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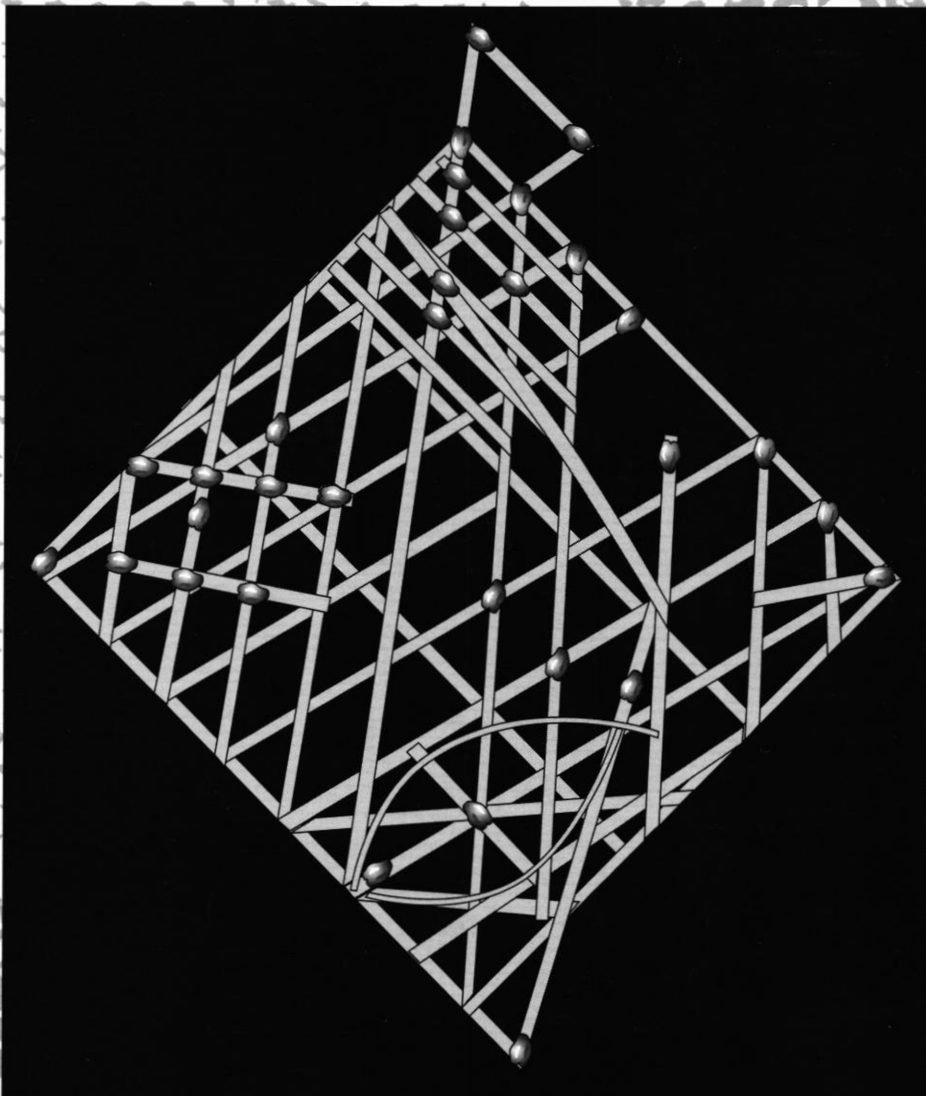

PREHISTORIC LONG-DISTANCE INTERACTION IN OCEANIA: AN INTERDISCIPLINARY APPROACH

Edited by Marshall I. Weisler

21
NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION MONOGRAPH

MARQUESAN VOYAGING: ARCHAEOMETRIC EVIDENCE FOR INTER-ISLAND CONTACT

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Direct evidence for post-colonisation voyaging in Polynesian prehistory was largely unproven prior to archaeometric studies that focussed on the provenancing of raw materials and artefacts. The recent application of archaeometry to the sourcing of lithic remains now provides an unequivocal record of inter-island contact both within archipelagoes and between islands separated by thousands of kilometres (cf. Anderson and McFadgen 1990; Best *et al*. 1992; Dickinson and Shutler 1974; Weisler 1993a; Weisler and Kirch 1996). Referencing of geological provenance to radiocarbon data offers the opportunity to reconstruct long term changes in both the range and frequency of inter-island voyaging contacts.

The investigation of prehistoric voyaging in the Marquesas, a relatively isolated archipelago of ten high volcanic islands situated along the eastern margin of Polynesia (Fig. 8.1), presents a case study of particular interest. Exploration of East Polynesia and colonisation of the Marquesas involved sophisticated canoe technology and navigational skills for crossing vast expanses of the open sea. Experimental voyaging research and computer simulation studies suggest that the early colonisation process was based on an ability for long distance two-way voyaging (cf. Irwin 1992; Finney 1994). While it is hypothesised that such voyaging initially allowed interaction within a regional East Polynesian homeland, by the time of European contact Marquesans apparently lacked the means for regular communication with islands lying beyond their own archipelago (Irwin 1992; Rolett 1993, 1996). As a result, Marquesan culture became isolated from the rest of Polynesia.

This study presents the first archaeometric evidence for prehistoric inter-island voyaging within the Marquesas. It focuses on the analysis of recently excavated lithic remains from the Ha'atuatua Dune, an archaeological site located on Nuku Hiva, the largest island (330 km^2) in the Marquesas (Rolett and Conte 1995). Discovered and first investigated by Robert C. Suggs (1961), this site has yielded the only direct evidence for long distance contacts between the Marquesas and other archipelagoes. A single imported pottery sherd recovered during Suggs' Ha'atuatua excavations and two others from surface collection of the site by Y. Sinoto derive from a source in the west Pacific, most likely Fiji (Dickinson and Shutler 1974). Based on mineralogical analysis of the pottery temper, this has been interpreted alternatively either as evidence for an initial voyage of colonisation (Green 1974) or for post-colonisation inter-archipelago contact (Rolett 1993).

Since pottery is extremely rare in Marquesan archaeological sites (only 14 sherds recovered from excavations on five islands), it is unsuitable for efforts to reconstruct general patterns of inter-island contact. By contrast, artefacts fashioned from volcanic stone offer a potentially large resource for the investigation of prehistoric voyaging and contact. Adzes, the basic woodworking implements throughout prehistoric Oceania, figure prominently in the archaeological evidence for inter-island contact within central and western Polynesia. For example, in the southern Cook Islands, where excavations have yielded a single imported pottery sherd (Walter and Dickinson 1989), archaeological deposits dating to the same time period (early second millennium A.D.) offer more extensive evidence for the inter-island transfer of basalt adzes (Walter 1990; Best *et al*. 1992; Weisler 1993b; Weisler and Kirch 1996; Walter and Sheppard 1996; see, Chapter 6, this volume).

Throughout Polynesia, the uneven distribution of economically valuable stone such as volcanic glass and fine-grained basalt was an important stimulus for the inter-island transport of these materials. Economic motivation was most likely not the only, nor even the most significant factor. Other motives for the transfer of both artefacts and raw materials depended on culturally defined concepts such as Polynesian gift exchange practices and perceptions of *mana*.

Volcanic stone is ideally suited for provenancing studies because lithic materials derived from separate volcanic eruptions usually differ in chemical composition,

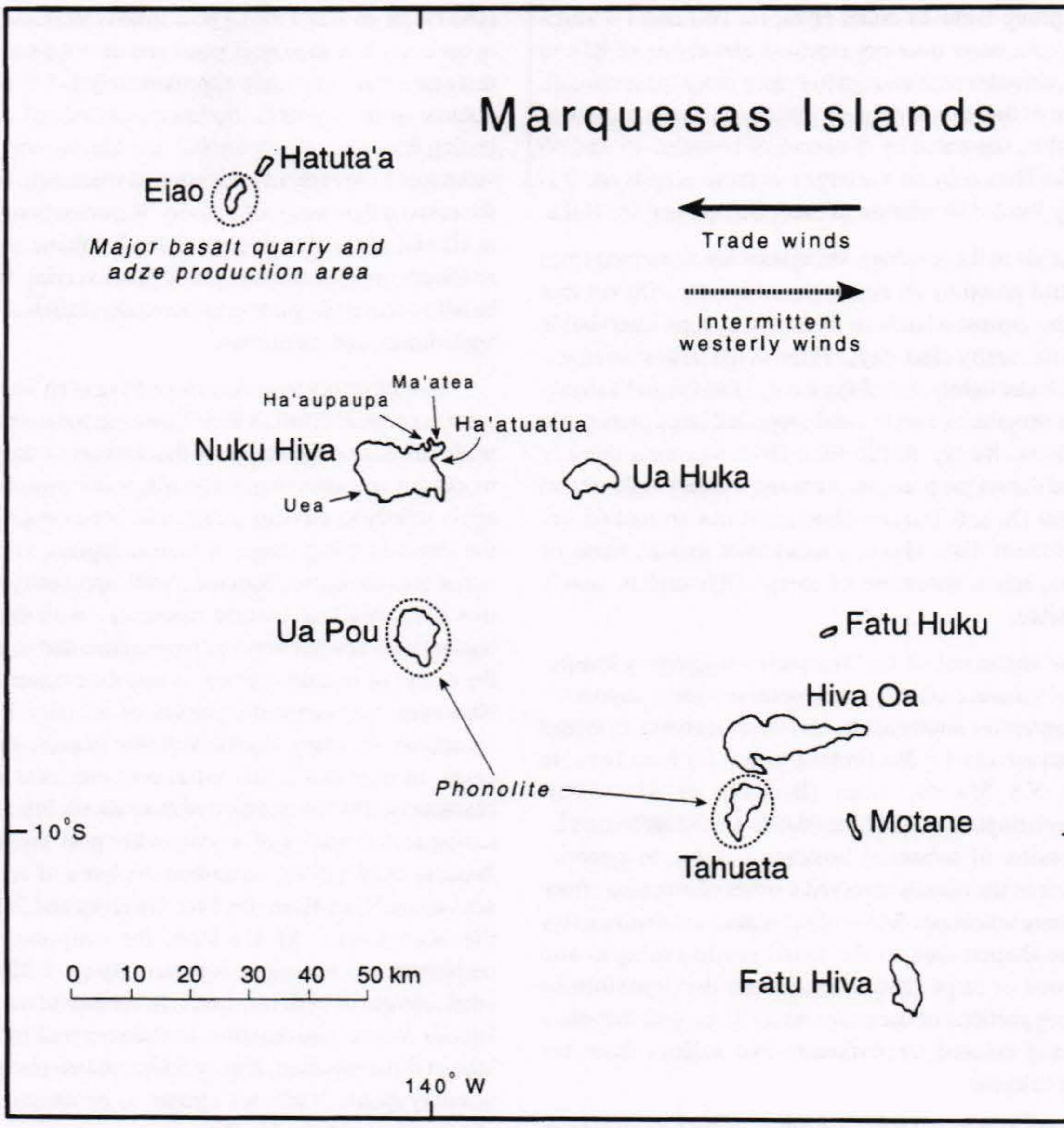

FIGURE 8.1. Map of the Marquesas Islands, East Polynesia. The archipelago is comprised of three clusters of islands: northern - Eiao and Hatuta'a; central - Nuku Hiva, Ua Pou and Ua Huka; and southern - Fatu Huku, Hiva Oa, Tahuata, Motane and Fatu Hiva.

which can be determined by x-ray fluorescence (XRF) or other routine analytical techniques. We present the first systematic application of geochemical provenancing methods to excavated artefact assemblages from the Marquesas. The analysis of lithic remains from the Ha'atuatua Dune, including artefacts from the archaeological context from which the excavated specimens of pottery derive, confirms the existence of prehistoric inter-island communication in eastern Polynesia.

GEOLOGICAL SETTING

The Marquesas Islands range in size from 1.3 to 330 km^2 and divide into three clusters comprising a total of ten islands.[1] The northernmost cluster consists of Eiao and Hatuta'a, relative outliers which lie around 100 km north of Nuku Hiva. Both Eiao and Hatuta'a have comparatively low maximum elevations (420 to 577 m), no significant orographic rainfall and were probably no more than sparsely inhabited during the prehistoric period. While Eiao is nearly equal in size to other once densely inhabited islands in the Marquesas, it is significantly drier and less fertile. The central group includes Nuku Hiva, Ua Pou and Ua Huka with mountainous interiors reaching elevations of 854 to 1252 m, altitudes high enough to induce orographic rainfall. All three of these once densely inhabited islands are easily intervisible, separated by distances of between 45 and 65 km. Nuku Hiva is by far the largest of these islands and it is centrally located in relation to Eiao, Ua Pou and Ua Huka.

Islands in the southern Marquesas are separated from the central group by an ocean gap of around 100 km that leaves the closest islands in these two groups intervisible only on unusually clear days. Three of the largest southern islands cluster tightly, but of these only Hiva Oa and Tahuata generate orographic rainfall and supported large prehistoric populations. Richly fertile Fatu Hiva was also densely inhabited during the prehistoric era and is easily visible from both Hiva Oa and Tahuata although it lies around 65 km south of them. Fatu Huku, a rocky islet located north of Hiva Oa, has a shoreline of steep cliffs and is nearly inaccessible.

The alignment of the Marquesas suggests a hotspot model of volcanic activity, an hypothesis that is supported by a progressive southeast to northwest increase in island age, from around 1.3 Ma (million years) for Fatu Hiva, to around 5.8 Ma for Eiao (Brousse *et al.* 1990). Geomorphologically, all of the islands are characterised by a succession of subaerial building phases. In general, formation of the islands involved a series of eruptions from one or more volcanoes. Many of the islands are distinctively crescent-shaped due to the cataclysmic collapse and subsidence of large land areas, events that transformed remaining portions of the crater rims into central mountain ridges and created amphitheatre-like valleys from the volcano calderas.

Ocean island volcanic evolution is best known from the Hawaiian Islands where a succession of volcanic stages has been identified (e.g., Clague and Dalrymple 1987; Macdonald *et al.* 1983; Stearns 1946; Weisler 1993b:64-68). In Hawaii, a shield-building stage is by far the most voluminous, mainly consisting of thin-bedded tholeiitic basalts that are erupted in rapid succession, either from a summit caldera or from radial rift zones. Toward the end of the shield stage, eruption frequency decreases and erupted lavas become richer in the alkali elements, primarily due to a decrease in the extent of partial melting of upwelling mantle as the island moves off the centre of the hotspot. A subsequent post-shield volcanic stage is characterised by much less frequent eruptions of differentiated alkalic rocks mainly varying from hawaiite to trachyte, with subordinate alkalic basalt. Volcanoes in this stage are characterised by the lack of a summit caldera, which probably indicates that the shallow subvolcanic magma chamber of the shield stage is no longer present. During post-shield volcanism, eruptions occur every few thousand years and the total succession of this stage makes up only approximately 1-3 % of the total volume of the volcano. Following periods of quiescence lasting from approximately 0.2 to 3 Ma, several Hawaiian volcanoes have experienced renewed volcanism, comprising the rejuvenation stage of activity. Rejuvenation volcanism in Hawaii generally consists of small volume eruptions of relatively undifferentiated mafic lavas varying from alkali basalt to more alkalic and silica-undersaturated basanites, nephelinites and melilitites.

Few other oceanic volcanoes have been studied in the same geological detail as their Hawaiian counterparts. What work has been done suggests that aspects of the Hawaiian model for volcanic stages and magmatic evolution do not apply strictly to all oceanic islands. For example, much of the shield-building stage of Samoa appears to be alkalic, rather than tholeiitic (Natland 1980), apparently indicating that the upwelling mantle associated with the Samoan hotspot is somewhat lower in temperature and consequently the extent of mantle melting is less than beneath Hawaii. However, rejuvenation phases of activity have been recognised on many Pacific volcanic islands, and in most cases, as in Hawaii, this later, post-erosional activity is characterised by the eruption of more alkalic lithologies than during earlier phases of shield and/or post-shield activity. Brousse *et al.* (1990) described evidence of rejuvenation activity on Nuku Hiva, Ua Pou, Ua Huka and Fatu Hiva in the Marquesas. At Ua Pou, the eruption of silica undersaturated basanites occurred almost 2 Ma after the emplacement of tholeiitic lavas. In contrast to the Hawaiian Islands, where rejuvenation is characterised by a distinct lack of differentiation, highly differentiated phonolites and possibly quartz trachytes appear to be among the latest phases of activity on Ua Pou.

The most comprehensive geochemical study of the Marquesas is that of Brousse *et al.* (1990). This work identifies several regional trends within the archipelago, including a general decrease in volcanic age from northwest to southeast and a northward increase in the proportion of silica undersaturated lavas. Brousse *et al.* (1990) also pointed out a general increase in K_2O (potassium-oxide) contents from northwest to southeast within the archipelago. This increase is not systematic, however, and there is much variation within individual volcanoes.

Many analysed Marquesan rocks have high H_2O contents, an indication that they have undergone low temperature alteration during tropical weathering. In addition to increasing water contents, this process also can effect other elements, most notably the alkali elements, sodium and potassium. Thus, some of the range in K_2O

values within the archipelago described by Brousse *et al.* (1990) may be associated with the effects of variable alteration. In order to assess regional trends within the Marquesas we have compiled a data set including that of Brousse *et al.* (1990 and references therein), supplemented by data from Bishop and Wooley (1973) and Liotard *et al.* (1986), but restricted to samples with less than 3 wt % total volatiles. Although considerable scatter persists, these data still show that islands in the southern Marquesas (Fatu Huku, Hiva Oa, Motane, Tahuata and Fatu Hiva), particularly samples with more than 5 wt % MgO (magnesium-oxide), tend to have higher K_2O than do those from elsewhere in the archipelago.

Most lavas from the Marquesas are alkalic (Fig. 8.2), although tholeiitic and transitional lavas occur on Eiao, Hatuta'a and Ua Pou, and transitional lavas occur on Hiva Oa and Fatu Huku. However, new samples collected in our study show that tholeiitic compositions also occur on Nuku Hiva (Fig. 8.2). Using only data from archaeological samples, Best *et al.* (1992) proposed that elemental variations of Fe_2O_3 (iron-oxides), P_2O_5 (phosphorous-oxide) and TiO_2 (titanium-oxide) could be used to distinguish

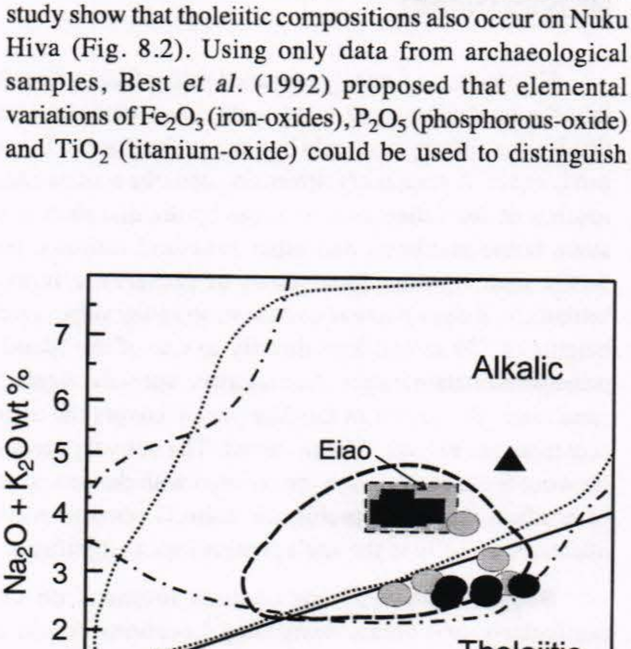

FIGURE 8.2. Total alkalis versus SiO_2 for Ha'atuatua artefacts (solid symbols) and selected Marquesan reference rocks. Artefact symbols: Type I, solid ovals; Type II, solid squares; Type III, solid triangle. Nuku Hiva reference rocks (Table 8.5) are shown as light shaded ovals; reference samples from Eiao are shown in the light shaded box. Other Marquesan reference samples are plotted within the fields as follows: heavy dashed line, northern islands; dash-dot line, central islands; dotted line, southern islands. Fields based upon data from Bishop and Wooley (1973), Brousse (1978), Brousse and Sevin (1978), Brousse *et al.* (1978) and Liotard *et al.* (1986).

Marquesan rocks from those of other Pacific islands. However, expanded data sets including geological data from throughout Polynesia show that few individual archipelagoes or island groups stand out from the general features that characterise the mid-plate Pacific volcanoes as a whole. Thus, on the basis of current XRF data, the geochemical evidence does not indicate diagnostic elemental abundance criteria suitable for distinguishing Marquesan rocks from those of many other Pacific islands. However, as shown by Dupuy *et al.* (1987), Nakamura and Tatsumoto (1988) and Staudigel *et al.* (1991), in some cases radiogenic isotopic ratios can be used to distinguish certain archipelagoes (see Chapter 13).

LITHIC AVAILABILITY, TECHNOLOGY AND PREHISTORIC TRANSPORT

The availability of raw materials is an important factor influencing both technology and the prehistoric movement of goods. In terms of lithic technology, one expectation is that high-quality rock (fine-grained, homogeneous material) is necessary for the production of tools with a preconceived form achieved by controlled chipping. It follows that, given an uneven geological distribution of high-quality rock, this material will be transported between regions in cultural settings where carefully chipped stone tools are valued. It also follows that availability of the high-quality rock will depend in part on ease of access to the source. Accessibility is affected not only by aspects of the physical landscape such as distance and topography, but also by technological, social and political factors. Resource accessibility further depends upon human knowledge, in the sense that resources must be part of the 'perceived environment' in order for them to be exploited (Brookfield 1969; Butzer 1982).

A general model proposed by Andrefsky (1994) predicts that in areas where high-quality rock is naturally scarce, or absent but obtained from a distance, this material will be used mainly for manufacturing formal tools (ones for which production involves the investment of considerable energy). By contrast, the model predicts that in areas where high-quality rock is abundant it will be used to produce both formal and informal (unstandardised and expediently made) tools in comparable quantities. Finally, it is expected that primarily informal tools will be produced from low-quality rock (coarse-grained material, as well as that which contains internal flaws), regardless of whether it is scarce or abundant.

This general model for a predictable, structured relationship between technology and the availability of raw materials provides a useful theoretical framework for examining Marquesan lithic assemblages. Because the production of basalt adzes requires controlled chipping and a significant labour investment, it is expected that these tools will be made of high-quality rock. Moreover, according to Andrefsky's model, if high-quality rock for adzes is naturally absent or scarce in a particular area, it is expected that this material will be imported from one or more different regions. In such a case, the abundance of adzes made of imported rock should in part reflect ease of access to the sources from which the imported material is obtained. In the prehistoric Marquesan context, accessibility of resources obtained from other islands can be measured by a set of factors including: (1) distance; (2) availability and quality of canoes, as well as skilled sailors; (3) sailing conditions (prevailing winds and currents); and (4) social and political relations that either enhance or limit communication between groups inhabiting different areas. The abundance of imported rock will also reflect cognitive mapping of the landscape as it relates to the perceived distribution of lithic resources. Thus, the presence of imported rock from a particular source denotes knowledge of that source's location.

Large deposits of fine-grained basalt are rare in the Marquesas and there are only two known archaeological sites which document the systematic extraction of this material (Fig. 8.1). Given the uneven distribution of fine-grained basalt and the importance of adzes in Marquesan culture, it is expected that raw materials and/or artefacts from these sources were inter-regionally transported commodities. The largest extraction site is on Eiao, an island renowned as a major prehistoric centre for the production of high-quality basalt adzes. With continuous lithic scatters covering areas of up to 10,000 m^2 (Candelot 1980; Linton 1925:106-107), Eiao is the only island in the Marquesas (and one of the few in Polynesia) with evidence of truly large-scale adze production. The second, much smaller, Marquesan basalt quarry (Ha'aupa'upa) is located on Nuku Hiva in a cove immediately adjacent to Ha'atuatua (Fig. 8.1). Partially excavated by Suggs (1961:67), stratified deposits of this *ca* 800 m^2 site yielded dense concentrations of debitage and numerous adze preforms. A single radiocarbon date, on charcoal from a hearth in the deepest cultural deposit, yielded an age of <200 BP (Suggs 1961:61, Fig. 20c). This suggests that Ha'aupa'upa was either unknown or not actively exploited until late in Marquesan prehistory. According to Suggs (1961:67), the Ha'aupa'upa adze industry may have been developed to provide tools used in extracting slabs and blocks of red tuff (for monumental architecture and anthropomorphic images) from a nearby, extensively quarried outcrop of this material. It is also possible that the late development of Ha'aupaupa adze production was linked to the declining availability of imported high-quality basalt.

In addition to adzes, excavated Marquesan artefact assemblages also include a diverse range of roughly worked, expediently produced stone tools such as flakes (utilised with or without retouch), scrapers and choppers. Andrefsky's model predicts that these informal tools will generally be produced from low-quality rock. Since coarse-grained basalt is widely distributed throughout the Marquesas (usually found in dykes, stream beds or boulder beaches), it is expected that locally available low quality rock was used for the informal tools. Phonolite, which occurs on all of the islands but is relatively rare except on Ua Pou, was also used for informally shaped flake tools, especially ones with a tabular form deriving from the material's natural cleavage planes (Rolett 1989:304, Figs 8.4-5).

HA'ATUATUA: A CASE STUDY OF LITHIC PROVENANCING

Ha'atuatua is a deeply embayed valley facing directly into the prevailing trade wind, with a surf-battered coast that is accessible by boat only because it opens onto a broad, sandy beach. A permanent stream descends the southwestern reaches of the valley and, to judge by the distribution of stone house platforms and other structural remains, this fertile area was the focal point of prehistoric human settlement. Ridges rising above the steep valley slopes reach heights of 750 m and lead directly to one of the island's principal mountain ranges. An expansive, sparsely vegetated sand dune, the largest in the Marquesas, covers the entire coastline and extends 250 m inland. The actively eroding blowout areas of this dune are covered with dense scatters of artefacts and other prehistoric cultural remains which attest dramatically to the site's archaeological significance.

Suggs' 1956-1957 excavations focussed on two particularly rich areas, designated Locations A and B, situated about 300 m apart along the eroding front face of the dune. Suggs obtained similar chronological data from both areas, with two radiocarbon dates from each part of the site. Location A yielded uncalibrated dates of 1270 ± 150 BP (human bone) and 2080 ± 180 BP, while those for Location B are 1090 ± 180 BP and 1910 ± 180 BP (all charcoal). Distinct differences between cultural remains recovered from the two areas suggested that Location A was a focal point for ceremonial and burial activities and Location B was a general habitation area. Suggs interpreted the site chronology as likely representing the earliest stages in Marquesan prehistory, with a long series of occupations extending from around 100 B.C. until A.D. 1000.

Debate over interpretations of the site's chronology, as well as questions concerning the context of the pottery finds has called for further research at Ha'atuatua (cf. Kirch 1986; Rolett 1993; Sinoto 1966; Spriggs and Anderson 1993). Rolett and Conte (1995) initiated new excavations in 1992, as part of a broader research program coordinated by the French Polynesian Department of Archaeology. This ongoing project was designed in part to provide data for evaluating hypotheses concerning prehistoric voyaging in the Marquesas, as well as within the broader regional context. During the first two field seasons, with Suggs as a member of the 1993 expedition, we relocated and further sampled the original Ha'atuatua excavation areas, while also testing other parts of the enormous dune site. Here, we present results of a pilot study to reconstruct prehistoric inter-island contact. The study identifies evidence of imported lithic materials in the Ha'atuatua artefact assemblages, using XRF to establish geochemical distinctions between locally derived and exotic rock types.

The lithic assemblages analysed for this study derive primarily from three 1 m^2 excavation units and represent stratified sequences of occupations in both Location A and the Central Dune (Fig. 8.3). The two units representing Location A (T4 and T10) are in the immediate vicinity of Suggs' original 60 m^2 excavation, where five pottery sherds (including at least one imported specimen) were discovered in 1957. One goal of the 1993 field work was to pinpoint the exact limits of Suggs' Location A excavation, an objective achieved through the excavation of ten 1 m^2 units. Fill was removed from Suggs' principal trench excavations and the stratigraphic profiles were compared with those of the surrounding 1993 test units, demonstrating widespread stratigraphic uniformity across Location A. This reconnaissance was followed in 1994 by a 12 m^2 areal excavation centred on one of the most promising localities. Neither the 1993 nor the 1994 excavations yielded additional pottery but both field seasons generated large samples of lithic remains from the same cultural deposits from which the imported sherds were recovered. These excavations also provide new data documenting the Ha'atuatua site stratigraphy and chronology.

The 1993 and 1994 field work at Location A determined that the stratigraphic sequence includes two cultural deposits, of which only one (Layer B) was identified during the 1956-57 excavations. Lying beneath a surface layer of sterile aeolian sand, Layer B represents a series of intensive occupations marked by large quantities of waterworn pebbles, probably introduced to the site as paving stones, as suggested by Suggs (1961:63). This darkly stained deposit also contains a wide range of faunal remains and artefacts, in addition to numerous features including stone pavements, pits, combustion structures and postholes. The Location A pottery sherds recovered by Suggs are believed to derive from Layer B. Layer C is an earlier, white sand cultural deposit, up to 100 cm thick and fairly rich in faunal remains but containing very few artefacts or features. Although the 1956-57 excavations extended well into Layer C, this deposit was considered by Suggs to represent the basal deposit of sterile dune sand, which it resembles closely in colour and texture.

Additional radiocarbon dates for Layer B now include age estimates for four charcoal samples from *in situ* combustion features and a fifth sample of isolated charcoal (Table 8.1). One sample (I-17,654) derives from a hearth in the wall profile of Suggs' trench while the four others (I-17,750, I-17,656, I-17,657 and CAMS-8666) derive from separate test pits (T3, T6, T9 and T11). Results for this series of samples are in close agreement, suggesting that Layer B is relatively late in the Marquesan cultural sequence, most likely in the time period of A.D. 1400-1650 but almost certainly no earlier than A.D. 1300 (based on 2 sigma age

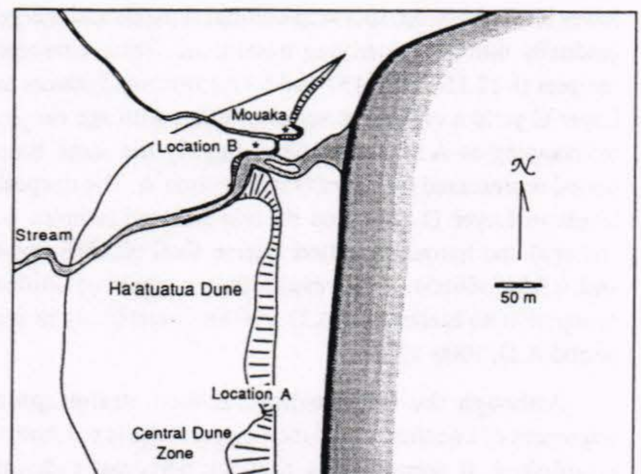

FIGURE 8.3. Ha'atuatua Dune site, Nuku Hiva, Marquesas Islands.

ranges for 95% confidence). These results contrast sharply with the original dates obtained by Suggs, calling for revision of the Ha'atuatua chronology. This revision is of critical importance for interpreting the imported pottery sherds, for it implies that, if they were recovered in primary context, these sherds document long distance voyaging at a relatively late period in Marquesan prehistory, not during the earliest stages as originally believed. Layer C is dated only by the results for two samples of human-modified marine shell (CAMS-8662 and CAMS-8663) which yielded calibrated 2 sigma age ranges of A.D. 662-1012 and A.D. 1326-1559. Both estimates are at variance with the much earlier date of 2080 ± 180 BP (calibrated 356 B.C.-A.D. 145) for Suggs' charcoal sample (I-394B) from Layer B.

This study also includes artefacts from a single 1 m^2 unit representing the Central Dune, a separate occupation area about 70 m inland from Location A. Four m^2 of the Central Dune were excavated in 1992 (Rolett and Conte 1995). As in Location A, the Central Dune stratigraphic sequence consists of a sterile surface layer underlain by a darkly stained cultural deposit (Layer C). The upper levels of Layer D, a white sand deposit, contain an occupation marked by numerous artefacts and faunal remains but the lower levels are more sparse in cultural remains and merge gradually into the underlying basal dune. Three charcoal samples (I-17,152, I-17,157 and I-17,158) from features in Layer C yield a consistent series of dates with age ranges overlapping at A.D. 1300-1625, roughly the same time period represented by Layer B in Location A. The deepest levels in Layer D are dated by two isolated samples of charcoal and human-modified marine shell (CAMS-8664 and CAMS-8665), with results that suggest an initial occupation no earlier than A.D. 700 and most likely in the period A.D. 1000-1250.

Although the relationship between stratigraphic sequences of Location A and the Central Dune is not firmly established, it seems likely that the principal cultural deposits of both areas represent the same expansive and long-term series of occupations. Each stratigraphic sequence contains a dark, charcoal-stained deposit (Layer B in Location A; Layer C in the Central Dune) marking an unusually intensive settlement during the period between A.D. 1300 and 1650. In both sequences, this deposit lies above a thick (up to 100 cm or more) but much more diffuse layer (Layer C in Location A; Layer D in the Central Dune) dating to no earlier than around A.D. 700. These similarities suggest that the Location A and Central Dune archaeological deposits document a contemporaneous and related series of occupations.

Lab No.	Excavation Area-Unit (1)	Sample Provenience (2)	Sample Material	Sample Context	Uncalibrated Determination	Calibrated Dates (3)	Calibrated Age Range (1 sigma)	Calibrated Age Range (2 sigma)	Reference
I-394A	A - unrecorded	54" bs	Bone	Burial pit	1270 ± 150	A.D. 657	A.D. 533-864	A.D. 376-987	Suggs 1961
I-394B	A - unrecorded	54" bs	Charcoal	Hearth	2080 ± 180	36 B.C.	356 B.C.-A.D. 145	489 B.C.-A.D. 418	Suggs 1961
I-17,654	A - E437 N498	B: 980-985 cmbd	Charcoal	Hearth (Ftr 45)	500 ± 110	A.D. 1441	A.D. 1398-1631	A.D. 1300-1657	Conte and Rolett in prep.
I-17,656	A - T22	B: 987-992 cmbd	Charcoal	Hearth (Ftr 14)	210 ± 90	A.D. 1680, 1753, 1804, 1937, 1954	A.D. 1665-1955*	A.D. 1523-1955*	Conte and Rolett in prep.
I-17,657	A - T25	B: 903 cmbd	Charcoal	Hearth (Ftr 8)	230 ± 90	A.D. 1675, 1777, 1798, 1943, 1954	A.D. 1653-1955*	A.D. 1517-1955*	Conte and Rolett in prep.
I-17,750	A - T19	B: 941-945 cmbd	Charcoal	Earth oven (Ftr 27)	390 ± 90	A.D. 1516, 1591, 1621	A.D. 1473-1641	A.D. 1412-1955*	Conte and Rolett in prep.
CAMS-8666	A - T17	B: 110-115 cmbs	Charcoal	2 isolated chunks	490 ± 70	A.D. 1444	A.D. 1409-1618	A.D. 1396-1640	Conte and Rolett in prep.
CAMS-8662	A - T26	C: 950-961 cmbd	Burnt gastropod	Isolated shell	1630 ± 80	A.D. 814	A.D. 719-916	A.D. 662-1012	Conte and Rolett in prep.
CAMS-8663	A - T20	C: 965-975 cmbd	*Pinctada margaritifera*	Isolated shell	940 ± 60	A.D. 1448	A.D. 1404-1499	A.D. 1326-1559	Conte and Rolett in prep.
I-17,152	CD - T12	C: 569-575 cmbd	Charcoal	Charcoal lens	570 ± 80	A.D. 1415	A.D. 1309-1450	A.D. 1290-1621	Rolett and Conte 1995
I-17,157	CD - T13	C: 560-561 cmbd	Charcoal	Burnt surface (Ftr 37)	560 ± 80	A.D. 1421	A.D. 1310-1462	A.D. 1294-1624	Rolett and Conte 1995
I-17,158	CD - T11	C: 551-559 cmbd	Charcoal	Burnt surface (Ftr 26)	460 ± 80	A.D. 1437	A.D. 1406-1475	A.D. 1305-1640	Rolett and Conte 1995
CAMS-8664	CD - T14	D: 659-669 cmbd	*Cellana radiata*	Isolated shell	1570 ± 90	A.D. 892	A.D. 792-987	A.D. 690-1053	Rolett and Conte 1995
CAMS-8665	CD - T14	D: 659-669 cmbd	Charcoal	Isolated chunk	970 ± 70	A.D. 1052, 1085, 1121, 1139, 1156	A.D. 1029-1171	A.D. 1000-1252	Rolett and Conte 1995
I-17,655	CD - E353 N503	D: 585-588 cmbd	Charcoal	Ftr 83	720 ± 110	A.D. 1298	A.D. 1258-1404	A.D. 1054-1449	Conte and Rolett in prep.

1) A, Location A; CD, Central Dune.
2) B, Layer B; C, Layer C; D, Layer D; bs, below surface; cmbd, cm below datum; cmbs, cm below surface.
3) Calibrations for all samples according to Stuiver and Reimer (1993). Delta R of 45 ± 30 (derived from Tahiti) used for calibrating marine shell samples.

TABLE 8.1. Radiocarbon dates for the Ha'atuatua Dune Site, Nukuhiva, Marquesas Islands.

Ha'atuatua lithic assemblages

Prehistoric human activities introduced a multitude of different lithic materials to the Ha'atuatua Dune, all of which are readily identifiable in the aeolian sand matrix of the cultural deposits. An initial stage in analysis of the lithic assemblages thus involved sorting the tools and tool manufacturing remains from other introduced material such as fire-cracked oven rocks and unmodified pebbles used as paving stones. Chipped and ground stone remains were then separated by hand inspection into three lithic categories: coarse-grained basalt, fine-grained basalt and phonolite. Petrographic thin sections of representative basalt artefacts show that the material categorised as coarse-grained has a matrix grain size of about .05-.1 mm. The matrix of the fine-grained basalt is distinctly different, with grain size generally less than .04 mm^2. The phonolite is highly distinctive because of its pale-green colour, which derives mainly from an abundance of the green mineral, arfvedsonite (Na-amphibole). This material has also been discovered at both the Hane (Ua Huka) and Hanamiai (Tahuata) dune archaeological sites (Rolett 1989) but it is unknown from archaeological sites outside the Marquesas. The phonolite is fine-grained (*ca* .02 mm) but has strongly defined cleavage planes that greatly limit the degree to which percussion flaking can be controlled.

The 1418 chipped and ground stone lithic specimens examined were further grouped by maximum dimension into a series of size classes as shown in Tables 8.2 and 8.3. Very few of the specimens show evidence of grinding, and all of these are flakes of fine-grained basalt that we interpret as originating from adzes chipped either during use or in reworking. Tables 8.2 and 8.3 show the stratigraphic distribution of chipped and ground stone remains for the three excavation units sampled.

Coarse-grained basalt is the predominant material in all three assemblages, representing between 64 and 92% of the total number of specimens recovered from each excavation unit. Fine-grained basalt is notably scarcer, as is phonolite. Both of these materials are present throughout the Location A occupation sequence, although neither is represented in the small sample of remains from the initial cultural deposit of the Central Dune. For all of the materials, size class distributions reveal a marked prevalence of relatively small flakes. Only nine of 1267 coarse-grained basalt flakes fall into the largest size class (maximum dimension of 6-10 cm) and none of the fine-grained basalt or phonolite flakes is larger than 30-60 mm.

Nine basalt flakes from the Ha'atuatua lithic assemblages were selected for XRF analysis. One goal was to choose flakes that appeared, on the basis of hand inspection, to represent the major types of raw material present in the artefact assemblages. A second goal was to sample the different cultural deposits, to provide data bearing on both the spatial and temporal distribution of raw

Layer	Basalt Flake Size (1)	Basalt (coarse-grained) T4	Basalt (coarse-grained) T10	Basalt (fine-grained) T4	Basalt (fine-grained) T10	Phonolite T4	Phonolite T10	Totals
A	<1.5 cm	6				4		
	1.5-3 cm	5		1	1			
	3-6 cm	3		1		1		
	6-10 cm							
	subtotal	*14*		*2*	*1*	*5*		22
B	<1.5 cm	10	26			6	1	
	1.5-3 cm	11	12	2		6	3	
	3-6 cm	3	6					
	6-10 cm							
	subtotal	*24*	*44*	*2*		*12*	*4*	86
C	<1.5 cm	5	79		6	2	2	
	1.5-3 cm	3	33			3	1	
	3-6 cm		6			1		
	6-10 cm	1						
	subtotal	*9*	*118*		*6*	*6*	*3*	142
	Totals	47	162	4	7	23	7	250

1) Maximum dimension.

TABLE 8.2. Stratigraphic distribution of basalt and phonolite lithic artefacts recovered from excavation Units T4 and T10, Location A, Ha'atuatua Dune (Marquesas Islands).

Layer	Flake Size (1)	Basalt (coarse-grained)	Basalt (fine-grained)	Phonolite	Totals
B	<1.5 cm	35		1	
	1.5-3 cm	4	5		
	3-6 cm	2			
	6-10 cm	1			
	subtotal	*42*	*5*	*1*	48
C	<1.5 cm	713	11	30	
	1.5-3 cm	199	46	6	
	3-6 cm	82	10	1	
	6-10 cm	7			
	subtotal	*1001*	*67*	*37*	1105
D	<1.5 cm	8			
	1.5-3 cm	6			
	3-6 cm	1			
	6-10 cm				
	subtotal	*15*			15
	Totals	1058	72	38	1168

1) Maximum dimension

TABLE 8.3. Stratigraphic distribution of basalt and phonolite lithic artefacts recovered from excavation Unit T14, central dune zone, Ha'atuatua Dune (Marquesas Islands).

material types in the Ha'atuatua site. Stratigraphic proveniences of the selected samples are schematically illustrated in Figure 8.4. The specimens include three coarse and two fine-grained basalt flakes from Location A, with an additional four flakes (two coarse, two fine) from the Central Dune (see Table 8.4 and Fig. 8.4 for provenience data). Two adzes (both fragments of finished, highly polished specimens made of fine-grained basalt) recovered during the 1994 Location A areal excavation were also selected for XRF analysis. In addition to these excavated artefacts, the XRF analyses included geological reference specimens from five different locations on Nuku Hiva. The Nuku Hiva reference specimens (collected during the 1993 field season) sample two dyke outcrops in the immediate vicinity of Ha'atuatua, the nearby Ha'aupa'upa adze quarry, and two other prehistorically exploited basalt sources marked by extensive artefact surface scatters in Ma'atea and Uea Valleys.

Geochemical characterisation by x-ray fluorescence

X-ray fluorescence (XRF) provides a means for determining the chemical composition of rocks and other natural materials. Reliable provenancing of lithic artefacts depends on chemical data that provide either a close match to a specific source or a more general identification of the geological province of origin. Chemical data reported here were obtained with the University of Hawaii XRF system. Finely ground samples were ignited at 900°C to drive off volatile elements (reported as loss on ignition - LOI) and fully oxidise all iron in the sample. Negative values of LOI indicate more oxygen gained by oxidation than weight of volatiles lost during ignition. Ignited powders were then mixed with a Li Tetraborate flux and fused at about 1000°C and pressed into a glass disk. These disks were then analysed for major elements using a Siemens 303AS instrument and the data reduced following procedures similar to those of Norrish and Hutton (1967). In general, data determined by this method have a precision of about 1% relative for SiO_2 (silicon-oxide), TiO_2, Al_2O_3 (aluminium-oxide), Fe_2O_3 (iron-oxide), MnO (manganese-oxide), MgO (magnesium-oxide), CaO (calcium-oxide) and K_2O about 2% relative for P_2O_5 and about 5% relative for Na_2O (sodium-oxide) (see Chapter 11).

The XRF results identify three chemically distinct categories (Groups I, II and III) of basalt among the Ha'atuatua artefacts (Table 8.5). Differences between these groups are illustrated in Figure 8.5, which graphs the XRF results for the oxides K_2O, TiO_2 and P_2O_5. Group I comprises all five flakes of coarse-grained material from both the Location A and Central Dune excavation areas. These specimens vary somewhat in composition but are close enough to the Nuku Hiva reference samples to be consistent with a local origin. The higher LOI values for the coarse-grained rocks, in comparison with those for finer grained lithologies, indicate that the former probably contain more low-temperature alteration minerals (clays). This is not unusual as coarser grained rocks typically are more

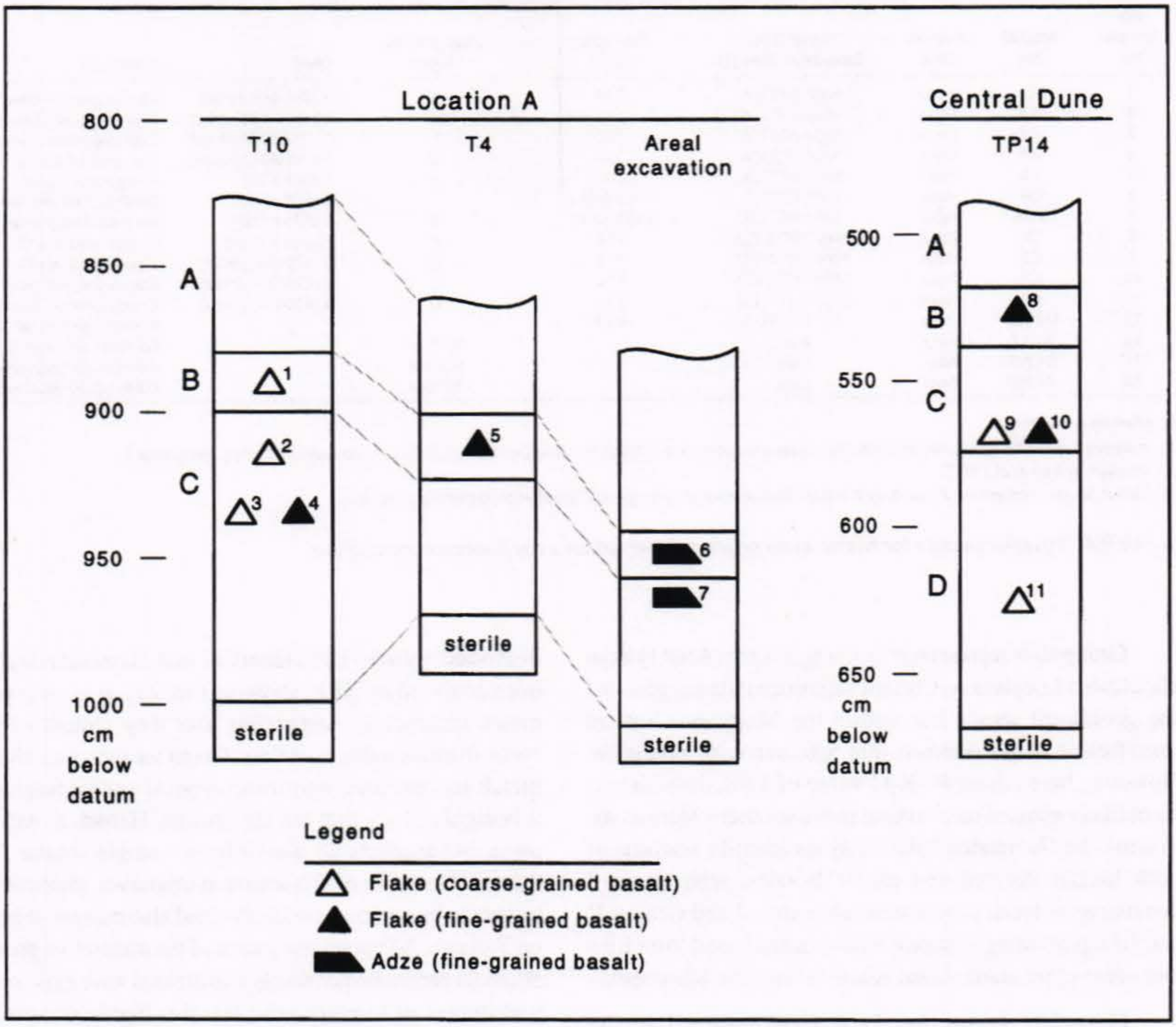

FIGURE 8.4. Stratigraphic proveniences of artefacts selected for X-ray fluorescence analysis (Ha'atuatua Dune, Marquesas Islands). Notations 1-11 are XRF sample numbers. See Table 8.4 for precise provenience data.

permeable to groundwater than are more massive, finer grained rocks.

Group II consists of all four flakes of fine-grained basalt (from both excavation areas) and one of the two adzes from Location A. These specimens are strikingly similar to one another in chemical composition while differing markedly from the Nuku Hiva reference samples. The Group II artefacts are nearly identical in composition to a flake and two adzes from surface collections (made by anonymous yachtsmen, not archaeologists) at lithic workshop areas on Eiao. These artefacts are believed to derive from a local source on that island, and lead to the conclusion that the Group II Ha'atuatua artefacts originated from the same Eiao source. One of the Group II Ha'atuatua artefacts was examined in thin section, showing that, mineralogically, it also closely matches the two Eiao reference specimens (D4296 and D4300) for which thin sections have been prepared.

A number of separately analysed artefacts (Best *et al.* 1992:82; Chapter 11) from the Hane Dune site (Sinoto 1966) on Ua Huka (located around 25 km east of Nuku Hiva) are chemically identical to the Group II artefacts and can also be provenanced to Eiao. The near constancy of chemical composition among artefacts from a wide variety of sites indicates that the Eiao quarry outcrop is likely to be a fairly extensive rock unit, i.e., a lava flow rather than a series of dykes. Average values for Eiao-derived artefacts, based upon the current database of XRF analyses have been calculated by Sinton and Sinoto (Chapter 11; see also Chapter 10:Table 10.3).

XRF Sample No.	Artefact No.	Artefact Type	Island: Site/ Excavation Area (1)	Excavation Unit	Stratigraphic Layer	Level	Comments
1	A1	Flake	NKV: HTT1/A	T10	B	9 (890-903 cmbd)	Coarse-grained basalt
2	A2	Flake	NKV: HTT1/A	T10	C	12 (920-932 cmbd)	Coarse-grained basalt
3	A3	Flake	NKV: HTT1/A	T10	C	15 (950-961 cmbd)	Coarse-grained basalt
4	A4	Flake	NKV: HTT1/A	T10	C	15 (950-961 cmbd)	Fine-grained basalt
5	A5	Flake	NKV: HTT1/A	T4	B	3 (915-925)	Fine-grained basalt
6	5041	Adze	NKV: HTT1/A	E430 N495	C	8 (969 cmbd)	Polished, fine-grained basalt
7	5190	Adze	NKV: HTT1/A	E432 N497	B	7 (975 cmbd)	Polished, fine-grained basalt
8	C1	Flake	NKV: HTT1/CD	T14	B	535-555 cmbd	Fine-grained basalt
9	C2	Flake	NKV: HTT1/CD	T14	C	3 (570-580 cmbd)	Fine-grained basalt
10	C3	Flake	NKV: HTT1/CD	T14	C	3 (570-580 cmbd)	Coarse-grained basalt
11	C4	Flake	NKV: HTT1/CD	T14	D	8 (620-630 cmbd)	Coarse-grained basalt
12	M74-51	Flake	UH: MUH1: B	M74			Y. Sinoto, excavator (2)
13	AN42	Flake	Eiao		Surface		Collector unknown (2)
14	D4296	Adze	Eiao		Surface		Collected by yachtsman (3)
15	D4300	Adze	Eiao		Surface		Collected by yachtsman (3)

All artefacts are of basalt.

1) Abbreviations: NKV, Nuku Hiva; HTT1/A, Ha'atuatua Location A; HTT1/CD, Ha'atuatua Central Dune; UH, Ua Huka; MUH1/B, Hane Area B.

2) Analysis by Best *et al.* (1992)

3) Bishop Museum collection. Analysis by J. Sinton, Department of Geology and Geophysics, University of Hawaii.

TABLE 8.4. Provenience data for Marquesan artefacts selected for x-ray fluorescence analysis.

Group III is represented by a single adze (A5041) from Ha'atuatua Location A. Current reference data suggest that the geological source lies within the Marquesas but are insufficient to provenance this artefact with precision. However, based upon the K_2O value of 1.98, the source is most likely situated on an island in the southern Marquesas. In sum, the Ha'atuatua XRF analyses identify artefacts of both locally derived and exotic basalts, with Group I consisting of local, coarse-grained material and Groups II and III representing imported fine-grained basalt from Eiao and some other unidentified island within the Marquesas.

Phonolite is another imported material in the Ha'atuatua lithic assemblages, albeit one that was utilised quite differently than the imported fine-grained basalt. The Ha'atuatua phonolite artefacts consist of small flakes, representing debitage or expedient tools, most of which have a thin, flat form deriving from the material's natural cleavage planes. Data from the Hanamiai (Tahuata) excavations suggests that this material may have been valued because it occurs naturally in large, tabular flakes that can be utilised with little or no modification.

Although none of the Ha'atuatua phonolite was analysed for chemical composition, one artefact examined in thin section is a sodalite phonolite essentially identical to phonolite artefacts from the Hanamiai and Hane (Ua Huka) sites. This rock type is quite unusual, particularly for the widespread presence of sodalite, and the distinctive texture consisting of splays of green, Na-rich amphibole (arfvedsonite) in a matrix of feldspar and nepheline crystals that have become aligned during viscous flow. It is this flow texture that gives the rock the strongly defined cleavage described earlier. The Hanamiai and Hane artefacts have been analysed by XRF, showing that they are a near perfect match chemically, suggesting that they almost certainly come from the same lava flow. Given the two-way chemical match and the three-way mineralogical and textural match, it is highly likely that the Ha'atuatua, Hanamiai and Hane phonolite artefacts all derive from a single source. While the exact location of this source is unknown, phonolites are known to be common on Ua Pou and also present at Motopu on Tahuata. Although the source of the distinctive phonolite artefacts cannot be positively constrained with existing data, it is important to emphasise that this highly unusual rock type has now been found at three widely dispersed archaeological sites, attesting to its prehistoric cultural significance in the Marquesas.

DISCUSSION

This Polynesian case study uses geochemical provenancing to document the prehistoric movement of lithic resources within the Marquesas Islands. Our analyses of excavated lithic assemblages from two locations situated about 100 m apart within the Ha'atuatua Dune suggest that low quality, coarse-grained basalt, the predominant material in all of the lithic assemblages, was readily available and obtained primarily (if not exclusively) from local sources. By contrast, high-quality, fine-grained basalt comprises only a small fraction of the lithic assemblages and evidently a high percentage of this material was imported to Nuku Hiva from other islands within the Marquesas[3]. Apparently all of the phonolite, which also accounts for a small fraction of the lithic assemblages, was imported, most likely from the

Excavated Artefacts

Provenience (1):	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	N: HTT	UH: HN
Specimen no. (2):	A1	A2B	CD3	CD4	A3A	A4A	A5A	CD1A	CD2A	A5041	A5190	74-51
Grain size: Specimen	Cr: Fl	Cr: Fl	Cr: Fl	Cr: Fl	Cr: Fl	Fn: Fl	Fn: Fl	Fn: Fl	Fn: Fl	Fn: Ad	Fn: Ad	: Fl (4)
Basalt group:	I	I	I	I	I	II	II	II	II	III	II	II
SiO_2	48.62	47.53	47.47	48.04	48.07	46.73	46.73	46.70	46.90	48.39	47.18	46.56
TiO_2	3.43	3.58	3.76	3.79	3.39	3.98	4.02	4.11	4.26	3.69	3.80	3.79
Al_2O_3	13.16	13.17	13.16	13.45	13.45	14.99	15.18	15.23	15.22	15.52	15.31	14.97
Fe_2O_3	13.05	13.00	12.44	13.0:	13.65	13.47	13.56	13.52	13.49	13.29	13.70	13.60
MnO	0.17	0.16	0.15	0.20	0.20	0.16	0.16	0.16	0.16	0.17	0.16	0.18
MgO	6.46	6.48	6.50	6.66	5.72	6.32	6.37	6.24	6.46	5.93	6.46	6.44
CaO	11.13	11.27	11.47	11.37	11.18	9.27	9.30	9.32	9.25	10.98	9.33	9.45
Na_2O	2.20	2.10	2.02	2.16	2.14	3.33	3.02	3.16	3.07	3.05	3.17	3.07
K_2O	0.66	0.71	0.64	0.55	0.68	0.93	1.02	1.01	0.99	1.98	0.94	1.01
P_2O_5	0.34	0.33	0.34	0.32	0.32	0.49	0.50	0.52	0.51	0.57	0.53	0.56
LOI	0.60	1.78	1.98	0.59	1.08	0.02	-0.30	-0.19	-0.05	-0.26	-0.29	-0.10
Total	99.81	100.11	99.95	100.23	99.87	99.68	99.56	99.77	100.26	103.32	100.29	99.53

Reference Specimens

Provenience (1):	Eiao	Eiao	Eiao	N: HTT	N: HTT	N: MAT	N: Uea	N: HPP
Specimen no. (2):	AN42	D4296	D4300	D1A	D2A	Q1A	Q2B	Q3
Grain size: Specimen	?: Fl (4	Fn:Ad	Fn:Ad	Cr: Dy	Cr: Dy	Fn: Fl	Fn: Fl	Fn: Ad
Basalt group:	II	II	II	I	I	I	I	I
SiO_2	46.74	46.62	46.94	46.69	47.18	48.16	47.69	48.40
TiO_2	3.83	3.85	3.87	3.19	3.78	4.33	3.44	2.93
Al_2O_3	15.09	14.80	14.94	12.92	14.24	14.14	14.16	13.31
Fe_2O_3	13.50	13.64	13.46	11.85	12.46	12.92	12.17	12.16
MnO	0.17	0.16	0.17	0.15	0.15	0.15	0.15	0.15
MgO	6.52	6.68	6.55	8.09	5.57	6.80	5.90	8.40
CaO	9.37	9.24	9.34	10.35	10.92	10.72	10.66	10.68
Na_2O	3.11	3.17	3.16	1.89	2.24	2.47	2.59	2.06
K_2O	1.01	1.02	1.03	0.80	0.69	0.83	1.32	0.84
P_2O5	0.58	0.58	0.68	0.29	0.35	0.38	0.37	0.31
LOI	-0.10	-0.19	-0.22	3.30	2.40	0.50	1.33	0.67
Total	99.92	99.76	100.14	99.52	99.99	101.38	99.77	99.92

All analyses by University of Hawaii, Department of Geology and Geophysics except as noted.

1) Abbreviations: N, Nuku Hiva; UH, Ua Huka; HTT, Ha'atuatua; HN, Hane; MAT, Ma'atea; HPP, Ha'aupaupa.

2) Abbreviations for Ha'atuatua excavation areas: A, Location A; CD, Central Dune.

3) Abbreviations: Ad, Adze; Cr, coarse; Dy, dyke rock; Fl, flake; Fn, fine.

4) Analysis by Best *et al.* 1992:82

TABLE 8.5. Wavelength dispersive x-ray fluorescence data for Marquesan basalt artefacts and reference specimens.

neighbouring island of Ua Pou. Unlike fine-grained basalt, the phonolite was not used for manufacturing adzes.

All six of the fine-grained basalt specimens analysed consist of imported material. Five of these artefacts (four flakes and an adze) are provenanced to Eiao, an island located about 100 km from Nuku Hiva. The sixth artefact of fine-grained basalt (another adze) originated from a different exotic source, probably in the southern Marquesas. At present, it is unknown if the four flakes of Eiao origin represent adze manufacturing or resharpening debitage, or if they derive from the production of other kinds of artefacts. However, in accordance with Andrefsky's (1994) general model for the relationship between raw material availability and lithic technology, it is expected that this high-quality imported rock was used primarily for manufacturing adzes and other formal tools. Testing of this hypothesis will require technological analyses of the Ha'atuatua lithic assemblages.

The open sea crossing from Nuku Hiva to Eiao is traversed in about half a day's sailing time with the prevailing easterly trade winds (B. Finney pers. comm.). The return voyage (into the prevailing winds under normal conditions) is more difficult unless facilitated by one of the periodic shifts in wind direction (see Fig. 8.1). Although we will not attempt to estimate the transport costs (including canoe construction and maintenance, as well as sailing time) involved in importing the Eiao basalt, these were substantial.

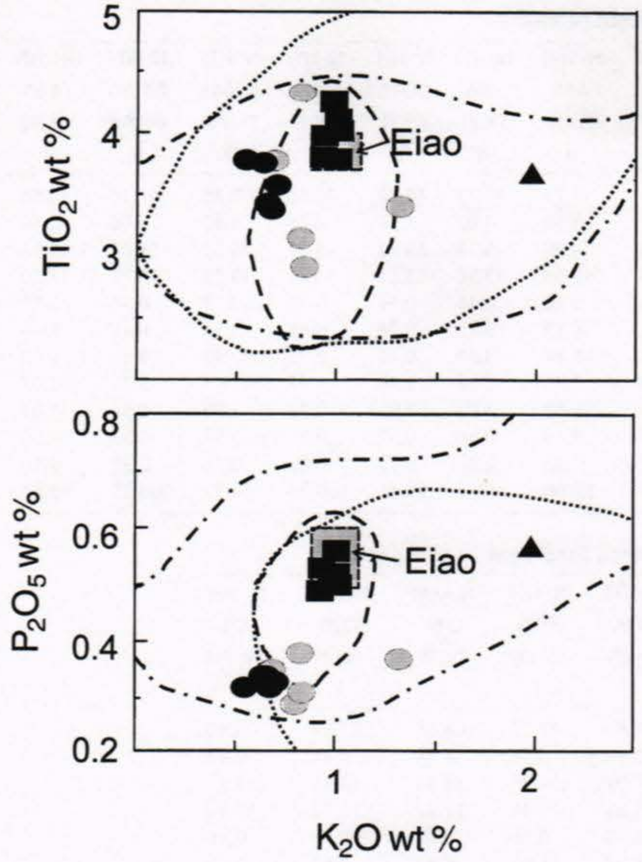

FIGURE 8.5. TiO_2 and P_2O_5 for Ha'atuatua artefacts (Table 8.5) and selected Marquesan reference samples. All symbols and fields as for Figure 8.2.

In any case, long term access to and widespread use of Eiao basalt by the inhabitants of Ha'atuatua is indicated by the chronological and spatial contexts of the specimens analysed. Our excavations yielded Eiao basalt from relatively distant areas of the Ha'atuatua Dune and, within these areas, from separate cultural deposits dated between A.D. 662-1012 and A.D. 1300-1650.

The high frequency of Eiao rock in our sample suggests relatively easy access to the island's resources and implies that significant quantities of the fine-grained basalt were transported to Nuku Hiva. This finding supports ethnohistoric accounts identifying Eiao as a major regional centre for adze production. Traditional accounts also maintain that Eiao adzes were circulated widely throughout the Marquesas, with Nuku Hiva serving as a sort of distribution centre (Linton 1923:321). In this context, we infer fairly regular or at least occasional but large-scale, direct inter-island contact between Nuku Hiva and Eiao beginning as early as the mid-late first millennium A.D. and continuing for the duration of Marquesan prehistory.

These findings raise several questions concerning the role of Eiao in adze production. Was Eiao basalt transported in the form of finished adzes, preforms or simply as a raw material? When did quarrying begin, and was it done by permanent or temporary residents? What were the factors that established Eiao as a major quarry island? While further analysis of the Ha'atuatua lithic assemblages may help answer some of these questions, resolution of the central issues will require additional studies focussed specifically on Eiao itself and its rich but still essentially unknown archaeological landscape.

Results of this study also document Marquesan knowledge of the distribution of economically valuable lithic resources. The detail and geographic extent of this knowledge increased during exploration following initial colonisation of the archipelago and it likely continued to change throughout prehistory. Thus, interpreted in light of the site chronology, the Ha'atuatua provenancing data are valuable in reconstructing the perceived environment at different points in time.

The early stratigraphic context of Eiao basalt in Ha'atuatua Location A suggests that the Eiao source, the largest and best known Marquesan adze quarry at the time of European contact, was already in use by the mid-late first millennium A.D. How much earlier did the process of quarrying and interisland transportation of Eiao basalt begin? It is significant to note that Eiao is perhaps the least accessible of the major islands. Not only is it a northern outlier but the coastline consists mainly of steep cliffs, with only two or three small bays suitable for landing a canoe. In the context of colonisation models which place initial settlement of the Marquesas at around A.D. 300-600 (Spriggs and Anderson 1993), the Ha'atuatua date for imported Eiao basalt implies discovery and established exploitation of the source within the first several centuries of prehistory. Models founded on the premise of an earlier colonisation of the Marquesas, by around A.D. 1 (cf. Kirch 1986; Rolett 1993), allow significantly more time for discovery of the Eiao lithic resources and the initiation of quarrying.

The provenancing data suggest that local sources of fine-grained basalt were either unknown, scarce or relatively inaccessible to the inhabitants of Ha'atuatua during time periods documented by our excavations. A more complete analysis of the lithic assemblages is necessary to test this hypothesis. Our study also identifies a second, unprovenanced source of fine-grained basalt, suggesting that Eiao may have been only one of several important quarries in the Marquesas. If this is the case, future analyses could also investigate possible changes through time in the availability of basalt from different sources, as measured by the relative or absolute abundance of this material in the Ha'atuatua artefact assemblages.

What was the role of phonolite and why was this material so widely distributed by prehistoric Marquesans? Was it valued for functional usage or for other reasons? Was the unusual green colour a factor? While these questions remain unanswered, it is significant to note that the reasons, economic or otherwise, for importing phonolite were apparently different from those influencing the acquisition of imported fine-grained basalt.

We return now to the broader issue of whether current archaeological evidence can be used to reconstruct voyaging patterns and interaction spheres in Marquesan prehistory. The Ha'atuatua pottery sherds provenanced to a western Pacific source remain the only physical evidence for inter-archipelago contact during Marquesan prehistory. In the case of the Location A sherd, it is possible that if there was no great discrepancy between the time this sherd reached the Marquesas and the time of its deposition in Layer B, then the pottery documents inter-archipelago voyaging as late as A.D. 1300-1650. Our provenancing study focussed on the Ha'atuatua lithic assemblages confirms the existence of inter-island voyaging during the same time period but yields evidence only of contacts within the Marquesas.

Dialectal and cultural differences distinguished islands within the Marquesas at the time of European contact, forming in particular a division between the northern and southern island groups (Dordillon 1931; Handy 1923; Linton 1925). Expanded provenancing studies centred on artefacts from Ha'atuatua and other sites in the Marquesas may help to explain the origin of these regional differences, by defining long term transformations in the level of prehistoric inter-island contact. Further studies may also provide additional evidence for inter-archipelago contact, which would be significant in efforts to reconstruct patterns of long distance voyaging in East Polynesia.

ACKNOWLEDGEMENTS

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NOTES

1. The anthropological literature on the Marquesas generally refers to two island groups, the northern (Eiao, Hatuta'a, Nuku Hiva, Ua Pou and Ua Huka) and the southern (Fatu Huku, Hiva Oa, Tahuata, Motane and Fatu Hiva) clusters. This division is based on linguistic data (cf. Dordillon 1931). Eiao and Hatuta'a apparently did not have permanent resident populations at the time of Euro-American contact but were included in the 'northern' group because of their geographic location. We have adopted a new subgrouping of the islands which separates them into three clusters, the northern, central and southern groups (see Fig. 8.1). While this may cause some confusion for readers accustomed to the linguistically-based subgrouping, it is necessary because of the unique prehistoric significance of Eiao as a major basalt quarry and adze production area.

2. It should be noted that the terms 'coarse-grained' and 'fine-grained' are used here in a relative sense in that, from a geological perspective, both varieties are fine-grained. Although, strictly speaking, we are distinguishing fine-grained from very fine-grained, the terms 'fine' and 'coarse' are used here to emphasise significant differences in the suitability of these different materials for the production of chipped and ground stone tools.

3. As noted by Weisler for the To'aga site, Manu'a Islands, American Samoa (1993c:182-183), medium and coarse-grained, locally-available basalt was used for flake production, while all fine-grained basalt—the products of adze manufacturing and use—was imported.

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