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Rapa Nui Journal, Volume 32, Issues 1 & 2, 2019, pp. 37-57 (Article)

Published by University of Hawai'i Press

DOI: <https://doi.org/10.1353/rnj.2019.0000>



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Kukuipahu: A Unique Hawaiian Monumental Structure Utilizing Cut-and-Dressed Stone Masonry

Patrick V. Kirch^a, Alan Carpenter^b, and Clive Ruggles^c

Although common in other islands of Eastern Polynesia, cut-and-dressed masonry is exceedingly rare in Hawai‘i. This article describes a significant exception, Kukuipahu Heiau, a monumental structure in the Kohala district, Hawai‘i Island, which incorporates more than one hundred cut-and-dressed basalt slabs, as well as worked red scoria blocks. There appear to have been at least two construction phases, with an earlier phase utilizing the worked stone, followed by a destructive interval, and then a later phase characterized by more typical Hawaiian stacked stone construction. A precise survey of the structure shows that it deviates only slightly from cardinality, but when the altitude of the Kohala ridgeline is taken into account, the site was oriented within 1–2° of the equinoctial rising of the sun. Hawaiian oral traditions associate the hewing of temple stones with the famed Hawai‘i Island king ‘Umi-a-Liloa; we suggest that Kukuipahu Heiau may have been built during his reign, a hypothesis that deserves further research.

Keywords: Hawaiian archaeology, monumental architecture, ‘Umi-a-Liloa, *heiau*, Polynesian stone-working

Introduction

Monumental architecture—especially the range of religious structures known as *heiau*—was highly developed and elaborated in pre-contact Hawai‘i (Kirch 1985:257–265). With very few exceptions, however, Hawaiian stone architecture involved stacking and fitting together natural stone cobbles and boulders, without artificial modification of the stones through cutting and dressing. Thus, ancient Hawaiian stonework contrasts with that in some other parts of Eastern Polynesia, such as the Society Islands, Marquesas, and especially Rapa Nui, where cut-and-dressed stonework was well developed (Linton 1925; Emory 1933; Heyerdahl & Ferdon 1961; Martinsson-Wallin 1994). A significant exception is Kīkī-a-Ola, sometimes called the “Menehune ditch” at Waimea, Kaua‘i, an irrigation canal partially lined with cut-and-dressed basalt blocks (Bennett 1931: 22–23, 105–107, fig. 24, pl. III). A few other structures, such as Maka‘ōpio Heiau at Honokāhau on Hawai‘i Island (Kirch 1985:167, fig. 148), and Kūki‘i Heiau also on Hawai‘i Island (Stokes

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1991:151–153) also incorporate a few cut-and-dressed stone slabs, but the vast majority of Hawaiian structures were built exclusively with stacked natural stones.

A significant exception to the dominance of stacked stonework in Hawai‘i is a large structure situated in the Kohala district of Hawai‘i Island, known as Kukuipahu Heiau, although this name apparently derives from the name of the *ahupua‘a* or land unit, and was probably not the proper name of the site. Kukuipahu exhibits substantial cut-and-dressed basalt slabs and large blocks of shaped red scoria. The extent of stone-working at Kukuipahu surpasses that in the Kīkī-a-Ola irrigation canal, making Kukuipahu the most elaborate example of cut-and-dressed stone architecture in ancient Hawai‘i.

Background and Prior Investigations

Although Kukuipahu Heiau has been known to some local residents of the Kohala district, it has never been formally described in the published archaeological literature on Hawaiian archaeology. Surprisingly, given its unique stonework, the site was not recorded in Stokes’s 1907 survey of *heiau* of Hawai‘i Island (Stokes 1991), nor is it mentioned in Thrum’s list of Hawai‘i *heiau* (Thrum 1908). It is possible, though by no means certain, that the proper name of this site is Ku‘upapaulau, one of several temples said to be associated with the *ali‘i nui* ‘Umi-a-Līloa and reported by Jules Remy (1868:59) to be located “inland at Kukuipahu-mauka.”

The first archaeological investigation of the site appears to have been by Paul Rosendahl, who made a plane table and alidade map of the structure in July 1969, coincidental to the University of Hawai‘i’s archaeological field school at Lapakahi (Adams & Athens 1993:10). This map, which shows most of the main features but omits some details, has never been published although a reworked version was included as part of a National Register of Historic Places nomination form by Jean Martin in 1972 (Adams & Athens 1993:figs. 39–41; Martin 1972). At the time of Rosendahl’s mapping in 1969, he and several University of Hawai‘i graduate students excavated a small test pit, finding a “post hole with a buried charcoal and ash lens” (Adams & Athens 1993:10). No report of this work was ever prepared and the location of any samples, if collected, is unknown.

Based on the National Register of Historic Places nomination prepared by Martin (1972), Kukuipahu Heiau is formally designated as site 50-10-02-4135 in the State of Hawai‘i Register of Historic Places. In 2005, the Hawai‘i State Legislature created the Kohala Historical Sites State Monument that included Kukuipahu Heiau (Hawai‘i Revised Statutes Chapter 6E, Section 38.5). The site is currently under the purview of the Division of State Parks, and is being cared for under a Curator Agreement with the Kuamo‘o Foundation (Division of State Parks 2015).

In this article, we provide a descriptive account of this unique structure, analyze its orientation in relation to possible astronomical phenomena, discuss the implications of its parallels to stone-working in the Marquesas, Rapa Nui, and other islands of Eastern Polynesia, and draw attention to Hawaiian oral traditions linking hewn stones to the *ali‘i nui* ‘Umi-a-Līloa. Kirch was first taken to Kukuipahu Heiau in the early 1970s by the late Paul Rosendahl who was at the time working on the development of the State historical park at nearby Lapakahi. At that time the structure was heavily overgrown with Christmas berry and other invasive trees and shrubs, making it difficult to discern the extent of the artificial stone-working. Nonetheless, it was evident that Kukuipahu differed in this regard from typical Hawaiian *heiau*. Kirch again visited Kukuipahu in August of 2008, by which time the site had come under the purview of the Division of State Parks, and had been cleared of invasive vegetation by volunteer caretakers. This allowed Kirch to make a GPS map of the site and to photograph the structure and its worked stones. At this time, Kirch also was informed that Alan

Carpenter of State Parks had made a detailed plane table survey of the structure. Kirch subsequently suggested to his colleague Clive Ruggles that he might be interested in conducting an archaeoastronomical survey of the site, which Ruggles carried out in June of 2009. Finally, Kirch again visited Kukuipahu in May of 2019, taking detailed measurements on the cut-and-dressed basalt and scoria stones. We have combined the observations and maps from all of the above visits to Kukuipahu to provide the account below.

Description of Kukuipahu Heiau

Location and Setting

The site lies at 260 m elevation above sea level in the center of Kukuipahu *ahupua'a* (Fig. 1), some 4 km from the leeward North Kohala coast (UTM coordinates 201035E, 2238150N). Topographically, the terrain slopes gently down from east to west. The geological substrate consists of weathered 'a'ā and pāhoehoe lava flows of the Pololu Volcanic series, dating to 260–500 kyr in age (Sherrod et al. 2007). It is likely that the cut-and-dressed basalt slabs at the site were quarried from an unknown location on this substrate, or from a nearby flow. Between 1–1.5 km north of the site are a series of scoria cinder cones, including Pu'u Ula ("Red Hill"), which may have been the source for the reddish scoria blocks at the site. Other scoria cones, including Pu'u Mamo, lie about 1.2 km to the southeast; these could also have been a source of the red scoria blocks.

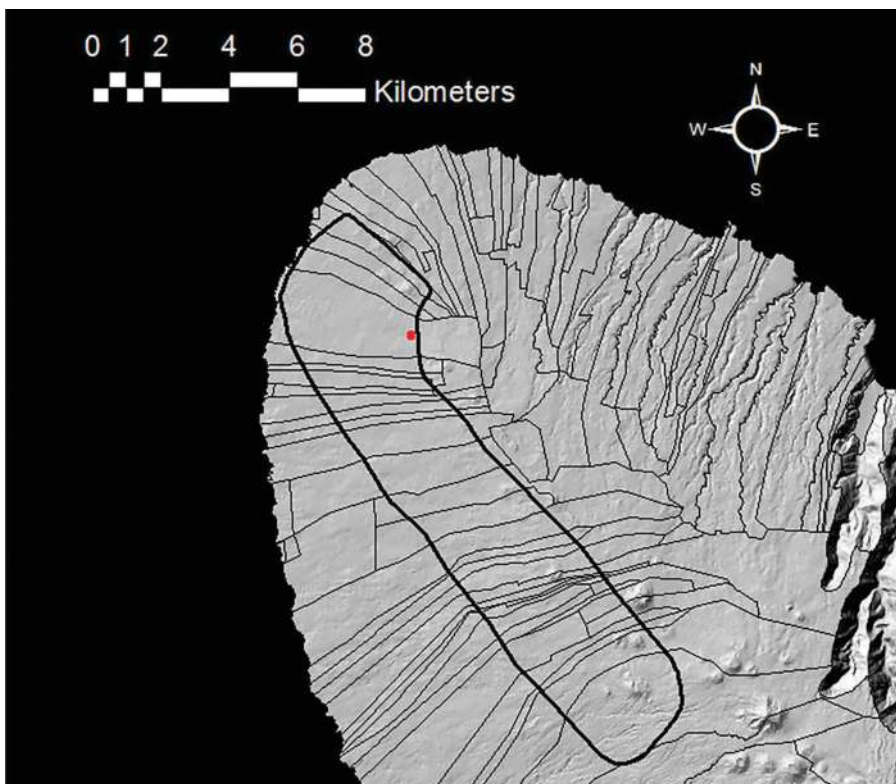


Fig. 1. Map of the Kohala peninsula at the northern end of Hawai'i Island, showing the location of Kukuipahu Heiau (red dot). The black lines indicate the boundaries of individual *ahupua'a* territories, while the heavy black line indicates the approximate boundaries of the Leeward Kohala Field System.

Kukuipahu Heiau is situated within but near the upper boundary of the Leeward Kohala Field System, a vast zone of formerly intensive dryland cultivation of sweet potato, taro, sugarcane, and other crops that developed from the A.D. 1400s and was abandoned in the early nineteenth century (Ladefoged et al. 2003, 2011). Several parallel field system alignments running along the contours to the east of the site are visible on aerial photos.

General Configuration of the Structure

Broadly speaking, the site consists of a rectangular terrace set into the gently sloping landscape, elevated on the west and cut slightly into the hillside on the east (Figs. 2 and 3).

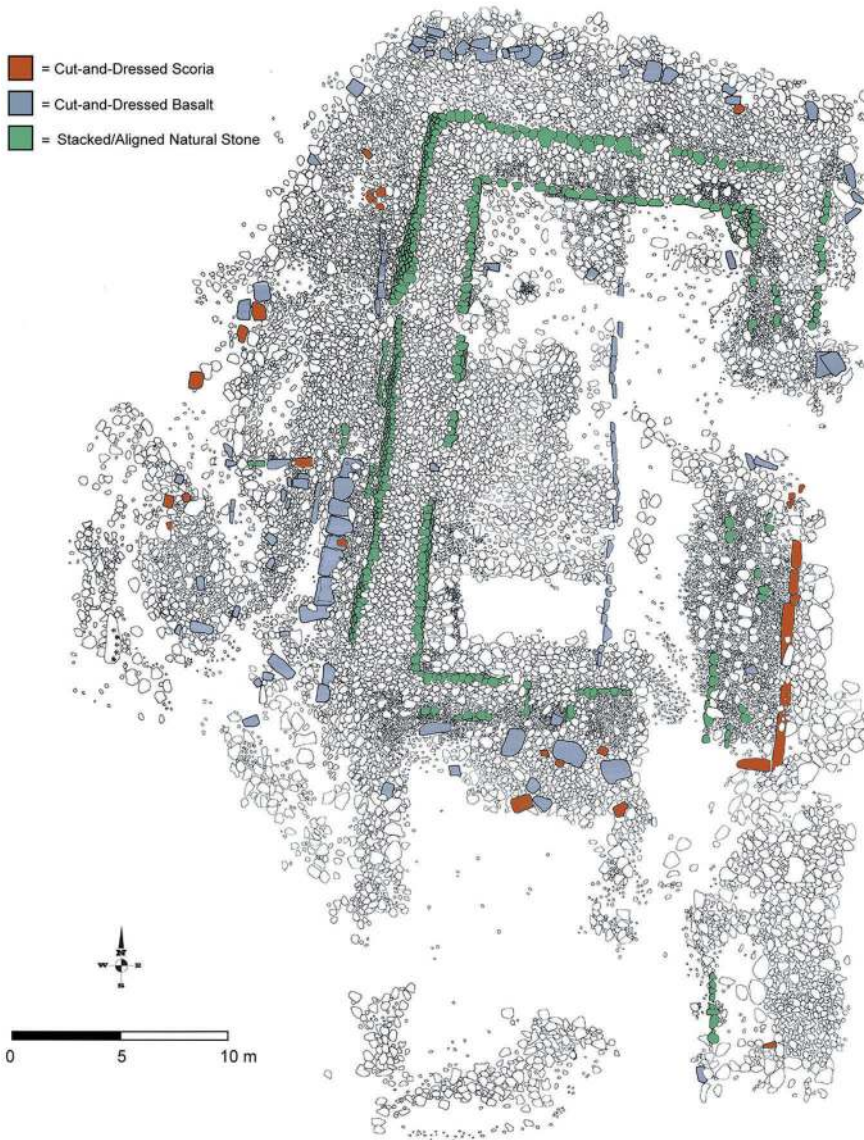


Fig. 2. Plan map of Kukuipahu Heiau, based on plane table and alidade survey by Alan Carpenter. Cut-and-dressed basalt slabs indicated by gray shading, red scoria blocks by red shading, and dry-stacked enclosure wall facings by green shading.



Fig. 3. General view of Kukuipahu Heiau from the northeast.

Overall dimensions, including a surrounding scree of stones that have fallen off of the former walls, are 51 m north-south by 35 m east-west. The distance between the outer facings of the north and south walls is 29 m, while that between the west and east wall faces is 20 m. Thus the main structure, not including the rubble scree, has a footprint of about 580 m².

Based on visible superposition of its components, it is evident that Kukuipahu Heiau has an earlier phase that incorporates the cut-and-dressed stonework, and a later phase utilizing more typical Hawaiian dry-stacked wall construction. In [Figure 2](#) we have color-coded the cut-and-dressed stones of the early phase, with light gray for basalt slabs and red for scoria blocks. The extant wall faces of the later stacked stone enclosure are similarly color-coded in green.

Working in a clockwise direction around the structure and with reference to [Figure 2](#), the principal features of Kukuipahu Heiau can be described as follows. On the south is a roughly rectangular level space, largely free of surface stones, defined on its perimeters by low walls of stacked stone (this space measures 15 m north-south by 11 m east-west). This level space is bounded on the north by a disturbed alignment of four large cut-and-dressed basalt facing slabs, the westernmost of which is still in its upright, original position ([Fig. 4](#)). All of these stones apparently once formed a prominent south facade to the early structure's main terrace. Immediately north of this disturbed facing is a somewhat collapsed wall of stacked boulders and cobbles, about 2.5 m thick, forming the southern part of the three-sided stacked enclosure wall that represents a later construction phase, post-dating the



Fig. 4. Large cut-and-dressed basalt facing slab still standing in situ along the southern side of Kukuipahu Heiau. Scale in this and subsequent photos is 1 m long.

cut-and-dressed stone facings (see Construction Sequence below). Also of note in this southern portion of the site is a rectangular basalt slab whose surface has been modified with pecked parallel rows of small indentations or cupules; this is evidently a *papamū* or board for playing the traditional Hawaiian game of *kōnane*.

Moving to the western (downslope) side of the structure, one encounters the most intact segment of the original facing of worked basalt slabs with eight adjacent slabs still in position, although they are leaning over strongly to the west (Fig. 5). Six additional cut-and-dressed slabs are scattered immediately to the south of the intact facing; these appear to have been part of the original corner of the early-phase terrace. Moving north along the western exterior, the slab facing disappears for a distance under stone rubble, but then reappears with a low, intact alignment of seven adjacent cut-and-dressed basalt slabs (Fig. 6); these may have formed a lower or base course of the original exterior facing of the earlier phase terrace. There is an extensive scree of stones to the west of the intact facing alignments made up of both natural stones and many smaller cut-and-dressed slabs of basalt and of red scoria. Immediately east of the intact facing slabs is a north-south trending, massive wall (2.5–3 m thick) of stacked natural boulders and cobbles; as with the stacked wall on the south (which this western wall abuts) this represents the second phase of construction, superimposed over the earlier terrace (Fig. 7).

Along the north side of the site there are no truly intact segments of original cut-and-dressed basalt facing, but a line of nearly continuous disturbed or displaced cut-and-dressed basalt slabs indicates where this facing formerly existed. The rubble scree surrounding the



Fig. 5. In situ alignment of cut-and-dressed basalt facing slabs along the western side of Kukuipahu Heiau, forming an intact segment of the early-phase terrace facing.



Fig. 6. Low alignment of in situ cut-and-dressed basalt slabs along the western side of Kukuipahu Heiau.



Fig. 7. View from north to south along the massive wall of stacked natural boulders and cobbles on the western side of Kukuipahu Heiau, part of the later-phase enclosure.

site on the north likewise incorporates numerous smaller cut-and-dressed basalt blocks, suggesting that the original facing along the north side may have been composed of two courses. As on the south and west, there is a crude, stacked wall of natural stones (ca. 2 m thick) that forms the northern wall of the later enclosure (and abuts the western stacked stone wall).

The eastern (upslope) side of the site has a large gap, apparently the result of a bulldozer episode some years ago (T. Tam Sing, pers. comm., 2019; see also Rosendahl's 1969 map [in [Adams & Athens 1993](#), Fig. 39]). Immediately south of this gap is an alignment of seven large, rectangular cut-and-dressed blocks of reddish scoria; an eighth block abuts these at a right angle at the southern end of the alignment ([Figs. 8 and 9](#)). These scoria blocks, impressive in their size and reddish color, are flanked on the west by a low bench or terrace of natural stones about 3.5 m wide, partly faced on its western side with natural boulders.

The interior of the structure is divided into western and eastern sectors by a low, single-course alignment of cut-and-dressed basalt slabs running north-south, also presumed to be part of the earlier phase. To the east of this dividing alignment the level ground is largely free of stones; there is a slight drop down to the west (of 10–20 cm). And, on the western side there is a massive concentration of natural stones that seems to form a kind of low platform, to the south and north of which the ground is again largely clear of stones; this low platform is associated with the second phase of construction.



Fig. 8. Alignment of large cut-and-dressed blocks of red scoria along the eastern side of Kukuipahu Heiau.



Fig. 9. Large upright red scoria block forming the southeast corner of Kukuipahu Heiau.

Cut-and-Dressed Basalt Slabs

More than 100 slabs of cut-and-dressed basalt are found at Kukuipahu. We have not made an exact count, although we took measurements of 80 individual slabs; no doubt some slabs are buried under stacked stone walls and in the rubble scree as well. (In addition, some slabs were apparently taken from the structure a number of years ago by cowboys from Parker Ranch, to pave the stable floor at Puakea.) The slabs are made of vesicular basalt, most likely from a *pāhoehoe* flow in which there are natural cleavage planes parallel to the surface, allowing sizeable blocks to be pried free. In general, the slabs are rectangular with right-angle corners, longer than wide (or high, when they were set upright), and of relatively consistent thickness. The faces are typically straight and well smoothed, although on some slabs the interior face that would have been hidden from view has not been flattened. [Figure 10](#) shows a good example of a nicely worked slab. [Figure 11](#) shows a slab with a notch cut out of one corner, a feature observed on only one slab; this likely was for fitting a slab of a higher, second course into the facade.



Fig. 10. Example of a well finished cut-and-dressed basalt slab.

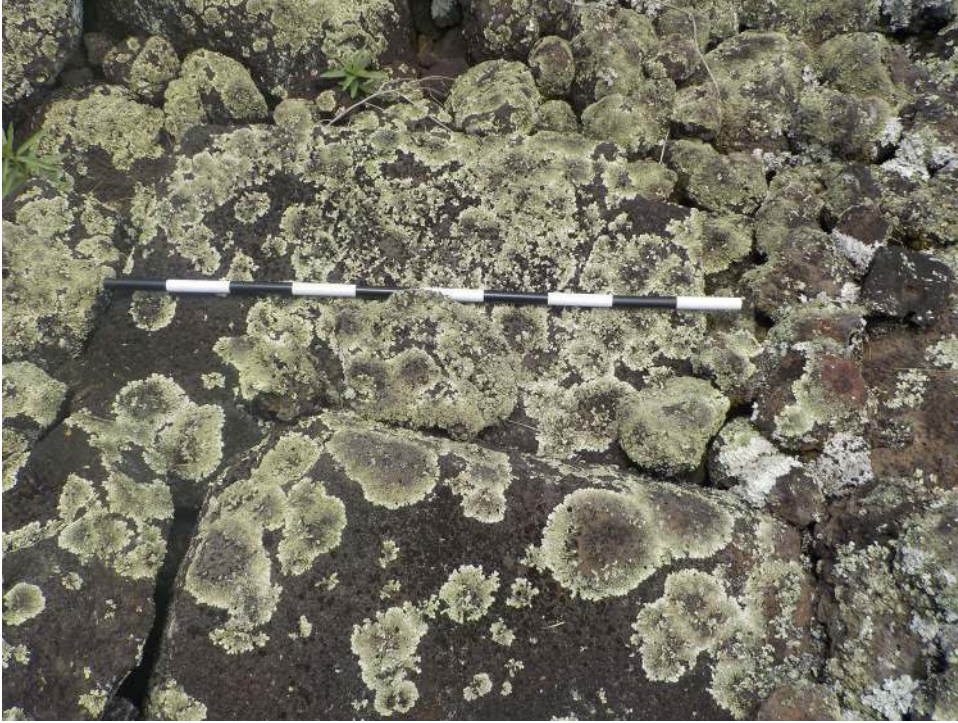


Fig. 11. The meter scale lies down the center of a cut-and-dressed basalt slab with a notch cut into the upper right-hand corner. Another cut-and-dressed slab is partially visible in the foreground.

The sizes of the cut-and-dressed basalt slabs vary around the structure, with the largest slabs being those of the disturbed south facing, and the smallest slabs being those of the northern face (Table 1). The largest slab in the southern series is 1.83 m long and 1.30 m high, with a thickness of 0.45 m. In the intact series of facing slabs along the southwest, the largest slab is 1.42 m long and 0.84 m high, with a thickness of 0.26 m. As seen in Table 1, the average length of slabs declines from south, to west, to north, with the largest slab in the north being 0.94 m long, and the average length of the northern slabs being just 0.70 m. These statistics suggest that the south and southwestern facades of the original terrace were more prominent. It also appears that the northern facade may have consisted of two courses, whereas the southern (and probably southwestern) facades consisted of only a single course of larger slabs.

Table 1. Dimensions (mean and standard deviation in meters) of cut-and-dressed basalt slabs at Kukuipahu Heiau.

Section of site	Length	Width	Thickness
South facing slabs ($N=4$)	1.46 ± 0.29	0.96 ± 0.27	0.36 ± 0.08
Southwest intact face ($N=8$)	1.03 ± 0.26	0.81 ± 0.11	0.32 ± 0.08
North displaced slabs ($N=20$)	0.70 ± 0.15	0.51 ± 0.14	0.22 ± 0.10
Interior dividing slabs ($N=19$)	0.65 ± 0.18	0.21 ± 0.07	0.21 ± 0.07

The slabs making up the low, north-south trending interior division in the center of the site are of a similar size to those of the northern face ([Table 1](#)). The mean width (height when set upright) of 0.21 m is a minimal value, as the stones are set in the ground and their full heights could not be ascertained without excavation.

Cut-and-Dressed Scoria Slabs

The exact number of reddish scoria slabs on the site is not known; we measured 12 of these slabs, but there are many smaller ones scattered about the site which we did not have time to count or measure. The most prominent scoria slabs are those making up the intact facing along the eastern edge of the site. The largest of these is an impressive 2.91 m long, with an exposed height of 0.36 m (the slab is partially buried), and thickness varying between 0.41 and 0.71 m. Another scoria slab is almost as long at 2.59 m, and a third is 1.68 m long. The original use of the many scattered, smaller scoria blocks found around the site is uncertain, but it is conceivable that these were set in an upper course that capped the main facade of cut-and-dressed basalt slabs.

The quarrying and moving of the very large scoria slabs must have required considerable skill and labor. According to [Patty \(1971:8\)](#), scoria ranges in weight from about 41 to 58 pounds per cubic foot. The largest scoria slab at Kukuipahu has an estimated volume of 0.73 m³, which calculates to a total weight of about 589 kg (1300 pounds).

Petroglyph Boulder

An additional feature of note is an elongated, naturally prismatic slab of basalt (about 2 m long) ornamented with raised-relief depictions of three anthropomorphs and two turtles. The slab is presently lying on some rubble boulders along the western edge of the site, but this may not have been its original position. The figures are difficult to discern in the bright sunlight, and we did not have time to make a detailed recording of the glyphs. [Figure 12](#)



Fig. 12. The elongated petroglyph stone with raised-relief anthropomorphic and turtle motifs.

shows both anthropomorphic and turtle motifs. The most significant aspect of this petroglyph boulder is the fact that the motifs are executed in raised relief, which is a rare technique in Hawai‘i, where most petroglyphs were pecked into the stone.

Construction Sequence and Possible Configuration of the Early-Phase Structure

Even in the absence of stratigraphic information derived from excavation, it is evident that the extant configuration of Kukuipahu Heiau reflects at a minimum two phases of construction, as well as an intervening probable phase of partial destruction. This is evidenced by the superposition in several places of the 2–2.5 m thick walls of stacked natural boulders and cobbles on the south, west, and north (outlined in green in Fig. 2) over the cut-and-dressed basalt facings (shown in gray in Fig. 2), indicating that the earlier construction phase incorporated the cut-and-dressed stonework, while the later construction phase involved stacking and fitting of natural stones in a manner more typical of Hawaiian monumental architecture. An episode of partial destruction of the early-phase structure can be inferred from the fact that the greater part of the cut-and-dressed stone facade that retained the terrace on its south, west, and east sides has clearly been torn up and the stones displaced. The degree of displacement of the facing slabs is far more than would be expected simply from normal weathering or collapse in situ. In short, we can infer the following sequence of events for Kukuipahu Heiau: (1) an initial phase of construction of the terrace utilizing cut-and-dressed basalt slabs to face the terrace along its south, west, and north sides, and with an east facade of red scoria blocks; (2) an episode when the original stonework was to a large extent purposefully dismantled, leaving only portions of the original facade intact; (3) a rebuilding phase during which a rectangular enclosure with thick walls of natural boulders and cobbles was constructed on top of the ruins of the original terrace. The actual sequence of events at the site may in fact have been more complex, but excavation and the careful establishment of stratigraphic relationships will be necessary to discern if this is the case.

Based on the visible surface evidence, it is possible to infer a hypothetical reconstruction of the original, early-phase structure, as depicted in Figure 13. The initial structure appears to have been a terrace, about 30 m north-south by 20 m east-west, carefully faced on the south, west, and north sides with a continuous facade of cut-and-dressed basalt slabs. The largest slabs were positioned on the south and southwest, with smaller slabs along the northwest and north, where two courses of stone were likely involved. The maximum height of this facade would have been about 1 m. It is possible—but not certain—that these facings of basalt slabs were capped by an upper course of smaller cut-and-dressed red scoria blocks. The eastern side of the terrace, which was cut slightly into the hillside, was defined by a row of large rectangular blocks of red scoria, adjacent to which was a kind of bench or narrow terrace about 3 m wide. The main terrace was divided into west and east sectors by a continuous alignment of cut-and-dressed basalt slabs, with the eastern sector elevated about 20 cm higher than the western sector.

If this hypothetical reconstruction is accurate—and we stress that it would be desirable to test this through carefully targeted excavations—it raises questions regarding the possible function of the earlier phase structure, which does not conform to typical forms of late Hawaiian *heiau* or religious structures. As we envision it in our reconstruction (Fig. 13), this early-phase structure resembles the simple terraced shrines or “*marae*” recorded by Emory (1928:71–86) on Mokumanamana (or Necker) Island in the

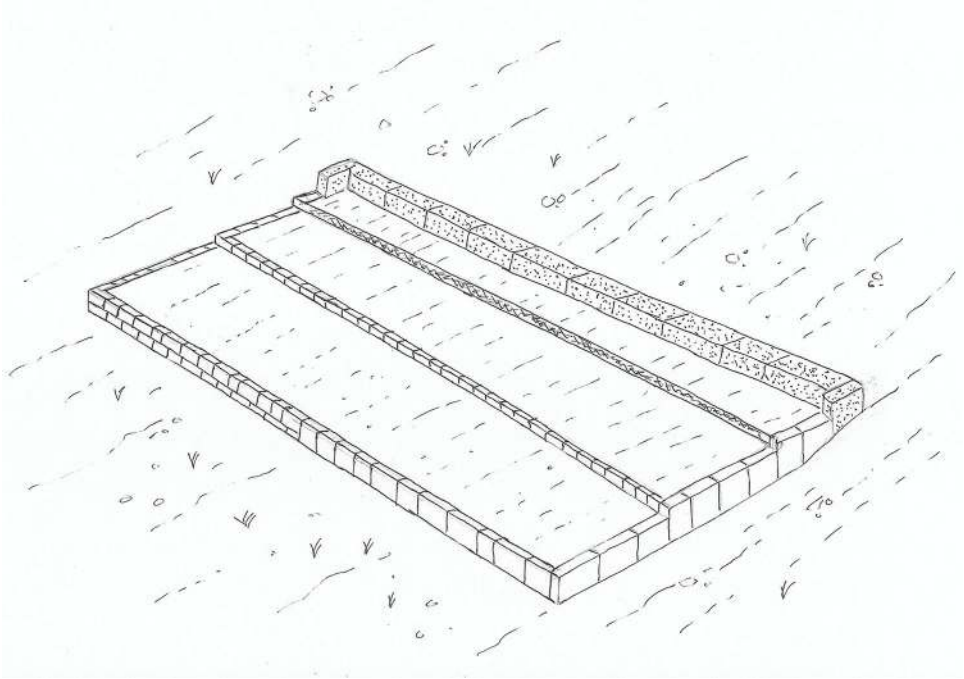


Fig. 13. Hypothesized reconstruction of the original structure at Kukuipahu; stippling indicates blocks of red scoria. The terrace would have measured approximately 30 m along the front facade, by 20 m along the sides.

northwestern Hawaiian Islands, albeit on a larger and more elaborate scale (see also Kikiloi 2012). This terraced kind of shrine was hypothesized by Emory (1933:24–25) to be an early *marae* form in the Society Islands. However, we also note that the early phase at Kukuipahu could alternatively be interpreted as a large residential platform with a main court divided into lower and higher sectors, and with an elevated sleeping platform along the eastern side, an architectural form well evidenced in Marquesan *paepae* or residential platforms or terraces (Linton 1925; Suggs 1961). Of course, both the size of the early-phase terrace and the enormous investment in labor evidenced in the quarrying, working, and emplacement of the stonework leave no doubt that if the early structure at Kukuipahu were residential rather than religious in function, it would have been occupied by a person or persons of the highest rank.

Unlike the early phase, the later-phase enclosure with its thick, dry-stacked walls and what appears to be a low platform within the western part of the now-enclosed court do conform to known patterns of later pre-contact Hawaiian *heiau* or temples.

Orientation of the Structure

Ruggles visited Kukuipahu independently on June 22, 2009 and carried out an archaeoastronomical survey using a Nikon NPL-332 Total Station. The instrument was set up outside the southeast corner of the temple enclosure, and true north was determined accurately from a series of timed observations of the sun, as is standard procedure in archaeoastronomy (Ruggles 1999:164–171). Sequences of surveyed points along segments

Table 2. Orientation data for Kukuipahu Heiau.

Feature	Azimuth
Alignment of red scoria (tuff) blocks on east side, inner face	$5.0^\circ/185.0 \pm 0.1^\circ$
Base of west wall, outer face: intact 4 m-long stretch	$5.5^\circ/185.5 \pm 0.5^\circ$
Alignment of small gray slabs dividing the central court	$3.1^\circ/183.1 \pm 0.1^\circ$
Alignment between slabs on south side, outer face	$95.7^\circ/275.7 \pm 0.1^\circ$

of intact wall facing were used to obtain best estimates of the intended orientation of the walls. These are summarized in [Table 2](#).

The well-preserved alignment of red scoria blocks that runs for approximately 10 m along the east side of the site yields a reliable azimuth of $5.0^\circ/185.0^\circ$. An intact segment of the west wall, comprising a single course of blocks running straight for about 4 m, yields a best-fit azimuth of $5.5^\circ/185.5^\circ$. The single large slab on the south side that appears to have survived in situ is aligned upon a single red scoria block in the southeast corner set perpendicular to those running down the east side. The azimuth between the two blocks is $95.7^\circ/275.7^\circ$, while our best estimate of the orientation of the westernmost block itself is $96.0^\circ/276.0^\circ$. (That of the red scoria block is $93.2^\circ/273.2^\circ$.) All these suggest that the intended orientation of the early-phase structure was between 5° and 6° clockwise from cardinal, most likely between 5° and 5.5° .

A somewhat sinuous alignment of small cut-and-dressed basalt slabs, about 20 m long, divides the central court. Assuming that the alignment originally formed a straight line, a best-fit analysis suggests that this was oriented slightly askew to the outer walls, with azimuth $3.1^\circ/183.1^\circ$.

As discussed at some length by [Kirch and Ruggles \(2019:89–97\)](#), Hawaiian monumental sites typically have an “axis of orientation” that follows a progression from less to more sacred (*kapu*). Determining this axis of orientation depends upon the observation and analysis of both architectural features and the surrounding topography and viewsheds. In Hawaiian and Polynesian cultures in general, relative height is associated with rank and *kapu*. Thus in the case of Kukuipahu Heiau, the higher elevation of the eastern side, and the elevated bench flanked by the red scoria facade are indications that the structure was oriented to the east (i.e. intended to be approached from the west). This interpretation is reinforced by the use of the red scoria along the eastern side, as red is a sacred color reserved for persons of high rank, and for the gods (red was associated in particular with the god Kū, although also with Kāne and Kanaloa [[Valeri 1985:270, 275–276, Table 1](#)]).

Consideration of the horizon to the east of Kukuipahu Heiau suggests a possible astronomical motivation for this orientation of the early-phase structure. The distant horizon cannot currently be observed directly, as trees planted around the site obscure the view to the north, east and south, with a stretch of open sea visible to the west. However, examination of a digital horizon profile generated from 1:24000 USGS Digital Terrain Model (DTM) data by Andrew Smith of the University of Adelaide (see [Kirch & Ruggles \[2019:88–89\]](#) for more information) shows that the horizon to the east, formed by the ridgeline of the Kohala Mountains, has an altitude of around 6.5° and maintains a similar altitude (at least 5.5°) all the way from azimuth 65° to 145° , which encompasses the entire solar rising arc ([Fig. 14](#)).

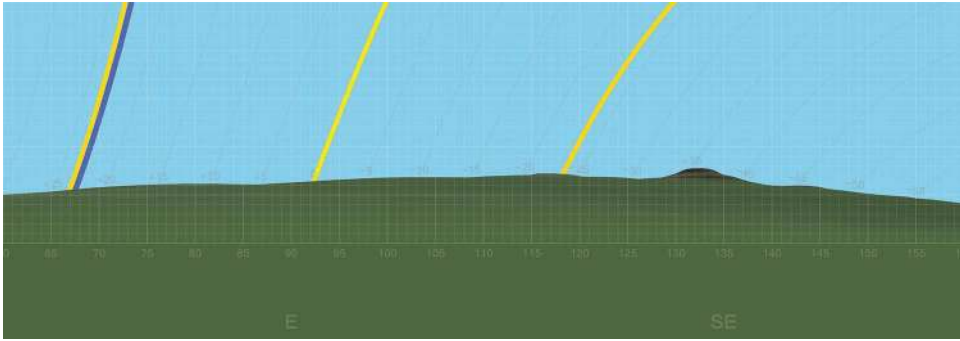


Fig. 14. Visualization of the eastern horizon at Kukuipahu, generated digitally from 1:24000 USGS Digital Terrain Model (DTM) data by Andrew Smith of the University of Adelaide. The yellow lines show the rising paths of the sun at the June solstice (left), December solstice (right), and equinoxes (center). The blue line indicates the rising path of the Pleiades in A.D. 1600.

Because of the altitude of the horizon as seen from Kukuipahu Heiau, the equinoctial sun rises between 2 and 3 degrees south of east rather than due east. Although there is no ethnohistoric evidence that the Hawaiians had any special interest in the equinoxes as such, the rising sun and the path of the sun across the sky were strongly associated with the god Kāne (Beckwith 1932:14–16, 80; Valeri 1985:16, Table 1; Kirch & Ruggles 2019:18–19). At Kukuipahu Heiau, a deliberate attempt to orient the early-phase structure broadly halfway along the solar rising arc, midway between the solstices, would have resulted in an orientation somewhat south of east, because the entire solar rising arc is displaced to the south (as a result of the horizon altitude being consistently high over the entire arc). While this does not provide an exact explanation of the deviation from cardinality of the structure's walls, which is 5°–6° clockwise rather than 2°–3°, such an exact fit is not to be expected given that the direction cannot be observed directly, only estimated by observing the changing position of sunrise over the year. That said, the orientation of the central alignment of small basalt slabs dividing the central court is much closer to the “ideal” displacement. In sum, there is reason to think that the early phase at Kukuipahu Heiau was intentionally oriented to the east, in such a manner that it falls within 2°–3° of the equinoctial rising of “the great sun of Kāne” (Beckwith 1932).

No other astronomical correlates are evident at the site, although it is perhaps noteworthy that the star Shaula (λ Sco, declination -36.7° in A.D. 1600) would have been seen to rise behind the peak in the Kohala Ridge that forms the highest point on the horizon, at azimuth 132° . Shaula formed the end of *Ka makau nui o Maui*, Maui's big fishhook (the tail of Scorpius) (Johnson et al. 2015:169), which stretched from declination -42.6° to -18.6° around this time (Kirch & Ruggles 2019, Table 4.2). According to legend, Maui's fishhook was used to fish up islands from the bottom of the sea (Fornander 1880: 371) and the peak below the asterism resembles an island being fished up from behind the slightly nearer ridge.

Discussion and Conclusions

Cut-and-dressed stonework is exceedingly rare in the Hawaiian Islands. The only other site with a comparable degree of worked basalt to that at Kukuipahu Heiau is Kīkī-a-Ola, an

irrigation canal at Waimea, Kaua‘i (Bennett 1931:105, Fig. 24, pl. III), with about 114 cut-and-dressed rectangular basalt slabs arranged in one to two courses. Several slabs of the canal’s facing exhibit corner notching, as in the example at Kukuipahu. On Hawai‘i Island, Maka‘ōpio Heiau at Honokāhau (Kirch 1985:167, Fig. 148) incorporates a few cut-and-dressed basalt slabs, but does not begin to compare to Kukuipahu in the extent of worked stone. Kūki‘i Heiau in the Puna district on Hawai‘i Island is described as having had cut-and-dressed paving blocks in its interior (Stokes 1991:151–153, Fig. 76); one of those paving slabs was removed and is curated in the Bishop Museum (catalog no. 4899). The famous Paepae Kapu o Līloa is a single cut-and-dressed basalt slab that, according to tradition, formerly provided the threshold for the royal residence at Waipi‘o, Hawai‘i; this stone was brought to O‘ahu during the reign of King Kalākaua, and sits today in front of the State of Hawai‘i Archives building. We are not aware of any sites in Hawai‘i other than Kukuipahu that incorporate cut-and-dressed red scoria (or tuff) in their construction, making Kukuipahu unique in that regard.

In contrast to the rarity of cut-and-dressed basalt—and general absence of cut-and-dressed red scoria—in Hawaiian monumental sites, these kinds of stone-working practices are well evidenced in other island groups of Eastern Polynesia. In the Marquesas, worked basalt was less commonly used than natural boulders, but quarrying and dressing of red scoria or tuff was widely practiced (Linton 1925:11–12). The most frequent use of cut-and-dressed tuff (and sometimes of basalt) was for “risers” that set off the slightly elevated sleeping platforms along the rear side of Marquesan “megalithic paepae” or house platforms (Suggs 1961:161, Fig. 38, D). Further use of “cut slabs of red or white tufa, coralline rock, or cut basalt standing on edge” was in the facings of “specialized rectangular platforms” known as *tu‘u*, upon which human sacrifices and enemy dead were displayed (Suggs 1961:162).

In the Society Islands, Emory (1933:11) describes the working of round-faced basalt stones that were stacked together to form the facings of *marae* (temple) altars and walls, as well as the “squaring” of tuff and coral incorporated in the facings of *ahu* (altar) platforms. Special care was taken in the dressing of *marae* cornerstones in the Windward Islands (Tahiti and Mo‘orea), which were most commonly made of red tuff. Kahn and Kirch (2014:70, Fig. 3.12) describe the cut-and-dressed cornerstones of red tuff or scoria that are present in virtually all of the *marae* enclosures of the upper ‘Opunohu Valley on Mo‘orea. One of these *marae* also has an *ahu* with a row of capping stones of cut-and-dressed red tuff (Kahn & Kirch 2014, Fig. 3.10).

Less is known regarding stone-working in the Austral Islands. For Ra‘ivavae, however, Edwards (2003:154–157) mentions the use of “red tuff blocks” in the enclosing walls and *ahu* of *marae*, and in the facings of burial cists.

The most extensive working of both basalt and red scoria or tuff in Eastern Polynesia occurred on Rapa Nui, where indeed the art of cutting-and-dressing stone reached its apogee (Heyerdahl & Ferdon 1961; Martinsson-Wallin 1994; Treister et al. 2013). Cut-and-dressed basalt slabs were used both in the facings of *ahu* (temple platforms) and in elite house foundations, while cut-and-dressed red scoria or tuff was used both to cap the facings of *ahu* and for the *pukao* (topknots) that were placed on the heads of some *moai* or statues.

When considered in this comparative Eastern Polynesian context, the combination of cut-and-dressed basalt slabs and red scoria blocks at Kukuipahu Heiau exhibits closer parallels with stone-working in the islands just described, than it does with other Hawaiian sites. The combination of worked basalt and red scoria in ceremonial sites is particularly well expressed both in the Marquesas and on Rapa Nui. However, the overall form of the

original structure at Kukuipahu—as we have tentatively reconstructed it—more closely resembles a Marquesan elite residential *paepae*, and does not have the same form as a Rapa Nui image *ahu*.

These comparisons raise the question of possible influence or contact between Hawai‘i and other islands of Eastern Polynesia. Was the original construction of Kukuipahu carried out by stone masons who came from the Marquesas or elsewhere in Eastern Polynesia, or who had visited those islands and been influenced by stone-working practices they witnessed? The English missionary William Ellis, traveling in 1823 through North Kohala in the general vicinity of Kukuipahu, was told of a tradition “in this part of the island” respecting “several visits, which in remote times some of the natives made to Nuuhiva [Nuku Hiva] and Tahuata, two islands in the Marquesan group, and to Tahiti” (Ellis 1963:284). One of these voyages was made by Kamapiikai, “a priest of a temple in Kohala, dedicated to Kānenuiākea.” Kamapiikai was said to have a vision in which the god directed him to make the voyage to Tahiti, which he carried out in four double-hulled canoes. After an absence of 15 years Kamapiikai returned to Hawai‘i, and then made three subsequent voyages to the southern islands, never returning from the last voyage (Ellis 1963:284–285). There is no way to know for certain whether or not this tradition relates to Kukuipahu Heiau; however, the eastern orientation of the site with its close alignment to the equinoctial rising of the sun would be consistent with a temple dedicated to Kānenuiākea, one of the many *kinolau* or particular forms of Kāne, who was closely associated with the sun.

Until subsurface excavations can be carried out at Kukuipahu, and either radiocarbon dates, or U-series dates on coral obtained, the chronology of the site’s construction and use will remain unknown. There is, however, a hint in the traditional histories collected by both Abraham Fornander (1880) and Samuel Kamakau (1961) that may link Kukuipahu to the reign of ‘Umi-a-Līloa, arguably the most famous of all Hawai‘i Island rulers. Of ‘Umi’s later life, after he had consolidated the rule of Hawai‘i Island, Fornander writes:

In making his tours around the island, *Umi* erected several Heiaus, distinguished from the generality of Heiaus by the employment of hewn stones. Such, among others, are the Heiau of *Kukii*, on the hill of that name, overlooking the warm springs of Kapoho, in the district of Puna; and of *Pohaku Hanalei*, in the district of Kau, above the wooded belt of the mountain. A number of hewn stones of this period—at least tradition, by calling them the *Pohaku Kalai a Umi* (“the hewn stones of Umi”), does so imply—were found scattered about the Kona coast of Hawaii, specially in the neighborhood of Kailua, and, after the arrival of the missionaries (1820), furnished splendid material wherewith to build the first Christian church at Kailua. (1880:101)

Kamakau gives a slightly different version of ‘Umi’s connection with hewn stone-working:

When ‘Umi-a-Līloa became old, the people of Hawaii built a stone tomb for him, to hold his corpse. He commanded his sons, daughters, chiefs, and commoners all over Hawaii to hew long, four-sided stone slabs, an *amana* [about six feet] and an *iwilei* [about three feet] in length, and half an *iwilei* in width. The stone used was the close-grained ‘*ala*’ . . . The stone tomb of ‘Umi-a-Līloa was not completed when he died on Hawaii. (1961:32)

A version of this tradition associating ‘Umi with cut stone-working is also reported by Remy (1868:27), who writes: “He employed everywhere workmen to cut stones, to serve,

some say, in the construction of a sepulchral cave; according to others, to build a magnificent palace.”

Emory comments at some length on “dressed blocks [of stone] now scattered through the village of Kailua on the island of Hawaii” that “. . . come from the facing of some structure which once stood on the shore of Kailua bay” (1933:47). Emory, quoting unpublished manuscript notes by J.F.G. Stokes, continues:

The dressed stones of Kailua have been looked upon as the “stones of Umi,” which, according to tradition, were ordered by chief Umi for his “tomb” (for the platform for a sepulchral house at Kailua?). These were to have been “a fathom or more in length, a yard wide, and half a yard deep,” and were to be sent in from all over Hawaii and Maui. The Naha stone at Hilo, and the Keoua and Kaahumanu stones at Honaunau, Hawaii, partly dressed blocks of about the size specified, are supposed to be among Umi’s stones which never reached Kailua (1933:47).

Although Stokes thought that ‘Umi’s structure at Kailua might never have been completed, Emory found, in 1933 at Kailua, a cut-and-dressed stone with a notch for fitting it against another slab (this stone was shipped by Emory to Bishop Museum, catalog number C.06449), convincing Emory that “the numerous squared stones found about these Kailua grounds were assembled at one time in some structure” (Emory MS).

Genealogical reckoning places the reign of ‘Umi between approximately A.D. 1570–1590 (Kirch 2010:92–98, Table 3.1). When an archaeological chronology for Kukuipahu is eventually established, it will be interesting to determine whether the construction of the initial phase at the site—with its unique emphasis on cut-and-dressed stone masonry—corresponds to the time frame of ‘Umi-a-Līloa’s reign. Should that prove to be the case, it would raise the additional question of whether the original structure at Kukuipahu functioned as a *heiau*, or alternatively, as the royal residence of ‘Umi himself, or possibly his intended tomb. For the present, this remains merely an hypothesis, but one worthy of further research.

Acknowledgements

Kirch extends his *mahalo piha* to Lehua and Kanani Kaulukukui and Darlene and Kenny Badua for facilitating access to Kukuipahu Heiau and sharing their *mana’o* during his 2019 visit to the site. Tracy L. Tam Sing provided valuable assistance in measuring the site’s stonework. Ruggles is grateful to Clyde Kojiro at Hawai‘i Community College, Hilo, for the loan of a Total Station and to Colin Richards for his assistance with the archaeoastronomical survey.

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