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<sup>230</sup>THORIUM DATING OF TOOLSTONE PROCUREMENT  
STRATEGIES, PRODUCTION SCALE AND RITUAL PRACTICES  
AT THE MAUNA KEA ADZE QUARRY COMPLEX, HAWAI'I

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With the advent of <sup>230</sup>Thorium dating of branch coral (e.g., *Pocillopora* spp.) in Pacific archaeology, the chronology of many sites, regions and ritual practices is being significantly refined (Khaweerat *et al.* 2010; Kirch and Sharp 2005; Sharp *et al.* 2010; Weisler *et al.* 2006). Although rare, the presence of unweathered pieces of *Pocillopora* spp. coral in the Mauna Kea Adze Quarry Complex, on the island of Hawai'i (Figure 1), provides an opportunity to refine the chronology of this site complex which until recently had been based on radiocarbon age-determinations alone (McCoy 1977, 1990, 1991). Two recently published <sup>230</sup>Th dates of AD 1398 ± 13 and AD 1441 ± 3 (McCoy *et al.* 2009) established the near-contemporaneity of two shrines in one part of this massive quarry complex. Since the publication of the first <sup>230</sup>Thorium dates, two additional pieces of branch coral were found in the adze quarry at a newly recorded site (State of Hawai'i Statewide Inventory of Historic Places Site 50-10-23-28637) during an archaeological survey of the Mauna Kea Ice Age Natural Area Reserve in 2008-2009 (Figure 1; McCoy and Nees 2012). One piece of coral, found on the surface of a workshop, was extremely weathered and unsuitable for dating. The dated sample reported here is from the interior surface of a habitation rockshelter.

In this paper we describe the provenience of the new <sup>230</sup>Th date, the dating methods used, and the results. We then discuss the implications that the three <sup>230</sup>Th dates now available for the Mauna Kea Adze Quarry Complex have for understanding the chronology of toolstone procurement strategies, the scale of production and ritual practices in the mid-14th to mid-15th centuries AD. We begin, though, with a brief overview of the Mauna Kea Adze Quarry Complex.



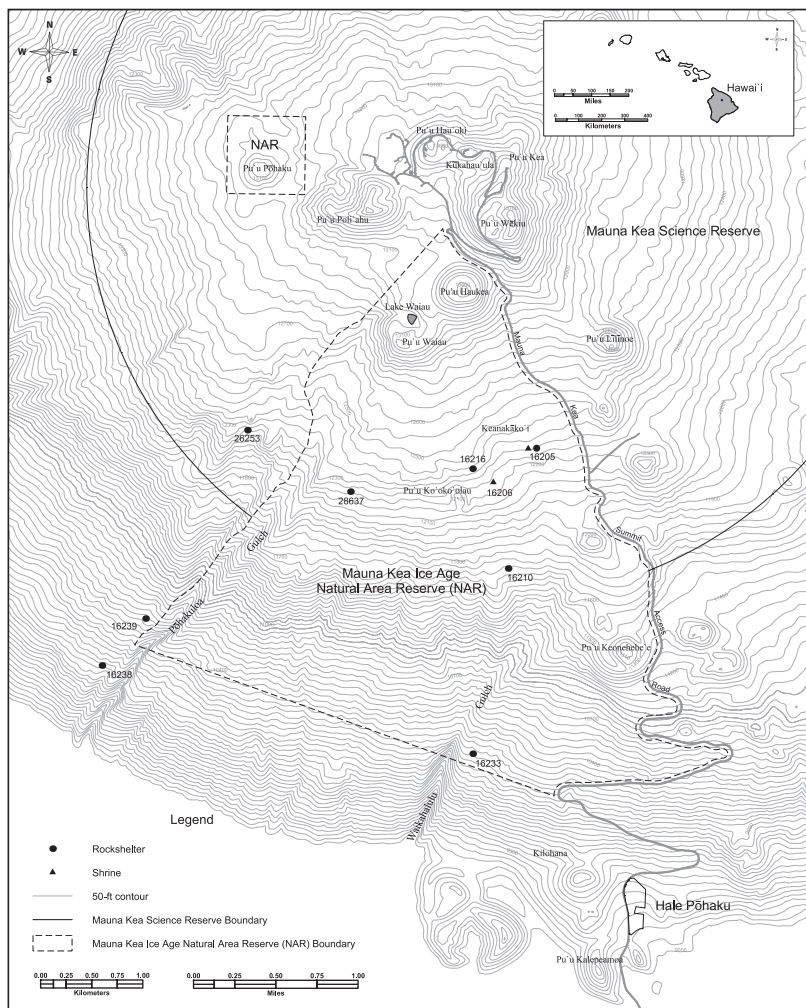


Figure 1. Location of dated sites in the upper reaches of the Mauna Kea Adze Quarry Complex.

## THE MAUNA KEA ADZE QUARRY COMPLEX

Prior to research investigations begun in 1975-76 (McCoy 1977, 1990) the Mauna Kea Adze Quarry Complex, located in an alpine desert and sub-alpine forest environment on the south flank of Mauna Kea (Fig. 1), was essentially archaeological *terra incognita*, even though it had been placed on the National Register of Historic Places in 1962 as a National Historic Landmark. Based on archaeological investigations (McCoy 1977, 1986, 1990, 1991; McCoy and Nees 2012) the quarry complex covers roughly 19.4 km<sup>2</sup>, although the southern or lower boundary is still unclear because of spotty survey coverage in the forest below the ~3000 m elevation.

However the boundaries are drawn, the Mauna Kea Adze Quarry Complex covers more area and contains more discarded adze preforms and manufacturing debitage than all of the other adze quarries in Hawai'i combined (McCoy 1977, 1990; McCoy and Nees 2010, 2012). The size of the quarry is directly related to the local geology. The Mauna Kea Adze Quarry Complex is unique among Hawaiian adze quarries in the presence of two different, but related, sources of toolstone. The primary source is a series of basalt flows found along and below an escarpment at 3750 m elevation in the vicinity of Pu'u Ko'oko'olau and at similar elevations in the Pōhaku'loa and Waikahalulu gulch drainages (Fig. 1). Here are found the largest and most diverse sites in the quarry complex, defined in terms of the number, density and variety of extraction areas, other workshops, habitation rockshelters, shrines, petroglyphs, a basaltic glass source and possible burials. The second raw material source consists of glacial drift deposits of different ages containing lithologically similar sub-angular to sub-rounded boulders and cobbles that occur in both unconsolidated and indurated form (Gregory and Wentworth 1937, Porter 1979, Wentworth and Powers 1941, Wolfe, Wise and Powers 1997). Sites located in the glacial drift tend to be smaller, less complex and more dispersed.

The Mauna Kea Adze Quarry Complex has one of the longest chronologies of any single archaeological complex in Hawai'i, although there is some geochronological evidence for short hiatuses in the quarry sequence (McCoy 1977, McCoy and Nees 2012). Based on radiocarbon dates on unidentified charcoal from three rockshelters (sites 16205, 16216 and 16239; see Figure 1), the quarry industry spanned approximately 700 years, between about AD 1100 and AD 1800 (McCoy 1977, 1990: 92-93), although a shorter chronology now seems more likely based in part on recently obtained radiocarbon age-determinations for the settlement of the Hawaiian Islands, which some archaeologists now argue probably did not occur until AD 900-1000 (Kirch 2011). The peak period of production, which clearly exceeded local needs

(McCoy 1990: 110, McCoy and Nees 2012), spanned a period of about 350 years between AD 1400 and 1750. Recent archaeological surveys have established the existence of ascent-descent routes used by adze makers from different parts of the island, thus lending new support to the hypothesis that the quarry was a common resource (McCoy 1990: 112, McCoy and Nees 2012).

#### SITE 28637

##### *Location and General Description*

Site 50-10-23-28637 is located on the edge of a ridge at about 3758 m elevation in a stony alpine desert. It is situated at the contact between an older (70-150,000 years) basaltic lava flow and a younger (13-40,000 years) deposit of glacial till (Dorn *et al.* 1991, Porter 1979, Wolfe *et al.* 1997). The site was found during a cultural resources survey in 2009 which did not include detailed mapping and excavations because of a lack of funding (McCoy and Nees 2012). The site is comprised of one bedrock extraction area, over 40 other workshops, three rockshelters and two diffuse scatters of debitage spread over an area of approximately 2 ha.

The toe of the ridge, where extraction took place, is an exposure of what appears to be petrologically uniform fine-grain basalt, although some between-flow geochemical variation exists (Mills and Lundblad 2006, Mills *et al.* 2008, McCoy and Nees 2012). Further study, currently in progress, using more highly discriminating geochemical techniques (e.g., Collerson and Weisler 2007) is needed to adequately characterise the multiple toolstone sources on Mauna Kea. The extraction area covers roughly 211 m<sup>2</sup> and is characterised by the presence of pits indicative of the mining of subsurface material. Numerous cores, adze preforms, hammerstones and flakes are found in and around the pits and other parts of the ridge. Mantling the ridge and landscape and extending far down slope are glacial drift deposits.

Of particular interest here is Rockshelter 1 which contained the dated piece of coral. It is located below and southeast of the extraction area and is contiguous with Workshop 1 (Fig. 2). A stacked and piled rock wall of cobbles and small boulders is located at the opening, beneath the dripline (Figs 2 and 3). The wall is oriented parallel to the opening and measures approximately 4.2 m long by 2.4 m wide at the southeast end and 1.1 m at the northwest end, with a maximum height of 0.45 m. The opening to the rockshelter is a southwest facing narrow crawlway between the enclosing wall and a natural rock pile. It is 1.0 m wide and 1.1 m high at the dripline. The interior of the rockshelter measures 3.5 m wide, 1.4 m deep (maximum), with a ceiling height between 1.1 m at the entrance and 0.4 m at the back. The interior surface is a sandy soil, mixed with cobble-size blocks of lava and debitage that may be from the enclosing wall, which is partially collapsed (Fig. 3).







Figure 3. Site 50-10-23-28637 Rockshelter 1 interior surface and enclosing wall.

### *Coral Sample Context*

The coral from Rockshelter 1 was found on the surface, together with some 50 flakes, at least three adze preforms and a small number of cores (Fig. 2). Noticeably absent on the surface is a hearth or any evidence of a fire, such as charcoal and ash. Fire hearths were an absolute necessity of living and working in the quarry because of the common occurrence of freezing nighttime temperatures at these high elevations. Also absent from the surface are bone, shell and plant residues. At first glance the rockshelter does not appear to have ever been occupied, except for the presence of the enclosing wall. The relatively clean appearance of the rockshelter floor, and many of the other 52 recorded rockshelters<sup>1</sup> in the quarry, is one of the reasons that Emory (1938) believed that the adze makers lived down the mountain in warmer places and walked daily to their work.

Even though the rockshelter has not been excavated, there are obvious signs of use in the presence of a substantial enclosing wall. Elsewhere in the quarry, rockshelters with enclosing walls (Table 1) are associated with well-

Table 1. Excavated rockshelter characteristics.

Site No.	Rockshelter	Elevation (m)	Enclosing Wall	Roof-top Shrine	Interior Floor Area (m <sup>2</sup> )	Excavated Area (m <sup>2</sup> )
16216	Ko'oko'olau 1	3780	+	+	8	4.0
16205	'Ua'u	3720	+	+	21	6.0
16210	'Ahinahina	3475	+	-	17	1.0
16233	Waikahalulu	3100	-	-	23	2.0
16238	Hopukani 1	3100	-	-	24	1.0
16239	Hopukani 2	3170	-	-	6	1.75
26253	—	3769	-	-	4	0.5

stratified deposits containing fire hearths, bird, fish and mammal remains, and both wild and domesticated plants that point to extended occupation (Allen 1981, 1986; McCoy 1977, 1986, 1990; McCoy and Nees 2010, 2012). It therefore seems highly likely that this rockshelter will also yield evidence of occupation upon excavation.

The likely reason for the lack of surface habitation evidence at many of the rockshelters in the quarry is that they are examples of what are variously referred to in the archaeological literature as “deliberate”, “structured”, or “special” deposits (Bradley 2000, 2003; Jones 1998; Richards and Thomas 1984; Thomas 1991) that are identified “through recurrent patterns of association and exclusion” (Bradley 2000: 118). As argued elsewhere (McCoy 1990), all of the evidence points to the rockshelter surface layers as “ritual fill” deposits resulting from deliberative actions intended to cap and thus remove from view the accumulated residues of meals and offerings to the gods that are polluting and thus dangerous to man in a sacred context (Douglas 1966: 160, 1975: xv; McCoy 1990).

#### DATING METHODS AND RESULTS

The sample consists of a single *Pocillopora* sp. finger 61.7 mm long, 47.3 mm wide and 37.0 mm thick and weighing 46.5 g. The sample was dated by the U-series method using the analytical procedure described in Weisler *et al.* (2006). The corrected <sup>230</sup>Th age is AD 1355 ± 28 (lab sample number 2010-003). This sample contains 5.65 ppb <sup>232</sup>Th, a Th level definitely not from seawater, but from sediment contaminant during burial at the site. In this case, the correction scheme for this sample, in which we use a bulk-earth

value for non-radiogenic <sup>230</sup>Th/<sup>232</sup>Th ratio, is more appropriate. Sediment Th/U ratios should be within the range of the bulk-earth average, similar to that of basaltic bedrock in the area. The large 2-sigma error of  $\pm 28$  years is due to the assumption of  $\pm 50$  percent for the bulk-earth value.

## DISCUSSION

The  $1355 \pm 28$  AD date for site 28637 is the first <sup>230</sup>Th date for a habitation rockshelter in the Mauna Kea Adze Quarry Complex. In contrast to the two previously dated pieces of coral from shrines at sites 16205 and 16206, both interpreted on contextual evidence as “dedicatory offerings”, the coral at site 28637 is more difficult to interpret in terms of why and when it was left on the floor of the rockshelter. Although it would appear to have been deposited at the time the rockshelter was abandoned, we cannot discount the possibility that it was introduced at an even later date as some kind of commemorative act performed in honour of earlier adze makers. Two pieces of coral found in layer II of ‘Ua‘u Rockshelter (site 16205, Fig. 1) during excavations in 1975 could help resolve this interpretive dilemma, but unfortunately we have not been able to relocate these specimens, which are housed with the rest of the Mauna Kea Quarry collections from the 1975-76 project in the Bernice P. Bishop Museum.

While the dated coral from site 28637 remains open to some question, the <sup>230</sup>Thorium dates for sites 16205, 16206 and 28637 taken together have significant implications for interpreting the chronology of toolstone procurement strategies, the scale of production and ritual practices in the mid-14th to mid-15th centuries AD.

### *Toolstone Procurement Strategies*

Unlike most adze quarries in Hawai‘i, where toolstone consisted primarily of boulders and blocks that were merely collected from the surface (McCoy, Sinoto and Makanani 1993; Weisler 1990, 2011), new strategies were developed on Mauna Kea to extract raw material from the margins of lava flows and to mine subsurface exposures of toolstone, in addition to collecting loose surface material. Though caution is needed in interpreting the single surface date from site 28637, it raises questions about the chronology of adze manufacture in this part of the quarry which was previously believed to have been characterised by an optimal, mixed strategy of earlier surface collecting and later bedrock extraction or mining (McCoy 1990: 93-94). The evidence from site 28637 points instead to multiple raw material procurement strategies and reduction methods at a relatively early period in the history of the quarry. Further research is needed to test this proposition, but there seems little doubt that by the middle of the 15th century AD, and possibly earlier,

the adze makers were using more labour-intensive methods of extracting raw material from flows while also making preforms from glacial cobbles and boulders found on the surface of glacial drift deposits.

### *Scale of Production*

There are now three  $^{230}\text{Th}$  dates from three different sites in the upper elevations of the Mauna Kea Adze Quarry Complex (Fig. 1). The dates confirm what could only be suggested with less precise radiocarbon dates, namely that different parts of the quarry were used contemporaneously during the 14th and 15th centuries. The new date of  $\text{AD } 1355 \pm 28$  from site 28637 is contemporaneous with a date of  $\text{AD } 1398 \pm 13$  from shrine 4, located above the entrance to Keanakako'i (lit. 'Cave of the adze') at site 16205, approximately 1.6 km to the east (Fig. 1). The date for site 28637 is slightly older than the  $\text{AD } 1440 \pm 3$  date from a possible communal shrine at site 16206 (McCoy *et al.* 2009), located about 440 m southwest of the site 16206 shrine and 1.5 km east of Rockshelter 1 site 28637 (Fig. 1).

Additional support for an increasing scale of production in the 14th and 15th centuries AD comes from a recently excavated site in a previously little known part of the quarry complex located along Pōhakuloa Gulch (McCoy and Nees 2010). In 2008 a radiocarbon date of  $450 \pm 40$  BP (Beta-256935), corrected to  $\text{AD } 1420\text{--}1480$  at the 95 percent confidence level, was obtained on a piece of *Dubautia* sp. charcoal from a rockshelter at site 26253, located roughly 1.2 km to the west of site 28637 (Fig. 1) at 3769 m elevation (McCoy and Nees 2010: Table 6.16). This date provides further support for the exploitation of raw material sources near the western extremity of the quarry in the mid to late 15th century. Like site 28637, site 26253 is located in an area with extraction pits as well as glacial drift deposits containing toolstone quality rock.

### *Variability in Ritual Practices*

The Mauna Kea Adze Quarry Complex is arguably one of the most important archaeological exemplars of what Handy called a "consecrated industry" in his description of traditional Polynesian crafts, where ritual was a pervasive element (Handy 1927: 282). There is abundant evidence that adze manufacture on Mauna Kea, like the making of a Hawaiian canoe, was an "affair of religion" (Malo 1951: 126). The ritual practices identified in the quarry include:

- (i) the propitiation of what are believed to have been the tutelary gods of adze manufacture at different social scales or levels (e.g., individual work groups and communal rites) in the form of lithic artefact offerings (flakes,

- cores, adze preforms and hammerstones) placed on shrines (McCoy 1981, 1990; McCoy *et al.* 2009; McCoy and Nees 2010, 2012);
- (ii) rites of passage performed on the ascent and descent from the quarry, involving in one case a probable change in status from *noa* to *kapu* at a treeline camp (McCoy 1991, 2012), and in another case, the possible initiation of apprentice adze makers (McCoy 1990, 1999);
  - (iii) mortuary rituals associated with the interment of what are inferred to be adze makers in the quarry and elsewhere in the summit region of Mauna Kea, including possibly Lake Waiau (McCoy and Nees 2012);
  - (iv) offerings of diverse perishable foods and goods left inside of at least two rockshelters (McCoy 1990, McCoy and Nees 2012); and
  - (v) the ritualised desecration of some shrines in the deliberate breakage of the god-stones (McCoy and Nees 2010, 2012).

The latter two practices, as well as the possible burials, may post-date the abandonment of the quarry.

What is rather surprising about these different forms of ritualisation (Bell 1992), and the rites performed at shrines in particular, is how few of them used branch coral. We know of only six coral specimens, including the two missing pieces found in the excavation of ‘Ua‘u Rockshelter, despite several large-scale archaeological surveys (McCoy 1977, 1990; McCoy and Nees 2010, 2012) that have recorded some 78 shrines in the upper reaches of the quarry.

Why so little branch coral has been found in the adze quarry is difficult to understand since it was commonly used elsewhere by Hawaiians before European contact as a ritual offering based on ethnographic data (Handy 1927, Malo 1951) and its archaeological occurrence in religious contexts (Kirch and Sharp 2005, Weisler *et al.* 2006). Another interesting question without any ready answer is why the three dated samples all fall within a relatively short time span in the 14th and 15th centuries AD. Portability was clearly not an issue since coral branches would have been an insignificant addition to the supplies carried by adze makers or their assistants, even though at more than 45 km from the sea the adze quarry is one of the most remote archaeological complexes in the Hawaiian Islands. One possible explanation for the scarcity of coral is the substitution of some other item. A probable example of such behaviour is the likely substitution of certain plants and marine foods for pigs which, along with dogs, were common offerings to the gods. Pig and dog remains occur in the quarry faunal assemblages but in unexpectedly small numbers given the status of the adze makers and abundance of other offerings to the gods. In the case of pigs, it is likely that what the Hawaiians called “leaf pigs” and “sea pigs” were used as substitutes



for the real thing (McCoy 1990, Valeri 1985). Another possible explanation is the restricted distribution of coral reefs on the island of Hawai‘i, especially on the windward coast which was the probable home of many of the adze makers based on both ethnographic and archaeological data. Whatever the reason, ritual performance among the Mauna Kea adze makers involving coral offerings was extremely limited with only 2.5 percent of shrines associated with coral. This is in marked contrast to the ubiquity of coral used for ritual and oftentimes included as construction fill in coastal fishing shrines; indeed, coral is considered a defining characteristic of this site class. Regional studies of branch coral use over time and space should elucidate additional details of Hawaiian ritual practice.

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#### NOTE

1. Archaeological classifications are not immutable and in fact often require revision. This is true of the original site classification system employed in research on the Mauna Kea Adze Quarry Complex. As explained in an earlier paper (McCoy 1990: 96), a distinction was originally made between rockshelters and what were called overhang shelters based on differences in surface characteristics. Rockshelters were described as containing a variety of residues indicating their use as camps. Overhang shelters were described as lacking midden deposits and containing only small quantities of adze manufacturing debitage (McCoy 1977: 229). The overhang shelters were inferred to have been used as either day-time work areas or for the storage of food, firewood and other bulky items. The test excavation of an overhang shelter at Hopukani Spring (Figure 1), in 1985, revealed a buried occupation layer with a fire hearth, faunal/floral remains and flake debitage (McCoy 1986). Based on the results of this excavation a new classification has been adopted that lumps all natural shelters into a single class, "rockshelters".

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#### ABSTRACT

<sup>230</sup>Thorium dates on unweathered pieces of branch coral from the Mauna Kea Adze Quarry Complex suggest that a significant part of this quarry, the largest in the Hawaiian Islands, was in use by the mid-14th to mid-15th centuries AD. The dates also point to the high probability of labour intensive mining of subsurface toolstone by this date, in addition to the much easier strategy of procuring toolstone from the surface. While there is abundant evidence that adze manufacture on Mauna Kea, like the making of a Hawaiian canoe, was an “affair of religion,” branch coral was rarely used in the several different forms of ritualisation that have been documented in the quarry. Possible reasons for this are briefly explored in this short paper, which is one more contribution to refining the chronology of this highly significant and important archaeological complex.

**Keywords:** Mauna Kea Adze Quarry Complex, <sup>230</sup>Thorium dating, procurement strategies, production scale, ritual practices.