One Hundred New Dates from Tutuila and Manu'a: Additional Data Addressing Chronological Issues in Samoan Prehistory

David J. Addison[1] and Tautala S. Asaua[2]

[1] Samoan Studies Institute, American Samoa Community College [2] Centre for Samoan Studies, The National University of Samoa

Abstract

This paper presents more than 100 ^{14}C dating results for Tutuila and Manu'a. The results address a number of current topics in Samoan archaeology. Deposition of volcanic ash on the Holocene Leone Volcanics (Tafuna Plain) continued to at least 13 or 14 centuries BP; ceramics under these ash strata suggest occupation of a lava landscape for up to 700 years prior to the ash falls. Models of ceramic cessation in Samoa are discussed in light of new dating results. Coastal flats on Tutuila aggraded and/or prograded significantly in the post 1600 BP period, creating many newly habitable areas. Two securely dated lithic manufacture sites dating to 600-700 BP are discussed. Inland settlement on Tutuila is discussed and began by at least 2000 BP. Shell bracelets and decorated pottery are found in relatively late contexts (1300-1600 BP).

KEYWORDS: Samoa, Tutuila, Manu'a, archaeology, ceramics, coastal geomorphology, Ancestral Polynesian Society, Holocene volcanics

It was decided early on in Samoan archaeology to resist "the temptation to divide the sequence into culturally defined periods, aspects, phases or stages" (Green and Davidson 1974:212). This conscious eschewing of a cultural historical framework has shaped subsequent research in the archipelago. Green (2002) recently noted that most archaeological research in Samoa has continued to be done in a settlement pattern framework. As Green states, this narrative approach has "stressed continuity and change within Samoa" (2002:127). This explicit "landscape" approach has avoided a saltational view of Samoan prehistory where important change is seen as occurring at the boundaries of internally homogenous phases or stages. Rather, trends and processes have been emphasised. We feel this has been beneficial to the development of archaeology in Samoa, and it is not our goal here to periodise Samoan prehistory - a process that we think could be premature and probably unhelpful.

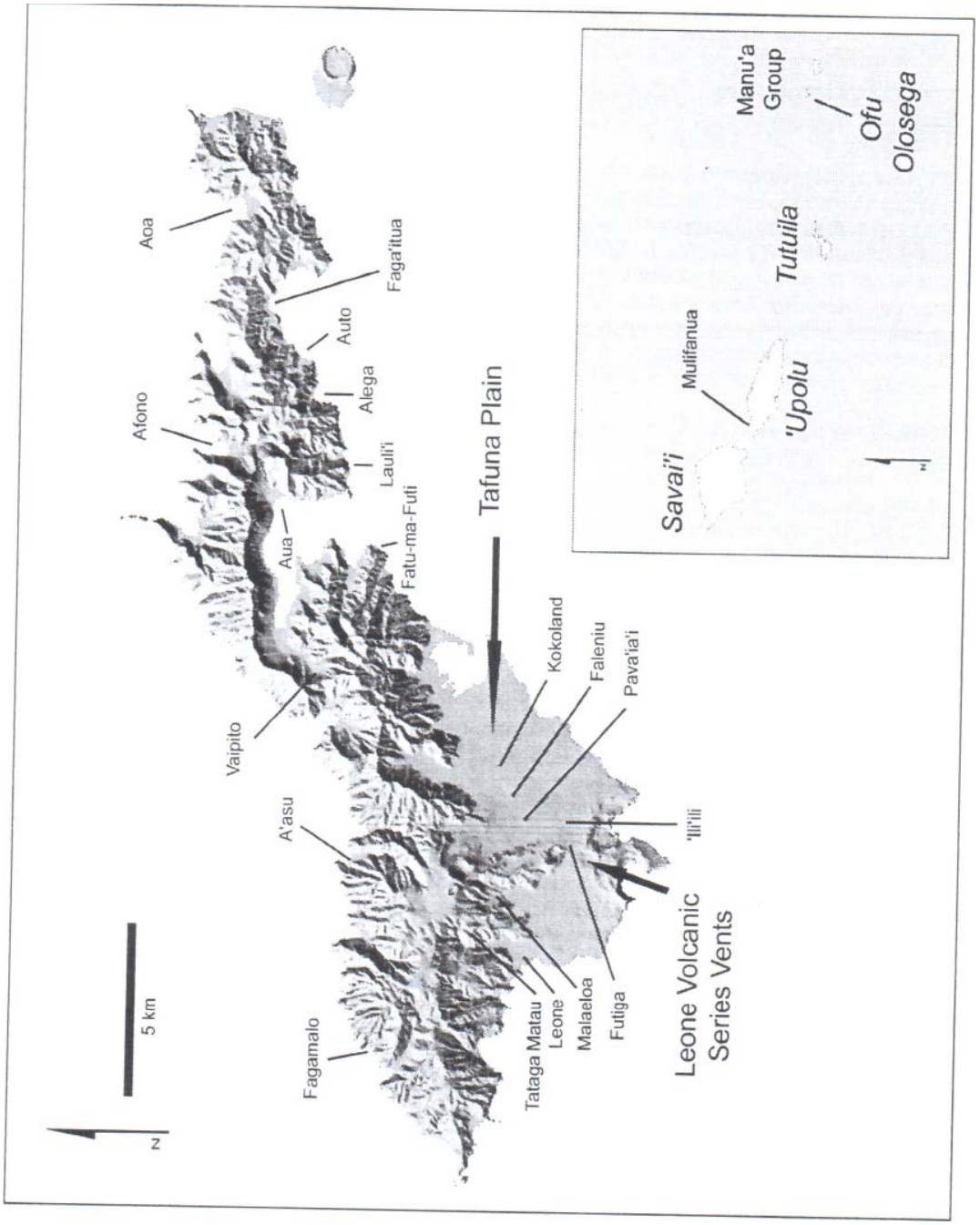
In this paper, we present a corpus of radiocarbon determinations generated over the past few years by the archaeology programme of the American Samoa Power Authority (ASPA). ' These dates are gleaned from projects around Tutuila and Manu'a (see Figure 1 and Appendix 1 and 2). Details of their context will appear in forthcoming reports. Our primary purpose here is to make these dating results available to other researchers. We also highlight several trends we see in the data. Readers interested in broader reviews of Samoan chronology may consult Green (2002) and Burley and Clark (2003).

Ceramic Bearing Sites Capped by Red Ash

The red-ash layer overlaying ceramic-bearing deposits first identified at Site AS-31-171 in Pava'ia'i (Addison et al. 2006) has now been found at other sites in the vicinity. WK18327 (1979±31 BP) [2] comes

[1] We acknowledge the foresight of former ASPA CEO Utu Abe Malae and former ASPA COO Fonoti P. Perelini in creating and fostering an in-house archaeology programme atASPA. We thank them and recognize that the results reported here would not have been possible without their continual support and encouragement. This paper is dedicated to these two fine leaders.

[2] All results reported here were processed by the University of Waikato Radiocarbon Laboratory. Dates in this paper are expressed as "conventional age" as per Stuiver and Polach (1977; that is, corrected for isotopic fractionation and expressed in years before AD 1950). Dates were calculated usint the Libby half life of 5568 years. Quoted standard errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier of 1. The isotopic fractionation (b"C) is expressed as‰wrt PDB. Graphs of dating results were prepared using OxCal v3.10 (Brook Ramsey 2005). Because Samoa lies under or near the South Pacific Convergence Zone (SPCZ) for much of each year (and past states of the SPCZ location are unknown) we follow McCormac et al. (2004:1088) and use the current Northern Hemisphere calibration curve (Reimer et al. 2004)


Aoa
Faga'itua
Auto
Alega
Afono
Lauli'i
Aua
Fatu-ma-Fuli
Tafuna Plain
Kokoland
Faleniu
Pava'ia'i
Vaipito
A'asu
'Ili'ili
Fagamalo
Tataga Matau
Leone
Malaeloa
Futiga
Leone Volcanic Series Vents
5 km
N
Savai'i
Mulifanua
'Upolu
Tutuila
Manu'a Group
Ofu
Olosega

f
rom a ceramic-bearing cultural deposit (including decorated pieces) capped by red ash and found -2 m under the *malae* of Pava'ia'i Village. WK18320 (1871±31 BP) from AS-31-131 in Faleniu is from a red-ash capped ceramic-bearing cultural deposit -60 cm below the surface. From a different part of Faleniu, WK18314 (1416±31 BP) and WK18315 (1482±31 BP) are from fire features associated with a ceramic-bearing deposit all capped by red ash. WK18321 (1639±31 BP) is from a ceramic-bearing deposit (with decorated pieces) capped by red ash near the border of Faleniu and Pava'ia'i. [3]

The latter three dates accord well with the initial dates for the red ash from Site AS-31-171. The other two extend the period of the pre-ash occupation in this area by up to 200 years, and pushes it back as early as any archaeological dates on the Holocene volcanic deposits of the Leone Volcanic Series. ° So far, no pre-2000 BP dates have been found on the area of the Leone Volcanics (including the Tafuna Plain). We wonder if this area was uninhabitable before -2000 BP due to continuing lava flow activity.

An upper date on the red ash is suggested by WK16986 (1304±34 BP) from a small charcoal concentration at the interface of the red ash layer in Faleniu, and WK16987 (1179±32 BP) from a charcoal concentration -10 cm above a red ash layer in Faleniu. WK15849 (1125±31 BP) and WK15843 (1005±33 BP) are from fire features at two locations in Pava'ia'i that were dug through the red ash from higher strata. Two dates (WK18316, 827±31 BP; and WK18317, 896±34 BP) from the bottom of fire features in two different Faleniu locations from -5-10 cm above the red ash layer (but probably dug from higher up the stratigraphy) postdate the red ash deposition. WK16984 (847±34 BP) is from dispersed charcoal in a stratum above the red ash in Faleniu.

Based on the limited dates available at the time, Addison et al. (2006) could suggest only that the red ash depositional event happened sometime after the period AD 240-640. Now, with 17 dates from both below and above the red ash, and from a -1 km diameter area, we are comfortable being more specific. The current evidence suggests that the red-ash depositional event(s) occurred roughly 13 or 14 centuries ago. It should be noted that the red ash is covered by up to 60 cm of ash-derived soils (mainly Pava'ia'i Series) and that deposition of fine pyroclastic material through volcanic eruptions may have continued for some considerable period after the red ash deposition. Also noteworthy is the indication of up to -700 years of use of what must have been a rugged lava landscape prior to the red ash (and subsequent ash) deposition.

Tutuila Coastal Geomorphology: Post-1600 BP Coastal Flats

Archaeologists in Samoa have long recognized the importance of understanding geomorphological (including human-induced) changes in reconstructing prehistoric landscapes and interpreting the spatial patterning of archaeological remains (eg, Green and Davidson 1974; Kirch and Hunt 1993; Clark 1996; Clark and Michlovic 1996; Hunt and Kirch 1997; Dickinson and Green 1998).[5] The accidental discovery of the submerged Lapita site at Mulifanua, Upolu was the first evidence in Samoa of the implications of changes in relative sea level for archaeological sites in Samoa.

At 'Aoa on Tutuila, Clark and Michlovic (1996) documented a 3,000 year sequence of changes in coastal geomorphology resulting in an open embayment being converted to a back-beach swamp/marsh that later filled with terrigenous sediments. Ceramic-bearing deposits were found at what would have been the edges of the palaeo-embayment.

Kirch and Hunt (1993) found profound changes in coastal geomorphology in their reconstruction of the historical ecology over the past 3,000 years at To'aga, 'Ofu. These changes included evidence supporting a higher relative sea level that stabilized to the modern position "some time between 1000 and 2000 BP" (Hunt and Kirch 1997:114) with subsequent coastal progradation. Archaeological deposits containing pottery were restricted to a zone along the interior of the coastal terrace with later non-ceramic deposits farther seaward (Hunt and Kirch 1997:112).

[3] Decoration at these two sites consists of minor and crude incising and impressing on or near rims.

° An additional date, WK16985 (1821±32 BP) from dispersed charcoal in a dark layer below the red ash was not associated with portable artefacts, however, we think the dispersed charcoal suggests human activity in the immediate area and offer it in support for the idea that there was an extended period of human use in Faleniu/Pava'ia'i prior to the red ash depositional events. Although not associated with red ash, WK15324 (1907+38 BP) from a feature interpreted as an earth over in Faleniu reinforces the idea of a long period of pre-ash use in this area.

[5] Pearl's recent paper (Pearl 2006) on geomorphological change at A'asu, Tutuila deals with the last -700 years and is temporally unrelated to the phenomena we discuss in this section.

Table 1: Dates below and above red ash in Pava'ia'i and Faleniu

Below red ash	
WK18327	1979±31 BP
WK18320	1871±31 BP
WK16985	1821±32 BP
WK14532	1657±58 BP
WK18321	1639±31 BP
WK15844	1561±32 BP
WK15842	1512±31 BP
WK18315	1482±31 BP
WK18314	1416±31 BP
Above red ash	
WK16986	1304±34 BP
WK16987	1179±32 BP
WK15849	1125±31 BP
WK16246	1066±35 BP
WK15843	1005±33 BP
WK18317	896±34 BP
WK16984	847±34 BP
WK18316	827±31 BP

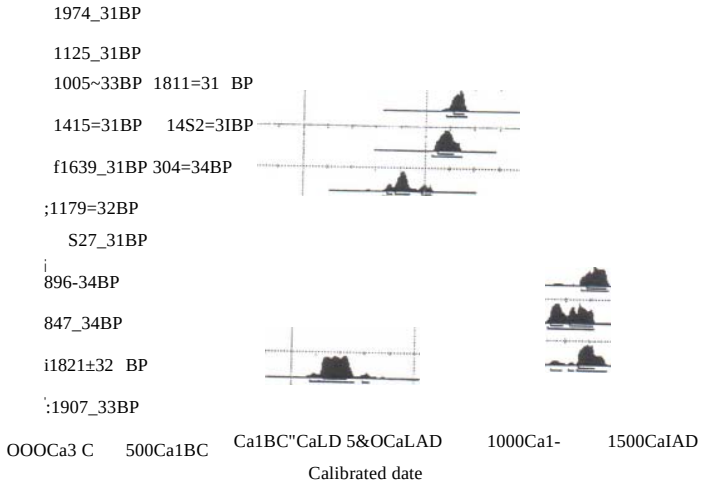


Figure 1: OxCal graph of dates below and above red ash in Pava'ia'i and Faleniu

New evidence from Tutuila suggests that coastal flats, in at least some parts of the island, may be only 12-14 centuries old. This suggests that stabilization of relative sea level happened on Tutuila toward the middle or end of the period proposed by Hunt and Kirch (1000-2000 BP). Our dates come from the lowest cultural deposits at near-beach sites at five villages widely distributed on the island.

The dates largely fall within the period 1200-1400 BP. At Fatu-ma-Futi, two dates are from the preceding two centuries (Table 2). This may be due to the "old wood" phenomenon (taxa of samples were not identified) or it may that these dates accurately reflect the first human use of a newly formed coastal flat. In this second scenario, increasing use in the following centuries would have left relatively more charcoal (hence the bulk of the dates being slightly later). If true, this would mean that smaller sample size at the other villages has missed the earlier (and rarer) charcoal.

Regardless of which scenario is accurate, we suggest that there are indications of significant changes in coastal geomorphology over much of Tutuila in the post-1600 BP period. For Fatu-ma-Futi, with 75 m2 of stratigraphic excavation, we are confident that the earliest cultural deposits related to the current beach ridge have been found. Currently this is the only coastal site on Tutuila with substantial excavation and a robust set of dates. Although the possibility exists for deeply buried sites at the back of Fatu-ma-Futi (similar to To'aga), we think that the very limited size of the Fatu-ma-Futi coastal terrace argues against this.

Four dates for 'Auto, Lauli'i, and Fagamalo also come from basal cultural deposits on or near the modern beach ridge. We find it intriguing that the dates for these deposits so closely match the basal deposits at Fatu-ma-Futi. Further dating of deposits at these villages can clarify whether this is a coincidence based on small sample size, or whether the Fatu-ma-Futi pattern is more generally applicable across Tutuila.

The 'Afono dates come from the interface of a deep colluvial deposit and a former marsh/ swamp. We interpret them as predating the infilling of a former back-beach marsh/swamp in a scenario similar to that proposed for 'Aoa (Clark and Michlovic 1996).

The appearance of cultural deposits on what appear to have been newly formed beach ridges at around 1200-1400 BP at four widely dispersed locations on Tutuila suggests a change in relative sea level. Goodwin and Grossman (2003) found evidence for significant progradation and aggradation on the south coast of Upolu beginning at -1000 BP and suggest a possible lowering in relative sea level in this period. [6] Their dating results had higher standard errors than ours and used older calibration methods. Recalibration of their dates and interpretation at two standard deviations suggests a similar period for our Tutuila evidence and together could be the signature of a regional pattern.

Alternatively, that the timing coincides with the red ash depositional event in Pava'ia'i and Faleniu leads us to wonder whether there was some localized uplift associated with the volcanic activity that produced the red ash. Such geologic disturbances could also have been responsible for destabilizing the slopes at 'Afono resulting in the colluvial deposition that filled its former marsh/ swamp.

[6] Also note that the geologists Kear and Wood obtained a date of 1180±55 (before 1950 uncorrected) in a similar context (published in Grant-Taylor and Rafter 1963).

Table 2: Basal dates from coastal sites on Tutuila

Fatu-ma-Futi	
WK18525	(1229±30 BP)
WK18529	(1279±28 BP)
WK18528	(1303±29 BP)
WK18526	(1339±28 BP)
WK18522	(1341±28 BP)
WK13002	(1397±50 BP)
WK16932	(1524±31 BP)
WK13001	(1630+42 RP)
Auto	
WK18325	(1329±30 BP)
Lauli'i	
WK18323	(1280±37 BP)
Fagamalo	
WK11507	(1218±40 BP)
Afono	
WK11506	(1396±44 BP)
WK11501	(1195±41 BP)
WK11500	(1289±39 BP)

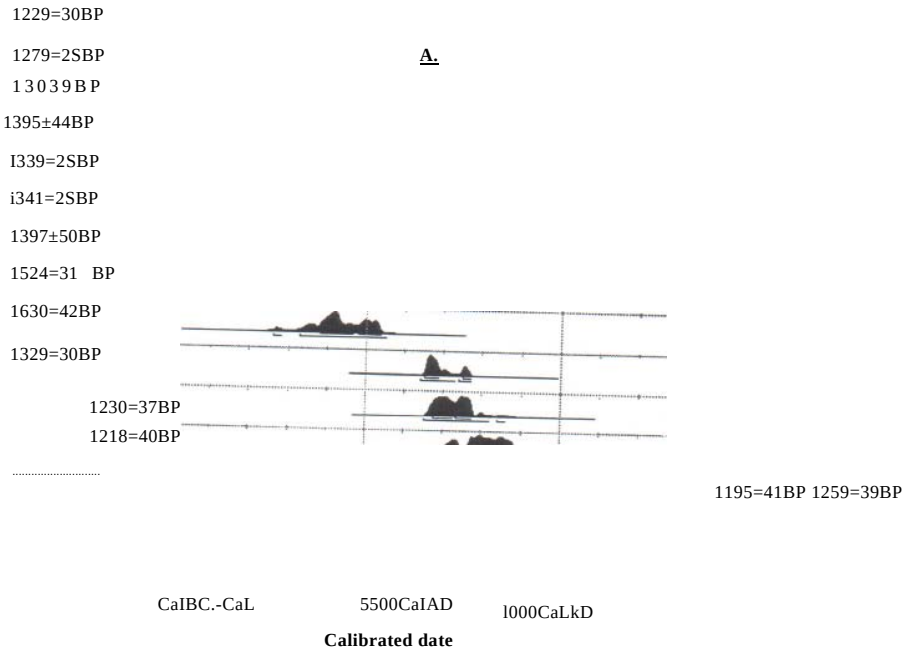


Figure 2: OxCal graph of basal dates from coastal sites on Tutuila

Lithics

Tutuila has been recognized as an important lithic manufacture location in the region, and numerous quarries and lithic manufacture areas are scattered around the island (Clark 1996). Securely dated lithic manufacture sites on the island are few (see Clark (1993) for Alega, Leach et al. (1998) for Tataga Matau, and Winterhoff et al. (2006) for Malaeloa). Here we report dates from two more sites with lithic manufacture debris in clear stratigraphic context and securely dated.

Fatu-ma-Futi and Vaipito, have stratigraphically discrete lithic manufacture areas that date to the period 600-700 BP. Lithics at both locations are the fine-grained high-quality basalt for which Tutuila is known. These two lithic manufacture areas may well relate to the Tutuila basalt export industry and thus date a period of wide-ranging Samoan interaction in the region (for example, see Sand this volume, Best et al. 1992; Clark et al. 1997; Weisler 1993).

Table 3: Dates from lithic manufacture strata on Tutuila

Vaipito	
WK12992	(680±35 BP)
WK12994	(697±53 BP)
WK12995	(630±45 BP)
WK12997	(647±36 BP)
Fatu-ma-Futi	
WK18523	(615±31 BP)
WK18524	(591±28 BP)
WK18527	(601±28 BP)
WK18530	(613±33 BP)

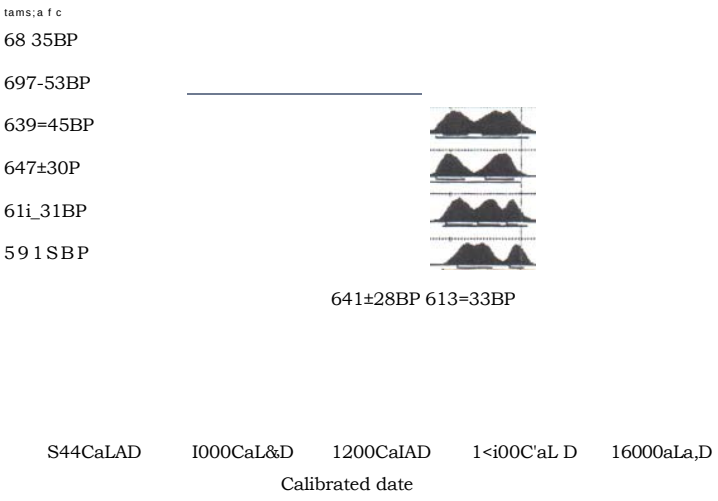


Figure 3: OxCal graph of dates from lithic manufacture strata on Tutuila

Strata with abundant lithic-manufacture debris occur at Fagamalo. These strata were not directly dated, but are stratigraphically above dates of 1218±40 BP (WK11507) and 1396±44 BP (WK11506).

Inland Settlement

Limited excavation at three ridge-top sites has produced dates ranging from 310±28 BP (Beta 194323) to 720±40 BP (Beta 193195). Pearl argues that stone foundations were first built on these ridgetops in the period AD 1270-1310 (Pearl 2004:339).

We note that inland (although not ridgetop) occupation occurs beginning -2000 BP at Vaipito and the Pava'ia'i-Faleniu area. These dates are roughly 1,000 years after the initial settlement of Tutuila, and it is not inconceivable that populations would have grown to a size requiring utilization of inland areas during this 1,000 year period. That the Pava'ia'i-Faleniu area was probably a relatively fresh and inhospitable lava landscape suggests that there was some pressure by -2000 BP to inhabit less-than-optimal parts of the island.

From our body of dates, if we consider only those with conventional ages of 600-699 BP, we see evidence of use of both inland and coastal areas in the period that Pearl suggests saw the initial construction of stone foundations on ridgetops. We interpret our corpus of dates as indicating more-or-less continual use of much of the island. More chronological data are needed from ridgetop sites to clarify whether ridgetop settlements were initially "contagiously established" (Pearl 2004:343) during this period, or whether the features sampled by Pearl were the later manifestations of a long-term process of ridgetop use that began much earlier.

We note that at Vaipito (inland) and Fatu-ma-Futi (coastal) the same kind of activity was happening (lithic manufacture) at this period. The argument that the Tongans had driven the Samoan population into refuge in the mountains seems stretched. Or perhaps Tongans were producing adzes at both places. We question whether appropriation of the Tutuila basalt export industry was not the impetus for the Tongan invasion. Could it have been Tongans and not Samoans that were responsible for the wide distribution of Tutuila basalt in the post-600 BP period? Much work remains to be done on this important period in Tutuila prehistory.

Table 4: Dates from inland and coastal sites on Tutuila 600-699 BP.

WK 18313	601±31 BP	Faleniu	Inland
WK 16244	690±36 BP	Faleniu	Inland
WK 12998	604±36 BP	Kok	
WK 15034	629±36 BP	Kokoland	Inland
WK 15321	638±45 BP	Futiga	Inland
WK 12995	630±45 BP	Vaipito	Inland
WK 12997	647±36 BP	Vaipito	Inland
WK 12992	680±35 BP	Vaipito	Inland
WK 12994	697±53 BP	Vaipito	Inland
WK 18527	601±28 BP	Fatu-ma-Futi	Coastal
WK 18530	613±33 BP	Fatu-ma-Futi	Coastal
WK 18523	615±31 BP	Fatu-ma-Futi	Coastal
WK 16936	619±31 BP	Fatu-ma-Futi	Coastal
WK 16933	619±33 BP	Fatu-ma-Futi	Coastal
WK 16929	637+35 BP	Aua Potholing	Coastal
WK 15683	680±34 BP	Afono	Coastal

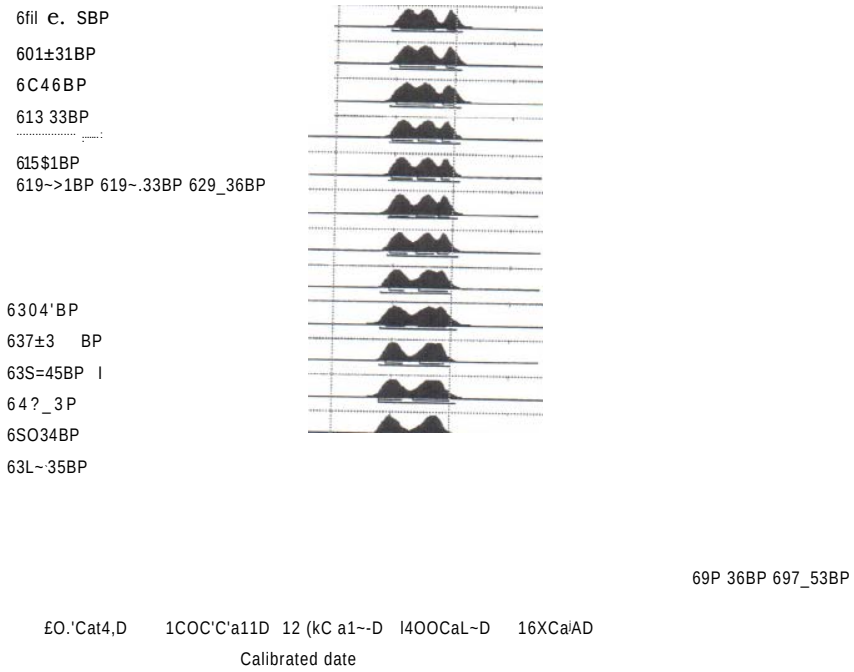


Figure 4: OxCal graph of dates from inland and coastal sites on Tutuila 600-699 BP.

Shell Bracelets and Decorated Pottery

Shell bracelets and decorated pottery have been used as typical markers of early deposits in Samoa (that is, before -2000 BP) or as indicative of sites dating to the period of Ancestral Polynesian Society (APS). We report here that both kinds of artefacts have been found on Tutuila in relatively late contexts.

Incised pottery at the Faleniu/Pava'ia'i border dates to 1639±31 BP (WK18321). Shell bracelet fragments have been found at Auto in a stratum dating to 1329±30 BP (WK18325), as well as at Fatu-ma-Futi. Although the ones from Fatu-ma-Futi are from undated contexts, they are from contexts above strata dated to -1300-1400 BP (as noted earlier, the oldest basal dates at Fatu-ma-Futi are only a couple of centuries earlier, and hence provide a maximum possible age for the bracelet fragments).

Kirch and Green (2001) used the triangulation method to characterize Ancestral Polynesian Society (APS). Clearly defined archaeological correlates remain elusive (Smith 2002), but APS remains an interesting heuristic tool for thinking about West Polynesian prehistory. A full treatment of APS is beyond the scope of this paper, but we suggest that, although decorated pottery and shell bracelets may be associated with APS, they continued in use on Tutuila for several centuries (and perhaps a millennium for the bracelets) and may not be good markers of APS sites on Tutuila. [8]

Late Ceramics

Using evidence from Upolu, Green and Davidson (1974:224) originally suggested that pottery stopped being used in Samoa AD -300. Kirch and Hunt (1993:230-213) found evidence from To'aga on 'Ofu to extend pottery use to AD 400-500 (these two we refer to as the "traditional model"). Clark and Michlovic (1996) have argued that at 'Aoa (Tutuila) pottery use continued to AD 1600 (we refer to this as the "late model"). Clark (1996:451) suggests the following possibility for Samoa:

8 Eckert and Pearl's current project at Aganoa, Tutuila, was explicitly designed to excavate an APS village and may help clarify the issues we raise in this section.

1. Pottery was widely used in Samoa through the first half of the first millennium AD;
2. Pottery use declined over the next few centuries, disappearing in some locations;
3. After AD 1000 pottery was uncommon in Samoa and absent from many areas;
4. Between AD 1300 and 1600, pottery became rare and was retained in very small amounts in very few locations;
5. By about AD 1600, pottery had been abandoned throughout the islands.

Work over the last seven years at ASPA has found many new ceramic sites that may address the conflicting ideas about cessation of ceramic use in Samoa. Our evidence of pottery in well-dated, undisputedly primary, contexts at Pava'ia'i and Faleniu (as well as Vaipito) on Tutuila supports points 1 through 3 above. Pottery in questionable stratigraphic and chronological context continues to be found on Tutuila and may, or may not, pertain to points 4 and 5.

Several ceramic sites have been found on the Tafuna Plain where, as noted earlier, sediments are generally shallow and disturbed through perhaps two millennia of gardening and domestic activities. Here, the only unequivocally undisturbed ceramic deposits occur under the red ash layer and date to the early first millennium AD. Other ceramic sites are either obviously disturbed or undated (Cochrane et at. 2004; see also Ishimura and Inoue (this volume) for a Savai'i Island site). We recognize that there is circularity in arguing that only deposits below an obviously undisturbed chronological marker (the red ash) can be considered as in primary context and used to date ceramic use, which is then in turn argued as dating the end of ceramic use on the island. Given the shallow deposits and long use-history of the area of the Leone Volcanics, we suggest that this area may not be helpful in addressing the cessation of ceramic use on Tutuila; late ceramics in this area can always be plausibly argued to be in secondary context.

We suggest that two other stratified and well dated sites support the traditional model of ceramic cessation in Samoa (that is, as argued by Green and Davidson 1974, and Kirch and Hunt 1993). The Vaipito site (AS-25-065) has two millennia of successive terrace building phases superimposed on each other. There are abundant ceramics in clear primary depositional context at the bottom of this sequence (dated to -2000 BP), and none in subsequent strata. This supports Clark's points 1, 2, and 3 and is not inconsistent with the traditional model.

The Fatu-ma-Futi site (AS-25-062) has a 1,300 year (or perhaps a couple of centuries earlier) sequence of superimposed strata. In some 75 m2 of excavation much evidence of domestic use was documented (e.g., pavements, postholes, midden, burials) yet no ceramics were found. We infer this to mean that ceramics were no longer in common use (or were absent) on Tutuila at the time of the earliest cultural deposits at Fatu-ma-Futi. Again, this is consistent with Clark's points 1, 2, and 3, but not inconsistent with the traditional model. We suggest that falsifying points 3 and 4 will be difficult.

As little as four years ago, Green noted a "mid-sequence gap in the archaeological record" for Samoa and bemoaned "just how poor our evidence is for the time between circa AD 400-500 and AD 1000-1100" (Green 2002:140). These Samoan "Dark Ages" have been noted by others as well (e.g., Davidson 1979; Kirch 2000:222; Burley and Clark 2003:240). We hope that the results reported here provide at least a glimmer of light on this period; although this paper has raised far more questions than it has answered. Again, our main aim in this paper was to make dating results available to others and to only briefly comment on some of the trends. Reports in preparation at ASPA will add details of context and interpretation. It is indeed an exciting time to be involved in archaeological research in Samoa. Many basic questions of chronology, material culture, and distribution of sites both spatially and temporally remain to be addressed in the archipelago. However, we see a bright future and feel confident that in the next decades of research by the emerging generation of workers (as well as those already established) many of the outstanding questions will begin to be answered.

Acknowledgements

We here acknowledge our debt to the pioneering archaeological work in Samoa of Janet Davidson and Roger Green. We thank them for their years of support and encouragement. Both of them have shown both of us, from our earliest days as goofy graduate students, the utmost respect and

ccollegiality; we have received more kindness from them than is our due.

Fiona Petchy of the University of Waikato Radiocarbon Dating Laboratory has been a
constant source of information on radiocarbon-dating-related matters. We thank her for her help and her collegial attitude.

We also thank ASPA Archaeology crew members Siaki Vaueli, Tuipuavai Tago, Jeffery Toloa, and Sonny Taomia for their keen interest, diligence, thoroughness, and dedication.

The results reported here would not have been possible without them. To the landowners
and occupants in the areas where we have worked, we extend our gratitude for their patience and kindness.

Janet Davidson, Roger Green, Jeffery Clark, Christophe Sand, Fiona Petchy, and Ethan
Cochrane read earlier drafts of this paper. We appreciate their comments and suggestions; errors remain our own.

References

Addison, D.J., T. Tago, J. Toloa and E. Pearthree, 2006. Ceramic deposit below 5th-6th Century

AD volcanic ash fall at Pava'ia'i, Tutuila Island, American Samoa: Preliminary results. New *Zealand Journal of Archaeology,* 27:5-18.

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.

Burley, D.V. and J.T. Clark, 2003. The archaeology of Fiji/West Polynesia in the post-Lapita era. In C. Sand (ed.) *Pacific Archaeology: Assessments and Prospects. Proceedings of the International Conference for the 50th anniversary of the first Lapita excavation. Kone-Noumea 2002.* Noumea: Departement Archeologie, Service des Musees et du Patrimoine, pp. 255-63.

Clark, G., 2002. Adzes of Interaction: Samoan Basalt Artefacts in Fiji. In S. Bedford, C. Sand, and D.V. Burley (eds), *Fifty* Years *in the Field.* Essays *in Honour and Celebration of Richard Shutter Jr's Archaeological* Career. Auckland: New Zealand Archaeological Association Monograph 25, pp. 227-38.

Clark, J.T., 1993. Prehistory of Alega, Tutuila Island, American Samoa, a small residential and basalt-industrial valley. *New Zealand Journal of Archaeology.* 15:67-86.

Clark, J.T., 1996. Samoan Prehistory in Review. In J.M. Davidson, G. Irwin, F. Leach, A. Pawley, and D. Brown (eds), *Oceanic Culture History: Essays in Honour of Roger* Green: New Zealand Journal of Archaeology Special Publication, pp. 445-60.

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 Interdisciplinary Approach.* Auckland: New Zealand

Archaeological Association Monograph, pp. 68-84.

Cochrane, E.E., M.T. Carson and J.S. Athens (eds), 2004. *Archaeological Inventory Survey for the Tualauta County Phase IIb Sewerline Project, Tutuila, American* Samoa. Honolulu: International Archaeological Research Institute, Inc.

Davidson, J.M., 1979. Samoan and Tonga. In J.D. Jennings (ed.) *The Prehistory of Polynesia.* Cambridge: Harvard University Press, pp. 82-109.

Dickenson, W.R. and R.C. Green, 1998. Geoarchaeological context of Holocene subsidence at the Ferry Berth Lapita site, Mulifanua, Upolu, Samoa. *Geoarchaeology,* 13:239-63.

Goodwin, I.D. and E.E. Grossman, 2003. Middle to late Holocene coastal evolution along the south coast of Upolu Island, Samoa. *Marine* Geology, 202:1-16.

Grant-Taylor, T.L. and T.A. Rafter, 1962. New Zealand radiocarbon age measurement 5. *New Zealand Journal of Geology and Geophysics* 5:331-59.

Green, R.C., 2002. A Retrospective view of Settlement Pattern Studies in Samoa. In T.N. Ladefoged and M.W. Graves (eds), *Pacific Landscapes Archaeological Approaches.* Los Osos: Bearsville Press, pp. 125-52.

Green, R.C. and J.M. Davidson, 1974. *Archaeology in Western Samoa, Volume II.* Auckland: Auckland Institute and Museum, Bulletin 7.

Hunt, T.L. and P.V. Kirch, 1997. The Historical Ecology of Ofu Island, American Samoa: 3000 BP to the Present. In P.V. Kirch and T.L. Hunt (eds), *Historical Ecology of the Pacific Islands: Prehistoric, Environmental and Landscape Change.* New Haven: Yale University Press, pp. 105-23.

Kirch, P.V., 2000. *On the Road of the Winds: An Archaeological History of the Pacific Islands before European* Contact Berkeley: University of California Press.

Kirch, P.V. and R.C. Green, 2001. *Hawaiki.: Ancestral Polynesia.* Cambridge: Cambridge University Press.

Kirch, P.V. and T.L. Hunt (eds), 1993. *The To'aga Site: Three Millennia of Polynesian Occupation in the Manu'a Islands, American* Samoa. Berkeley CA: University of California Archaeological Research Facility No. 51.

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

McCormac, F.G., A.G. Hogg, P.G. Blackwell, C.E. Buck, T.F.G. Higham and P.J. Reimer, 2004. SHCAL04 Southern Hemisphere calibration, 0-11.0 cal kyr BP. *Radiocarbon,* 46(3):1087-92.

Pearl, F.B., 2004. The chronology of mountain settlements on Tutuila, American Samoa. *Journal of the Polynesian Society,* 113(4):331-48.

Pearl, F.B., 2006. Late Holocene landscape evolution and land-use expansion in Tutuila, American Samoa. *Asian Perspectives,* 45(1):48-68.

Reimer, P.J., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, C.J.H. Bertrand, P.G. Blackwell, C.E. Buck, G.S. Burr, K.B. Cutler, P.E. Damon, R.L. Edwards, R.G. Fairbanks, M. Friedrich, T.P. Guilderson, A.G. Hogg, K.A. Hughen, B. Kromer, F.G. McCormac, S.W. Manning, C.B. Ramsey, R.W. Reimer, S. Remmele, J.R. Southon, M. Stuiver, S. Talamo, F.W. Taylor, J. van der Plicht and C.E. Weyhenmeyer, 2004. IntCaIO4 terrestrial radiocarbon age calibration, 26-0 cal kyr BP.

Radiocarbon, 46(3):1087-92.

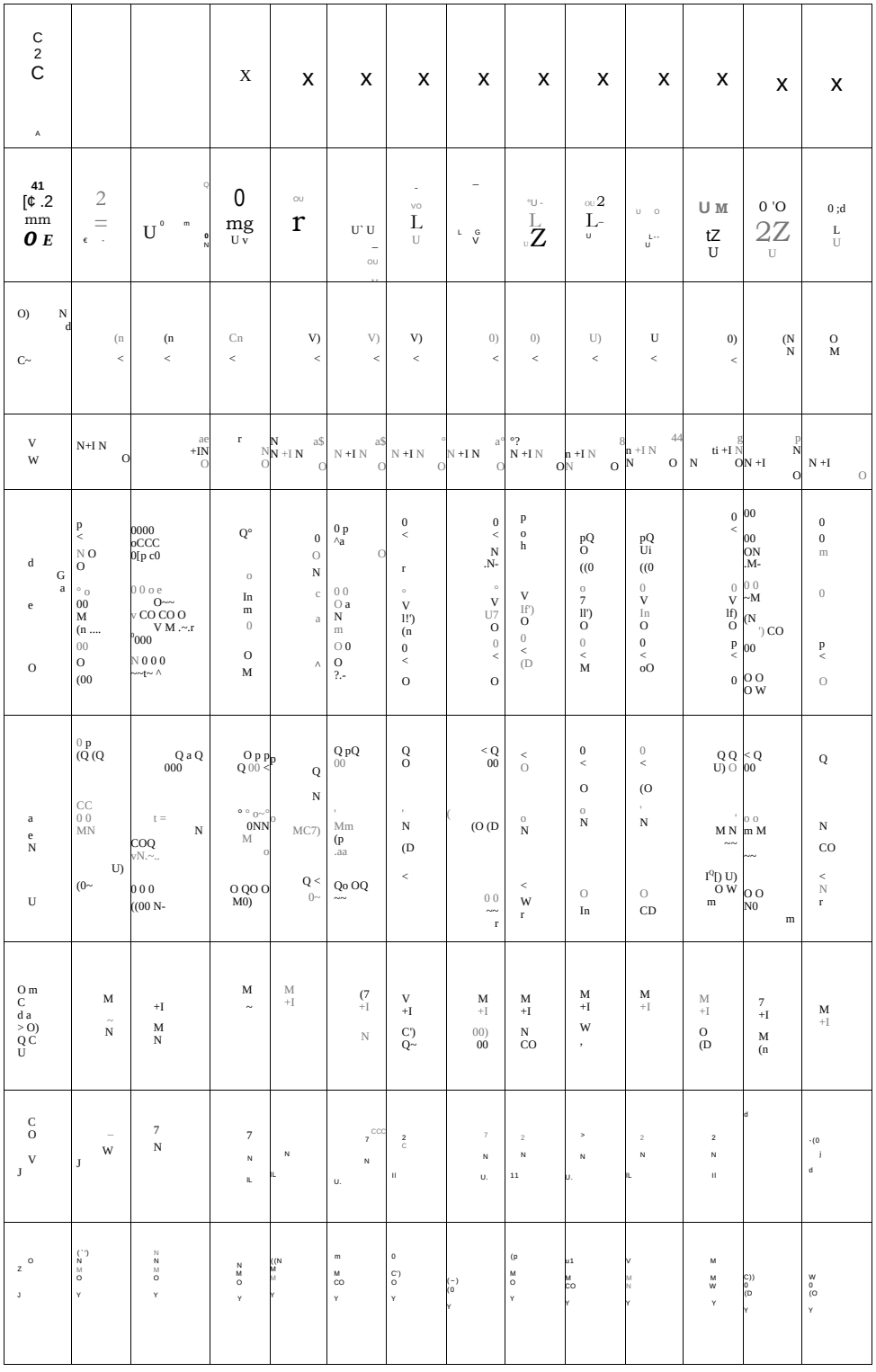
Smith, A., 2002. *An Archaeology of West Polynesian Prehistory.* Terra Australis 18. Canberra: Pandanus Press ANU.

Stuiver, M. and H.A. Polach, 1977. Discussion: Reporting of 14C data. *Radiocarbon,* 19:355-63.

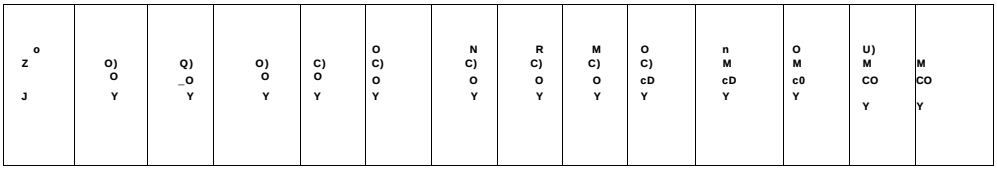
Weisler, M., 1993. Chemical characterization and provenance of Manu'a adze material using non-destructive X-ray fluorescence. In P.V. Kirch and T.L. Hunt (eds), *The To'aga Site: Three Millennia of Polynesian Occupation in the Manu'a Islands, American* Samoa. Berkeley CA: University of California Archaeological Research Facility No. 51, pp. 167-87.

δ 13C	Counting Time (minutes)	Sample Material	>1 km Inland
-24.1 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-25.8 ± 0.2‰	AMS	charcoal (unid.)	
-25.6 ± 0.2‰	AMS	charcoal (unid.)	
-23.2 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-24.0 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-25.2 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-27.2 ± 0.2‰	AMS	charcoal (unid.)	
-24.4 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-28.5 ± 0.2‰	AMS	charcoal (unid.)	
-24.1 ± 0.2‰	AMS	*Cocos nucifera* endocarp	X
-25.1 ± 0.2‰	AMS	charcoal (unid.)	
-25.5 ± 0.2‰	AMS	charcoal (unid.)	
-27.4 ± 0.2‰	AMS	charcoal (unid.)	

J	Y	Y	Y	Y	Y	_ O Y	_O Y	O Y	O Y	O Y	O Y	O y	C C O y



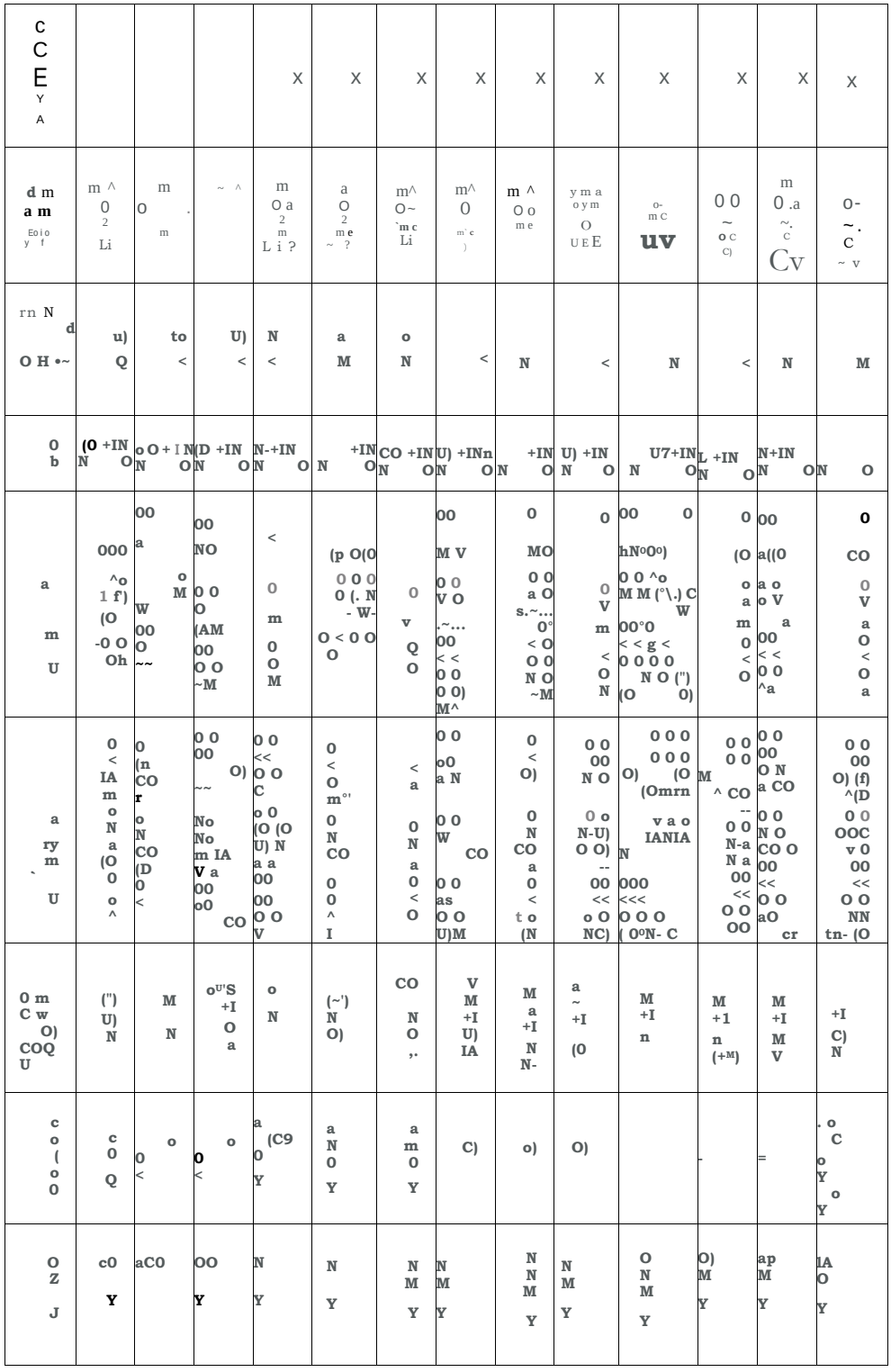
δ ^{13}C	Counting Time (minutes)	Sample Material	>1 km Inland
-28.4 ± 0.2‰	AMS	charcoal (unid.)	X
-27.3 ± 0.2‰	AMS	charcoal (unid.)	X
-24.6 ± 0.2‰	AMS	charcoal (unid.)	X
-27.5 ± 0.2‰	AMS	charcoal (unid.)	X
-27.1 ± 0.2‰	AMS	charcoal (unid.)	X
-29.2 ± 0.2‰	AMS	charcoal (unid.)	X
-25.9 ± 0.2‰	AMS	charcoal (unid.)	X
-25.4 ± 0.2‰	AMS	charcoal (unid.)	X
-24.2 ± 0.2‰	AMS	charcoal (unid.)	
-24.4 ± 0.2‰	AMS	*Cocos nucifera* endocarp	
-26.8 ± 0.2‰	AMS	charcoal (unid.)	
-27.3 ± 0.2‰	AMS	charcoal (unid.)	
-26.4 ± 0.2‰	AMS	charcoal (unid.)	

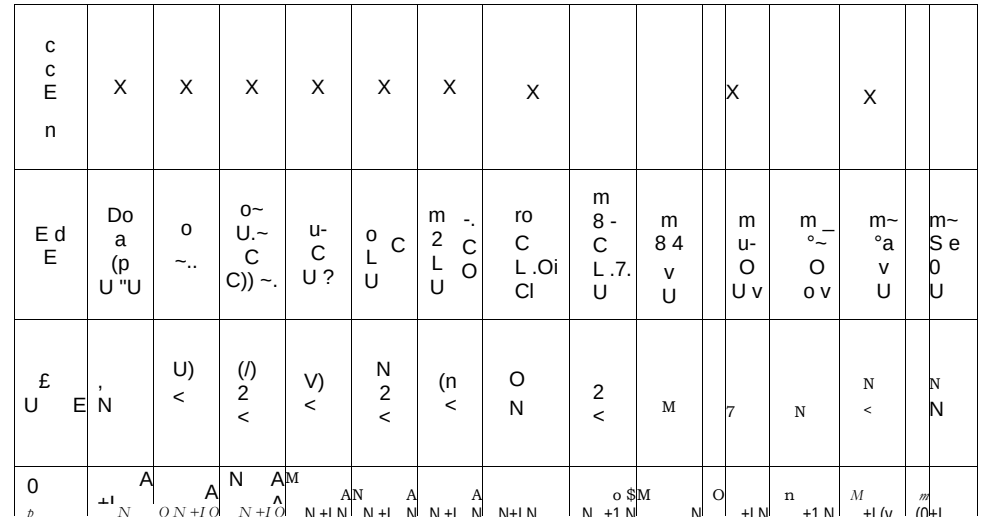


U) m E A						x	x	x	X	x	x	x	x	x
d Ʊ) p,'~ (0 (6 ℕ~	N .-. O C ʟ m 5 …,. U	U) .-. O C 7 L v U	f0 .-. O 2 C ʟ m 7 .... U	f4 .. O V C ʟ m 7 - U	f- 2 C ʟ m 5 ,,. U	c N V C ʟ m O ~… U	,·. O V C ʟ m O …. U	I0 O V C ʟ m O …. U	O v c ʟ m] .... U	O v c ʟ f6] .. U	O c ʟ m 5 v U	O c ʟ ID 7 ~. U	O c m 7 L - U	O c m 7 .C U
0 « •E U	U) a	U) <	U) <	U) a	(V N	U) Q	O N	O N	V) <	N N	(n <	(n <	U) <	f/) a
U O	ti ap M (0 11N N O	a@ U) a +IN N O	8Q O U)+IN M+IN N ON O	a4 O +IN N O	a8 O+IN N O	O +IN N O	a I- +IN N O	6 I-+IN N O	O I-+IN N O	O U O +IN N O	O) N +IN N O	M Q)+IN N O	N U)+IN N O
T 2 (0 G 6 m U	0 o a 0 a U) O 0 < O N	< O 0 a U) a 0 < M a	0 0 0 oCo O N (0 (ENO) 0 0 o o NN M M O N U) r 000 0 0 o aNN Or O	V O c O 0 a 0	0 o O a o a (f) 0 0 o 07 N	0 a 0 c 6 O) 0 a O	0 < O) N a (n 0 o U)	00 00 N O M a 0 Oa a O M 0 0 0 0 (Oa N M	0 < O N 0 a u) a 0 0 0	0 0 N a 0 a U) 0 0 0 O) N	00 00 M a U) (D 0 0 'M O) O U) m 00 0 00 a (C) a6	00 00 M M U) (O 0 0 Oa a h N 00 0 0 MU) a6	0 0 0 O) (o) 0 o e o U) N U) v 0 0 0 0 0 0 aNN 6h	0 0 0 O) M N Q) 0 0 0 Q) N M M a 0 0 0 0 0 0 MMN 6r6
A G (0 U	U6)00 N (~O) MMM o h W M v(OM l°f) 0 0 0) a I- NMM	< OO 0)0 a0 e ~~ 00 0 0 (OM a6	0) oCo (0 (0)0(1 ^ o MGM (f')MM 0 0 0 (O M M O -o	Qo pN N O m~ o c OO -a a 00 O)~	00 NO M M ~~ e o ma ~~ 0 0 0)(A NM	< Op NN 00 -~ Nc. MN 0 0 00 O)O)	< ply N N c 6 O) ~(a,0 0)l°f) ~O ~N	o0 Q) M o 6 (O (D aao 0 0 h6 NM	0 I~ N (D O N N	oQ UJO M~) 0 O)M v6 N 6 000 MM	o0 NN 6O 0 0 N'4' O 0 0 0)0) a6	00 ON 6… 0 0 NO ~O 0 0 a0 a6	0) O D N00 0 0 0 O V 0(00 O) 6m 0 0 0 (f) (O Man. 0h	000000 070 6 0 0 N Nm O O 6
C a^ O m C d d >• C) O Q U	M M +1 Q) (0	+ a N	O M +I (") O)	M +1 6 O	U) M +I M (0	O M +I 6 O	N a +I O W	(D M +1 O O (D	n M +I O O) N-	U) M +I a O) 6	N M +I W N- M	a M +I M O a	M +I O O N	N M +I U) N N
	LL o E m w	LL 0 E m LL	l o E io LL	w m E LL L	m Q	-°	7 E a U	7 'C a (m	.2 C a w	m >	m > a	u > a	m > a	m > a
Z a	M M O Y	N M O) 6 Y	M O) 6 Y	O M O) 6 Y	O) N O) 6 Y	(O a N (o Y	u) a N 6 Y	a a N Y	M a N 0 Y	a U) 00 6 Y	M U) 07 6 Y	N U) W 6 Y	(C) 0) 6 Y	O u) a6 0) Y

	X	X	X	X	X	X	X	X	X					
					M	<	<	<	<	<	N	<	<	¢

0 Z J	0 Y	a t[) Y	N m II) Y	a w (!) Y	N am (n Y	a ma 0 Y	M aw u) Y	N N Y	a Y	O (U, Y	O (0 Y	N 6 Y	m 0) U07 Y	(0 Y

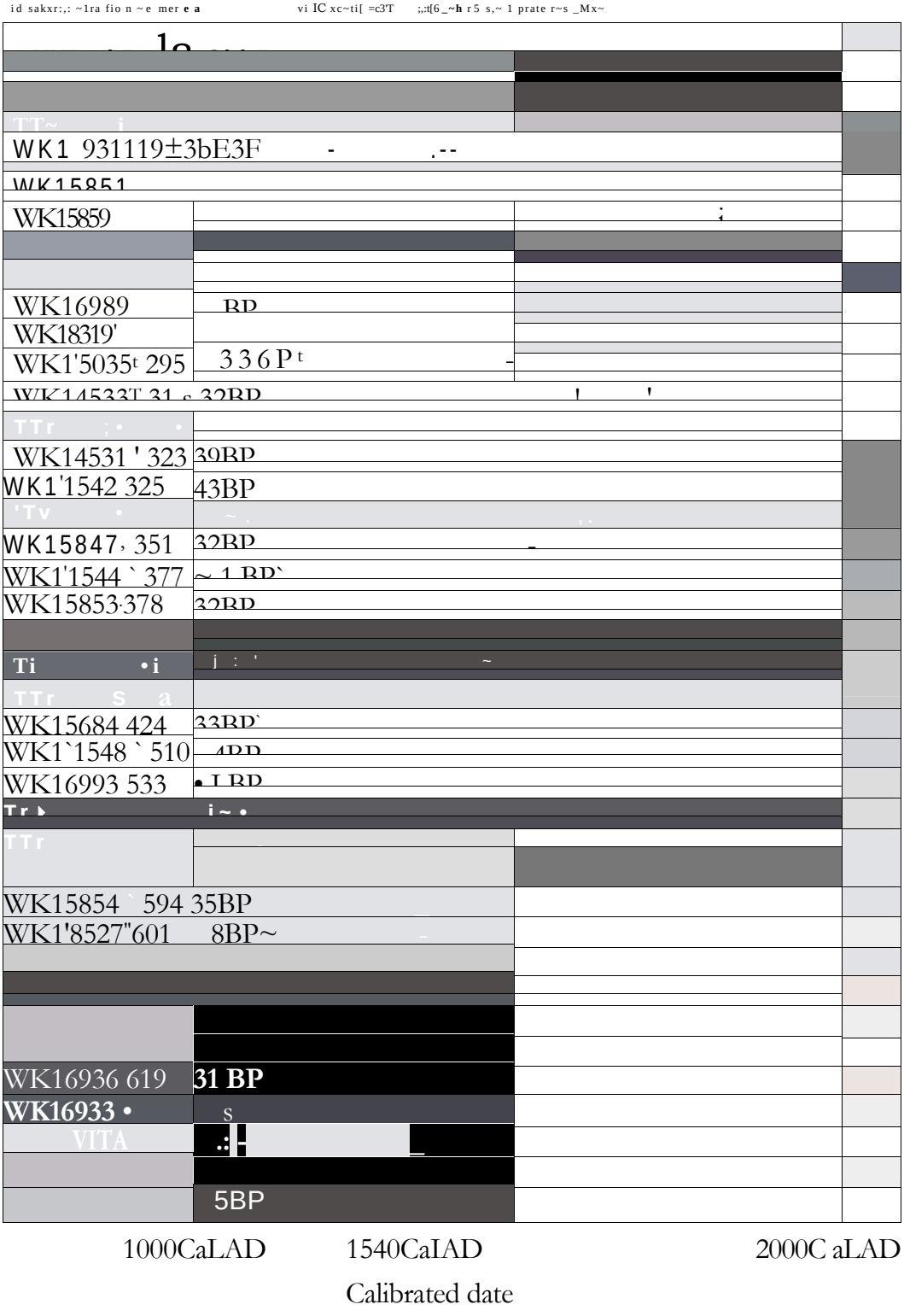


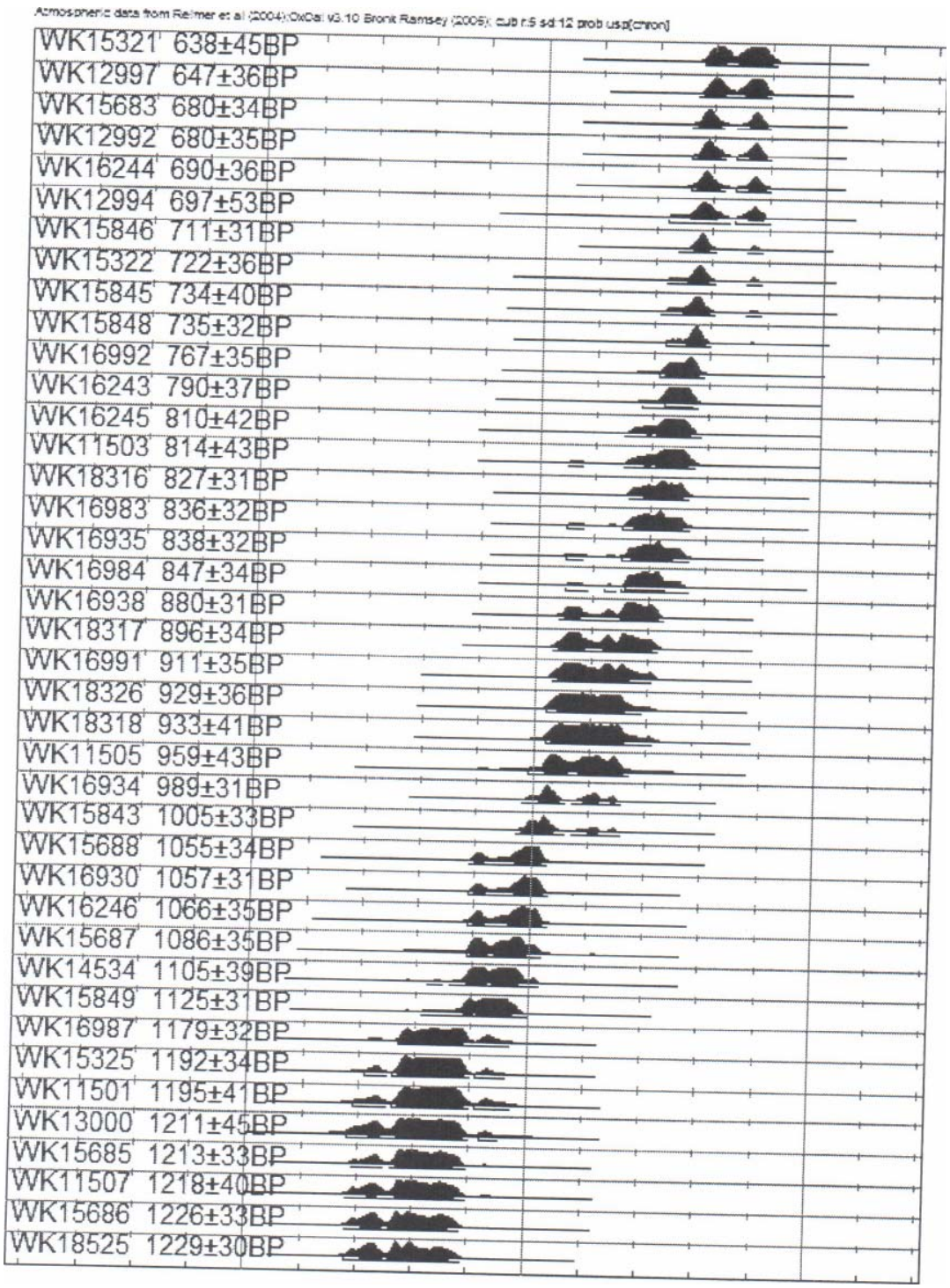


Conventional Age (BP)	Cal. 68.2% probability	C
	1295AD (26.1%) 1320AD 1345AD (42.1%) 21395AD	[illegible]
	200BC (65.1%) 90BC 70BC (3.1%) 60BC	350BC (9.3%) 290BC 210BC (86.1%) 40BC
	[illegible]	60BC (92.8%) 90AD 100AD (2.6%) 130AD
	[illegible]	160BC (2.1%) 130BC 120BC (93.3%) 90AD
	[illegible]	1
	360BC (37.4%) 280BC 240BC (30.8%) 170BC	
	1680AD (27.3%) 1770 AD 1800AD (7.8%) 1820AD 1830AD (22.2%) 1890AD 1910AD (10.9%) 1940AD	[illegible]
	890AD (27.3%) 930AD 935AD (40.9%) 985AD	[illegible]
	1520AD (52.1%) 1600AD 1610AD (16.1%) 1650AD	1
	260AD (6.5%) 290AD 320AD (52.8%) 440AD 490AD (8.9%) 530AD	250A
	[illegible]	D
	170BC (68.2%) 50BC	2
	1680 AD (20.0%) 1740 AD 1800 AD (37.1%) 1890 AD 1910 AD (11.1%) 1940 AD	1670 AD (38.2%) 1780 AD 1790 AD (57.2%) 1950 AD

A			x	x	x	x	x	x	x	x	x			
E 0 U	U p m	u C mV U	U-p t = 0 v	g L= 0 v	L7 0	(0 u m C L 7 0 v	O_O = L 0 v	8m L C ,i 0	8m O L 0 v	m L 0 v	8m O t U v	(p0 .-(0 `a = U	-. ov (- 7 U	V m 7 0
C E 0 E 3	Q	<	V	O N	O N	c°O N	Q	C V	M V'	Q	N	<	<	(n <
	N+IO	N+IO	N+IO	\ N+I	A U' A N O N+I N O N+I O	°	O	N+INN +INN+ IN	A O O	N+I N O	O	O	N+I N N+ ıN	O
. ~ ". U	o O n (V N .0 ... < < 0	O° N O _· OQD N M	0o ° O rn 'A ~' (V N O) - < < 0 0)	0 ° w Q~ Q N.	00 O a 7 v Q N	0 O 7 v < N	m° Q M e e_ U O Um O O	0 ° _ C C J) 0 N	co M O ee M (0 M O0 NM N	< < °1 ^ V (O e ° M O) QD C)	00 N O ^ ee N h v o DO NM	00 (p llO ee '7 O 00 M M	O O O) v C) O (0	O O (D _ V C)j 0 (n
n e N O	o e ON, c0 0 < O	00 (R ee ~ (N V N 00 00 N W	0 4e w. (O DO °o ^ I~	0 N eo N° (O O0 o° O	00 Ma ee O N 00 00 O O	00 M M ee N MOW M co 00 O ti 1	ON. U °	00 MN ee O O N 0 000 C) V	co MM ee N V - N 00 00 (C (D	(~ N (p O <	00 (~)N -- ee (O (O s N 00 00 (O N	0 V O 0 0 O	°. (N -s 00 00 N h ^n	(Np N (p 0 < p O
d p m d > O1 U	(A O	V O M cD	Q +I	C +1 0 N	M +I V °	M +I n	V +I °	+1 OM	U') +I It ^	t^{ry}f7 +I	N +1 °	° } °	V +1 O	V +I m
C p o	7 11 E	LL E	'~ 0 0	p 0 Y	O o Y	a .a >	O a >	a >	O a >	O n >	O a >	O E Li	O E ti	O E li
O Z	O O	O O	o O	00) 0) N	0) C) N	C) N	(O 00) N	N 00) N	C)) N_	('~ Op) N 2	N 00) ry 2	O 1°A r	n N 2	O t(˚j

Appendix 2


WK1 931119±3bE3F
WK15859
WK16989
WK18319'
WK1'5035t 295
3 3 6 P t
WK14531 ' 323
39BP
WK1'1542 325
43BP
WK15847, 351
32BP
WK1'1544 ` 377
WK15853·378
32BP
WK15684 424
33BP`
WK1`1548 ` 510
WK16993 533
WK15854 ` 594 35BP
WK1'8527"601 8BP~
WK16936 619
31 BP
WK16933 •
5BP
1000CaLAD
1540CaIAD
2000C aLAD
Calibrated date


Atmospheric data from Reimer et al (2004);OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]
WK15321 638±45BP
WK12997 647±36BP
WK15683 680±34BP
WK12992 680±35BP
WK16244 690±36BP
WK12994 697±53BP
WK15846 711±31BP
WK15322 722±36BP
WK15845 734±40BP
WK15848 735±32BP
WK16992 767±35BP
WK16243 790±37BP
WK16245 810±42BP
WK11503 814±43BP
WK18316 827±31BP
WK16983 836±32BP
WK16935 838±32BP
WK16984 847±34BP
WK16938 880±31BP
WK18317 896±34BP
WK16991 911±35BP
WK18326 929±36BP
WK18318 933±41BP
WK11505 959±43BP
WK16934 989±31BP
WK15843 1005±33BP
WK15688 1055±34BP
WK16930 1057±31BP
WK16246 1066±35BP
WK15687 1086±35BP
WK14534 1105±39BP
WK15849 1125±31BP
WK16987 1179±32BP
WK15325 1192±34BP
WK11501 1195±41BP
WK13000 1211±45BP
WK15685 1213±33BP
WK11507 1218±40BP
WK15686 1226±33BP
WK18525 1229±30BP
500CalAD
1000CalAD
1500CalAD
Calibrated date


1 00 1 89±3 • .BP
8528 1 03±29B
1 06' 1 96+4 BP
3002 1397±50B'
6·32 1 24±31.BP
WK 5844 1 61±32B°
K 6985 1821±3 BP
8320 1871 ±31f
5324' 1007+38BP
!Tr
~f330 X041 ~4:dgP _.-'
1N
1000CaIBC
500CaIBC
CaIBC/CalAD
500CaIAD
1000CalAD
Calibrated date