A Tale of Two Quarries: Investigating Prehistoric Basalt Adze Production on Tutuila Island, American Samoa

E. Quent Winterhoff and David E. Rigtrup Department of Anthropology, University of Oregon

Abstract

This current article compares the reduction strategies occurring at two basalt adze production sites in Tutuila, American Samoa - AS-32-13b in Malaeloa Valley and Tataga Matau northeast of Leone. Flake Aggregate Analysis was utilized to examine the sites' lithic assemblages by size, cortex and diagnostic flake types. The resultant data highlights key differences found in Samoan adze production, which reflect changes in the larger economic realm.

KEYWORDS: Samoa, Tutuila, Quarry, Adze, Lithic analysis.

Introduction

The importance of adzes and adze production to West Polynesian archaeology is self-evident, due to their time depth (Green and Davidson 1969), their archaeological durability, their ability to be sourced (Weisler and Kirch 1996), and their societal context in both subsistence and political economies (Earle 1997). Thus, examining adze manufacture at archaeological sites should be a major focus; in West Polynesian Archaeology; however, only sparse work to date has been conducted in understanding the relationship of larger social processes and the region's heterogeneous geological setting. In an effort to address this issue, the authors have been conducting a long term programme on adze research at Tutuila Island, American Samoa (Figure 1).

Prior archaeological research has documented at least 11 prehistoric basalt quarries scattered throughout Tutuila Island (Ayres and Eisler 1987; Leach and Witter 1990; Best et al. 1992; Clark et al. 1997). These different production sites contain significant variation recorded in acquisition techniques, periods of occupation and scales of production (Clark et al. 1997). The

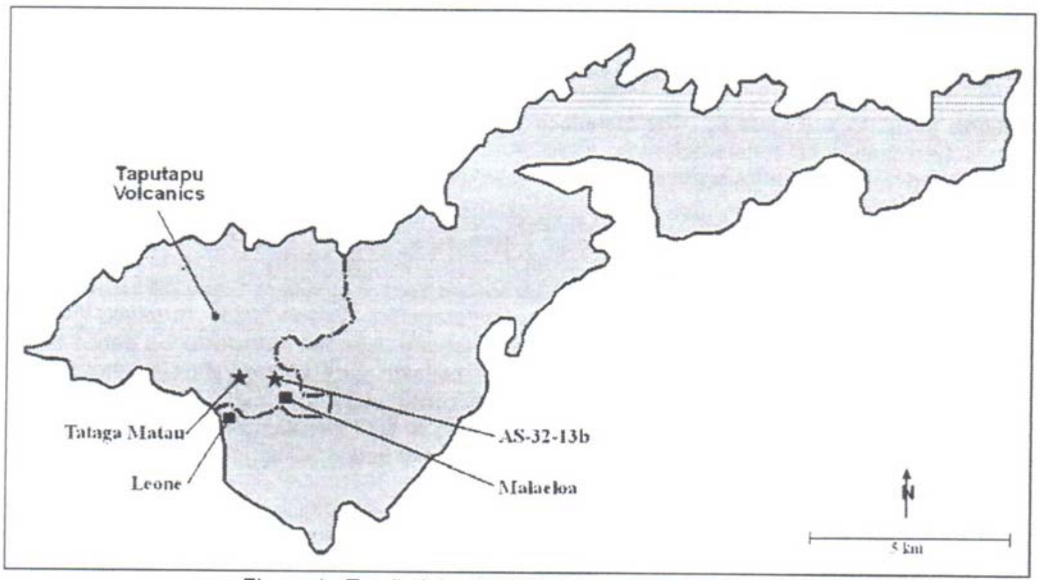

Figure 1: Tutuila Island with locales mentioned in text

dissimilarities recorded in tool manufacture often reflect changes in exchange and larger economic processes (Torrence 1986), thus allowing archaeologists to chart and evaluate the possible social and environmental mechanisms.

This current article compares the reduction strategies occurring at two neighbouring production sites (See Figure 1), Site AS-32-13b in Malaeloa Valley and Tataga Matau northeast of Leone, in an effort to further examine the previously documented production variability. Located within the same volcanic episode, Taputapu, Tataga Matau and AS-32-13b provide an excellent opportunity to study this manufacturing variation occurring in close proximity, creating a desirable foundation for future analyses. AS-32-13b represents one of seven manufacturing sites recorded during prior research conducted by the authors in Malaeloa (Ayres et al. 2001; Winterhoff 2003; Winterhoff et al. 2006). Tataga Matau was selected for both the extensive archaeological research conducted at the site and also its importance in regional provenance research (Buck 1930; Leach and Witter 1987, 1990; Leach et al. 1989; Best et al. 1992). In addition, Tataga Matau and Malaeloa share an interesting similarity as both are sources for regionally distributed adzes (Winterhoff 2003; Table 1).

Table 1: Adze distribution on WD-XRF analysis

Tataga Matau Quarry	Malaeloa Quarry
Tutuila, Am. Sāmoa	Atafu, Tokelau
Nukunonu, Tokelau	Fakaofo, Tokelau
Moce, Fiji	Fulaga, Fiji
Taumako, Santa Cruz	Upolu, Samoa
San Cristobal, Solomon	

Archaeological Background

AS-32-13b

The Malaeloa Valley is a broad, inland valley that is located 1 km east of the village of Leone (see Figure 1). The relatively flat valley floor has an area of 0.7 sq km, and is at roughly 60 m above sea level. The surround ridges have steep slopes, 30 to 70 percent, and rise up to an elevation of 360 m. The bedrock is composed mainly of alkalic olivine basalts (Daly 1924; Nateland 1980).

Site AS-32-13b is situated on the west facing side slope of the eastern ridge in the northeast portion of Malaeloa surrounded by ample raw material including large basalt boulders, outcrops, cobbles recovered in terrace construction and a nearby stream (Winterhoff et al. 2006). Covering an area of 0.11 ha, AS-32-13b consists of three terrace features, a house foundation and considerable amounts of debitage (Figure 2). The manufacturing component of the site has been dated to the 15th to 17th century AD (Winterhoff et al. 2006). Artefacts recovered during test excavations at the site included twenty-two adze preforms, fourteen flake tools, seven adze flakes and 13,223 pieces of debitage (49.5 kg).

Tataga Matau

Regrettably for comparison purposes, only the Star Mound Terrace at Tataga Matau will be discussed in this article. Obviously, additional quarry areas are present at Tataga Matau; however, the Star Mound Terrace excavations represent the only systematically collected manufacturing debris at the site. This limitation in sampling methods marks a larger methodological consideration in data recovery conducted on island as a whole. Noted, time and money considerations plague all field research. But, without simple comparable sampling strategies occurring at field investigations, the resulting data places severe limitations upon later in-depth analyses. This limitation will and has created a dramatic hole in our future archaeological interpretations.

The Star Mound Terrace is situated on the southwest portion of Tataga Matau and was chosen for investigation because of the presence of the star mound feature, the likelihood of intact buried cultural remains, and a potsherd was recovered from the terrace's surface (Leach et al. 1989: 19). The terrace has an approximate area of .04 ha. Roughly, 1.6 cu. m of soil was excavated

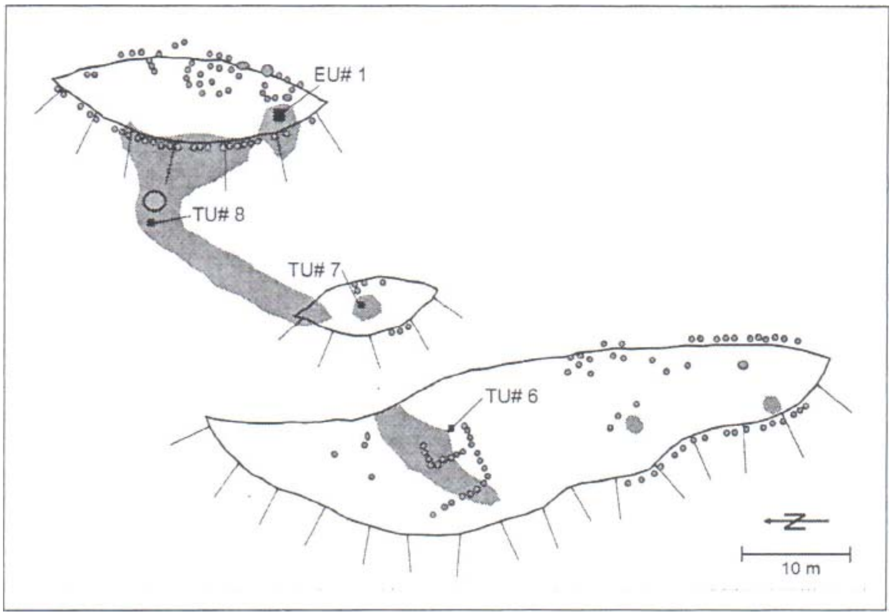

Figure 2: Plan view of site AS-32-13b.

from Test Unit 1, a 2 x 1 metre unit located in the centre of the terrace. Stratigraphically, the terrace contained two intact living floors - the surface of the Star Mound and stratigraphic Layer B. Layer B has a conventional age of 602 +/- 50 BP representing the earliest occupation of the terrace and also contains the only intact evidence for adze production activities. Whereas, the mound fill was deemed uniform between Layer B and the surface and the recovered debris in the fill had been disturbed as a product of mound building. Artefacts recovered during test excavation in layer B at the terrace included 18 preforms, one flake tool, one blade core and 601 pieces of debitage (17.7 kg).

Lithic Analysis

Methods

Due to the tremendous amount of lithic material produced at the two Samoan production sites, initial analysis of the assemblages was conducted using Flake Aggregate Analysis (FAA), which stratifies an assemblage based on particular criteria, such as size or weight. This method not only allowed for a high level of efficiency and objectivity, but also allowed for a minimal amount of researcher bias (Ahler 1989). The assemblages were scrutinized by three main criteria: size/weight, dorsal surface characteristics, and diagnostic flake types.

Size category

Each assemblage was first separated into distinct size grades using a series of concentric circles. Size was chosen as the initial criteria due to its ability to indicate particular patterning in the reduction process (Ahler 1989), and although weight has been used elsewhere with success (Turner and Bonica 1994), the volume of lithic material deterred the authors from this more time consuming process. Once sorted by size, the assemblages were then weighed, counted and entered into a database.

Table 2: Size category specifications

Group no.	Size Grade	Representative Stage in the Reduction Strategy
1	< 1.5 cm	fine trimming or shatter
2	1.5 - 3 cm	final stage of preform reduction
3	3 - 4 cm	middle stage of preform reduction
4	4 - 6 cm	early stage of preform reduction
5	> 6 cm	1 initial blank production

Dorsal surface category

To compliment the size g grade data, dorsal surface characteristics were also analysed. Utilizing Turner and Bonica's classification scheme (1994), lithic assemblages were grouped into three categories based on presence of cortex and the number of flake scars present. Flakes exhibiting cortex that had two or less flake scars were classified as primary, those exhibiting cortex in conjunction with more than two flake scars were deemed secondary. Flakes exhibiting no cortex were categorized as tertiary. This hierarchy was adhered to size groups 2 to 5. The exception, Group 1 flakes, was simply identified based on the presence or absence of cortex, because of their small size flake scarring could not easily be identified.

Diagnostic flake category

While FAA was utilized as the main method in analyzing debitage assemblages, flakes were also examined individually. Here, we examined two diagnostic flake forms that allowed for differentiation between triangular versus quadrangular adze preforms. Triangular blanks have a ridgeline down the centre of its mass that needs to be removed for a bevel; the resultant ridge flakes have a triangular cross-section and have alternating flake scars on its dorsal surface. Next, quadrangular blanks tend to have cortex on their dorsal surface, and when the blank is reduced to its desired shape, bi-marginal flakes are produced (Leach and Witter 1987). Here, bi-marginal flakes are classified as flakes that have cortex on either their platform or terminate surface, and have a greater flake width than length. These diagnostic flakes coupled with the above two categories created an effective and efficient methodology for examining reduction stages in Samoan prehistoric adze manufacture.

Results

In Figures 3 and 4, results from analysis of AS-32-13b and Star Mound, Layer B's lithic assemblages are presented in two bar graphs charting the percentage of debitage by weight per category. In Figure 3, there is a marked majority of the large Group 5 flakes recovered from Layer B; whereas, AS-32-13b's assemblage split approximately evenly into quarters among Groups 2 through 4. In Figure 4, Layer B had a decreasing trend of cortex flakes from Primary to Tertiary, and AS-32-13b results showed an opposite trend. In addition, there was a Significant difference between the two sites' average individual flake weight for Group 5. AS-32-13b had an average Group 5 flake weight of 35.2 g and Layer B had an average of 91.3 g

In Table 3, there is an almost 3 to 1 ratio of bi-marginal to ridge flakes at AS-32-13b. If one takes into account that many bi-marginal flakes are produced in narrowing a blank for a quadrangular preform, and only one or two ridge flakes are produced to create a bevel on a triangular preform, then this site provides evidence of a more equal ratio for the two performs. The Star Mound Terrace's Layer B lacks any significant number of either diagnostic flake type, thus providing insufficient evidence of either preform manufacture.

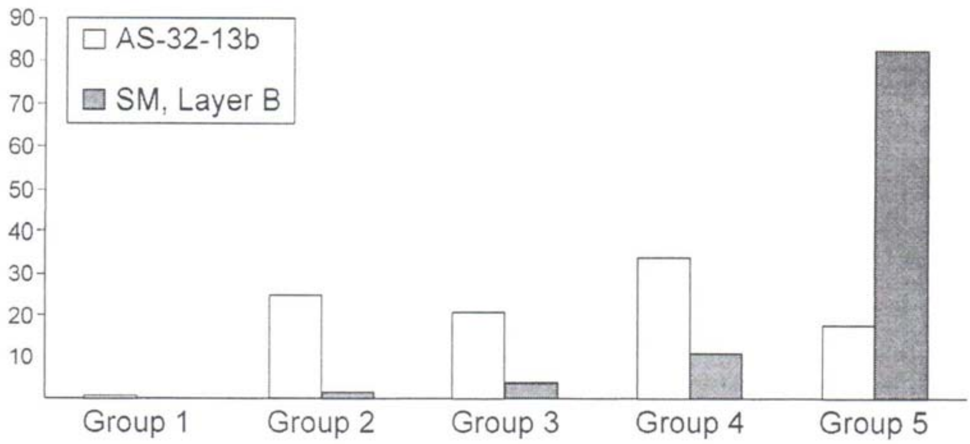

Figure 3: Size grade results of the lithic analysis

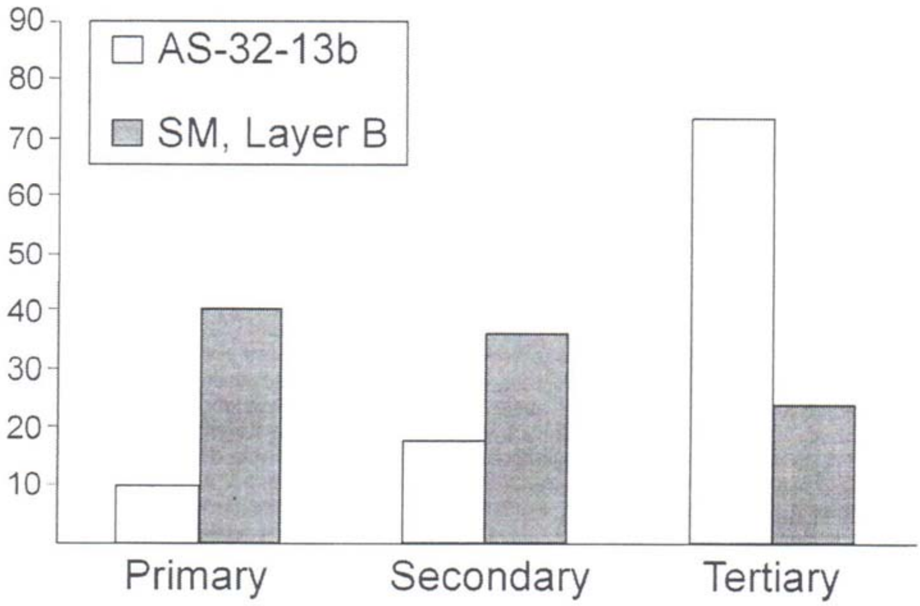

Figure 4: Dorsal surface results of the lithic analysis

Table 3: Breakdown of specific flake types recovered from the two sites by flake count.

	Star Mound Terrace, Layer B	AS-32-13b
Bi-Marginal Flakes	4	74
Ridge Flakes	0	24

Discussion and Conclusion

Based the results from the lithic analysis, there exists a marked difference in the type of reduction strategies employed at either site. The activities occurring at Star Mound Terrace's layer B is indicative of blank production, while AS-32-13b is more suggestive of preform reduction. Examining the differences in size grade percentages between the two sites, AS-32-13b has 81 percent of its debitage occurring in size grades 2 to 4; whereas Layer B has 83 percent of its assemblage in group 5. The disparity between the sites' assemblages based on size grade composition highlight that past residents at AS-32-13b were reducing blanks into preforms, and that both blank production and the fine trimming of preforms were occurring elsewhere. At Star Mound Terrace's Layer B, the sheer amount of Group 5 flakes represents a strong tendency toward only blank production occurring at that locale. In addition, the Group 5 flakes' average weights at each site marks a larger tendency at Layer B for blank production (Leach and Witter 1987, 1990), where many flakes of adequate blank size were recovered although left unmodified.

Also, the dorsal surface percentages at AS-32-13b and Layer B present a dissimilarity in reduction strategies. AS-32-13b had 73 percent tertiary flakes and Layer B had 76 percent cortex flakes. This reverse of dorsal surface characteristics lends more credence to the size grade portion of the analysis as cortex flakes are routinely produced in the initial part of stone tool manufacturing. Finally, the lack of diagnostic flake types recovered from Layer B compared to AS-32-13b show that the majority of preform reduction was occurring away from the Star Mound Terrace.

Studies of adze production can provide clues regarding the development of political complexity through the analysis of standardization, intensification, specialization and control of these basalt sources (Earle 1997; Torrence 1986). In examining basalt tool production in a cultural context, there are avenues of archaeological measurement in which to evaluate how changes in lithic tool production can mirror developments in exchange and society (Torrence 1986).

First, is there evidence of restricted access to quarries? Restricted access denotes a form of ownership of valuable resources; and to test this, one would need to examine the proximity of acquisition to habitation sites and if there are associated defensive fortifications occurring at coeval periods of production. The Tataga-Matau Quarry on Tutuila provides an excellent example of restricted access to tool production. The hill-top quarry has both defensive features and a remote locale away from populated areas (Leach and Witter 1990). However, Tataga-Matau is anomalous compared to other known quarries on island in both those terms (Clark, Wright and Herdrich 1997), including AS-32-13b. Second, are adzes becoming more standardized over time? Because adze types are not well dated, more excavations are needed at deeply stratified sites, both at quarries and habitations, to adequately address this issue. Third, is there evidence of product or manufacture specialization at the quarry locales? Although there is not evidence to support product specialization at either site, there is ample data to suggest that specialized activities were occurring: initial reduction and preform reduction. But issues arise when attempting to define the possible tool trajectories happening at the two sites, because of the sheer size of large un-worked waste flakes at Layer B. These large flakes may be part of an intentional strategy because of the abundance of raw material or could be unintentional because of poor craftsmanship. If poor craftsmanship was the reason, then the lack of these large un-worked flakes at AS-32-13b may be a result of Malaeloa knappers being more successful in reducing their own material. However, this variation needs to be systematically tested to assess its significance. Finally, do the quarry sites provide evidence of intensification in the number or types of products manufactured? The overall size of Tataga Matau's size and the overall volume of manufacturing debris at AS-32-13b can be generally related to the intensification of production for distribution (Leach and Witter 1990). Also, the two sites date to the period of the Tongan Maritime

Chiefdom and related exchange network (Kaeppler 1978; Burley 1993). The temporal overlap with the exchange network, the tremendous amount of debris recovered, and the documented adze sources for regional distribution makes these sites a likely candidate for intensified production locales whose commodities were controlled by chiefs for prestige competition.

Regrettably, proper quantifiable terms and definitions are not yet available for Samoan adze production and site types. Whereas there is ample ethnographic material and oral traditions explaining issues on Samoan settlement patterns, Samoan stone tool production lacks similar contextual understanding. This dearth of direct observations requires archaeologists to pay more attention to defining legitimate units of study when examining ancient manufacturing behaviours and intents. To compensate for the lack of direct observations in production behaviours, there is a need for more published results from experimental studies and modern basalt knappers so comparisons can be made between their data sets and recovered debitage from archaeological sites. It is the hope of the authors that this article stimulates further reserach into this area, and provides a basic framework for efficient lithic analysis in West Polynesia.

Acknowledgements

The authors would like to extend their greatest appreciation to Dr Helen Leach, the supervising researcher at Tataga Matau (1987, 1990), for allowing the re-analysis of the Star Mound Terrace assemblage. Also, we would also like to warmly thank Dr David Addison and Tautala Asaua M.A. from the Archaeological Specialist Division of American Samoa Power Authority for their intellectual discussions and critiques on earlier drafts of this article.

References

Ahler, S., 1989. Mass analysis of flaking debris: Studying the Forest rather than the Tree. In D. Henry and G. Odell (eds), *Alternative* Approaches *to Lithic Analysis:* Archaeological Papers of the American Anthropological Association No.1, pp. 85-118.

Ayres, W.C., J.A. Wozniak, G. Robbins and E. Suafo'a, 2001. Archaeology in American Samoa: Maloata, Malaeimi, and Malaeloa. In C.M. Stevenson, G. Lee, and F.J. Morin (eds), *Pacific 2000: Proceedings of the Fifth International Conference on Easter Island and the Pacific.* California: Bearsville Press, pp. 227-35.

Ayres, W.S. and D. Eisler, 1997. Archaeological Survey in Western Tutuila --A Report on Archaeological Site Survey and Excavations. Eugene, Oregon: University of Oregon.

Best, S., H. Leach and D. Witter, 1989. *Report on the Second Phase of Fieldwork at the* Tataga *Matau site, American* Samoa, *July August:* Dept. of Anthropology, University of Auckland, Working Papers in Anthropology, Archaeology, Linguistics and Maori Studies 83.

Best, S., P. Sheppard, R.C. Green and R. Parker, 1992. Necromancing the stone: Archaeologists and Adzes in Samoa. *The Journal of the Polynesian Society,* 101:45-85.

Buck, P., 1930. *Samoan Material Culture.* Honolulu: Bernice P. Bishop Museum Bulletin 75.

Burley, D.V., 1993. Chiefly prerogatives over critical resources: archaeology, oral traditions and symbolic landscapes in Ha'apai, Kingdom of Tonga. In R. Jamieson, S. Abonyi, and N. Mirau (eds), *Culture and Environment: A Fragile Coexistence.* Calgary: University of Calgary Archaeological Association, pp. 437-43.

Clark, J.T., E. Wright and D.J. Herdrich, 1997. Interactions within and beyond the Samoan

Archipelago: Evidence from basaltic rock geochemistry. In M.I. Weisler (ed.) *Prehistoric Long-distance Interaction in Oceania: An InterdisciplinaryApproach.* Auckland: New Zealand Archaeological Association Monograph, pp. 68-84.

Daly, R., 1924. The Geology of American Samoa. Carnegie Institution of Washington, Department of Marine Biology, Paper 19, (Publication No. 340).

Earle, T., 1997. Exchange in Oceania: Search for Evolutionary Explanations. In M.I. Weisler (ed.) *Prehistoric Long-Distance Interaction in Oceania: An Interdisciplinary Approach.* Auckland: New Zealand Archaeological Association Monograph 21, pp. 224-36.

Green, R.C. and J.M. Davidson, 1969. *Archaeology in Western Samoa.* Volume I. Auckland: Auckland Institute and Museum, Bulletin 6.

Kaeppler, A., 1978. Exchange patterns in Goods and Spouses: Fiji, Tonga and Samoa. *Mankind,* 11: 246-52.

Leach, F. and R.C. Green, 1989. New information for the Ferry Berth Site, Mulifanua, Western Samoa. *The Journal of* the *Polynesian Society,* 98:319-30.

Leach, H. and D. Witter, 1987. Tataga Matau "rediscovered". *New Zealand Journal of Archaeology,* 9:33-54.

Leach, H. and D. Witter, 1990. Further investigations at the Tataga Matau site, American Samoa. *New Zealand Journal of Archaeology,* 12:51-83.

Natland, J.H., 1980. The progression of volcanism in the Samoan linear volcanic chain. *American Journal of Science,* 280A (Jackson Volume):709-35.

Torrence, R., 1986. *Production and Exchange of Stone Tools: Prehistoric Obsidian in Aegean.* Cambridge: Cambridge University Press.

Turner, M. and D. Bonica, 1994. Following the Flake Trail: Adze production on the Coromandel East Coast, New Zealand. *New Zealand Journal of Archaeology,* 16:5-32.

Weisler, M. and P.V. Kirch, 1996. Interisland and interarchipelago transfer of stone tools in prehistoric Polynesia. *Proceedings of* the *National Academy of Sciences .of the United* States *of America,* 93(4):1381-5.

Winterhoff, E., 2003. Ma'a a Malaeloa: A Geochemical Investigation of a New Basalt Quarry Source in Tutuila, American Samoa. Unpublished MA, University of Oregon.

Winterhoff, E., W.S. Ayres and D. Rigtrup, 2006. Recent Archaeological Investigations in Malaeloa, Afao and Asili: American Samoa. Eugene, Pacific Island Archaeological Laboratory: University of Oregon Museum of Anthropology.