

NEW DIRECTION IN HUMAN COLONISATION OF THE PACIFIC:

Lapita Settlement of South Coast New Guinea

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Abstract

Expansion of Austronesian-speaking peoples from the Bismarck Archipelago out into the Pacific commencing c.3300 cal BP represents the last great chapter of human global colonisation. The earliest migrants were bearers of finely-made dentate-stamped Lapita pottery, hitherto found only across Island Melanesia and western Polynesia. We document the first known occurrence of Lapita peoples on the New Guinea mainland.

The new Lapita sites date from 2900 to 2500 cal BP and represent a newly-discovered migratory arm of Lapita expansions that moved westwards along the southern New Guinea coast towards Australia. These marine specialists ate shellfish, fish and marine turtles along the Papua New Guinea mainland coast, reflecting subsistence continuities with local pre-Lapita peoples dating back to 4200 cal BP. Lapita artefacts include characteristic ceramics, shell armbands, stone adzes and obsidian tools. Our Lapita discoveries support hypotheses for the migration of pottery-bearing Melanesian marine specialists into Torres Strait of northeast Australia c.2500 cal BP.

Introduction

Around 3300 cal BP a distinctive type of pottery with finely-executed dentate-stamped designs and labelled 'Lapita' arose in the Bismarck Archipelago of northeastern Papua New Guinea and continued in various forms through to sometime between 2600 and 2200 cal BP (Summerhayes 2007, 2010a, 2010b:95). Soon after its development, bearers of this pottery began migrating eastwards to commence the great 4500km-long colonisation process of

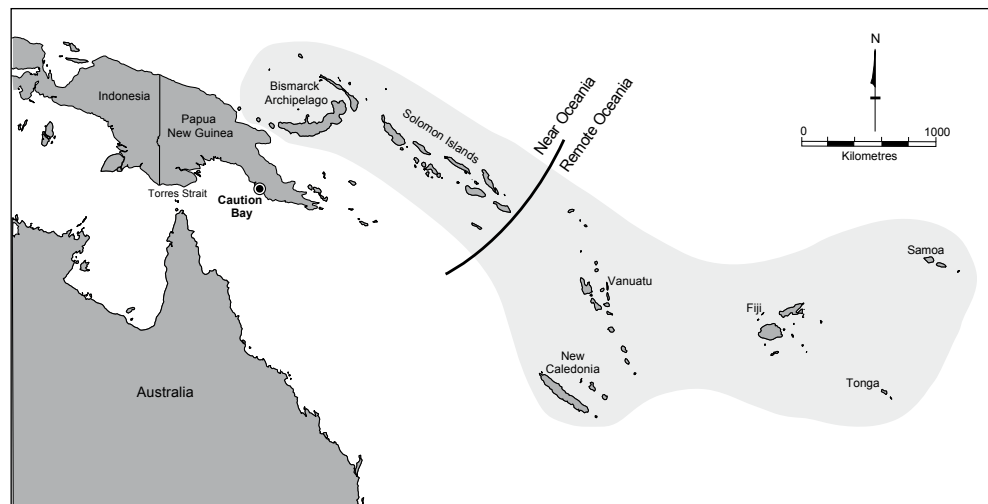


Figure 1 Study area (light grey shading indicates previously-known distribution of Lapita).

the Pacific. East of the Bismarcks, Lapita colonisers have been documented in Remote Oceania in the Reef/Santa Cruz Islands (c.3200 cal BP) (Green *et al.* 2008), Vanuatu, New Caledonia and Fiji (c.3000 cal BP) (Bedford *et al.* 2006; Clark and Anderson 2009:175), Tonga (c.2900 cal BP) (Burley and Connaughton 2007) and Samoa (c.2700 cal BP) (Rieth *et al.* 2008) (Figure 1). Despite the status of Papua New Guinea (specifically the Bismarck Archipelago) as the homeland of Lapita pottery, no Lapita sites have been documented on the New Guinea mainland and the landmass appeared to have been 'avoided by Lapita makers and users' (Lilley 2008:79). The earliest mainland pottery documented was the first phase of the Early Papuan Pottery tradition (EPP) dated to 2000 cal BP on the south coast of Papua New Guinea (Summerhayes and Allen 2007). However, red-slipped pottery dating to c.2500 cal BP in Torres Strait adjacent to the central south coast of New Guinea, and made with tempers consistent with local geological sources, was hypothesised to have been made locally by peoples with ancestral connections to pottery-making peoples of the Gulf of Papua (McNiven *et al.* 2006). A major implication of this hypothesis was that pottery along the south coast of Papua New Guinea must date to earlier than 2000 cal BP, and thus at least 500 years older than the earliest known ceramics from the south coast of Papua New Guinea, with deeper ancestral connections back to Lapita peoples of the Bismarck Archipelago. Recent discoveries of undecorated pottery dating to 2300–2800 cal BP on Wari Island off the far southeast corner of mainland Papua New Guinea gave partial support to this hypothesis (Negishi and Ono 2009).

In 2009–2010, we excavated nine sites with Lapita pottery at Caution Bay located 20km northwest of Port Moresby, southern Papua New Guinea (Figure 1). Here Lapita pottery first appears 2900 cal BP with pre-ceramic occupation extending back to at

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Figure 2 Bogi 1 during excavation, March 2010. The dense layer of shell midden deposit exposed in the section next to the lower set of steps dates to 2600–2900 cal BP and contains the deepest and oldest Lapita pottery in the site. Partly excavated pre-Lapita burial (bottom left-hand corner of the excavation pit) (Photograph: Rob Skelly).

least 4200 cal BP and what is the earliest known evidence for human settlement of the south coast of New Guinea.

Caution Bay Lapita Sites

The Lapita sites are located within an area extending 6.5km along the coast and up to 1.75km inland. This makes Caution Bay the largest contiguous Lapita landscape found anywhere in the Pacific. Sites occur along a linear sand spit backing the shoreline (sites Bogi 1, JD17, JD6, JD10 and JD14) and on low grassy hills with clay sediments (sites JA1, RS63, Moiapu 1 and Edubu 1). Initial AMS radiocarbon dating indicates that at least two of the

frontal dune sites (Bogi 1 and JD6) were occupied intermittently for the past 4200 years. Other sites (e.g. Edubu 1, Moiapu 1) reveal shorter-term occupation. We present major finds from these sites and demonstrate that together they conform to key markers of the ‘Lapita cultural complex’ (Green 1979:31; Kirch 1997; Spriggs 1997). In addition, we illustrate the high stratigraphic integrity of sites with the long-term sequence at Bogi 1. Here, as at all sites, fine-grained excavations were undertaken using 2–3cm thick Excavation Units (XUs) following the stratigraphy to allow detailed analyses and high resolution understandings of depositional history and cultural change. Charcoal samples for radiocarbon dating and significant cultural materials (e.g. decorated sherds) were plotted in three dimensions. Excavated sediments were wet sieved through 2.1mm mesh.

Bogi 1 Stratigraphy and Chronology

An 8m x 9m pit divided into 1m x 1m squares was excavated at Bogi 1 to a depth of 3.5m in central Squares C and D (Figure 2). Sediments are mostly aeolian dune sands. Stratigraphic Units (SUs) were differentiated by changes in sediment texture and colour and the density of midden deposits (Figure 3). Cultural materials such as stone artefacts, charcoal, shells and animal bones occur in varying densities from the ground surface to a depth of at least 2.5m. Below 2.0m, calcium carbonate concretions increase in density with a zone of cemented sediments located 3.0–3.3m below the surface.

Twenty-four AMS radiocarbon dates on single fragments of charcoal are available for Squares C and D (Table 1, Figure 4). The single anomalous ‘modern’ date (XU20a, Square C) probably

Table 1 AMS radiocarbon ages (charcoal) for Squares C and D, Bogi 1. *Median probability of calibrated dates rounded to the nearest 50 years.

Lab. Code	Square	XU (Sample #)	Depth (cm)	$\delta^{13}C\%$ (± 0.2)	^{14}C Age (years BP)	Calibrated Age BP (95.4% probability)	Calibrated Age BP (circa*)
Wk-28266	C	6 (2)	11.0	-26.7	1603 \pm 30	1411-1548	1500
Wk-28267	C	8 (2)	13.8	-25.0	1599 \pm 30	1410-1545	1450
Wk-28268	C	11 (3)	22.0	-27.1	1537 \pm 30	1359-1518	1450
Wk-30458	C	15a (1)	28.3-30.5	-24.5	2090 \pm 25	1994-2128	2050
Wk-29210	C	17a	33.3-36.2	-23.8	2148 \pm 32	2006-2305	2150
Wk-29211	C	20a	40.3-43.0	-14.9	105.8 \pm 0.4%	modern	modern
Wk-28270	C	24a (3)	53.0	0.0	2147 \pm 30	2007-2304	2150
Wk-28271	C	29a (2)	65.4	-25.2	2159 \pm 30	2053-2307	2150
Wk-27500	C	36a (1)	84.4	-28.4	2223 \pm 30	2152-2332	2250
Wk- 29953	C	53 (1)	116	-	2448 \pm 25	2359-2700	2500
Wk-29954	C	58 (4)	128	-23.3	2508 \pm 25	2488-2733	2600
Wk-27713	D	60 (2)	132.8	-24.6	2538 \pm 30	2494-2746	2650
Wk-27712	D	61 (1)	136.4	-25.8	2537 \pm 30	2494-2746	2650
Wk-27711	D	63 (1)	142.5	0.0	2775 \pm 30	2791-2949	2850
Wk-27707	D	67a (1)	150.8	-26.5	2783 \pm 30	2793-2955	2900
Wk-30465	C	72 (1)	164.4-167.2	-27.5	3491 \pm 25	3695-3835	3750
Wk-27710	D	74 (1)	169.7	-22.5	2533 \pm 30	2492-2745	2600
Wk-29956	C	81 (1)	188	-26.8	3667 \pm 25	3914-4084	4000
Wk-27708	D	84 (1)	194.1	-25.1	3826 \pm 30	4096-4406	4200
Wk-28272	C	90 (1)	209.8	-25.9	3824 \pm 30	4095-4405	4200
Wk-28273	C	93 (2)	215.7-218.1	0.0	3811 \pm 30	4089-4350	4200
Wk-28274	C	100 (1)	233.2	-24.2	3833 \pm 30	4103-4406	4250
Wk-28275	C	104 (1)	242.3-244.5	-25.4	3816 \pm 30	4091-4382	4200
Wk-28278	C	127 (1)	301.3	-25.6	4053 \pm 30	4428-4784	4550

reflects dating of light-weight plant material (e.g. grass) that inadvertently blew into the pit during excavation, a conclusion consistent with the $\delta^{13}\text{C}$ value of $-14.9 \pm 0.2\text{‰}$ (Bender 1971). In contrast to most other carbon dates, this dated material was obtained from the sieves (it was not a 3D-plotted *in situ* sample), and came from the first XU excavated after the pit had been exposed for two days. Dates were determined by the University of Waikato Radiocarbon Dating Laboratory and calibrated into calendar years using the online calibration programme Calib 6.0 and the IntCal09 dataset (Reimer *et al.* 2009; Stuiver and Reimer 1993). Dates range from 1450 cal BP near the surface down to 4550 cal BP at a depth of 301cm. The series of dates is generally in chronological order with depth, suggesting little or no significant post-depositional disturbance of sediments. The three major midden concentrations date to c.2000–2150 cal BP (SUs 5–6), 2600–2900 cal BP (SU7B and lower 7A), and >3000–4200 cal BP (upper SU8). At the top of the stratigraphic sequence, SUs 1–4 largely date to c.1500 cal BP and seal the uppermost midden concentration of SUs 5–6 from later cultural activity. There is no archaeological or geomorphological evidence that the area of Bogi 1 was ever used for recent gardening activity, thereby avoiding this potential source of sediment disturbance often problematic at other Pacific Lapita sites. Occupational continuity between the upper two midden concentrations is indicated by intervening radiocarbon dates and cultural materials, including pottery evidencing the *in situ* transformation of design conventions through time. In contrast, little activity, and possibly an occupational hiatus exists between the two lower midden concentrations.

Pottery

The deepest 3D-plotted sherd at Bogi 1 lying flat in original depositional context comes from a depth of 154cm (Square C) dating to 2900 cal BP. Between 155cm and 127cm below the surface in Squares C and D a total of 32 pottery sherds were plotted in 3D, revealing the earliest unambiguous presence of pottery at the site. Of these, 14 sherds were lying flat, suggesting strongly that they are *in situ* and have undergone little if any post-depositional movement/disturbance. Similarly, a concentration of

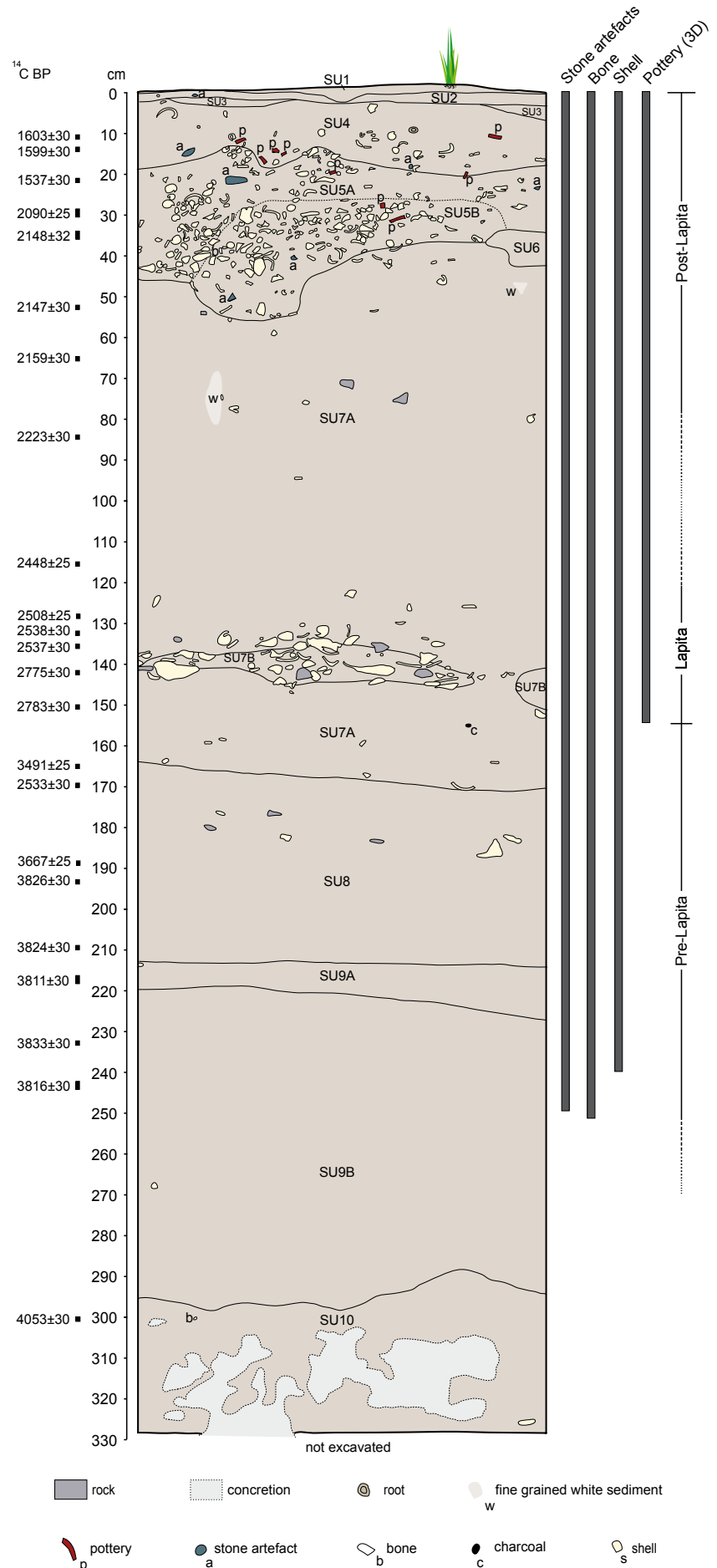


Figure 3 Stratigraphy of Square D, Bogi 1.

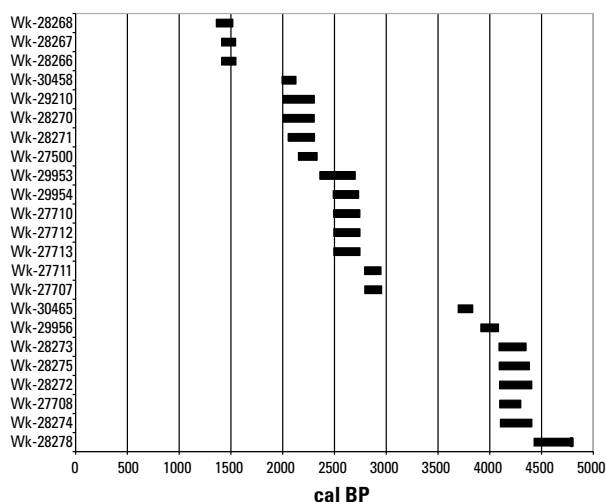


Figure 4 AMS radiocarbon dates (calibrated 95.4% probability range) for Squares C and D, Bogi 1 (excluding anomalous modern date).

over 20 3D-plotted sherds lying flat and deriving from a single pot was recovered from Square F (located next to Square D) between 140cm and 150cm below the surface. These two groups of more than 50 sherds date to between 2600 and 2900 cal BP. Given pottery sherds are found throughout the upper 155cm of deposit, pottery use at Bogi 1 dates from 2900 cal BP to 2000 cal BP.

Comb dentate-stamped Lapita pottery dates from 2900 cal BP and gives way to sparsely-decorated, shell valve end-impressed curvilinear designs and structurally simple geometric comb dentate-stamped designs below the lip sometime between 2500 and 2250 cal BP, which then give way to shell valve end-impressed dentate designs. Lapita pottery is represented by a range of vessel shapes including low-fired, thick-walled carinated and sometimes collared vessels, but no flat-bottomed vessels are present. Decoration includes comb dentate (including needlepoint as well as relatively broad-tined) stamping and red-slipping. Incised designs are virtually absent. A common theme that characterises the Caution Bay Lapita sites is impressed parallel (usually paired) sets of single-curve impressions made with a narrow tool (sometimes tined, sometimes continuous-edged) repeated in various combinations across the upper part of pots (Figure 5). A single comb-impressed, shallow cylinder stand fragment has been found, indicating that unlike the situation further to the northeast, cylinder stands are rare. The face design typically found in other Lapita regions is entirely absent.

Food Remains

The Caution Bay Lapita peoples were characteristically 'harvesting the sea' (Kirch 1997, 2010). Sites reveal exploitation of over 130 species of shellfish (e.g. *Anadara* spp., *Gafrarium* spp., *Ostrea* spp., *Pinctada* spp., *Strombus* spp. and *Cerithidea* spp.) from a range of sandy, rocky and muddy intertidal habitats. Other marine foods include reef-dwelling parrotfish (Scaridae), wrasse (Labridae), sea urchin and crab, with marine hunting using canoes indicated by bones of marine turtle (probably *Chelondia mydas*). Catfish (Ariidae) bones reveal exploitation of estuarine/freshwater habitats. Marine subsistence was supplemented by terrestrial fauna, in particular macropods (e.g. *Macropus agilis*). Like many Lapita sites, bird bones are rare.

Shell and Stone Artefacts

Typical of Lapita sites elsewhere (Szabó 2010), Caution Bay Lapita sites contain a variety of shell artefacts. Most common are ground, narrow rings (typical of Lapita armbands) made from cone shell (*Conus* sp.) and clam shell (*Tridacna* sp.); broad rings are also present but less common (Figure 6). Shell fishhooks, rare in Lapita sites more generally, are absent.

Stone artefacts in Caution Bay Lapita sites represent the familiar technological repertoire of ground stone (igneous) adzes and flakes (mostly unretouched) of chert and obsidian (e.g. Sheppard 2010). While chert is plentiful locally, adzes were probably imported from the mountainous hinterland while the nearest source of obsidian is West Fergusson Island located 500km to the southeast (Irwin and Holdaway 1996). In Square C at Bogi 1, obsidian starts at XU53 (c.2500 cal BP) but only becomes a regular part of stone artefact assemblages after XU39 dating to c.2500–2250 cal BP. While importation and long-distance movement of obsidian is a key dimension of Lapita exchange systems (Summerhayes 2009), at Caution Bay obsidian use dates to the end of the Lapita period and is more a feature of post-Lapita assemblages, as has been found elsewhere along the southeast Papuan coast (Irwin and Holdaway 1996; Allen *et al.* 2011).

Pre-Lapita Burial

A flexed human burial was recovered from pre-ceramic cultural deposits at a depth of 195cm at Bogi 1 (Figures 2, 7). The burial was associated with shell grave-goods (e.g. *Pinctada* sp., *Tridacna* sp.) grouped into two clusters located on the left and right side of the body. The absence of pottery in the grave fill suggests strongly that the burial is pre-ceramic in age and thus dates to before 2900 cal BP. As the burial pit was excavated into sediments dating to 4200 cal BP, the burial is bracketed in age between 2900 and 4200 cal BP. More precise dating will need to await the results of direct radiocarbon dating of human bone. Whatever the case, these remains represent the first complete human burial recovered from beneath Lapita levels in the Pacific.

Food remains (shells and bones of fish and turtle) in the lower levels of Bogi 1 and JD6 confirm that pre-Lapita peoples of Caution Bay were marine specialists similar to subsequent Lapita peoples. Shell grave-goods indicate this maritime economic orientation extended to the ritual realm. Ground-stone adzes indicate similar continuities, including fully-ground adzes dating to c.4200 cal BP.

Conclusions

The Caution Bay Lapita sites have overturned decades of archaeological orthodoxy which characterised Lapita as an exclusive phenomenon of Island Melanesia but not mainland New Guinea. It is now clear that Lapita colonisers moving out of the Bismarck Archipelago not only moved eastwards into the Pacific but also south and then westwards along the Papua New Guinea south coast. The presence of Lapita at Caution Bay at 2900 cal BP is synchronous with the Lapita colonisation of Remote Oceania 3000–2900 cal BP. Unlike Remote Oceania, however, pre-Lapita occupation at Bogi 1 and JD6 indicates that Caution Bay Lapita peoples colonised a previously settled coastline. As with the significant issue of the Lapita/pre-Lapita boundary in the Bismarcks (Specht 2009), the extent to which

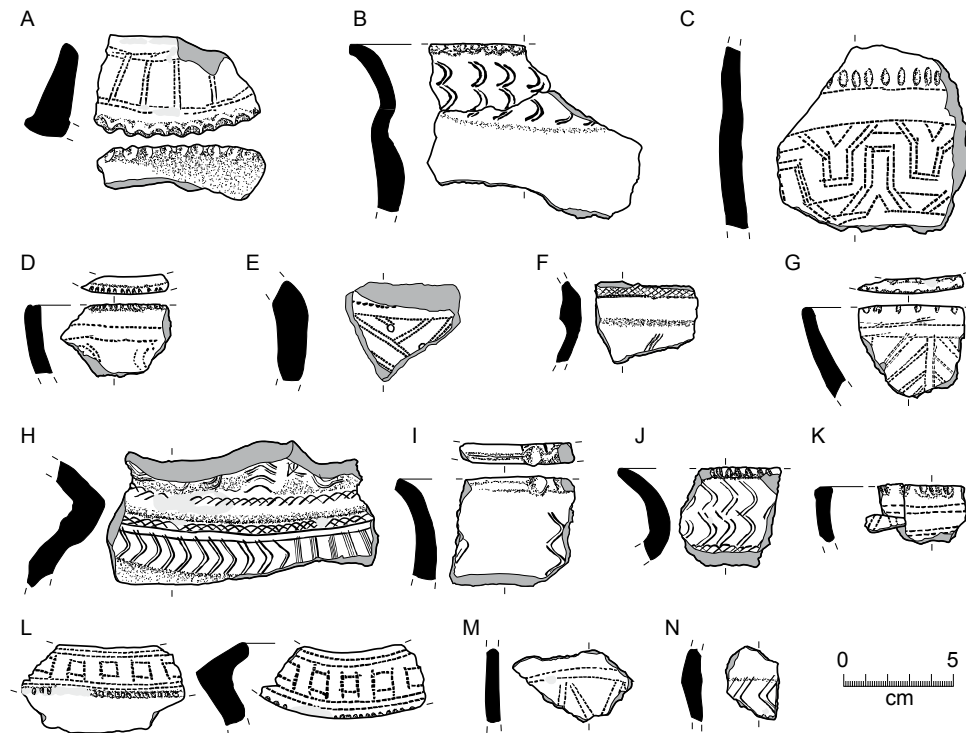


Figure 5 Lapita pottery from Caution Bay dating between 2900 and 2500 cal BP. A, B, F, G, K, L, M: site Bogi 1; C, D: site Moiapu 1; E, H, I, J: site JD6 and N: site JD17.

an occupational hiatus exists at this boundary at Caution Bay remains to be determined. Whatever the case, Caution Bay provides a unique opportunity on a landscape scale to explore the extent to which Lapita settlement was a negotiated process of social interaction and accommodation.

The ensemble of Lapita sites at Caution Bay spanning at least 400 years indicates a locally-viable Lapita community and not simply Lapita transients. Unprecedented in most other Lapita contexts, the Caution Bay sites provide an opportunity to examine localised Lapita village differentiation and interaction on a landscape scale, in addition to more conventional investigations of long-distance exchange networks. Most significantly, more than 1200 years of continuous occupation and ceramics from Lapita into the period of the earliest hitherto-documented evidence of ceramics along the south coast of mainland Papua New Guinea, followed by the presence of later ceramics, provides a unique opportunity to understand both Lapita transformations on a landscape scale and the origins and development of later ceramic assemblages leading into the ethnographic period (Allen *et al.* 2011).

Finally, the presence of Lapita peoples on the southern New Guinea coast at 2900 cal BP raises the question of the western limit of these migrating peoples. Pottery dating back to c.2500 cal BP in Torres Strait located 500km west of Caution Bay suggests influences from the Papua New Guinea mainland and/or from long-distance seafaring ceramicists. While recent DNA analyses found no recent Melanesian intrusions into Aboriginal Australia (Hudjashov *et al.* 2007), such conclusions are premature given analytical exclusion of relevant DNA samples from northeast Australia. The presence of pottery-bearing Melanesian peoples on Australia's doorstep allows hypotheses for Melanesian cultural influences down the Australian east coast over the past 3000 years (Barham 2000; Barker 2004:148) plausibly to include genetic transfers and even migration.

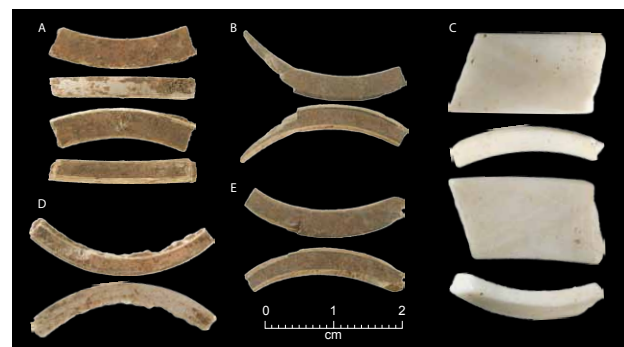


Figure 6 Lapita shell artefacts from Caution Bay dating to c.2600–2500 cal BP. A: site Moiapu 1; B: site JA1; C: site JD14; D: site Moiapu 1; E: site JA1 (Photograph: Steve Morton).



Figure 7 Pre-Lapita burial dating to between 2900 and 4200 cal BP, Bogi 1 (Photograph: Ian J. McNiven).

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References

- Allen, J., G. Summerhayes, H. Mandui and M. Leavesley 2011 New data from Oposisi: Implications for the Early Papuan Pottery phase. *Journal of Pacific Archaeology* 2(1):69-81.
- Barham, A.J. 2000 Late Holocene maritime societies in the Torres Strait Islands, northern Australia – Cultural arrival or cultural emergence? In S. O'Connor and P. Veth (eds), *East of Wallace's Line: Studies of Past and Present Maritime Cultures of the Indo-Pacific Region*, pp.223-314. Modern Quaternary Research in Southeast Asia 16. Rotterdam: A.A. Balkema.
- Barker, B. 2004 *The Sea People: Late Holocene Maritime Specialisation in the Whitsunday Islands, Central Queensland*. Terra Australis 20. Canberra: Pandanus Books.
- Bedford, S., M. Spriggs and R. Regenvanu 2006 The Teouma Lapita site and the early human settlement of the Pacific Islands. *Antiquity* 80:812-827.
- Bender, M.M. 1971 Variations in the ¹³C/¹²C ratios of plants in relation to the pathway of photosynthetic carbon dioxide fixation. *Phytochemistry* 10:1239-1244.
- Burley, D.V. and S.P. Connaughton 2007 First Lapita settlement and its chronology in Vava'u, Kingdom of Tonga. *Radiocarbon* 49(1):131-137.
- Clark, G. and A. Anderson 2009 Site chronology and a review of radiocarbon dates from Fiji. In G. Clark and A. Anderson (eds), *The Early Prehistory of Fiji*, pp.153-182. Terra Australis 31. Canberra: ANU E Press.
- Green, R. 1979 Lapita. In J.D. Jennings (ed.), *The Prehistory of Polynesia*, pp.27-60. Canberra: ANU Press.
- Green, R.C., M. Jones and P. Sheppard 2008 The reconstructed environment and absolute dating of SE-SZ-8 Lapita site on Nendö, Santa Cruz, Solomon Islands. *Archaeology in Oceania* 43(2):49-61.
- Hudjashov, G., T. Kivisild, P.A. Underhill, P. Endicott, J.J. Sanchez, A.A. Lin, P. Shen, P. Oefner, C. Renfrew, R. Villems and P. Forster 2007 Revealing the prehistoric settlement of Australia by Y chromosome and mtDNA analysis. *Proceedings of the National Academy of Sciences* 104(21):8726-8730.
- Irwin, G. and S. Holdaway 1996 Colonisation, trade and exchange: From Papua to Lapita. In J. Davidson, G. Irwin, F. Leach, A. Pawley and D. Brown (eds), *Oceanic Culture History: Essays in Honour of Roger Green*, pp.225-235. Dunedin: New Zealand Journal of Archaeology Special Publication.
- Kirch, P.V. 1997 *The Lapita Peoples*. Cambridge: Blackwell.
- Kirch, P.V. 2010 Between garden and reef: Lapita ecology and subsistence. In C. Sand and S. Bedford (eds), *Lapita: Oceanic Ancestors*, pp.253-267. Paris: Musée Du Quai Branley.
- Lilley, I. 2008 Flights of fancy: Fractal geometry, the Lapita dispersal and punctuated colonisation in the Pacific. In G. Clark, F. Leach and S. O'Connor (eds), *Islands of Inquiry: Colonisation, Seafaring and the Archaeology of Maritime Landscapes*, pp.75-86. Terra Australis 29. Canberra: ANU E Press.
- McNiven, I.J., W.R. Dickinson, B. David, M. Weisler, F. von Gnielinski, M. Carter and U. Zoppi 2006 Mask Cave: Red-slipped pottery and the Australian-Papuan settlement of Zenadh Kes (Torres Strait). *Archaeology in Oceania* 41(2):49-81.
- Negishi, Y. and R. Ono 2009 Kasasinabwana shell midden: The prehistoric ceramic sequence of Wari Island in the Massim, eastern Papua New Guinea. *People and Culture in Oceania* 25:23-52.
- Reimer, P.J., M.G.L. Baillie, E. Bard, A. Bayliss, J.W. Beck, P.G. Blackwell, C. Bronk Ramsey, C.E. Buck, G.S. Burr, R.L. Edwards, M. Friedrich, P.M. Grootes, T.P. Guilderson, I. Hajdas, T.J. Heaton, A.G. Hogg, K.A. Hughen, K.F. Kaiser, B. Kromer, F.G. McCormac, S.W. Manning, R.W. Reimer, D.A. Richards, J.R. Southon, S. Talamo, C.S.M. Turney, J. van der Plicht and C.E. Weyhenmeyer 2009 IntCal09 and Marine09 radiocarbon age calibration curves, 0-50,000 years cal BP. *Radiocarbon* 51(4):1111-1150.
- Rieth, T.M., A.E. Morrison and D.J. Addison 2008 The temporal and spatial patterning of the initial settlement of Sāmoa. *Journal of Island and Coastal Archaeology* 3:214-239.
- Sheppard, P. 2010 Lapita stone tool technology. In C. Sand and S. Bedford (eds), *Lapita: Oceanic Ancestors*, pp.241-251. Paris: Musée Du Quai Branley.
- Specht, J. 2009 The aceramic to ceramic boundary in the Bismarck archipelago. In P.J. Sheppard, T. Thomas and G.R. Summerhayes (eds), *Lapita: Ancestors and Descendants*, pp.11-34. New Zealand Archaeological Association Monograph 28. Auckland: New Zealand Archaeological Association.
- Spriggs, M. 1997 *The Island Melanesians*. Oxford: Blackwell.
- Stuiver, M. and P.J. Reimer 1993 Extended ¹⁴C database and revised CALIB radiocarbon calibration program. *Radiocarbon* 35:215-230.
- Summerhayes, G.R. 2007 The rise and transformation of Lapita in the Bismarck Archipelago. In S. Chui and C. Sand (eds), *From Southeast Asia to the Pacific: Archaeological Perspectives on the Austronesian Expansion and the Lapita Cultural Complex*, pp.129-172. Taipei: Academia Sinica.
- Summerhayes, G.R. 2009 Obsidian network patterns in Melanesia – Sources, characterisation and distribution. *Bulletin of the Indo-Pacific Prehistory Association* 29:110-124.
- Summerhayes, G.R. 2010a Lapita interaction – An update. In M. Gadu and Hsiu-man Lin (eds), *International Symposium on Austronesian Studies*, pp.11-40. Taitong: National Museum of Prehistory.
- Summerhayes, G.R. 2010b The emergence of the Lapita cultural complex in the Bismarck Archipelago. In C. Sand and S. Bedford (eds), *Lapita: Oceanic Ancestors*, pp.93-101. Paris: Musée Du Quai Branley.
- Summerhayes, G.R. and J. Allen 2007 Lapita writ small. In S. Bedford, C. Sand and S.P. Connaughton (eds), *Oceanic Explorations: Lapita and Western Pacific Settlement*, pp.97-122. Terra Australis 26. Canberra: ANU E Press.
- Szabó, K. 2010 Shell artefacts and shell-working within the Lapita Cultural Complex. *Journal of Pacific Archaeology* 1:115-127.