– ARTICLE –

Early Marquesan Settlement and Patterns of Interaction: New Insights from Hatiheu Valley, Nuku Hiva Island

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ABSTRACT

Hatiheu, one of Nuku Hiva's largest and most fertile valleys, is an ideal setting for settlement but the valley's early human history is poorly known. Its importance in late prehistory is well attested, with six major community ceremonial complexes (*tohua*) and hundreds of domestic structures (*paepae*). Recent excavations and AMS dating at Pahumano-o-te-tai indicate use of the area began around the late 13th to late 14th century AD and continued into the post-contact period. Evidence from the earliest occupation suggests a structure and domestic activities, including preparation and cooking of both wild and domesticated animals, and tool maintenance and adze manufacture involving both local and exotic raw materials, as identified through pXRF analysis. A remarkable number of stone sources are represented in the relatively small sample, including the newly identified East Hatiheu Quarry (described herein), four other Nuku Hiva localities, Eiao Island and a possible southern Marquesan source. A ~600-year stratigraphic sequence of repeated burning, erosion, and colluviation informs on long-term geomorphic dynamics at this locality. Pahumano joins a number of similarly-aged sites from throughout the archipelago which, as a whole, identify the 13th to 14th centuries AD as a period of widespread established settlement.

Keywords: settlement, chronology, stone tool geochemistry, landscape change, Polynesia

INTRODUCTION

The timing of Marquesan settlement remains unresolved, despite a lengthy history of investigation (e.g., Linton 1925; Sinoto 1968; Suggs 1961). Situated at the eastern margin of central Polynesia, the archipelago could have been settled relatively early in the regional settlement history or, alternatively, comparatively late. These alternatives have recently been considered by Allen & McAlister (2010) who suggest three regional colonisation models (Leap-frog, Stepping-stone, and Advancing wave) along with potential drivers. As one of a small number of archipelagos that were elevated prior to late Holocene sea level fall (Dickinson 2003), the Marquesas Islands could have been settled relatively early, with Polynesian colonists leap-frogging (*sensu* Sheppard & Walter 2006) from settlement areas in the west and by-passing low-lying archipelagos like the Tuamotus. Alternatively, if island exploration and settlement was a systematic and gradual process (see Irwin 1992, 2006; Green & Weisler 2002), the Marquesas may have been reached relatively late through a series of 'stepping stones' including the Cook, Society and Tuamotu Islands. The third possibility is pene-contemporaneous colonisation by a rapidly spreading 'wave' of colonists from the west, driven by some natural or social crisis or opportunity, as for example changing climate conditions (see Anderson *et al.* 2006; Nunn 2000).

To better understand the place of the Marquesas Islands vis-à-vis these models and regional settlement generally, recent field studies on Nuku Hiva Island have targeted areas of potentially early occupation where resources are attractive and/or plentiful. Several new settlement age sites, defined here as pre-15th century AD occupations with characteristics representative of discovery, colonisation or established settlement activities (*sensu* Graves & Addison 1995), have been identified. These include Teavau'ua (Allen 2004), Hakaea Beach (Allen & McAlister 2010), Ho'oumi Beach (Allen *et al.* 2012) and Pahumano-o-te-tai, the focus of this article. The latter was uncovered during ground-breaking activities associated with construction of a new church for the Hatiheu Catholic Mission and initially investigated in 2002 by Michel Orliac (2003). A single radiocarbon sample from the lowest cultural layer returned a ~9th century AD date, suggesting the locality was amongst the earliest settlement areas on the island; however, the wood charcoal was unidentified, leaving open the possibility of in-built age. Our 2011 excavations were aimed at recovering additional materials for dating and gaining a better understanding of the associated cultural activities. Our results inform on early Marquesan settlement patterns, exchange and inter-

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action across the archipelago, and both initial and post-settlement landscape change. We also report on a newly identified source of fine-grained tool-stone rock, the East Hatiheu Quarry, which is represented in the Pahumano-o-te-tai lithic assemblage.

HATIHEU VALLEY

Hatiheu is a broad, amphitheatre-headed valley on the northern coast of Nuku Hiva, one of the largest and best watered catchments on the island (Figure 1). The steep enclosing ridges rise to nearly 800 m and are particularly precipitous on the western and southern sides. Secondary ridges extend seaward from the valley crest, creating sub-valleys which in the past were occupied by different Marquesan clans (Tehina Teikitohe Teikiehuupoko, pers. comm., 2003). The valley is one of the highest rainfall areas in the archipelago, receiving on average 1500 mm per annum; this rainfall feeds four perennial streams and numerous tributaries (Cauchard & Inchauspe 1978), making it an attractive locality for traditional Polynesian agriculture.

The area from the coast to about a kilometre inland is gently sloping ground, dominated today by aging coconuts and secondary forest. In the past this lower valley zone was a locus of human settlement, agricultural activities, and ceremonial life. At the head of the U-shaped bay is a ca. 500 m long black sand beach which gives way to rocky headlands at both ends. Today the beach is backed by a two-to-three metre high boulder retaining wall, but archival photographs show there was once a gently sloping beach that led into coastal strand forest. The valley is susceptible to tsunami events, with two occurring within living memory, one in 1946 and another in 1960 (Schindelé *et al.* 2006). Both caused damage to the Hatiheu coast, but the 1946 tsunami was especially destructive, destroying the Catholic church at Pahumano.

In prehistory, Hatiheu was an important population centre. Numerous ceremonial and/or religious complexes have been recorded, including seven named *tohua* or community centres where tribal ceremonies, feasts, and dancing exhibitions were conducted. Two such complexes have been extensively restored, Hikokua and the larger and more complex *tohua-me'ae* (community-religious) centre of Teiipoka-Kamuihei-Tahakia (Ottino-Garanger 2006) (see cover). Excavations indicate that religious and funerary practices here date from the late 15th to mid-17th centuries AD (Ottino-Garanger *et al.* 2003; Ottino 2005; Orliac 2003). The valley also has been the subject of a detailed study of indigenous rock art which is often associated with such complexes (Millerstrom 2001).

House foundations, raised stone platforms and ter-

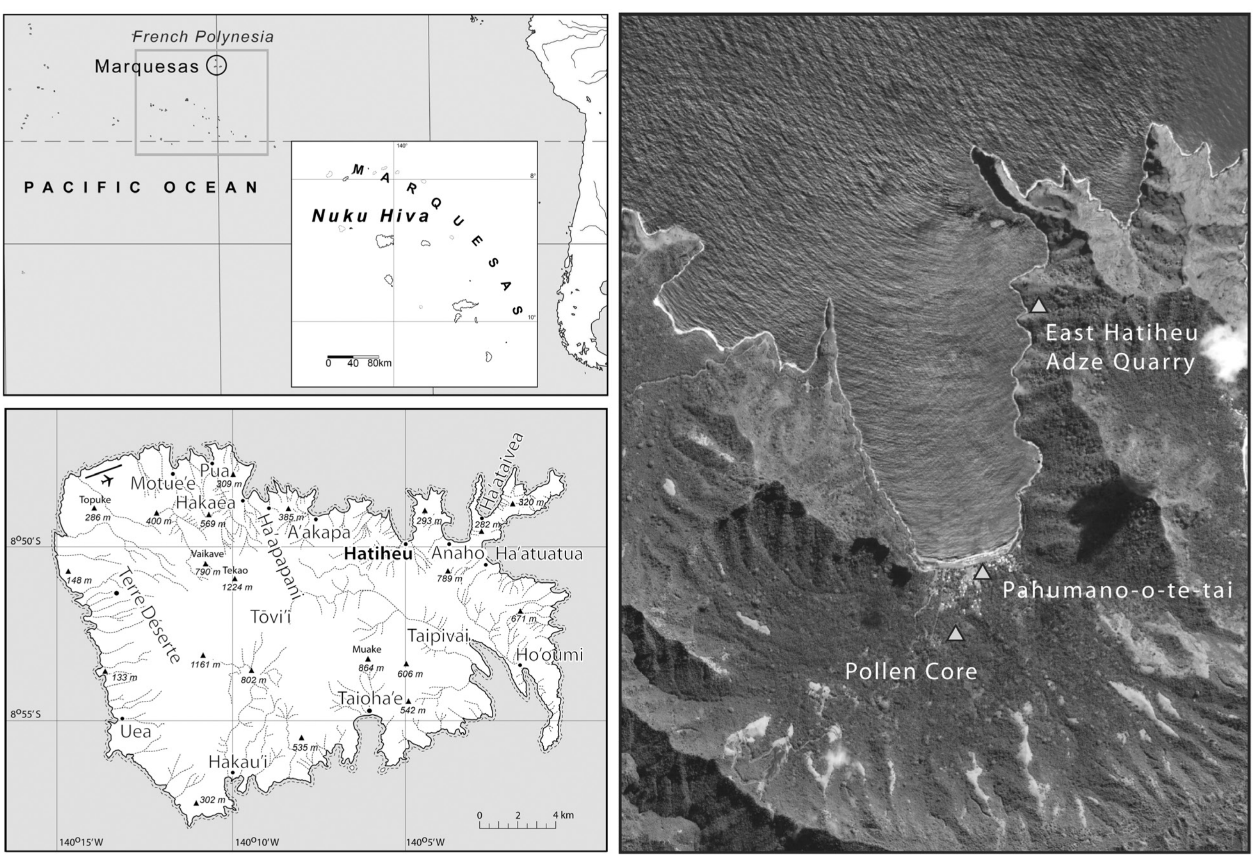

Figure 1. Nuku Hiva Island and Hatiheu Valley (IKONOS image).

races known as *paepae*, are common throughout Hatiheu Valley, although only a few sectors have been surveyed in detail or excavated (Addison 2006; Millerstrom 2001; Ottino-Garanger 2001). Radiocarbon dates on domestic features indicate lower valley habitation from around the 14th century AD (Millerstrom & Coil 2008). These domestic structures are often closely associated with irrigated terraces, thought to be related to taro cultivation (Addison 2006). Wood charcoal studies attest to the importance of traditional tree crops such as *Artocarpus altilis* (breadfruit), *Inocarpus edulis* (Tahitian chestnut) and *Cocos nucifera* (coconut);

Until recently little was known about the valley's early human history. Following Orliac's 2002 coastal investigation, our team secured a pollen core from the valley interior in 2003 which appears to reflect gardening activities. Palynologist Kevin Butler extracted a 145 cm long core from a centrally located inland marsh (Figure 1). AMS dating of pollen concentrate from the core base (145–147 cmbs) returned a 2σ age range of AD 1160–1278 (NZA-20039; 809 ± 40) (Allen *et al.* 2011, Table 1). Preliminary analysis indicates that charcoal is present throughout the core and cultivated species have been tentatively identified in the upper late prehistoric levels (K. Butler, pers. comm., 2011). No diagnostic crop plants have been identified in the lower levels, but palynomorphs here are sparse. Given the foregoing, coupled with the rarity of natural fires on this windward coast and well dated cultural sites elsewhere on the island which are contemporary with the basal core date (see review in Allen & McAlister 2010), we suggest the pollen core charcoal relates to anthropogenic burning.

EAST HATIHEU ADZE QUARRY

Although archaeologists have been active in Hatiheu for some time, no stone quarries have previously been reported for the valley. In 2011, local informants showed MSA a source of dike stone and a locality of adze manufacture on the eastern peninsula of Hatiheu Bay, about an hour long walk north from the village boat ramp. The site is located on a steep slope which probably exceeds 45 degrees, and in the vicinity of a grove of *Pisonia grandis* (*Pukatea*) trees (Figure 2). Several vertical dike exposures near the ridge crest were apparently exploited, giving rise to a significant volume of flake debitage and manufacturing rejects, materials which are now actively migrating towards the sea. Although little site structure is preserved on the exceptionally steep slopes, piles of debitage, coupled with abandoned adze blanks and preforms, identify this as an important tool-stone source. Smaller workshops also were identified along the trail leading from the main valley area to this peninsular location. The occurrence of flakes that are geochemically consistent with this source in the earliest Pahumano-o-te-tai occupation layer (see below) suggests initial use of the quarry between the late 13th to late 14th centuries AD. Importantly, this source can be geochemically differentiated from previously analysed sources in nearby Anaho Valley (McAlister 2011), as discussed in more detail below.

THE PAHUMANO-O-TE-TAI SITE

Pahumano, literally 'thousands of drums,' is a traditional land unit which extends from the coast into the valley interior, similar to Hawaiian *ahupua'a* or Cook Island *tapere*. A large inland *tohua* is reported in Ottino-Garanger (2006, Figure 5), but was not described by Linton (1925: 117–8) who visited the valley in 1920–21. However, neither were any of the valley's many other *tohua* and *me'ae,* other than the spectacular 117 m long Naniuhi Tohua which also boasts a 22-m long tunnel. The Pahumano *tohua* also was not reported by Suggs (1961: 68–76) who carried out extensive excavations at Tohua Hikokua where he uncovered a complex construction history.

Pahumano-o-te-tai ('Pahumano of the coast') is the name we have given to a coastal archaeological site in this same land unit, located on the grounds of the Hatiheu Catholic Mission. Hereafter simply referred to as Pahumano, the site faces directly out of the bay, towards the open sea, and would have been an ideal location for both landing and viewing incoming vessels (Figure 3). Permanent streams are found in close proximity, lying a few hundred metres to either side of the church grounds. Looking inland from the coastal flat, the site lies at the terminus of a massive ridge, which effectively divides the coastal lowlands of Hatiheu Valley into two sectors. The lower slope of this ridge is the site of the church cemetery, while higher areas are terraced and places of contemporary residence. A brief visit suggested that the graves higher up the slope are older; where headstones were used they date from the 1930s but several graves are simply marked by rock borders (Figure 3 foreground).

The site also is historically significant as the location of the valley's first Catholic church, which is reported to date to 1879 (Chester *et al.* 1998: 31). In 1889 author Robert Louis Stevenson (1896: 67) visited Hatiheu and observed 'About midway of the beach no less than three churches stand grouped in a patch of bananas, intermingled with some pine-apples. Two are of wood: the original church, now in disuse; and a second that, for some mysterious reason, has never been used.' After the church was destroyed by the 1946 tidal wave it was rebuilt in wood. The deteriorating wood structure was replaced in 2003 by the present church, Sacré-Coeur and the church residence constructed (see Figure 4). This latter structure is situated on what appears to be a buried stone foundation, of uncertain chronological association. A rock face is exposed some 3 m seaward (or north-northwest) of the residence and a second face, which parallels the church, is suggested by slightly elevated ground to the south-west.

In 2002, construction of the new church provided an opportunity to investigate subsurface deposits in this lo-

Figure 2. The East Hatiheu Adze Quarry.

cality. A ~17 m long inland-seaward trench was opened preparatory to laying the church foundation and examined by Michel Orliac (2003). A photograph of the trench in an unpublished typescript was particularly helpful in relocating the specific area of his investigation, apparently under the north-west wall of the current church (Figure 4). He provides a schematic cross-section of the trench (Figure 5) and a brief description of his findings.

At the inland end of the trench, the terminus of the ridge was cleaned and profiled by Orliac, who identified three cultural layers alternating with sterile colluvial sediments. Nine metres seaward of this face (Figure 5), a radio-

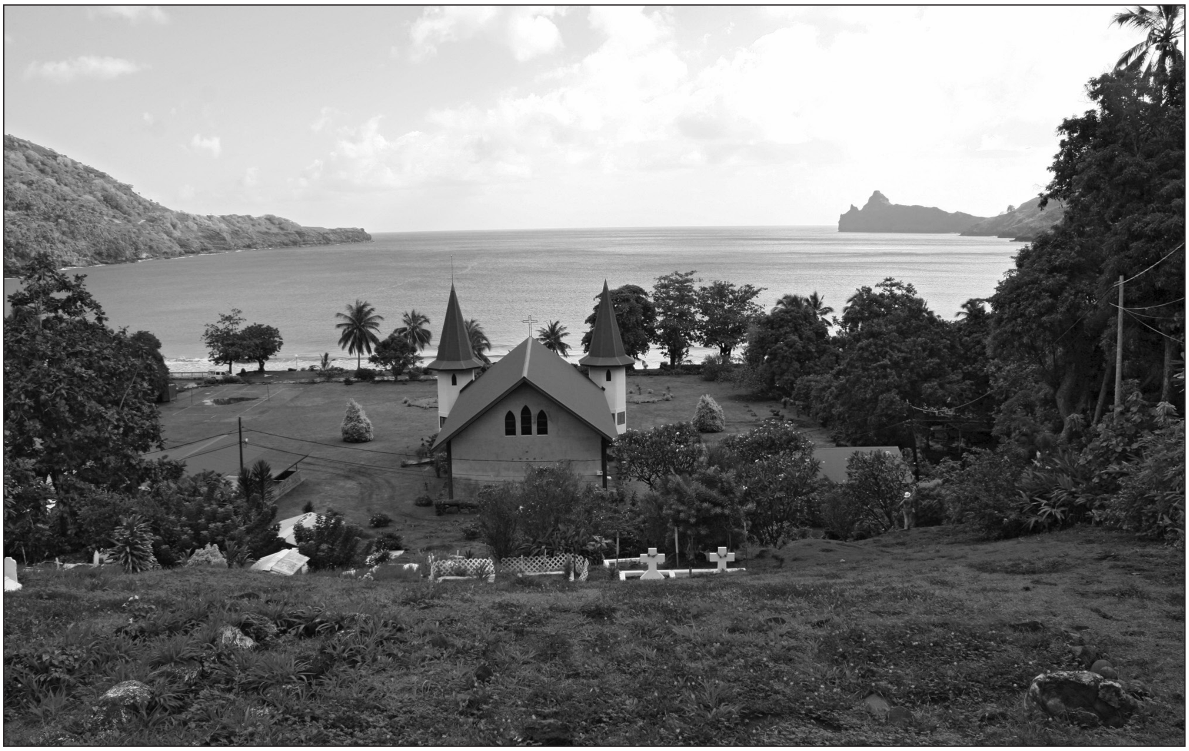

Figure 3. View of Hatiheu Bay from the church cemetery; our excavation area lies between the church and the partially obscured residence on the right.

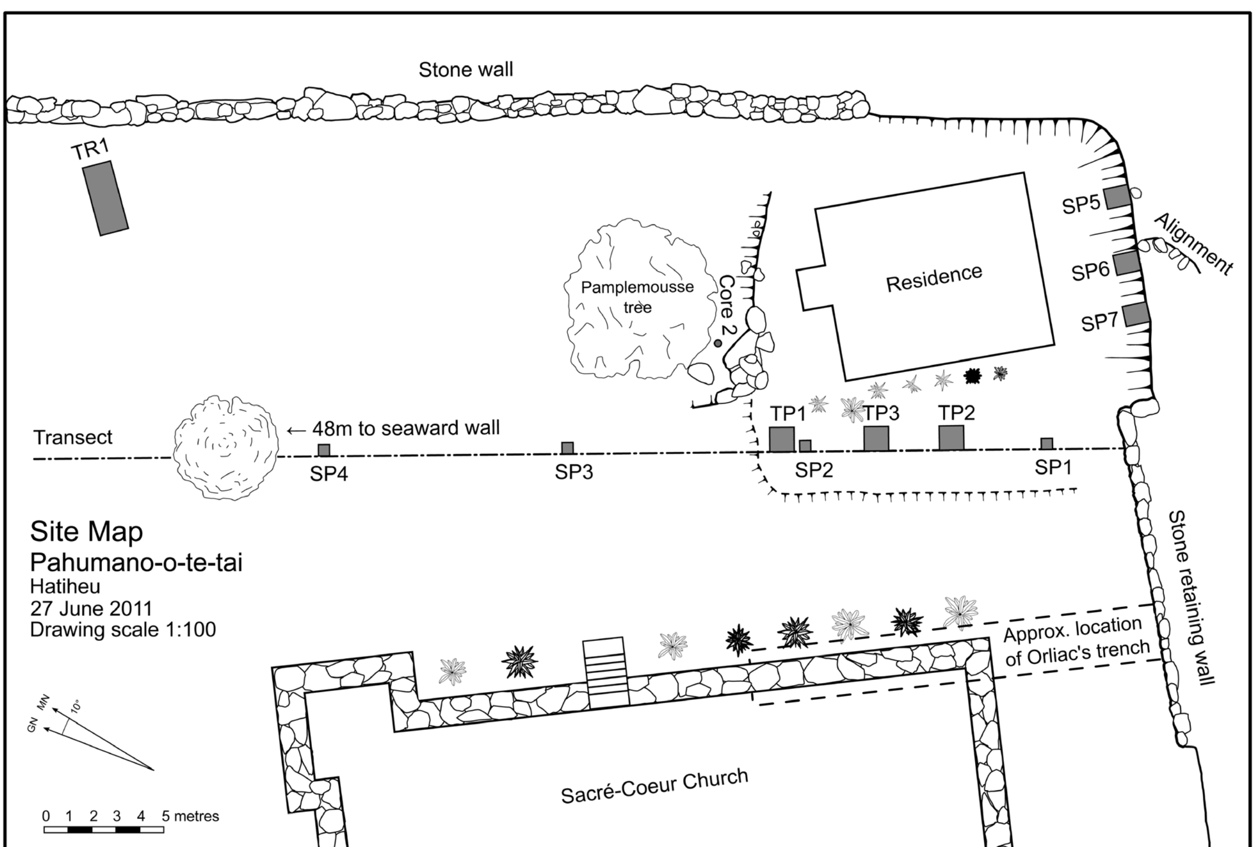

Figure 4. Pahumano-o-te-tai site map, location of the 2011 tests, and approximate location of Orliac's trench.

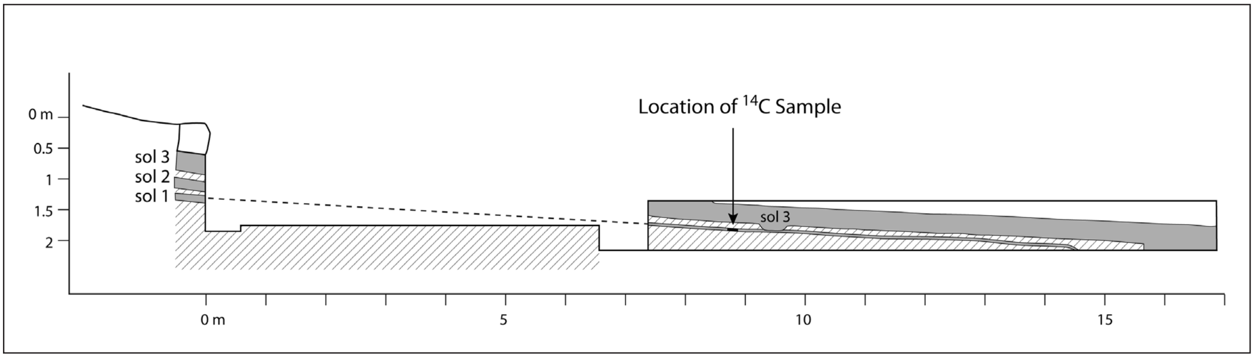

Figure 5. Cross-section of the trench face recorded and sampled by Orliac (2003).

carbon sample from the lowest of these three layers (Beta-170319) returned a conventional date of 1190 ± 90 with a calibrated 2σ age range of AD 665–1012. In light of recent reviews of the Marquesan sequence (Allen 2004; Allen & McAlister 2010), the date suggested an early settlement but, as the charcoal was not identified, the possibility of in-built age could not be discounted (see Allen & Wallace 2007; 117, Table 2; McFadgen *et al.* 1994; Spriggs & Anderson 1993). The present research was undertaken to gain additional samples from this potentially early activity area.

THE 2011 EXCAVATIONS

Initially, a seaward-inland running transect was established along a 340° degree line and a series of small (~25 cm²) shovel pits (SP1–SP4) opened at 10 m intervals (Figure 4). These shovel pits indicated the subsurface presence of both cultural remains and variation in sediments, but rocks frequently impeded excavation and it was not possible to determine if undisturbed deposits were present. A black sand lens in SP4 at 40–45 cm below the surface, and roughly 50 metres from the present coast, suggested marine incursions to this point in the past.

Additional shovel pits (SP5–SP7) were opened along the exposed ridge face where Orliac had identified the stratigraphic sequence of three cultural layers (Figure 4). While much of this escarpment is now faced with a ~1.25 m high, two-to-three tier retaining wall of very large boulders (~80 cm wide), the area immediately behind the church residence remains exposed and accessible (Figure 6). Areas more seaward of the church were considered likely to have been disturbed by the two known tsunami events and recent construction activity. A ~2 m long trench (TR1), placed roughly parallel to the coast but avoiding church ground plantings, was opened here with a backhoe to test for intact cultural deposits (Figure 4).

Following these preliminary investigations, three 1m² units were opened on the coastal flat (TP1–TP3), seaward of the ridge terminus (Figure 4). Excavation here was by troweling, following the natural stratigraphy. Three-dimensional control was maintained and features, artefacts and other significant finds were point-plotted. Sediments were processed with ¼ inch screens; although smaller mesh sieves would have been ideal, this was not practical given the heavy clay sediments and the lack of water processing facilities. Small bones observed in Layer III and at the Layer III–IV contact were collected *in situ* given their potential for providing important environmental information. Upon completion of the excavation, stratigraphic profiles were drawn and photographed for each unit. Radiocarbon samples were taken from *in situ* concentrations or exposed features whenever possible and four were submitted for AMS dating (see Table 1 and discussion below).

RESULTS

Backhoe trench

The backhoe trench (TR1) was excavated to a depth of 280 cm below surface (cmbs). Two layers were encountered, a very dark brown loam (10YR 2/2) from 0 to 90 cmbs with 20th century materials and below this a dark yellowish brown (10YR 3/4) sterile clay. At the Layer I/II boundary there was a considerable amount of charcoal and oxidation which was suggestive of *in situ* burning. The sterile clay was interrupted by a black beach sand lens at 120 cmbs and the water-table was encountered at 210 cmbs. The trench confirmed that the area had been considerably modified and no intact cultural stratigraphy remained. The backhoe driver subsequently informed us that much of this area had been previously disturbed, to a considerable depth, during construction of the new church. He also noted that he had excavated a very large pit near SP4 and filled it with boulders, which might explain our difficulties in coring.

Ridge face

Nine strata were identified in the ridge face (Figure 7): four cultural layers (I, III, V, and VII), three colluvial deposits (II, IV, and VI), and two sterile *in situ* sub-soils. All of the sediments were clays which varied mainly in colour and proportions of charcoal, bone, and artefacts. The colour descriptions below are based on dry samples from SP5, classified using a Munsell colour chart. Charcoal was present in all of the cultural layers but was especially concentrated in Layers III and VII (Figure 7). The depth of the stratified sequence varies along the length of the exposed profile; the layer thicknesses indicated below are based on SP5.

Layer I (10YR 3/2, very dark grayish brown) apparently was not present in Orliac's trench, removed or obscured by a large boulder (see Figure 5). In SP5 it extended from the surface to 23 cmbs. A small boulder alignment on the slope above SP6 suggests the layer represents *in situ* cultural activity. Layer II, from 23–45 cmbs in SP5, was largely acultural colluvium (5YR 5/3, brown), but isolated bone and shell fragments were observed.

Layer III (10YR 2/2, very dark brown), 45 to 55 cmbs, had a high charcoal content. A log surrounded by red (fired) sediments in SP6 indicated *in situ* burning. One flake and a fragment of pig bone were recovered from this layer. The boundary between Layers II and III was sharp in all three shovel pits, suggesting the surface of Layer III may have been removed by erosion (Figure 7). Layer IV, 55 to 65 cmbs, was acultural colluvium (10YR 4/3, brown), similar to Layer II.

Layer V (5YR 3/3, dark reddish brown) contained dispersed charcoal and varied in thickness along the length of the exposed profile, from 10 cm in SP5, to 21 cm in SP6, to 42 cm in SP7. In SP7 a 48 cm wide by 175 cm deep pit of undetermined function was uncovered; it contained dispersed charcoal and was filled with small cobbles in the base and larger rocks above. Both mammal (probably pig) and bird bone were recovered from this layer, along with a few basalt flakes. Layer VI, acultural colluvium, extended from 75 to 85 cmbs (5YR 4/3, reddish brown).

Layer VII (10YR 2/2, very dark brown) is a charcoal-rich layer (85–95 cmbs in SP5) with small amounts of fish bone and basalt flakes. Of note, Layer VII extended to 115 cmbs in SP6 where the radiocarbon sample reported in Table 1 was taken. The boundary between Layer VI and VII was clear and suggestive of an erosional contact. The excavation area was too small to determine whether the cobbles seen in SP6 Layer VII (Figure 7) were natural or part of a cultural feature. The thin lens of charcoal below the base of Layer VII is thought to be the result of root action. Layer VII was not represented in SP7.

Two subsoils were differentiated in SP5, mainly on colour: Layer VIII (10YR 3/3, dark brown) extended from 95 to 120 cmbs, while Layer IX (5YR 5/6, yellowish red) ran from 120 cmbs to the base of excavation at 155 cmbs. Excavation into the slope indicated that the layers described above extend at least 50 cm into the hillside and in most

Figure 6. Terminus of the ridgeline and the location of SP5–7 behind the church residence (view to the south-west).

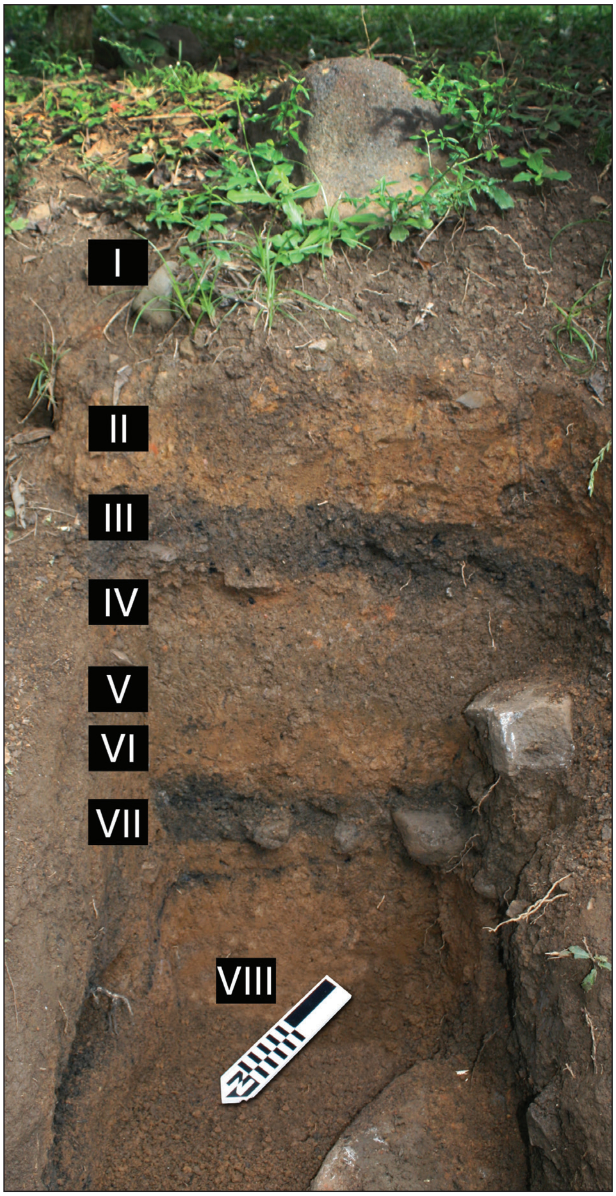

Figure 7. Stratigraphy of SP5.

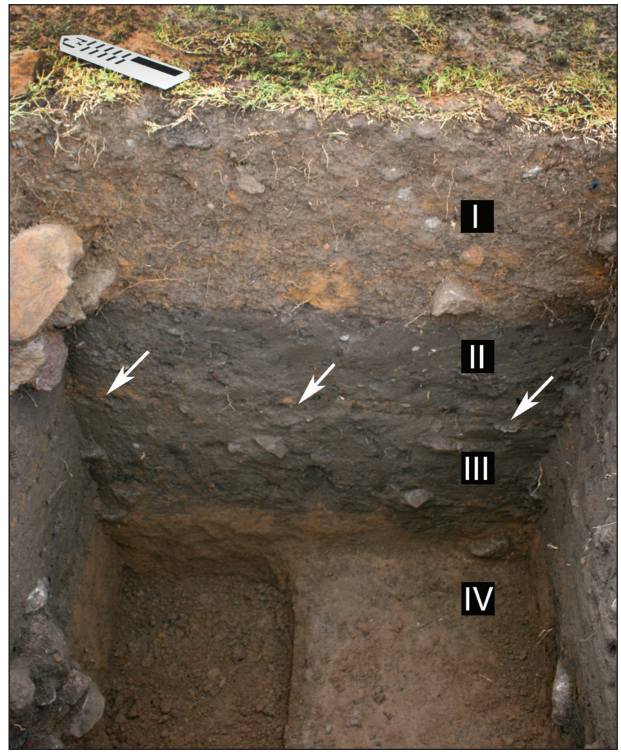

Figure 8. Stratigraphy of TP1 with the Layer II-III boundary and yellowish brown clay lens indicated by arrows.

cases increase in thickness. This, in addition to the *in situ* burned log in Layer III of SP6 and a pit feature in Layer V of SP7, indicate that the cultural layers represent *in situ* activities, as opposed to being re-deposited sediments.

Controlled excavations

On the coastal flat, three controlled excavation units were opened (Figure 4) and excavated to sterile subsoil. Four strata were recognised in the controlled test units (Figure 8), with the following depths (in centimetres) below surface (cmbs) based on TP1. Layer I extended from 0 to 30 cmbs and contained an abundance of historical materials in a clay matrix which varied from brown (10YR 5/3) in TP2, to yellowish brown (10YR 5/6) with reddish yellow clay mottles in TP1. In some places the base of this layer was marked by a 2 to 6 cm thick brownish-yellow (10YR 6/8) clay lens. Both recent (e.g., aluminium can pull tabs) and probably late 19th century to early 20th century materials (glass, nails, ceramics) were recovered. We interpret this layer the product of recent earth-moving activities, most likely those associated with construction of the new church.

Layer II (30 to 50 cmbs) was, in TP1, a dark brown (10YR 3/3) loamy clay which contained both historical and traditional materials. The former appear to be late 19th to early 20th century in age and probably relate to use of the early church structures. Traditional materials in Layer II include adze preforms and flakes. Given that stone tools were often rapidly replaced once metal became available, we think it likely that this layer is a mixture of materials from at least two distinct time periods and possibly more. The boundary between Layers II and III was in some places marked by a 2–4 cm thick brownish yellow (10YR 6/8) clay lens (Figure 8) but in other instances the transition was less obvious.

Layer III, a very dark brown (10YR 2/2) loamy clay, extended from 50 to 80 cmbs in TP1 and contained several *in situ* features. The radiocarbon results (Table 1) suggest this layer is equivalent to Layer VII of the ridge cross-section sequence. However, the layer is about twice as thick here.

Layer IV was a sterile clay that varied in colour from dark yellowish brown (10YR 4/4) in TP1 to reddish brown

(5YR 4/3) in TP2. The abrupt boundary between this layer and the one above suggests the possibility of an erosional contact and/or that Layer III was not exposed long enough for *in situ* weathering. Coring was carried out from the base of excavation at 115 cmbs to a depth of 220 cmbs and no further cultural materials were encountered. In TP3, two large flat boulders were encountered a few centimetres into Layer IV and covered most of the unit. The stones are curious given that boulders were completely lacking in the sterile subsoil of the other two units. The rock was of uncertain material, but basalt and sandstone can be discounted.

Site chronology

Four samples, all single pieces of coconut shell (endocarp), were submitted for AMS dating (Table 1). Three were extracted from layers exposed in the ridge profile (III, V, and VII) which contained an abundance of charcoal. The fourth came from an oven feature in the undisturbed basal cultural layer (Layer III) of TP3 on the coastal flat. The samples were identified by wood charcoal specialist Jennifer Huebert and MSA.

The two samples from the basal cultural layers, one from each locality, are internally consistent and date between the late 13th and late 14th century AD (Figure 9). These two new determinations suggest that Orliac's original sample is probably affected by in-built age, possibly on the order of several centuries. Allen & Wallace (2007) present evidence which suggests that some tropical coastal trees, like *Cordia subcordata*, can live for up to 300 years. There also is the possibility that Orliac's sample included problematic exotic driftwood. For example, long-lived continental taxa like *Sequoia* (redwood), *Quercus* (oak), and *Pinus* (pine) charcoal have been recovered from prehistoric hearths on Kahoʻolawe Island in Hawaiʻi, where Murakami (1992) argues they arrived as driftwood. Alternatively, Orliac's (2003) sample could date re-deposited

Table 1. *Pahumano radiocarbon (AMS) results.*

Lab No.	Provenience: unit, layer, depth, sample no.	Material*	$\delta^{13}C$ ‰	Conventional age BP	Calibrated AD age range (2σ)†	Analytical zone
Ridge profile						
Beta-303439	SP6, Layer VII, 110–115 cmbs, #6795, *in situ*	Coconut endocarp	–23.9	660 ± 30	1277–1393	Zone H
Beta-303438	SP5, Layer V, 65–75 cmbs, #6774, *in situ*	Coconut endocarp	–25.7	560 ± 30	1310–1430	Zone F
Beta-305117	SP5, Layer III, 45–55 cmbs, #6775, *in situ*	Coconut endocarp	–24.4	280 ± 30	1495–1796	Zone D
Controlled Units						
Beta-303440	TP3, Layer III, Feature 20 (oven), 80 cmbs, #6841, *in situ*	Coconut endocarp	–24.8	690 ± 30	1270–1380	Zone H

* All samples were single fragments of *Cocos nucifera* endocarp, large enough for confident identification.
† Samples were calibrated with OxCal 4.1.7 (Bronk Ramsey 2009) and the IntCal09 Northern Hemisphere atmospheric curve (Reimer *et al.* 2009) was used, following Petchey *et al.* (2009).

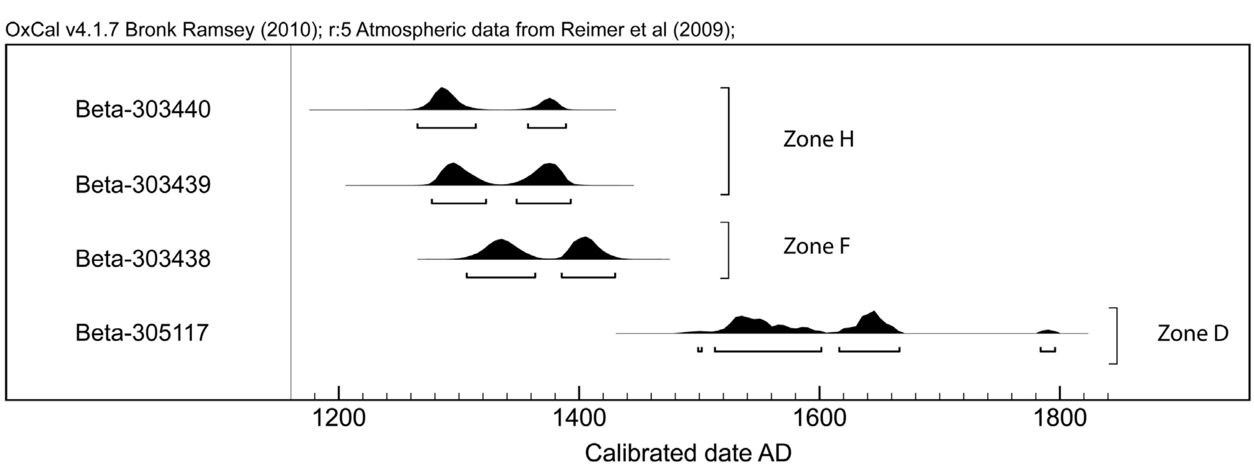

Figure 9. Calibrated radiocarbon results (OxCal 4.1.7).

charcoal, derived from earlier cultural activities elsewhere (e.g., upslope), or an earlier *in situ* occupation not represented in our test units; however, we consider both of these possibilities less likely on present evidence.

Our single sample from Layer V of SP5 dates to a slightly later period of time. The sample from Layer III of SP5 is more recent, but still within the prehistoric period on the basis of the 2σ age range. As a whole the four new AMS dates provide an internally consistent chronological sequence and suggest cultural activities in this locality throughout most of Marquesan prehistory.

Drawing on the radiocarbon and other evidence, Figure 10 compares the stratigraphic sequences from the ridge face and the coastal flat and links the two areas through nine analytic zones (A though I). Notably, Zone A, the disturbed layer found on the coastal flat, is missing from the ridge profile. Also, Zones B through G are not represented on the coastal flat as intact layers and as such were not sampled by our controlled excavations. They are, however, probably represented in Layer II of the coastal flat where mixed historical and traditional materials were recovered. Layer II of the coastal flat also may include post-Zone B sediments related to activities associated with previous church structures.

Excavated features, portable artefacts and biota

Features were mainly identified in Zone H and include fire features, post-moulds, and rock-filled pits (Table 2). These help to establish that the associated strata are *in situ* rather than transported sediments. One cluster of post-moulds in TP1, similar in size and depth, and in close proximity, suggest a structure, possibly circular or oval in plan.

An unusual feature in TP2 (Fe. 11) was a pit filled with basalt cobbles and large pebbles, similar to that noted above for Layer V of SP7. The sediments within the pit were loosely packed and included lenses of bright red clay and mottles of fine to medium charcoal, suggesting the pit had been quickly filled; similarly the orientation of the stones within the feature was haphazard. Among the potential functions are a very large post-mould, or a pit dug to gain access to red clay.

Faunal remains were infrequent in the disturbed sediments on the coastal flat but pig and bird (probably chicken) were present. The Zone H fauna, although not abundant, was diverse. It included modest amounts of fish and bird bone, turtle, a shark and a dog tooth, and highly weathered shell and chiton. Bird bones were especially frequent near to Feature 10, a small oven; however, as the bone was not burnt these materials may not be directly associated with feature use. The very small size of the bones, combined with their concentration at the boundary between Zones H and I suggests they may be natural rather than food debris. A few very small fish bones, similarly located, also may be natural. No rat bone was observed in any of the layers. In general, shell remains were highly weathered and the bone was exceptionally fragile and difficult to recover even when observed *in situ*.

Several samples of wood charcoal were secured from the site. These are being analysed by Jennifer Huebert as part of her doctoral research on Marquesan aboriculture and vegetation histories. The stratified sequence of charcoal-rich layers provides an exceptional opportunity to track vegetation change at a single site over a period of several hundred years and a distinctive vegetation record is emerging.

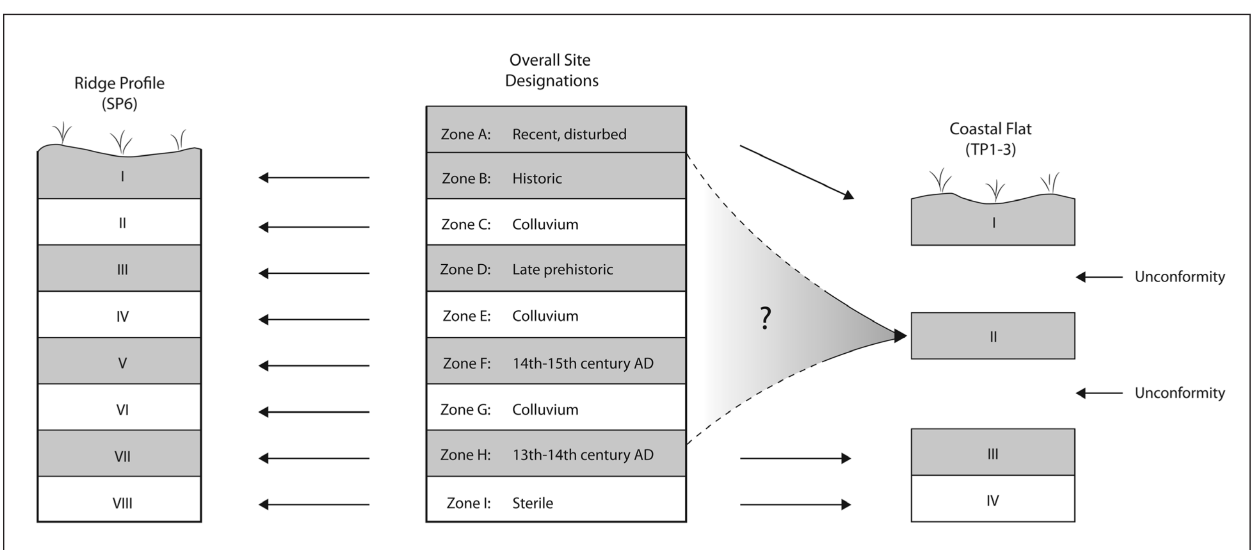

Figure 10. Schematic drawing of the stratigraphy identified in the two tested areas, cross-correlations of strata, and designation of analytic zones based on sedimentary characteristics, artefact content, and radiocarbon dating.

Table 2. *Excavated features and their associated materials.*[1]

No.	Functional type	Assoc. Layer	Dimensions (cm) L, W, depth	Plan shape	Profile shape	Contents	Portion excavated
Test Pit 1							
2	oven	III	70 × 70 × 15	round	basin	FCR, charcoal, bone, 1 flake, oxidised base	*ca.* ½
3	lens	III	100 × 35 × 5	irregular	lens	mottled yellow-brown clay	uncertain
4	post-mold	III	13 × 9 × 18	oval	tapered		entire
5	post-mold	III	20 × 19 × 20	round	tapered		entire
6	post-mold	III	10 × 9 × 10	round	tapered		entire
7	post-mold	III	15 × 10 × 12	oval	tapered		entire
8	post-mold	III	19 × 14 × 14	oval	tapered	1 flake, few cobbles	entire
9	post-mold	III	9 × 9 × 14	round	tapered		entire
Test Pit 2							
10	oven	III	90 × 60 × 15	rectangular	basin	FCR, charcoal, bone, oxidised base	*ca.* ½
11	deep pit	III	60 × 25 × 26	irregular	basin	FCR, bone, cobbles	*ca.* ¼
12	pit	III	40 × 15 × 8	round	basin	red clay, little charcoal, oxidised base	*ca.* ⅓
13	post-mold	III	8 × 8 X 10	round	tapered	charcoal flecks	entire
14	post-mold	III	15 × 14 × 14	triangular	tapered	charcoal flecks	entire
15	uncertain	III	25 × 18 × 11	uncertain	irregular	some charcoal	*ca.* ½
16	pit?	III	30 × 16 × 7	uncertain	uncertain	charcoal flecks, 2 rocks	*ca.* ¼
Test Pit 3							
18	pit with rocks	II	35 × 30 × 20	uncertain	uncertain	rocks, 1 nail, no charcoal	*ca.* ¼
19	hearth or rake-out	III	65 × 35 × 20	uncertain	uncertain	FCR, charcoal, flakes, bone	partial
20	oven	III	65 × 50 × 15	uncertain	basin	charcoal, partially oxidised base	*ca.* ¼
21	post or root mold	III	25 × 20 × 17	square	uncertain		entire

1. FCR denotes fire-cracked rock. Feature numbers 1 and 17 were not assigned.

A variety of historical materials were recovered, particularly in the disturbed sediments on the coastal flat (Layers I and II). These include window and bottle glass, a marble, iron and other metal including a lead-capped nail and a copper nameplate, glazed tiles and ceramic dinnerware fragments. A few small metal fragments and a nail also were recovered from the upper few centimetres of Layer III in TP1 but these are considered intrusive given the preponderance of evidence that this layer is prehistoric in age, the absence of historical materials in Layer III of the other two test pits, and an intrusive pit feature (Fe. 18).

Altogether 116 lithic artefacts were recovered from the overall site area, most from Layer III (Zone H) of the controlled test pits (TP1–3). The majority are flakes (n = 108), ranging in weight from 0.2 g to 114.5 g. Several include cortex and four exhibit polish, suggesting that various stages of adze manufacture and repair were carried out at the site. The most noteworthy find is a finely finished adze bevel from Zone H (Figure 11). The adze had fractured transversely through the mid-section, and a series of chips on the bevel suggest that it was broken during use. Other items of note include a grindstone fragment and six adze preforms in varying states of completeness (Table 3, Figure 11). With the exception of the coarse-grained grindstone, the entire assemblage was geochemically analysed. No shell or bone artefacts were recovered from the prehistoric cultural layers.

GEOCHEMICAL STUDY

Methods

Geochemical analysis of the Pahumano assemblage was carried out using an Innov-X Delta Premium portable X-ray Fluorescence (pXRF) analyser equipped with a rhodium (Rh) target and a Silicon Drift Detector (SDD). The instrument's Soil Mode was used because this setting

Table 3. *Description of non-flake lithic artefacts.*

Sample	Unit	Layer	Manufacture stage	Source Attribution	Cross section shape	Weight (g)	Maximum linear dimensions (mm)		
							length	width	thickness
7216	n/a	surface	preform, broken	Henua a Taha	triangular	272	98	44	47
6783	n/a	surface	preform, butt	North-east Nuku Hiva	rev. triangular	57	45	56	20
6792	TP1	II	preform, bevel	North-east Nuku Hiva	quadrangular	192	73	53	37
7492	TP1	III	preform, butt	North-east Nuku Hiva	quadrangular	93	55	56	31
6838	TP3	III	adze bevel	Southern Marquesas?	rev. trapezoid	466	76	60	72
6821	TP3	III	preform, butt	North-east Nuku Hiva	quadrangular	85	51	45	23
6831	TP3	III	preform, butt	North-east Nuku Hiva	triangular	67	66	28	29
6816	TP3	III	grindstone piece	n/a	n/a	256	101	69	33

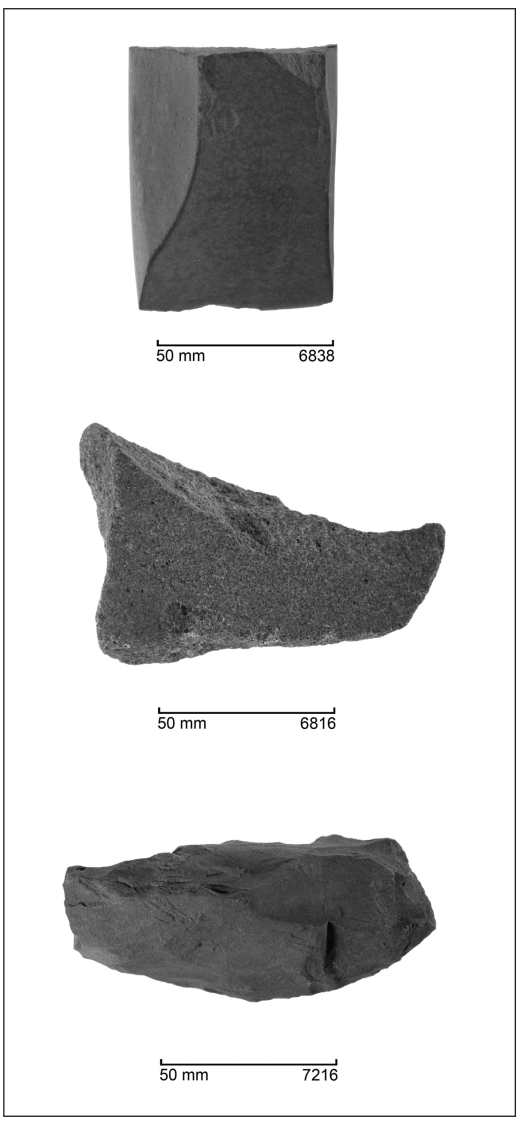

Figure 11. Stone artefacts: adze bevel (#6838 from TP3, Layer III); grindstone fragment (#6816, TP3, Layer III); adze preform (#7216, surface collection).

provides the most accurate results for basalts and allows a wide range of potentially useful trace elements to be quantified. In Soil Mode, samples are analysed in three sequential runs (Beams 1, 2 and 3), each using different operating conditions that are optimised for particular groups of elements. Beams 1 and 2 both operate at 40 keV with a current of 90 μA and are used for the mid-z elements Ni to Nb. Beam 3 provides increased sensitivity for the lighter elements K to Fe; it operates at 15 keV and 55 μA.

Instead of using the analyser's in-built calibration and quantification software, raw spectra data were extracted from the instrument and empirical calibrations were used to derive elemental concentrations. This technique allows more control over calibration procedures and provides substantial gains in accuracy for the lighter elements and small but consistent improvements for most of the mid-z elements. Similar methods were employed with Innov-X's earlier generation Alpha model pXRF analyser (McAlister 2011) and are described in detail for the Delta model in a forthcoming paper (McAlister in prep.).

Sixteen elements were quantified for this study (see Table 4). Spectra were calibrated using 21 standards, which cover the range of elemental variation typical of Oceanic island basalts. They included international rock standards (JB-1a, JB-2, JB-3, GSP-2) and 'in-house' samples previously analysed using Wavelength Dispersive X-ray Fluorescence (WDXRF) at the University of Auckland, Geology Department (see Parker & Sheppard 1997; McAlister 2011). One international standard, BHVO-1, a Hawaiian basalt broadly similar to Marquesan basalts, was omitted from the calibration procedure and used to check for accuracy (Table 4).

Prior to pXRF analysis each sample was scrubbed clean under hot water, immersed in an acid solution (10% HCl) for approximately 30 seconds to remove surface carbonates, rinsed under tap water and placed in an ultrasonic bath with distilled water for 20 minutes. All specimens were analysed whole; the most uniform surfaces, those without obvious inclusions, were selected for analysis and placed as close and parallel to the detector window as pos-

Table 4. *Comparison of instrument results to basalt standard BHVO-1.*

		Given value	Innov-X Delta
K_2O	%	0.52	0.53
CaO	%	11.40	11.58
TiO_2	%	2.71	2.66
V	ppm	317	351
Cr	ppm	289	248
MnO	%	0.17	0.17
Fe_2O_3T[1]	%	12.23	12.25
Ni	ppm	121	126
Cu	ppm	136	140
Zn	ppm	105	101
Rb	ppm	11	10
Sr	ppm	403	395
Y	ppm	28	29
Zr	ppm	179	180
Nb	ppm	19	21
Pb	ppm	3	2

1. Total iron expressed as Fe_2O_3.

sible. Each sample was analysed for 120 seconds live time per beam giving a total of 360 seconds per analysis.

Reference samples

For geochemical provenance analyses, Weisler (1993; see also Weisler & Sinton 1997) discusses the importance of defining an appropriate 'provenance environment.' This entails incorporating relevant archaeological, geological and ethnographic information to place spatial limits on the most probable sources of artefacts. For the Marquesas Islands, direct evidence of prehistoric inter-archipelago imports is currently limited to a few ceramic fragments that most likely originated in Fiji (Allen *et al.* 2012). Marquesan stone tools from the island of Eiao, however, have been identified in several other Polynesian archipelagos, including Mangareva and the Tuamotu, Society and Line Islands (Weisler 1998, 2008; Di Piazza & Pearthree 2001; Weisler *et al.* 2004; Collerson & Weisler 2007). To investigate whether this outward movement of Marquesan adzes might have been reciprocated, McAlister (2011) included reference data from throughout Oceania in a study that examined over 250 adzes and preforms from four northern Nuku Hiva Valleys. He found that no extra-archipelago materials were represented and that Marquesan basalts are geochemically distinctive and readily differentiated from other known Oceanic sources. For these reasons, we have limited the provenance environment for the current study to the Marquesas Islands, with one exception (see below).

A total of 119 reference samples were used to characterise Marquesan tool-stone sources (Figure 12). Most were collected by the authors and originally analysed using an Innov-X Alpha series pXRF instrument by McAlister (2011). All reference samples included in the present study either have been reanalysed with the more accurate Innov-X Delta Premium instrument or with WDXRF.

For analytical purposes, the reference samples were divided into eight groups according to geographical location and geochemical similarities. Two groups derive from quarry sites: the small East Hatiheu Quarry discussed above and the much larger Henua a Taha Quarry in the north-western Terre Déserte region (T. Maric, pers. comm., 2007; McAlister 2011). This latter quarry is extensive and includes several workshop areas; it is represented here by 12 flakes provided by Tamara Maric. The North-east group of reference samples derives from three neighbouring valleys east of Hatiheu (Anaho, Ha'ataivea and Ha'atuatua) that were grouped together because they possess virtually identical geochemistry. Included in this region are three utilised exposures: the Ha'aupa'upa Quarry in Ha'ataivea Valley (Suggs 1961; Rolett *et al.* 1997) and two smaller dike exposures in Anaho Valley, both which show evidence of material extraction and reduction (McAlister 2011). This North-east group also includes fine-grained specimens collected from un-utilised outcrops.

Three other Nuku Hiva geochemical groups contain adze-quality basalt collected by AM from natural outcrops and boulders: a North-west group (the valleys of Hakaea and Pua), a Southern group (Taiohae and Taipivai Valleys), and the Inner Hatiheu group which is distinguishable from the newly identified East Hatiheu Quarry.

Two geochemical groups from other Marquesan islands also are included in the reference set. Eiao Island, located approximately 100 km north of Nuku Hiva, has long been recognised as a source of high quality basalt. Reference data for Eiao are currently scant (see Weisler & Sinton 1997), and limited to four samples with trace element data (Best 1984; Weisler 1993; Collerson & Weisler 2007). To gain a better understanding of the variability of this source, the reference material includes both samples collected on Eiao and adzes from elsewhere in the Marquesas Islands that are geochemically consistent with Eiao rock (see McAlister 2011). The final geochemical group is from Atuona on Hiva Oa Island, in the southern Marquesas and consists of two specimens of fine-grained basalt collected by MSA.

Results

A bivariate scatter plot of Sr against Nb visually separates most of the reference groups into distinct clusters (Figure 12). Several other elements, such as K, Ca and Zr, also are useful for analysing our data. Enclosing the source data with 95% standard ellipses (see Batschelet 1981) helps to delimit the expected boundaries for each source. Because only two samples are currently available for Hiva Oa, it is not possible to construct a statistically-defined ellipse for this source.

Plotting the artefact data against the same elements shows a similar patterning and associates many specimens with a particular reference group (Figure 12). One cluster of artefacts is enclosed only by the North-east Nuku Hiva group ellipse and another only by the Eiao ellipse. Notably, all of the artefacts assigned to the Eiao are very fine-grained and dark grey in hand specimen, characteristics considered typical of basalt from this island (Rolett *et al.* 1997; McAlister 2011).

A single specimen, the large finished bevel described above (see Figure 11), is geochemically distinct from all other archaeological specimens in this study. In addition to the elements shown in the plot, this specimen has almost twice the concentration of K (2.0%) and higher concentrations of Rb and Zr than any of the other Pahumano artefacts. The closest reference specimens are the two samples from Atuona Valley on Hiva Oa but at present these are the only reference specimens of tool-quality basalt

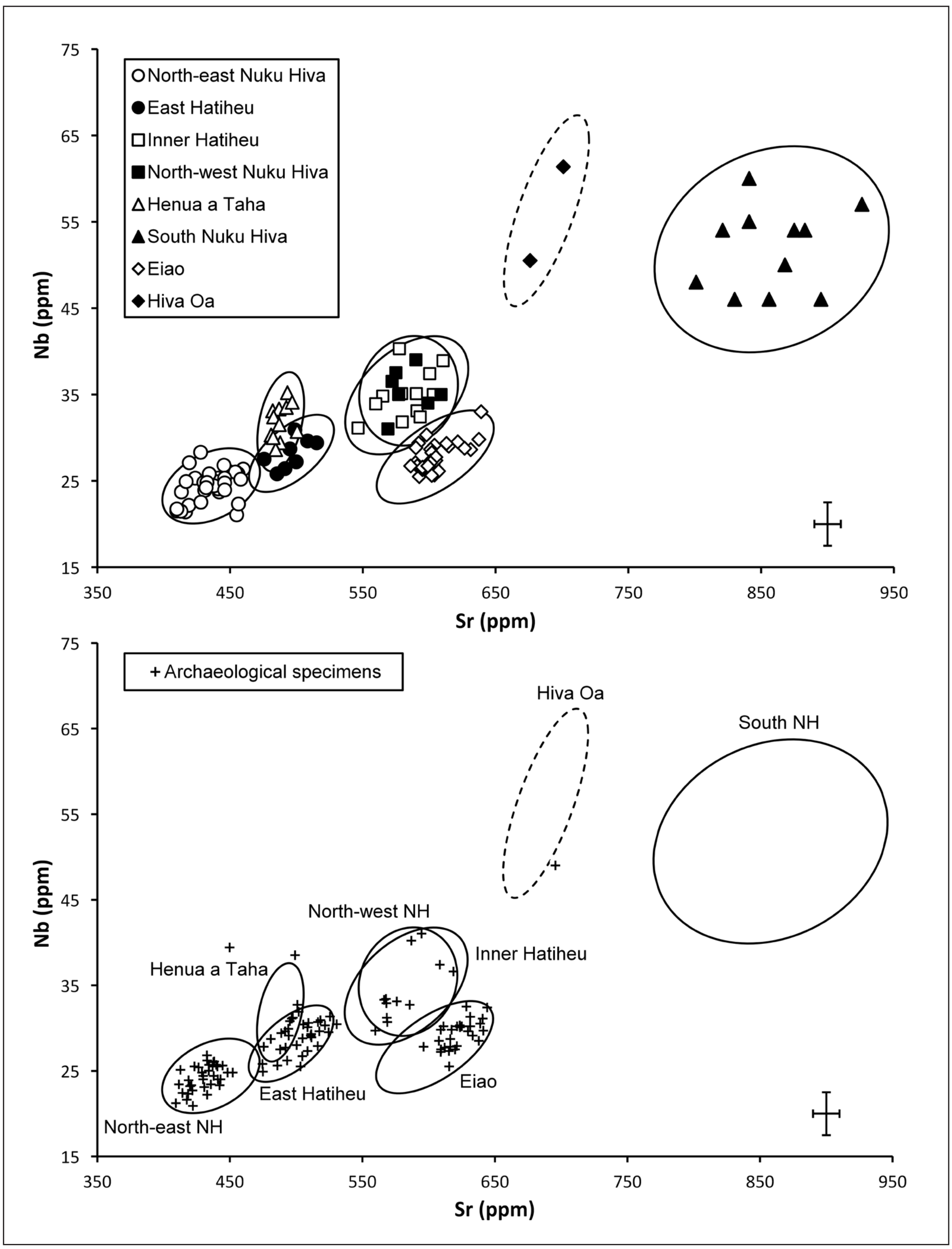

Figure 12. Scatterplots of Sr against Nb; the upper plot shows the reference samples and the lower, the archaeological specimens. Representative error bars are shown.

from the southern Marquesas that have been analysed for archaeological provenancing. Although its geochemistry is consistent with the Atuona samples, we cannot rule out the possibility that the adze derives from some other source in the southern Marquesas. Because this specimen was both geochemically and physically conspicuous, geochemical data from extra-archipelago sources also were examined. The Samoan Tatanga Matau source data reported in Sinton and Sinoto (1997) provided the closest match to both the bevel and our Hiva Oa reference samples for some elements, but differed substantially for others, including K, Rb and, Ni and Zn, suggesting that a southern Marquesan source is more probable.

In two instances, reference data from different groups have overlapping concentrations of Sr and Nb. It is, however, possible to distinguish between them using other pairs of elements; the Henua a Taha specimens are enriched in several metallic elements and can be visually separated from the East Hatiheu references on the basis of Ni and Cr (Figure 13). Similarly, the North-west Nuku Hiva group can be differentiated from the Inner Hatiheu specimens using the major elements K and Ca (Figure 13).

Two artefacts, both flakes, are not clearly associated with any of the included geochemical groups (Figure 12, Table 5). Both were run multiple times using different areas of their surfaces and returned similar values, suggesting neither sample surface irregularities nor instrument error biased the results. The samples are closest to the Henua a Taha (Terre Déserte) group and although they have compatible levels of Ni, their Rb, Zr and Zn concentrations are considerably higher, suggesting that they may have originated from an as yet unidentified source.

The analysis identified at least seven geochemical groups in the Pahumano lithic assemblage (Table 5). Most specimens derive from sources within Hatiheu and the neighbouring north-east valleys. The next most common provenance is Eiao, which accounts for just under one-quarter of the flakes. The other identified groups are represented only sparsely, possibly a reflection of their distances from Hatiheu. Also of note, flakes from local and nearby sources are relatively large, with an average weight almost twice that of the specimens assigned to Eiao (Table 6). These large flakes, the number of flakes overall, and the occasional presence of cortex suggest on-site manufacturing using local and nearby sources. In contrast, the Eiao flakes are not only smaller but also include the four polished specimens, all probably detached through use or rejuvenation.

It is not possible to identify chronological patterning in this assemblage as most of the specimens (68%) are from a single occupation layer (Zone H). Of note, however, is the sheer variety of sources in this early zone, indicating not only that multiple sources of tool-stone had been identified by the late 13th century to late 14th century AD, but also that materials were commonly transported between communities, sometimes over considerable distances. Only two groups, the East Hatiheu Quarry and Eiao Island, were identified in the more recent Zone F, but the comparatively small sample (n=8) should be noted.

Additionally, another 29 artefacts from contexts for which a secure chronology could not be assigned were geochemically analysed (Table 5). It is notable that, with

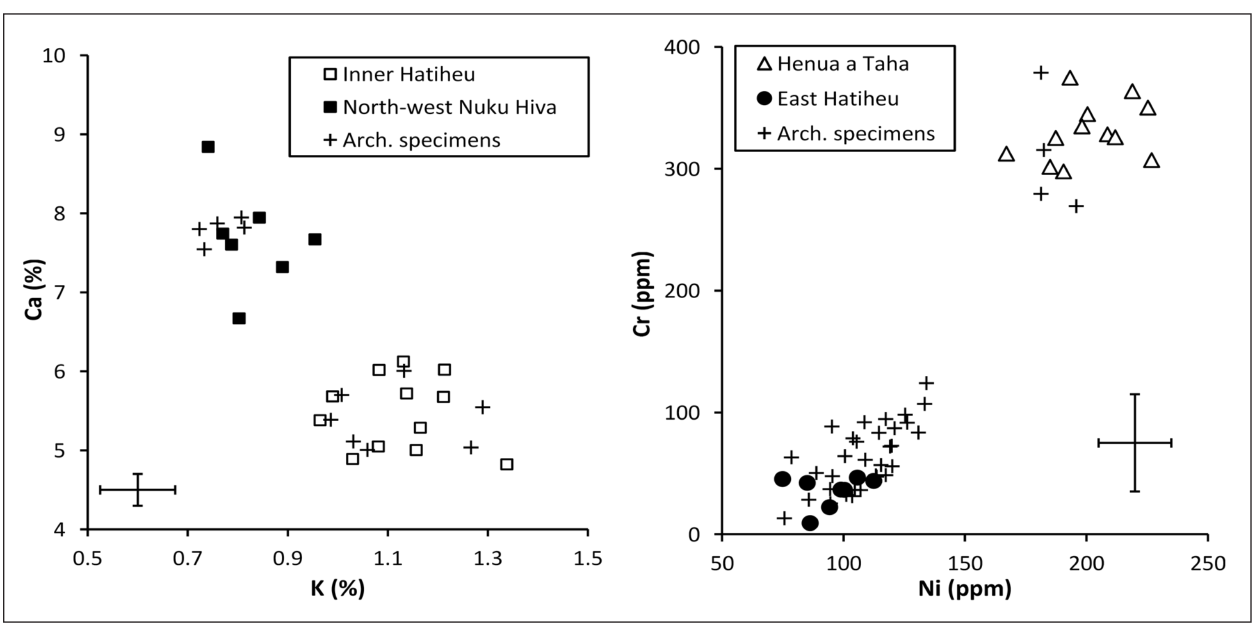

Figure 13. Left: Scatterplot of K against Ca showing the separation of the North-west Nuku Hiva and Inner Hatiheu groups; Right: Scatterplot of Ni against Cr showing the same for the East Hatiheu and Henua a Taha reference groups. Representative error bars are included.

Table 5. *Source attributions by provenience and analytic zone (where available).*

Unit	**TP1**	**TP2**	**TP3**	**SP5**	**SP6**	**SP7**	**TP1**	**TP3**	**SP1, 3, 4, surface**	**Totals**
Zone	H	H	H	F	F	F	Mixed	Mixed	na	
Nuku Hiva Groups										
North-east	20	1	8				3		4	**36**
East Haitheu	10		7	1	4	1	7		2	**32**
Inner Hatiheu	4		2					1		**7**
North-west		1	1				1		2	**5**
Henua a taha	3								1	**4**
Extra-Island sources										
Eiao Island	13	1	5	1	1		5	1	1	**28**
Southern Marquesas?			1							**1**
Unknown	1						1			**2**
Zone totals		**78**			**8**		**19**		**10**	**115**

Table 6. *Flake counts and weights by attributed source.*

Attributed source	**Count**	**Total weight (g)**	**Mean weight (g)**	**Weight range (g)**	
				min.	**max.**
North-east Nuku Hiva	31	360.6	11.6	0.2	99.7
East Haitheu	32	529.4	16.5	0.3	114.5
Inner Hatiheu	7	36.5	5.2	0.5	29.6
North-west Nuku Hiva	5	60.3	12.1	1.8	23.4
Henua a Taha	3	10.1	3.3	2.0	5.1
Eiao Island	28	168.3	6.0	0.2	29.1
Unknown	2	60.2	30.1	2.0	58.1

the exception of the southern Marquesas, all of the groups identified in the securely-dated assemblage are present. Moreover, the same three geochemical groups (North-east Nuku Hiva, the East Hatiheu Quarry and Eiao) dominate in both cases.

DISCUSSION

Early settlement in Hatiheu Valley

Hatiheu's ample streams, extensive areas of relatively flat land, and easy access to the sea make it an attractive place for human settlement, particularly in the context of the rugged and drought-prone Marquesan environment. Given these factors, and the emerging regional chronology (see Allen & McAlister 2010), Orliac's (2003) report of a 9th century AD date for coastal Hatiheu initially was not altogether surprising. The new dates reported here, however, suggest that this previous sample probably was affected by in-built age. Two new AMS determinations, both on coconut endocarp, place initial human activities at Pahumano sometime between the late 13th to late 14th century AD (1270–1393, 2σ range). Another two dates, from overlying cultural layers exposed in the ridge cross-section, are internally consistent and constrain the upper end of the age estimate for the earliest cultural stratum. A single 14th century AD date also was obtained by Millerstrom and Coil (2008), on *Hibiscus* charcoal from a lower valley earth oven. Notably, Pahumano does not appear to represent first use of the valley; the inland pollen core discussed above evidences burning, argued to be anthropogenic, beginning sometime between the mid-12th to late 13th centuries AD (1160–1278, 2σ range), possibly up to a century before the Pahumano coastal area was cleared and occupied.

The new excavations also offer insights into the nature of early coastal use in this valley. Post-moulds in the basal cultural layer (Zone H) suggest a structure, possibly oval or circular in shape, while the associated fire features point to food preparation. The diverse faunal assemblage includes both wild (small birds, fish, turtle, shark, and shellfish) and domesticated (dog) resources. Other on-site tasks included tool rejuvenation (suggested by polished flakes) and adze manufacture (indicated by preforms, large flakes, and flakes with cortex). While the former could simply relate to forest clearance, the latter suggests a broader range of activities.

Identification of the East Hatiheu Quarry makes an important contribution to our understanding of local practices of raw material acquisition and adze manufacture. The site adds to previous evidence which indicates widespread use of modest exposures of fine-grained rock, often dike-stone, in the Marquesan past (McAlister 2011; Rolett *et al.* 1997) and usefully, the new quarry can be differentiated from other nearby sources, including those of Inland Hatiheu and neighbouring valleys. Geochemically consistent flakes in the early Pahumano occupation help to establish both when and how the East Hatiheu Quarry was used.

Geochemical study of the Pahumano stone artefacts also informs on relations between the site occupants and other Marquesan localities. While most of the assemblage comes from proximate sources, including East Hatiheu and neighbouring north-eastern valleys (Anaho, Haʻataivea and/or Haʻatuatua), more distant sources on Nuku Hiva (the North-west group and the Henua a Taha Quarry) also are represented. The superior Eiao Island source also figures prominently amongst the flakes (25%), including all of the polished examples. This pattern is consistent with McAlister's (2011) earlier study where he demonstrated that adzes made from Eiao rock are well represented in sites of a similar age in Anaho Valley, and common in many Nuku Hiva valleys in late prehistory. Rolett (1998) also found Eiao basalts in the stratified Hanamiai site on Tahuata Island. In the roughly contemporary early occupation (11th to 14th century AD), they account for about 50% of the assemblage, as is also the case at Haʻatuatua Dune (Rolett *et al.* 1997).

Remarkably, all of the Pahumano adze preforms derive from sources outside of Hatiheu Valley, the majority coming from the North-east group (Anaho, Haʻataivea and/or Haʻatuatua Valleys). Moreover, the large, highly polished adze bevel is geochemically consistent with stone from Hiva Oa. We note that both of the finished adzes Rolett *et al*. (1997) recovered from Haʻatuatua also were thought to have originated outside of that valley. One was assigned to Eiao and the other (their Group III), with a geochemistry similar to our possible Hiva Oa example, they assigned to a southern Marquesas origin based on known geochemical trends for the archipelago.

Overall, our geochemical results point to population mobility and interaction in this early settlement period by peoples well acquainted with the geology of the Marquesas Islands. These findings are consistent with prior Marquesan studies (Rolett 1998; McAlister 2011), as well as those from several other East Polynesian archipelagos (e.g., Allen & Johnson 1997; Kahn *et al.* 2013; Sheppard *et al*. 1997; Weisler 1998). More difficult to assess is Rolett's (1998) model that Marquesan interaction spheres contracted over time, as the Pahumano lithic sample is mainly from the early stratum (Zone H), making it difficult to evaluate chronological change at this locality.

Landscape change

The Pahumano study also informs long-term landscape dynamics. The ridge cross-section preserves a remarkable record of repeated burning, slope destabilisation, erosion and occupation over a roughly 600-year period. These cycles of firing and erosion were probably anthropogenic in origin, given their association with human occupation at this locality. However, increased precipitation, as suggested in a pollen core from 810 m on the Tōviʻi Plateau (Allen *et al.* 2011), also could have increased erosion.

Sediment mobilisation, apparently facilitated by vegetation removal, affected earlier occupation layers in two ways. Sharp boundaries point to erosional unconformities, as observed at the Zone E-F and Zone G-H contacts. These boundaries suggest that portions of the underlying strata were removed following vegetation loss, slope exposure, and eluviation. However, cultural deposits that survived these processes were protected by the ensuing colluviation. How far the exposed deposits extend into the hillside, or the extent to which the morphology of the ridge terminus is the outcome of anthropogenic activities are interesting questions, but ones which cannot be answered on present evidence and might be difficult to investigate given the proximity of this site to the village cemetery. Nevertheless, the position of the earliest cultural layer (Zone H), under nearly a metre of sediment, points to significant landscape change during the period of human settlement.

While the foregoing are most likely aspects of landscape change initiated by human activities, this coastline also has been disturbed by tsunami. The Marquesas Islands, especially the northern coastlines, are particularly susceptible to South American-generated seismic waves. The absence of Zones C through G in the vicinity of TP1–3 could be the result of past shoreline inundation, although no direct sedimentological evidence of marine intrusions was apparent in these three test units. The complete lack of intact cultural deposits in the more seaward area of the church yard also most likely can be attributed to some combination of tsunami and more recent mechanical earth-moving activities.

Marquesas colonisation and established settlement

The present study brings us a step closer to differentiating between the three East Polynesian colonisation models outlined above. The emerging picture suggests human arrival in the Marquesas was at least as early as in the Society Islands and Mangareva, where AMS analyses on short-lived materials have returned 11th to 13th century age ranges (Anderson & Sinoto 2002; Kahn 2012; Kirch *et al.* 2010). Although clearly post-colonisation in age, the early occupation at coastal Pahumano joins a number of other settlement age sites on Nuku Hiva which have been recently recognised through targeted investigation.

Slightly earlier occupations have been identified at Hakaea Beach (~AD 1225–1300; Allen & McAlister 2010) and on the Ho'oumi Valley coast (~AD 1260–1300) (Allen *et al.* 2011) through AMS analysis of short-lived materials. Earlier cultural activities also are documented in Anaho Valley to the east (~AD 1000–1200) through AMS dating of short-lived taxa (Allen 2004, 2009). Even earlier, albeit controversial, dates derive from Ha'atuatua Beach (Rolett & Conte 1995; see review in Allen & McAlister 2010) where additional dating would be beneficial.

Contemporaneous sites elsewhere in the archipelago include Manihina Dune on Ua Huka Island (Conte 2002) and Hanamiai on Tahuata Island (Rolett 1998). Conte and Molle's re-investigation of the Hane Dune Site on Ua Huka provides convincing evidence for settlement here dating between ~AD 900–1000 (Molle 2011, Table 2.3), contemporaneous with the less securely dated early occupation at Ha'atuatua Beach. As a whole, these records unambiguously indicate human populations were well established (*sensu* Graves & Addison 1995) across the Marquesan archipelago by the 13th century AD, with human arrival at least a century or two before, and possibly three on the basis of the new Hane results.

CONCLUSIONS

Pahumano-o-te-tai is significant both as a locale of early Marquesan occupation and as an archive of several centuries of landscape change. Earliest use of the area, dating from between the late 13th to late 14th centuries AD, involved simple domestic activities, reliance on both wild and domestic food resources, and tool maintenance and manufacture. The first occupants of the site were not isolated, but engaged both with other areas on Nuku Hiva Island and, at least indirectly, with islands to the north and south as indicated by stone tool geochemistry. Forest clearance accompanied initial occupation of the area, while burning had an on-going role in the evolving landscape over the next few centuries. The heavy clay sediments that were mobilised also had archaeological consequences, removing, burying and sometimes reworking evidence of earlier cultural activities. The discontinuities seen in the Pahumano stratigraphy speak to these processes, and more generally to the vulnerability of Marquesan coasts to both anthropogenic and natural disturbances. Although the local record highlights the difficulties of recovering early settlement histories, the earlier pollen core date from the Hatiheu Valley interior suggests that continued exploration of the coast may yet be productive.

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