– ARTICLE –

Re-dating Lapita Movement into Remote Oceania

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ABSTRACT.

Understanding the nature and process of initial Pacific settlement by people carrying the Lapita culture is ultimately founded upon accurate knowledge of the timing and speed of settlement. This paper reports on re-dating of one of the earliest Lapita sites (SE-SZ-8) from Santa Cruz in the Temotu Province of the Solomon Islands on the western margin of Remote Oceania. Our results indicate this site is considerably younger than previously believed and comparison of this result to other early Lapita sites suggests initial settlement of Remote Oceania was at not much more than 3000 BP. This would argue for very rapid Lapita settlement of much of the South-western Pacific.

Keywords: radiocarbon Bayesian chronology Lapita settlement

INTRODUCTION

Knowledge of the timing of the initial settlement of Remote Oceania by people bearing the Lapita archaeological culture is significant, not only as a historical fact, but for providing baseline information about the speed of advance into the Western Pacific which may tell us something about the drivers behind that movement (Sheppard 2011). It has become routine in the general archaeological literature to state that the movement into Remote Oceania dates to 3200 cal BP. This date is based primarily on the Reef/Santa Cruz excavations carried out by Roger Green in the Temotu Province of the Solomon Islands under the umbrella of the Southeast Solomon Islands Culture History Programme (SSICHP) (Green and Cresswell 1976). The SSICHP was a multi-institutional research programme directed by Roger Green and Douglas Yen in 1970 and was responsible for establishing the foundations of Solomon Island archaeology especially as it concerned the Lapita expansion into Remote Oceania.

The Reef/Santa Cruz Islands form the first set of islands east of the Near/Remote Oceania boundary (Figure 1). Based on the dating of shell from the SE-SZ-8 (Nanggu) site located on the high volcanic island of Nendö (Santa Cruz island) Green argued that the regional Lapita sequence commenced at a '… time earlier than the 14th century B.C…' (Green 1976: 263). In 1991 he reviewed all the dating evidence for the Reef/Santa Cruz Lapita sequence and summarized as follows:

> A much earlier dating of SZ-8 is not supported by the recalibration of a pair of marine shell dates from that site. Rather, SZ-8 seemingly belongs in the same age range as RF-2, i.e., between 1200 and 900 BC, with the 11th to 12th century BC date provided by sample SUA-111 as indicative of a lower limit for its initial occupation. The somewhat shorter and more certainly one-phase occupation of RF-2 had occurred before the end of the 10th century BC and that of RF-6 before the end of the 6th century BC. The whole classic Lapita sequence involving excavated sites SZ-8, SZ-45, SZ-47, SZ-33, RF-2 and RF-6 would appear to be contained within the years 1200–600 BC and more probably within the range 1150–650 BC. This is a shorter period than that entertained in earlier publications (Green 1991: 203).

In 1997 Kirch, in his influential overview *The Lapita Peoples* noted, following Green, that Lapita was certainly established in the Santa Cruz region by 1100 BC but suggested that the radiocarbon corpus of the Eastern Lapita area supported a colonisation date of Remote Oceania by 1200 BC and that the earliest sites in the Reef/Santa Cruz area had likely not yet been found (Kirch 1997: 62). With reference to Green's Reef/Santa Cruz sequence Kirch (1997: 156) reported that SZ-8 was, based on the radiocarbon dates, clearly the oldest site in the sequence although RF-2 was not much younger and was possibly contemporaneous (Kirch 1997: 296). Following on from this Best (2002) argued in his Lapita review *Lapita a View from the East*, that the radiocarbon dates from the Reef/Santa Cruz sequence were problematic with unknown marine reservoir (ΔR) corrections for shell dates at SZ-8 and poor collection contexts for charcoal dates from the other sites (Best 2002: 89–90). In his view the ceramic stylistic

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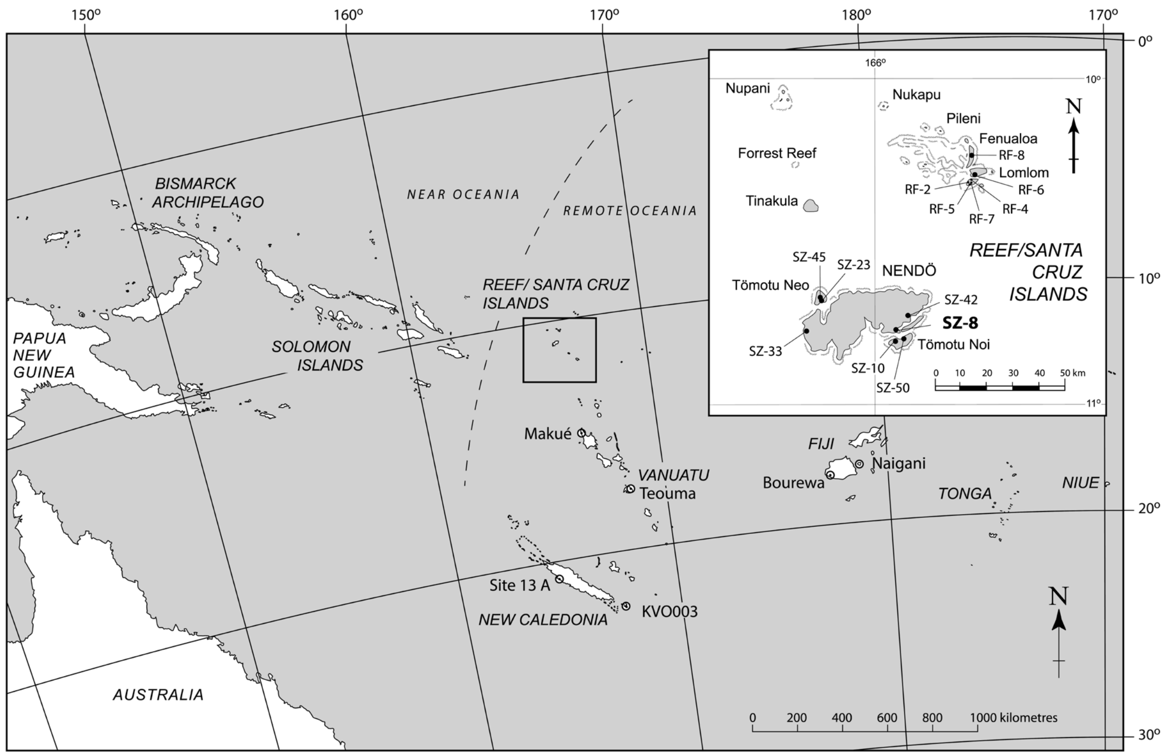

Figure 1. Location of the Reef/Santa Cruz islands in the Temotu province of the Solomon Islands.

evidence supported a completely reversed sequence with SZ-8 being the youngest site with poorly made pottery and simpler design execution, while RF-2 and RF-6 containing better made pottery with more complex design, suggesting the possibility that RF-6 was in fact the oldest site. This was despite the young radiocarbon dates on charcoal from scattered samples in the bottom of pits (Best 2002: 93) (but see [Green and Jones 2007]).

In 2008 Green responded to Best's argument with additional shell dates on SZ-8 which were now calibrated with a ΔR value obtained on charcoal/shell comparisons from RF-2 in the Reef Islands (−81±64 (Jones *et al.* 2007)) which are small sand keys located 50 km north of Santa Cruz (Green, Jones, and Sheppard 2008). Using this new ΔR value and a Bayesian analysis of the shell dates now supplemented with two new dates the authors concluded '… the Lapita component of the SE-SZ-8 archaeological record corresponds to activity beginning sometime in the interval 3650–3000 BP and ending in the interval 3300–2600 BP'(Green, Jones, and Sheppard 2008: 59). It was then argued that as few would advocate for settlement of Remote Oceania before 3300 BP that prior would reduce the early range to 3300 to 3000 BP.

Despite the improvements over the years in the dating of the Reef/Santa Cruz Lapita sites some fundamental problems still remained in 2008. The combination of charcoal and shell provided a reasonable age estimate for RF-2, however the application of that Reef Island ΔR to shell from a site on the south coast of the high island of Nendö over 60 km south contains unknown errors and, additionally, many of the older dates already have large error ranges in their radiocarbon determinations. Therefore in order to improve our knowledge of the chronology and archaeological record from SZ-8 the authors decided in 2010 to return to the site and, as one of the goals of the project, to recover charcoal for AMS dating. As described below this proved to be more challenging than we had anticipated.

SZ-8 EXCAVATIONS 2012

In 2010 Sheppard and Chiu, along with John Keopo from the Solomon Island Museum visited Nanggu village and obtained support for a programme of research which ultimately resulted in a research permit from Temotu Province and the Ministry of Education of the Solomon Islands. In July 2011 Sheppard attempted to begin fieldwork at Nanggu, however problems with aircraft resulted in all flights to Lata on Nendö being cancelled and the fieldwork was called off. In November 2012 the authors tried once more to reach Lata and despite ongoing problems with the aircraft, managed to reach Lata. However our main equipment trunks were off-loaded at the last minute and we did not see them again until the conclusion of fieldwork when leaving Lata to return to Honiara.

Despite our limited equipment we were able to excavate 17 sq m over a period of three weeks (Figure 2). Green had used a breadfruit tree as his datum in 1979 (Green,

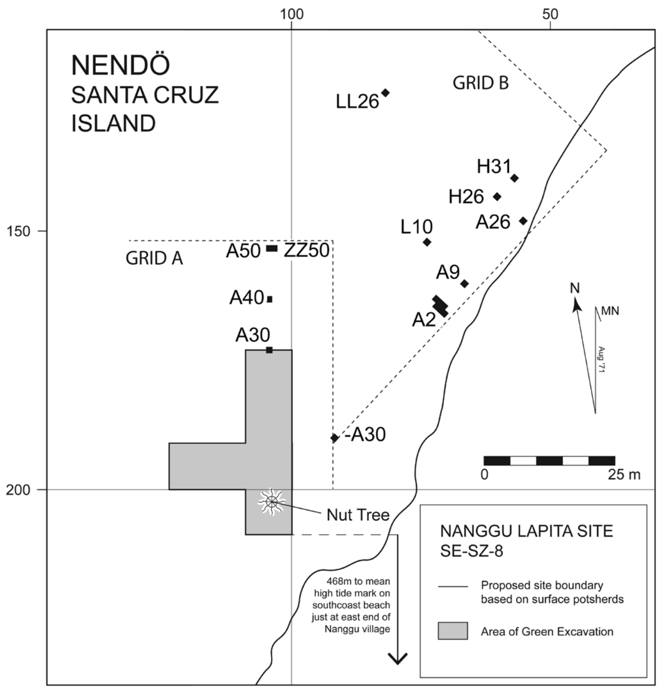

Figure 2. Excavation plan of the Nanggu site (SE-SZ-8) showing the 2012 excavations.

Jones, and Sheppard 2008: Figure 4) however it was no longer visible. Fortunately the nut tree located on the 1979 plan was still alive and was used as a new datum (Figure 2; UTM 58 L 614807 E 8808089.75 N) allowing us to tie our excavation to that of Green. As we had very limited surveying equipment we laid out a new grid (Grid B) with a baseline running from the nut tree at 42 degrees north along the long axis of the modern gardens. The SW corner of square A1 was at 50.2 m north along the baseline from the site datum (the nut tree). Most of our excavation was carried out using this grid. With the arrival of additional survey equipment later in the work we were able to extend Green's grid (Grid A) immediately north of the area he excavated and excavate four additional squares.

The stratigraphy we recorded was identical to that described by Green as follows:

> *Layer 1.* A dark fine black loam containing fire cracked rock, variable in thickness with an average thickness of 30 cm.
> *Layer 2.* A brown/gray mottled sediment containing considerable shell and Lapita ceramics. Approximately 40–50 cm thick over much of the site, but 20 cm or less in the northernmost squares.
> *Layer 3.* A sterile rough coral beach of white indurated sand and beach rock (Figure 3).

The area of Green's excavation (Grid A) is today old garden covered in thick secondary growth. Most of the site area in Grid B was in 2012 modern garden planted in sweet potato (*Ipomoea batatas*) however much of that area is reported to have been used in the past as a yam garden,

Figure 3. Stratigraphy in south wall of Grid A B3.

suggesting considerable disturbance and the layer 1 and 2 interface was of variable depth (above).

The area of maximum depth of cultural deposit and seemingly intact features was in the six contiguous squares located adjacent to A2 in Grid B. There in places larger pieces of ceramic were found lying flat, along with concentrations of large shells just at the Layer 2/3 interface, suggesting an undisturbed living surface.

DATING SAMPLES

Our expectation had been that we would be able to easily find small charcoal samples, or perhaps coral artefacts, to date the Lapita deposit. Unfortunately charcoal was only ever very common in Layer 1 and almost absent from Layer 2 and no suitable coral artefacts were recovered for dating. In addition, with the exception of shell, there is no faunal preservation anywhere in Layer 2. This leads us to conclude that the pig bone which has been previously associated with SZ-8 (Green 1976: 255) must come from Layer 1 which dates in the last 1200 years.

A total of seven new radiocarbon dates (Table 1 all NZA numbers) were obtained from the 2012 excavations to join the five dates generated earlier by Green (Green, Jones, and Sheppard 2008). Despite efforts to collect charcoal *in situ* very little material was observed. The sample sizes were very small and, although submitted for examination, were not able to be identified. All of the samples dated come from the area of contiguous excavation (A2–3; B2–3) in Grid B. One sample (NZA-53716 1327±18) recovered from the sieve (390 mg raw sample) was recorded as coming from Layer 2 however it is clearly post-Lapita. Although statistically slightly older than the date Green obtained on an oven in Layer 1, we assume the sample is intrusive from that Layer. The only other charcoal sample collected *in situ* in the field was NZA-53689 (640 mg) obtained from the Layer 2/3 interface at the bottom of the cultural deposit beside a rock in the east face which formed part of a linear rock feature. The final sample (NZA-53697 – 112 mg) was recovered while excavating sediment from out of a *Trochus* shell (NZA-53698) in the lab at Auckland.

A variety of shell species were dated and included algae consuming reef grazing snails (*Trochus* sp and *Cerithium egenum*), found in shallow inter-tidal reef flats, sandy beach bivalves (*Actatodea striata*) and large filter feeding clams (*Tridacna* sp.) from lagoon and reef settings. All of these taxa produced very similar ages and these ages were all very similar to those shell dates obtained in the earlier investigations (Green, Jones, and Sheppard 2008: Table 2). As Nendö is a high basaltic island without any limestone in the vicinity of Nanggu, problems associated with potential incorporation of old carbonate from grazing snails should not be a problem (Nunn and Petchey 2013). The similarity of the ages from different species suggests differences in shellfish feeding behaviour is not a significant problem at this site. At the time of the Lapita occupation the site would have been adjacent to the edge of the lagoon (Green, Jones, and Sheppard 2008: Figure 2) which today is located

Table 1. *Radiocarbon dates for Nanggu (SE-SZ-8).*

Material	Context	Lab Code	$\delta^{13}C$ [‰]	CRA[2]	Error
charcoal	Layer 1 oven	I-5752		910	95
Two *Tridacna* sp.	Square VV-50 Level 4, 40–60 cm dbs towards base of Grey Sand layer Layer 2	SUA-112	0.0[1]	3140	70
Turbo astrea (?)	Square HH-61 Level 5, 1st lens 60 cm dbs Grey Sand layerLayer 2	Wk-12305	2.8	3149	57
Trochus niloticus	Square PP54 Level 4, 45–60 cm dbs Brown Sand layer Layer 2	Wk-12304	1.6	3192	51
misc. clam + 1 *Tridacna*	Square DD-64 Level 4 45–65 cm dbs at base of coralline grey brown sandy layer Layer 2	SUA-111	0.0[1]	3250	70
charcoal	Square A3, Layer 2, NW Quadrant Sieve	NZA-53716	–29.2	1327	18
charcoal	Square B2, Layer 2/3 interface –70 DBS, beside rock in linear feature, east face of square	NZA-53689	–24.9	2710	15
charcoal from inside shell (NZA 53598)	Square A2 Layer 2	NZA-53697	–26.6	2768	15
Trochus sp.	SQ A2 Layer 2	NZA-53598	4.06	3137	24
Atactodia striata (?)	Square B3 bottom of Layer 2, SE Quadrant, side of rock; Bag 72	NZA-53597	–12	3121	24
Tridacna sp.	Square A2 SE Quadrant, Layer 2/3 interface, associated with oven stones; Bag 32	NZA-53601	3.43	3180	24
Cerithium egenum (?)	SQ A2 Layer 2/3 interface	NZA-53599	–6.7	3189	24

1. Assumed value see (Green, Jones, and Sheppard 2008: Table 2); 2. Conventional radiocarbon age.

500 m east of the site and stretches east along the south coast of the island.

RESULTS OF NEW DATES AND CALCULATION OF A NEW ΔR

The fortuitous recovery of charcoal from within a shell allowed us to calculate the first ΔR marine reservoir correction for Santa Cruz. This was calculated following the standard model which assumes the samples are isochronous (Jones *et al*. 2007: 96–97) and using the Marine 04 (Hughen *et al*. 2004) curve to convert the terrestrial value to the marine equivalent. The calculated result is +122±28 ^{14}C which is very different to the value for the Reef Islands of −81±64 ^{14}C determined by Jones *et al*. (2007) using Bayesian methods and the IntCal98 curves, or the value of −20±62 ^{14}C we now calculate for the same Reef Island samples using the standard methodology and the Marine 04 curve. This was determined using charcoal and marine shell from SE-RF-2 on Ngangaua in the Main Reef Islands and is comparable to the values reported for the nearby Outer Reef Islands (Pileni) of 5±21 ^{14}C and 30±19 ^{14}C by Petchey *et al.* (2008: Table 1).

Figure 4 illustrates the results of Bayesian analysis of dates from SZ-8 using OxCal version 4.2.3 (Bronk-Ramsey 2013) with the details of the analysis in Table 2. These results are calibrated using the IntCal13 and Marine13 curves (Reimer *et al*. 2013). This northern hemisphere curve has become the standard for calibrating Lapita chronology; although there is good evidence to believe that there is a southern hemisphere offset which existed throughout the Holocene (Hogg *et al*. 2009) variation in the position of the thermal equator (ITCZ), which varies seasonally and possibly through time, makes it difficult to estimate the

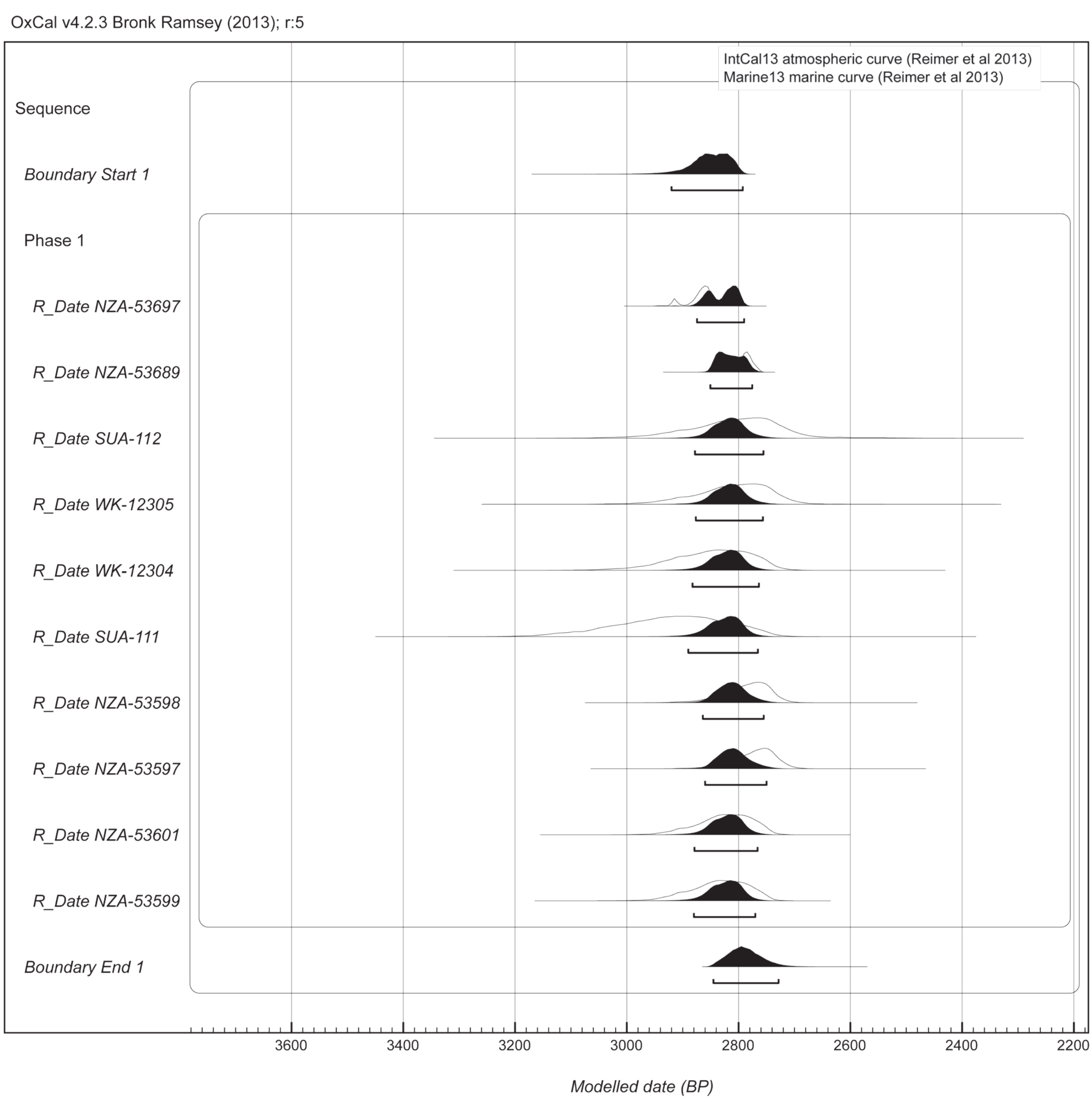

Figure 4. Single phase Bayesian analysis of dates from Nanngu (SE-SZ-8).

Table 2. *Results of Bayesian Analysis for all dates from Nanngu (SE-SZ-8).*

	Unmodelled (BP)			Modelled (BP)			Indices	
Name	from	to	%	from	to	%	A	C
Sequence								
Boundary Start 1				2920	2793	95.4	97.9	
Phase 1								
R_Date NZA-53697	2923	2794	95.4	2875	2790	95.4	71.0	99.8
R_Date NZA-53689	2849	2767	95.4	2851	2776	95.4	95.1	99.9
Curve Marine13								
Delta_R LocalMarine	65	179	95.4	69	146	95.4	108.1	99.8
R_Date SUA-112	3001	2652	95.4	2878	2756	95.4	124.0	99.8
R_Date WK-12305	2956	2691	95.4	2877	2757	95.4	120.4	99.8
R_Date WK-12304	2991	2727	95.4	2883	2764	95.4	126.3	99.8
R_Date SUA-111	3114	2745	95.4	2890	2766	95.4	98.8	99.8
R_Date NZA-53598	2870	2715	95.4	2864	2755	95.4	92.1	99.8
R_Date NZA-53597	2855	2705	95.4	2860	2750	95.4	75.5	99.8
R_Date NZA-53601	2924	2740	95.4	2879	2766	95.4	120.3	99.8
R_Date NZA-53599	2934	2745	95.4	2880	2770	95.4	121.8	99.8
Boundary End 1				2845	2729	95.4		99.1

Indices A model 111.5 A overall 110.3

extent of this offset as one approaches the equator. This is a problem which exists, of course, on both sides of the equator.

The dates were analysed as a combined single uniform phase (Bronk-Ramsey 2009). The results of the analysis generated a very good level of the Agreement (> 60%) and Convergence (> 95%) indices suggesting that the prior uniform phase model agrees well with the observations and the MCMC (Markov Chain Monte Carlo) algorithm is effective in producing a representative set of posterior probability distributions. The dark lines in Figure 4 indicate the calibrated ages (priors) and the solid area the modelled result. The analysis indicates an upper limit of the age of the site at a 95% probability interval (HPD) of 2920 to 2793 cal BP and a lower limit at 2845 to 2729 cal BP. The available data therefore support the argument that the site is considerably younger than previously estimated.

Figure 5 and Table 3 provide an identical analysis of the available dates from Nenumbo (SE-RF-2) (Jones *et al.* 2007) using a ΔR of −20±62 ^{14}C. The analysis indicates an upper limit of the age of the site at a 95% HPD interval of 3185 to 2785 cal BP and a lower limit at 2993 to 2639 cal BP. These results would indicate that there is a considerable probability that this site is older than SZ-8 and very likely overlaps it. Figure 5 also indicates that the probability that the site is older than 3000 cal BP is very low.

DISCUSSION AND COMPARISON WITH OTHER EARLY LAPITA SITES IN REMOTE OCEANIA

The results of this analysis agree very well with the results from recent analysis of chronology at other sites in Remote Oceania which appear to be early in the colonisation phase. Recent reporting (Petchey *et al.* 2014) of the comprehensive dating of 36 burials and 5 *conus* rings from the Teouma site on Efate in Vanuatu concludes, following Bayesian analysis, that initial use of the site may have been as early as 2970 cal BP with regular use by circa 2940–2880 cal BP (68% HPD)[1]. This is considerably younger than the initial estimate for the age of the site based on the then age of the Reef/Santa Cruz sites (Bedford, Spriggs, and Regenvanu 2006).This site has a number of characteristics which suggest it is early including a considerable amount of obsidian from the Bismarck Archipelago (Reepmeyer *et al.* 2010) and isotopic data on human remains which suggests that some individuals at the site who had been given special burial treatment had originated outside of Efate and possibly in the Bismarck Archipelago (Bentley *et al.* 2007).

In Fiji the Bourewa site has been argued to be occupied very early and might possibly be a founding settlement. The dating of this site has been difficult given considerable disturbance. However recent careful review of the chronology (Nunn and Petchey 2013) has indicated that this site was initially occupied in the period 2866–2771 cal BP (95.4%). The authors conclude that the only other reliably dated early site in the Fijian archipelago is Matanamuani (VL 21/5) site on Naigani Island (Irwin *et al.* 2011). Our Bayesian analysis of all the dates from that

1 Petchey (pers com) reports that the unpublished 95% HPD is 2980–2850 cal BP with earliest possible use at 3020 cal BP.

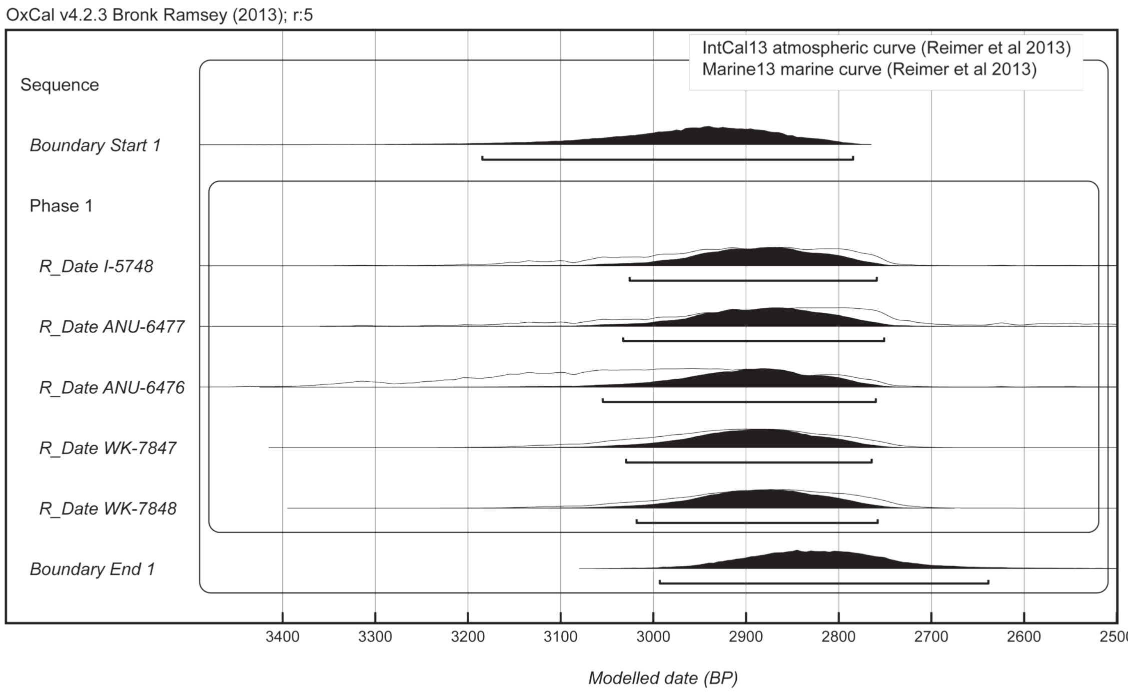

Figure 5. Single phase Bayesian analysis of dates from Nenumbo (SE-RF-2)

Table 3. *Results of Bayesian Analysis for all dates from Nenumbo (SE-RF-2).*

	Unmodelled (BP)			Modelled (BP)			Indices	
Name	**from**	**to**	**%**	**from**	**to**	**%**	**A**	**C**
Sequence								
Boundary Start 1				3185	2785	95.4	97.8	
Phase 1								
R_Date I-5748	3164	2741	95.4	3026	2759	95.4	118.7	99.6
R_Date ANU-6477	3207	2493	95.4	3033	2751	95.4	123.9	99.6
R_Date ANU-6476	3339	2750	95.4	3055	2760	95.4	113.7	99.6
Curve Marine13								
Delta_R LocalMarine	–143.5	103.5	95.4	–122	70	95.4	111.3	99.6
R_Date WK-7847	3100	2740	95.4	3030	2765	95.4	114.4	99.6
R_Date WK-7848	3072	2727	95.4	3018	2758	95.4	112.8	99.6
Boundary End 1				2993	2639	95.4		98.2

Combined Indices A model 152.3 A overall 143

site reports an upper boundary of 3117 to 2858 cal BP (95% HPD) however one (WK-10295) of the two charcoal dates has very poor agreement (A=39%) with the one phase model. Irwin *et al.* (2011: 72) have also noted that this date is considerably older than the others and suggest the unidentified wood may have in-built age. The other charcoal date (WK-10294) is identified as grass or palm frond and calibrates to 3020–2790 (95% HPD) and re-running the analysis without WK-10295 produces an upper boundary for the site of 3001–2790 cal BP (95% HPD). This site has a number of signatures of early status. It has the largest amount of obsidian from the Bismarck Archipelago in the Fijian sites albeit only 3 pieces and the faunal assemblage includes very large shellfish and extinct iguana, crocodile and bird indicative of a very early settlement (Irwin *et al.* 2011: 75).

Although some of the earliest dates determined on Lapita sites in Remote Oceania are from New Caledonia they now suffer from the fact that all of the charcoal dates are on unidentified charcoal and the errors on many of the dates are very large (Sand 1997: Table 1; 1998; 2010: 71–96). The earliest dates on Lapita material in New Caledonia are from site WKO013A/B (Lapita) although there is one date (Beta-92755 CRA 3050±80) on charcoal from site KVO003

(St Maurice-Vatcha) which equals the oldest radiocarbon age at the Lapita site. Sand has indicated that these sites and that of Nessiadou (WBR001) and Goro (SGO015) which date slightly younger are among the oldest sites in La Grande Terre. While in the Loyalty Islands early dates are reported from the bottom of the Kurin site (LPO023) on Maré (Sand 2010: 95). Bayesian analysis (using IntCal 13) of the eight dates on Lapita levels from WKO013A/B reported in Sand (1997: Table 1) generate an upper boundary age from one phase of 3496 to 2973 cal BP (95% HPD). As noted by Sand (1997) the oldest charcoal dates most probably suffer from inbuilt age. The one shell date (Beta-55998 2970±60 *Anadara scapha*) calibrates (ΔR −3±9 [Petchey *et al.* 2008]) to 2908 to 2610 cal BP (95% HPD). Similar analysis of the 6 unidentified charcoal dates on Lapita levels from KVO003 minus the one date (ANU-262) with an error of ±165 produces an upper boundary of 3449 to 2878 cal BP (95% HPD). As can be seen from the plot of the Vatcha dates (Figure 6) the modelled probability of occupation before 3000 cal BP is very small. Other indicators of early status of these sites are few however these are the only sites with Bismarck Archipelago obsidian reported from New Caledonia, although the amounts are very small with four flakes from Vatcha and one from Lapita (Sand and Sheppard 2000). The early dates from the Kurin site which Sand suggests (2010: 94–95) is amongst the earliest sites in New Caledonia suffer from rather large errors on unidentified wood (Beta 118334 2920±110 BP; Beta 118335 2900±60). These give calibrated ranges (95% CI) using Intercal13 of 3400–2750 BP (Beta 118334) and 3210–2870 BP (Beta 118335). It seems probable that these sites represent the initial period of settlement of New Caledonia and although the chronology is still poorly resolved we would agree with Sand and Sheppard (2000: 238) that initial settlement at the Lapita and Vatcha sites likely dates in the period 3000 to 2900 cal BP. Most recently in his comprehensive review of Lapita chronology in New Caledonia Sand has suggested that Lapita and Kurin sites are slightly older dating to '1050 BC' (Sand 2010: 94).

We return now to the only site in Remote Oceania which has a series of dates which all tend older than 3000 cal BP. That is the site of Makué excavated by Galipaud on

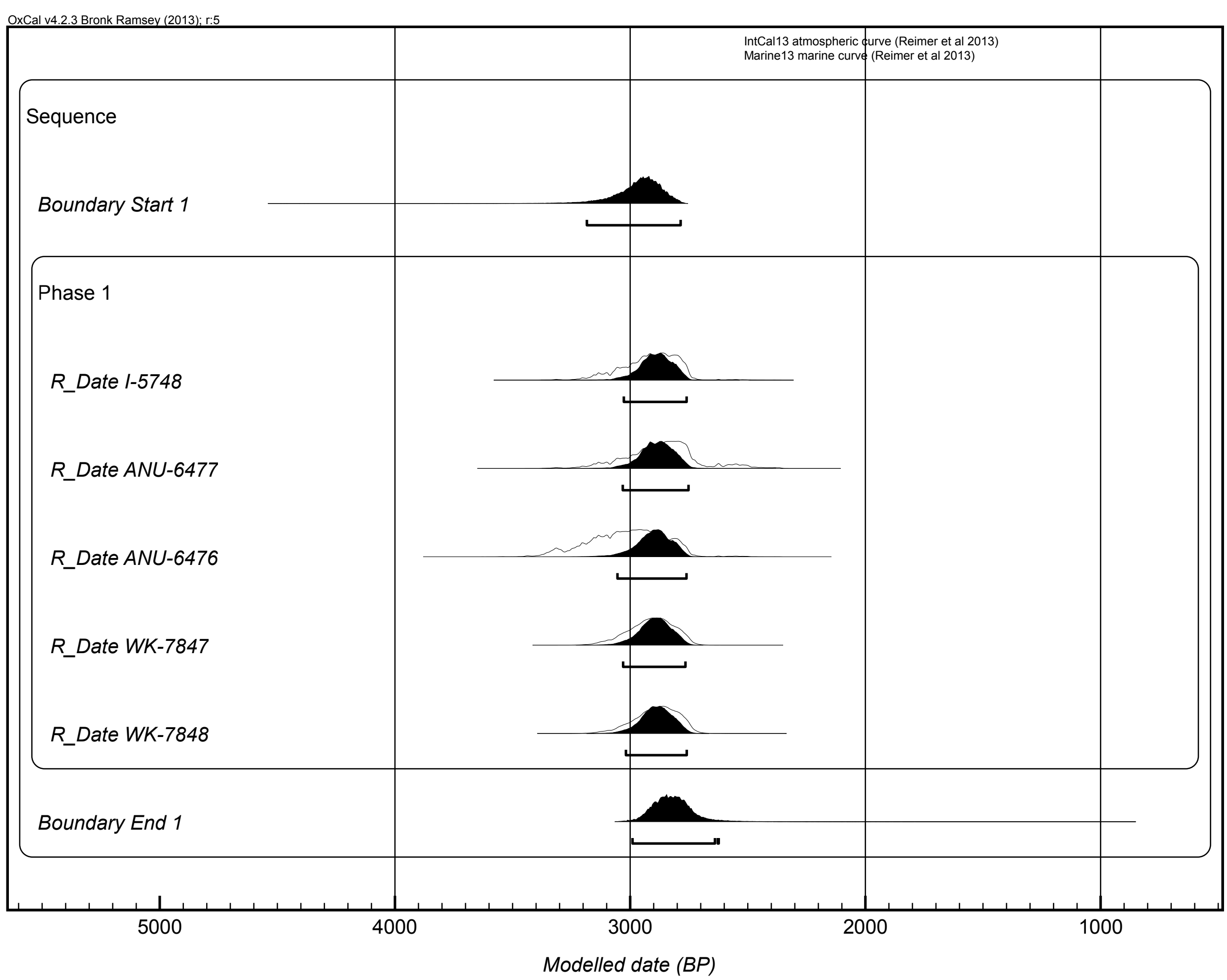

Figure 6. Single phase Bayesian analysis of dates from Vatcha, Isle des Pins, New Caledonia (KVO03).

Santo in northern Vanuatu. The Bayesian one phase analysis of the seven dates on unidentified charcoal reported by Galipaud and Swete-Kelly (2007) generates an upper boundary estimate of 3313 to 3008 cal BP (95% HPD). As can be seen from Figure 7 the probability that the sites dates earlier than 3000 cal BP is very high assuming the charcoal does not have significant in-built age. The presence of a considerable amount (87 pieces) of Bismarck obsidian at the site as well as fine dentate ceramic and turtle bone would suggest it represents an early occupation. There are no shell dates clearly identified with the site however a shell (*Hippopus hippopus)* collected by Galipaud and described as archaeological from Mauké was dated (HhES 3625±30 bp) as part of a study of the El Nino-southern Oscillation during the Lapita period (Duprey *et al.* 2014). This returned a calibrated age (ΔR 29±28 (Petchey *et al.* 2008)) of 3597 to 3379 cal BP (95% HPD) and is clearly too early. Given that this site produces a series of dates which appear to be anomalous we need to treat that data with caution until additional dates on identified wood or shell are provided.

CONCLUSION

In a recent publication reporting Bayesian analysis of Lapita associated dates from the Bismarck Archipelago and Remote Oceania Denham *et al.* (2012) have concluded, regarding the timing of settlement of Remote Oceania, that:

> The dispersal of Lapita pottery to Vanuatu occurred at 3430–3030 cal BP (95.4%) and 3250–3100 cal BP (68.2%). The dispersal of Lapita pottery to Fiji occurred at 3290–2970 cal BP (95.4%) and 3130–3010 cal BP (68.2%). Current radiocarbon dating is suggestive of a slightly earlier dispersal of Lapita pottery to Vanuatu than to Fiji, and is slightly earlier than previously considered (Bedford *et al.*2006; Clark and Anderson 2009). (Denham, Bronk-Ramsey, and Specht 2012: 44).

In their analysis Denham *et al.* (2012) limited their study to charcoal samples, all of which were unidentified and did not use samples from the Reef/Santa Cruz sites as they had large errors. The resulting dataset is heavily

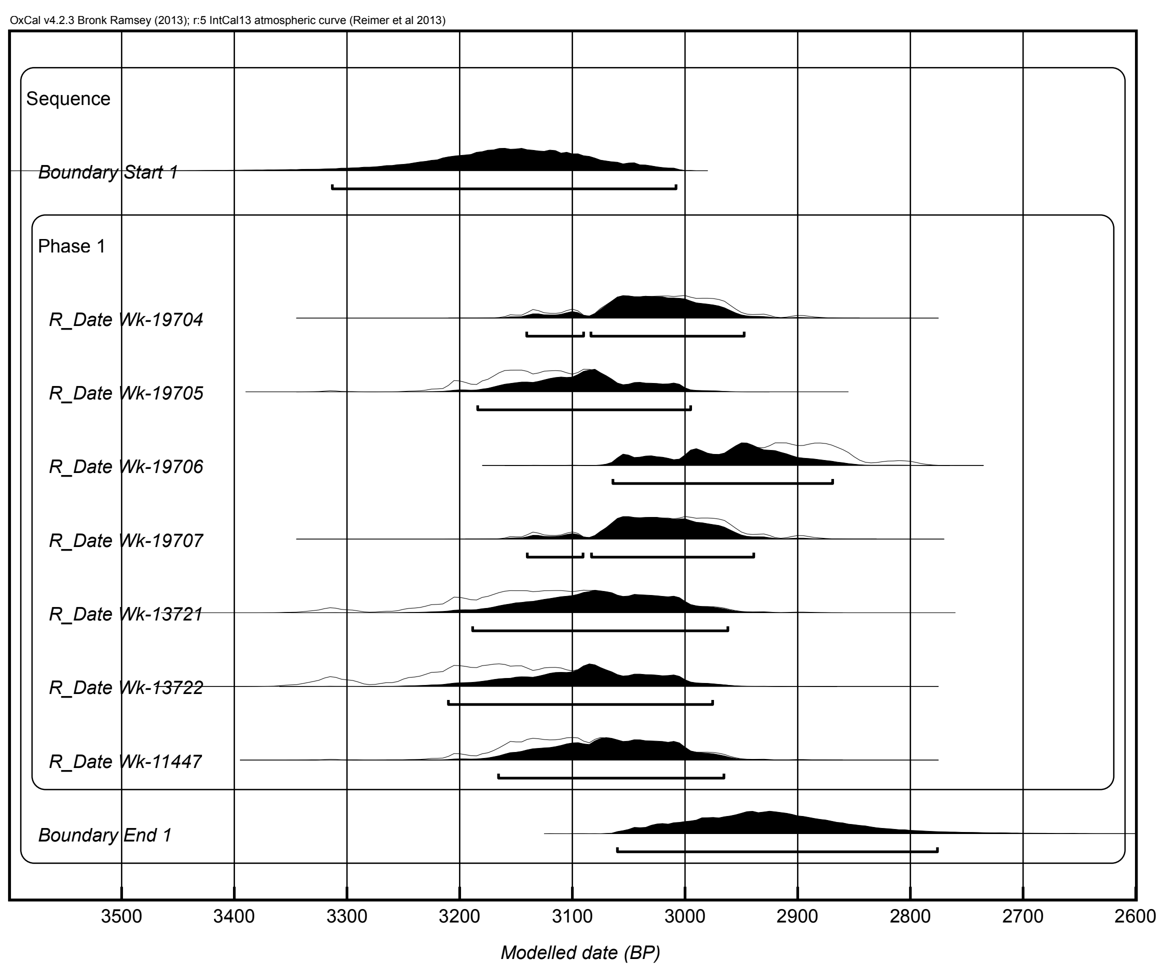

Figure 7. Single phase Bayesian analysis of dates from Maké, Aore Island Espiritu Santo, Vanuatu.

biased then to the samples from Makué on Vanuatu and samples from the disturbed site of Bourewa in Fiji. Despite the laudable attempt to improve analysis by applying a form of chronometric hygiene to the available dates they fail to sufficiently consider the potential problems of old wood or poor sample context. Recent publication has also, of course, provided much better data for Bourewa (Nunn and Petchey 2013) and Teouma (Petchey *et al*. 2014) which is included here. Given those results and our analysis we would have to conclude that the probability that the initial settlement of Remote Oceania was earlier than 3000 BP is very low, although the data from Kurin and Makué may push that slightly earlier.

The implications of this result are significant for our understanding of the process of Lapita expansion. A younger date for the movement into Remote Oceania increases the time for development of Lapita culture in the Bismarck Archipelago. If we follow the Denham *et al.* (2012) estimate of the youngest possible ages for the appearance of Lapita in the Bismarck Archipelago then we now have 250 years before the movement into Remote Oceania allowing some time for the build-up of population or spread of the cultural tradition prior to the expansion. There is now no close correlation with the massive WK-2 eruption on New Britain dated at 3480–3150 (95% HPD) cal. BP which has been suggested as a possible impetus for Lapita period population dislocation and movement (Petrie and Torrence 2008). The movement event is now clearly extremely rapid, with no potential for a staging period in the Reef/Santa Cruz. It would appear that within at most a few generations Lapita settlement extended as far south as New Caledonia and east to Fiji. There is clearly no evidence for a standard wave of advance model based on a demographic driver to explain the Lapita expansion. As argued earlier (Sheppard 2011; Sheppard and Walter 2006) the speed of movement into Remote Oceania can be explained only by a direct leap-frog movement from the Bismarck Archipelago over 2000 km out to the Reef/Santa Cruz and evidence continues to accumulate to support that hypothesis (Duggan *et al*. 2014). Once into Remote Oceania it would appear that pull factors promoted an almost continuous expansion, possibly through a series of leap-frogs, into new resource rich islands with earliest populations carrying with them some traces of their origins in the form of obsidian from the Bismarck Archipelago.

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