– RESEARCH REPORT –

# Coastal Occupation at the GS-1 Site, Cook's Bay, Mo'orea, Society Islands

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ABSTRACT

Excavations at the GS-1 site uncovered buried stratigraphic deposits of some depth. Site stratigraphy and artifact content suggests the area was first used as a coastal habitation prior to being covered by substantial colluvial deposits and in historic times, modern fill. Wood charcoal samples recovered from the site were identified to short lived species for AMS radiocarbon dating. The wood charcoal identifications were also used to identify indigenous versus introduced species in order to clarify the depositional events associated with the stratigraphic deposits. The lowest deposits at GS-1 date to as early as the 11th century AD. Colluvial deposits overlying the lowest strata were definitively related to human activities, as Polynesian introductions are present in the wood charcoal assemblages. Finally, the frequency and types of artifacts recovered suggest the area served as an adze manufacturing locale through time.

*Keywords*: Society Islands, coastal sites, settlement chronology, wood charcoal identification

## INTRODUCTION

Given its central location, archaeologists have long argued that the Society Islands archipelago is a key locale for understanding the settlement of Eastern Polynesia. On both archaeological and linguistical grounds, early studies argued that the Societies were among the first areas settled in the region (Emory 1946; Jennings 1979). Unfortunately, for some time the Society archipelago has lacked any sustained research effort to uncover early settlement sites. This is likely, in part, a result of the Emory-Sinoto archaeological model which posited that the Marquesas archipelago was the first area settled in Eastern Polynesia from a Western Polynesian homeland. The Emory-Sinoto model (1965; Sinoto 1970; 1979), as well as the exciting recovery of Polynesian plainware sherds in the Marquesas Islands, stimulated field research in that archipelago from the 1990s onwards. Recent Marquesan field projects have recovered and dated early colonization remains and reappraised sites with initial early dates (Allen and McAlister 2010; Rolett 1998; Rolett and Conte 1995). In contrast, the Society Islands have continued to be a lacuna with respect to dating early colonization sites. Leeward Society Islands sites on Huahine and Maupiti excavated in the 1960s and 1970s yielded Archaic style artifacts originally dated to as early as the 8th–9th centuries (Emory 1979). However, after the advent of the long versus short chronology debate (Irwin 1992, 1993; Kirch 1986; Spriggs and Anderson 1993), archaeologists revisited these purportedly early colonization sites to obtain new charcoal samples for more precise radiometric dating. These redating programs have shortened the chronologies for these key sites, returning dates in the 11th century or later for Vaito-otia-Fa'ahia, Huahine (Anderson and Sinoto 2002) and after the 13th century for the Maupiti burial site (Anderson *et al.* 1999).

While in the last three decades few archaeological projects have focused on leeward Society Islands coastal sites, even less effort has been expended to identify buried coastal deposits in the windward Society Islands (Tahiti and Mo'orea). Excavations in the 1960s by the Rappaports, as part of Roger Green's larger settlement pattern project, recovered a sub-surface earth oven at Papetoa'i, Mo'orea (ScMf5; see Figure 1) which was dated to between the 13th–15th centuries (Green *et al.* 1967: 182). These deposits lacked Archaic style artifacts or other indicators of initial settlement (i.e. bird bone, turtle bone, etc.). The only other available data derive from paleo-ecological work on Mo'orea. Lepofsky's excavations in the lower 'Opunohu Valley (at backhoe trench EU 23) recovered anaerobically preserved coconuts interpreted as semi-domesticated forms (Lepofsky *et al.* 1992). Two coconut samples were dated, yielding calibrated age ranges overlapping at 2 sigma and possibly indicating settlement in the 7th century. However, no other cultural materials were associated with these remains, leaving some researchers to discount their validity. In the 1990s, results from Parkes's Lake Temae pollen cores suggested an initial colonization date for the windward Societies after AD 640 (Parkes 1997). Unfortunately, this study was completed during the debut of pol-

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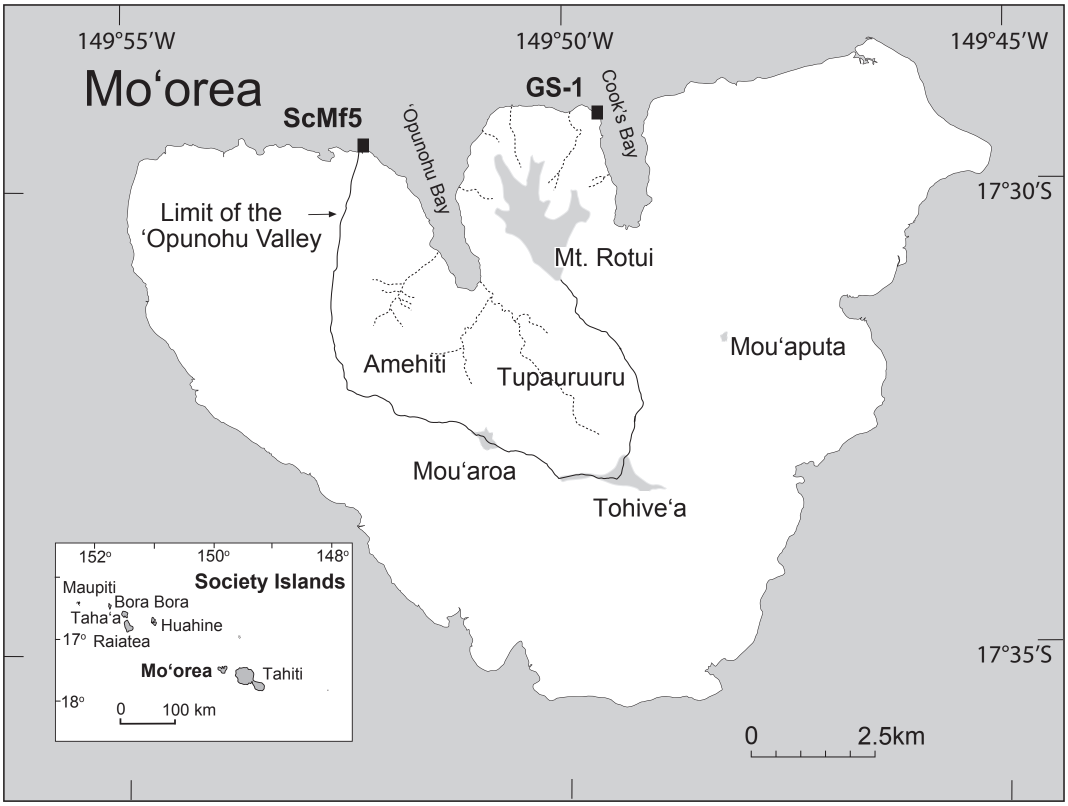


Figure 1. Map of Mo´orea and Location of GS-1 and ScMf5. Amehiti and Tupauruuru are the main divisions of the ʻOpunohu Valley, while Mou´aputa, Tohive´a, and Mou´aroa are mountain peaks on the main crater line.

len core analysis in Polynesia, and since then there have been substantive advances in the precision of dating pollen cores in the region.

As this brief review suggests, detailed investigations of coastal archaeological deposits in the windward Society Islands have been few and far between. In light of renewed chronological debates as to the timing of settlement in Eastern Polynesia and Hawai‘i (Dye 2011; Kirch 2011; Mulrooney *et al.* 2011; Rieth *et al.* 2011; Wilmshurst *et al.* 2011), there is a pronounced need for new data on Society Islands coastal deposits. In 2002 I instituted a pilot research program of coastal deposits along the western headlands of Cook's Bay, Mo‘orea. The excavation of test pits and a trench at the GS-1 site revealed a deep depositional sequence. As a coastal site with evidence for colluvial deposits overlying calcareous sand deposits, GS-1 has excellent preservation of shell and coral materials in addition to lithic artifacts. In this paper I discuss the summary report of the 2002 excavations and their implications for understanding the first settlement of the Society Islands. My discussion of the GS-1 material culture assemblages focuses on three main questions: 1) What depositional processes do the stratigraphic deposits derive from? 2) What periods does the site occupation date to? and 3) What types of activities were carried out at the locale through time?

## THE RESEARCH AREA

Cook's Bay, on the northern coast of Mo‘orea, is one of two large bays flanking the ‘Opunohu Valley (Figure 1). The GS-1 site is located at the headlands of the western side of the bay, on the property of the Gump Research Station. Here, the coastal plain is fairly wide, ending in steep slopes *ca.* 120 m or more inland.

In 2002 the Gump Station was about to initiate construction of a new laboratory structure on the coastal plain, inland and to the south of the circle-island road. Salvage excavations were completed by the author prior to this building's construction. Previous roadwork in the area, notably the excavation of a drainage canal just inland of the circle-island road, had recovered adzes more than 1 m below the surface, suggesting that coastal deposits here had well preserved archaeological deposits of some depth.

## THE 2002 EXCAVATIONS

The 2002 excavations consisted of three 1 × 1 m test pits and one 1 × 2 m trench arranged along a E-W transect running roughly parallel to the coast and situated *ca.* 20 m inland of the circle-island road (Figure 2). Historical documents suggested that the approximately 20 m of coastal plain on the northern side of the circle-island road was

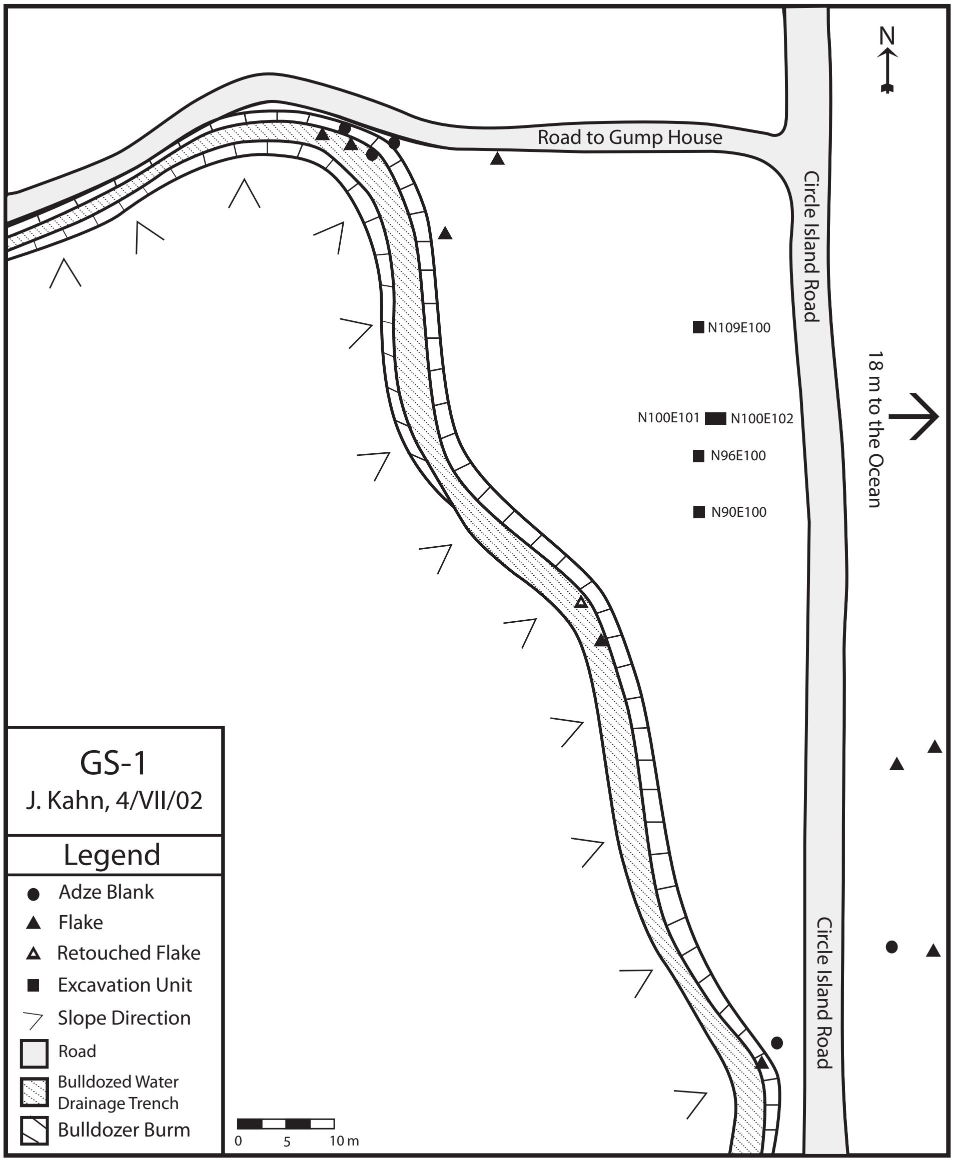


Figure 2. Plan View of the GS-1 Site

the result of modern fill and that the prehistoric shoreline lay inland of this road.

Excavations were conducted following international standards of precision. Horizontal metric grid control was established prior to excavation and a site datum was established. Excavation proceeded with trowels and whisk brooms, by 10–20 cm levels within stratigraphic layers. Recovered artifacts were point-plotted in three-dimensional space. Vertical control was maintained by measuring depth with telescopic and stadia rod and converting this to depth below datum. Charcoal was removed by trowel and placed directly into tin foil and plastic bags. 50% of excavated sediments were screened through ¼ inch mesh and 50% were screened through ⅛ inch mesh to recover smaller artifacts and organic materials. Upon completion of the excavation, stratigraphic profiles were photographed and drawn for at least one face of each unit excavated.

Figure 3 presents the stratigraphic profile from N109 E100, the northernmost unit excavated. Four layers were distinguished in the 110 cm profile. Layer A is a silty clay loam dark brown in color (7.5YR 3/3) and represents a mixture of modern fill and recent humus with frequent rootlets. The interface between Layers A and B is diffuse and mottled. Layer B is a dark brown (7.5YR 4/6) silty loam with frequent degrading scoria and sub-angular to sub-rounded vesicular basalt. The layer has infrequent charcoal flecking and represents a massive wasting deposit, likely the result of colluvial activity from the nearby inland outcrops. Basalt flakes, a few pieces of historic glass, and metal fragments were recovered from this deposit, suggesting that historic fill was used to cap the colluvial layer (Table 1). Layer C is a dark grey sandy clay (10YR 3,3/2) with frequent coral and shell inclusions, small to medium basalt pebbles, infrequent charcoal flecking, and lithic ar-

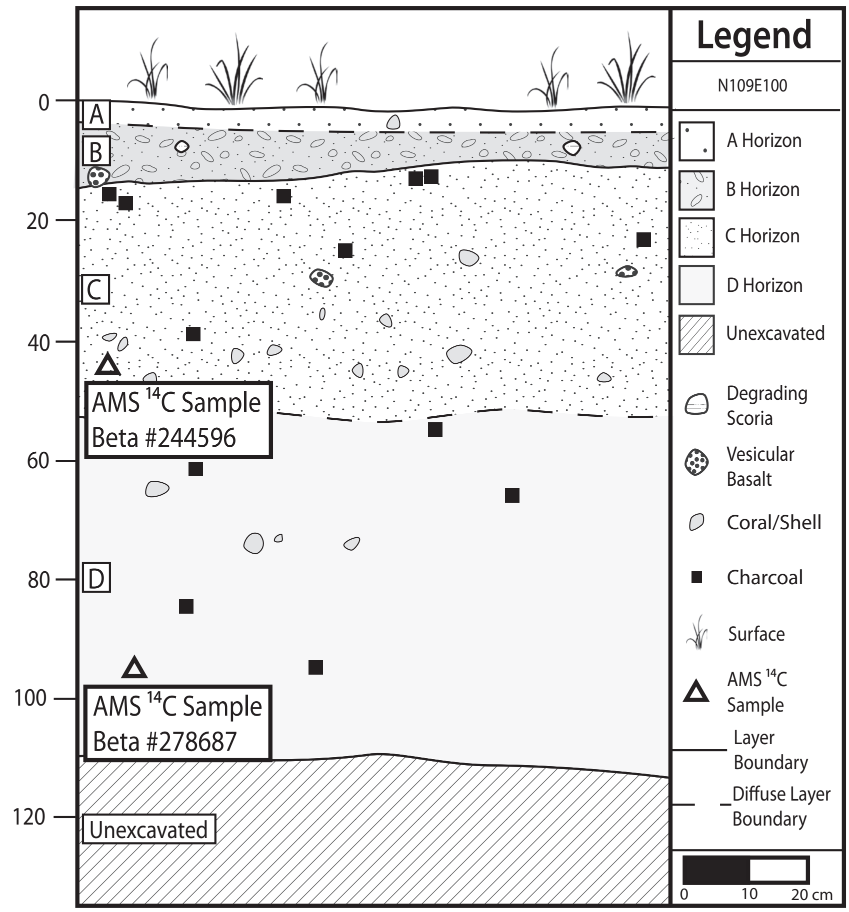


Figure 3. Stratigraphic profile of N109 E100 with areas where the $^{14}C$ samples were collected

tifacts. Some disturbance of the deposit is suggested by the recovery of a single historic ceramic and a piece of glass in the top 10 cm of Layer C. Layer D is a sticky grey clay (7.5YR 3/3) with infrequent lithic artifacts and charcoal flecking but generally lacking coral, shell, or pebbles. Layer D has a higher clay content and lower sand content than Layer C. The Layer D deposit becomes more sticky and plastic with increasing depth. With increasing depth, fewer artifacts and less frequent charcoal flecking were recovered in Layer D, although fully culturally sterile deposits were not reached in the 2002 excavations. The Layer D deposit lacks evidence for historic artifacts or other evidence for post-depositional disturbance (Table 1).

Units to the south of N109 E100 had similar stratigraphy, with a few notable exceptions as can be seen in the profile for N100 E101–102 (Figure 4). Layer B was thicker in these units, suggesting that the southern portion of the site, where the coastal plain is narrower, had more intensive episodes of colluvial wasting. In these areas, Layer D was characterized by thin lenses of coral rubble, branch coral fingers, and sand, suggestive of a relatively high depositional environment, such as storm activity along an exposed beach front. These data indicate that the southern portion of the site may have been situated closer to the paleo-shoreline than the area surrounding N109 E100.

Table 1. *General classes and frequencies of artefacts and materials recovered in the GS-1 excavations*

| Layer | Lithic Materials | Coral | Shell | Historic Artifacts | Comments |
|---|---|---|---|---|---|
| A | 6 | 0 | 16 | 0 | |
| B | 3 | 393 | 32 | 29 | Metal fragments, historic glass |
| C | 144 | 704 | 163 | 2 | Historic ceramic, glass |
| D | 2 | 46 | 26 | 0 | |
| Total | 155 | 1143 | 237 | 31 | |

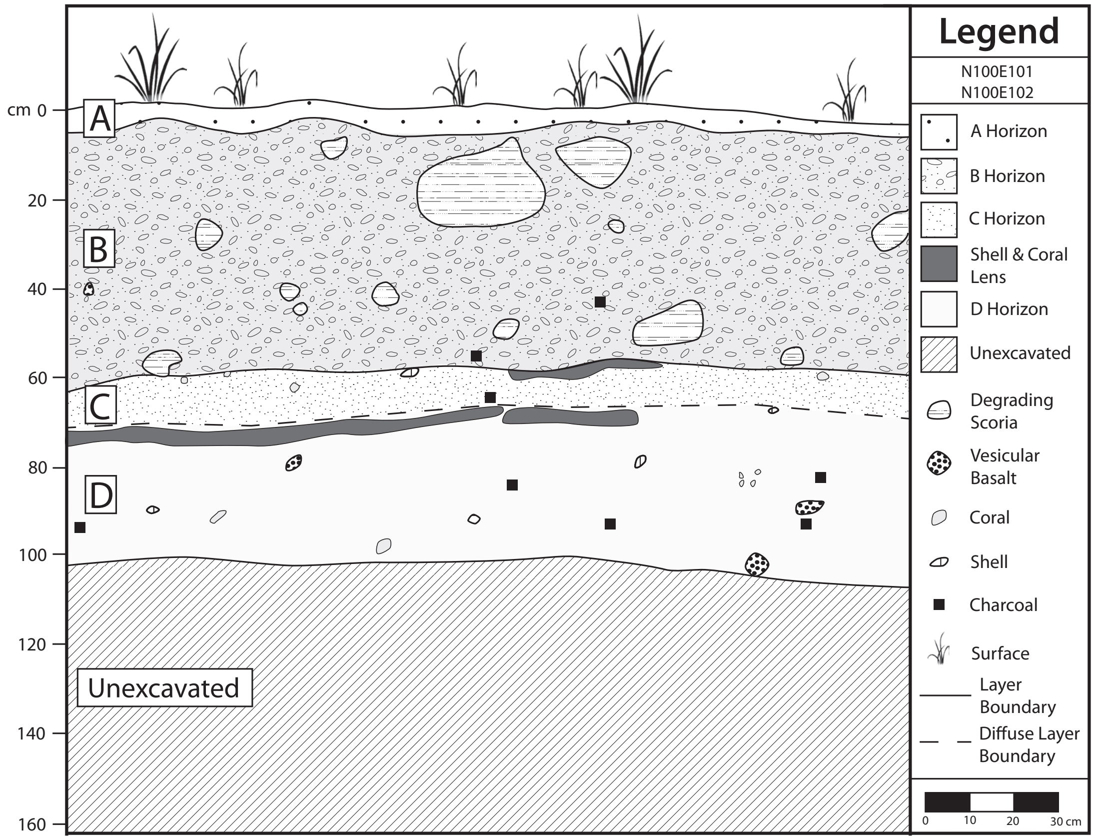


Figure 4. Stratigraphic Profile of N100 E101–102

Stone tool artifacts, including basalt debitage and adze related material, were the most commonly recovered objects in the GS-1 excavations (Tables 1, 2). A total of 17 surface lithics, including four adze blanks, a core, retouched flakes, and fire-cracked rock were collected in addition to the sub-surface materials recovered in the excavations. Surface lithics were scattered over a wide portion of the site, including the coastal plain on both sides of the circle-island road (Figure 2). In the excavations, the majority of stone artifacts (debitage, adze related materials, and fire cracked rock) were recovered from Layer C deposits which also had the highest density of coral fragments. While only a few stone tool artifacts derived from Layer D, the overall pattern indicates that stone tool production was an important component of the activities carried out at the site through time.

Precise details of the GS-1 lithic assemblage analysis are forthcoming (Kahn in prep.). Pertinent to the study at hand are the adze types and the form of the raw material worked at the site. The two adzes recovered from Layer C had Duff 3A reverse-triangular cross-sections (Figure 5; see Duff 1959). This type has been considered a dominant form in late prehistoric Society Islands contexts (Kahn 2009). With respect to raw material procurement at GS-1, approximately 32% of the artifacts derived from stone tool production had cortex cover. Artifacts retaining cortex include prismatic basalt slabs and waterworn cobbles, indicating that both forms of raw material were being worked at the site. Adze replication experiments from Hawaiʻi and New Zealand have a range of cortical debitage frequencies: Cleghorn (1982) reports 12–78% with a mean of 40%, while Turner and Bonica (1994) report 64.6–78.12% for early stage blank production and 10–30% for later stage adze manufacture. The relatively high cortical debitage value at GS-1 suggests that early stage adze blank manufacture and later preform production were being carried out at this locale.

Preliminary geochemical data retrieved via non-destructive EDXRF (to be published in full elsewhere) indicate that the majority of the GS-1 lithic assemblage derives from a local source area, however, there is some variability within this source. These data are broadly consonant with collection of cobbles and prismatic basalt from a river bed cross cutting a series of volcanic rock flows which belong to a similar geological event. Interestingly, a small percent of the assemblage have geochemical signatures suggesting they represent off-island imports. Two other published data sets on stone tool geochemistry for Moʻorea archaeology sites similarly suggest low levels of off-island imports from other locales within the Society archipelago (Raʻiatea and Tahiti; Kahn 2005) or from farther afield, such as Eiao in the Marquesas Islands (Weisler 1998).

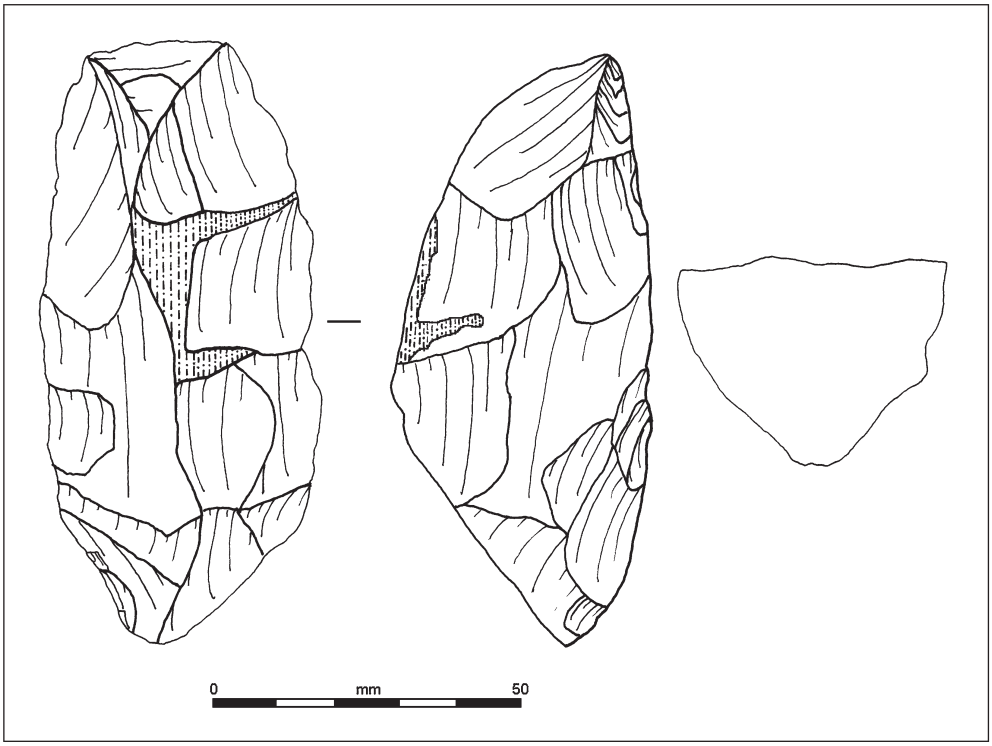


Figure 5. A Duff 3A adze recovered in the GS-1 excavations

In addition to the stone tool artifacts, fifty seven pieces of fire-cracked rock were recovered in the GS-1 excavations and the surface artifact collection. The majority of the fire-cracked rock derives from the Layer C deposits (Table 2).

Nineteen invertebrate taxa were identified to genus or species (Table 3). Overwhelmingly, the assemblage is dominated by marine species habituated to reef and sandy intertidal zones or shallow subtidal zones. This suggests that the paleo-shoreline at GS-1 was similar to that of today, namely a low energy, lagoon beach environment. *Drupa* is the only species represented that is typically found in a rocky shoreline environment, and it is represented in low frequency (n=2), albeit in Layer C, which based on other artifactual evidence appears to have some post-depositional disturbance. In addition, an apical fragment of the gastropod *Achatina fulica* (Bowdich 1822), as well as ten other fragments, were recovered in N100 E102 in the upper portion of Layer C. This species, known commonly as the Giant African Snail, is of terrestrial origin. It was recently introduced to Tahiti in 1967 and rapidly spread to nearby islands. Three other land snails from the upper Layer C deposit in N100 E102 were identified as *Bradybaena similaris* (Rang 1831). This Asian species has become widely distributed in the Pacific Islands, and was first reported from Hawai'i in 1893. These data confirm other artifactual evidence suggesting that Layer C is to some extent mixed with historic deposits.

Vertebrate faunal material was not recovered from the site. Layers A and B were highly acidic, and given previous archaeological work on Mo'orea (Green *et al.* 1967: 216; Kahn 2005: 216; Oakes 1994: 86), one would not expect bone recovery from these deposits. However, this does not explain the lack of bone recovery from Layers C and D

Table 2. *Lithic artefacts and fire-cracked rock recovered in the GS-1 excavations*

| Context | Debitage | Retouched Flake | Worked Basalt | Adze Blank | Adze/Reworked Adze | Adze Flake | Hammerstone | Waterworn Pebble | Fire-Cracked Rock |
|---|---|---|---|---|---|---|---|---|---|
| Surface | 5 | 3 | 3 | 4 | – | – | – | – | 2 |
| Layer A | 5 | – | – | – | – | – | – | – | 1 |
| Layer B | 2 | – | – | – | – | – | – | – | 1 |
| Layer C | 83 | – | – | 2 | 2 | 2 | 1 | 1 | 53 |
| Layer D | 2 | – | – | – | – | – | – | – | – |
| Total | 97 | 3 | 3 | 6 | 2 | 2 | 1 | 1 | 57 |

Table 3. *Summary of presence and absence of invertebrate taxa from GS-1*

| | Layer A | Layer B | Layer C | Layer D |
|---|---|---|---|---|
| *Achatina fulica* | | | × | |
| *Bradybaena similaris* | | | × | |
| *Barbatia* spp. | | | × | |
| *Cerithium echinatum* | × | | | |
| *Cypraea* spp. | | | × | × |
| *Cypraea caputserpensis* | | | × | |
| *Cypraea moneta* | | × | × | × |
| *Cypraea obvelata* | × | | × | |
| *Drupa* spp. | | | × | |
| *Gafrarium pectinatum* | | × | × | × |
| *Naticidae* spp. | | | × | × |
| *Quidnipagus palatam* | | × | × | |
| *Pectinidae* spp. | | × | | |
| *Pteriidae* spp. | | × | × | × |
| *Strombus* spp. | | | × | |
| *Strombus maculatus* | | × | | |
| *Tellina palatam* | | | × | |
| *Thaididae* cf. *Morula* spp. | | | × | |
| *Turbo* spp. | | × | × | |
| *Turbo argyrostomus* | | | × | |

which were calcareous deposits. In these lower deposits, the lack of vertebrate faunal recovery is likely related to the site's function, i.e. a focus on lithic activities.

## WOOD CHARCOAL ANALYSIS AND DATING RESULTS

Seventeen wood charcoal samples recovered from Layers C and D were submitted to Gail Murakami for wood charcoal identification (Table 4). The goal was to identify short lived species for radiocarbon dating and to identify indigenous versus introduced species in order to clarify the depositional events associated with the Layer C and D deposits. The sample is biased however to Layer C which had more abundant charcoal remains that were of a larger size and therefore easier to identify to species than samples from Layer D. The Layer D samples tended to be small in size and were generally under the size limit for species identification. Thus, the frequency of taxa must be used with caution, as the lower Layer D deposits are only represented in 2 of the 17 wood charcoal samples reported here, or 12% of the overall sample.

How can the represented wood charcoal taxa inform us about the potential depositional processes associated with Layers C and D? *Hibiscus tiliaceus*, an indigenous species is highest in frequency across the deposits. Second in ubiquity is *Pandanus* a contested species as to indigenous or exotic (i.e. Polynesian introduced) origin. Recent pollen research in other Eastern Polynesia archipelagoes (Prebble 2008; Prebble and Wilmshurst 2008) indicates that *Pan-*

Table 4. *Summary of the wood charcoal identifications for the GS-1 site*

| Layer | Unknown | cf. Palm | *Cocos nucifera* | cf. *Ficus* sp. | *Hibiscus tiliaceus* | cf. *Pandanus* sp. | cf. *Artocarpus atilis* |
|---|---|---|---|---|---|---|---|
| C1 (first 20 cm) | 7 | – | 19 | – | 9 | 10 | 3 |
| C2 | 2 | – | 4 | 4 | – | 3 | 7 |
| C3 | 3 | 1 | – | – | 1 | – | 2 |
| D1 (first 20 cm) | 1 | – | – | – | 14 | 4 | – |
| D2 | – | – | – | – | 4 | – | – |
| Total | 13 | 1 | 13 | 4 | 29 | 17 | 12 |

*danus* had a pre-Polynesian dispersal in at least some parts of Eastern Polynesia, while additional varieties could have been Polynesian introductions. Whether *Cocos nucifera* was naturally dispersed in Eastern Polynesia is unresolved. Pollen records are equivocal (Prebble 2008). As previously mentioned, Lepofsky recovered preserved coconuts interpreted as early cultivated forms from deposits in the ʻOpunohu Valley dated to between the 7th and 10th centuries (Lepofsky *et al.* 1992), but these were not associated with other evidence for human presence. *Ficus* is generally considered to be endemic to Remote Oceania. This leaves *Artocarpus altilis* as the only taxon identified in the GS-1 samples that has an accepted exotic origin. *Artocarpus* was recovered with low frequency from the Layer C deposits. Because of the biased nature of the identified samples, I cannot rule out that larger charcoal samples from Layer D would not have produced *Artocarpus* fragments as well. Overall, the wood charcoal data indicate that Layer C deposits were definitively related to human activities, as Polynesian introductions are present. The wood charcoal identification data unfortunately fail to clarify the anthropogenic nature of the Layer D deposits because of small sample sizes; however, charcoal flecking was found throughout the Layer D deposits, including depths of over 60 cm under the interface with Layer C. This strongly suggests that the deposit was the result of human activity and did not derive from purely natural processes.

Two wood charcoal samples were submitted for AMS radiocarbon dating (Table 5). Both samples derive from unit N109 E100 which had the most intact stratigraphic deposits. Beta-278687 dates a piece of *Hibiscus tiliaceus* recovered from 40 cm deep into Layer D. This sample is a relatively short lived species and has a potential inbuilt age of several decades. At two sigma the sample calibrates to between the early 11th to early 13th centuries. Beta-305697 dates a piece of *Artocarpus altilis* wood recovered from 60 cm deep within Layer C. This sample has a potential inbuilt age of many decades and most likely dates to the early 19th century.

## CONCLUSIONS

Preliminary investigations at the GS-1 site indicate the existence of stratigraphic deposits dating to as early as the 11th century AD The earliest deposits, Layer D, are associated with charcoal, lithic debitage, and fire-cracked rock, data which suggest the presence of a habitation in vicinity of the beach. Until a larger sample of radiocarbon dates and cultural materials can be excavated from the site, it would be premature to label this the earliest phase of settlement on Moʻorea, even though the results are in line with newly published settlement dates for other archipelagoes in Central Eastern Polynesian and in Hawaiʻi (Kirch 2011). Furthermore, the 2002 GS-1 excavations did not hit sterile deposits, nor were organic materials from sterile deposits dated, so the precise relationship of the Layer D deposits to the settlement of the island remain uncertain. Clearly though, GS-1 has coastal deposits pre-dating the inland expansion on Moʻorea (Kahn 2011; Lepofsky and Kahn 2011). Larger excavations at the GS-1 site would certainly be beneficial for documenting the period of pre-European contact coastal habitation on Moʻorea which remains poorly studied. Future investigations should also incorporate geoarchaeological analyses to better interpret the depositional histories of the stratigraphic deposits.

The recovery of charcoal, lithic artifacts, and fire-cracked rock in the lowest deposits at GS-1 indicates that this coastal area likely served as a residential area. The site also has some import as an apparent long-term lithic activity area. Tools and debitage were recovered in all stratigraphic deposits at the site. The geochemical analyses of the basalt artifacts indicate raw material provisioning from one geochemical flow, but there are several clusters within the data suggesting some variation within this flow. Overall, the data point to long-term basalt extraction from a source area. There are presently no other source areas documented on Moʻorea, which reflects the overall paucity of geochemical analyses carried out on Moʻorean artifacts. Future analyses are likely to discover more source areas.

Table 5. *Summary of the AMS radiocarbon dates for GS-1*

| Lab No. | Layer | Provenience | Material Dated | Conventional $^{14}$C Age Years BP | $\delta^{13}$C ‰ | Calibrated Age at 2σ |
|---|---|---|---|---|---|---|
| Beta-278687 | C5 | Isolated pieces of charcoal found 40 cm within the lower C deposit (40 cm below the interface with upper C). | *Hibiscus tiliaceus* wood charcoal | 910 ± 40 | –25.5 | AD 1031–1210 (95.4%) |
| Beta-244596 | C3 | Isolated pieces of charcoal found at the bottom of the upper C deposit, 60 cm below the interface with Layer B. | *Artocarpus altilis* wood charcoal | 310 ± 40 | –25.3 | AD 1680–1763 (29.9%) AD 1801–1938 (65.5%) |

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