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– RESEARCH REPORT –

Re-interpreting Old Dates: Radiocarbon Determinations from the Tokelau Islands (South Pacific)

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ABSTRACT

A re-evaluation of available archaeological radiocarbon dates from the Tokelau Islands in West Polynesia demonstrates that careful assessment is essential when developing chronologies from previously published radiocarbon data. The new calibration results point to concurrent and continual human occupation of Fakaofo and Atafu from at least 750–550 years ago up until European contact in AD 1765.

Keywords: Radiocarbon, Tokelau, settlement

INTRODUCTION

Our archaeological research is exploring the proposition that the Tokelau Islands had been a key gateway to the human exploration and settlement of East Polynesia and the Polynesian Outliers to the west (Figures 1 and 2). Chronology is a vital aspect of this issue. Eight radiocarbon dates have been obtained from archaeological deposits from the Tokelau atolls of Fakaofo & Atafu (Figure 1). The samples were collected in 1986 (Best 1988), and 2008 (Addison & Kalolo 2009, Addison *et al.* 2009). As new fieldwork is occurring 2009–2011 it is important to assess the value of the established chronology, both for Tokelau in particular and for similar situations elsewhere in the Pacific.

THE RADIOCARBON DATES

Simon Best (1988: Table 1) reported three radiocarbon dates from Fakaofo (NZ-7439; NZ-7396; and NZ-7449) and one from Atafu (NZ-7462). Determinations NZ-7449 and NZ-7396 were from non-cultural deposits. NZ-7449 was obtained from a sample of *in situ* coral taken from the 'coral basement' 40 cm below the water table in TP1 and was reported as 2370 ± 65 BP. This was intended to provide a date immediately prior to the emergence of Fale Islet as dry land and indicate the age at which Fakaofo became habitable (Best 1988: 115) (Figure 1). Determination NZ-7396, reported as 1620 ± 60 BP, was on a large *Conus* sp. shell from the surface of a layer of clean sand, between the lowest cultural layer and the coral basement in TP1. Best (1988: 115–117) thought that the *Conus* shell was associated with the cultural layer above, but the radiocarbon date prompted him to reconsider and, on this evidence, he suggested that the atoll may have been suitable for settlement by about 1600 BP.

Determinations NZ-7439 and NZ-7462 were on cultural material; NZ-7439 (1090 ± 60 BP) was a date on turtle bone recovered from a concentration of turtle bone within the earliest cultural layer of TP4 on Fakaofo. Determination NZ-7462, dated to 1000 ± 100 BP, was on unidentified charcoal from the earliest cultural deposits of TP5 on the nearby atoll of Atafu. These radiocarbon results suggested to Best (1988: 117) that the occupation of Fakaofo and Atafu was contemporaneous, occurring approximately 1000 years ago, although he considered the possibility of earlier settlement.

Two additional radiocarbon determinations (Wk-11242 and Wk-11243) were obtained by McAlister (2002: 33–35) on short-lived monocotyledon charcoal collected during Best's 1986 fieldwork on Fakaofo. Charcoal sample Wk-11243 came from a charcoal-rich lens in the middle layers of TP3, while Wk-11242 dated a charcoal lens in TP2, at a similar level. These two samples weighed considerably less than the preferred minimum weight for standard radiometric dating at the Waikato Radiocarbon Dating laboratory and the results had large standard errors that made subsequent interpretation tricky. McAlister calibrated the radiocarbon data using the then available Intcal98 (Stuiver *et al.* 1998) calibration curve for northern hemisphere terrestrial samples and arrived at the calibrated age ranges given in Table 1. At the time McAlister considered the result for Wk-11242 to be too young, not only because it was much younger than Wk-11243 but because

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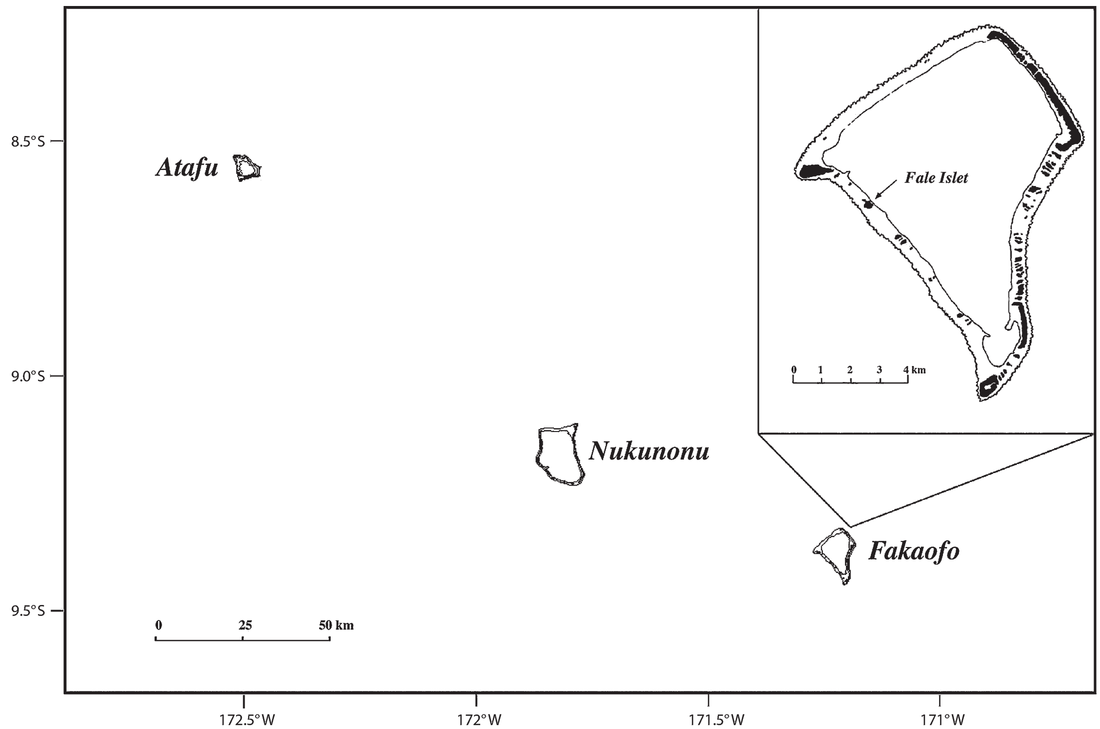

Figure 1. Tokelau with inset of Fakaofo Atoll showing the location of Fale Islet. Base map courtesy of Peter Minton (www.evs-islands.blogspot.com).

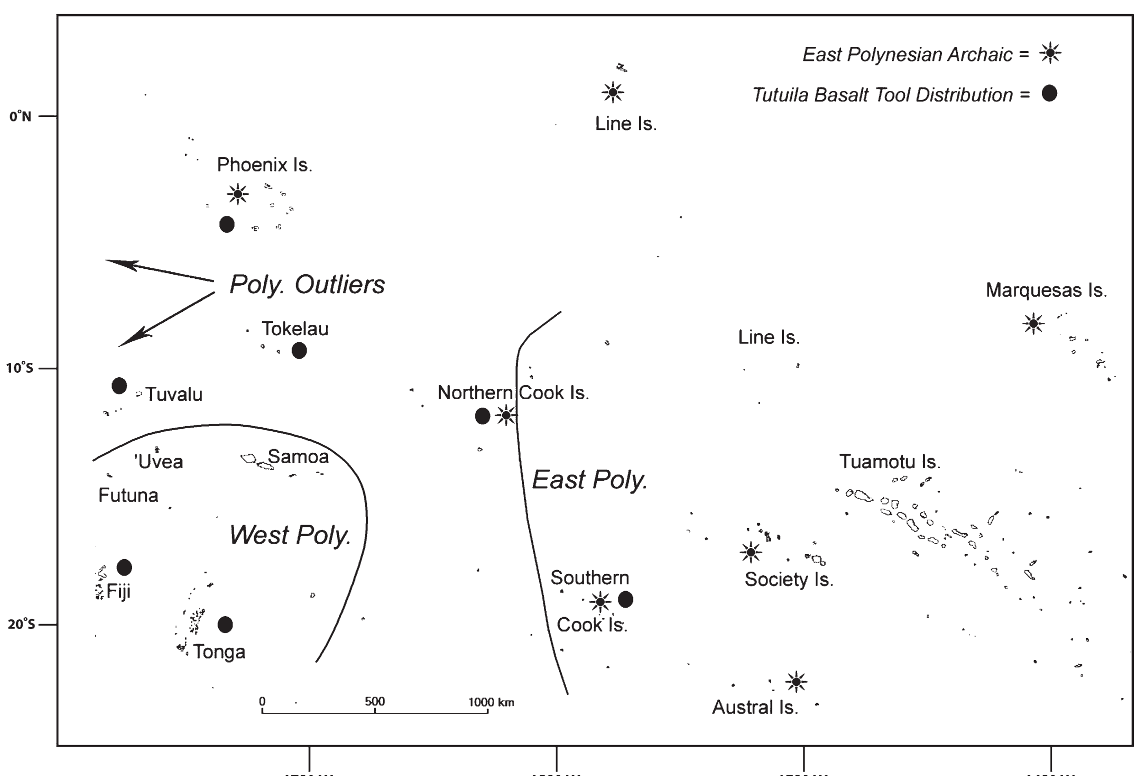

Figure 2. Tokelau in regional context. Note distributions of Tutuila basalt and East Polynesian Archaic. For details on the distributions of Tutuila basalt and Archaic sites, see Addison (in press) and Addison *et al*. (2009:5). Base map courtesy of Peter Minton (www.evs-islands.blogspot.com).

Table 1. *Tokelau radiocarbon determinations and calendar ages based on current 2010 conventions and as reported by Best (1988), McAlister (2002), Addison & Kalolo (2009) and Addison* et al. *(2009).*

Lab. No.	Location	Material	$\delta^{13}C$ (±0.2 ‰)	^{14}C CRA ± error (bp)	2010 Calibrated Age#	Published calibrated radiocarbon data		
						Best (1988)	McAlister (2002) (95.4% probability)	Addison & Kalolo (2009); Addison *et al*. (2009)
FAKAOFO – NON CULTURAL STRATA								
NZ-7396	TP1-H1	*Conus* sp.	+2.5	1960 ± 70*	1600–1410 cal BP (68.2% prob.) 1690–1340 cal BP (95.4% prob.)	1620 ± 60 BP	1690–1350 cal BP	1270-1120 cal BP (68.2% prob.) 1320-1030 cal BP (95.4% prob.)
NZ-7449	Basement coral (TP1-J)	Coral	+0.5	2777 ± 75*	2650–2400 cal BP (68.2% prob.) 2700–2330 cal BP (95.4% prob.)	2370 ± 65 BP	2710–2210 cal BP	2110-1920 cal BP (68.2% prob.) 2240-1830 cal BP (95.4% prob.)
FAKAOFO – CULTURAL STRATA								
Wk-11242	TP2 F2CS1	Mostly fibrous husk (prob. *pandanus* sp. or *cocos* sp.)	–23.7	171 ± 135	300–11 cal BP (68.2% prob.) 470–11 cal BP (95.4% prob.)	–	500–0 cal BP	–
Wk-11243	TP3 F3CS1, middle layers	Unidentified Monocotyledon	–26.2	704 ± 118	740–550 cal BP (68.2% prob.) 910–850 and 840–510 cal BP (95.4% prob.)	–	910–510 cal BP	–
NZ-7439	TP4-E1, lowest cultural layer	Turtle bone	–15.9	1090 ± 68*	720–590 and 580–570 cal BP (68.2% prob.) 780–520 cal BP (95.4% prob.)	1090 ± 60 BP	1170–920 cal BP	730–600 cal BP (68.2% prob.) 790–530 cal BP (95.4% prob.)
ATAFU								
NZ-7462	TP5-C2, earliest cultural layer	Charcoal unidentified	–25.4	1003 ± 118*	1060–780 cal BP (68.2% prob.) 1180–690 cal BP (95.4% prob.)	1000 ± 100 BP	1170–690 cal BP	1060–1030 and 990–780 cal BP (68.2% prob.) 1150–690 cal BP (95.4% prob.)
Wk-24479	TU-2	Charred *Cocos nucifera* endocarp	–21.4	359 ± 30	490–420 and 380–320 cal BP (68.2% prob.) 500–310 cal BP (95.4% prob.)	–	–	490–420 and 380–320 cal BP (68.2% prob.) 500–310 cal BP (95.4% prob.)
Wk-24478	TU-1, Layer VII	Charred *Cocos nucifera* endocarp	–24.6	616 ± 30	655–620, 610–580 & 570–555 cal BP (68.2% prob.) 660–540 cal BP (95.4% prob.)	–	–	655–620, 610–580 & 570–555 cal BP (68.2% prob.) 660–540 cal BP (95.4% prob.)

Calculated with a ΔR of 0.
* Dates recalculated in line with current ^{14}C convention (*pers comm*. D Chambers, Feb 2009).

dog, which was thought to have died out long before European contact in AD 1765, was found in the same context. McAlister (2002: 35) considered Best's bone and shell dates to be potentially contaminated and concluded that while the radiocarbon dates broadly agreed with the stratigraphy they were too inconsistent to allow comparison between the test pits.

During fieldwork in 2008 two additional charcoal ^{14}C determinations were obtained from deposits on Atafu; Wk-24479 from the top of a rock pavement (a probable

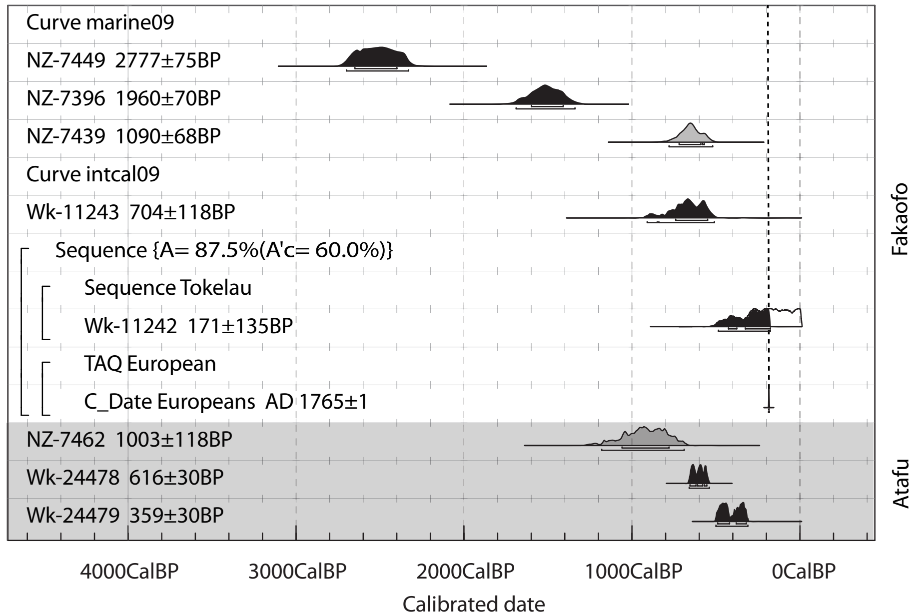

Figure 3. 2010 calibrated radiocarbon ages for Fakaofo and Atafu (grey band). Black probability distributions = identified charcoal and shell/coral determinations; dark grey = unidentified charcoal and turtle bone determinations that are considered to be less reliable.

house foundation) in TU-2, and Wk-24478 from the lowest cultural layer of TU-1 (Addison *et al.* 2009: 7). These were identified as short-lived *Cocos nucifera* endocarp and the earlier date was considered to indicate a minimum calibrated age for people on Atafu of 660–540 BP (95.4% probability), younger than Best's charcoal date NZ-7462. Addison & Kalolo (2009: 45) and Addison *et al.* (2009: 7) then recalculated Best's (1988) data using the marine calibration curve of Hughen *et al.* (2004) (Marine04) with a marine reservoir correction value (ΔR) of −14 ± 28 ^{14}C yrs and the northern hemisphere calibration curve (Intcal04) (Reimer *et al.* 2004). This made the coral, shell and turtle bone age ranges younger than previously reported by Best (1988) and McAlister (2002) (Figure 3). In particular, the emergence of dry land on Fakaofo now calibrated to ca. 1300–1000 years ago (Addison & Kalolo 2009: 15) (Table 1).

Assessment and recalibration of the radiocarbon dates

These three interpretations of the radiocarbon data are somewhat contradictory. The marine samples, and therefore the timing of atoll emergence, have become progressively younger. There have also been differing opinions about the most reliable radiocarbon sample types.

The marine radiocarbon dates reported in Best (1988) were reservoir-corrected ages that had been adjusted for an in-house laboratory standard; in this instance a combination of the New Zealand marine shell standard and the Fiji marine shell standard (Rafter Radiocarbon Laboratory 2009)(*cf.*, Rafter *et al.* 1972). This meant that the coral and *Conus* sp. shell dates had already been adjusted for a marine offset (which approximates to a ca. 400-year difference from terrestrial samples). This enabled Best (1988) to compare terrestrial and marine dates easily, but presentation of them in the format for a conventional radiocarbon age (CRA) (i.e. date ± error BP) contributed to subsequent erroneous interpretations of the chronology (see below).[4]

McAlister's (2002) use of the terrestrial (Intcal98) curve to calibrate Best's (1988) marine reservoir corrected values was therefore technically correct but the methodology was outdated. An alternative method for the calibration of marine samples had been introduced by Stuiver and others in 1986 which was designed to take into account both regional and temporal variability, whereby marine CRA's were calibrated using a modeled marine curve (*e.g.,* Hughen *et al.* 2004) into which a reservoir offset (ΔR), specific to the region in question, was added. Addison & Kalolo (2009) recalibrated all the dates using these current calibration methodologies, but because Best's shell data were not CRA's, as defined by Stuiver & Polach (1977), the dates could not be calibrated using the modelled marine calibration curve without the marine correction first being removed. Consequently, the calibrated age ranges presented by Addison & Kalolo (2009: 17) for these shell and coral determinations were incorrect. However, to make things even more confusing, a marine correction was never applied to the turtle bone determination (NZ-

4 The following assumptions are explicit in a conventional radiocarbon age; the age is calculated using the Libby half-life of 5568 years; 0.95 NBS oxalic acid provided the modern reference standard; AD 1950 is the reference year zero; and that radiocarbon years BP are the units used to express the age.

7439). Consequently, the calibrated age range for NZ-7439 given by Addison & Kalolo (2009: 17) is more correct than that presented by either Best (1988: 17) or McAlister (2002: 33–34).

There is also the question of which marine ΔR to apply to the marine determinations. Although, Addison & Kalolo (2009: 17) used a value of −14 ± 28 ^{14}C yrs for calibrating the marine samples (source unknown), there is no published ΔR value available for the Tokelau islands. The closest available ΔR values are from the Samoan Archipelago (28 ± 26 ^{14}C yrs), Manihiki (Northern Cook Islands; 8 ± 19 ^{14}C yrs) and Funafuti (Tuvalu; −37 ± 19 ^{14}C yr) (Petchey *et al.* 2008). The Funafuti value is more negative than typical for the South Pacific and may represent a lagoon value influenced by atmospheric CO_2, a factor that might also influence the Tokelau atolls. Whether these ΔR values are applicable to radiocarbon dates of turtle bone is also unknown. Petchey (2001) suggested that an average of all the ΔR values for this region might more closely model the carbon intake of marine turtles since they can travel up to 2000 km. While extant data indicate that the ΔR correction factor for the South Pacific is fairly uniform and close to 0 (Petchey *et al.* 2008), there are areas at the margins of the region where ocean upwelling occurs, adding further uncertainty to turtle bone radiocarbon dates.

McAlister also questioned the reliability of the turtle bone determination NZ-7439. Bone dates are usually problematic for two reasons; insufficient removal of contaminants and dietary corrections. Turtle bone dates, in particular, have been viewed with suspicion (Anderson & Clark 1999: 36). Records of the specific pre-treatment applied to NZ-7439 are limited, but contemporary literature suggests that this bone would have been decalcified with phosphoric acid (Jansen 1984: 29; *pers. comm.* D. Chambers, Feb 2009). Such pre-treatment is generally considered to result in a minimum age (Petchey 1999: 98–99). Consequently, the reliability of this date is questionable.

Of the five charcoal radiocarbon dates, four are identified to short-lived species or nutshell with limited inbuilt age while the oldest cultural date for Tokelau is on unidentified charcoal (NZ-7462). Allen & Wallace (2007) have demonstrated that un-calibrated wood charcoal samples identified to short-lived species can give radiocarbon results that are on average 64 ^{14}C yrs older than nutshell samples, and that some unidentified samples could be 300 or 400 years too old, especially in early Pacific sites where older wood sources were readily available (*pers. comm.* R. Wallace June 2009). The earlier date for human occupation on these atolls, as indicated by the unidentified charcoal date (NZ-7462; 1060–780 cal BP at 68% probability), cannot be substantiated at present, and the possibility remains of intermittent use prior to permanent settlement (e.g., Graves and Addison 1995). Further ^{14}C data from unambiguous stratigraphic and cultural contexts will be needed to further resolve this question.

Re-interpretation of the dates

We recalibrated conventional radiocarbon ages (CRA's) obtained directly from the laboratories using IntCal09[5] for terrestrial samples and Marine09 for marine samples (Reimer *et al.* 2009) with a ΔR of 0. All dates were calibrated using OxCal 3.10 (Bronk Ramsey 1995, 2005). The results are presented in Figure 3.

These newly calibrated dates indicate that Fale Islet on Fakaofo was still submerged ca. 2650–2400 cal BP (68.2% probability; NZ-7449). Although Best (1988) considered the non-cultural *Conus* sp. shell sample NZ-7396 to post-date the emergence of the atoll, this association is by no means secure as such large durable shells can persist in the environment long after death. The first unambiguous evidence for human occupation occurs simultaneously on both Fakaofo (Wk-11243; 740–550 years cal BP at 68.2% probability) and Atafu (Wk-24478; 655–620, 610–580 and 570–555 cal BP at 68.2% probability).

In order to refine the dating of Wk-11242 we used the *terminus ante quem* command in OxCal which sets a date after which the calibrated age range cannot occur. OxCal employs Bayesian statistical methods to analyze radiocarbon determinations in association with prior historical and archaeological information (Bronk Ramsey 2005) thereby giving more precise calendar results. In this case, the presence of dog in the same deposit as Wk-11242 limits the age of this sample to pre-AD 1765. This gives a calibrated age range for Wk-11242 of 430–360 and 320–180 BP at 68.2% probability, removing ca. 200 years from the calibration tail (see complete calibrated 68.2% probability range in Table 1).

DISCUSSION

Tokelau, discovered by Europeans in AD 1765 (see Huntsman & Hooper [1996: 140] for a detailed account of European discovery and early visitors), has not previously been thought of as important in Polynesian prehistory but analysis of daily wind patterns (Addison 2008) suggests the regular occurrence of conditions favourable to 'stepping-stone' voyaging between the northern atoll arc (Phoenix Islands, Northern Cook Islands, Line Islands and Tokelau Islands) and the high islands of East Polynesia. While this strategy makes sense from a sailing perspective, it would not have been successful until atoll emergence ca. 1500 BP, with stabilization of sea level after the mid-

5 For ^{14}C purposes the boundary between the atmosphere of the Southern and Northern Hemispheres is considered to lie along the thermal equator, commonly called the Inter-Tropical Convergence Zone (ITCZ) (McCormac *et al.* 2004: 1088). Because the Tokelau Islands lie within the South Pacific Convergence Zone, which merges with the ITCZ to the west we have opted to use the Northern Hemisphere calibration curve (IntCal09: Reimer *et al.* 2009) for the terrestrial calibrations.

Holocene hydro-isostatic highstand (Addison & Asaua 2006: 8–9; Dickinson 2003).

Early ethnological research established Tokelau as lying in a zone intermediate between West and East Polynesia (Burrows 1938). Archaeological evidence also suggests Tokelau as a cultural crossroads, with basalt tools from Tutuila (Samoa) found in deposits (Best *et al*. 1992; Addison *et al.* 2009). Tutuila basalt tools spread some 5000 km across the Pacific around 700–600 years ago (Addison in press). Although relatively little archaeological work has been done in the northern atoll arc, the currently known distribution of Archaic East Polynesian artifacts dating to ca. 700–600 BP also goes right to the edge of Tokelau (Pearthree & Di Piazza 2003), but such artefacts have not been found in the cultural deposits in Tokelau (Figure 2). Radiocarbon and cultural evidence from Tokelau point to continuing prehistoric occupation, unlike the nearby Phoenix and Line Islands which were abandoned at European contact. Hence, the initial human settlement of Tokelau, and the chronology of cultural materials from different strata on each atoll are important in understanding not only local prehistory, but regional processes as well.

CONCLUSIONS

The interpretation of radiocarbon data is becoming ever more complex as the researcher has to deal with extant data, changing conventions in data presentation, revised calibration curves and methodologies, improved pretreatments and understandings of ^{14}C variation in nature. With the advent of sophisticated statistical modelling techniques, which promise the ability to further refine dating sequences, it is important that the raw data is correctly presented and interpreted. It is also essential that initial sample selection is undertaken carefully, so that the best sample types are selected for the event under study (*cf.* Bayliss 2009), and the most appropriate dating techniques are chosen to achieve the most accurate and precise ages possible. Such care and attention to radiocarbon detail is essential when studying cultural adaptation and environmental change over the relatively brief time it took humans to explore and settle East Polynesia and the Polynesian Outliers.

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References

Addison D.J., 2008. The northern atoll arc and sailing strategies between West and East Polynesia: Paper presented at the 19th Annual Maritime Archaeology and History of the Pacific Symposium, 16–18 February, Honolulu, Hawai'i. Program and Abstracts, p. 5.

Addison D.J., in press. The Tutuila Basalt Export Industry and the 5600 km distribution of Samoan adzes at ~700–600 BP. In P. Wallen & H. Martinsson-Wallin (eds), *The Gotland Papers–Migrations, Identity, and Cultural Heritage: Selected Presentations from the VII International Conference on Easter Island and the Pacific.* Visby: Gotland University Press Vol. 7.

Addison D.J., & Asaua, T.S., 2006. 100 new dates from Tutuila and Manu'a: Additional data addressing chronological issues in Samoan prehistory. *Journal of Samoan Studies,* 1: 295–117.

Addison D.J., Bass B., Christensen C.C., Kalolo J., Lundblad S.P., Mills P.R., Petchey F., & Thompson A., 2009. Archaeology of Atafu, Tokelau: Some initial results from 2008 *Rapa Nui Journal,* 23: 5–9.

Addison D.J., & Kalolo J., 2009. *Tokelau Science Education and Research Program: Atafu Fieldwork August 2008*. Pago Pago and Atafu: Samoan Studies Institute and Tokelau Department of Education.

Allen M.S., & Wallace R., 2007. New evidence from the East Polynesian gateway: Substantive and methodological results from Aitutaki, southern Cook Islands. *Radiocarbon,* 49: 1–17.

Anderson A., & Clark G., 1999. The age of Lapita settlement in Fiji. *Archaeology in Oceania,* 34: 31–39.

Baylis A., 2009. Rolling out revolution: using radiocarbon dating in archaeology. *Radiocarbon,* 51: 123–147.

Best S., 1988. Tokelau archaeology: A preliminary report of an initial survey and excavation. *Bulletin of the Indo-Pacific Prehistory Association,* 8: 104–118.

Best, S., Sheppard, P., Green, R.C., & Parker, R., 1992. Necromancing the stone: archaeologists and adzes in Samoa. *Journal of the Polynesian Society*, 101(1): 45–85.

Bronk Ramsey C., 1995. Radiocarbon calibration and analysis of stratigraphy: The OxCal program. *Radiocarbon,* 37: 425–30.

Bronk Ramsey C., 2005. OxCal Program v3.10. Oxford: Radiocarbon Accelerator Unit, University of Oxford.

Burrows E.G., 1939. *Western Polynesia: A Study in Cultural Differentiation*. Gothenburg: Ethnological Studies 7.

Dickinson, W.R. 2003. Impact of mid-Holocene hydro-isostatic highstand in regional sea level on habitability of islands in Pacific Oceania. *Journal of Coastal Research,* 19: 489–502.

Graves M.W., & Addison, D.J., 1995. The Polynesian settlement of the Hawaiian Archipelago: Integrating models and methods in archaeological interpretation. *World Archaeology,* 26: 380–399.

Hughen K.A., Baillie M.G.L., Bard E., Beck J.W., Bertrand C.J.H., Blackwell P.G., Buck C.E., Burr G.S., Cutler K.B., Damon P.E., Edwards R.L., Fairbanks R.G., Friedrich M., Guilderson T.P, Kromer B., McCormac G., Manning S., Bronk-

Ramsey C., Reimer P.J., Reimer R.W., Remmele S., Southon J.R., Stuiver M., Talamo S., Taylor F.W., van der Plicht J., & Weyhenmeyer C.E., 2004. Marine 04 Marine Radiocarbon Age Calibration, 0–26 Cal Kyr BP. *Radiocarbon,* 46: 1059–1086.

Huntsman J., & Hooper A., 1996. *Tokelau: a historical ethnography*. Auckland: Auckland University Press.

Jansen H.S., 1984. *Radiocarbon Dating for Contributors. Institute of Nuclear Sciences INS-R-328.* Wellington, Institute of Nuclear Sciences, Department of Scientific and Industrial Research.

McAlister A.J., 2002. Prehistoric Fishing at Fakaofo, Tokelau: A Case for Resource Depression on a Small Atoll. Unpublished MA thesis, University of Auckland.

McCormac F.G., Hogg A.G., Blackwell P.G., Buck C.E., Higham T.F.G., & Reimer P.J., 2004. SHCAL04 Southern Hemisphere Calibration, 0–11.0 CAL KYR BP. *Radiocarbon,* 46: 1087–1092.

Petchey F., 1999. New Zealand bone dating revisited: a radiocarbon discard protocol for bone. *New Zealand Journal of Archaeology* (1997), 19: 81–124.

Petchey F., 2001. Radiocarbon determinations from the Mulifanua Lapita site, Upolu, Western Samoa. *Radiocarbon,* 43: 63–68.

Petchey F., Anderson A., Zondervan A., Ulm S., & Hogg A., 2008. New marine ΔR values for the South Pacific Subtropical gyre region. *Radiocarbon,* 50: 373–397.

Pearthree E., & Di Piazza, A., 2003. An Archaic East Polynesian assemblage from the Phoenix and Line Archipelagos. In C. Sand (ed.), *Pacific Archaeology: Assessments and Prospects, Proceedings of the New Caledonia 2002 Conference*. Nouméa: Service des Musées et du Patrimoine de Nouvelle-Calédonie: 327–336.

Rafter Radiocarbon Laboratory, 2009. Tokelau radiocarbon dates – R11427/1–4. Lower Hutt, Institute of Geological and Nuclear Sciences Ltd, National Isotope Centre. Compiled by D. Chambers.

Rafter T.A. Jansen H.S. Lockerbie L., & Trotter M.M., 1972. New Zealand radiocarbon reference standards. In T.A. Rafter, and T. Grant-Taylor (eds), *Proceedings of the 8th International Conference of Radiocarbon dating, Vol 2*. Wellington: The Royal Society of New Zealand: 625–675

Reimer P.J., Baillie M.G.L., Bard E., Bayliss A., Beck J.W., Bertrand C.J.H., Blackwell P.G., Buck C.E., Burr G.S., Cutler K.B., Damon P.E., Edwards R.L, Fairbanks R.G., Friedrich M., Guilderson T.P., Hogg A.G., Hughen K.A., Kromer B., McCormac G., Manning S., Bronk-Ramsey C., Reimer R.W., Remmele S., Southon J.R., Stuiver M., Talamo S., Taylor F.W., van der Plicht J., & Weyhenmeyer C.E., 2004. IntCal04 terrestrial radiocarbon age calibration, 0–26 cal Kyr BP. *Radiocarbon,* 46: 1029–1058.

Reimer P.J., Baillie M.G.L., Bard E., Bayliss A., Beck J.W., Blackwell P.G., Bronk Ramsey C., Buck C.E., Burr G.S., Edwards R.L., Friedrich M., Grootes P.M., Guilderson T.P., Hajdas I., Heaton T.J., Hogg A.G., Hughen K.A., Kaiser K.F., Kromer B., McCormac F.G., Manning S.W., Reimer R.W., Richards D.A., Southon J.R., Talamo S., Turney C.S.M., van der Plicht J., & Weyhenmeyer C.E., 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. *Radiocarbon,* 51: 1111–1150.

Stuiver M., & Polach H.A., 1977. Discussion: Reporting ^{14}C data. *Radiocarbon,* 19: 355–63.

Stuiver M., Reimer P.J., & Braziunas S., 1998. High precision radiocarbon age calibration for terrestrial and marine samples. *Radiocarbon,* 40: 1127–1151.