8	x			6.0 x 7.5
		5	30.0 x 12.4 x 12.0		Square		x	x	x	N/A	x			8.0 x 11.0
	38	1	34.3 x 11.2 x 6.5		Rectangular	x				11.2		x		
	43	1	26.2 x 9.5 x 8.2		Rectangular	x				7.6	x			9.1 x 6.1
	49	1	22.5 x 7.5 x 4.3	Core	Rectangular	x				9.2	x			7.8 x 7.5
	55	1	31.0 x 16.0 x 11.0		Reverse Trapezoidal		x	x	x	N/A		x		
		3	33.0 x 12.0 x 10.0		Reverse Trapezoidal	x				N/A			x	
		5	20.0 x 9.0 x 8.0		Trapezoidal	x				N/A			x	
		7	32.5 x 11.5 x 11.0		Rectangular	x				12.0		x		
		9	26.0 x 14.5 x 11.5		Rectangular	x				N/A			x	
	54	1	25.0 x 11.5 x 8.5		Reverse Trapezoidal	x				N/A		x		
	56	1	21.0 x 13.5 x 10.5		Rectangular			x		N/A			x	
		3	41.0 x 13.5 x 13.0		Reverse Trapezoidal	x				N/A			x	
		5	22.0 x 16.0 x 11.5		Rectangular	x				N/A			x	
		7	27.0 x 11.0 x 10.0		Rectangular	x				N/A			x	
	95	1	34.0 x 10.0 x 6.5		Reverse Triangular	x				12.0			x	
		3	34.0 x 9.5 x 10.0		Rectangular	x				8.0	x			14.0 x 7.0
		5	24.0 x 12.5 x 9.0		Rectangular			x	x	N/A		x		
		7	17.5 x 8.0 x 6.5		Indeterminate			x		N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
		9	34.0 x 8.0 x 10.0		Square	x				9.5	x			11.5 x 8.0
		11	19 x 7.5 x 7.5		Square		x			N/A	x			10.5 x 6.5
		13	27.5 x 8.5 x 7.0		Rectangular		x	x	x	N/A			x	
27604	1	1	27.0 x 9.0 x 9.0		Square	x				9.0		x		
27605	**4**	1	17.5 x 2.9 x 2.0		Reverse Trapezoid	x				N/A		x		
		2	20.0 x 4.3 x 5.1		Reverse Triangular			x		N/A			x	
		3	24.3 x 9.4 x 8.4		Quadrangular			x		N/A			x	
		4	16.9 x 5.0 x 5.3		Rectangular		x	x	x	N/A	x			8.5 x 4.5
		5	22.1 x 6.5 x 6.0		Rectangular			x		N/A			x	
		6	15.5 x 6.5 x 4.7		Square			x		N/A			x	
		7	25.0 x 7.5 x 7.0		Square	x				6.6	x			10.0 x 6.8
		8	12.8 x 9.7 x 5.2		Quadrangular			x		N/A			x	
		9	19.0 x 8.0 x 4.3		Rectangular	x				6.6		x		
		10	13.7 x 5.9 x 6.5		Square			x		N/A			x	
		11	10.8 x 4.6 x 4.6		Square			x		N/A			x	
		12	18.8 x 7.1 x 6.2		Reverse Trapezoid	x				6.3		x		
		13	27.1 x 10.7 x 7.1		Reverse Trapezoid	x				5.1		x		
		14	25.1 x 11.2 x 6.1		Reverse Trapezoid	x				9.1		x		
	16	1	19.0 x 12.0 x 7.0		Rectangular			x		N/A			x	
		3	18.5 x 10.1 x 7.0		Trapezoid			x		N/A			x	
	17	1	16.3 x 7.5 x 4.6		Reverse Trapezoid		x	x		N/A			x	

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Integrity: Whole	Integrity: Broken: Butt End	Integrity: Broken: Mid-section	Integrity: Broken: Bevel	Cutting edge in cm	Tang: Present	Tang: Absent	Tang: Indeterminate	Tang: Dimensions Length x Width in centimeters
27605	**18**	2	22.8 x 7.8 x 7.5		Reverse Trapezoid	x				8.4		x		
		4	22.9 x 11.9 x 4.5		Quadrangular	x				10.7	x			7.2 x 10.2
	20	1	15.5 x 10.1 x 7.8		Rectangular			x		N/A			x	
	21	2	26.6 x 9.2 x 8.6		Rectangular	x				N/A			x	
		4	20.1 x 6.7 x 5.5		Quadrangular	x				6.2		x		
		6	25.1 x 7.8 x 6.6		Rectangular	x				6.4	x			8.2 x 7.1
		8	30.4 x 10.5 x 7.3		Quadrangular	x				8.0		x		
	22	2	25.4 x 10.2 x 5.7		Rectangular	x				4.4		x		
		4	22.9 x 11.3 x 10.0		Rectangular	x				7.9		x		
		6	28.9 x 7.8 x 11.4		Rectangular	x				9.7	x			9.4 x 7.9
	23	1	15.1 x 6.6 x 4.4		Quadrangular	x				N/A		x		
		3	25.2 x 11.4 x 6.3		Rectangular	x				11.3		x		
	57	1	22.0 x 7.0 x 6.0	core	Rectangular	x				9.3		x		
	59	1	24.4 x 8.9 x 7.7	core	Rectangular	x				7.9		x		
		2	28.1 x 11.2 x 8.5	core	Reverse triangular	x				7.8		x		
		3	25.8 x 10.9 x 8.0	core	Rectangular	x						x		
		4	20.6 x 6.8 x 5.5	core	Rectangular	x					x			8.5 x 7.0
	64	1	29.6 x 10.4 x 9.1	core	Rectangular	x				11		x		
	67	1	32.5 x 8.9 x 8.3		Reverse Triangular			x		N/A			x	
		2	30.5 x 10.3 x 13.4		Rectangular	x				9.2	x			17.9 x 9.2
	72	1	32.0 x 10.2 x 8.4		Rectangular	x				N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27605		2	25.8 x 10.1 x 8.5		Rectangular			x		N/A			x	
27606	**R1**	1	17.7 x 2.8 x 3.3	Chisel						1.9	x			3.5 x 2.6
		2	14.5 x 5.8 x 3.2		Reverse Triangular	x				6.7	x			5.5 x 5.1
		3	30.0 x 11.0 x 10.5		Indeterminate		x	x		N/A			x	
		4	21.7 x 6.6 x 5.4		Rectangular	x				6.2	x			7.0 x 6.0
		5	22.5 x 6.2 x 6.5		Rectangular	x				6.0	x			7.5 x 6.2
		6	20.2 x 6.5 x 5.3		Rectangular		x	x		N/A	x			10.0 x 5.4
		7	8.5 x 3.4 x 1.6	flake	Rectangular	x				3.7		x		
		8	17.2 x 9.8 x 4.0		Rectangular		x	x		N/A	x			6.6 x 9.2
		9	24.8 x 6.7 x 5.7		Rectangular	x				7.8	x			7.8 x 5.7
		10	24.0 x 12.0 x 3.0		Rectangular	x				11.6		x		
		11	13.5 x 7.5 x 4.2		Reverse Plano-convex	x				8.2		x		
		12	23.0 x 11.5 x 6.9		Rectangular	x				11.6	x			4.5 x 8.0
		13	26.3 x 11.2 x 5.2		Indeterminate	x				12.6		x		
		14	15.2 x 5.0 x 2.6		Rectangular		x	x		N/A		x		
		15	12.1 x 6.8 x 2.6		Rectangular	x				7.7		x		
		16	9.3 x 4.7 x 2.1		Rectangular		x	x		N/A		x		
		17	21.5 x 7.6 x 4.0		Rectangular		x	x	x	6.7	x			6.0 x 5.6
		18	19.5 x 7.6 x 4.1		Rectangular	x				8.1		x		
		19	29.0 x 13.0 x 10.2		Indeterminate					N/A			x	
		20	14.0 x 5.0 x 3.5		Reverse Triangular	x				5.2	x			4.4 x 4.2

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27606		21	15.8 x 6.8 x 7.7		Rectangular		x	x			x			10.5 x 6.2
27616	**2_4**	1	17.5 X 8.5 X 7.0		Rectangular	x				N/A			x	
		2	16.5 x 5.6 x 4.0		Rectangular	x				5.7		x		
		3	15.4 x 6.7 x 4.0		Rectangular	x				5.7		x		
		4	10.2 x 7.0 x 2.8		Rectangular			x	x	5.9		x		
		5	18.4 x 6.9 x 7.0		Rectangular			x	x	N/A		x		
		6	16.4 x 7.6 x 6.0		Reverse Triangular	x				5.5		x		
		7	19.5 x 10.3 x 4.0		Reverse Triangular	x				7.2		x		
		8	18.8 x 8.4 x 7.2		Rectangular	x				7.2		x		
		9	11.1 x 7.1 x 4.8		Rectangular			x		N/A		x		
		10	9.3 x 7.9 x 3.1		Rectangular			x		N/A		x		
		11	10.9 x 6.1 x 6.0		Reverse Trapezoidal			x	x	7.4			x	
		12	13.7 x 6.9 x 6.6		Rectangular			x	x	6.5			x	
		13	17.0 x 8.0 x 6.2		Rectangular			x	x	6.6			x	
		14	14.1 x 7.8 x 6.6		Rectangular			x		N/A		x		
		15	20.2 x 9.1 x 8.9		Rectangular		x	x		9.5		x		
		16	14.0 x 10.7 x 5.9		Rectangular			x		N/A		x		
		17	15.8 x 5.7 x 2.0		Rectangular	x				6.2		x		
		18	19.4 x 5.0 x 5.1		Unknown					N/A		x		
		19	10.9 x 5.2 x 3.7		Reverse Trapezoidal	x				5.5		x		
		20	13.9 x 8.1 x 3.8		Rectangular			x	x	7.0			x	

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		21	17.3 x 6.1 x 3.8		Quadrangular	x				3.9		x		
		22	16.9 x 8.1 x 4.1		Rectangular	x				6.3		x		
		23	10.0 x 4.4 x 3.8		Rectangular	x				3.3	x			3.7 x 4.8
		24	13.6 x 6.4 x 4.0		Rectangular	x				5.8		x		
		25	21.7 x 8.3 x 5.0		Rectangular	x				6.0	x			6.5 x 6.5
	5	1	27.5 x 10.2 x 7.0		Rectangular	x				10.3		x		
		2	15.8 x 9.5 x 6.6		Rectangular		x	x		N/A	x			3.6 x 8.9
		3	11.9 x 5.9 x 6.5		Rectangular			x		N/A			x	
		4	14.3 x 6.4 x 3.8		Rectangular	x				5.7		x		
		5	27.2 x 11.5 x 5.5		Rectangular	x				11.5		x		
		6	21.6 x 6.2 x 6.0		Rectangular	x				6.0		x		
		7	17.7 x 6.7 x 7.8		Rectangular	x				?		x		
		8	28.5 x 7.2 x 5.5		Indeterminate	x				9.0		x		
		9	28.0 x 12.4 x 10.4		Rectangular	x				10.3		x		
		10	29.8 x 8.1 x 8.6		Quadrangular	x				8.0		x		
		11	31.1 x 13.5 x 11.3		Rectangular	x				8.4		x		
		12	28.5 x 10.1 x 10.5		Quadrangular	x				8.4		x		
		13	22.5 x 10.0 x 6.9		Reverse Triangular	x				7.2		x		
		14	29.0 x 10.5 x 6.1		Reverse Triangular							x		
		15	17.5 x 7.2 x 4.5		Rectangular	x				6.6		x		
		16	14.1 x 9.1 x 4.2		Reverse Triangular	x				7.2		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		17	22.5 x 6.3 x 3.6		Rectangular	x				9.4		x		
		18	19.4 x 8.1 x 7.9		Quadrangular		x	x		N/A	x			9.0 x 7.4
		19	14.4 x 5.3 x 3.8		Reverse Trapezoidal		x	x		4.8	x			5.2 x 3.0
		20	21.1 x 9.5 x 6.9		Reverse Triangular	x				10.0		x		
		21	23.0 x 7.1 x 5.1		Rectangular		x	x	x	9.2	x			6.4 x 6.3
		22	20.0 x 6.6 x 5.3		Rectangular	x				7.0	x			7.3 x 6.0
		23	20.6 x 7.4 x 5.2		Indeterminate	x				9.3		x		
		24	20.8 x 10.1 x 9.3		Indeterminate	x				N/A		x		
		25	26.6 x 9.3 x 9.7		Indeterminate		x	x		N/A		x		
	6	1	26.0 x 11.0 x 6.5		Reverse Trapezoidal	x				N/A		x		
		2	25.0 x 8.0 x 6.0		Reverse Triangular	x				7.0		x		
		3	17.0 x 6.5 x 4.0		Reverse Trapezoidal	x				N/A		x		
		4	20.0 x 11.0 x 5.5		Reverse Triangular	x				N/A		x		
		5	24.2 x 7.0 x 7.1		Reverse Triangular	x				N/A		x		
		6	28.0 x 9.5 x 8.4		Reverse Triangular	x				N/A		x		
		7	26.7 x 8.3 x 5.0		Indeterminate	x				N/A		x		
		8	9.9 x 3.2 x 3.5		Reverse Triangular			x		N/A			x	
		9	11.5 x 4.4 x 3.0		Indeterminate		x	x		N/A		x		
		10	28.3 x 11.0 x 6.0		Lenticular	x				11.0		x		
		11	31.8 x 8.1 x 6.4		Rectangular	x				8.0		x		
		12	11.9 x 4.4 x 4.6	Core	Square		x[1]	x	x	4.9	x			4.0 x 4.0

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Integrity: Whole	Integrity: Broken – Butt End	Integrity: Broken – Mid-section	Integrity: Broken – Bevel	Cutting edge in cm	Tang: Present	Tang: Absent	Tang: Indeterminate	Tang: Dimensions Length x Width in centimeters
27616		13	23.6 x 8.6 x 6.5		Trapezoidal	x				6.5	x			8.5 x 6.0
		14	30.0 x 9.0 x 7.2		Indeterminate	x				6.4		x		
		15	18.6 x 5.2 x 5.5		Reverse Trapezoidal	x				3.6		x		
		16	18.0 x 6.4 x 5.0		Reverse Trapezoidal	x				5.1		x		
	7	2	25.2 x 7.6 x 7.7		Rectangular	x				6.7	x			6.9 x 6.1
		4	29.9 x 9.1 x 5.6		Rectangular	x				7.9		x		
		6	28.6 x 11.5 x 5.2		Reverse Triangular	x				10.6		x		
		9	23.4 x 6.6 x 5.7		Rectangular	x				5.6	x			8.1 x 6.6
		10	24.9 x 6.2 x 5.5		Indeterminate	x				4.9		x		
	8	12	39.3 x 12.8 x 3.2		Plano-Convex	x				8.7		x		
		14	27.7 x 14.0 x 8.7		Indeterminate	x				N/A		x		
	9	1	22.0 x 12.4 x 8.3		Rectangular	x				N/A		x		
		4	23.1 x 7.3 x 5.4		Rectangular	x				7.9	x			6.6 x 5.9
	10	2	17.2 x 6.1 x 7.3		Rectangular			x	x	6.9		x		
		3	18.2 x 5.3 x 4.9		Rectangular		x	x		N/A	x			7.0 x 4.2
		4	19.6 x 4.2 x 4.1	Core	Square	x				4.5	x			6.2 x 4.2
		5	18.9 x 5.1 x 4.0	Core	Rectangular	x				5.0	x			6.3 x 5.0
		6	26.1 x 5.1 x 6.2		Rectangular	x				4.6	x			8.1 x ?
		8	17.4 x 6.6 x 4.3		Indeterminate	x				N/A		x		
		10	18.4 x 9.7 x 8.4		Reverse Trapezoidal			x		N/A			x	
		12	28.1 x 9.0 x 9.0		Rectangular	x				10.5		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		14	20.5 x 7.7 x 7.6		Rectangular		x	x		N/A	x			6.9 x 7.6
		16	37.5 x 9.1 x 8.5		Reverse Trapezoidal	x				10		x		
		18	23.5 x 7.8 x 7.7		Quadrangular	x				6.1		x		
		20	27.9 x 6.6 x 7.1		Quadrangular	x				8.0		x		
		22	23.1 x 10.1 x 7.3		Rectangular	x				9.2		x		
		24	26.2 x 10.6 x 7.2		Rectangular	x				10.3		x		
		26	33.7 x 9.2 x 6.7		Quadrangular	x				9.8		x		
		29	20.0 x 6.4 x 6.1		Square	x				N/A			x	
		30	8.9 x 7.3 x 5.1		Quadrangular			x		N/A			x	
		32	12.6 x 7.1 x 7.4		Indeterminate			x		N/A			x	
		34	19.9 x 12.4 x 7.5		Reverse Trapezoidal		x	x		N/A		x		
		36	23.3 x 8.5 x 4.8		Rectangular	x				N/A		x		
		38	23.8 x 8.6 x 7.0		Rectangular	x				8.4	x			6.2 x 7.6
		40	12.3 x 7.7 x 4.8		Rectangular					N/A			x	
	11	2	20.4 x 7.3 x 6.8		Rectangular	x				6.8		x		
		4	25.0 x 10.9 x 5.9		Rectangular	x				9.1	x			10.1 x 10.4
		6	23.3 x 8.1 x 5.8		Rectangular	x				7.0		x		
		8	25.4 x 5.6 x 5.4		Quadrangular	x				5.6	x			8.4 x 4.5
	12	1	27.7 x 8.5 x 9.4		Rectangular	x				8.5		x		
	14	1	20.2 x 4.8 x 4.3		Rectangular	x				4.0	x			7.2 x 5.1
		3	37.2 x 8.5 x 8.2		Rectangular	x				8.8	x			10.2 x 8.0

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity								
							Broken				Tang			
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616	**17**	1	29.0 x 5.5 x 8.3		Quadrangular	x				8.4		x		
		3	17.6 x 6.6 x 3.8		Reverse Triangular	x				8.1		x		
		5	18.7 x 5.8 x 5.0		Rectangular	x				N/A		x		
		7	26.5 x 8.2 x 7.2		Rectangular	x				7.8		x		
	18	1	28.5 x 7.6 x 6.7		Rectangular	x				5.8	x			11.1 x 7.3
	19	1	30.2 x 9.1 x 8.4		Rectangular	x				10.3	x			9.4 x 8.0
		3	29.6 x 8.1 x 6.2		Rectangular	x				7.2	x			11.2 x 7.2
	20	2	24.9 x 7.3 x 9.6		Rectangular	x				8.6		x		
		4	26.8 x 4.9 x 5.4		Reverse Trapezoidal	x				6.9	x			9.4 x 6.2
	21	2	27.5 x 7.4 x 9.6		Rectangular	x				3.4		x		
		4	28.6 x 11.9 x 8.4		Rectangular	x				8.2		x		
	25	1	22.9 x 11.4 x 7.7		Rectangular	x				11.9		x		
	26	1	28.9 x 9.8 x 10.1		Quadrangular	x				6.0	x			9.9 x 8.8
		3	18.4 x 9.9 x 5.9		Rectangular			x	x	14.1		x		
		5	28.9 x 9.0 x 8.0		Rectangular	x				8.1	x			11.3 x 9.2
	27	1	21.5 x 10.7 x 8.4		Reverse Triangular	x				13.0		x		
	28	2	29.8 x 9.9 x 6.2		Rectangular	x				7.3		x		
	29	1	19.3 x 7.1 x 6.4		Rectangular		x	x		N/A	x			9.7 x 7.3
	30	1	14.4 x 6.0 x 4.3		Rectangular	x				5.1		x		
	31	1	26.9 x 8.7 x 7.9		Reverse Trapezoidal	x				5.2		x		
		3	24.2 x 14.1 x 9.7		Rectangular	x				N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		6	30.5 x 8.0 x 10.1		Indeterminate	x				N/A		x		
	32	1	27.2 x 14.1 x 7.2		Reverse Triangular	x				7.4		x		
	34	1	28.3 x 10.9 x 7.7		Rectangular		x			N/A	x			7.2 x 11.0
		3	14.3 x 5.8 x 4.6		Rectangular	x				3.5	x			4.1 x 5.0
	35	1	19.0 x 6.3 x 6.3		Reverse Triangular	x				N/A		x		
		3	30.8 x 7.3 x 7.3		Rectangular	x				6.1	x			7.6 x 6.1
		5	12.0 x 7.8 x 6.1		Rectangular			x	x	6.3			x	
		7	12.2 x 8.6 x 6.7		Rectangular			x		N/A			x	
		10	25.8 x 7.7 x 6.7		Rectangular	x				5.9		x		
		11	26.0 x 6.1 x 6.6		Rectangular	x				4.1	x			8.7 x 6.1
	36	1	29.2 x 9.9 x 6.2		Rectangular	x				10.4		x		
	37	1	26.4 x 6.6 x 8.0		Quadrangular	x				6.9		x		
	38	2	17.2 x 6.8 x 6.2		Quadrangular		x	x		N/A	x			11.5 x 6.3
		4	20.1 x 8.1 x 7.2		Rectangular		x	x		N/A		x		
		6	28.8 x 5.7 x 6.5		Reverse Trapezoidal	x				5.9	x			12.1 x 5.2
	39	1	27.1 x 7.8 x 5.4		Rectangular	x				3.9	x			10.2 x 7.1
	41	1	25.5 x 7.5 x 8.3		Rectangular	x				9.1		x		
	42	1	24.6 x 7.6 x 7.3		Reverse Trapezoidal	x				11.0	x			
		3	26.3 x 7.2 x 6.4		Rectangular	x				6.5		x		
		5	27.9 x 9.0 x 10.2		Reverse Triangular	x				6.1		x		
		7	42.3 x 11.9 x 6.9		Lenticular	x				4.9		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		9	15.9 x 6.0 x 5.5		Quadrangular		x	x		N/A		x		
		11	23.1 x 8.7 x 4.5		Indeterminate	x				8.4	x			
		13	22.4 x 7.4 x 6.6		Rectangular	x				5.5		x		
		15	22.2 x 7.9 x 4.2		Rectangular	x				8.5		x		
	44	2	24.3 x 10.1 x 10.2		Rectangular	x				8.1		x		
		4	22.7 x 8.8 x 6.8		Quadrangular	x				8.3		x		
		6	26.1 x 8.0 x 5.9		Reverse Triangular	x				5.2	x			9.1 x 7.8
	45	1	28.7 x 9.4 x 7.3		Rectangular	x				7.1		x		
	46	1	21.3 x 7.9 x 6.6		Rectangular	x				7.5	x			8.3 x 7.4
	47	1	27.8 x 8.2 x 7.9		Rectangular	x				8.2		x		
		2	19.0 x 8.4 x 7.6		Rectangular			x		N/A			x	
	48	2	30.6 x 11.9 x 7.6		Rectangular	x				13.1		x		
		4	26.0 x 8.8 x 5.0		Rectangular	x				6.4	x			7.5 x 8.6
		6	14.2 x 10.9 x 11.8		Quadrangular			x		N/A			x	
	49	1	19.5 x 8.0 x 6.9		Quadrangular	x				6.6		x		
		3	23.1 x 6.5 x 5.3		Rectangular	x				5.9	x			8.2 x 6.3
	50	1	29.3 x 6.5 x 7.6		Quadrangular	x				5.3	x			10.0 x 7.9
	51	1	25.1 x 7.3 x 6.1		Rectangular	x				7.5		x		
	52	2	26.5 x 9.0 x 8.8		Quadrangular	x				11.7		x		
		4	26.3 x 8.8 x 5.7		Rectangular	x				7.2		x		
		6	30.7 x 8.7 x 9.2		Rectangular	x				9.3		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616	**53**	3	29.1 x 7.6 x 7.8		Rectangular	x				8.0		x		
		7	27.3 x 6.9 x 4.4		Reverse Trapezoidal	x				7.6		x		
		10	20.2 x 4.6 x 4.5		Rectangular	x				4.7		x		
	54	1	29.2 x 10.0 x 7.8		Rectangular			x	x	9.0	x			7.2 x 10.0
		3	20.6 x 10.2 x 8.2		Rectangular		x	x		N/A		x		
		5	17.5 x 9.4 x 7.3		Rectangular			x		N/A		x		
	56	1	24.2 x 9.4 x 6.8		Rectangular	x				6.8	x			7.4 x 8.0
		3	25.5 x 9.8 x 9.0		Quadrangular	x				8.4	x			10.0 x 9.0
		5	26.4 x 6.5 x 6.0		Rectangular	x				7.0	x			6.1 x 6.5
		7	20.5 x 7.3 x 4.2		Rectangular	x				9.6	x			6.6 x 6.8
		9	20.5 x 10.2 x 7.5		Reverse Triangular			x	x	6.0		x		
	57	2	25.0 x 7.0 x 6.6		Rectangular	x				7.5	x			8.0 x 7.4
		4	16.8 x 7.8 x 4.1		Indeterminate	x				N/A		x		
		6	21.1 x 7.1 x 6.1		Reverse Triangular	x				8.0		x		
		8	28.0 x 7.4 x 7.0		Rectangular		x	x		8.4	x			7.0 x 7.0
	58	1	24.7 x 15.5 x 8.0		Reverse Trapezoidal	x				N/A		x		
		3	23.5 x 7.6 x 7.5		Quadrangular	x				6.5	x			6.0 x 6.1
	59	1	20.2 x 4.2 x 6.2	Core	Quadrangular	x				5.3	x			10.8 x 4.2
		3	16.5 x 8.0 x 4.6		Rectangular	x				9.1		x		
	62	1	20.5 x 12.6 x 9.2		Rectangular	x				8.0		x		
		2	28.0 x 8.5 x 7.5		Rectangular	x				9.2	x			12.2 x 7.3

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		3	20.6 x 7.1 x 7.3		Quadrangular	x				N/A		x		
	63	1	24.0 x 9.6 x 8.0		Quadrangular	x				8.5	x			11.2 x 7.7
		3	18.1 x 10.1 x 7.0		Rectangular	x				8.2		x		
		5	18.0 x 6.7 x 3.5		Lenticular	x				7.1		x		
		8	29.0 x 9.6 x 8.5		Rectangular	x				9.8	x			7.2 x 9.0
		10	23.3 x 7.5 x 6.5		Reverse Trapezoidal		x	x		N/A	x			6.0 x 7.5
		12	16.5 x 6.3 x 5.7		Reverse Trapezoidal			x	x	8.1		x		
		14	26.2 x 9.8 x 11.0		Quadrangular	x				8.4	x			8.1 x 8.8
		16	17.2 x 7.0 x 4.5		Rectangular			x	x	7.2	x			4.0 x 6.0
		18	26.0 x 8.8 x 8.0		Indeterminate	x				N/A		x		
	65	1	15.4 x 5.5 x 2.8		Quadrangular			x	x	5.5		x		
	66	1	30.0 x 11.0 x 8.5		Rectangular	x				13.0		x		
		3	18.5 x 6.9 x 6.0		Rectangular	x				6.8		x		
	67	2	27.4 x 8.9 x 4.5		Reverse Trapezoidal	x				8.0		x		
		3	31.5 x 9.2 x 8.0		Indeterminate	x				N/A		x		
		5	23.4 x 9.0 x 9.5		Reverse Trapezoidal	x				9.3	x			9.0 x 7.2
	68	1	17.2 x 7.5 x 5.9		Reverse Trapezoidal	x				5.2	x			4.0 x 6.0
		3	30.0 x 8.1 x 9.4		Quadrangular		x	x		9.0	x			13.0 x 8.7
	69	2	15.2 x 5.2 x 3.7		Rectangular	x				6.6		x		
		4	47.5 x 18.0 x 13.0		Indeterminate	x				20.0		x		
		6	25.0 x 8.5 x 6.9		Quadrangular		x	x		N/A	x			10.0 x 8.4

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		8	22.5 x 7.9 x 7.4		Rectangular	x				5.9	x			8.8 x 6.0
		10	32.1 x 10.6 x 10.8		Rectangular	x				N/A		x		
	70	1	16.6 x 5.5 x 4.0		Reverse Trapezoidal	x				5.5		x		
		3	19.5 x 10.6 x 7.0		Quadrangular		x	x		N/A		x		
	72	2	20.5 x 8.3 x 6.8		Rectangular			x	x	N/A		x		
		4	24.5 x 9.1 x 6.2		Rectangular	x				7.0		x		
		6	29.5 x 9.3 x 8.8		Rectangular	x				7.0	x			11.0 x 9.9
		8	34.0 x 10.5 x 11.4		Reverse Trapezoidal	x				10.0	x			18.5 x 9.2
		10	25.0 x 11.0 x 12.0		Rectangular	x				11.6		x		
	73	1	34.4 x 10.5 x 9.2		Reverse Trapezoidal	x				10.0		x		
		2	21.2 x 6.1 x 3.7		Rectangular	x				6.7	x			10.0 x 5.2
		3	15.4 x 9.5 x 8.6		Rectangular	x				N/A		x		
	74	1	27.0 x 7.3 x 8.2		Rectangular		x	x		N/A	x			10.0 x 7.3
		3	17.5 x 8.1 x 4.0		Reverse Trapezoidal	x				9.6		x		
		4	16.1 x 5.4 x 5.0		Indeterminate			x	x	N/A		x		
		5	23.5 x 9.2 x 8.0		Indeterminate	x				5.2		x		
		9	28.7 x 10.1 x 5.4		Reverse Trapezoidal	x				5.7		x		
		12	19.7 x 9.9 x 8.2		Indeterminate		x	x		N/A		x		
		14	25.4 x 9.3 x 6.3		Indeterminate	x				11.2		x		
	75	3	13.4 x 8.8 x 9.1		Reverse Triangular		x	x		N/A		x		
		4	21.0 x 9.5 x 8.4		Reverse Triangular		x	x		N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		11	14.5 x 5.7 x 4.2		Rectangular	x				5.3		x		
		13	22.0 x 7.9 x 7.5		Rectangular	x				7.9		x		
		15	25.1 x 13.0 x 8.3		Rectangular	x				10.0		x		
		17	44.1 x 15.8 x 17.1		Reverse Triangular	x				11.2		x		
		18	30.9 x 11.0 x 12.0		Rectangular	x				10.3		x		
		22	31.2 x 10.0 x 6.2		Rectangular	x				9.2	x			10.0 x 10.0
		23	18.7 x 9.0 x 4.5		Rectangular		x	x		N/A		x		
		31	17.7 x 6.5 x 4.9		Rectangular		x	x		4.2		x		
		33	15.8 x 7.1 x 3.4		Reverse Triangular	x				5.6		x		
		36	19.9 x 8.5 x 7.9		Rectangular		x	x		N/A		x		
	76	2	19.1 x 4.9 x 4.3		Reverse Trapezoidal	x				4.8	x			6.5 x 4.5
		3	16.5 x 4.7 x 2.7		Reverse Trapezoidal	x				4.4	x			5.7 x 4.7
	78	1	18.7 x 7.5 x 8.0		Quadrangular			x		N/A		x		
		2	28.7 x 14.2 x 9.2		Reverse Trapezoidal	x				13.8		x		
		3	32.0 x 12.0 x 10.3		Quadrangular	x				N/A		x		
		4	29.3 x 15.1 x 11.7		Indeterminate	x				N/A		x		
		5	31.0 x 17.4 x 13.0		Indeterminate	x				N/A		x		
	79	1	21.2 x 8.4 x 7.7		Indeterminate			x		N/A		x		
		2	30.4 x 6.5 x 7.9		Quadrangular	x				8.1	x			5.9 x 7.0
		3	24.9 x 8.9 x 7.0		Square	x				N/A		x		
	80	1	19.0 x 6.5 x 3.1		Reverse Triangular		x	x		5.5		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27616		2	19.5 x 6.9 x 4.3		Rectangular		x	x		N/A		x		
		3	25.4 x 6.5 x 5.2		Quadrangular		x	x		N/A	x			7.3 x 7.3
	81	1	30.5 x 9.5 x 10.6		Reverse Triangular		x	x		N/A	x			
		2	20.7 x 11.8 x 10.5		Reverse Triangular		x	x		N/A		x		
		3	30.1 x 8.9 x 7.2		Reverse Triangular		x	x		9.2	x			
	90	1	35.0 x 13.0 x 9.0		Rectangular	x				N/A			x	
	Shrine 3	1	14.0 x 4.9 x 3.5		Rectangular	x				N/A			x	
	Shrine 4	1	25.8 x 78.1 x 6.4		Rectangular	x				8.9	x			8.5 x 6.2
		2	30.0 x 8.0 x 6.5		Rectangular	x				8.0	x			10.5 x 8.3
	Shrine 5	1	16.0 x 6.8 x 5.75		Square			x	x	6.0			x	
		2	18.5 x 3.0 x 3.5		Square			x	x	5.5			x	
27618	**1**	2	23.0 x 6.0 x 6.8		Rectangular	x				5.9	x			6.7 x 6.9
		4	22.5 x 7.2 x 5.0		Rectangular	x				8.8	x			8.8 x 6.0
		6	25.5 x 6.5 x 6.1		Rectangular	x				7.3	x			8.0 x 6.9
		8	36.0 x 12.5 x 16.0		Rectangular	x				13.2		x		
	2	1	31.3 x 11.2 x 11.5		Rectangular	x				N/A		x		
		3	21.0 x 7.5 x 8.6		Quadrangular		x	x		N/A		x		
		5	41.0 x 15.0 x 18.0		Rectangular	x				12.5		x		
	3	1	26.8 x 7.0 x 5.2		Rectangular		x	x		N/A	x			6.2 x 6.8
		3	23.4 x 10.2 x 9.4		Quadrangular		x	x		N/A		x		
		5	25.5 x 11.0 x 9.4		Quadrangular					N/A		x		

APPENDIX I. SUMMARY OF METRIC AND NON-METRIC DATA FOR FIELD SAMPLED ADZE PREFORMS

						Integrity					Tang			
							Broken							
State Site Number	Workshop Number	Adze Sample Number	Dimensions Length x Width x Thickness in centimeters (cm)	Blank Type	Cross-section	Whole	Butt End	Mid-section	Bevel	Cutting edge in cm	Present	Absent	Indeterminate	Dimensions Length x Width in centimeters
27618		7	25.0 x 6.2 x 5.5		Rev. Plano-Convex	x				7.5	x			7.1 x 6.0
		9	31.5 x 11.0 x 9.0		Rectangular	x				8.8	x			10.0 x 10.7
		11	18.5 x 6.8 x 4.4		Reverse Trapezoidal	x				6.8		x		
	I.O.slope	1	15.9 x 5.5 x 4.9		Indeterminite	x				5.5	x			6.7 x 5.5

APPENDIX J

Metric and Non-Metric Data for Collected Adze Preforms

APPENDIX J. SUMMARY OF METRIC AND NON-METRIC DATA OF COLLECTED ADZE PREFORMS

								If cortex is present							
Site Number	Workshop Number	Adze Sample Number	Blank Type	Cross-section	Integrity Whole	Broken	Cortex Present Yes No	Front	Back	1 side	2 sides	Longitudinal Profile	Thickness (cm)	Weight in grams	Selected for XRF Testing
26253	R1	1	Core	Square	x		N					Parallel	5.9	1,635.8	
26253	R1	15	Core	Rectangular	x		Y	x				Parallel	3.6	638.8	
26253	R1	36	Core	Reverse Trapezoidal		x	Y	x				Divergent	4.4	524.9	
26253	R1	37	Core	Square	x		Y	x				Parallel	3.3	299.2	x
26253	R1	46	Core	Reverse Trapezoidal		x	Y	x	x	x		Parallel	2.8	236.2	x
26253	R1	48	Core	Rectangular	x		Y	x				Parallel	3.5	336.2	x
26253	R1	49	Core	Rectangular	x		Y	x	x	x		Parallel	7.6	3,026.1	
26253	R1	53	Core	Square	x		Y				x	Parallel	4.9	572.5	
26253	R1	54	Core	Rectangular	x		Y	x	x			Parallel	5.0	2,150.4	
26253	R1	55	Core	Rectangular	x		N					Divergent	6.3	2,468.0	
26253	R1	58	Core	Rectangular	x		N					Parallel	7.4	2,766.1	
26253	R1	61	Core	Square	x		Y				x	Parallel	6.3	1,671.1	
26253	R1	64	Core	Rectangular	x		Y	x	x			Divergent	6.5	2,097.2	
26253	R1	65	Core	Rectangular	x		N					Divergent	6.4	1,980.6	
26253	R1	67	Core	Rectangular	x		N					Parallel	4.9	961.2	
26253	R1	69	Core	Rectangular	x		Y		x			Divergent	6.0	1,800.5	x
26253	R1	76	Core	Reverse Trapezoid	x		N					Parallel	2.8	1,805.0	
27598	2	1	Core	Reverse Trapezoid	x		Y		x			Parallel	6.6	1,123.7	
27598	2	2	Core	Reverse Triangular	x		Y	x				Parallel	5.3	694.7	x
27598	2	10	Core	Indeterminate	x		Y	x	x			Parallel	4.6	931.8	x
27601	74	1	Core	Square	x		Y	x				Divergent	5.9	2,190.0	x
27601	86	1	Core	Rectangular	x		Y	x	x		x	Divergent	4.6	1,670.0	
27606	R1	1	Core	Square	x		Y		x			Parallel	3.6	303.8	
27606	R1	2	Flake	Indeterminate	x		Y		x			Divergent	3.5	361.3	
27606	R1	5	Core	Square	x		Y	x				Parallel	6.7	1,560.0	
27606	R1	20	Core	Reverse Trapezoid	x		Y	x	x			Divergent	3.9	433.0	x
27606	R1	21	Core	Square	x		Y	x	x		x	Divergent	7.6	1,241.4	x
27616	5	12	Core	Square		x	Y	x			x	Parallel	4.5	416.9	x
27616	8	4	Core	Square	x		Y	x	x		x	Parallel	4.3	707.0	
27616	8	5	Core	Rectangular	x		Y	x		x		Parallel	4.2	671.9	x
27616	27	20	Core	Square	x		Y	x	x		x	Parallel	7.5	2,022.2	
27616	58	1	Core	Square	x		N					Parallel	6.0	1,133.9	x
27616	I.O.slope	1	Indeterminate	Indeterminate	x		N					Parallel	4.9	633.0	
	1	1	Core	Square	x		N					Divergent	7.5	2,754.1	x

APPENDIX K

Metric and Non-Metric Data Collected in the Field for Hammerstones

APPENDIX K. HAMMERSTONE METRIC AND NON-METRIC ATTRIBUTES

Site Number	Workshop No.	Hammerstone Sample Number	Dimensions Length cm	Width / Diameter cm	Thickness cm	Condition	Shape
26253	R1	1	16.0	13.5	4.5	Whole	Discoidal
26253	R1	2		7.9		Whole	Spherical
26253	R1	3	11.5	8.0	4.5	Whole	Discoidal
26253	14	1	7.5	7.5	6.1	Whole	Discoidal
26253	19	1	10.5	9.0	4.5	Broken	Discoidal
26253	34	1		9.0		Whole	Spherical
26253	49	1	12.0	8.0	7.5	Whole	Irregular
26263	65	1	9.5	8.5	9.0	Whole	Spherical
27581	1	1	12.5	8.8	5.7	Whole	Discoidal
27581	2	1	13.4	8.0	7.3	Whole	Discoidal
27581	2	2	14.1	8.8	3.5	Whole	Discoidal
27581	2	3	11.4	9.1	9.6	Whole	Spherical
27588	1	1	11.4	9.3	9.9	Broken	Irregular
27588	2	2	10.9	6.6	5.1	Broken	Discoidal
27598	1	2	16.5	15.8	10.4	Whole	Discoidal
27598	1	4	18.1	16.8	8.1	Broken	Discoidal
27598	1	6	10.1	8.5	5.4	Broken	Discoidal
27598	1	8	10.6	10.8	4.3	Whole	Discoidal
27598	1	10	16.2	11.7	8.3	Broken	Discoidal
27598	3	1	10.0	7.2	7.0	Broken	Spherical
27598	4	1	20.0	15.0	7.5	Broken	Irregular
27598	5	1	12.7	11.0	8.0	Whole	Irregular
27598	7	1	15.3	9.9	10.3	Broken	Discoidal
27598	7	3	13.0	13.2	5.4	Broken	Discoidal
27598	18	1	8.5	5.9	5.0	Whole	Discoidal
27598	22	1	8.0	6.5	4.2	Whole	Discoidal
27598	23	1	13.2	10.4	4.7	Broken	Discoidal
27598	24	1	9.9	6.1	3.0	Broken	Discoidal
27598	41	1	9.3	7.8	7.2	Whole	Spherical
27598	42	1	11.7	9.9	4.9	Broken	Discoidal
27598	43	1	11.1	10.8	5.3	Whole	Discoidal
27598	47	1	17.1	11.3	6.2	Broken	Discoidal
27601	1	1	10.2	12.5	9.5	Whole	Spherical
27601	1	3	9.2	8.7	5.7	Whole	Discoidal
27601	1	5	9.3	9.0	8.7	Whole	Spherical
27601	14	1	7.5	7.0	5.5	Whole	Discoidal
27601	14	2	8.0	7.5	7.0	Sheared	Discoidal
27601	25	1		10.5		Whole	Spherical
27601	45	1		11.8	4.2	Whole	Discoidal
27601	51	1	14.5	12.0	4.5	Broken	Discoidal

APPENDIX K. HAMMERSTONE METRIC AND NON-METRIC ATTRIBUTES

Site Number	Workshop No.	Hammerstone Sample Number	Dimensions Length cm	Width / Diameter cm	Thickness cm	Condition	Shape
27601	54	1	9.0	8.5	8.0	Whole	Spherical
27601	61	2		9.0		Whole	Spherical
27601	61	4	17.0	12.0	2.0	Broken	Discoidal
27601	61	6	11.0	10.0	4.0	Broken	Discoidal
27604	5	1		10.0		Whole	Spherical
27605	4	1	13.0	7.6	6.6	Broken	Discoidal
27605	4	2	8.3	7.3	6.5	Whole	Spherical
27605	4	3	8.0	7.5	5.8	Whole	Discoidal
27605	4	4	10.8	8.5	5.8	Broken	Discoidal
27605	4	5	9.6	8.7	6.3	Broken	Spherical
27605	4	6	8.2	7.5	7.5	Whole	Spherical
27605	4	7	13.9	12.7	6.0	Whole	Discoidal
27605	4	8	14.9	11.2	3.1	Whole	Discoidal
27605	4	9	11.1	7.2	6.5	Broken	Discoidal
27605	16	1	13.0	9.5	4.2	Sheared	Discoidal
27605	20	2	7.0	6.5	4.7	Whole	Discoidal
27605	22	1	13.3	10.9	2.8	Broken	Discoidal
27605	23	1	12.4	9.5	7.3	Broken	Discoidal
27605	65	1	14.2	11.5	6.5	Whole	Discoidal
27605	65	2	15.6	11.7	8.5	Whole	Discoidal
27616	1	1	8.4	8.3	8.0	Whole	Spherical
27616	2_4	1	8.6	9.2	5.8	Broken	Discoidal
27616	2_4	2	6.9	6.3	4.4	Whole	Discoidal
27616	2_4	3	8.4	8.0	4.7	Whole	Discoidal
27616	5	1		8.0		Whole	Spherical
27616	5	2	14.6	13.2	6.2	Whole	Discoidal
27616	5	3	8.4	9.5	7.5	Whole	Spherical
27616	5	4	10.1	9.0	6.5	Whole	Discoidal
27616	5	5	8.8	9.3	8.4	Whole	Spherical
27616	5	6	8.6	7.5	5.5	Whole	Discoidal
27616	5	7	12.8	11.4	6.6	Whole	Irregular
27616	6	1	9.0	9.0	8.0	Whole	Discoidal
27616	6	2	12.0	9.0	3.0	Whole	Irregular
27616	6	3	15.0	12.0	6.5	Whole	Irregular
27616	6	4	19.0	14.0	8.0	Whole	Irregular
27616	6	5	14.0	10.0	9.0	Whole	Irregular
27616	6	6	12.0	9.0	8.5	Whole	Discoidal
27616	6	7	9.0	6.0	2.0	Whole	Irregular
27616	6	8	12.0	11.0	11.0	Whole	Irregular
27616	6	9	17.0	14.0	13.0	Whole	Discoidal
27616	6	10		7.8	6.7	Whole	Discoidal
27616	6	11	20.0	17.0	11.0	Whole	Discoidal
27616	6	12	9.0	8.0	8.0	Whole	Discoidal

APPENDIX K. HAMMERSTONE METRIC AND NON-METRIC ATTRIBUTES

Site Number	Workshop No.	Hammerstone Sample Number	Dimensions Length cm	 Width / Diameter cm	 Thickness cm	Condition	Shape
27616	6	13	20.0	18.0	10.0	Broken	Discoidal
27616	6	14	14.0	9.0	8.0	Whole	Irregular
27616	7	1	10.2	10.7	5.1	Broken	Discoidal
27616	7	2	10.0	7.2	5.2	Whole	Discoidal
27616	9	1	8.2	7.0	5.0	Whole	Discoidal
27616	10	1	10.0	12.0	10.7	Whole	Irregular
27616	10	2	22.2	19.9	12.8	Whole	Discoidal
27616	10	3	8.2	8.1	5.1	Whole	Discoidal
27616	10	7	15.9	12.1	5.2	Whole	Discoidal
27616	12	1	11.5	13.8	9.9	Whole	Discoidal
27616	13	1	15.0	15.0	4.0	Whole	Irregular
27616	14	1	13.9	12.2	10.5	Whole	Discoidal
27616	14	2	21.6	20.2	14.6	Whole	Discoidal
27616	16	1	19.2	12.7	11.8	Whole	Irregular
27616	17	1	8.7	8.4	5.2	Whole	Discoidal
27616	17	3	10.2	7.8	6.3	Whole	Discoidal
27616	18	1	19.2	14.5	8.5	Whole	Irregular
27616	19	1	18.8	15.4	7.1	Broken	Discoidal
27616	20	1	11.2	8.2	8.4	Whole	Irregular
27616	20	3	18.2	12.7	15.3	Whole	Irregular
27616	25	1	9.9	10.6	5.6	Whole	Discoidal
27616	27	1	16.2	11.6	6.8	Whole	Irregular
27616	31	1	18.2	13.3	13.1	Whole	Irregular
27616	31	2	7.3	6.7	3.9	Broken	Discoidal
27616	32	1	10.1	7.9	2.3	Broken	Discoidal
27616	34	1	10.2	9.0	8.4	Whole	Spherical
27616	35	1	11.6	7.6	6.4	Whole	Irregular
27616	35	2	24.6	20.2	15.3	Whole	Irregular
27616	35	3	7.9	5.9	5.5	Broken	Irregular
27616	35	7	12.0	11.6	3.7	Broken	Discoidal
27616	35	9	14.9	14.6	9.1	Broken	Discoidal
27616	36	1	11.0	9.3	3.3	Whole	Discoidal
27616	37	1	13.2	11.8	6.5	Whole	Discoidal
27616	38	1	8.7	8.1	5.6	Whole	Discoidal
27616	44	1	9.7	8.7	4.9	Broken	Discoidal
27616	46	1	9.9	9.7	5.9	Whole	Discoidal
27616	46	2	12.1	11.8	9.1	Whole	Irregular
27616	46	5	13.7	13.0	6.3	Whole	Discoidal
27616	48	1	13.7	9.5	5.7	Whole	Discoidal
27616	50	1	13.0	12.2	6.1	Whole	Discoidal
27616	53	1	10.9	10.6	7.7	Whole	Discoidal
27616	53	3	10.3	8.6	7.3	Whole	Discoidal
27616	53	5	8.6	8.4	7.2	Whole	Spherical

APPENDIX K. HAMMERSTONE METRIC AND NON-METRIC ATTRIBUTES

Site Number	Workshop No.	Hammerstone Sample Number	Dimensions Length cm	 Width / Diameter cm	 Thickness cm	Condition	Shape
27616	53	7	11.9	9.4	7.5	Whole	Irregular
27616	54	1	15.8	9.7	3.1	Broken	Discoidal
27616	56	1	10.0	8.5	6.6	Whole	Discoidal
27616	56	3	14.0	10.6	10.0	Whole	Discoidal
27616	57	1	10.7	8.2	7.2	Whole	Discoidal
27616	59	1	9.5	7.5	5.0	Whole	Discoidal
27616	62	1	8.1	8.0	5.4	Whole	Discoidal
27616	62	2	13.0	9.7	4.1	Whole	Discoidal
27616	62	3	13.0	9.4	6.5	Whole	Irregular
27616	63	1	15.5	12.5	11.0	Whole	Irregular
27616	65	1		7.8		Whole	Spherical
27616	67	1	13.6	8.2	3.1	Whole	Irregular
27616	69	2	25.0	21.0	8.5	Whole	Irregular
27616	72	1	13.1	10.0	9.0	Whole	Irregular
27616	73	1	14.0	13.0	10.0	Whole	Irregular

APPENDIX L

Radiocarbon Data from Beta Analytic, Inc.

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4985 SW 74 Court
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Fax: 305 663 0964
beta@radiocarbon.com
www.radiocarbon.com

MR. DARDEN HOOD
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

March 30, 2009

Mr. Stephan D. Clark
Pacific Consulting Services
720 Iwilei Road
Suite 424
Honolulu, HI 96817
USA

RE: Radiocarbon Dating Result For Sample OMKM-1

Dear Steve:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. As usual, the method of analysis is listed on the report sheet and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. It was analyzed with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Thank you for prepaying the analysis. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood

BETA

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Stephan D. Clark

Report Date: 3/30/2009

Pacific Consulting Services

Material Received: 3/9/2009

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 256935	420 +/- 40 BP	-22.9 o/oo	450 +/- 40 BP

SAMPLE : OMKM-1
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1420 to 1480 (Cal BP 540 to 470)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.9:lab. mult=1)

Laboratory number: **Beta-256935**

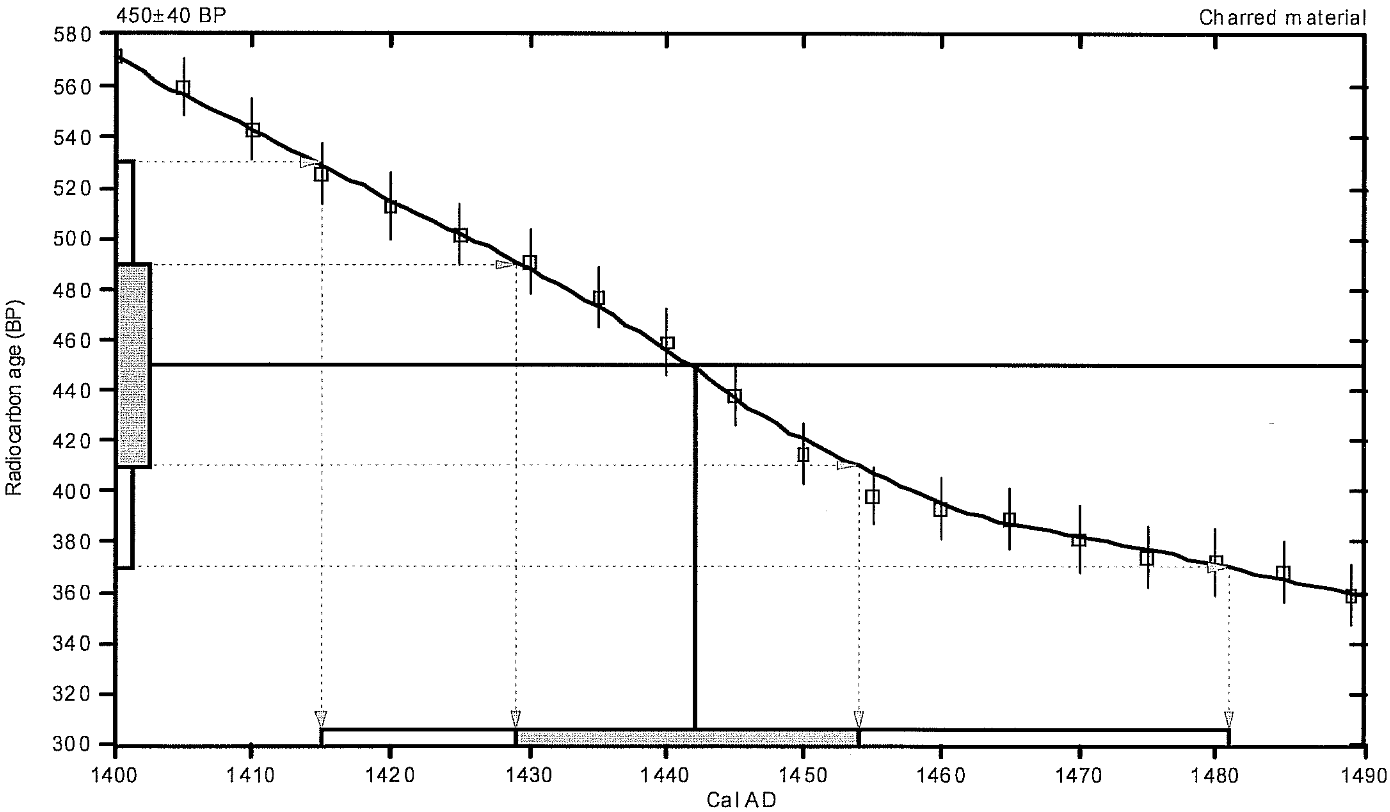
Conventional radiocarbon age: **450±40 BP**

2 Sigma calibrated result: **Cal AD 1420 to 1480 (Cal BP 540 to 470)**
(95% probability)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1440 (Cal BP 510)

1 Sigma calibrated result: Cal AD 1430 to 1450 (Cal BP 520 to 500)
(68% probability)



References:

Database used

INTCAL04

Calibration Database

INTCAL04 Radiocarbon Age Calibration

IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

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Mr. Darden Hood
Director

Mr. Ronald Hatfield
Mr. Christopher Patrick
Deputy Directors

Final Report

The final report package includes the final date report, a statement outlining our analytical procedures, a glossary of pretreatment terms, calendar calibration information, billing documents (containing balance/credit information and the number of samples submitted within the yearly discount period), and peripheral items to use with future submittals. The final report includes the individual analysis method, the delivery basis, the material type and the individual pretreatments applied. The final report has been sent by mail and e-mail (where available).

Pretreatment

Pretreatment methods are reported along with each result. All necessary chemical and mechanical pretreatments of the submitted material were applied at the laboratory to isolate the carbon which may best represent the time event of interest. When interpreting the results, it is important to consider the pretreatments. Some samples cannot be fully pretreated, making their ^{14}C ages more subjective than samples which can be fully pretreated. Some materials receive no pretreatments. Please look at the pretreatment indicated for each sample and read the pretreatment glossary to understand the implications.

Analysis

Materials measured by the radiometric technique were analyzed by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in one of 53 scintillation spectrometers, and then calculating for radiocarbon age. If the Extended Counting Service was used, the ^{14}C content was measured for a greatly extended period of time. AMS results were derived from reduction of sample carbon to graphite (100% C), along with standards and backgrounds. The graphite was then detected for ^{14}C content in one of 9 accelerator-mass-spectrometers (AMS) .

The Radiocarbon Age and Calendar Calibration

The "Conventional ^{14}C Age (*)" is the result after applying $^{13}C/^{12}C$ corrections to the measured age and is the most appropriate radiocarbon age. If an "*" is attached to this date, it means the $^{13}C/^{12}C$ was estimated rather than measured (The ratio is an option for radiometric analysis, but included on all AMS analyses.) Ages are reported with the units "BP" (Before Present). "Present" is defined as AD 1950 for the purposes of radiocarbon dating.

Results for samples containing more ^{14}C than the modern reference standard are reported as "percent modern carbon" (pMC). These results indicate the material was respiring carbon after the advent of thermo-nuclear weapons testing (and is less than ~ 50 years old).

Applicable calendar calibrations are included for materials between about 100 and 19,000 BP. If calibrations are not included with a report, those results were either too young, too old, or inappropriate for calibration. Please read the enclosed page discussing calibration.

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic

Unless otherwise requested by a submitter or discussed in a final date report, the following procedures apply to pretreatment of samples submitted for analysis. This glossary defines the pretreatment methods applied to each result listed on the date report form (e.g. you will see the designation "acid/alkali/acid" listed along with the result for a charcoal sample receiving such pretreatment).

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date, which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. Effects such as the old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of differing age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimize the added subjectivity associated with these types of problems. If you suspect your sample requires special pretreatment considerations be sure to tell the laboratory prior to analysis.

"acid/alkali/acid"

The sample was first gently crushed/dispersed in deionized water. It was then given hot HCI acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated. This type of pretreatment is considered a "full pretreatment". On occasion the report will list the pretreatment as "acid/alkali/acid - insolubles" to specify which fraction of the sample was analyzed. This is done on occasion with sediments (See "acid/alkali/acid - solubles"

Typically applied to: charcoal, wood, some peats, some sediments, and textiles "acid/alkali/acid - solubles"

On occasion the alkali soluble fraction will be analyzed. This is a special case where soil conditions imply
That the soluble fraction will provide a more accurate date. It is also used on some occasions to verify the present/absence or degree of contamination present from secondary organic acids. The sample was first pretreated with acid to remove any carbonates and to weaken organic bonds. After the alkali washes (as discussed above) are used, the solution containing the alkali soluble fraction is isolated/filtered and combined with acid. The soluble fraction, which precipitates, is rinsed and dried prior to combustion.

"acid/alkali/acid/cellulose extraction"

Following full acid/alkali/acid pretreatments, the sample is bathed in (sodium chlorite) $NaClO_2$ under very controlled conditions (Ph = 3, temperature = 70 degrees C). This eliminates all components except wood cellulose. It is useful for woods that are either very old or highly contaminated.

Applied to: wood

"acid washes"

Surface area was increased as much a possible. Solid chunks were crushed, fibrous materials were shredded, and sediments were dispersed. Acid (HCI) was applied repeatedly to ensure the absence of carbonates. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of each sample. The sample was not be subjected to alkali washes to ensure the absence of secondary organic acids for intentional reasons. The most common reason is that the primary carbon is soluble in the alkali. Dating results reflect the total organic content of the analyzed material. Their accuracy depends on the researcher's ability to subjectively eliminate potential contaminants based on contextual facts.

Typically applied to: organic sediments, some peats, small wood or charcoal, special cases

PRETREATMENT GLOSSARY
Standard Pretreatment Protocols at Beta Analytic
(Continued)

"collagen extraction: with alkali or collagen extraction: without alkali

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water, the surface scraped free of the outer most layers and then gently crushed. Dilute, cold HCI acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. "With alkali" refers to additional pretreatment with sodium hydroxide (NaOH) to ensure the absence of secondary organic acids. "Without alkali" refers to the NaOH step being skipped due to poor preservation conditions, which could result in removal of all available organics if performed.

Typically applied to: bones

"acid etch"

The calcareous material was first washed in de-ionized water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCI etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core remained. In the case of porous carbonate nodules and caliches, very long exposure times were applied to allow infiltration of the acid. Acid exposure times, concentrations, and number of repetitions, were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliches, and calcareous nodules

"neutralized"

Carbonates precipitated from ground water are usually submitted in an alkaline condition (ammonium Hydroxide or sodium hydroxide solution). Typically this solution is neutralized in the original sample container, using deionized water. If larger volume dilution was required, the precipitate and solution were transferred to a sealed separatory flask and rinsed to neutrality. Exposure to atmosphere was minimal.

Typically applied to: Strontium carbonate, Barium carbonate
(i.e. precipitated ground water samples)

"carbonate precipitation"

Dissolved carbon dioxide and carbonate species are precipitated from submitted water by complexing them as ammonium carbonate. Strontium chloride is added to the ammonium carbonate solution and strontium carbonate is precipitated for the analysis. The result is representative of the dissolved inorganic carbon within the water. Results are reported as "water DIC".

Applied to: water

"solvent extraction"

The sample was subjected to a series of solvent baths typically consisting of benzene, toluene, hexane, pentane, and/or acetone. This is usually performed prior to acid/alkali/acid pretreatments.

Applied to: textiles, prevalent or suspected cases of pitch/tar contamination, conserved materials.

"none"

No laboratory pretreatments were applied. Special requests and pre-laboratory pretreatment usually accounts for this.

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Director

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Calendar Calibration at Beta Analytic

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short-term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer-term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to about 10,000 BP. Calibration using tree-rings to about 12,000 BP is still being researched and provides somewhat less precise correlation. Beyond that, up to about 20,000 BP, correlation using a modeled curve determined from U/Th measurements on corals is used. This data is still highly subjective. Calibrations are provided up to about 19,000 years BP using the most recent calibration data available.

The Pretoria Calibration Procedure (Radiocarbon, Vol 35, No.1, 1993, pg 317) program has been chosen for these calendar calibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. A single spline is used for the precise correlation data available back to 9900 BP for terrestrial samples and about 6900 BP for marine samples. Beyond that, splines are taken on the error limits of the correlation curve to account for the lack of precision in the data points.

In describing our calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $^{13}C/^{12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 35, Number 1, 1993) prior to the calibration. Marine carbonates that have not been corrected for $^{13}C/^{12}C$ are adjusted by an assumed value of 0 %0 in addition to the reservoir corrections. Reservoir corrections for fresh water carbonates are usually unknown and are generally not accounted for in those calibrations. In the absence of measured $^{13}C/^{12}C$ ratios, a typical value of -5 %0 is assumed for freshwater carbonates.

(Caveat: the correlation curve for organic materials assume that the material dated was living for exactly ten years (e.g. a collection of 10 individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated). For other materials, the maximum and minimum calibrated age ranges given by the computer program are uncertain. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of younger or older material in matrix samples. Since these factors are indeterminant error in most cases, these calendar calibration results should be used only for illustrative purposes. In the case of carbonates, reservoir correction is theoretical and the local variations are real, highly variable and dependent on provenience. Since imprecision in the correlation data beyond 10,000 years is high, calibrations in this range are likely to change in the future with refinement in the correlation curve. The age ranges and especially the intercept ages generated by the program must be considered as approximations.)

APPENDIX M

List of Samples and Results of EDXRF Analysis

APPENDIX M. EDXRF LIST AND RESULTS

		ELEMENTS																		
		Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	V	MnO	Fe	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba
PCSI SAMPLE	**ARTIFACT**	%	%	%	%	%	%	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
PCSI 1	adze preform	3.144	4.168	15.727	52.286	0.735	8.396	3.136	403.399	2028.278	11.885	27.529	64.845	132.839	20.504	596.264	33.61	288.234	27.384	357.87
PCSI 2	adze preform	2.54	4.284	15.374	53.441	0.709	8.015	3.057	407.233	1537.514	11.677	24.404	53.775	159.796	19.916	617.363	36.474	319.788	31.536	287.141
PCSI 3	adze preform	2.897	4.731	15.422	51.891	0.721	8.258	3.269	415.894	1699.686	12.464	24.945	34.93	133.088	22.646	549.255	32.036	276.428	25.182	332.103
PCSI 4	adze preform	2.961	3.171	14.977	51.068	0.901	7.258	3.651	506.176	1748.808	10.983	15.119	55.738	139.303	30.287	610.689	41.483	405.555	40.324	370.405
PCSI 5	adze preform	2.568	3.426	14.291	52.2	0.892	7.577	3.802	469.937	1706.539	12.535	15.238	35.889	142.639	25.429	536.994	38.558	339.312	36.358	568.23
PCSI 6	adze preform	4.002	4.481	15.789	53.656	0.759	7.911	3.426	378.929	1670.426	12.497	27.006	202.151	150.628	18.623	655.741	43.78	366.867	34.542	359.119
PCSI 7	adze preform	3.04	2.883	14.592	56.545	1.045	6.974	3.543	470.961	1706.66	11.695	14.107	45.231	159.871	34.298	631.488	53.528	479.15	53.451	519.807
PCSI 8	adze preform	2.769	4.615	14.528	52.513	0.778	8.385	3.254	387.232	1566.583	12.006	22.913	52.541	133.059	17.529	562.437	35.221	279.271	27.208	362.328
PCSI 9	adze preform; red cortex	1.994	3.451	8.61	43.419	0.919	6.778	3.557	396.873	1808.05	11.854	15.115	169.038	148.112	19.106	646.851	40.623	415.081	33.723	341.319
PCSI 9	adze preform; end shock surface	2.639	3.553	15.828	55.648	0.814	7.701	3.793	484.447	1900.71	12.752	14.76	50.038	140.016	21.507	558.543	39.865	345.68	41.098	492.832
PCSI 10	adze preform; clean flake scar on poll	3.327	1.824	17.302	61.41	1.632	5.897	2.608	208.634	2319.513	11.194	5.605	18.608	152.438	55.842	1383.085	65.842	697.555	72.219	926.511
PCSI 11	adze preform; underside of bit	1.956	2.782	14.537	55.947	0.82	7.626	3.43	425.226	1491.266	12.319	9.89	70.635	144.319	24.267	602.165	43.025	350.847	36.788	414.23
PCSI 12	adze preform	2.601	3.137	13.174	51.07	0.841	7.706	3.394	420.123	1543.32	11.307	17.29	51.853	135.398	24.705	517.052	39.264	306.482	35.367	495.591
PCSI 13	adze preform	3.85	2.537	16.299	61.449	1.237	6.171	3.23	438.265	1743.398	10.338	0.999	37.764	155.013	43.909	700.889	63.528	601.419	59.144	510.004
PCSI 13	adze preform; 2nd run	3.283	2.472	14.356	61.255	1.19	6.314	3.387	407.23	1794.71	10.799	3.347	30.512	170.338	40.556	659.605	53.18	532.847	50.155	543.699
PCSI 14	hammerstone; rerun	1.818	3.072	13.227	51.402	0.711	7.92	3.474	380.202	1616.239	15.247	14.961	104.933	142.021	20.283	542.101	37.035	296.836	30.603	428.267
PCSI 15	hammerstone; rerun	2.04	3.33	15.421	52.705	0.738	8.565	3.433	414.105	1548.883	14.409	26.939	76.624	133.891	19.996	570.028	33.701	297.403	32.56	436.87
PCSI 16	hammerstone; rerun	2.128	3.387	14.4	46.166	0.711	7.354	3.763	411.148	1574.414	16.211	18.665	118.304	151.049	17.211	589.928	32.921	335.752	35.028	365.874
PCSI 17	hammerstone; rerun	1.835	3.175	18.531	43.451	0.455	8.72	3.185	403.47	1630.366	15.55	29.31	130.397	133.299	11.654	513.772	31.789	257.566	30.059	372.102
PCSI 18	cobble; elongated	1.711	2.926	11.646	71.758	0.602	8.432	2.303	299.371	1566.611	9.751	90.201	94.724	137.999	12.015	317.129	23.802	143.78	10.143	167.038
PCSI 18	cobble; rerun along flake scar	1.711	3.011	12.389	57.665	0.697	9.214	2.324	307.267	1578.929	9.44	84.968	73.575	125.942	8.654	300.764	24.066	139.995	8.893	146.404
PCSI 19	cobble; round	1.711	1.419	13.121	70.055	1.415	4.659	3.003	204.657	2536.423	11.455	0.999	19.603	142.372	40.436	1013.618	47.55	588.99	68.447	1022.321
PCSI 19	cobble; rerun	1.711	1.348	12.777	72.406	1.425	4.724	2.97	234.775	2525.241	10.01	1.517	15.113	146.858	38.047	995.344	45.704	576.819	62.097	1079.353
PCSI 20	cobble; elongated fragment	1.711	1.48	8.245	98.469	0.859	3.04	2.141	169.684	1573.578	5.582	0.999	16.534	127.41	42.879	1242.854	47.98	470.028	54.874	1150.488
PCSI 20	cobble; rerun on fractured surface	1.711	1.379	13.68	77.767	1.757	5.901	2.586	239.373	1875.821	7.479	0.999	19.722	117.49	45.161	1361.863	50.789	532.242	59.912	974.977
PCSI 21	cobble; pecked	3.322	1.703	17.104	61.151	1.918	6.402	2.623	228.837	2116.495	7.8	0.999	24.045	148.997	53.825	1363.076	54.212	614.331	65.943	966.482
PCSI 22	cobble; broken 1	2.495	0.969	15.204	53.569	1.846	6.603	2.99	216.301	2178.695	10.113	0.999	11.351	128.095	40.512	1229.857	49.514	547.424	58.859	1093.478
PCSI 22	cobble; broken 2	2.937	1.287	15.254	48.005	1.694	6.288	2.848	218.796	2101.849	9.351	4.101	3.379	124.641	39.16	1244.431	45.056	538.907	60.643	1110.857
PCSI 22	cobble; run on fresh break	3.716	0.891	16.828	49.648	1.74	7.085	2.689	260.466	2378.254	7.664	0.999	15.051	131.647	49.446	1537.419	56.461	639.066	65.258	820.391
PCSI 23	adze preform	2.777	4.132	16.108	50.188	0.908	7.934	3.385	379.132	1573.635	13.146	18.076	49.917	205.227	54.348	676.231	43.94	372.109	40.916	506.248
PCSI 24	cobble; fractured	1.998	1.966	13.697	59.241	1.24	5.143	2.974	284.261	1697.826	9.726	1.646	11.472	144.315	35.301	1225.131	45.662	436.601	48.279	861.98
PCSI 25	volcanic glass	1.711	5.265	11.457	53.839	0.543	9.427	2.199	297.539	1641.278	10.276	55.194	121.904	127.966	7.483	315.888	23.837	132.395	9.84	100.134
PCSI 26	volcanic glass	1.711	5.893	11.639	51.211	0.921	7.322	3.613	441.851	1592.659	12.843	14.224	36.052	146.545	34.833	528.361	42.625	349.984	41.478	626.042
PCSI 27	flake; worked	1.938	3.611	12.703	52.397	1.113	7.498	3.819	418.343	1790.962	12.254	9.327	16.619	139.693	34.423	557.487	40.431	343.782	37.202	535.998
PCSI 28	flake	4.031	2.222	17.847	53.205	1.474	6.272	3.307	301.008	2361.165	9.251	0.999	22.888	122.809	34.071	1401.277	41.517	570.685	63.416	802.96
PCSI 29	flake	2.408	3.277	16.494	49.292	0.923	7.176	3.839	450.45	1660.748	12.993	12.451	37.904	151.094	31.354	598.397	37.835	383.476	39.718	530.761

APPENDIX M. EDXRF LIST AND RESULTS

		ELEMENTS																		
		Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	V	MnO	Fe	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba
PCSI SAMPLE	ARTIFACT	%	%	%	%	%	%	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
PCSI 30	adze preform	1.711	9.096	8.442	50.33	0.89	7.382	3.16	426.804	1468.612	12.373	14.085	138.184	283.24	35.051	565.546	38.238	327.92	34.002	517.86
PCSI 31	adze preform	1.711	6.043	12.085	46.783	0.46	9.321	2.089	318.308	1169.723	11.08	113.323	149.376	125.159	6.88	278.38	22.738	130.262	9.978	98.975
PCSI 32	adze preform	2.25	4.074	12.788	47.937	0.771	9.079	3.28	410.801	1497.005	10.989	26.177	65.07	148.281	25.402	552.27	35.607	281.15	27.133	417.22
PCSI 33	adze preform	1.887	5.362	14.203	51.803	0.507	9.696	2.491	336.396	1529.75	9.011	67.739	57.495	125.769	11.462	344.55	23.833	161.399	11.919	83.704
PCSI 34	adze preform	2.902	4.116	13.228	49.327	0.949	7.581	3.546	450.871	1498.31	11.637	9.261	49.358	140.448	36.926	552.473	35.975	319.06	35.702	502.292
PCSI 35	flake; worked	1.846	2.927	15.984	59.54	0.998	7.699	3.751	526.34	1889.109	15.374	14.641	38.442	159.007	21.415	536.204	40.919	341.087	39.927	595.228
PCSI 36	adze preform; run on clean flake scar	3.524	4.451	19.673	55.011	0.923	6.883	3.693	446.492	1597.858	14.237	8.292	30.635	148.274	29.744	572.423	42.675	375.829	44.512	610.467
PCSI 37	flake; run on bulb	2.617	3.474	14.798	58.5	0.928	7.61	3.855	476.063	1737.575	13.682	13.494	55.733	157.207	34.628	552.744	37.696	337.936	39.185	640.305
PCSI 38	flake; clean portion of ventral near termination	4.072	4.37	16.017	56.513	0.944	7.422	3.682	468.151	1589.995	13.338	11.238	36.32	140.5	33.717	569.501	38.276	345.562	42.505	573.132
PCSI 39	flake; run on bulb	2.797	3.687	18.904	52.488	0.932	7.665	3.799	462.87	1765.157	13.064	15.625	63.284	143.759	28.731	514.215	37.608	316.698	33.882	571.86
PCSI 40	flake; run on bulb	3.185	6.474	18.524	54.58	0.867	8.218	3.686	469.636	1813.653	14.297	13.83	63.02	143.51	26.797	518.058	30.126	286.351	37.176	568.576
PCSI 41	adze preform	2.432	3.19	22.09	45.401	0.942	7.938	3.852	433.935	1790.193	14.883	15.845	86.315	161.305	33.08	600.684	36.784	358.407	42.813	591.624
PCSI 42	adze preform; run on flake scar near butt	2.375	3.362	16.957	56.756	0.947	6.831	3.739	448.166	1611.469	12.352	12.604	58.968	141.381	27.675	535.419	40.96	335.721	40.253	581.26
PCSI 43	adze preform; run on clean flake scar	4.34	3.362	18.171	57.098	1.612	6.619	3.404	279.269	2110.281	10.92	2.682	1.926	116.174	38.492	1214.856	44.22	444.156	52.847	984.608
PCSI 44	adze preform; run on flat surface	5.303	2.993	18.657	59.194	1.851	4.833	2.696	233.899	2346.631	12.421	2.343	17.249	151.29	50.018	1225.258	51.027	640.26	68.699	1205.118
PCSI 45	flake; run on ventral surface	3.104	3.869	14.445	49.115	0.909	7.289	3.58	430.493	1640.478	12.243	14.327	74.673	165.115	29.809	548.515	38.706	337.759	37.851	581.757
PCSI 46	flake; run on bulb	2.554	3.746	15.833	51.677	0.902	7.533	3.805	447.626	1688.348	13.071	15.263	58.423	146.073	33.071	524.28	37.648	325.655	33.452	612.437
PCSI 47	adze flake preform; run on bulb	3.626	4.205	17.352	51.742	0.864	6.81	3.49	477.582	1464.466	12.152	12.424	68.685	149.431	18.594	549.79	38.486	330.04	31.944	487.634
PCSI 48	hammerstone	2.649	3.151	16.874	46.146	0.753	7.677	3.27	456.798	1574.553	14.896	12.521	47.212	144.694	19.362	558.877	33.52	314.671	33.401	405.532
PCSI 49	flake run on bulb	3.808	4.63	15.106	53.356	1	8.091	3.916	488.802	1718.588	12.839	12.57	35.67	145.421	33.175	552.566	38.842	325.674	36.35	624.381
PCSI 50	flake; run on clean portion of ventral surface	2.833	3.667	17.382	47.595	0.905	7.564	3.721	455.45	1679.731	13.182	12.57	56.807	152.276	33.059	584.608	42.999	356.505	39.743	548.067
PCSI 51	adze preform	4.928	3.15	18.854	62.266	1.694	6.252	2.999	297.697	2066.48	10.304	0.999	5.139	133.963	43.893	1272.084	52.199	500.159	57.487	983.22
PCSI 52	flake run on ventral near termination	1.878	3.366	12.297	55.718	0.757	8.199	3.31	441.302	1560.13	11.881	15.58	69.059	143.209	21.309	580.109	39.598	276.667	28.785	420.823
PCSI 53	flake blank run on bulb	2.223	3.423	13.526	57.081	0.939	7.652	3.774	457.812	1657.649	13.181	20.786	64.693	138.129	19.546	513.887	35.576	283.911	27.751	483.125
PCSI 54	adze preform; run on clean but cuspate section of tang	3.092	4.311	15.86	50.48	0.792	7.87	3.766	438.019	1661.844	14.168	18.781	50.118	152.85	19.179	572.308	41.07	317.563	32.368	436.411
PCSI 55	adze preform; run on clean bedding plane	2.323	2.167	15.646	40.4	0.887	6.533	3.584	489.922	3196.606	11.804	27.623	123.71	132.499	25.23	539.468	37.107	339.407	36.454	517.983
PCSI 56	hammerstone	1.711	2.582	12.976	57.905	0.868	7.436	3.555	431.646	1507.998	11.715	26.668	83.244	127.659	21.171	571.853	33.711	296.681	35.987	550.878
PCSI 57	adze preform; run near bit	3.377	4.362	15.431	53.839	0.922	7.298	3.77	496.793	1618.518	13.839	11.352	28.506	131.126	26.292	528.389	36.95	326.549	33.196	480.062
PCSI 58	broken surface of 'cooking stone'	3.418	1.132	17.584	64.079	1.981	6.656	2.436	217.331	2205.368	6.753	0.999	14.237	103.457	46.845	1170.816	53.773	551.469	60.673	1029.957
PCSI 58	exterior surface of 'cooking stone'	2.16	1.545	11.45	65.943	1.475	6.587	2.943	265.571	1967.061	8.845	0.999	18.169	124.652	38.505	1239.376	51.279	451.401	56.441	1079.136
PCSI 59	broken surface of 'cooking stone'	1.973	0.942	11.591	52.718	1.483	7.065	2.84	268.548	2032.185	9.16	0.999	15.039	148.597	43.385	1409.238	55.983	522.743	60.085	1016.144
PCSI 59	exterior Surface of 'cooking stone'	2.754	1.847	14.122	62.092	1.839	6.608	2.533	197.56	2250.637	7.498	3.718	-0.587	123.088	50.563	1258.111	56.307	584.098	68.333	1098.736
PCSI 60	interior surface of 'cooking stone'	2.993	2.35	16.287	58.743	1.68	6.409	2.916	238.237	2041.654	9.605	0.999	11.632	140.581	40.091	1182.047	44.559	459.12	57.677	1071.135
PCSI 60	exterior surface of 'cooking stone'	1.711	1.77	14.113	73.098	1.658	6.23	2.924	250.675	2051.689	10.215	0.999	18.225	161.734	43.287	1246.838	55.71	468.104	53.376	1091.061
PCSI 61	interior surface of 'cooking stone'	3.448	3.219	16.954	50.961	2.302	6.933	2.827	237.62	1685.39	9.274	0.999	19.955	172.489	48.682	1503.267	54.357	519.227	58.832	914.667
PCSI 61	'cooking stone'	1.711	3.703	11.802	38.906	2.191	7.584	3.007	257.441	1776.643	8.796	5.078	29.789	219.631	43.922	1299.184	53.797	449.713	51.678	1011.82

APPENDIX M. EDXRF LIST AND RESULTS

PCSI SAMPLE	ARTIFACT	Na2O %	MgO %	Al2O3 %	SiO2 %	K2O %	CaO %	TiO2 %	V ppm	MnO ppm	Fe %	Ni ppm	Cu ppm	Zn ppm	Rb ppm	Sr ppm	Y ppm	Zr ppm	Nb ppm	Ba ppm
		ELEMENTS																		
PCSI 62	interior surface of 'cooking stone'	2.152	2.827	15.892	53.783	0.915	6.728	3.389	413.007	1658.948	14.204	14.919	81.235	160.498	28.738	638.48	46.496	360.71	35.147	413.476
PCSI 62	cooking stone'	1.711	2.102	12.969	56.98	1.076	5.705	4.264	377.089	1443.982	12.754	20.143	56.713	177.95	42.354	579.905	36.598	295.63	36.125	594.968
PCSI 63	'cooking stone'	2	1.752	13.819	53.158	1.473	6.089	3.006	299.989	1808.031	6.328	0.999	25.633	133.852	41.528	1256.949	51.352	430.508	53.184	1032.266
PCSI 64	interior surface of 'cooking stone'	2.846	2.676	16.519	54.177	1.167	5.954	3.075	282.408	2079.18	10.304	10.804	21.958	157.507	28.815	1304.55	50.899	446.009	55.837	788.451
PCSI 64	'cooking stone'	1.812	2.028	13.92	58.095	1.153	5.423	3.685	360.798	2036.36	13.032	0.999	8.841	144.592	26.327	1112.582	44.298	416.491	54.301	1089.26

APPENDIX N

A STATISTICAL SUMMARY AND ANALYSIS OF SELECTED SHRINE ATTRIBUTES FROM THE MAUNA KEA SCIENCE RESERVE, KA`OHE AHUPUA`A, HĀMĀKUA DISTRICT, ISLAND OF HAWAI`I, HAWAI`I

By

DENNIS C. GOSSER

July 10, 2010

INTRODUCTION

Between 2005 and 2009, Pacific Consulting Services, Inc. (PCSI) conducted an archaeological survey of the approximately 11,288 acre (4,568 hectares) Mauna Kea Science Reserve (Figure 1), located within the *ahupua`a* of Ka`ohe (Hāmākua District). As a result of the survey, 150 newly or previously recorded shrine sites, which include between 545 and 618[1] individual upright stones, were documented (Figure 2).

The purpose of this report is twofold: to provide a statistical investigation of the shrine and upright data and to undertake several exploratory data analyses to help place the shrines and uprights in their possible social or ritual context. Other than the data collected as part of the current project and several earlier, less comprehensive projects, there is little direct ethnographic, historical, or archaeological information concerning the sites (Maly 1999; McCoy 1982; McEldowney 1982). With several exceptions, there appear to be few or no durable artifacts associated with the sites, and the uprights (again, with a few exceptions) do not appear to have been modified beyond their placement on the landscape. In short, the best data to interpret the function of these sites are the stones themselves, their plan view (when present), the relationships between uprights, and the relationship between shrine sites.

Within the context of the Mauna Kea summit region, there are three prominent archaeological themes: human burial, basalt quarrying and adze production, and the construction of the above-mentioned shrines. Although relationships between these themes may exist in specific instances—for example, adzes (complete and incomplete) have been recorded on shrine sites and shrine sites have been recorded within adze quarries—these relationships do not appear to be exclusive. Based on previous surveys, adze quarries/production sites and human burial sites appear to be restricted to specific environments within the summit region, and, as will be discussed in this report, there may be an environmental variable involved in the placement of some shrines. Maly (1999) conducted oral-historical interviews of Hawaiian families who were familiar with or who used the summit region for various activities. While some of the consultants noted seeing uprights, others were not familiar with these features. However, there was a consensus that the summit region was (and continues to be) a ritual landscape.

While there is little ethnographic information concerning the shrine sites on Mauna Kea, there is information on similar site types from East Polynesia. McCoy's (1999) review and use of Emory's information provides indirect, yet powerful homologies suggesting that the term shrine appropriately describes many of the sites within the summit region. The current study follows McCoy's (1999) terminology.

Data collected in the field for each upright included metric measurements (height, width, and thickness), locations using a Global Positioning System (GPS) unit, as well as nominal data such as upright body form, upright top form, foundation type, and whether or not individual uprights were erect or fallen. In addition, scaled sketch maps were produced showing the

[1] During the survey, some uprights were classified as "possible." In general these were non-erect "uprights" in contexts where the recorder did not have high confidence in assigning the stone as part of the shrine. For the current analysis, the 73 possible uprights were excluded unless otherwise noted.

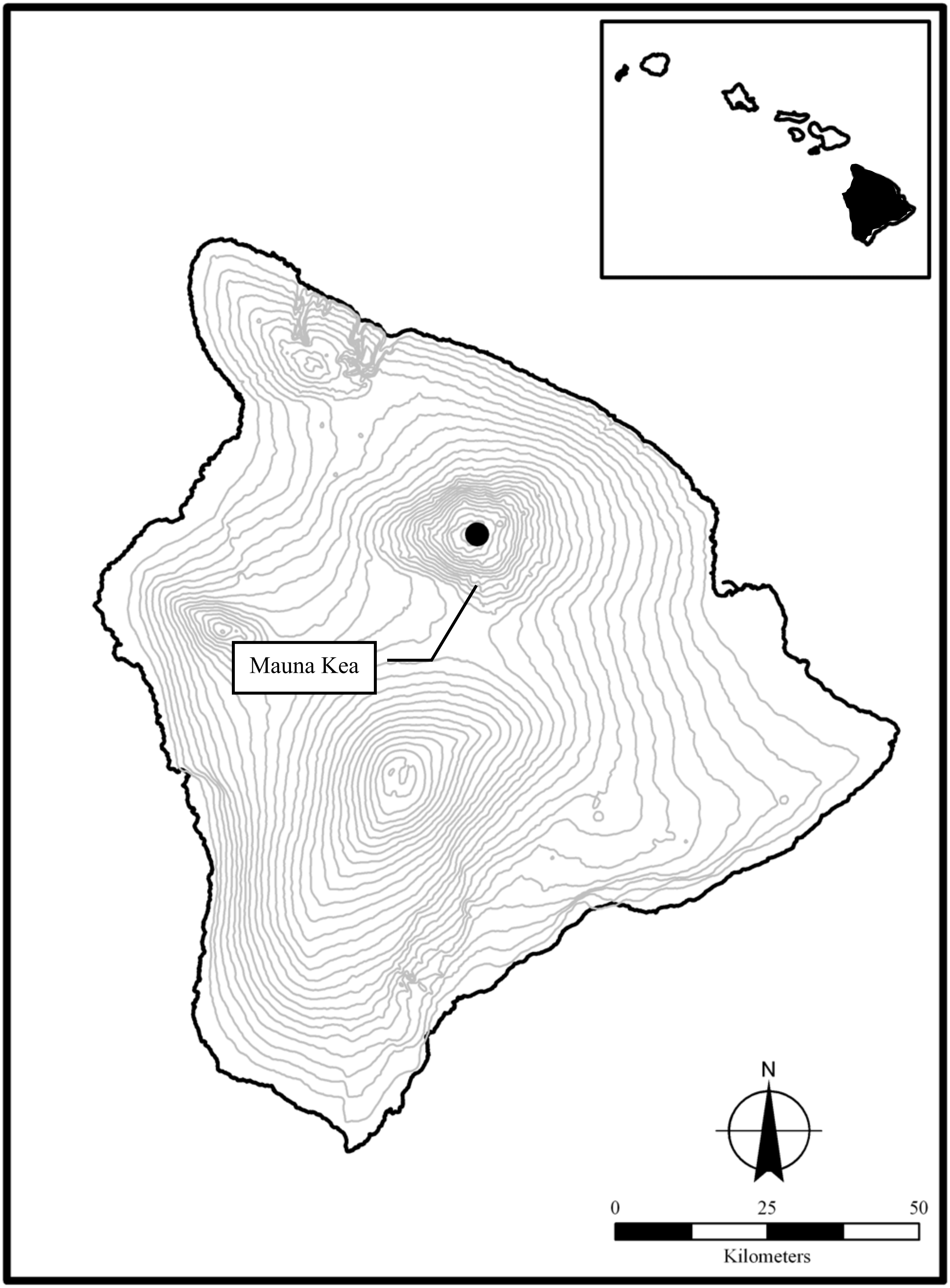


Figure 1. Island of Hawai`i Showing the Location of Mauna Kea. Inset: The Hawaiian Islands

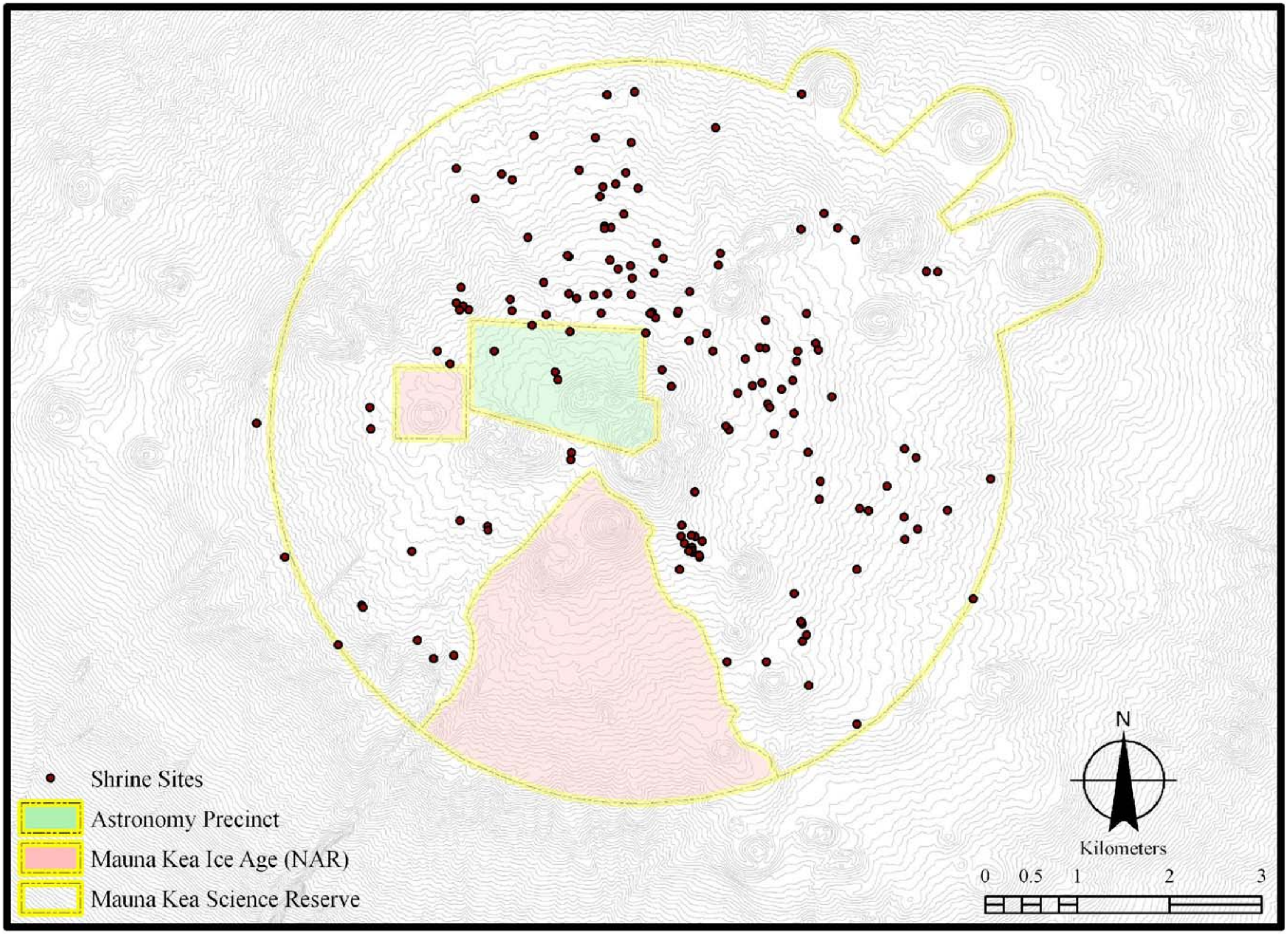


Figure 2. Mauna Kea Science Reserve Showing the Location of Shrine Sites.

relationships of uprights within sites, as well as the relationship of shrine sites to landform features. A typology for shrine sites as well as for composite upright types (based on body form and top form) was developed after the fieldwork was completed.

METHODS

Most of the analyses undertaken as part of this project use basic descriptive statistics. The primary method of describing data in this analysis is the box-and-whisker plot (Figure 3). The box-and-whisker plot is a convenient, yet robust way of graphically depicting groups of numerical data using five summary values: the sample minimum (the smallest value), the sample maximum (the largest value), the median (Q2), the lower quartile (Q1, the lower 25 percent of observations as measured from the median), and the upper quartile (Q3, the upper 25 percent of observations as measured from the median). In a box-and-whisker plot, the box represents the interquartile range (IQR), or 50% of the observations. The whiskers (a line extending from either or both ends of the box) represent data with a value 1.5 times that of the interquartile range. Values beyond the whiskers are outliers (represented by circles and asterisks. Figure 3 shows the relationship between the elements of a box-and-whisker plot and a normally distributed probability density function for a set of data.

Box-and-whisker plots usefully display differences between numerical populations. In the current study, where we are mostly concerned with uprights and the possibility that, within the observed typology, differences in upright shape and size may be indicative of socially or ritually derived patterns, box-and-whisker plots are an effective means of comparing central tendency, dispersion (size ranges), and skewness.

Shapiro-Wilk Test

Along with the box-and-whisker plots of upright shapes, there is an interest in whether the size data are distributed normally. In probability theory and statistics, the normal distribution is a continuous probability distribution that describes data that cluster around a mean or average. The graph of the associated probability density function is bell-shaped, with a peak at the mean. The Shapiro-Wilk test compares a set of measures against the normal distribution and tests the null hypothesis that a sample $x_1, ..., x_n$ came from a normally distributed population. The Shapiro-Wilk test is used here to explore whether there is a preference in stone selection that might be manifested as a non-normal distribution of samples.

K-Means Cluster Analysis

K-means nonhierarchical clustering analysis was undertaken on 148 shrine sites. K-means nonhierarchical cluster analysis is an appropriate type of analysis to test and explore

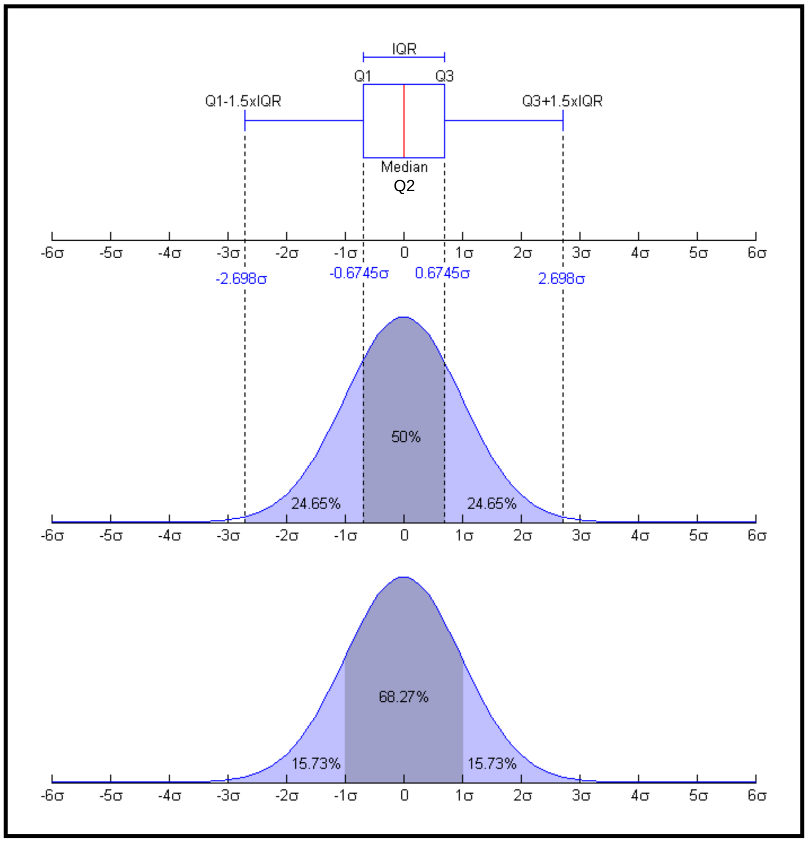


Figure 3. The Relationship Between a Box-and-Whisker Plot and a Normally Distributed Probability Density Function.

hypotheses concerning spatial data where there is no initial claim that the relationship between sites is phylogenetic. K-means has been described as a "variance minimizing" or "divisive" clustering technique (Kintigh 1994). The computation to undertake k-means analysis (using computers) begins by assuming there are *k* random clusters, where *k* is a number decided upon by the analyst. The program then moves objects (in our case, sites) between those clusters with the goal to (1) minimize variability within clusters and (2) maximize variability between clusters. This is analogous to "ANOVA (Analysis of Variance) in reverse" in the sense that the significance test in ANOVA evaluates the between group variability against the within-group variability. K-means clustering tries to move objects in and out of groups (clusters) to get the most significant ANOVA results.

In addition to the spatial clustering of sites, cluster composition can be derived from K-means. This can be an important exploratory tool for understanding if homologies (similarities) exist between clusters in terms of the types and frequencies of shrines.

Pairwise Comparison Matrices

Pairwise comparison generally refers to any process of comparing entities in pairs to evaluate which of each pair is preferred. Although in some disciplines the methodology can be complex, here a simple matrix is constructed and populated with observations concerning the placement frequency of upright types in a sample of multi-upright sites; in other words, how often upright types co-occur. For example, in the following shrine configuration

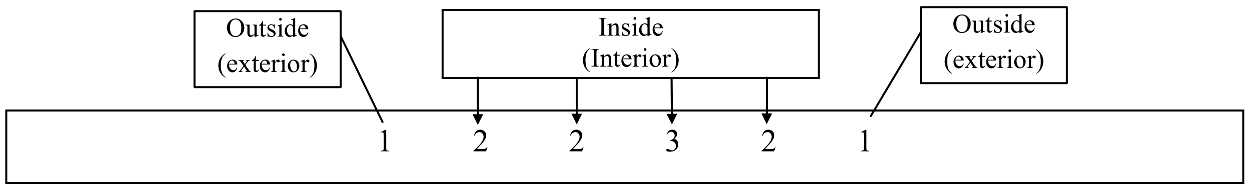
1	2	2	3	2	1

the pairwise comparison matrix would look like this

		Upright Type		
		1	**2**	**3**
Upright Type	**1**	--	2	--
	2		1	2
	3			--

showing that upright types 1 and 2 occur next to each other two times, upright types 2 and 3 occur next to each other two times, and that upright types 2 and 2 occur next to each other one time. No distinction is made based on how pairs are ordered. In the above case, the upright pairs 1-2 and 2-1 are treated as identical. Likewise, the pairs 2-3 and 3-2 are treated as identical.

The pairwise comparison matrices are presented in three levels of increasing abstraction. First, actual upright types in their actual placement are compared (similar to the above matrix). Second, generalized upright top forms (flat, pointed, gabled, etc.) and generalized body form (divergent, parallel, etc.) are compared in terms of their actual placement. Finally, the actual and generalized data are compared in terms of their plan view placement as either outside (exterior) or inside (interior). Using the example above, the generalized placement would be:



Shrine Upright Diversity Analysis

Diversity is the number of categories present in an assemblage and how those categories are distributed (Kintigh 1989:25). With reference to the current study, diversity is a function of richness—the number of categories present—and evenness—how those categories are distributed (Kintigh 1989:25-29). Measures of diversity provide a semi-quantitative means of comparing and summarizing variability in archaeological assemblages.

Richness

Kintigh (1989) presents a model and computer program to generate expected richness values for given sample sizes by simulating the construction of random assemblages. By repeating the simulation (in this case, 500 times) and aggregating the data, a statistical estimate or expectation of richness can be obtained. If the simulations are repeated for sample sizes that bracket the actual data, a confidence interval (e.g., 80 percent) can be constructed to evaluate how the actual data compare with the expected data generated from the simulations.

Evenness

In the same publication, Kintigh developed a measure of evenness based on the information statistic usually noted as H/H_{max} (Kintigh 1989). The H/H_{max} statistic is a function of the number of categories and the relative proportion of each category in the assemblage. This statistic produces a quantitative measure of the evenness of a distribution of categories (Kintigh 1989:29). The reader is referred to Kintigh (1989) for a discussion of the mathematical details of the evenness statistic, but the results of this measure are reasonably simple to evaluate. The H/H_{max} computation produces values between 0.0 and 1.0. A value of 0.0 indicates minimal evenness in which only one category is present. Alternatively, a value of 1.0 indicates maximum evenness in which all categories are present in the same proportions.

DATA

The 545 uprights have been categorized into 28 types based on top form and body form (Table 1; see Appendix A). The six top forms include pointed, beveled, gabled, rounded, flat, and mesial curved or notched (absent from the curved body form). In addition, Pat McCoy has classified the shrine sites into seven categories, building on his 1982 and 1999 classifications

(McCoy 1982, 1999). The shrine typology reflects differences in ground plan configuration and complexity. The types, possibly reflecting functional differences, range from the architecturally simple single upright (Type 1) to more complex shrines with multiple architectural elements (pavements and courts) and a larger number of uprights (Table 2).

Table 1. Summary of Mauna Kea Upright Samples by Type.

Upright Type	Body Type	N	Percent Group/Total	Height*				Width				Thickness			
				Min	Max	Median	Mean	Min	Max	Median	Mean	Min	Max	Median	Mean
Parallel/Sub-parallel															
1	Pointed	49	17.9/9.0	30	103	53	55.8	10	56	21.3	23.8	4	24	10	10.9
2	Beveled	104	38.0/19.1	26	115	58	58.4	9	60	25	25.5	3	25	10	10.8
3	Gabled	27	9.9/5.0	32	89	60	59.2	15	40	26.5	27.1	3.5	25	11	11.7
4	Rounded	20	7.3/3.7	27	100	49	55.7	14	40	22	24	3	23	11	11.7
5	Flat	62	22.6/11.4	24	121	52	56	10	70	23	23.8	3	28	10	10.6
6	Mesial notched	12	4.4/2.2	23	70	50.5	50.4	14	51	26	26.8	5	16	9	9.1
	Total	**274**	**100/50.3**												
Divergent															
7	Pointed	66	9.1/12.1	23	95	54	55.5	10	55	27	27.6	4	27	10	11.6
8	Beveled	23	17.3/4.2	25	130	51	55.6	12	50	24.5	26.4	3	30	9	11.0
9	Gabled	10	7.5/1.8	40	90	50	57.9	15	62	30	35.2	3	19	10	10.9
10	Rounded	10	7.5/1.8	27	93	46	49.7	15	42	24	27.6	4	20	7	9.4
11	Flat	20	15.0/3.7	40	110	53	59	10	62	27	28.3	6	26	11	11.6
12	Mesial notched	4	3.0/0.7	53	65	58	58.2	33	51	38	39.2	5	15	7	9.0
	Total	**133**	**100/24.4**												
Irregular															
13	Pointed	24	27.3/4.4	40	110	57	59	15	51	24	27	3	37	13	13.3
14	Beveled	24	27.3/4.4	41	100	58	61.4	12	49	23	24.9	3	22	9	9.7
15	Gabled	7	8.0/1.2	44	79	64	61.9	14	52	32.5	33.4	4	15	8	8.4
16	Rounded	6	6.8/1.1	34	77	57	56.8	18	44	26	28.5	6	20	16	13.8
17	Flat	25	28.4/4.6	28	118	55	56.8	15	68	29.5	32.7	3	18	10	11.1
18	Mesial notched	2	2.3/0.4	44	71	47	54	20	56	33	36.3	7	9	7	7.7
	Total	**88**	**100/16.1**												
	Convergent														
19	Pointed	9	20.5/1.7	30	72	49	52	16	31	22	23.5	4	15	11	10.1
20	Beveled	10	22.7/1.8	39	85	62	62.8	17	40	25	27	4	20	7.5	9.2
21	Gabled	11	25.0/2.0	47	96	57.5	61.5	15	47	34.5	33.2	3	17	9.5	9.1
22	Rounded	2	4.5/0.4	47	63	55	55	25	29	25	26.3	8	18	10	12
23	Flat	10	22.7/1.8	37	80	50.5	52.7	13	72	29	32.3	4	20	7	9.1
24	Mesial notched	2	4.5/0.4	43	80	48	57	25	35	30	30	8	16	10	11.3
		44	**100/8.1**												
	Crescent														
25	Pointed	2	33.3/0.4	46	50	46	47.3	17	28	22	22.3	5	10	7	7.3
26	Beveled	0	0.0/0.0	--	--	--	--	--	--	--	--	--	--	--	--
27	Rounded	1	16.7/0.2	--	70	--	--	--	30	--	--	--	9	--	--
28	Flat	3	50.0/0.6	49	90	72	70.8	13	26	22	20.8	5	9	6.5	6.8
	Total	**6**	**100/1.1**												
	Grand Total	545													

*All measurements in cm.

Table 2. Summary of Mauna Kea Shrine Sites by Type.

Shrine Type	Description	Count	Percent	Sites
1	Single upright stone	65	44.2	11077, 16171, 16172, 16178, 16181, 16188, 16193, 16197, 16202, 21198, 21199, 21200, 21205, 21206, 21207, 21208, 21210, 21211, 21213, 21406, 21407, 21408, 21409, 21417, 21422, 21425, 21427, 21428, 21429, 21432, 21433, 21435, 21442, 21443, 21444, 21447, 21451, 25763, 25780, 25782, 25784, 25788, 25791, 25794, 25795, 25797, 25798, 25810, 25811, 25821, 26221, 26222, 26223, 26225, 26227, 26234, 26235, 26236, 26238, 26239, 26242, 26243, 26251, 26253, 26255
2	Uprights aligned in a single row	36	24.5	16163, 16165, 16167, 16176, 16179, 16185, 16187, 16191, 16192, 16194, 16196, 18682, 18683, 21201, 21202, 21203, 21212, 21410, 21424, 21426, 21448, 25783, 25786, 25790, 25793, 25820, 25825, 25826, 25827, 26217, 26219, 26229, 26231, 26244, 26248, 26252
3	Single row of uprights with a gap	10	6.8	16169, 16186, 16189, 16201, 21421, 21430, 21445, 25776, 25778, 26254
4	Type 2 or 3 with additional uprights offset	19	12.9	16170, 16177, 16180, 16190, 16199, 16203, 16204, 21197, 21214, 21418, 21441, 21446, 25772, 25789, 25818, 25819, 26228, 26240, 26250
5	Type 4 + court and uprights	8	5.4	16168, 16184, 16198, 21420, 21431, 25764, 25799, 26233
6	Shrines w/ multiple rows	2	1.4	16166, 25781
7	Dispersed uprights (some on boulders)	7	4.8	16164, 16173, 16174, 16175, 16182, 16200, 26253
	Total	**147**		

RESULTS

Upright Types: Heights, Widths, Shape, and Ratios

Two assumptions have been made about the Mauna Kea uprights. First, with few exceptions, the stones used for uprights do not appear to have been modified; they were likely selected from naturally occurring sources. It is also assumed that, within certain size parameters, the natural occurrence of suitable stone is normally distributed (see Figure 3). From these two assumptions, we can develop two hypotheses. First, if the size of stones used for uprights deviates from a normal distribution, then we may be able to suggest that a non-random selection of material has occurred. Furthermore, if there are substantial size deviations between upright types, we may argue that the size and shape of the selected stones was meaningful and possibly served a functional purpose (e.g., the size of stones had representational value).

Table 1 summarizes the upright data for the 545 uprights used in this analysis. In addition, Figure 4 generalizes the overall size proportions of the data as a ternary graph, based on height, width, and thickness. More than 67 percent of the uprights have a top form that is not flat (i.e., pointed, gabled, or beveled), while flat topped uprights account for approximately 22.1 percent of the assemblage. Rounded and mesial notched topped uprights account for approximately 11 percent of the assemblage. Uprights with parallel, sub-parallel, or divergent (tapering out from the top to the bottom) shapes account for approximately 74.7 percent of the assemblage, while irregular and convergent body forms make up approximately 24.2 percent of the sample. Crescent shaped uprights are rare and only make up about 1.1 percent of the assemblage.

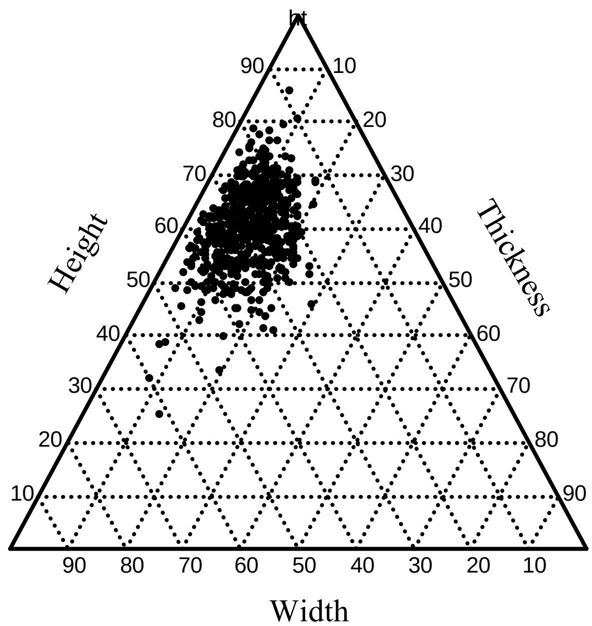


Figure 4. Ternary Plot of Upright Height (ht), Width (wd), and Thickness (th) Proportions.

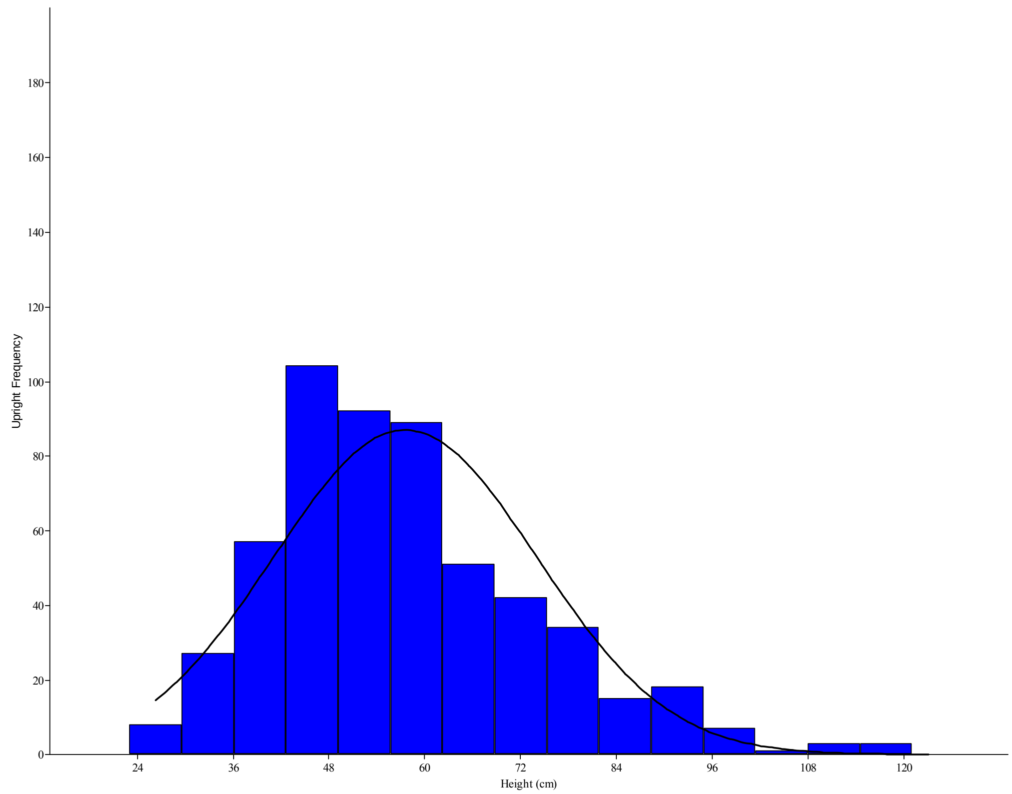
Figure 5 shows a distribution histogram of 545 uprights by height and width. Included on the figure is the projected normal distribution for the same dataset. A Shipiro-Wilk test for normality (W= 0.958, *p[normal]*= 1.099^{-12} for height and W=0.937, *p[normal]*= 7.652^{-16}) determined that neither height nor width is normally distributed, and is skewed, primarily towards shorter and narrower stones. This is demonstrated in Figures 6 and 7 as well, which show box-and-whisker plots of height and width measurements for uprights with 10 or more samples. In Figure 6, 12 of the 18 upright types have median height values less than the mean, while in Figure 7, 10 of the 18 upright types have median width values less than the mean.

When only single upright shrine sites are considered, the results are nearly identical. The Shipiro-Wilk tests for normality (W= 0.958, *p[normal]*= 0.003966 for height and W=0.942, p[normal]=0.004583 for width) are similar to the data for all uprights. Like the full dataset, the single upright shrine data suggest a preference for shorter and narrower stones. However, there is no evidence that that preference deviates significantly from the overall pattern or that individual upright types within the single-upright subset deviate from one another significantly.

In addition to the height and width data presented, the ratio of height to width for each upright was examined. The purpose of this was to investigate the overall shape of each upright type as well as the overall distribution for shrine types (see Figure 4). The results indicate a mean height to width ratio of 2.34, suggesting an overall height that is more than twice the width (where a 1:1 ratio would indicate the same height as width). Variation, however, is indicated by the relatively large number of outliers in Figure 8 and in the overall spread of data (minimum ratio of 0.4 [indicating a wide, short upright] and a maximum ratio of 10.1 [indicating an extremely tall, narrow upright]). The overall distribution of height to width ratio by shrine type is consistent and does not indicate an observable preference by type. While a component of this shape consistency may reflect some natural processes in the formation of the raw materials, the observed variation within the source universe is much greater than the upright population suggesting a cultural choice or preference.

Another aspect of upright size is how it is manifested within individual shrines. In other words, size consistency within a shrine. One way to measure this is to evaluate how much parity there is between uprights in a single shrine by determining the ratio between the tallest and the shortest upright within a shrine or a shrine feature. Values close to 1.0 represent shrines in which the uprights are of the same approximate size, while values close to 0.0 would indicate shrines with large upright size differences.

Figure 9 plots the size ratio relative to the number of uprights per shrine. There is a reasonably strong inverse relationship between upright size parity and the number of uprights per shrine. That is, shrines with more uprights tend to exhibit more consistent upright sizes, while shrines with fewer uprights exhibit greater upright size differences. Furthermore, it appears that two- and three-upright shrines have substantially higher value (more parity) than other shrine types, possibly indicating differences in representational meaning between architecturally less complex shrines and more complex shrines with more uprights and some formal attributes such as courts and well-constructed foundations. The two shrines (sites 16190 and 16194) with the lowest ratios (most size difference) are type 4 and type 2 shrines.



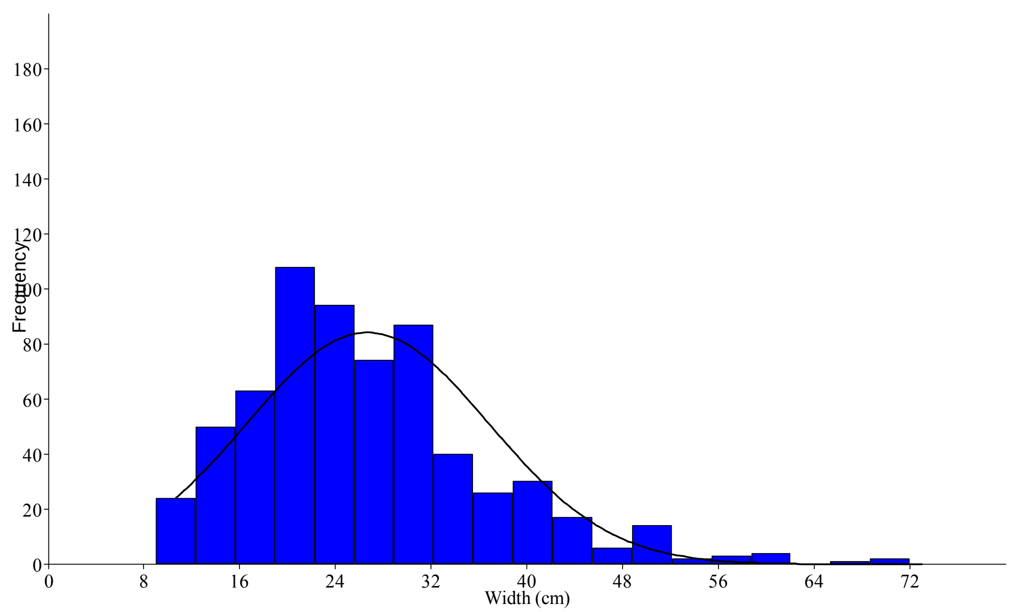


Figure 5. Top: Distribution of All Upright Heights Shown Against the Normal Distribution Curve. Bottom: Distribution of All Upright Widths Shown Against the Normal Distribution Curve. Normal Probability Plot of Same Data.

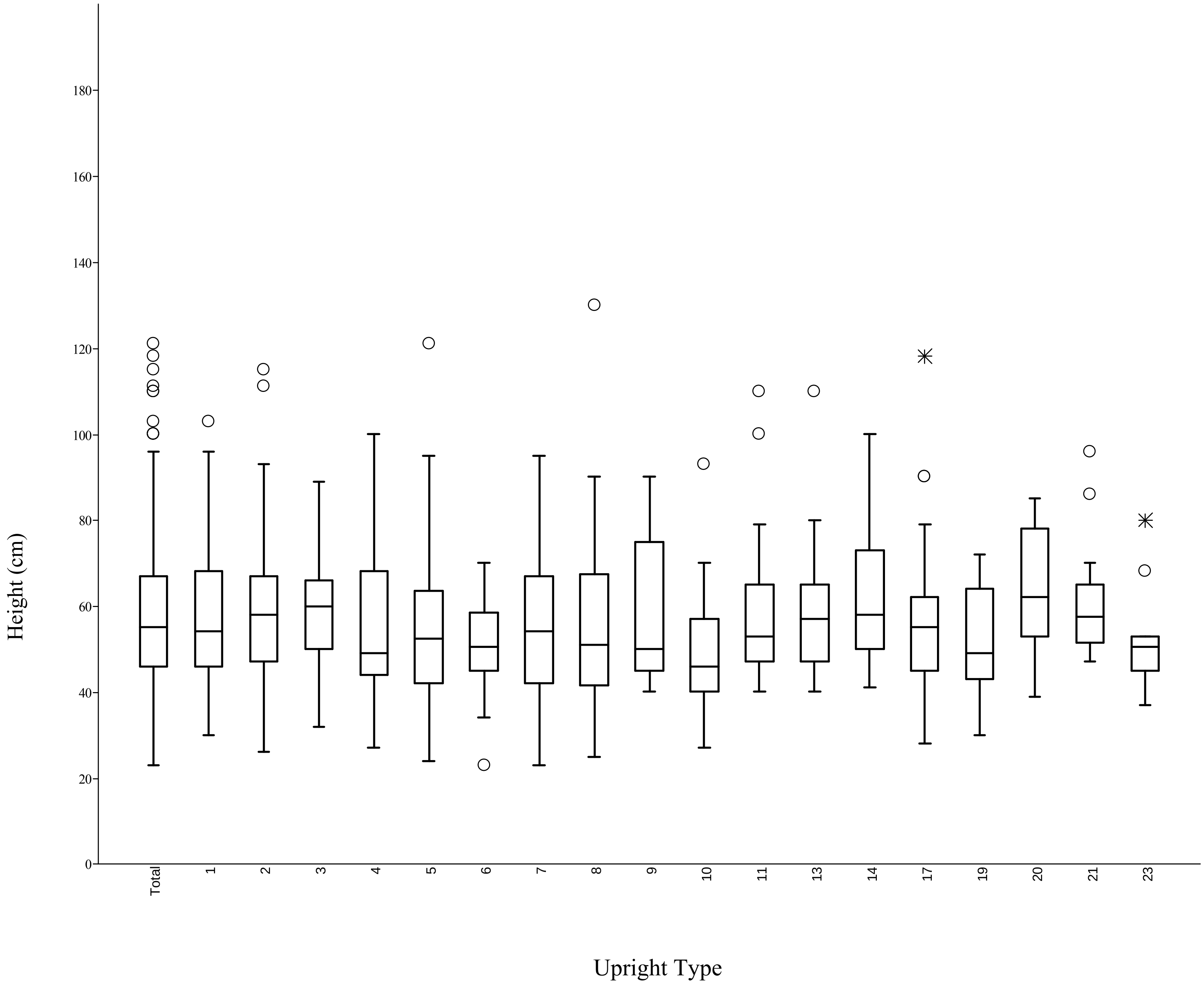


Figure 6. Box-and-Whisker Plot of Upright Heights by Type. Note: refer to Table 1 for a key to the types. Some types have been omitted due to small sample sizes.

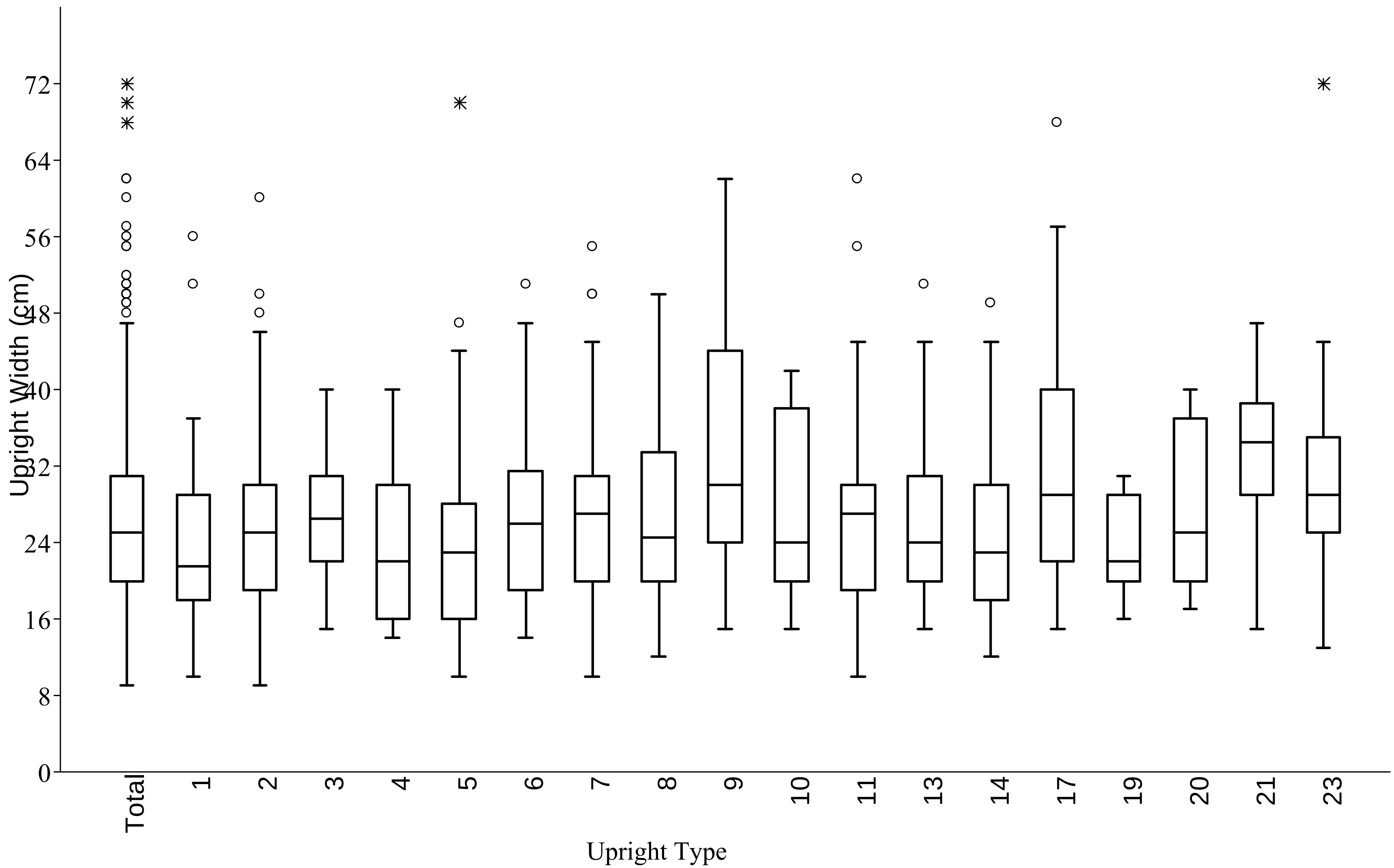


Figure 7. Box-and-Whisker Plot of Upright Width by Type. Note: refer to Table 1 for a key to the types. Some types have been omitted due to small sample sizes.

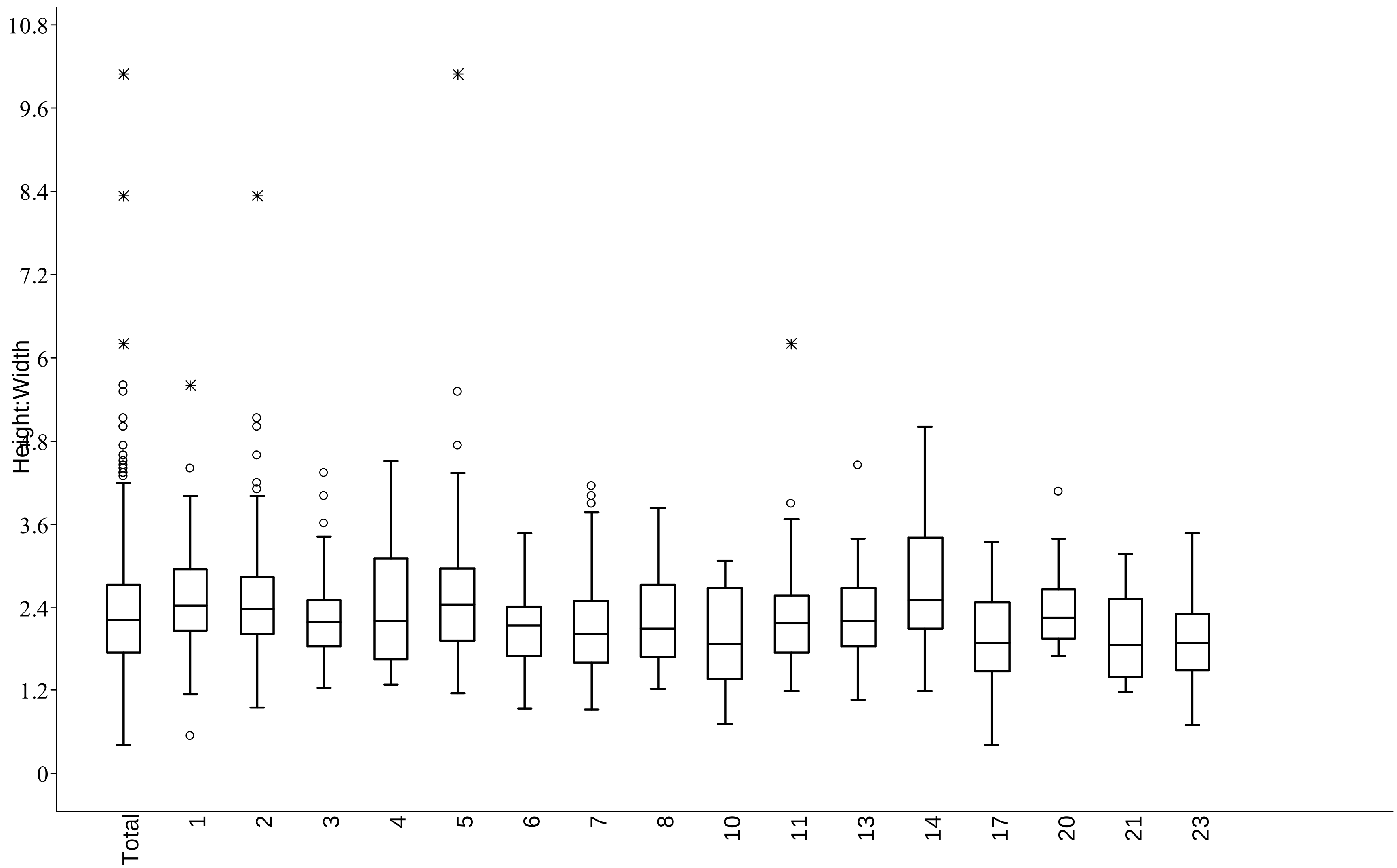


Figure 8. Box-and-Whisker Plot of Upright Height:Width Ratio by Type. Note: refer to Table 1 for a key to the types. Some types have been omitted due to small sample sizes.

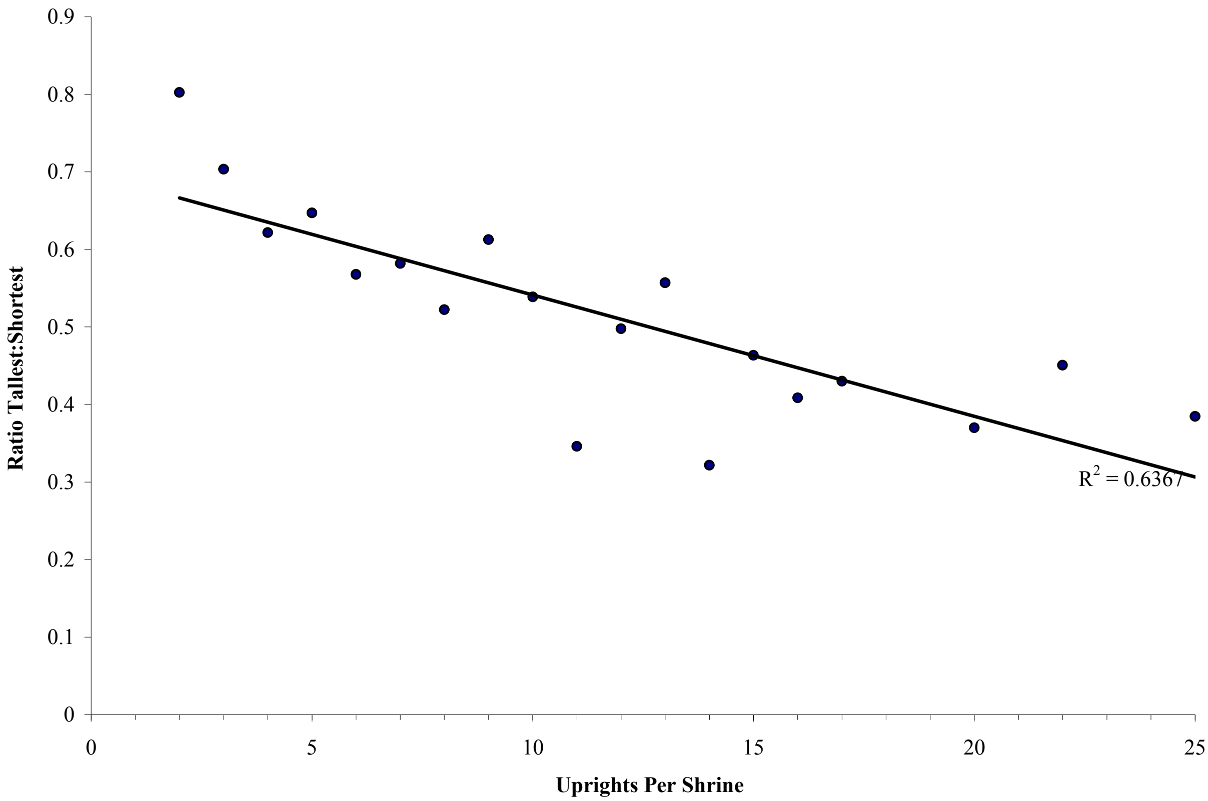


Figure 9. Plot of Upright Parity by Shrine Size (Number of Uprights per Shrine).

The investigation of height and width data by upright type or shrine type did not document significant upright variation that could be confidently attributed to preference beyond the physiology and economics of lifting, moving, and placing large stones. However, the size of uprights may matter in the relative distribution within shrines. As noted, shrines with few uprights show little difference in stone height, while shrines with more uprights have greater size differences. While it may appear that this states the obvious (the more stones, the more variation), it should be remembered that the ratio produced for all shrines was based on only two stones, the largest and the smallest. The relationship suggests that more complex, formal shrines with more than two or three uprights may have communicated more complex information that included relationships between uprights that, in part, was conveyed by size. For less complex shrines with two or three uprights, size parity may be more indicative of generalized or non-specific functions. Within a ritual landscape, a hierarchy of generalizations may be present. For example, if uprights represent deities or possibly human ancestors, then some simple shrines may represent generalized "deity-ness" or human-ness conveying generalized information such as ritual boundaries on the landscape, while in more complex features uprights may represent specific deities or ancestors with specific physical properties.

Uprights and Shrines by Elevation

The shrine and upright data were categorized within seven groups spanning 240 ft of elevation. Tables 3 and 4 show the distribution, by elevation range, of shrine types and upright types, respectively, while Figure 10 shows the distribution of shrine sites graphically. More than 85 percent of the uprights were recorded at elevations between 12,041-ft amsl and 13,000-ft amsl, while over 30 percent of the uprights were recorded between 12,761-ft amsl and 13,000-ft amsl. The data for shrine sites mirror those generated for individual uprights. The high percentage of uprights (and shrines) located within an approximately 250-ft band, 800 to 1,000 ft below the summit may indicate a spatial relationship with the lower limits of the annual snow pack (McCoy 1982), although more refined climatological data that could project past snowfall data are necessary to develop this idea further.

Another observation that might support a relationship between shrines and the lower limits of the annual snow pack is the apparent concentration of shrines in the northern and northeastern quadrant of the summit where approximately 45 percent of shrines (30 percent of the single upright shrines) between 12,761-ft amsl and 13,000-ft amsl have been recorded. Likewise, approximately 47 percent of type 1 shrines were recorded at elevations between 12,521 and-13,000 ft. In addition to more climatological data as noted above, a more complete site inventory of the Mauna Kea Ice Age NAR, which comprises a large portion of the southern quadrant, is needed. In addition to the concentration of shrine sites within a narrow elevation band, the lack of shrine sites above 13,000 ft (approximately 11 percent of the uprights and shrine sites) may also support the snow line argument since the upper summit region would have likely been inaccessible in deep snow. However, inaccessibility to the summit area may have been restricted by social or ritual constraints as well (McCoy 1999).

Another component of the elevation data relates to richness, as described in the methods section. Figure 11 shows the richness plot (derived from the data presented in Table 4) of upright types within the seven elevation zones. As plotted, the upright data for the three lower elevation zones fall well within the expected richness values for their sample sizes using simulated data. However, the data for the upper four elevation zones are quite different. The richness values for the upper two elevation ranges are below expected, while the richness value for the elevation ranges between 12,521 and 13,000 ft is higher than expected. If shrine richness relates to functional diversity then the region between 12,521 and 13,000 ft elevation shows a wider range of activities than any other area in the summit region. Again, several factors such as snow levels, restricted access or restricted activities, and possibly access to resources such as the Mauna Kea adze quarry at approximately 12,400 ft elevation may be responsible for the aggregation.

Table 3. Shrine Type by Elevation Range.

			Shrine Type							
	Elevation Group	**Elevation (ft)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Percent**
Elevation Range	1	<12,040	4	3	2	--	--	1	--	6.9
	2	12,041-12,280	14	4	--	4	3	--	--	17.2
	3	12,281-12,520	11	4	1	2	1	--	1	13.8
	4	12,521-12,760	17	9	1	3	1	--	--	21.4
	5	12,761-13,000	13	14	4	7	2	--	4	30.3
	6	13,001-13,240	4	--	1	3	1	--	1	6.9
	7	>13,241	1	2	--	--	--	1	1	3.4
		Total								**100**

Table 4. Upright Types by Elevation Range.

		Upright Type																											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**27**	**28**	**Total**
Elevation Range	**<12,040**	1	4	--	--	4	--	3	1	--	1	1	--	--	1	--	1	1	--	--	2	--	--	1	--	--	--	--	3.4
	12,041-12,280	12	23	1	4	14	4	22	2	2	2	4	--	13	2	1	3	4	--	3	--	4	2	2	--	--	1	--	20.4
	12,281-12,520	5	22	1	5	7	4	4	5	3	4	3	1	6	3	2	1	4	1	2	2	--	--	2	1	--	--	--	14.5
	12,521-12,760	1	17	11	7	14	2	10	5	2	4	7	2	3	4	2	--	7	--	2	4	4	--	4	--	--	--	--	18.2
	12,761-13,000	19	31	11	2	29	5	19	10	4	3	8	2	7	13	3	3	11	2	3	1	4	1	1	2	2	--	4	32.7
	13,001-13,240	6	14	4	--	4	1	6	4	--	--	--		1	3	--	--	1	--	--	--	--	--	--	--	--	--	--	7.2
	>13,241	1	6	2	4	1	--	4	--	--	--	--		2	--	--	--	1	--	1	1	--	--	--	--	--	--	--	3.6
	Total																												**100**

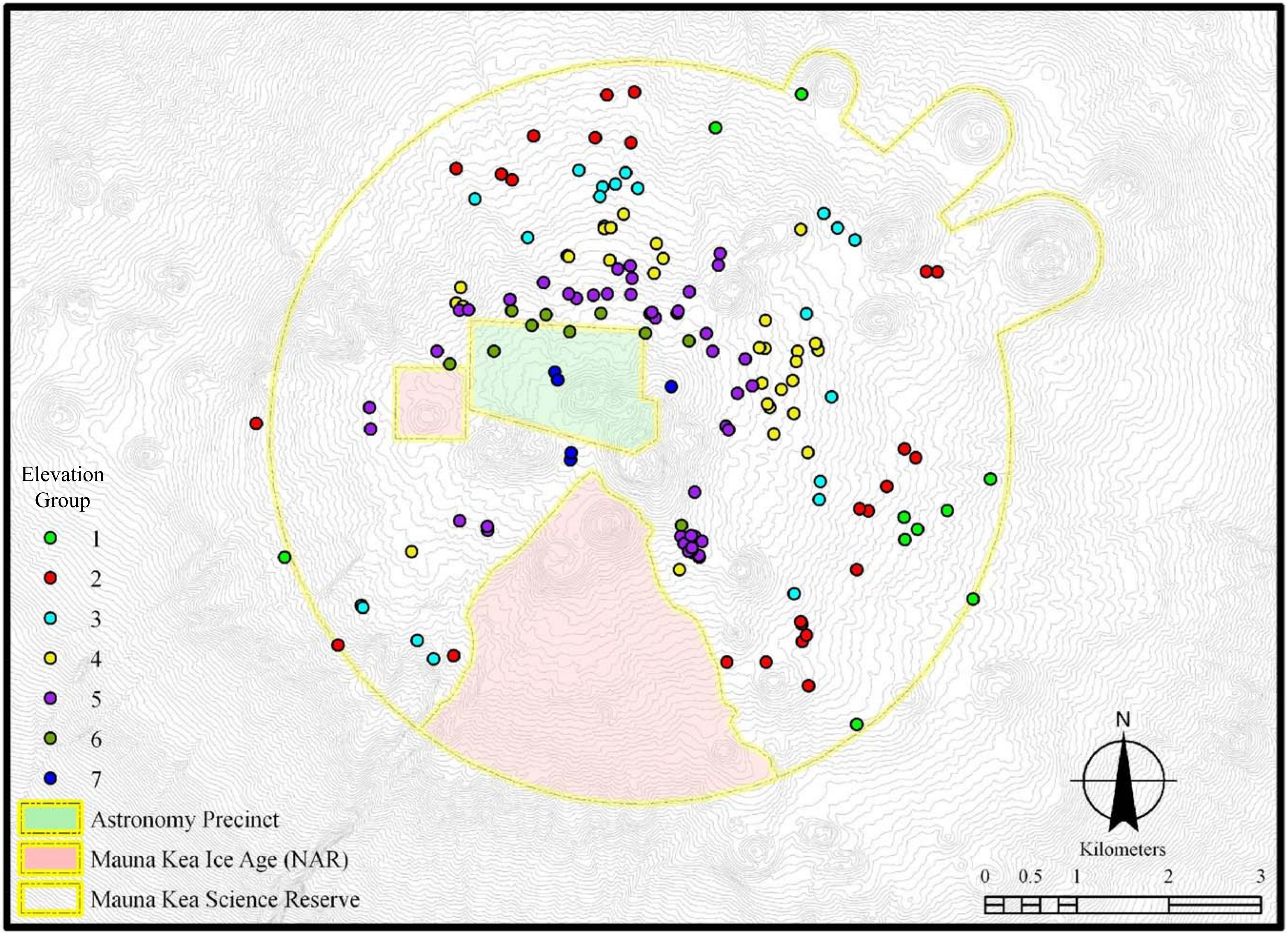


Figure 10. Shrine Sites by Elevation Group. See Table 3 for Corresponding Elevation Range.

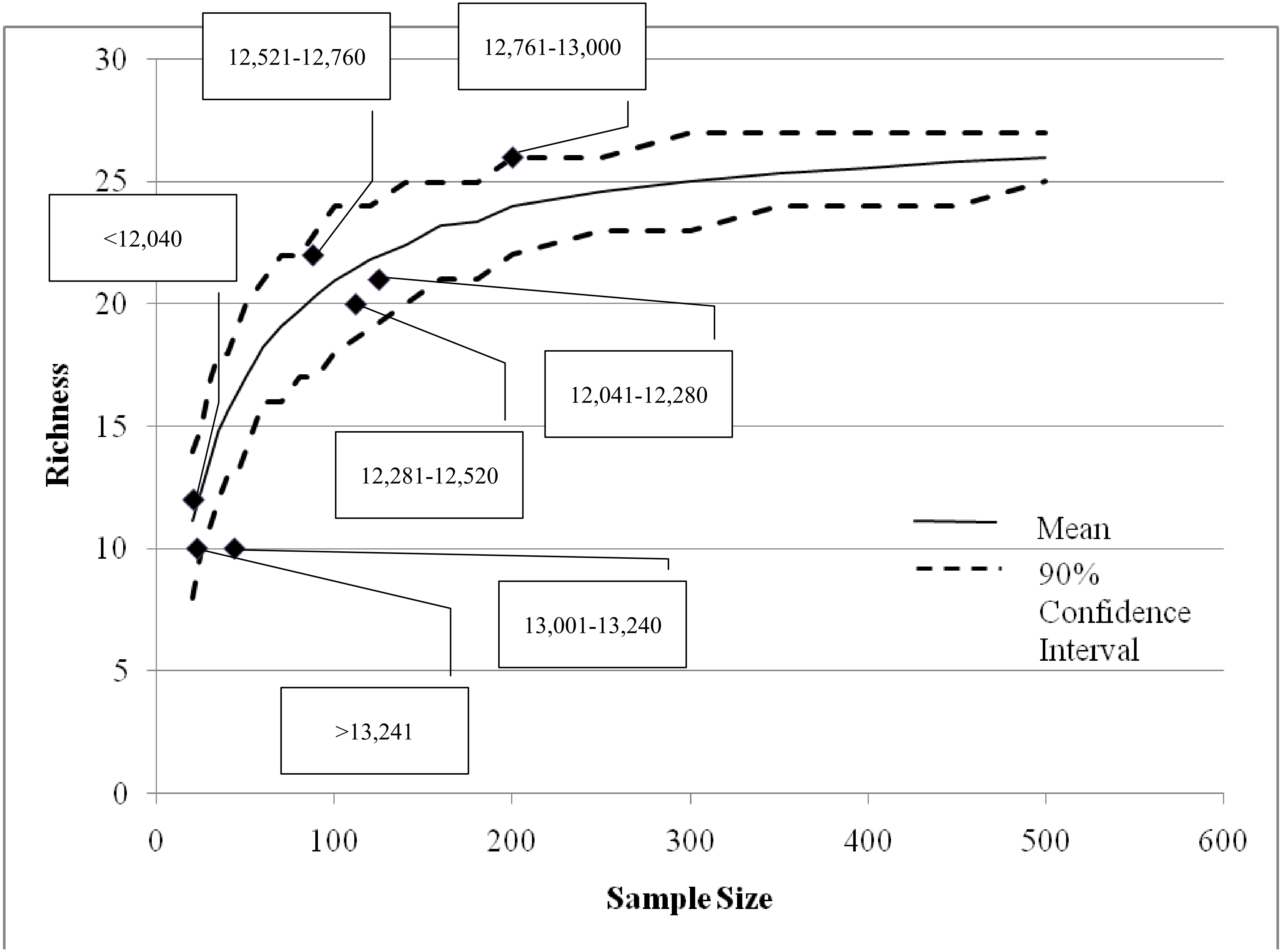


Figure 11. Richness Plot for Uprights by Elevation Range Showing the Mean as well as 90 Percent Confidence Intervals.

Pairwise Comparison

As noted above, pairwise comparison refers to any process of comparing entities in pairs to evaluate which of each pair is preferred. Table 5 shows the placement frequency (pairwise matrix) of upright types for a sample of 26 multiple upright shrine sites.

Table 5 is not particularly informative beyond the observation that several pairs (2/1, 5/2, and 7/5) co-occur slightly more frequently than other pairs. However, when the data are consolidated by upright top form, a pattern begins to emerge. Table 6 consolidates the pairwise data by the six upright top forms. Eighteen (45 percent) pairwise combinations include a flat top upright next to either a pointed or a beveled upright, suggesting a tentative, non-random, relationship. Since the relationship involves two primary upright types, it would be reasonable to look for social or ritual relationships emphasizing dichotomies such as male/female or paired deities.

Table 5. Pairwise Distribution of Upright Types.

		Upright Type														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**11**	**13**	**14**	**17**	**20**	**23**
Upright Type	**1**	2	3	--	--	1	--	1	1	--	--	1	--	1	--	--
	2		1	--	1	3	1	1	1	--	2	--	--	2	--	--
	3			--	--	--	--	--	--	--	--	1	--	--	--	--
	4				--	--	--	--	--	--	--	--	--	--	--	--
	5					1	--	4	--	--	--	--	1	2	1	--
	6						--	--	1	--	--	--	--	--	--	--
	7							1	1	--	--	--	--	--	--	--
	8								--	2	--	--	--	--	--	--
	10									--	--	--	--	--	--	--
	11										--	--	1	1	--	--
	13											--	--	--	--	--
	14												--	--	--	--
	17													--	--	1
	20														--	--
	23															--

Table 6. Consolidated (generalized) Pairwise Distribution of Upright Top Forms.

	Pointed	Beveled	Gabled	Rounded	Flat	Mesial
Pointed	4	5	1	--	8	--
Beveled		1	--	2	10	2
Gabled			--	--	--	--
Rounded				--	--	--
Flat					7	--
Mesial notched						--

An additional consolidation or abstraction of the data for 26 multiple upright shrine sites is shown in Table 7, where basic upright top forms are considered against whether they occur on the edges (outside) of shrine configurations or on the interior (inside) of shrine configurations. Because there are twice as many opportunities for an upright to occur on the outside of a shrine (either on the left or right side) than on the inside, the data appear to show no real preferences, although there may be a tendency toward flat uprights occurring on the interior of shrines.

Table 7. Generalized Distribution of Upright Placement by Top Form.

	Pointed	Beveled	Gabled	Rounded	Flat	Mesial
Inside	4	5	--	--	7	--
Outside	8	8	--	--	10	1

K-Means Clustering

As described in the Methods sections, K-Means clustering was applied to 148 shrine sites in the summit region. Since there was no *a priori* indication of the number of possible clusters, a range between one (all sites) and 10 clusters was investigated based on visual inspection of the data distribution. Figure 12 plots the number of clusters against the percent of squared-sum error (SSE) for each cluster. The SSE value indicates the centricity or amount of cohesion within the cluster groups. Where that cohesion value shifts dramatically (noted on the graph as a "dog-leg") is generally understood to be the optimal number of clusters. In this case, the optimal number of clusters is four. The distribution of each cluster on the landscape is shown graphically in Figure 13.

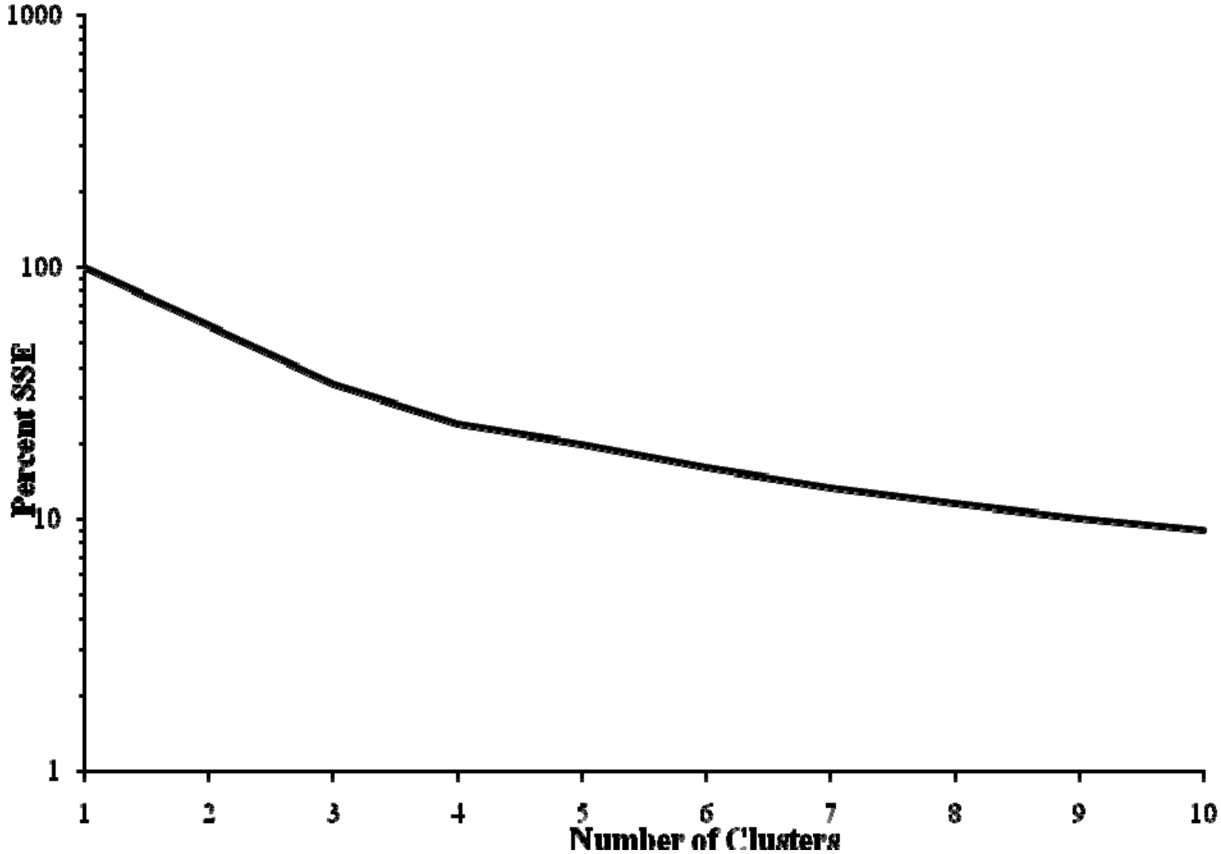


Figure 12. Plot of Percent SSE versus Number of K-means Clusters. Note that the Y-axis is scaled logarithmically.

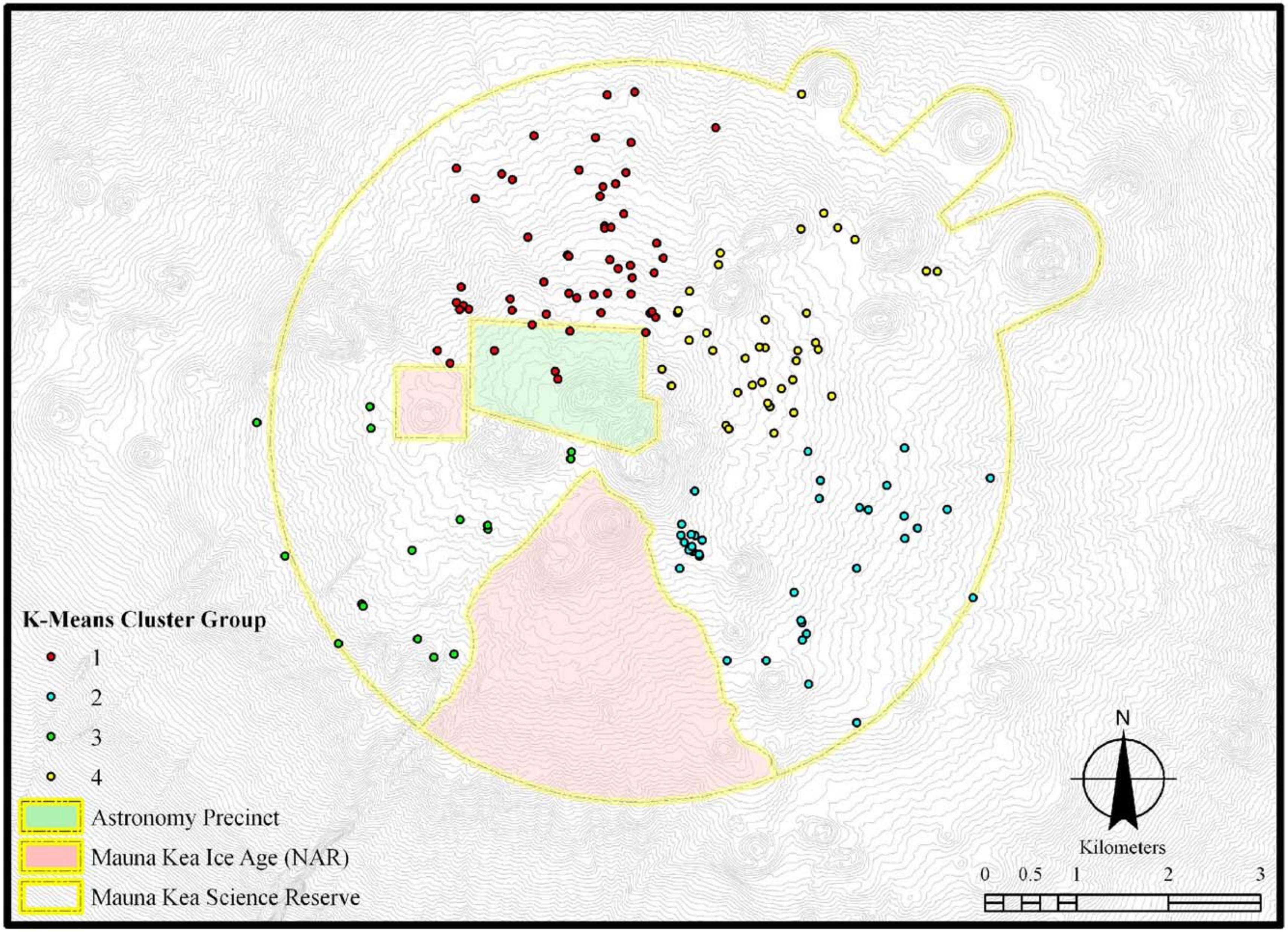


Figure 13. Graphic Display of Four Cluster K-means Solution.

Overall, the spatial distribution of the clusters reflects the cone-like topography of the summit region and the observation that comparatively few sites have been recorded above the 13,240 ft elevation, thus creating an apron-like distribution. As well, the cluster configurations would likely change if data from the Mauna Kea Ice Age NAR were included for the southern portion of the summit region. While most of the cluster groups are intuitively reasonable, Cluster 2 (see Figure 13) appears to contain, minimally, three "sub clusters." However, these sub clusters are not distinguished or broken into individual clusters in the k-means analysis until an eight-cluster solution is reached. In other words, the cohesion of Cluster 2 is robust and the apparent sub clustering is likely an artifact of projecting three-dimensional space onto a two-dimensional surface (remembering that k-means is a purely spatial analytical tool).

Another aspect of k-means analysis that can provide additional meaning is analyzing group composition for homologies. Table 8 shows the sites and their respective shrine types. Table 9 provides summary data for Table 8.

Table 8. Shrine Sites by K-means Cluster Group.

Site Number	**Shrine Type**
Group 1	
16171	1
16172	1
16178	1
21198	1
21199	1
21200	1
21417	1
21422	1
21425	1
21427	1
21428	1
21429	1
21442	1
21443	1
21444	1
21447	1
26221	1
26222	1
26223	1
26225	1
26227	1
26234	1
26235	1
26236	1

Site Number	Shrine Type
26238	1
26239	1
16167	2
16176	2
16179	2
21201	2
21424	2
21426	2
21448	2
26217	2
26219	2
26229	2
26231	2
16169	3
21421	3
21445	3
16170	4
16177	4
16180	4
21418	4
21441	4
21446	4
26228	4
26240	4
16168	5
21420	5
26233	5
16166	6
16173	7
16174	7
16175	7
Group 2	
11077	1
16197	1
16202	1
21210	1
21211	1
21213	1
21409	1
21432	1
21451	1

Site Number	**Shrine Type**
25763	1
25780	1
25782	1
25784	1
25788	1
16163	2
16194	2
16196	2
18682	2
18683	2
21212	2
25783	2
25786	2
16201	3
21430	3
25776	3
25778	3
16199	4
16203	4
16204	4
21197	4
21214	4
25772	4
16198	5
21431	5
25764	5
25781	6
16200	7
Group 3	
21406	1
21407	1
21408	1
26242	1
26243	1
26251	1
26253	1
26255	1
16165	2

Site Number	Shrine Type
21410	2
26244	2
26248	2
26252	2
26254	3
26250	4
16164	7
26253	7
26253	8
Group 4	
G416181	1
16188	1
16193	1
21205	1
21206	1
21207	1
21208	1
21433	1
21435	1
25791	1
25794	1
25795	1
25797	1
25798	1
25810	1
25811	1
25821	1
16185	2
16187	2
16191	2
16192	2
21202	2
21203	2
25790	2
25793	2
25820	2
25825	2
25826	2

Site Number	Shrine Type
25827	2
16186	3
16189	3
16190	4
25789	4
25818	4
25819	4
16184	5
25799	5
16182	7

Table 9. Percentage of Shrine Types by K-means Cluster Group.

	Shrine Type							
	N	1	2	3	4	5	6	7
Group 1	*55*	47	20	5	15	5	2	5
Group 2	*37*	38	22	11	16	8	3	3
Group 3	*18*	44	28	6	6	--	--	11
Group 4	*38*	45	32	5	5	5	--	3

The overall distribution of shrine types by k-means group suggests reasonable similarity between clusters, especially for shrine types well represented within the samples. Again, if shrine types are indicative of function, it would appear that similar functions were occurring in most of the clusters rather than being geographically localized, which might indicate that the summit region was somewhat integrated socially or ritually, even if it was not integrated politically. As well, it appears that shrine size is not geographically isolated and that larger shrines are spread throughout each cluster. Again, if shrine size held functional importance, that importance was shared throughout the summit area. However, this observation is tentative based on the lack of data from the Mauna Kea Ice Age NAR.

Summary

Although the dataset did not develop overwhelming evidence for any particular shrine or upright pattern, several areas of inquiry provided additional information to develop cultural-historical interpretations. First, the size parity data may indicate a communicative difference between shrines with two or three uprights and shrines with more complex configurations; smaller shrines may describe the minimum essence of what the builder or builders was trying to communicate, while more complex shrines communicate more detail. It is unclear whether simpler shrines evolved into more complex forms over time. Second, the elevation data provide stronger evidence that a diversity of functions, based on the diversity of shrine types, were undertaken in a narrow band approximately 800 to 1,000 ft below the summit. One of these functions may have included the repeated marking of the lower limits of the annual snow pack, but others may relate to the ritual use of the summit, possible access restrictions to the summit, or even activities occurring at lower elevations in the ahupua`a necessitating ritual displays at the summit. Finally, the k-means clustering may indicate that, overall and with regards to shrines, the summit region was fairly well integrated and that activities that occurred in one geographic area were repeated in similar ways in other geographic regions.

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