Routledge
Taylor & Francis Group

The Journal of Island and Coastal Archaeology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/uica20

The intentional variability of Lapita pottery fabrics

Mathieu Leclerc, Tracey Pilgrim, Kristine Hardy, Matthew Spriggs, Stuart Bedford & Numa F. Longga

To cite this article: Mathieu Leclerc, Tracey Pilgrim, Kristine Hardy, Matthew Spriggs, Stuart Bedford & Numa F. Longga (07 Nov 2023): The intentional variability of Lapita pottery fabrics, The Journal of Island and Coastal Archaeology, DOI: 10.1080/15564894.2023.2251115

To link to this article: https://doi.org/10.1080/15564894.2023.2251115

THE JOURNAL OF ISLAND AND COASTAL ARCHAEOLOGY
https://doi.org/10.1080/15564894.2023.2251115

The intentional variability of Lapita pottery fabrics

Mathieu Leclerc[a,b], Tracey Pilgrim[a], Kristine Hardy[a], Matthew Spriggs[a,c], Stuart Bedford[d,e], and Numa F. Longga[f]

[a]School of Archaeology and Anthropology, College of Arts and Social Sciences, The Australian National University, Canberra, ACT, Australia; [b]Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage, School of Culture, History and Language, Australian National University, Canberra, ACT, Australia; [c]Vanuatu Cultural Centre, Port Vila, Vanuatu; [d]Archaeology and Natural History, School of Culture, History and Language, College of Asia and the Pacific Australian National University, ACT, Australia; [e]Max Planck Institute for Evolutionary Anthropology Department of Linguistic and Cultural Evolution, Leipzig, Germany; [f]Malakula Cultural Centre, Lakatoro, Vanuatu

ABSTRACT

Results from petrographic and chemical analysis of decorated Lapita pottery from Vao, Vanuatu show that the majority was manufactured locally but that several variations of local raw materials were used. This indicates that temper material was collected from a range of settings, most of them accessible locally on Malakula. Two samples have temper corresponding with raw materials expected from the island of Efate in central Vanuatu where other significant Lapita sites are located. This pattern of fabric variability parallels recurrent practices documented at other founder Lapita sites, including Teouma on Efate. We propose that mobility and experimentation are not the only explanations available to justify the greater initial variability in raw materials used for pottery manufacturing at founder Lapita settlements. We argue that the variability of raw material results from a purposeful strategy guided by cultural norms or rules similar to those directing other behaviors associated with decorated Lapita pots, such as decorative motifs, paint application, vessel forms, and deliberate burial.

ARTICLE HISTORY
Received 15 March 2022;
Accepted 12 August 2023

KEYWORDS
Technology; ceramic; Vanuatu; Pacific; temper

Introduction

Lapita pottery signals the first appearance of pottery in the southwest Pacific with its earliest appearance in the Bismarck Archipelago dating back to around 3300–3100 BP. It rapidly spread further southeast following populations and/or social networks before eventually reaching previously unpopulated Remote Oceania (Bedford and Spriggs 2019). Lapita sites are documented from most major island groups between the Reef-Santa Cruz Islands and Tonga/Samoa, including Vanuatu.

The main tools used to monitor the movement of pottery across the Pacific are petrography and chemical analysis (e.g., Burley and Dickinson 2010; Chiu et al. 2020; Dickinson

CONTACT Mathieu Leclerc mathieu.leclerc@anu.edu.au School of Archaeology and Anthropology, College of Arts and Social Sciences, The Australian National University, Canberra, ACT, Australia

Supplemental data for this article can be accessed online at https://doi.org/10.1080/15564894.2023.2251115.

2006, 2021). These analyses have revealed a recurrent pattern across Lapita sites in Near and Remote Oceania. There is generally a wider variability of pottery fabrics during the earlier phases of occupation compared to later in time, when a much more limited range of fabrics is used (e.g., Anson 1999; Best 2002; Green and Anson 1991; Hogg, Summerhayes, and Chen 2021; Hunt 1989; Leclerc 2019; Summerhayes 2000).

This has been observed at several founder Lapita sites (i.e., sites that are amongst the earliest Lapita sites in their region and where there is clear evidence that the Lapita cultural system and its underlying social values were still relevant at the time of initial occupation). In Remote Oceania, behaviors associated with Lapita were followed by the emergence of distinctive regional practices after a few centuries at most (Anderson 2001; Bedford 2006a; Sand, Bolé, and Ouetcho 2011). The brevity of Lapita occupations allows us to identify founder sites accurately based on criteria such as the dates of these occupations; the significant presence of dentate-stamped decorations, specific motifs, and vessel forms such as cylinder stands and large carinated vessels; the dominance of obsidian from West New Britain (Kutau/Talasea); and the presence of extinct fauna such as tortoises and flightless birds (Sheppard 1993; Summerhayes 2009).

In Near Oceania, the wider variability of pottery fabrics during the earlier phases of occupation is interpreted as revealing the higher mobility of primary migratory groups compared to later generations, an argument also supported by obsidian distribution and vessel form (Hogg, Summerhayes, and Chen 2021; Summerhayes 2000, 2003, 2004; Wu 2016). It has also been suggested that the initial variability in raw materials may reflect a technological experimentation phase following arrival into a new territory (Ambrose 2007; Summerhayes and Allen 2007).

These assumptions are difficult to test and fine-grained comparisons between sites are difficult, mostly because of the large distance between Lapita sites where detailed information about pottery fabrics is available. There is little doubt that Lapita groups were highly mobile (Anderson 2001, 2003), but the direct causality between mobility and variability in fabrics deserves to be questioned further.

The relatively dense Lapita-scape across the Vanuatu archipelago provides an opportunity to address this issue by allowing refined comparisons between assemblages that are close geographically and chronologically (Bedford 2019; Bedford et al. 2010; Bedford, Spriggs, and Regenvanu 2006). As has been highlighted before, greater attention to scale and timing when studying the minor variations within Lapita is necessary to assess intra-Lapita diversity (Bedford 2019; Bedford and Spriggs 2008; Sand 2015). Here, the pottery collections from Vao and Teouma allow us to investigate the variations in pottery manufacturing and raw material procurement over a short period of time at nearby Lapita founder settlements (Figure 1).

The Teouma cemetery site is firmly recognized as relating to a founder settlement dating back to 2940–2710 cal BP based on studies on ancient DNA (aDNA), pottery, and obsidian (Petchey et al. 2014, 2015; Skoglund et al. 2016). Various aspects of the dentate-stamped pottery assemblage from Teouma are documented elsewhere, including decorations, vessel forms, and fabric types (Bedford et al. 2010; Dickinson, Bedford, and Spriggs 2013; Leclerc et al. 2019). Eight different types of pottery fabrics were identified at Teouma, with local and exotic provenances identified (Dickinson, Bedford, and Spriggs 2013). Even though Vao was probably occupied slightly later than Teouma and

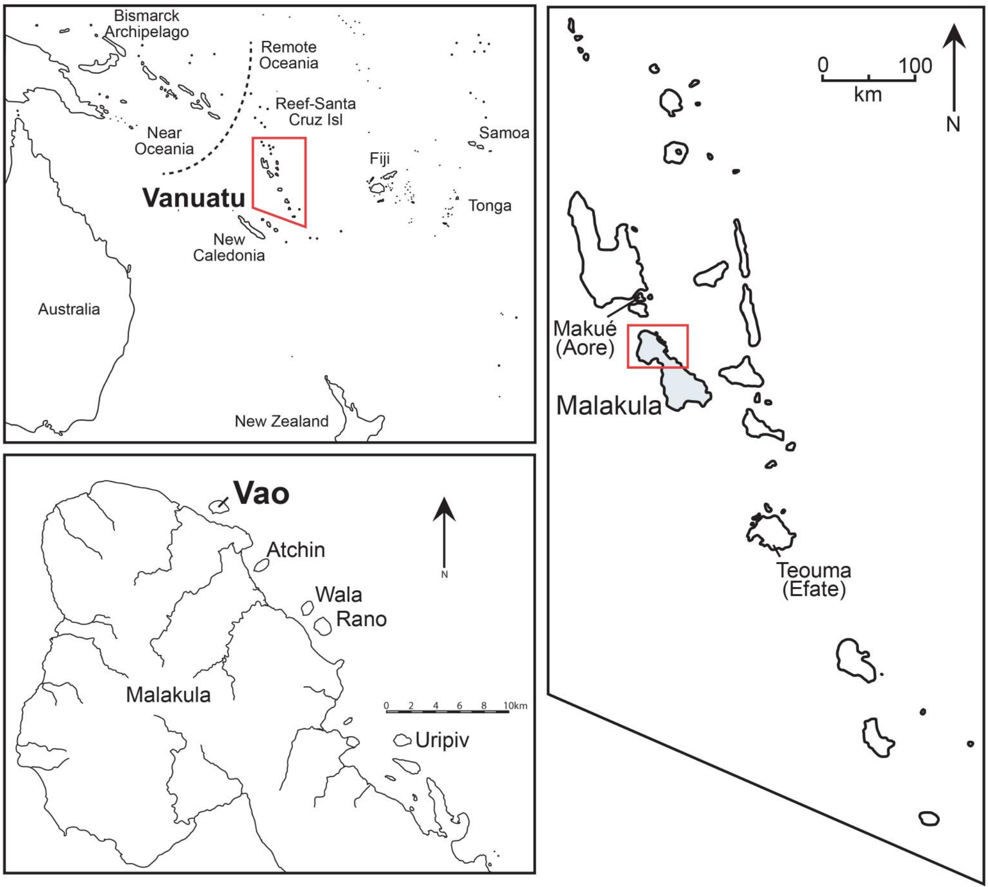

Figure 1. Location of Vanuatu and the Lapita sites of Vao and Teouma.

Makué (another founder site on Aore Island in northern Vanuatu), the Vao site is considered a primary colonizing Lapita center in the north of the archipelago based on the start date of occupation 2996–2880 cal BP/2925–2800 cal BP and the documented (albeit rare) presence of obsidian from West New Britain as well as bones of an extinct tortoise (Bedford 2019).

The substantial assemblages from Vao and Teouma and their close geographic and chronological proximity provide a unique opportunity to investigate the fine-grained variations of dentate-stamped pottery manufacturing practices in space and time. Fabric types for decorated Lapita vessels at the Vao site are described using a combination of petrographic and chemical data. The comparison of the results with petrographic data from other founder Lapita settlements allows us to reassess the models connecting variability of fabrics with mobility or experimentation.

Similar to other types of productions, pottery manufacturing is embedded in the social fabric and its practice is associated with learning processes and specific social relationships (Gosselain 1992; Lemonnier 1993). While the technological decisions taken during the manufacturing process are influenced by environmental and functional contexts, they are also guided by cultural values; the manufacturing process cannot operate independently of the society that produces the material (Lechtman 1977; Lemonnier 1986). We propose here that the raw materials selected to manufacture decorated Lapita pottery were connected to the ways these peoples gave meaning to their surroundings.

Materials and methods

Vanuatu is a key region for understanding the first settlement of Remote Oceania, thanks to its geographic location and the extensive archaeological work undertaken across the archipelago (Bedford 2006a; Garanger 1972). This situation has resulted in the identification of at least 30 Lapita sites across Vanuatu, including major sites at Teouma on Efate Island (Bedford et al. 2010) and at Makué on Aore Island where the earliest human presence in Vanuatu has been dated to 3180–3000 cal BP (3330–2940, 2σ) (Galipaud et al. 2014, recalibrated in Shaw et al. 2022). The smaller islands at the southeastern tip of Espiritu Santo and the chain of islets off the northeastern coast of Malakula (where Vao is located) host a cluster of Lapita sites with significant pottery assemblages (Bedford 2007; Bedford et al. 2011; Bedford and Spriggs 2008).

Vao

Of the chain of islets off the northeastern coast of Malakula, namely Wala, Atchin, Uripiv, and Vao, all host Lapita sites (Bedford 2015). The islet of Vao is the northernmost of the islets and is the closest to Malo (19 km) and Aore (33 km). The islet of Vao is limestone where non-calcareous detritus should not be present except possibly from volcanic tephra airborne to Vao from elsewhere in Vanuatu (Dickinson 2003; Mitchell and Warden 1971). The larger island of Malakula is primarily limestone overlying the original basaltic and andesitic volcanic bedrock dating from the late Oligocene to the middle Miocene (Bergeot et al. 2009; Carney and MacFarlane 1982).

The site is located on the sheltered west side of the islet on an uplifted back beach terrace facing the island of Malakula (Bedford et al. 2011, 28). Excavations on Vao revealed a well-preserved Lapita midden with material sealed beneath a heavily compacted layer made of locally imported worn branch coral, pebbles, and tephra-laden soil (Bedford 2007, 188; Bedford et al. 2011, 28). Settlements on the northeastern Malakula islets lasted from 2900 to 2600 BP and the initial settlement of Vao around ca. 2900 BP occurred slightly earlier than on the rest (Bedford 2007, 189; Bedford et al. 2011, 34). Conventional radiocarbon and AMS dates obtained from charcoal recovered from the concentrated Lapita layer were dated back to 2776 ± 38 BP (Wk 14040; 2948–2782 cal BP) and 2839 ± 40 BP (Wk 14041; 3077–2847 cal BP) (Bedford 2006b, 549). Several elements such as the decorations on pottery, vessel forms, and the quantities of obsidian and tortoise bones reveal "that Vao was almost certainly occupied earlier than Uripiv and may even have acted as an initial and primary colonizing Lapita center in northeastern Malakula," but "the pottery and obsidian suggest a later settlement for the Malakula sites than at Makue and Teouma" even though the radiocarbon ages overlap (Bedford 2019, 231).

The range of decorated Lapita vessel forms at Vao includes carinated vessels, shallow and deeper incurving bowls, and occasional flat-bottomed dishes (Bedford 2019).

The carinated vessels at Vao are distinctively small and tend to be “softly curved rather than angular” and dominantly have incurving rims (Bedford 2019). Globular plainware vessels with outcurving rims were also found in association, and a number of incised sherds have been recorded (Bedford 2007, 189). The assemblage also revealed evidence showing that red and/or gray and/or white painting had been applied after firing on exclusively dentate-decorated Lapita sherds (Bedford 2006b).

Prior fabric studies

Previous petrographic analysis of dentate-stamped sherds from Vao by William Dickinson provided a comparative framework for this study. His examination of 22 Lapita sherds revealed that all but one sherd had a mineralogical content corresponding to a “local” origin from Malakula (Dickinson 2003). The sherds displayed texturally varied albeit generically related non-placer lithic-rich volcanic sand tempers with a range of mineral grains corresponding with the Lower to Middle Miocene bedrock assemblage of Malakula (Dickinson 1995, 4). The volcanic tempers were composed principally of felsitic volcanic rock fragments together with plagioclase, clinopyroxene, hornblende, opaque iron oxides, and occasionally calcareous grains. Six distinctive types of non-placer tempers were identified, revealing that various stream and coastal beach sands were sampled from different inland and coastal locations on Malakula (Dickinson 2003). This variability is more significant than would be expected if a “limited textural and compositional range reflecting some preferred temper source” had been used (Dickinson 2003, 4). Prior chemical analysis has also demonstrated the significant variability of the Vao collection compared to other sites in the archipelago (Leclerc 2016, 213–25). The exotic sample identified by Dickinson contained a high content of volcanic glass fragments with microvesicular texture, probably derived from reworked deposits of pumice breccia on Efate (Dickinson, Bedford, and Spriggs 2013).

Analysis

Thirty-one pottery samples were analyzed for this project: 28 dentate-stamped, two incised (va40 and va44), and one with applied relief decoration (va43). The sampling was made based on criteria related to the size and condition of the sherds in order to include the full range of fabric types. Every dentate-stamped sample and one of the incised samples (va40) were recovered from the Lapita layer. The other incised (va44) and the applied relief (va43) samples are associated with more recent horizons (Figure 2).

Forty elements were analyzed by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS): 7Li, 11B, 23Na, 24 Mg, 27Al, 29Si, 39K, 43Ca, 47Ti, 51V, 55Mn, 57Fe, 59Co, 60Ni, 65Cu, 66Zn, 71Ga, 72Ge, 75As, 85Rb, 88Sr, 89Y, 90Zr, 93Nb, 95Mo, 118Sn, 133Cs, 137Ba, 139La, 140Ce, 146Nd, 147Sm, 157Gd, 163Dy, 166Er, 172Yb, 178Hf, 208Pb, 232Th, and 238 U. A principal component analysis (PCA) involving the log-10 values of 18 elements (Na, Al, K, Ca, Ti, V, Fe, Co, Rb, Sr, Y, Zr, Nb, Sn, Nd, Hf, Pb, Th) resulted in three interpretable components, representing 86.3% of the original variance (Norman and Streiner 2008, 211–4). The principal component scores

Figure 2. Decorated pottery samples from the Lapita site on Vao analyzed by LA-ICP-MS.

were then grouped by a hierarchical clustering analysis using the Average/Centroid method and were performed with the software JMP 15 (SAS Institute Inc 2019).

Following the chemical analysis, petrography was performed on diagnostic samples for each cluster. Thin sections for va14, va20, va30, va33, va38, and va44 were observed under a polarizing microscope to identify the mineral grains present in the fabric. Thin sections were observed at a range of magnifications from 20× to 200× under plane-polarized light (PPL) and cross-polarized light (XPL) using an Olympus BX53R optical polarizing microscope with DP74 camera microscopes. Stitched photomicrographs of each sample at 40× magnification in PPL and XPL can be found in the Supplementary Material.

Results

The hierarchical clustering of geochemical compositions reveals four main clusters (Figure 3). The majority (28/31) of the samples are grouped into two large clusters representing an array of local fabrics with inclusions typical of Malakula geology. Neither cluster is associated with a homogeneous fabric. Chemical and petrographic analysis reveals several variants of local fabrics and degrees of placering, indicating that different environments were sampled for raw materials. What results is a gradational continuum of related temper sands, as illustrated by the distribution of the PCA scores, particularly for the component associated with Ti, V, Fe, and Co (Figure 4). Both samples post-dating the Lapita occupation (va43 and va44) group together among other samples manufactured with raw materials available locally. Three samples (va33, va14, and va42) display distinctive attributes as discussed below.

Cluster Orange

The petrographic study showed that approximately 90% of inclusions were of medium sand-sized, micritic-textured calcareous grains, including a few skeletal grains, likely of beach sand origin. The sample showed a much higher concentration of Ca and Sr compared with others in this study, which is consistent with a hybrid temper originating from a marine environment. The moderate sorting and rounded morphology of the grains indicate that the temper source had been exposed to aqueous or wave action erosion conditions. There is also an absence of coarser microspar amongst the calcareous inclusions, which is the usual indicator of detritus originating from uplifted limestone terraces (Dickinson 2003).

The base clay used to form sample va33 is terrigenous and therefore of separate origin to the temper. The orange-brown clay matrix is moderately heterogeneous under both plane and crossed-polarized light, with a fine fraction of significantly altered, iron-rich rock fragment inclusions which exhibited an opaque, dark red-brown to black color in PPL. Three coarse sand-sized, iron-rich inclusions can also be observed in the sample but it is likely that these are natural to the clay source.

Cluster Red

This cluster is comprised of va14 and va42, two samples noticeably different from the rest of the collection. Both share similar distinctive features, notably a red slip, a paste with a distinctive orange color, and comparatively higher levels of Al, Pb, Hf, Zr, and Th. Despite their very similar profiles, their different decorative motifs suggest it is unlikely they originate from the same vessel, even though they were recovered from the same stratigraphic unit.

Petrographic analysis of sample va14 showed a fabric characterized by poorly sorted temper of vitroclastic origin within an iron-rich, pink-red, silty clay matrix. The dominant

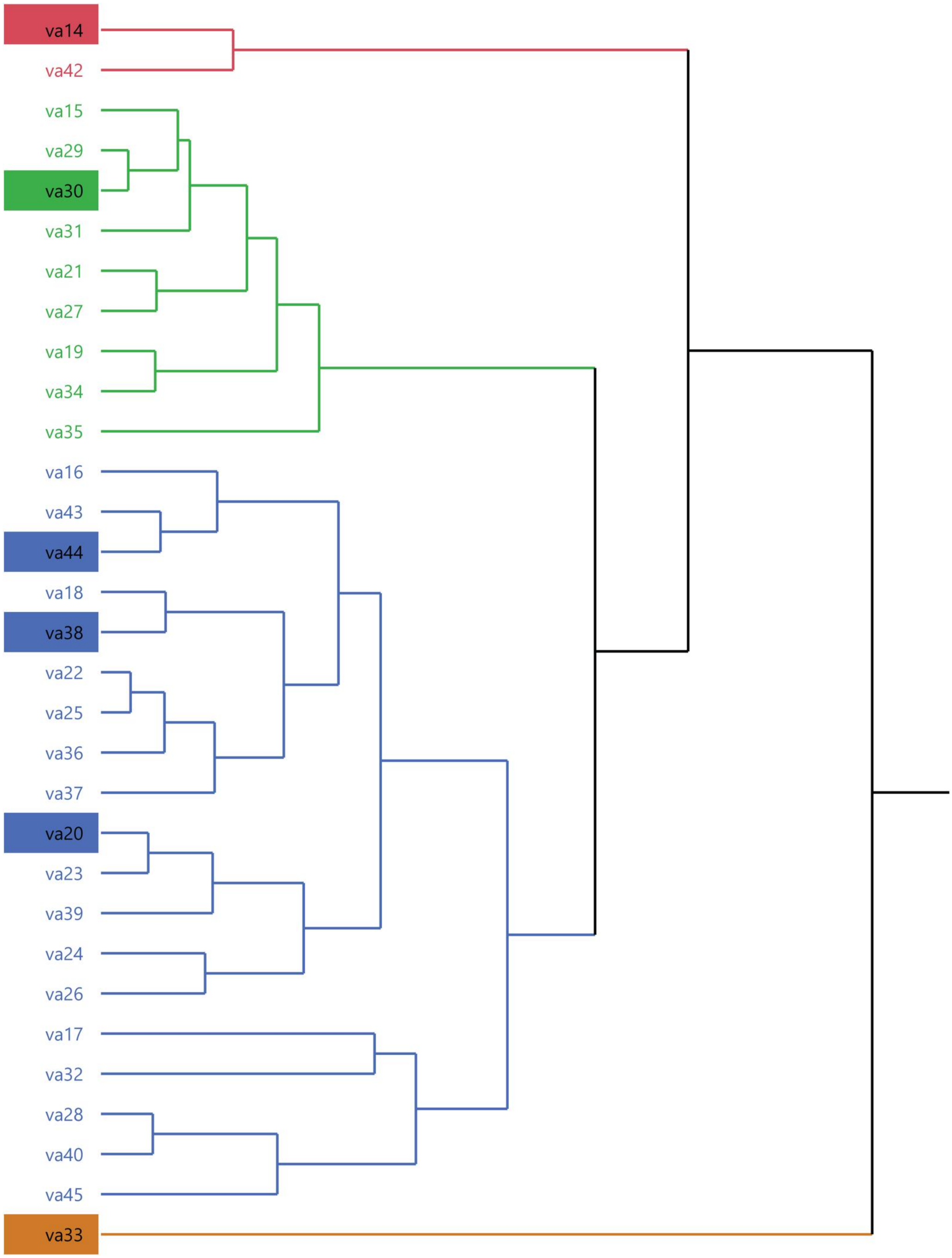

Figure 3. Dendrogram resulting from the hierarchical clustering analysis using the Average/Centroid method. The four fabric types identified are identified by colors.

inclusions are tan-colored, felsic volcanic glass with internal pumiceous texture, followed by subangular opaque iron (probably magnetite) and clinopyroxene mineral grains (Figure 5). There are also minor plagioclase inclusions in varying stages of alteration. Sub-

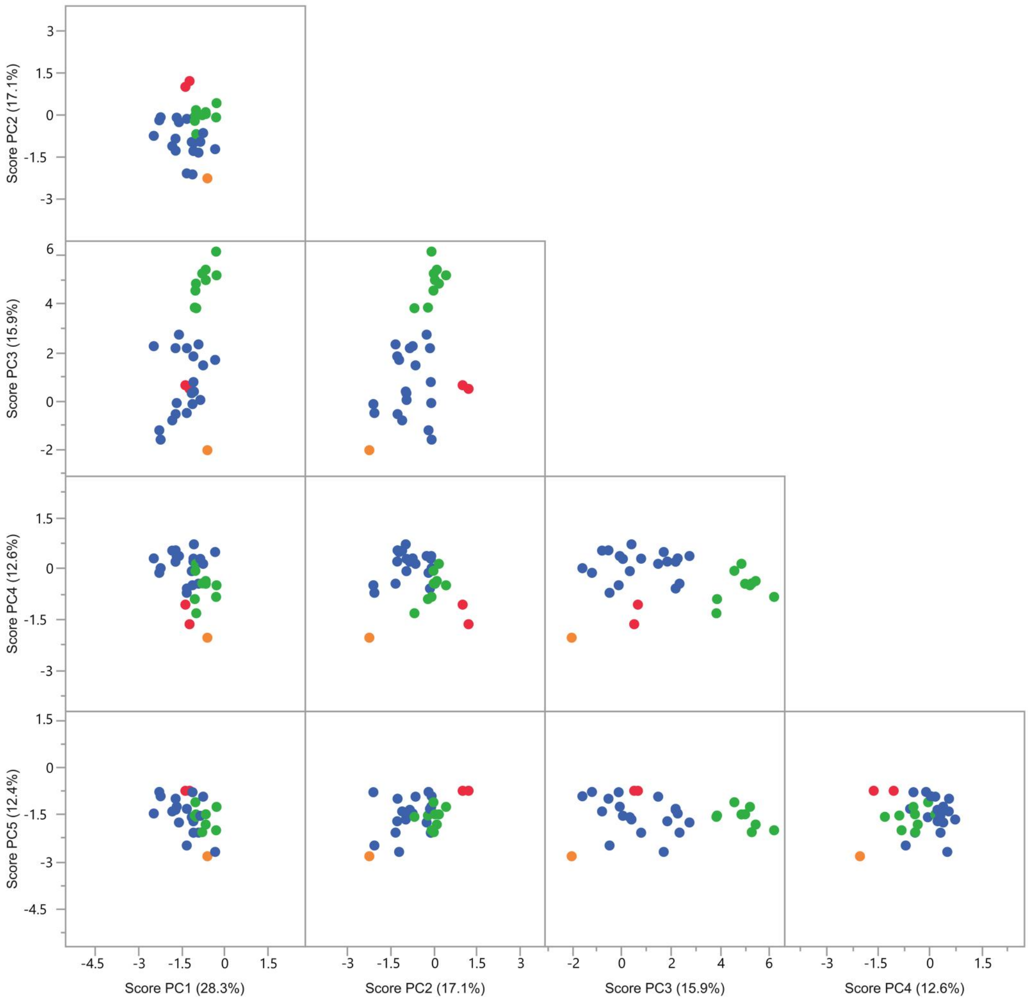

Figure 4. Scatter plot of the rotated PCA scores for samples from Vao. The range of values on the axes was determined based on the range of values obtained from the analysis of 112 archaeological pottery samples from sites in Vanuatu (Vao, Mangaasi, Chachara, Tenmiel, Tenmaru, Albalak, and Teouma; see Leclerc et al. 2019 for details). There is significant variability at Vao, particularly for PC3. The variables loading significantly are Na, K, Rb for PC1; Nb, Zr, Sn, Hf, Pb, Th for PC2; Ti, V, Fe, Co for PC3; Y, rare earth elements for PC4; Al, Ca, Sr for PC5. The clusters are identified by their colors.

rounded, intermediate igneous rock fragments with an intersertal texture of plagioclase and magnetite are also present in minor amounts but the glassy components of the inclusions can be in varying stages of devitrification. The higher Al content identified by LA-ICP-MS can be explained by the presence of volcanic rock fragments from the intermediate to felsic end of the composition spectrum, which are enriched in feldspars.

Cluster Blue

Sample va44's fabric is characterized by poorly sorted, coarse to fine sand-sized temper of andesitic origin within a silty, orange- to red-brown clay matrix. The sample features

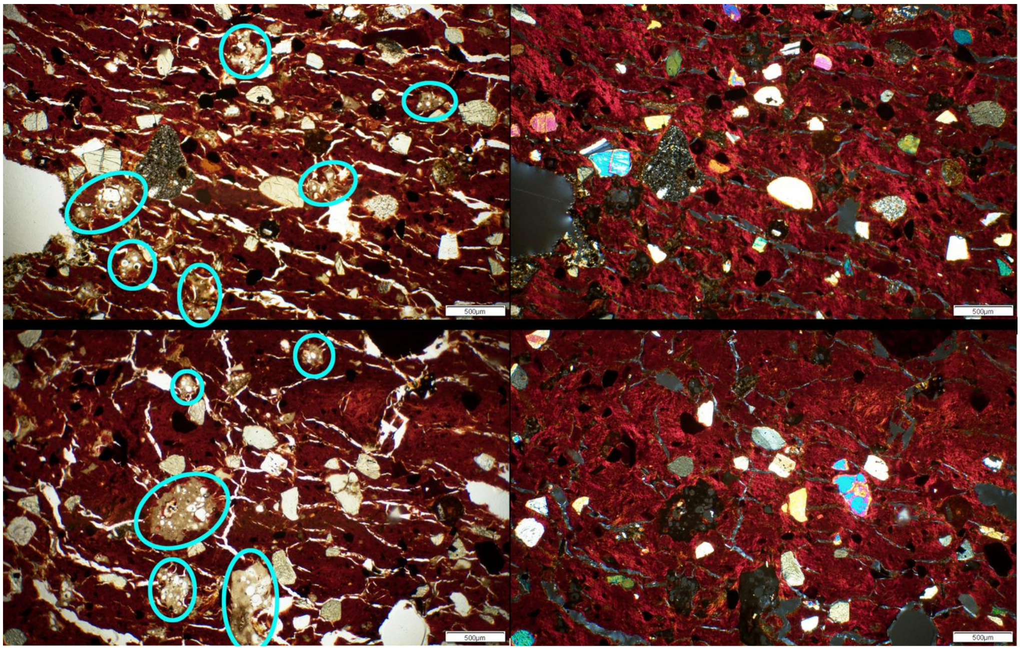

Figure 5. Photomicrographs in PPL (left) and XPL (right) of two representative locations on the thin section for va14. Microvesicular vitric volcanic rock fragments, typical of Efate in central Vanuatu are identified by blue circles.

a high proportion of felsitic and microporphyritic volcanic rock fragments (with quartz-feldspar mosaic and mircophenocrysts of hornblende) and lesser proportions of microlitic and glassy rock fragments along with a moderate proportion of plagioclase and ferromagnesian silicate mineral grains characteristic of intermediate rock sources. Fine to very fine sand-sized inclusions of mostly iron-rich opaques (dark brown in PPL) appear within the fine fraction, with lesser amounts of magnetite, volcanic glass (amber in PPL), and feldspars. The presence of a broad range of grain sizes within temper material usually suggests an origin from an *in situ* source but the general roundness of the majority of grains in sample va44 could also indicate a stream sand source.

Sample va38 is a hybrid volcanic-limestone lithic temper fabric. It features volcanic temper sands originating from intermediate bedrock sources (and generically related to sample va44) but calcareous grains with a micritic internal texture are also common. The dominant volcanic rock fragments are felsitic with a microcrystalline, mosaic texture of quartz and feldspar minerals while the lesser components are microlitic with a pilotaxitic texture in a mafic glassy groundmass. Accessory pyribole and feldspar minerals are also present in smaller quantities, consistent with an andesitic composition. However, sample va38 also features minor microdiorite inclusions, with an internal composition of microgranular quartz-feldspar mosaic with pyroxene and magnetite inclusions. The hybrid nature of the temper source used for this sample suggests that the raw material was collected from a location where volcanic and calcareous detritus converge. The sub-rounded morphology of the grains and the moderate sorting of the temper sands also indicate that they likely come from a coastal location or from a stream near to the coast.

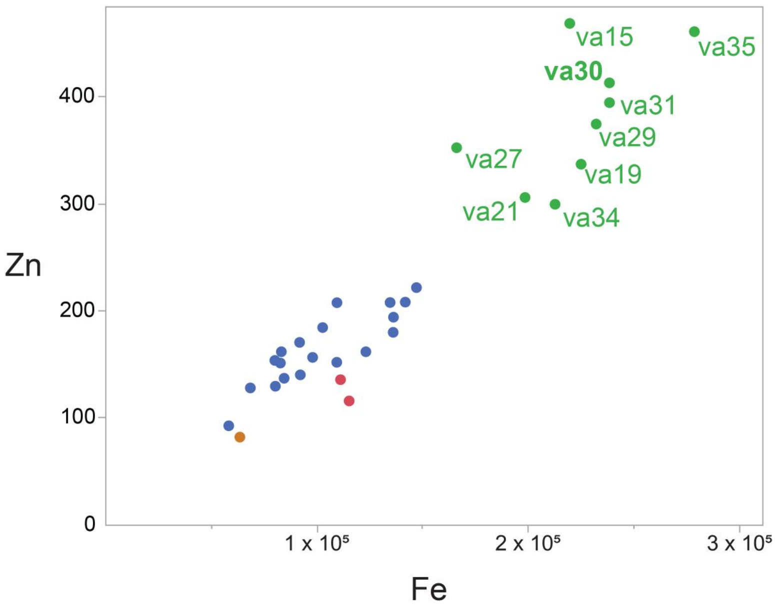

Figure 6. Biplot of iron and zinc, highlighting the higher content in elements associated with opaque iron oxides in samples grouped in Cluster Green (values in ppm).

Sample va20 is tempered with a volcanic placer sand. The inclusions are dominated by fine to medium sand-sized opaque iron (probably magnetite) and pyroxene mineral grains which are moderately sorted. Present in lesser quantities are two types of volcanic rock fragments; partially devitrified, cryptocrystalline volcanic glass particles and felsitic grains with a microcrystalline quartz-feldspar mosaic, pyroxene microphenocrysts, and magnetite inclusions. Minor hornblende grains complete the mineralogical profile.

Cluster Green

Like va20, the temper used in sample va30 is also derived from a volcanic placer sand deposit. However, sample va30 groups with other samples with significantly higher levels of Fe and other elements (Zn, Mn, Ti, V) commonly found as impurities in magnetite (Figure 6). This is consistent with the elevated level of magnetite grains observed within the fabric of these samples compared to those in Cluster Blue. In va30, opaque iron oxide and pyroxene mineral grains are frequent, moderately sorted, and well mixed. Subordinate felsitic and microdiorite rock fragments are also present along with a few feldspar and hornblende mineral grains. The fine fraction of the fabric is composed of very fine sand-sized magnetite grains, likely present due to an incomplete placering effect.

Discussion

Fabric types at Vao

All but two samples (va14, va42) show mineral grains compatible with derivation from Malakula. The vast majority of the samples analyzed (Cluster Blue and Green) have variants of tempers made of locally available material with attributes corresponding to previous descriptions made by Dickinson (2006, 66): dominance of felsitic volcanic rock fragments over microlitic, and placer tempers with opaque iron oxides, clinopyroxene, and hornblende as the dominant grain type. Different proportions of minerals (calcareous grain, plagioclase, opaque iron oxide, and clinopyroxene) show that temper material was not collected in the same conditions for every sample. This intra-cluster variability is exemplified by the differences described in the previous section between the fabrics of va20, va38, and va44, all members of the Blue Cluster. The groupings are made to simplify the variability, but there is no doubt that the variability between fabrics is present, as was described by Dickinson. Similarly, the most highly placered samples are grouped in Cluster Green, but va20's fabrics show that some samples with placered fabric are also grouped in Cluster Blue. The gradational variability observed chemically and attested by petrography corresponds with Dickinson's assessment of the Vao pottery assemblage: it contains several variants of local fabrics collected from different locations.

Sample va33 displays a temper almost entirely composed of calcareous grains. Its provenance remains unknown since the rarity of terrigenous grains makes it difficult to associate them with specific geology or locations. Sample va33's distinctively high content in Na and Sr is directly related to the dominance of calcareous grains and is not helpful in determining its provenance in this case.

Both samples in the Red Cluster (va14 and va42) have a fabric dominated by vitric volcanic rock fragments and associated with central Vanuatu, corresponding to the exotic glassy temper identified by Dickinson (2001, 2006; Dickinson, Bedford, and Spriggs 2013). The presence of vitric rock fragments with microvesicular texture (tuff) is compatible with the island of Efate, demonstrating that these vessels were manufactured in central Vanuatu before being transported to Vao.

Raw material procurement strategies for Lapita pottery

As described below, there is multi-proxy evidence that the communities at Vao and Teouma were connected. This is not unusual for Lapita sites, and similar preferred links between individual settlements are documented elsewhere (Bedford 2019; Chiu et al. 2020; Noury 2013).

Fabrics dominated by microvesicular volcanic rock fragments, typical for central Vanuatu and Efate, are identified at Vao. Conversely, pottery samples with hornblende, typical of Malakula, have been found at Teouma (Dickinson 2006, 66; Dickinson, Bedford, and Spriggs 2013, 8). The comparison of decorations and vessel forms at Teouma and Vao also highlights some parallels between the sites. Rare globular incurving rim vessels not recorded at Lapita sites on Aore and Malo are documented at both sites (Bedford 2019). The other dominant vessel form at Vao, carinated incurving vessels, is also found at Teouma (Bedford 2019, 235). Flat dishes are present at both sites, albeit rare at Vao (Bedford 2019, 231). A distinctive decorative feature seen on Pot 4 from Teouma (i.e., sets of vertical bars), has also been found on Vao (Bedford et al. 2007, 238; Bedford et al. 2010, fig. 8a). In addition, the only two pieces of obsidian found at Vao originated from the same sources of obsidian identified at Teouma (i.e., Northern Vanuatu [Banks Islands] and West New Britain [Talasea]), with the presence of the latter usually limited to the colonization phase of the Lapita migration (Constantine et al. 2015; Reepmeyer et al. 2010).

In light of the evidence showing that Lapita groups at Teouma and Vao: (1) were connected; and (2) went through the same initial processes of using several combinations of raw materials to manufacture pottery, we put forward two suggestions. First, we argue that this situation is incompatible with an experimenting phase. Second, we think this provides an opportunity to reassess the direct relation between mobility and diversity of fabrics in Remote Oceania. We argue that the initial variability of fabrics was purposeful, rather than a direct consequence of embedded procurement practices or a random selection process. Other considerations were at play, and we suggest that the fabrics were varied intentionally. Only a conscious effort could have resulted in such a recurrent pattern across Lapita fabrics at founder sites.

Experimentation

The suggestion that Lapita potters experimented with raw materials is based on the observation that raw materials (clays and fillers), physical properties, and firing temperatures show significant variability across Lapita assemblages (Ambrose 2007, 213; Clough 1992, 189; Intoh 1982, 169; Summerhayes and Allen 2007, 115). While we cannot reject the idea that experimentation might have happened in some cases, we think this hypothesis should be reconsidered in light of the data presented here. It is doubtful that an experimentation phase was necessary at Vao as the occupants of the site were in contact with groups in central Vanuatu (Efate) who already knew how to manufacture pottery from local materials. The environments at Vao and Teouma are not different enough to justify two experimental phases in interconnected communities close in time. It is highly probable that members of the community had already acquired proficiency in pottery making using local clay and temper constituents by the time they settled on Vao.

More generally, Lapita decorated pottery had been manufactured for several centuries by the time the sites of Vao and Teouma were occupied (Bedford et al. 2019). It is unlikely that an experimental phase had been required considering that Lapita potters were able to manufacture highly decorated vessels from a wide range of tempers. The technological necessity of undertaking an experimental phase is also dubious when considering that temper grains have limited mechanical effects on the final product in the conditions Lapita pots were fired using the raw materials available in the South Pacific (Clough 1992).

In addition, extremely heterogeneous conditions of atmosphere and temperature are inevitable in open bonfires (Clough 1992, 182, 189; Rice 2015, 387), which is most likely the way Lapita pots were fired since no sign of kiln use was recorded across Oceania until much later. Consequently, uneven firing and high porosity, two characteristics of Lapita pottery supposedly indicative of experimentation, are likely to result from the irregular and low temperatures of open bonfires, generally insufficient for vitrification and sintering (Ambrose 1993; Clough 1992; Dickinson 2006, 10; Rice 2015, 318).

Recurrent pattern at founder Lapita sites

The Vao assemblage is characterized by a range of fabrics compatible with Malakula, revealing that no preferential temper source was privileged and that various stream and coastal sands were sampled at different locations. Exotic samples from central Vanuatu have also been identified, in addition to a few samples with a temper made of almost exclusively calcareous grains. Overall, this pattern of fabrics (or technological style) echoes what is observed at other Lapita founder sites. The range of fabrics at Vao is comparable to what is observed at Teouma for instance, where the variety of locally available raw materials indicates that an array of sampling locations was used, and where exotic samples and hybrid tempers were identified. On both Efate and Vao/Malakula, the magnitude of the variability at founder Lapita sites is also significantly higher than that observed at later sites (Leclerc 2016, 2019). Overall, we argue that this recurrent pattern results from a deliberate strategy to replicate a procurement strategy documented at numerous founder Lapita sites across the distribution.

In the Bismarck Archipelago, specifically in the Arawe and Anir Islands, most of the pots are locally produced with only a small imported component (Summerhayes 2000, 2007). In the Arawe Islands, potters display "a complex use of minerals from nearly all the main river systems along the south coast" of West New Britain (Summerhayes 2000, 229). Similar to what we see at Vao and Teouma, there is also a notable reduction in the number of fabrics through time in the Arawe, Anir, and Garua Islands, with later producers selecting only local resources, as exemplified particularly by the comparison of fabrics at FOH (Adwe or Makekur; Early to Middle Lapita; 3240–2750 BP) and FOJ (Apalo; Early to Late Lapita; 3200–2520 BP) in the Arawes (Summerhayes 2000, 228; 2003; 2007, 147).

In New Caledonia, the petrographic analysis of 16 samples from the Lapita deposits at WKO013A (Xapeta'a/Lapita) showed a significant variety of locally available tempers, for which Dickinson commented that it was unusual that all these different tempers were employed to make pottery at the same place and at the same time (Chiu 2003).

Further east, petrographic analysis of potsherds at the founder settlement of Bourewa on the Rove Peninsula of Viti Levu, Fiji reveals that the vast majority of the pottery analyzed was locally produced (94%) using a variety of coastal sands collected at unspecified localities near the archaeological sites (Dickinson and Nunn 2013, 15). "Rove temper compositions are among the most heterogeneous known for Oceanian potsherds" (Dickinson and Nunn 2013, 21), which reflects the heterogeneous lithology of the Wainimala orogeny exposed in the Rove Peninsula, but also evidence of the desire to collect a range of materials to manufacture pottery.

At Naigani (VL 21/5), another Lapita site possibly related to the initial colonization of the Fijian archipelago, at least four different fabrics were identified, revealing a diversified range of fabrics compatible with importation from different nearby locations (Dickinson 1997; Irwin et al. 2011). As on Vao, the Naigani full ceramic assemblage is assumed to have been imported from nearby larger islands such as Ovalau, Lomaiviti, or mainland Viti Levu. Correspondence between the decline in decoration and the reduction in the number of vessels with ferromagnesian black sand tempers is also documented at Lakeba (101/7/197) in Eastern Fiji, as is the higher diversity in tempers in Lapita assemblages compared to immediately subsequent pottery (Best 2002, 21, 38)

In Tonga, the Lapita site in the village of Nukuleka (To.2/TO-NK-2) is considered a founder settlement for Polynesia (Burley et al. 2010). Pottery fabrics at Nukuleka revealed at least 16 different vessels with an exotic tan paste distinctive from the body paste of all other ceramics from Nukuleka and other Ceramic Period sites in Tonga (Burley and Dickinson 2010). Little information is available about the rest of the fabrics at Nukuleka, with only a handful of samples examined by Key (Poulsen 1987, 274–7) and Dickinson (1974). Still, Dickinson notes that "it seems likely that various kinds of sands from beaches, ravines, and pyroclastic accumulations on several islands may be represented" when describing the fabrics from sherds from Tongatapu (including those from Nukuleka), Niuatoputapu, Vava'u, and Ha'apai (Dickinson 1974, 342).

As this review demonstrates, decorated pottery vessels at founder Lapita sites are recurrently characterized by a range of varied local tempers (feldspathic, placered, or hybrid), accompanied by relatively few exotic fabrics that are presumably evidence of the movement of pots between settlements incidental to other activities (Spriggs 2021). We argue that these behaviors are not repeated by coincidence and that they cannot be fully explained by mobility.

In Near Oceania, the initial variability of fabrics in Lapita pottery is a direct consequence of the mobility of these groups of pioneers. Obsidian and pottery studies show that Lapita groups were highly mobile during early phases of settlement, and then gradually became more sedentary (Anderson 2001; Green and Kirch 1997; Kirch 2021; Summerhayes 2003). It is also commonly assumed that communities had to explore these new landscapes to gather resources, including suitable materials for pottery manufacture (e.g., Grainger, Summerhayes, and Gosden 2021; Hogg, Summerhayes, and Chen 2021; Summerhayes 2000). We agree with this interpretation, the evidence for which is exhaustive. We are, however, not convinced the same process should be assumed in Remote Oceania, where the social and ecological environments are different than in the Bismarck Archipelago (Anderson 2001, 19). Other explanatory avenues need to be considered to complement the model in place.

We argue that the decisions guiding the selection of raw materials at founder sites were motivated by cultural values, similar to those that guided pottery decorations and vessel forms (Chiu 2015; Mead 1975; Sand and Bedford 2010). Mobility alone does not necessarily explain the variability of fabrics seen at founder settlements. Regardless of whether procurement was embedded in mobility or resulted from exchanges between neighboring communities, Lapita potters *chose* to use a range of fabrics. They did not need to use raw materials from all over the landscape and technological attributes of decorated Lapita pottery reveal that functional attributes were often not the main priority for Lapita potters. This is exemplified by the documented use of "counter-productive" practices that would ultimately decrease the mechanical strength of a vessel, such as adding a high proportion of sand filler to clay content (Ambrose 1997; Hedrick 1971, 14), and mixing different combinations of raw material (differing clay-filler mixes) in the same vessel (Clough 1992, 188–9; Leclerc et al. 2019; Summerhayes 2000). It is apparent that Lapita potters prioritized using a range of raw materials over the intrinsic physical qualities of their vessels. It has previously been suggested that the variability of fabrics in Lapita assemblages is so significant that the exact nature of temper sand did not seem to be of prime importance for Lapita manufacturers (Dickinson and Nunn 2013; Leclerc 2019, 362). In light of the discussion presented here and the recurrence of the pattern at founder Lapita sites, we suggest the opposite is true: variability of temper sands was in fact the objective.

It is striking that this pattern of using a diversified range of raw materials is unique to the period when dentate-stamped decorations were still culturally relevant and obsidian from West New Britain was still being exchanged. We propose that raw material procurement practices associated with Lapita pottery manufacturing at nodal sites were regulated or codified by social and/or ideological considerations. The uniquely eclectic choice of materials characteristic of founder Lapita occupations is evidence for a purposeful strategy of using various raw materials from the surroundings of a newly established settlement to manufacture Lapita pottery.

Using elements of the landscape to articulate, embody, and remember mythological events and/or oral histories is a practice documented ethnoarchaeologically in the region (e.g., Kahn 1990; McNiven 2008). Two examples from New Guinea convincingly demonstrate that soil can convey social meanings and cultivate social memories. Thin layers of tephra encountered during gardening by the Huli of the Southern Highlands are associated with oral histories involving catastrophic volcanic events (Ballard 1995). In the oral traditions of Orokolo Bay in the Gulf of Papua, "buried black (iron-rich) sand deposits signal further evidence of ancestral action through time and across space to local villagers and are integral to the memory work done by Orokolo Bay locals" (Urwin 2023, 197). Rather than a passive backdrop, the landscape and its raw materials are ingrained into and constitutive of past human experiences (e.g., Byrne 2008; Ingold 2000; Thomas 2008). How human beings give meaning to their surroundings through experiencing the world and communally remembering key locations and events relies on the culturally specific ontologies of place (Dobres 2000). Assessing how Lapita people perceived their environment is beyond the scope of this paper, but the discussion presented here opens the door for future research addressing how the landscape actively provided the context for the formulation of human projects in these archipelagos. While more work is required to test this argumentation further, we argue that the recurrent pattern of fabric at founder Lapita sites could demonstrate that Lapita potters were integrating meaningful elements of the landscape into pottery, possibly because it allowed them to reinforce and facilitate the remembrance of places and ancestors. Such a conception of raw materials is directly aligned with current interpretations of Lapita pottery designs, particularly the face motifs, and their role in the construction of social identity and representations of ancestors (Chiu 2007; Kirch 2017, 96).

Conclusion

It is suggested here that the variability of raw materials observed at initial Lapita occupation sites resulted from a desire to make pottery from a range of various raw materials in a newly settled environment rather than being uniquely the consequence of a settlement pattern characterized by mobility and/or technological experimentation. We argue that there was a purpose behind the variability of fabrics and that this strategy was shared between Lapita communities, similarly to ideas related to decorations and vessel forms. This argument is based on: (1) the similarities between the general profile of fabrics observed at Teouma and Vao, two connected communities; and (2) the recurrence of this pattern elsewhere across the Lapita distribution.

The perspective presented in this paper will hopefully lead scholars to reconsider the automatic assumption that the variability of raw materials used to manufacture Lapita pottery during the first phases of occupation across Remote Oceania was simply due to Lapita groups being highly mobile. Rather, given its recurrence, the variability is likely to have been based on a purposeful collection strategy driven by cultural practices.

Acknowledgements

The authors would like to thank Les Kinsley, Ulrike Troitzsch, and Shane Paxton from the Research School of Earth Sciences of the Australian National for their help preparing and analyzing the samples. We are grateful for the help of Iarawai Phillip, one of the archaeologists at the Vanuatu Cultural Centre/National Museum, who greatly facilitated data collection. We greatly appreciated Justyna Miszkiewicz's collaboration for microscope access, as well as Chris Urwin's generosity for accepting to provide an exclusive early access to his manuscript at such short notice. We would like to thank the two reviewers and the editors for taking the necessary time and effort to review the manuscript and for their constructive feedback. We appreciate the valuable comments and suggestions, which helped us in improving the quality of the manuscript.

Funding

Data collection and analysis were funded by an ANU Research Scholarship for International Students and a Doctorate scholarship from the Fonds de Recherche Société et Culture du Québec.

ORCID

Mathieu Leclerc http://orcid.org/0000-0003-1093-802X
Kristine Hardy http://orcid.org/0000-0003-1660-4477
Matthew Spriggs http://orcid.org/0000-0002-7293-6778
Stuart Bedford http://orcid.org/0000-0001-6476-5617

Data availability statement

The data that support the findings of this study are openly available in the volume *Debating Lapita. Distribution, Chronology, Society and Subsistence* published by ANU Press at http://doi.org/10.22459/TA52.2019.17.

Disclosure statement

The research presented is our own except in cases where we acknowledge the work of other researchers. This article has not been submitted or previously published in any form at this or any other journal. The authors report there are no competing interests to declare.

References

Ambrose W. 1993. Pottery raw materials: Source recognition in the Manus Islands. In *A community of culture: The people and prehistory of the Pacific*, ed. M. Spriggs, D. E. Yen, W. Ambrose, R. Jones, A. Thorne, and A. Andrews, 206–17. Canberra: Department of Prehistory, Research School of Pacific Studies, The Australian National University.

Ambrose, W. 1997. Contradictions in Lapita pottery, a composite clone. *Antiquity* 71 (273):525–38. doi:10.1017/S0003598X00085306.
Ambrose, W. 2007. The implements of Lapita ceramic stamped ornamentation. In *Oceanic explorations: Lapita and Western Pacific settlement*, ed. S. Bedford, C. Sand and S. P. Connaughton, 213–22. Canberra: ANU Press.
Anderson, A. 2001. Mobility models of Lapita migration. In *The archaeology of Lapita dispersal in Oceania*, ed. G. Clark, A. Anderson and T. Vunidilo, 15–23. Canberra: Pandanus Press.
Anderson, A. 2003. Initial human dispersal in Remote Oceania: Pattern and explanation. In *Pacific archaeology: Assessments and prospects*, ed. C. Sand, 71–84. Nouméa: Département Archéologie.
Anson, D. 1999. Compositional analyses of dentate-stamped Lapita and nail-incised and applied relief pottery from Watom Island. In *The Pacific from 5000 to 2000 BP: Colonisation and transformations*, ed. J.-C. Galipaud and I. Lilley, 85–102. Paris: IRD Éditions.
Ballard, C. 1995. The death of a great land: Ritual, history and subsistence revolution in the southern highlands of Papua New Guinea. PhD. diss., Australian National University.
Bedford, S. 2006a. *Pieces of the Vanuatu Puzzle. Archaeology of the North, South and Centre*. Terra Australis 23. Canberra: ANU Press.
Bedford, S. 2006b. The Pacific's earliest painted pottery: An added layer of intrigue to the Lapita debate and beyond. *Antiquity* 80 (309):544–57. doi:10.1017/S0003598X00094023
Bedford, S. 2007. Crucial first steps into Remote Oceania, Lapita in the Vanuatu Archipelago. In *From Southeast Asia to the Pacific: Archaeological perspectives on the Austronesian expansion and the Lapita Cultural Complex*, ed. S. Chiu and C. Sand, 185–205. Taipei: Centre for Archaeological Studies, Academia Sinica.
Bedford, S. 2015. Going beyond the known world 3000 years ago: Lapita exploration and colonization of Remote Oceania. In *The Lapita Cultural Complex in time and space: Expansion routes, chronologies and typologies*, ed. C. Sand, S. Chiu and N. Hogg, 25–48. Archeologica Pasifika. 4. Nouméa: Institut d'archéologie de la Nouvelle-Calédonie et du Pacifique, New Caledonia.
Bedford, S. 2019. Lapita pottery from the small islands of north-east Malakula, Vanuatu: A brief overview and implications. In *Debating Lapita. Distribution, society and subsistence*, ed. S. Bedford and M. Spriggs, 225–40, Terra Australis, 52. Canberra: ANU Press. doi:10.22459/TA52.2019.11.
Bedford, S., H. R. Buckley, F. Valentin, N. G. Taylesa, and N. F. Longga. 2011. Lapita burials, a new Lapita cemetery and post-Lapita burials from Malekula, Northern Vanuatu, Southwest Pacific. *Journal of Pacific Archaeology* 2 (2):26–48.
Bedford, S., and M. Spriggs. 2008. Northern Vanuatu as a Pacific crossroads: The archaeology of discovery, interaction, and the emergence of the "ethnographic present". *Asian Perspectives* 47 (1):95–120. doi:10.1353/asi.2008.0003
Bedford, S., and M. Spriggs. 2019. *Debating Lapita. Distribution, chronology, society and subsistence*. Terra Australis 52. Canberra: ANU Press. doi:10.22459/TA52.2019.
Bedford, S., M. Spriggs, H. R. Buckley, F. Valentin, R. Regenvanu, and M. Abong, C. Sand. 2010. A cemetery of first settlement: The site of Teouma, South Efate, Vanuatu/Un cimetière de premier peuplement: Le site de Teouma, au sud d'Efaté, au Vanuatu. In *Lapita: Ancêtres océaniens/Oceanic ancestors*, ed. C. Sand and S. Bedford, 140–61. Paris: Musée du Quai Branly and Somogy Éditions d'Art.
Bedford, S., M. Spriggs, D. V. Burley, C. Sand, P. Sheppard, and G. Summerhayes. 2019. Debating Lapita: Distribution, chronology, society and subsistence. In *Debating Lapita. Distribution, society and subsistence*, ed. S. Bedford and M. Spriggs, 5–36. Terra Australis 52. Canberra: ANU Press. doi:10.22459/TA52.2019.01.
Bedford, S., M. Spriggs, and R. Regenvanu. 2006. The Teouma Lapita site and the early human settlement of the Pacific Islands. *Antiquity* 80 (310):812–28. doi:10.1017/S0003598X00094448
Bedford, S., M. Spriggs, R. Regenvanu, C. Macgregor, T. Kuautonga, and M. Sietz. 2007. The excavation, conservation and reconstruction of Lapita burial pots from the Teouma site, Efate, Central Vanuatu. In *Oceanic Explorations: Lapita and Western Pacific settlement*, ed. S.

Bedford, C. Sand, and S. P. Connaughton, 223–40. Terra Australis, 26. Canberra: ANU Press. doi:10.22459/TA26.2007.14.

Bergeot, N., M. N. Bouin, M. Diament, B. Pelletier, M. Régnier, S. Calmant, and V. Ballu. 2009. Horizontal and vertical interseismic velocity fields in the Vanuatu subduction zone from GPS measurements: Evidence for a central Vanuatu locked zone. *Journal of Geophysical Research* 114 (B6):B06405. doi:doi:10.1029/2007JB005249

Best, S. 2002. *Lapita: A view from the East*. Monograph 24. Auckland: New Zealand Archaeological Association.

Burley, D. V., A. Barton, W. R. Dickinson, S. P. Connaughton, and K. Taché. 2010. Nukuleka as a founder colony for West Polynesian settlement: New insights from recent excavations. *Journal of Pacific Archaeology* 1 (2):128–44.

Burley, D. V., and W. R. Dickinson. 2010. Among Polynesia's first pots. *Journal of Archaeological Science* 37 (5):1020–6. doi:10.1016/j.jas.2009.12.002

Byrne, D. 2008. Counter-mapping in the archaeological landscape. In *Handbook of landscape archaeology*, ed. B. David and J. Thomas, 609–17. Walnut Creek, CA: Left Coast Press.

Carney, J. N., and A. MacFarlane. 1982. Geological evidence bearing on the Miocene to recent structural evolution of the New Hebrides Arc. *Tectonophysics* 87 (1–4):147–75. doi:10.1016/0040-1951(82)90225-6

Chiu, S. 2003. The socio-economic functions of Lapita ceramic production and exchange: a case study from site WKO013A, Koné, New Caledonia. PhD. diss., University of California, Berkeley.

Chiu, S. 2007. Detailed analysis of Lapita face motifs: Case studies from Reef/Santa Cruz Lapita sites and New Caledonia Lapita site 13A. In *Oceanic Explorations: Lapita and Western Pacific settlement*, ed. S. Bedford, C. Sand and S. P. Connaughton, 241–64, Terra Australis 26. Canberra: ANU Press. doi:10.22459/TA26.2007.15.

Chiu, S. 2015. Where do we go from here? Social relatedness reflected by motif analysis. In *The Lapita Cultural Complex in time and space: Expansion routes, chronologies and typologies*, ed. C. Sand, S. Chiu and N. Hogg, 185–206. Archeologia Pasifika 4. Nouméa: IANCP.

Chiu, S., D. Killick, C. Sand, and Y. Su. 2020. Long-distance Lapita pottery transfers and ancient social relationships: A case study from the St. Maurice-Vatcha (KVO003) Lapita site on Île des Pins, New Caledonia (Southern Melanesia). *Journal of Archaeological Science: Reports* 34: 102641. doi:10.1016/j.jasrep.2020.102641

Clough, R. 1992. Firing temperatures and the analysis of Oceanic ceramics: A study of Lapita ceramics from Reef/Santa Cruz, Solomon Islands. In *Poterie Lapita et peuplement*, ed. J.-C. Galipaud, 177–92. Nouméa: ORSTOM.

Constantine, A., C. Reepmeyer, S. Bedford, M. Spriggs, and M. Ravn. 2015. Obsidian distribution from a Lapita cemetery sheds light on its value to past societies. *Archaeology in Oceania* 50 (2):111–6. doi:10.1002/arco.5064

Dickinson, W. R. 1974. Sand tempers in sherds from Niuatoputapu and elsewhere in Tonga. *Journal of the Polynesian Society* 83:342–5.

Dickinson, W. R. 1995. Petrographic report WRD-117. Temper types in prehistoric Vanuatu potsherds indigenous to Efate. Santo, Malakula, and other islands of the New Hebrides Island Arc. Canberra, ACT, Australia: The ANU Pacific Research Archives. Honolulu, Hawai'i: The archives of the Bernice Pauahi Bishop Museum.

Dickinson, W. R. 1997. Petrographic report WRD-159. Sand tempers in Lapita sherds from Naigani, Lomaiviti, Fiji. Canberra, ACT, Australia: The ANU Pacific Research Archives. Honolulu, Hawai'i: The archives of the Bernice Pauahi Bishop Museum.

Dickinson, W. R. 2001. Petrography and geologic provenance of sand tempers in prehistoric potsherds from Fiji and Vanuatu, South Pacific. *Geoarchaeology* 16 (3):275–322. doi:10.1002/1520-6548(200103)16:3<275::AID-GEA1005>3.0.CO;2-E

Dickinson, W. R. 2003. Petrographic report WRD-228. Petrography of temper sands in sherds from Vao in Vanuatu. Canberra, ACT, Australia: The ANU Pacific Research Archives. Honolulu, Hawai'i: The archives of the Bernice Pauahi Bishop Museum.

Dickinson, W. R. 2006. *Temper sands in prehistoric Oceanian pottery: Geotectonics, sedimentology, petrography, provenance*. Special paper 406. Boulder, Colorado: The Geological Society of America.

Dickinson, W. R. 2021. Sand tempers in Mussau ceramics: Evidence for ceramic transfer within the Bismarck Archipelago. In *Talepakemalai. Lapita and its transformations in the Mussau Islands of Near Oceania*, ed. P. V. Kirch, 375–90. Monumenta Archaeologica 47. Los Angeles: Cotsen Institute of Archaeology Press.

Dickinson, W. R., S. Bedford, and M. Spriggs. 2013. Petrography of temper sands in 112 reconstructed Lapita pottery vessels from Teouma (Efate): Archaeological implications and relations to other Vanuatu tempers. *Journal of Pacific Archaeology* 4 (2):1–20.

Dickinson, W. R., and P. Nunn. 2013. Petrography of sand tempers in Lapita potsherds from the Rove Peninsula, Southwest Viti Levu, Fiji. *Journal of Pacific Archaeology* 4 (1):15–31.

Dobres, M.-A. 2000. *Technology and social agency*. Oxford: Blackwell Publishers.

Galipaud, J.-C., C. Reepmeyer, R. Torrence, S. Kelloway, and P. White. 2014. Long-distance connections in Vanuatu: New obsidian characterisations for the Makué site, Aore Island. *Archaeology in Oceania* 49 (2):110–6. doi:10.1002/arco.5030.

Garanger, J. 1972. *Archéologie des Nouvelles-Hébrides [Archaeology of the New Hebrides]. Musée de l'Homme*, Publication no. 30. Paris: Société des Océanistes.

Gosselain, O. P. 1992. Technology and style: Potters and pottery among Bafia of Cameroon. *Man* 27 (3):559–86. doi:10.2307/2803929

Grainger, A., G. Summerhayes, and C. Gosden. 2021. Investigating the nature of mobility patterns and interaction: Ceramic production at the Late Lapita site of Amalut, Papua New Guinea. *Australian Archaeology* 87 (1):93–104. doi:10.1080/03122417.2020.1840489

Green, R. C., and D. Anson. 1991. The Reber-Rakival Lapita site on Watom. Implications of the 1985 excavations at the SAC and SDI localities. In *Report of the Lapita Homeland Project*, ed. J. Allen and C. Gosden, 170–81. Canberra: Department of Prehistory, RSPacS, The Australian National University.

Green, R. C., and P. V. Kirch. 1997. Lapita exchange systems and their Polynesian transformations: Seeking explanatory models. In *Prehistoric long-distance interaction in Oceania: An interdisciplinary approach*, ed. M. I. Weisler, 19–37. Auckland: New Zealand Archaeological Association Monograph.

Hedrick, J. 1971. Lapita style pottery from Malo Island. *Journal of the Polynesian Society* 80 (1): 5–19.

Hogg, N. W. S., G. R. Summerhayes, and Y.-L E. Chen. 2021. Moving on or settling down? Studying the nature of mobility through Lapita pottery from the Anir Islands, Papua New Guinea. In *From field to museum. Studies from Melanesia in Honour of Robin Torrence*, ed. J. Specht, V. Attenbrow and J. Allen, 71–86. Report 34. Technical Reports of the Australian Museum Online. Sydney: The Australian Museum. doi:10.3853/j.1835-4211.34.2021.1744

Hunt, T. L. 1989. Lapita ceramic exchange in the Mussau Islands, Papua New Guinea. PhD. diss., University of Washington.

Ingold, T. 2000. *The Perception of the environment: Essays on livelihood, dwelling and skill*. London: Routledge.

Intoh, M. 1982. The physical analysis of Pacific pottery. MA thes., University of Otago.

Irwin, G., T. H. Worthy, S. Best, S. Hawkins, J. Carpenter, and S. Matararaba. 2011. Further investigations at the Naigani Lapita site (VL 21/5), Fiji: Excavation, radiocarbon dating and palaeofaunal extinction. *Journal of Pacific Archaeology* 2 (2):66–78.

Kahn, M. 1990. Stone-faced ancestors: The spatial anchoring of myth in Wamira, Papua New Guinea. *Ethnology* 29 (1):51–66. doi:10.2307/3773481

Kirch, P. V. 2021. *Talepakemalai. Lapita and its transformations in the Mussau Islands of Near Oceania*. Monumenta Archaeologica 47. Los Angeles: Cotsen Institute of Archaeology Press.

Kirch, P. V. 2017. *On the road of the winds. An archaeological history of the Pacific Islands before European contact*. Oakland: University of California Press.

Lechtman, H. 1977. Style in technology—Some early thoughts. In *Material culture: Styles, organization and dynamics of technology*, ed. H. Lechtman and R. S. Merrill, 3–20. St. Paul, MN: West.

Leclerc, M. 2016. Investigating the raw materials used for Lapita and post-Lapita pottery manufacturing: A chemical characterisation of ceramic collections from Vanuatu. PhD. diss., The Australian National University.

Leclerc, M. 2019. Lapita to post-Lapita transition: Insights from the chemical analysis of pottery from the sites of Teouma, Mangaasi, Vao and Chachara, Vanuatu. In *Debating Lapita: Distribution, chronology, society and subsistence*, ed. S. Bedford and M. Spriggs, 349–76. Terra Australis 52. Canberra: ANU Press. doi:10.22459/TA52.2019.17

Leclerc, M., E. Grono, S. Bedford, and M. Spriggs. 2019. Assessment of the technological variability in decorated Lapita pottery from Teouma, Vanuatu, by petrography and LA-ICP-MS: Implications for Lapita social organisation. *Archaeological and Anthropological Sciences* 11 (10): 5257–73. doi:10.1007/s12520-019-00862-z.

Lemonnier, P. 1986. The study of material culture today: Toward an anthropology of technical systems. *Journal of Anthropological Archaeology* 5 (2):147–86. doi:10.1016/0278-4165(86)90012-7.

Lemonnier, P. 1993. Introduction. In *Technological choices: Transformation in material cultures since the Neolithic*, ed. P. Lemonnier, 1–35. London: Routledge.

McNiven, I. J. 2008. Sentient sea: Seascapes as spiritscapes. In *Handbook of Landscape Archaeology*, ed. B. David and J. Thomas, 149–57. Walnut Creek, CA: Left Coast Press.

Mead, S. M. 1975. The decorative system of the Lapita potters of Sigatoka, Fiji. In. *The Lapita style of Fiji and its associations*, ed. S. M. Mead, L. Birks, H. Birks and E. Shaw, 19–43. Memoir 38. Wellington: Polynesian Society.

Mitchell, A. H. G., and A. J. Warden. 1971. Geological evolution of the New Hebrides island arc. *Journal of the Geological Society* 127 (5):501–29. doi:10.1144/gsjgs.127.5.0501.

Norman, G. R., and D. L. Streiner. 2008. *Biostatistics: The bare essentials*. 3rd ed. Shelton, CT: PMPH USA, BC Decker.

Noury, A. 2013. *Le Lapita. À l'origine des sociétés d'Océanie [Lapita. The origins of Oceanic societies]*. Paris: Lulu.

Petchey, F., M. Spriggs, S. Bedford, and F. Valentin. 2015. The chronology of occupation at Teouma, Vanuatu: Use of a modified chronometric hygiene protocol and Bayesian modeling to evaluate midden remains. *Journal of Archaeological Science: Reports* 4:95–105. doi:10.1016/j.jasrep.2015.08.024.

Petchey, F., M. Spriggs, S. Bedford, F. Valentin, and H. R. Buckley. 2014. Radiocarbon dating of burials from the Teouma Lapita cemetery, Efate, Vanuatu. *Journal of Archaeological Science* 50: 227–42. doi:10.1016/j.jas.2014.07.002.

Poulsen, J. 1987. *Early Tongan prehistory. The Lapita period on Tongatapu and its relationships*. Terra Australis 12. Canberra: Department of Prehistory, Research School of Pacific Studies, The Australian National University.

Reepmeyer, C., M. Spriggs, S. Bedford, and W. R. Ambrose. 2010. Provenance and technology of lithic artefacts from the Teouma Lapita Site, Vanuatu. *Asian Perspectives* 49 (1):205–25. doi:10.1353/asi.2010.0004

Rice, P. M. 2015. *Pottery analysis: A sourcebook*. 2nd ed. Chicago: The University of Chicago Press.

Sand, C. 2015. Comparing Lapita pottery forms in the Southwestern Pacific: A case study. In *The Lapita Cultural Complex in time and space: Expansion routes, chronologies and typologies*, ed. C. Sand, S. Chiu and N. Hogg, 125–71. Archeologia Pasifika 4. Nouméa: IANCP.

Sand, C., and S. Bedford. 2010. *Lapita: Ancêtres océaniens [Lapita: Oceanic ancestors]*. Paris: Musée du Quai Branly and Somogy Éditions d'Art.

Sand, C., J. Bolé, and A. Ouetcho. 2011. A revision of New Caledonia's ceramic sequence. *Journal of Pacific Archaeology* 2 (1):56–68.

SAS Institute Inc 2019. *JMP® 15 multivariate methods*. Cary, NC: SAS Institute Inc.

Shaw, B., S. Hawkins, L. Becerra-Valdivia, C. S. M. Turney, S. Coxe, V. Kewibu, J. Haro, K. Miamba, M. Leclerc, and M. Spriggs. 2022. Frontier interaction with Papuan populations set the stage for Lapita peopling of the Pacific. *Nature Ecology & Evolution* 6 (6):802–12. doi:10.1038/s41559-022-01735-w.

Sheppard, P. J. 1993. Lapita lithics: Trade/exchange and technology. A view from the Reefs/Santa Cruz. *Archaeology in Oceania* 28 (3):121–37. doi:10.1002/j.1834-4453.1993.tb00303.x.

Skoglund, P., C. Posth, K. Sirak, M. Spriggs, F. Valentin, S. Bedford, G. R. Clark, C. Reepmeyer, F. Petchey, D. Fernandes, et al. 2016. Genomic insights into the peopling of the Southwest Pacific. *Nature* 538 (7626):510–3. doi:10.1038/nature19844.

Spriggs, M. 2021. The political economy of prestige practices in the Pacific: Understanding Lapita and after. In *Theory in the Pacific, the Pacific in theory*, ed. T. Thomas, 180–99. London: Routledge.

Summerhayes, G. R. 2000. *Lapita interaction.* Terra Australis 15. Canberra: Archaeology and Natural History Publications and the Centre for Archaeological Research, The Australian National University.

Summerhayes, G. R. 2003. Modelling differences between Lapita obsidian and pottery distribution patterns in the Bismarck Archipelago, Papua New Guinea. In *Pacific archaeology: Assessments and prospects*, ed. C. Sand, 135–45. Nouméa: Département Archéologie, Service des Musées et du Patrimoine, Nouvelle-Calédonie.

Summerhayes, G. R. 2004. The nature of prehistoric obsidian importation to Anir and the development of a 3,000 year old regional picture of obsidian exchange within the Bismarck Archipelago, Papua New Guinea. *Records of the Australian Museum, Supplement* 29:145–56. Sydney: The Australian Museum. doi:10.3853/j.0812-7387.29.2004.1411

Summerhayes, G. R. 2007. The rise and transformations of Lapita in the Bismarck Archipelago. In *From Southeast Asia to the Pacific: Archaeological perspectives on the Austronesian expansion and the Lapita Cultural Complex*, ed. S. Chiu and C. Sand, 141–84. Taipei: Center for Archaeological Studies, Research Center for Humanities and Social Sciences, Academia Sinica.

Summerhayes, G. R. 2009. Obsidian network patterns in Melanesia—Sources, characterisation and distribution. *Bulletin of the Indo-Pacific Prehistory Association* 29 (0):109–24. doi:10.7152/bippa.v29i0.9484.

Summerhayes, G. R., and J. Allen. 2007. Lapita writ small? Revisiting the Austronesian colonisation of the Papuan South Coast. In *Oceanic explorations: Lapita and Western Pacific settlement*, ed. S. Bedford, C. Sand and S. P. Connaughton, 97–122. Terra Australis 26. Canberra: ANU Press.

Thomas, J. 2008. Archaeology, landscape, and dwelling. In *Handbook of landscape archaeology*, ed. B. David and J. Thomas, 300–6. Walnut Creek, CA: Left Coast Press.

Urwin, C. 2023. *Building and remembering. An archaeology of place-making on Papua New Guinea's South Coast*. Honolulu: University of Hawai'i Press.

Wu, P.-H. 2016. What happened at the end of Lapita: Lapita to post-Lapita pottery transition in West New Britain, Papua New Guinea. PhD. diss., University of Otago.