Ceramic Deposit Below Fifth to Sixth Century AD Volcanic Ash Fall at Pava'ia'i, Tutuila Island, American Samoa: Preliminary Results from Site AS-31-171

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ABSTRACT

A Polynesian Plainware-bearing cultural deposit underlying a volcanic ash deposit is described for Pava'ia'i, Tutuila Island. The cultural deposit dates to *c.* cal AD 240–640. Volcanic activity on Tutuila is inferred to have continued until at least this period. Metric attributes and rim form of a 33-sherd assemblage from the site (Site AS-31-171) are summarised. The uniqueness in Samoa of the deposit as an undisturbed primary ceramic-bearing deposit with well defined chronology is proposed. Effects of the late Holocene volcanism on prehistoric human populations of Tutuila are suggested.

Key Words: LEONE VOLCANICS, TUTUILA ARCHAEOLOGY, POLYNESIAN PLAINWARE, CERAMICS, SETTLEMENT PATTERN, SAMOA.

INTRODUCTION

This paper reports cultural material found under a volcanic ash deposit on Tutuila Island, American Samoa. Three radiocarbon dates indicate that the cultural material is at least 1500 years old. This is the first absolute dating for post-erosional volcanics on Tutuila and provides an upper-limit date for the lavas and a lower-limit date for the ash deposits. These dates indicate that for at least the first millennium of human occupation, the island was a volcanically dynamic landscape. Volcanic activity may have increased the land area, with pyroclastic deposits potentially doubling the island's agricultural productivity, processes that probably had important demographic and socio-political effects.

TUTUILA GEOLOGY

Located in West Polynesia, the Samoan archipelago stretches over some 300 km from Savai'i Island in the west to Ta'u Island in the east (Fig. 1). All are volcanic islands ranging in age from 3.2 Ma for Savai'i (although more recent post-erosional volcanics have covered most of the island's surface) to 0.2 Ma for Ta'u (Duncan 1985; Natland and Turner 1985). Most of the subaerial parts of Tutuila were formed 1.0–1.5 Ma (McDougall 1985). Natland (1980, 2003) has suggested that there was no spatial progression along

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the axis of Tutuila, but that three shield volcanoes formed roughly simultaneously along a fracture lineament associated with deformation of the underlying Pacific Plate near the Tonga Trench. Following a long erosional interval, a 6 km rift zone perpendicular (north-south trending) to the axis of the older Tutuila volcanics (east-west trending) produced lava, tuff, and ash deposits forming a large bulge on the southern coast—the Tafuna Plain to the east of the vents and Leone, Taputimu, and Vailoa to the west (Fig. 1).

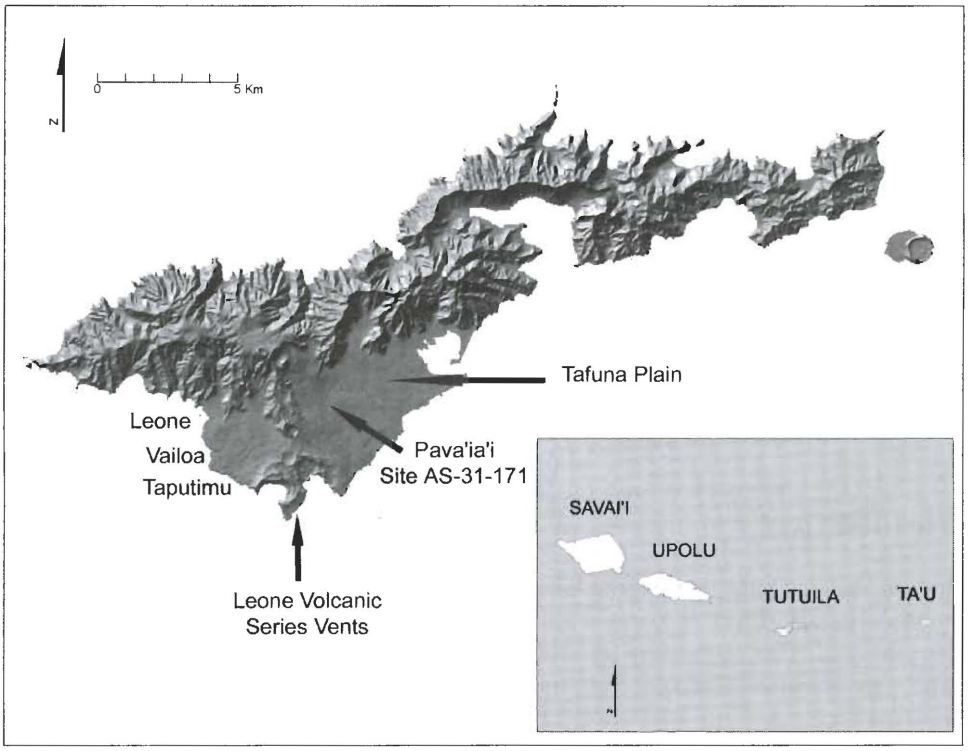

Figure 1: Tutuila and the Samoa island group showing places mentioned in the text. The Leone Volcanics largely coincide with the area of minimal topography bulging from Tutuila's southern coast.

Natland (1980, pers. comm.) places the Leone Volcanics "along the eastern extension of a bend in the [Pacific] plate trending at 285 degrees and paralleling the transform-fault portion of the Tonga Trench," and states that they are on "a direct linear extension of the major post-erosional volcanic rift system that spans the length of Savai'i and 'Upolu." These post-erosional lavas on Savai'i, 'Upolu and Tutuila are "essentially identical nephelinite-series lavas...derived from great depths in the upper mantle." Daly (1924) determined these volcanics to postdate the last Pleistocene glacial Maximum (>19,000 BP). Stearns termed the Tutuila post-erosional deposits the "Leone Volcanics" and estimated them as Holocene in age (Stearns 1944: 1313). No geological work has further refined this age estimate.

SAMOAN ARCHAEOLOGY

The work of Green, Davidson, and colleagues (Green and Davidson [eds] 1969, 1974) on Savai'i and 'Upolu proposed a 2700-year culture history sequence for Samoa that has formed the basis of subsequent archaeological research in the archipelago (Table 1). Green and Davidson proposed settlement by 800 BC, but "securely dated habitation layers" dated only to the first century AD (Green and Davidson 1974: 224). Some inland areas on 'Upolu had "occupation and/or use" at this time though it may have extended 300 years earlier (ibid.). Pottery — first Lapita and later Polynesian Plainware — was made locally until the third century AD (ibid.). By the third to sixth centuries AD, inland areas were occupied and remained so throughout the sequence (ibid.). After the tenth or eleventh centuries AD both low- and high-status habitation mounds were constructed both inland and at the coast. Both mounds and low-pavement house foundations continued to be used in all zones through the 1830s when, under missionary influence, "nearly all occupation returned to the coast" (ibid.). Kirch and Hunt (1993: 230–231) suggest from their excavations in Manu'a that initial settlement was several centuries earlier and that pottery may have been made for a few centuries later than posited by Green and Davidson (1974; Green 1974). Clark and Michlovic (1996) raise the possibility that localised ceramic production continued until *c.* AD 1600. Green (2002: 139–140) notes that 'Upolu sites dating from AD 400–500 to 1000–1100 remain to be documented and cautions that the current information is insufficient to "assess whether ceramics were abandoned uniformly throughout the archipelago over a matter of centuries, or whether it occurred far more differentially over space and time."

TABLE 1
CHRONOLOGY OF SAMOAN CERAMICS

	Initial settlement	**Plainware**	**Inland sites**	**Aceramic**
Green and Davidson	by 800 BC	to AD 300	by AD 300–600	after AD 300
Kirch and Hunt	by 1000 BC	to AD 400–500	—	after AD 400–500
Clark and Michlovic	*c.* 1000 BC	to AD 1600	—	after AD 1600

The earliest cultural deposits on Tutuila — dating to *c.* 1000 BC (Clark and Michlovich 1996: 163) — are contemporaneous with the earliest dates from 'Upolu and Manu'a and suggest relatively simultaneous pottery-using occupation of the whole Samoan archipelago. The next millennium of Tutuila prehistory is unknown. At *c.* 0 BC/AD there is a pottery-using occupation at two sites well inland at Pago Pago (Addison 2004). At *c.* AD 500–1000 there are occupations both inland and coastal around the island (Addison 2002; Cochrane *et al.* 2004; Walter and Addison n.d.). By AD 1000–1300 a large-scale basalt tool industry was widespread on Tutuila (Addison 2002; Addison and Radewagen n.d.; Best *et al.* 1989; Clark 1993; Leach and Witter 1987, 1990). Tutuila basalt tools have been found in many parts of the southwest Pacific (Best *et al.* 1992; Clark *et al.* 1997).

Ridgetop settlements may have been established *c.* AD 1300–1400 (Frost 1976, 1978; Pearl 2004). Pigeon-catching mounds appear to have been built in both upland and lowland contexts only towards the end of Tutuila prehistory (Herdrich 1991; Herdrich and Clark 1993). Clark (1996) and Green (2002) provide recent syntheses of Samoan prehistory (see also Burley and Clark [2003] for a regional perspective).

THE PAVA'IA'I ASH SITE (SITE AS-31-171)

The Archaeology Program of the American Samoa Power Authority (ASPA) is tasked with documenting archaeological sites in areas subject to damage from construction of utilities infrastructure. This often involves initial surface survey of project areas as well as subsequent monitoring of earth-moving construction activities. During monitoring of sewerline trench excavations, cultural material was found under a volcanic ash layer at three places in Pava'ia'i Village. All three are within 80 m of each other (Fig. 2). These three locations (and surface sherds at a fourth) comprise Site AS-31-171. Lithic material such as graters or scrapers, debitage, and adze fragments were found on the surface near and at Site AS-31-171. Their temporal relationship with the sherds is unknown and they are not further treated in this report. Stratigraphic excavation to sample the deposits at Site AS-31-171 will be started in the near future and should help clarify such relationships as well as resolve other issues raised in this paper.

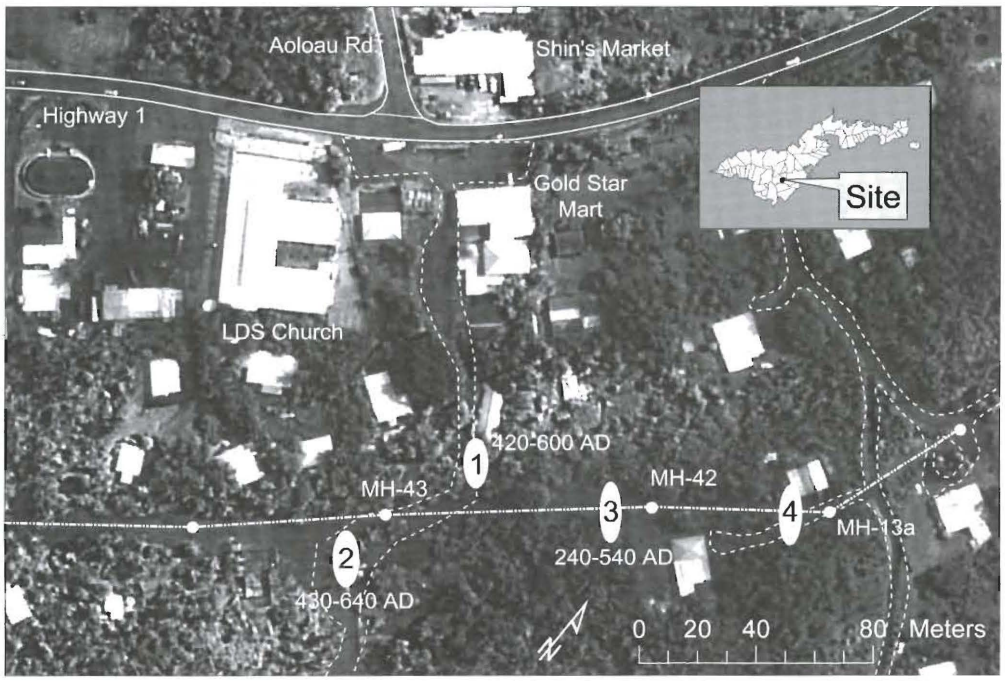

Figure 2: Pava'ia'i showing Locations 1, 2, 3, and 4 (white ellipses). Manholes (dots) are labelled MH-; the P6 sewerline runs between the manholes. The P7 sewerline (not shown) branches to the southeast from the P6 sewerline and passes through location 2. See Table 2 for details of dates.

Pava'ia'i Village is located on the Leone Volcanics at the eastern edge of the Tafuna Plain, 3 km from the sea and 1 km east of the chain of craters that formed those deposits. Analysis of the overall stratigraphy of the Pava'ia'i area, the order of eruptions, and their sources is underway. At this point it can be said that the volcanic ash layer that overlies the cultural material in the three locations reported here is found in many, but not all, parts of Pava'ia'i. In some places, the ash is directly on an underlying lava flow, in others there is one or more tuff deposits between the ash and lava, and in some there is a layer of sandy loam to silty loam between the ash and lava. (Although the deposits we term ash, tuff, and loam all have the same ultimate origin — aerially deposited fine volcanic material — we distinguish the three as follows: ash is an unconsolidated fine-grained granular volcanic material not weathered into soil and here encountered as an undisturbed reddish layer; tuff means consolidated and lithified fine-grained granular volcanic material; loam consists of fine-grained granular volcanic material mixed with smaller material [clay and silt] and organic material derived from decomposed vegetation.)

LOCATION 1

Location 1 is 17 m north of the ASPA P6 sewer mainline on a service lateral going to the Gold Star Mart (Fig. 2). The stratigraphy at Location 1 is underlain by a pahoehoe lava flow (Fig. 3). Layer III is a dark brown sandy to silty loam. Layer II is a brown sandy to silty loam mixed with pieces of semi-consolidated red/orange ash. Layer IIA is a *c.* 80 cm length of intact red/orange ash. A charcoal concentration was found below this ash at the top of Layer III. A sample of this charcoal taken from the cleaned trench wall dates to cal AD 420–600 (Table 2 and Fig. 4). No other cultural material was noted in Layer III and no sediments were screened. Layer I is a loamy garden soil with some charcoal flecking.

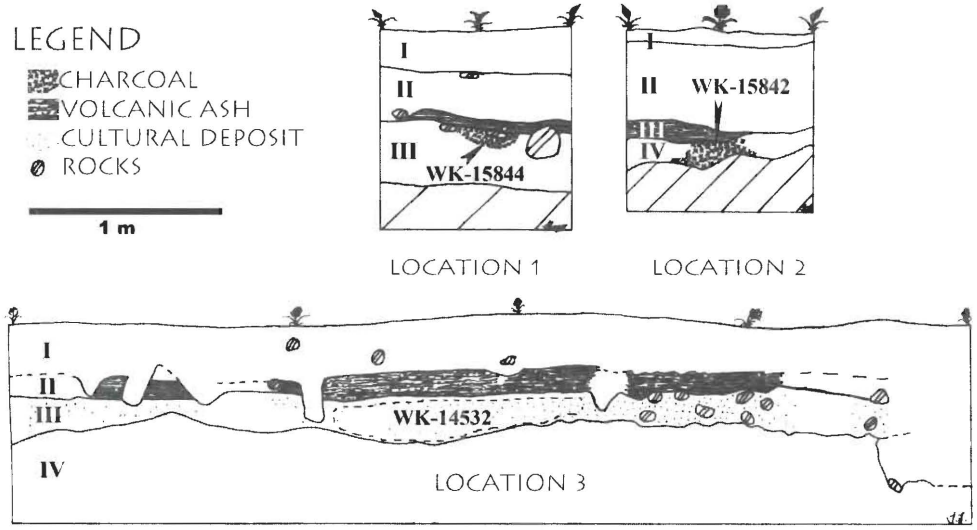

Figure 3: Trench profiles for Locations 1, 2, and 3. Positions of radiocarbon samples are marked with their Waikato laboratory numbers. The area from which Wk-14532 was taken is surrounded by a dashed line.

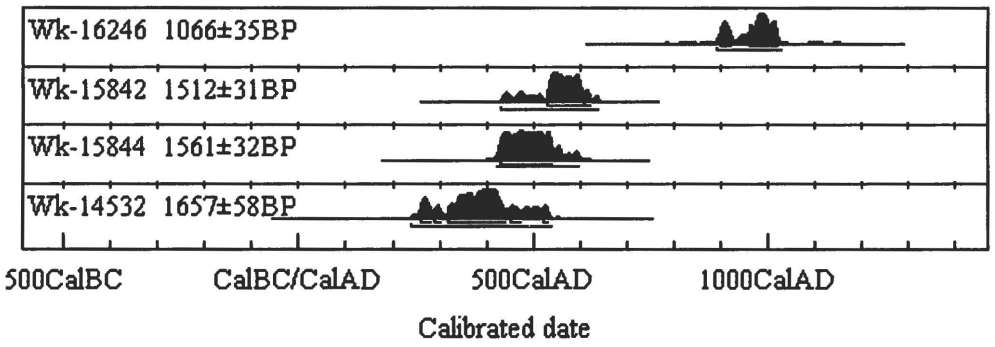

Figure 4: Graphical representation of calibrated Pava'ia'i dates. See Table 2 for details.

TABLE 2
PAVA'IA'I RADIOCARBON DATES

Radiocarbon age determinations were made by the University of Waikato Radiocarbon Dating Laboratory; calibrations were done using OxCal v3.9 (Bronk Ramsey 2003) using atmospheric data from Stuiver *et al.* (1998). Conventional age as per Stuiver and Polach (1977) based on the Libby half-life (5568 yr) with correction for isotopic fractionation applied. In the row labelled depth, cmbs refers to cm below modern ground surface.

	Wk-15844 (Location 1)	**Wk-15842 (Location 2)**	**Wk-16246 (Location 2)**	**Wk-14532 (Location 3)**
Conventional age	1561 ± 32 BP	1512 ± 31 BP	1066 ± 35 BP	1657 ± 58 BP
Cal. 68.2% probability	AD 430–540	AD 530–620	AD 900–1020	AD 260–530
Cal. 95.4% probability	AD 420–600	AD 430–640	AD 890–1030	AD 240–540
$\delta^{13}C$	-27.3 ± 0.2 ‰	-26.3 ± 0.2 ‰	-26.3 ± 0.2 ‰	-27.0 ± 0.2 ‰
Counting time	AMS	AMS	AMS	4116 minutes
Sample weight	0.28 g	0.30 g	1.2 g	7.24 g
Weight after pre-treatment	0.16 g	0.0069 g	0.23	1.50 g
Sample description	Single piece unidentified wood charcoal	Multiple small pieces unidentified charcoal	Unidentified charcoal	Multiple pieces unidentified charcoal
Depth	Layer III 50–60 cmbs	Layer IV 60–75 cmbs	Layer II 100–105 cmbs	Layer III 40–60 cmbs

LOCATION 2

Location 2 is 25 m south of manhole P-43 on P7 sewer mainline (Fig. 2). An undulating pahoehoe lava flow underlies the stratigraphy at Location 2 (Fig. 3). Layer IV is a dark brown sandy to silty loam. A charcoal concentration found in this layer dates to cal AD 430–640 (Table 2 and Fig. 4). No other cultural material was found in this layer, and no sediments were screened. Layer III is semi-consolidated reddish volcanic ash. Layer II is a brown sandy to silty loam. A large pit feature (*c.* 9.5 m south of the Layer IV charcoal concentration) is associated with Layer II and dates to cal AD 890–1030 (Table 2 and Fig. 4). Although the pit is filled with rocks and charcoal — suggestive of an earth oven (*umu*) — it lacks an oxidised soil layer at its lower edge, and the rocks do not appear heat-altered. Layer I is a dark brown loamy garden soil.

LOCATION 3

Location 3 is 15 m west of manhole P-42 on the P6 sewer mainline (Fig. 2, UTM Easting 527120, UTM Northing 8415240). At the bottom of the stratigraphy, Layer IV is an undulating pahoehoe lava flow (Fig. 3). Layer III is a dark, charcoal enriched, cultural deposit sitting directly on this lava. The deposit was apparent for *c.* 10 m in the trench wall and thinned to both the east and the west. Layer II is reddish volcanic ash. This layer is discontinuous and its upper boundary shows evidence of disturbance, probably from gardening activities (several possible digging-stick holes and possible taro [*Colocasia esculenta*] molds were noted as well as a pit — not shown on profile — similar to those used for planting *Dioscorea* spp.). Layer I is a brown silty loam garden soil 20–40 cm thick.

Individual charcoal pieces (dating to cal AD 240–540, Table 2 and Fig. 4) were picked from Layer III on the cleaned trench wall in an area where Layer II (volcanic ash) was intact (Fig. 3). Layer III was then scooped out (*c.* 20 cm horizontally into the trench wall) along its 10 m length. This material was passed through 6.35 mm (1/4 inch) wire mesh. Fifty-five Polynesian Plainware sherds were found; four of these were rim sherds (Fig. 5). No stone tools or debitage were found.

Before screening, both walls of the construction trench were closely examined for cultural material; ceramic sherds were only found in Layer III. Thus, while it may argued that we found sherds only in Layer III because we screened only Layer III, we think that our examination of the trench walls was sufficient to indicate that the main ceramic deposit is indeed in Layer III. This can be clarified by careful stratigraphic excavation at this location in the future.

EXCAVATED CERAMICS

In general, no attribute of the sherds is remarkable — their temper, form, and thickness fall well within the variability documented for late ceramics in Samoa (Clark and Michlovich 1996; Cochrane 2004; Green 1974; Hunt and Erkelens 1993). Each of the four rim sherds has distinct cross-section morphology (Fig. 5; #517, 522, 528, 529), indicating that at least four vessels are represented. The rims are direct or inverted and some are thickened, indicative of simple rims on open bowls. The four rim sherds are small for calculating vessel orifice diameter, but indicate diameters in perhaps the 30–50 cm range.

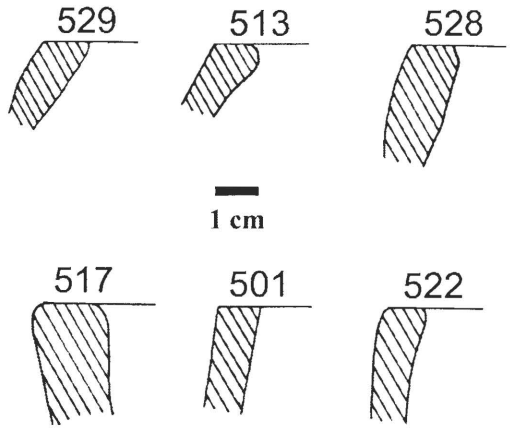

Figure 5: Rim forms of Polynesian Plainware ceramics from Pava'ia'i.

All sherds have terrigenous temper; one has fine temper (a rim sherd, Fig. 5 #522), and the rest have coarse. None of the sherds are decorated (to date, no decorated sherds have been reported from any site on Tutuila). Of the 55 sherds from Location 3, 22 measure <24 mm in any dimension, including diagonals, and their metric attributes were not recorded.[2] The remaining 33 were measured for thickness, surface area, and weight (Table 3).

TABLE 3
DIMENSIONS OF SURFACE AND EXCAVATED SHERDS
FROM LOCATION 3 (n=33)

	Mean	**Range**	**Std deviation**
Thickness (mm)*	9.5	6.2–13.6	1.8
Area (cm^2)	7.3	3–16	3.2
Weight (g)	10.8	1.9–39.7	7.9

*Mean of maximum and minimum thickness for each sherd.

SURFACE CERAMICS

Before the start of sewerline excavation 15 Polynesian Plainware sherds were found on the surface in the immediate area of the Location 3 cultural deposit. Sherd #501, a rim sherd, was among these (Fig. 5). Given the stratigraphy at Location 3 and the lack of

[2] There appears to be no established convention among Pacific archaeologists for identifying a minimum size for measurable sherds. We have adopted the simple and practical procedure of not measuring any sherds so small that they fit under and are completely obscured by an American quarter dollar coin (24 mm diameter).

portable artefacts in Layer I, it is likely these surface sherds were displaced from Layer III by gardening or other digging activities.

Sixty metres to the east, near manhole 13a (Fig. 2) 11 Polynesian Plainware sherds were found on the surface (Location 4). Although metric attributes of these sherds have not been recorded, they are generally similar to the Location 3 surface and excavated sherds. One of the Location 4 sherds is a rim fragment (Fig. 5 #513) and is from a vessel of similar shape and size as the Location 3 rim sherds. Sewerline trenching between manholes P-42 and 13a and service line trenches to nearby houses revealed no cultural deposit similar to that at Location 3. We assume that one exists somewhere near manhole 13a and that the surface sherds were displaced from it to the surface, in a manner similar to the situation at Location 3.

DISCUSSION

The surface and subsurface distribution of sherds suggests that in this area for the period cal AD 240–640, subsurface deposits with ceramics in primary context may be small and spatially discrete. The long sewerline trench revealed a subsurface ceramic-bearing deposit only at Location 3 and the deposit was only 10 m long. At Location 4, as at Location 3, sherds were found on the surface, but no subsurface ceramic-bearing deposit was encountered during sewerline trenching. This may suggest that a deposit similar to Location 3 Layer III exists in the vicinity of Location 4 but is so spatially confined that it was not found during sewerline trenching. Another possibility is that the surface sherds are in primary context.

Here, we are interpreting ceramics as indicating habitation sites. The small charcoal concentrations at Locations 1 and 2 may be the result of limited burning activities by the people living at Location 3, or may themselves be outliers of more concentrated (but spatially confined) cultural deposits similar to Location 3 and near Locations 1 and 2.

Extensive survey (>70 ha) on portions of the Tafuna Plain found Polynesian Plainware sherds on the surface at 19 locations (Cochrane *et al.* 2004; Taomia 2001a, 2001b, 2002). Subsurface testing by Cochrane and colleagues (Cochrane *et al.* 2004) at these and other sites on the Tafuna Plain consisted of 338 0.5 m x 0.75 m units. An explicit goal of this testing was to identify intact pottery-bearing deposits in primary context. The testing found no such deposits, further suggesting the tightly constrained spatial limits of intact primary-context subsurface pottery-bearing deposits on the Leone Volcanics and the difficulty of finding them. This may in part be due to the minimal post-eruptive deposition in many parts of the Tafuna Plain and a millennium or more of gardening on the relatively shallow sediments overlying the lava. At many sites, deposits relating to the whole period of human occupation of the area may be largely mixed because of these factors (as Cochrane *et al.* [2004] frequently found to be the case). Thus, because the Layer III deposit at Location 3 is bounded by bedrock below and capped with a layer of volcanic ash and is apparently not mixed with later deposits, it represents a rare situation on the Tafuna Plain. Stratigraphic excavation at Site AS-31-171 offers the possibility of a chronologically discrete ceramic sample from near the end of Polynesian Plainware use in Samoa (unless ceramic production continued for another millennium at 'Aoa as argued by Clark and Michlovic [1996] and Clark *et al.* [1997]).

The landscape before the ash fall that buried the deposits at Locations 1 to 3 appears to have been one with areas of exposed lava flow and areas (perhaps low spots) with some sediment over the lava. There were at least two habitations (Locations 3 and 4) and perhaps

more. It is currently not known how long an interval separated the deposition of the lava and the subsequent ash fall.

Extensive sewerline trenching within 1.5 km of the locations reported here — in places with a similar depositional history — has revealed no identifiable palaeosol between the lava and later tuff and ash deposits. This suggests that the interval separating the lava and the later deposits was less than the time required for soil formation. There may have been limited vegetation in this area at the time, but it may have been a largely barren and rocky landscape.

With the exception of Savai'i, the other islands of Samoa have been thought to have had roughly their current shape and landforms — excepting coastal geomorphological effects related to island emergence/submergence (e.g., Dickinson 1997; Dickinson and Green 1998; Nunn 1998) at the time of human settlement. However, it is possible that for the first 1000 to 1500 years of human occupation on Tutuila, large parts of the Leone Volcanics were not usable (and may not even have been there). This area may have been recent and continuing lava flows, fresh ash or tuff surfaces and largely devoid of soil or significant plant cover. The effects may have been more widespread than the bulge on the south side of Tutuila.

To the west of the chain of craters, the tuff packets are 1.0–2.5 m thick at Leone near the principal vents, but even 9 km to the northwest they are still 0.5–1.0 m thick (Stearns 1944: 1307). Depending on how thick each ash/tuff fall was and their periodicity, parts of western Tutuila may have been uninhabitable for extended periods. Green (n.d.), using historic census data and inferences based on agricultural potential, has argued for a proto-historic Tutuila population of 6,500. This figure is based, in part, on an estimated 10,000 acres (*c.* 4,045 ha) of cultivable land. The cultivable portion of the Leone Volcanics is roughly 2,000 ha—nearly half of the cultivable land on the island. Not only is it large, but it also has much gentler slopes than the rest of island and rich soils derived from late Holocene ash falls. The cessation of volcanic activity on Tutuila and the availability of the Leone Volcanics for habitation and gardens would have doubled the productive potential of the island. This may have had profound effects on the demographics and sociopolitical relationships on the island.

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