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Moving On or Settling Down? Studying the Nature of Mobility through Lapita Pottery from the Anir Islands, Papua New Guinea

Nicholas W. S. Hogg[1], Glenn R. Summerhayes[1,2], and Yi-lin Elaine Chen[1]

[1] Archaeology Programme, School of Social Sciences, University of Otago, Dunedin, New Zealand

[2] School of Social Science, University of Queensland, St Lucia QLD 4072, Australia

Abstract. Summerhayes has argued that changes in the mobility of Lapita communities within the Bismarck Archipelago of Papua New Guinea is reflected in numerous aspects of their pottery assemblages. Such changes are seen most markedly in a reduction in the number of clay and temper combinations over time, which indicates less movement across the landscape to collect clays and tempers for pottery production. This pattern was identified in the Arawe Islands and Mussau Islands, and more tentatively in the Anir Islands of southern New Ireland Province. This research reviews and re-interprets the previous studies of the Anir pottery assemblages through mineralogical and geochemical analyses to test whether the Arawes and Mussau model applies in this region. Previous work upon pottery assemblages from the Tanga islands is also brought into the discussion as a means of comparison and to identify possible exchange relationships between the Anir and Tanga groups.

Introduction

Extensive research by Anson (1983, 1986), Hunt (1989) and Summerhayes (2000a, 2000b, 2000c, 2003, 2010) upon Lapita ceramic assemblages from sites of the Bismarck Archipelago of Papua New Guinea, has begun to isolate clear differences between Early Lapita ceramic assemblages and those from Middle/Late Lapita contexts. The differences stem from both the function of the ceramic assemblages and changes occurring within Lapita society.

Based upon a comparison of assemblages from the Arawe Islands and the mid north coast of New Britain, the Mussau Islands off northern New Ireland, and the results of preliminary analyses conducted on the Anir Islands sites, Summerhayes (2000a: 231–233, 2001a, 2001b: 61) argued that Lapita ceramic assemblages could be functionally divided between vessels with dentate stamping and those without, and these two components had variable rates of change, where the former changed dramatically over time while the latter changed very little.

This pattern was first identified in the Arawe Islands assemblages, whereby the ratio of dentate stamped wares and the vessel forms primarily associated with such decoration (bowls and stands) declined over time from the Early to Middle Lapita periods, while vessels without dentate stamping, such as outcurving jars, remained the same in terms of decoration and numbers (Summerhayes, 2000a: 155–156, 231; 2000c: 301). Similar observations were made with preliminary research undertaken on material from the Anir Islands, where Early Lapita deposits in Kamgot (ERA) have higher proportions of dentate stamping as well as bowls and stands, as opposed to the later sites of Balbalankin (ERC) and Malekolon (EAQ) which have a much higher proportion of carinated jars lacking dentate stamping. Additionally, such patterns can also be seen in the Early and Middle/Late Mussau Lapita assemblages (Summerhayes, 2000a: 232–233; 2000b: 57–62; 2003: 139–140).

Alongside the changes occurring with form and decoration, Summerhayes (2000a: 225–290) also argued for changes in pottery production, whereby Early Lapita

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Corresponding author: Nicholas W. S. Hogg hogni630@student.otago.ac.nz
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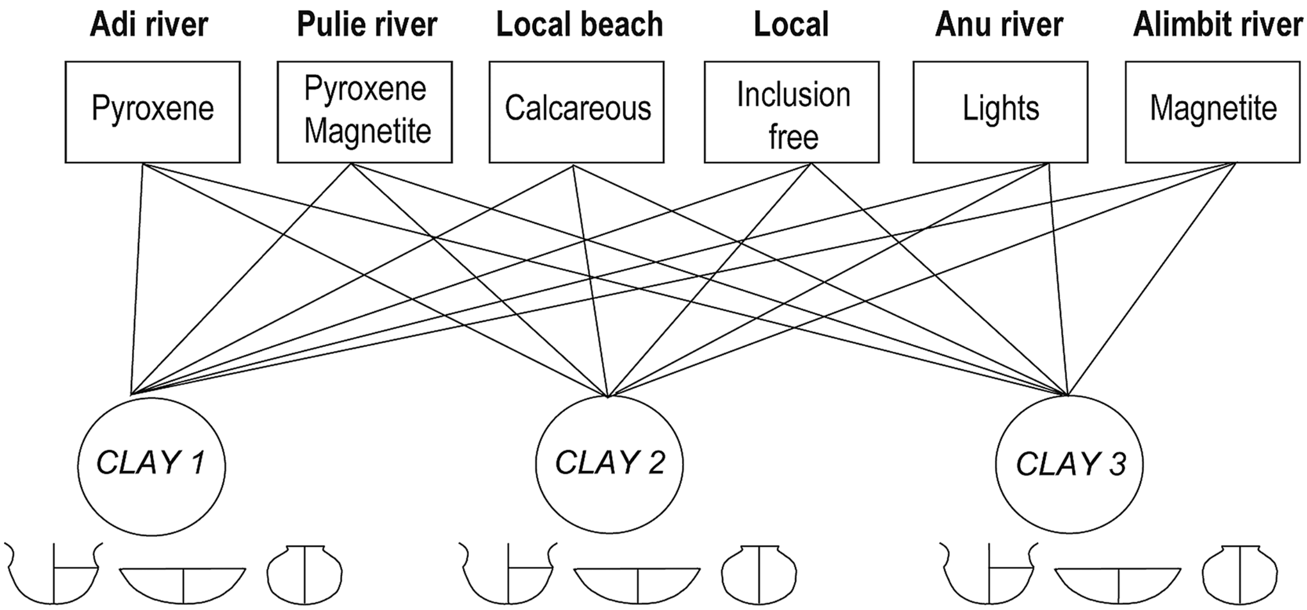

Figure 1. Early Lapita production model identified with the Arawe assemblages (after Summerhayes and Allen, 2007: fig. 5).

pottery was produced using a wide range of temper sands and clays, and Middle/Late pottery was produced using a narrower range of such materials. This change arguably reflects a decrease in population mobility. In this model, highly mobile early populations were exploring and moving around the landscape to acquire resources for pottery production, resulting in the use of an eclectic mixture of clays and tempers. However, over time such populations became more sedentary and conservative and thus used a more restricted range of resources collected from the vicinity of their settlements. The model was argued using the comparison of Early Lapita assemblages from the Arawe Islands (Adwe, Paligmete and lower layers of Apalo) and the Middle/Late Lapita assemblages from Garua Island, Boduna Island and upper layers of Apalo. The early assemblages were made with a number of local clays and temper sands from various rivers along the south coast of New Britain (Fig. 1), while the later assemblages were made from one or two local clays in combination with a small number of locally sourced sands (Fig. 2). Interestingly, no specific clays and temper sands were used exclusively for any specific vessel forms (Summerhayes, 2000a: 225–229, 2003: 140–141).

Referencing a preliminary fabric analysis (discussed below), Summerhayes (2001b) tentatively proposed that similar changes in pottery production may have occurred in the Anir Islands. Following this publication, studies undertaken upon Lapita ceramics from the Anir Islands by Hennessey (2007) and Hogg (2007) provide important contributions to the discussion of Anir pottery production and will be reviewed in detail in the following sections. A similar reduction in the number of fabric-clay combinations over time was also observed by Hunt (1989: 134–146, 193–213) in the Mussau Lapita assemblages, though Kirch (1990: 123; 1997: 242–246) interpreted this as resulting from the importation of pottery from fewer pottery production localities due to the regionalisation of long-distance exchange networks.

Finally, Cath-Garling (2017: 128, table 5.25) identified a similarly complex pattern of production in her analyses of Early-Middle Lapita pottery (arguably produced using at

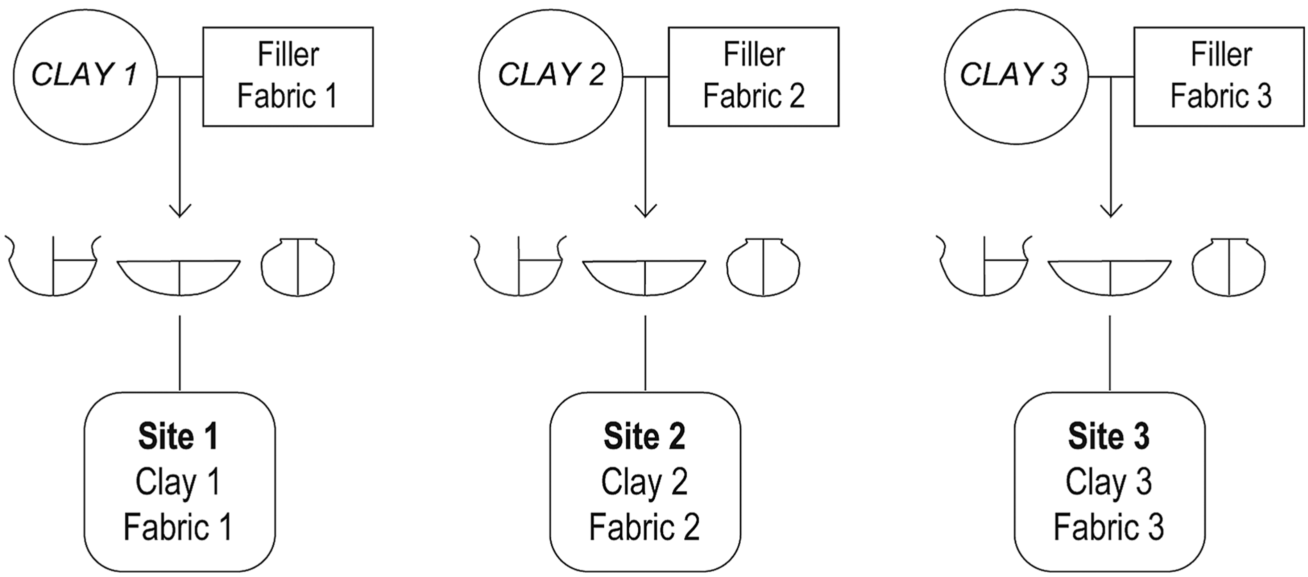

Figure 2. Middle/Late Lapita production model (after Summerhayes and Allen, 2007: fig. 6).

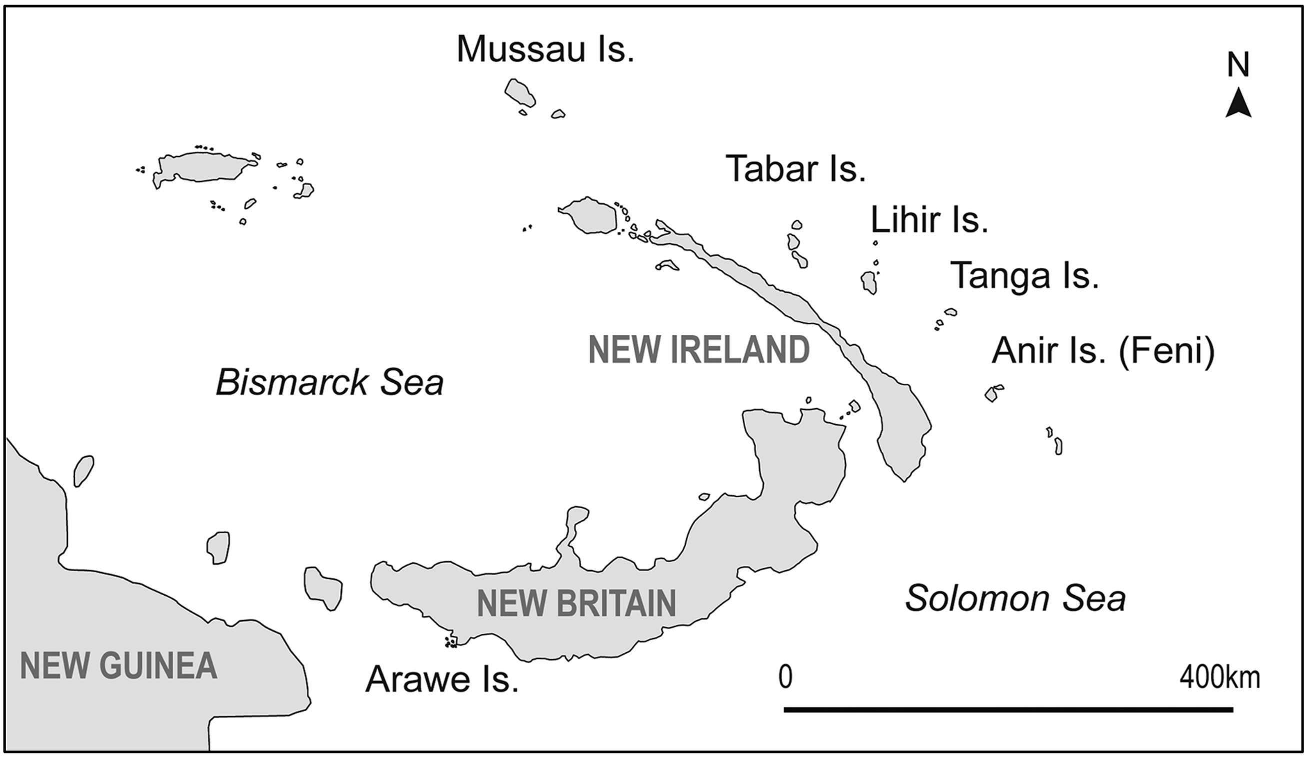

Figure 3. Bismarck Archipelago showing relevant island groups.

least three clays in combination with eight temper groups) from the Angkitkita (ETM) site on Lif Island in the Tanga group of islands. Importantly, she suggested that some tempers and clays are exotic to the Tanga Islands and might ultimately derive from the Anir Islands, thus potentially indicating the movement of pottery. Interestingly, no link was made between the exotic pottery and any known Lapita sites in the Anir group; however, she argued that some post-Lapita pottery from ETM had similar tempers to Lapita pottery analysed by Dickinson (2004a) from Malekolon (EAQ) on Ambitle (Cath-Garling, 2017: 149).

In this paper, the form, decoration and fabric of pottery from three Anir sites, Kamgot, Balbalankin and Malekolon are studied to further refine our understanding of Lapita society within and between the Early and Middle/Late Lapita periods.

The archaeology of the Lapita occupation of the Anir Island Group

The Anir Islands (also known as the Feni Islands), consisting of the two islands of Ambitle and Babase, is the last in the Tabar, Lihir, Tanga and Feni (TLTF) chain which runs down the northeast coast of New Ireland in the Bismarck Archipelago, Papua New Guinea (Fig. 3). Ambitle, the larger of the two islands, is 14 km long with a maximum width of 10 km, while Babase is 10 km long and 5 km at its widest point (Fig. 4). Geologically the two islands are composed of Neogene alkalic volcanic rocks of basanite, tephrite and trachybasalt (Wallace *et al*., 1983). Ambitle Volcano occupies all of Ambitle Island and has a maximum elevation of 479 m; the cone of this volcano is composed primarily of lava flows with pyroclastic and epiclastic rocks. Underlying the

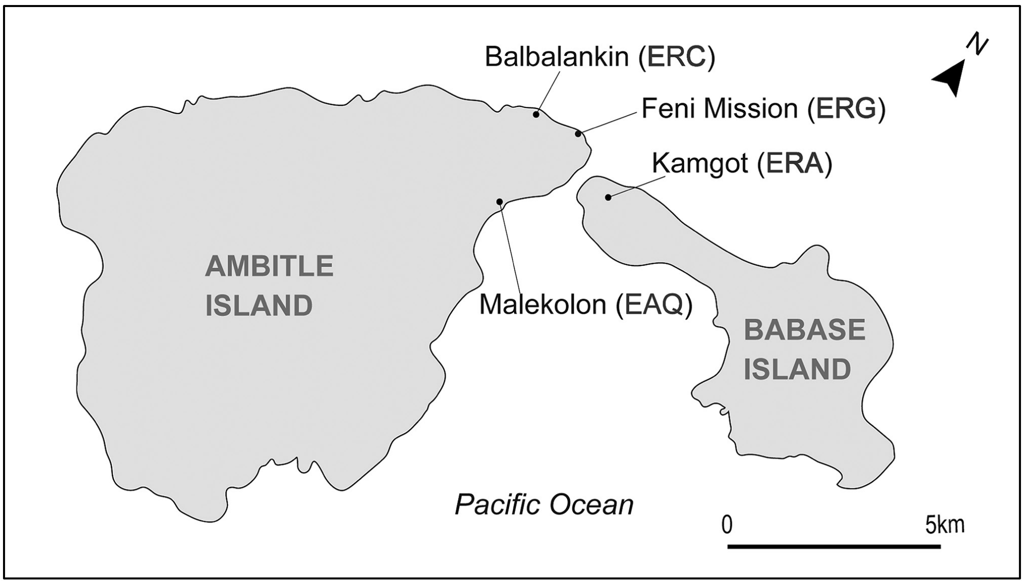

Figure 4. Map of the Anir Islands (see Fig. 3) displaying the locations of the sites of Balbalankin (ERC), Malekolon (EAQ), Feni Mission (ERG), and Kamgot (ERA).

volcanic deposits are Oligocene basement rocks (Lindley, 2015: 532). Similarly, Babase Island consists of a volcanic cone to the east, with an extrusion extending to the west overlain by Oligocene limestone (Horz *et al*., 2004: 88; Woolley, 2019: 291).

Early Lapita settlement site of Kamgot (ERA), Babase Island

ERA is located 100 m inland near the village of Kamgot on the northwest coast of Babase Island (Fig. 4). The site was extensively excavated in 23 test pits (77 m^2) in a north-aligned 200 x 100 m grid. Abundant cultural remains were unearthed at the site with over 20,000 pottery sherds, 1000 pieces of obsidian, a variety of tools and ornaments made of shell, coral, and other materials, and a large amount of faunal and shell remains (Summerhayes, 2000b, 2004; Szabó and Summerhayes, 2002; Summerhayes *et al*., 2019).

The chronology of the Early Lapita occupation of ERA is based upon two pairs of charcoal and marine shell determinations from Layer 2 in Test Pit 1 (Summerhayes, 2001a: table 3; 2007: 146; Summerhayes *et al*., 2019: 100). All determinations discussed in this section and those provided in the following section were calibrated using OxCal v. 4.4.1 (Bronk Ramsey, 2009) using the IntCal13 calibration curve for charcoal determinations and the Marine13 curve for marine shell dates (Reimer *et al*., 2013) and employing a Delta R correction of –69±51 years (see Summerhayes, 2010: 20–24 for more details).

The radiometric ages are:

1 Spit 6: 3035±45 BP (Wk-7561, charcoal) and 3260±45 BP (Wk-7560, marine shell), which calibrate to 3361–3080 cal. BP and 3353–2981 cal. BP at 2σ, respectively.
2 Spit 9: 3075±45 BP (Wk-7563, charcoal) and 3350±45 BP (Wk-7562, marine shell), which calibrate to 3381–3170 cal. BP and 3451–3100 cal. BP at 2σ, respectively.

Middle–Late Lapita settlement sites of Malekolon (EAQ) and Balbalankin (ERC), Ambitle Island

EAQ is located 0.5 km inland on a plantation situated in a V-shaped valley on the north-eastern coast of the island of Ambitle. The site is bordered to the north, south and west by cliffs and the sea and an offshore reef to the east. Five test pits were excavated across the site to gain an understanding of site formation processes. Only Test Pit 4 contained cultural material, while the remainder were culturally sterile (Summerhayes, 2004: 147). The cultural materials include 2459 pottery sherds, 211 obsidian pieces, a stone adze, a possible stone chisel, and a small amount of quartz and chert (Summerhayes, 2000b: 170, table 4).

The deposits in the test pits suggest that the Lapita occupation identified in Test Pit 4 was located next to an embayment with a fringing reef. Earlier occupation of the site (discussed below) was situated on the beach, which due to subsequent progradation and infilling of the valley over time, is represented by deposits situated further inland. Massive post-depositional disturbance of these earlier deposits is a result of a major volcanic eruption on Ambitle dated to 2300 years ago (Licence *et al*., 1987: 274) which deposited tephras that were subsequently eroded into the valley and built up behind the reef.

Two radiocarbon dates associated with cultural materials in Test Pit 4 are available (Summerhayes, 2001a: table 3):

1 ANU-11190 (spit 10), charcoal: 2110±240 BP, 2727–1570 cal. BP at 2σ.
2 ANU-11193 (spit 11), charcoal: 3220±170 BP, 3872–2997 cal. BP at 2σ.

In addition, a further two radiocarbon determinations associated with the earlier deposits are available:

1 ANU-957 (basal deposit), charcoal from *Canarium* sp. nutshell: 2050±210 BP, 2697–1541 cal. BP at 2σ (Anson, 1983: 12; Ambrose, pers. comm. 2020).
2 ANU-771 (basal deposit), charcoal: 1340±230 BP, 1773–786 cal. BP at 2σ (Anson, 1983: 12).

In line with the earlier argument made by Summerhayes (2004: 147), ANU-11190 and ANU-957 are seen as dating the volcanic eruption, while ANU-11193 dates the cultural deposits in Test Pit 4. Because of the large standard error associated with this date, the upper range limit overlaps with that of the Early Lapita period when calibrated to 2σ. However, this broad range can be narrowed considerably by reference to obsidian source exploitation within the deposit, which closely aligns with Middle Lapita sites within the Bismarck Archipelago dating to between c. 2900 to 2700–2600 BP (Summerhayes, 2004: table 2, 150). Thus, the most parsimonious interpretation of the available archaeological evidence is that the cultural material within Test Pit 4 dates to the Middle Lapita period.

This interpretation does not preclude the presence of earlier occupation further inland. Indeed, specific pottery from the site (discussed below) is arguably early in nature, while a dentate stamped sherd from the deposit was dated to 3200 BP using thermoluminescence dating. That said, other aspects of the pottery assemblage, together with the radiocarbon determination ANU-771 (above) and a second thermoluminescence date of 2500 BP, all strongly point to the early deposits being highly disturbed (Ambrose quoted in Anson, 1983: 12).

Site ERC is located approximately 140–200 m inland on an area of flat garden land backed by an escarpment, to the south of the hamlet of Farangot on the north-western tip of Ambitle Island. Eight test pits were excavated across the site to establish the presence of cultural material and identify site formation processes. Cultural materials recovered include 1416 pottery sherds, a single piece of chert, earth oven stones, fragments of two *Tridacna* armbands, and abundant faunal remains (Summerhayes, 2001b: 170).

The site's occupational sequence is based upon a single radiocarbon determination from Test Pit 1, spit 5 (Summerhayes, 2001a: table 3):

1 ANU-11188, charcoal: 2620±110 BP, 2950–2365 cal. BP at 2σ.

Previous research on pottery assemblages from the Anir Islands

Peter White and Jim Specht conducted the first analysis of Lapita pottery from the Anir Islands. This assemblage consisted of 77 sherds collected by Mr. G. Carson at Malekolon (known then as Malekolon Plantation) and sent into the Australian Museum in 1969 (White and Specht, 1971: 88–90). Most of the collection is plain, with only 24 decorated sherds identified. Despite this, a wide range of decoration types was identified, including dentate stamping, incision, notching, slashing, plain circle, crescent stamping and another form of stamping thought to be fingernail impression by the authors. Vessel forms were also tentatively identified and included multiple forms of bowls, including both a straight-sided form with an outward rim/wall orientation, an open form, and lastly a restricted bowl form. Other forms identified included globular pots with everted rims and, lastly, vertical-walled 'beakers' (White and Specht, 1971: 89–90).

Wal Ambrose subsequently undertook archaeological excavations (19 m^2) at the Malekolon site (EAQ) in 1970 and 1971 and although little has been written on the excavations, the pottery was used by Anson (1983: 264, 1986: 162) in his formulation of a Far Western Lapita style. An article by Ambrose (1973: 372) also contained images of Lapita pottery which we would classify as Early Lapita. Yet the pottery that Ambrose recorded covered a variety of decoration types, including incision, appliqué and shell impressions, alongside a large amount of plain ware. As noted above, the EAQ dates suggest disturbance; this conclusion is reinforced by Ambrose, who observed that the materials derived from these excavations had been 'jumbled by water' (Ambrose n.d. quoted in Anson, 1983: 12).

Most recently, Summerhayes undertook archaeological research on both Ambitle and Babase Islands. This consisted of a series of excavations between 1995 and 2002 at a number of locations including Malekolon, Kur Kur, and Balbalankin on Ambitle, and Kamgot on Babase (Summerhayes, 2000b, 2001a, 2001b, 2003, 2004). As already argued, excavations on Malekolon in 1995 confirmed that the earlier deposits of Ambrose were disturbed post-depositionally, while those in the later Middle Lapita occupation in Test Pit 4 were intact.

Research resulting from the Summerhayes excavations also provided a preliminary analysis of form, decoration and fabric from each site. The study found that between 8.1% and 11.1% of sherds from the ERA Test Pits 1, 2 and 17 were dentate stamped, while at ERC and EAQ only 1% and 0.5% had dentate stamping, respectively (Summerhayes, 2001b, table 1). The broad fabric analysis indicated that ferromagnesium fabrics were dominant within all three assemblages, making up 67% of the fabrics identified in ERA, 75% in ERC and 97% in EAQ. Light fabrics were noted as present in ERA (28%) and ERC (23%) together with a small amount of calcareous fabrics (4% and 2% respectively). The remaining 3% of the fabrics in EAQ were not discussed (Summerhayes, 2001b: 60).

The final aspect of the preliminary study was to provide basic counts of vessel forms within each of the three assemblages. The discussion below is limited to vessel form counts (Summerhayes, 2001b: table 4) for ERA, as those presented for ERC and EAQ have since been superseded by the results presented in this paper (see below). The most common vessel forms identified in ERA Test Pits 1, 2 and 17 were the open bowl and outcurving carinated jar, both of which comprised 36% of vessels identified, followed by stands (12%) and lastly globular pots (10%).

Following on from the research discussed above, two complementary studies of the production of pottery from the Anir Islands were undertaken by Hennessey (2007) focusing upon Early Lapita ceramics from ERA Test Pit 1 and Hogg (2007) upon Middle-Late material from the sites of ERC, EAQ and Feni mission (ERG). The results of the two studies are presented in this paper.

The two studies employed a shared methodology for chemical analysis, using electron microscopy to selectively analyse the non-plastic inclusions and clay matrix of pottery samples. Data generated from the analysis of the clay matrix was then interpreted via the concept of the 'Chemical Paste Compositional Reference Unit' (CPCRU), whereby each distinct group defined within an elemental dataset on the basis of elemental similarity is considered a single CPCRU or, put more simply, a distinct clay source (Bishop and Rands, 1982; Bishop *et al*., 1982: 302–306; see also Summerhayes, 2000a; Summerhayes and Allen, 2007 for its application).

Table 1. Temper groups identified by Dickinson from the sites of ERA, ERC, and EAQ.

temper group	ERA	ERC	EAQ	total
hornblendic non-placer	0	3	2	5
pyroxenic non-placer	1	2	2	5
pyroxenic placer	5	3	1	9
totals	6	8	5	19

Finally, W. R. Dickinson examined petrographically 19 pottery thin-sections from the three Anir Island sites, eight from ERC, six from ERA and five from EAQ (Dickinson, 2000, 2004b, 2006: appendix table A1) (Table 1). Dickinson (2006: 76), noted that sherds from ERA typically contain more iron oxide (i.e. more placered) than those from EAQ (more non-placered), while ERC has both placer and non-placer tempers. He identified the temper sands within the samples as indigenous to the Anir Islands and belonging to the 'postarc' temper class which is abundant in clinopyroxene and plagioclase feldspar minerals, alongside lesser amounts of hornblende and olivine (Dickinson, 2006: table 1, table 16). Postarc tempers are one of five temper classes defined by Dickinson (2006: 13) for temper sands within Oceanic pottery and can be defined simply as those 'derived from eruptive suites that postdate subduction along dormant island arcs' (Dickinson, 2007: 988). He categorised the Anir tempers into three groups as follows (Dickinson, 2004b: 1–2):

1 Hornblendic non-placer temper: plagioclase-rich or lithic rich volcanic sands with clinopyroxene dominant over hornblende.
2 Pyroxenic non-placer temper: placer volcanic sands with clinopyroxene and iron oxides dominant over hornblende.
3 Pyroxenic placer temper: plagioclase-rich and lithic-rich volcanic sands with hornblende dominant over clinopyroxene.

The clinopyroxenes in the Anir sherds are exclusively augite with high optic axial angles (2V > 75°), a unique greenish cast and a particular faint yellow pleochroism under polarised light that is a distinctive trait of the TLTF chain tempers (Wallace *et al*., 1983; Dickinson, 2006: 76). On the other hand, green-brown to red-brown hastingsitic hornblende are commonly found in Anir tempers, which makes them distinguishable from the other TLTF tempers; in fact, seven sherds from the Tanga Islands were suggested to be of Anir origin based on the paucity of such hornblende (Dickinson, 2004a: 8, 2006: 76). Unfortunately, because of the small sample size, ceramic transfer between the Ambitle and Babase Island sites could not be proved (Dickinson, 2004b: 2). This issue is discussed further below.

Formal and decoration analyses of the Anir Island pottery assemblages

Sherds assessment: macroscopic fabric classification

Prior to the formal and decoration analyses, each of the Anir Island assemblages had a basic macroscopic fabric classification undertaken with a low powered binocular microscope (17× magnification). Fabric groups were

Table 2. Number of samples per fabric group (after Hogg, 2007: tables 4.3–4.4, and Hennessey, 2007: table 1).

fabric group	ERA	ERC	EAQ
ferromagnesium–magnetite (M)	1	—	—
ferromagnesium–pyroxene (P)	20	9	18
ferromagnesium–pyroxene/magnetite (PM)	7	—	—
ferromagnesium–light (PL)	7	7	2
calcareous (CA)	3	—	—
light inclusions (L)	5	2	—
totals	43	18	20

summarised based upon the predominant inclusions visible upon each sherd, including Ferromagnesium-magnetite (M), Ferromagnesium-pyroxene (P), Ferromagnesium-pyroxene/magnetite (PM), Ferromagnesium-light (PL), Calcareous (CA), and Light inclusions (L) (Table 2). The creation of fabric groups is useful as it provides a basic indication of fabric composition and provides both a preliminary means of sorting temper types to aid in vessel form identification, and acts as a foundation for targeted sample selection for the more in-depth techniques of petrography and chemical analysis.

Methodology

The method of formal and decoration analyses employed in this study focused on the rim as the most diagnostic element of a vessel, a method that has been successfully applied by a large number of studies (e.g., Poulsen, 1987: 87; Summerhayes, 2000a: 33; Bedford, 2006: 76–77). The attributes of rim direction, rim profile, lip profile, extra rim features, thickness, and orifice diameter were analysed to assign sherds to vessel form. Following Summerhayes (2000a: 33, 93) vessel forms include: Form I—open bowl/cup; Form II—open pot/bowl; Form IV—jar; Form V—carinated jar; Form VI—globular pot; Form VII—incurving bowl; Form VIII—pot stand (Fig. 5). Form III—possible open bowl with horizontal rim, is generally rare and does not occur in the Anir assemblages. The calculation of minimum number of vessels (MNV) was achieved using the rim attributes above in combination with those collected for the decoration analysis, including technology (type of decoration) and location of decoration, together with the fabric analysis, as this allowed the accurate identification of sherds belonging to the same vessel (see Summerhayes, 2000a: 33–37 for a detailed discussion of the allocation of sherds to vessel form and the calculation of MNV). To ensure all variation was accounted for within each assemblage, unique sherds (i.e. those with rare form, decoration, or fabric) were also selected (Table 3).

Table 3. Number of excavated sherds, number of rim/stand sherds, and the minimum number of vessels (MNV).

site	sherds excavated	rim/stand sherds	MNV
ERA (Test Pit 1)	498	172	88
ERC	1416	29	13
EAQ	2459	61	14

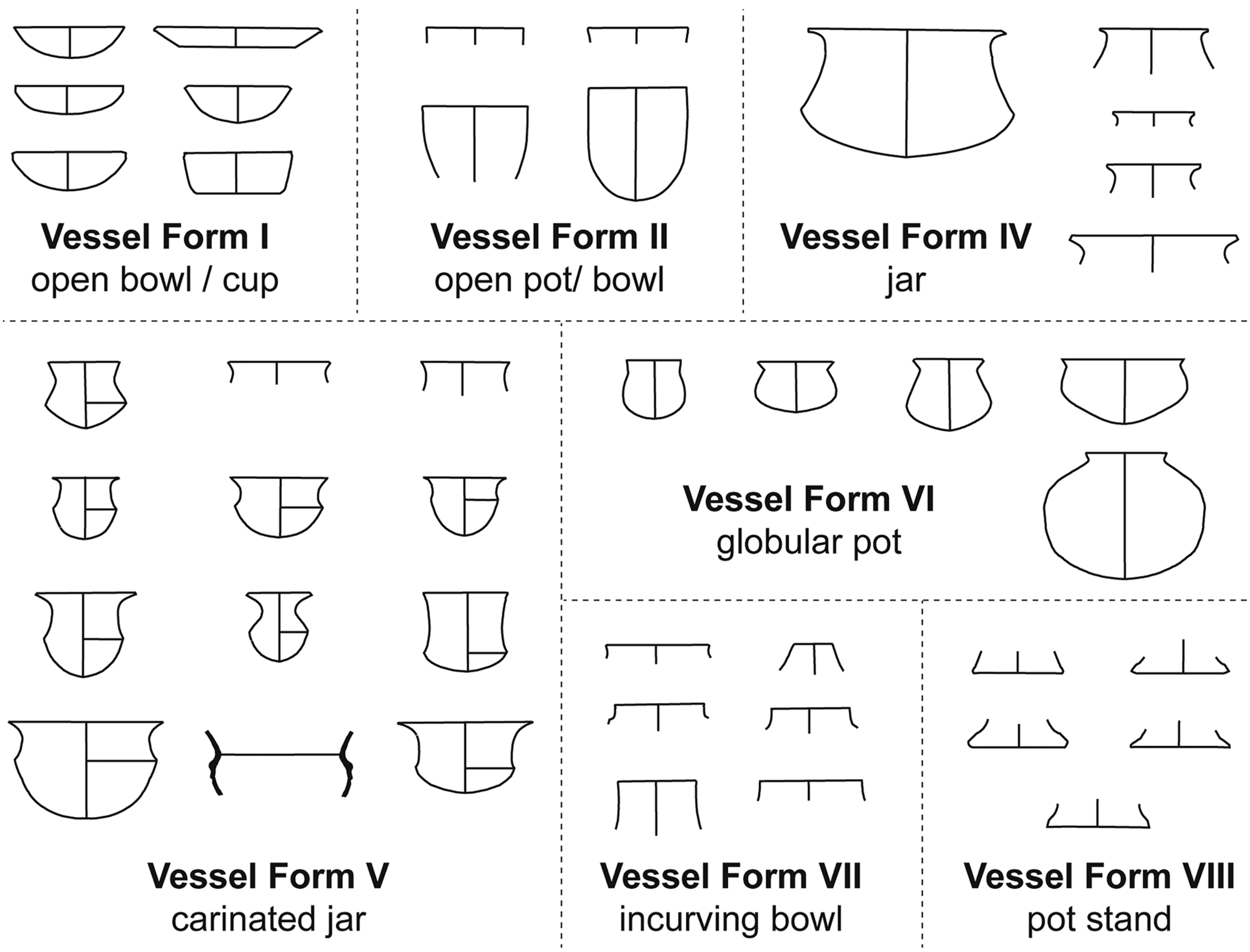

Figure 5. Vessels forms identified in the study (after Summerhayes, 2000a: figs 4.1–4.3).

Figure 6. Decorated pottery from the sites of ERA, ERC, and EAQ. Top row: dentate stamped and single tool impressed rim sherd, and dentate stamped and stamped impressed stand sherd (ERA); bottom row: incised rim sherd and dentate stamped rim sherds (ERC and EAQ).

Kamgot (ERA) results

Test Pit 1 produced 498 sherds, of which 172 are diagnostic rim or stand sherds (Table 3, Fig. 6). An MNV of 88 vessels was calculated for seven vessel forms present in this assemblage (Table 4); the vessel forms reported in this study represent the most up-to-date data available and supersede those in Hennessey (2007: table 3). The most common form is the open bowl/cup which makes up over 56% of the vessels identified, followed by the pot stand, carinated jar and globular pot which comprise 16%, 10% and 10% of the assemblage, respectively. Three other vessel forms were also identified in the assemblage, but only in minimal quantities. Decoration is dominated by dentate stamping, which was identified on 62 vessels or 70% of all vessels identified (Table 5). The only other decoration types identified in any quantity are stamped impression and the combined group of gouging, cut-out triangle and excision found upon approximately 15% of vessels each. Dentate stamping is also found to have been applied alongside a wide range of other decorations and in varying combinations (Table 6 lists the most common combinations) but was most commonly used with single tool impression and stamped impression, and in combination with gouging, cut-out triangle and excision.

Table 4. Vessel forms identified at the sites of ERA, ERC, and EAQ.

vessel form	ERA		ERC		EAQ	
	count	%	count	%	count	%
I, open bowl/cup	49	56	3	23	4	29
II, open pot/bowl	2	2	—	—	—	—
IV, jar	3	3	—	—	—	—
V, carinated jar	9	10	8	62	7	50
VI, globular pot	9	10	1	8	3	21
VII, incurving bowl	2	2	—	—	—	—
VIII, pot stand	14	16	1	8	—	—
totals	88		13		14	

Table 5. Types of decoration in the ERA Test Pit 1, ERC, and EAQ assemblages by vessel form (vessels can be counted more than once).

decoration type	ERA								ERC			EAQ			
	I	II	IV	V	VI	VII	VIII	total	I	V	total	I	V	VI	total
dentate stamping	41	1	3	1	—	2	14	62	2	1	3	3	—	—	3
stamped impression	12	—	—	—	—	1	1	14	—	—	—	—	—	—	—
single tool impression	6	—	—	1	—	1	—	8	—	—	—	—	—	—	—
fingernail impression	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—
stick impression	1	—	—	—	—	—	—	1	—	2	2	—	—	—	—
notched lip	3	1	—	5	—	—	—	9	—	5	5	—	4	1	5
cut lip	5	—	—	1	1	—	1	8	—	1	1	—	2	—	2
scalloped lip	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2
incision	—	—	—	—	—	—	—	—	1	1	2	—	—	—	—
linear incision	—	—	—	1	—	—	—	1	1	1	2	—	—	—	—
miscellaneous incision	1	—	1	—	—	—	—	2	—	—	—	—	—	—	—
groove/channel	2	—	—	—	—	—	—	2	—	—	—	—	—	—	—
gouging, cut-out triangle, excision	8	—	—	—	—	—	5	13	—	—	—	—	—	—	—
carving	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—
appliqué (nubbin)	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—
brushing	2	—	—	1	—	—	1	4	—	—	—	—	—	—	—
indeterminate	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
totals	83	2	4	10	1	4	23	127	5	11	16	4	7	1	12
%	65	2	3	8	1	3	18		31	69		33	58	8	

Finally, looking at the relationship between vessel form and decoration, most of the forms are associated with two to six decoration types, though open bowls/cups are decorated much more variably and are associated with 12 types. Discussion focuses on the decoration on open bowls/cups, carinated jars, and pot stands which comprise 91% of all decoration identified.

Considering decoration on open bowls/cups, 12 types are present with the most common being dentate stamping (84%, n = 41) and stamped impression (24%, n = 12). Only three other types are present on more than 10% of vessels, including gouging, cut-out triangle and excision, single tool impression and cut lip.

Carinated jars are associated with six decoration types but are dominated by notched lips which represent 56% (n = 5) of all the decoration identified. Dentate stamping and linear incision are equally represented with only one instance each.

Six types of decoration occur on pot-stands, though only dentate stamping occurs on all of them. Gouging, cut-out triangle and excision also occur (36%, n = 5).

Looking at the formal and decoration data for ERA Test Pit 1, this assemblage is dominated by dentate stamped open bowls/cups and to a lesser extent pot stands (or the former vessels with such stands attached). The removal of these forms from the assemblage would remove the vast majority of the decorated sherds from the assemblage. The importance of this result will be discussed further below.

Balbalankin (ERC) results

The total ceramic assemblage from ERC comprises 1416 sherds, of which 29 are rim/stands (Table 3, Fig. 6). An MNV of 13 was calculated for this assemblage (Table 4); the vessel forms and decoration reported in this study for ERC and EAQ (discussed below) represents the most up-to-date data available and supersedes those in Hogg (2007: tables 3.1–3.2). The most common form is the carinated jar which comprises 62% of the vessels identified, followed by the open bowl/cup which makes up 23% of all of the identified vessels. Single examples of a pot stand and a globular pot are also present.

Decoration identified for the assemblage is limited to eight types, of which notched lip (38%, n = 5) and dentate stamping (23%, n = 3) are the most common (Table 5). Only five decoration combinations were identified in the assemblage, each with one example. These include dentate stamping with incision, dentate stamping with carving, dentate stamping with stick impression, notched lip with stick impression and notched lip with linear incision.

Finally, the only decorated vessels in ERC are open bowls/cups and carinated jars. Carinated jars are associated with the broadest range of decorations, including dentate stamping, incision, linear incision, stick impression, notched lip and cut lip, whereas open bowls/cups have dentate stamping, incision, linear incision, stick impression and carving.

Table 6. Common dentate stamped decoration combinations for the ERA Test Pit 1 assemblage by vessel form (vessels can be counted more than once).

decoration type/vessel form	I	V	VII	VIII	total
dentate stamping + stamped impression	4	0	1	0	5
dentate stamping + stamped impression + cut lip	1	0	0	1	2
dentate stamping + stamped impression + gouge, cut-out triangle, excision	4	0	0	0	4
dentate stamping + single tool impression	5	1	1	0	7
dentate stamping + cut lip	2	0	0	0	2
dentate stamping + gouging, cut out triangle, excision	2	0	0	5	7
dentate stamping + brushing	1	0	0	1	2
totals	19	1	2	7	29

Malekolon (EAQ) results

The total ceramic assemblage from EAQ amounts to 2459 sherds, of which 61 are rim/stand sherds (Table 3, Fig. 6). An MNV of 14 was calculated for this assemblage (Table 4). These comprise seven carinated jars, four open bowls/cups and three globular pots.

Decoration is limited to four types of which notched lip (36%, n = 5) and dentate stamping (21%, n = 3) are the most common (Table 5). No combinations of decoration types were identified from this assemblage.

Finally, dentate stamping occurs only on open bowls/cups, in one case with a scalloped lip. Notched lips are present on carinated jars and globular pots and the carinated jars also have cut or scalloped lips.

Temper groups construction

Hennessey (2007) undertook the chemical analysis of the non-plastic inclusions of 43 sherds from ERA, while Hogg (2007) did the same for 18 sherds from ERC and a further 20 from EAQ, using a JEOL JXA-8600 electron microprobe analyser then housed within the Geology Department of the University of Otago (see Hennessey (2007: 92) for operating conditions employed for ERA and Hogg (2007: 42) for the same for ERC and EAQ). While the original studies only required the presence and absence of minerals to be recorded, this level of detail is insufficient for the current study. To generate data capable of drawing comparisons with temper sands within the broader region (and thus potentially identify pottery exchange), it is necessary to reinterpret the data and calculate the abundance and ratio of minerals present. In this study, new temper groups were created by reinterpreting the original microprobe photomicrographs and chemical data of Hennessey (2007: appendix 4–5) and Hogg (2007: appendix 2–3), with respect to the mineralogy, grain size and roundness of the non-plastic inclusions in each sherd.

Results

The re-interpretation of the chemical data lead to the identification of five major temper groups (Table 7, Fig. 7):

1. Calcareous (A)
2. Feldspathic-hornblendic-pyroxenic (B)
3. Hornblendic-lithic (C)
4. Pyroxenic placer (D) (divided into D1–D3 based on varying degrees of placering)
5. Feldspathic-pyroxenic non-placer (E)

The presence of trace alkali feldspar, quartz and olivine across the assemblages, characteristic of the local alkalic volcanic suite of the TLTF island chain (Wallace *et al*., 1983), suggests that the sherds are derived from this region. This interpretation is supported by the presence of the signature augite (Dickinson, 2004a: 8, 2006: 76) in all of the temper groups. Overall, there are no temper types requiring or implying transfer of pottery from outside the TLTF chain.

Comparison with the research of Dickinson (2000, 2004a, 2004b, 2006) indicates that all three of his temper groups were identified in this research: Hornblendic non-placer temper is equal to temper B in this study; Pyroxenic non-placer temper is equivalent to temper E, and Pyroxenic placer temper is equivalent to temper D and its variants. However, the two studies arrived at different conclusions as to the presence or absence of certain other temper groups in the three sites. Looking at the sites in turn:

1. ERA has six of the seven temper groups but is dominated by D1 (n = 17) and D2 (n = 16) which make up three quarters of all the ERA samples studied. Most of the remaining samples have tempers D3 (n = 4) or B (n = 3), and one sample has the rare C temper. ERA has one unique temper group, A, which was only found in two samples. Finally, Dickinson (2004b) identified one sample with a pyroxenic non-placer temper (equivalent to temper E), which was not present in this study; this likely means that at least seven tempers were in use at the site.
2. ERC has six temper groups but only two, B (n = 7) and D1 (n = 6), are present in significant numbers, making up 70% of those identified; the remaining samples are spread over D2, D3 and C, while a single example has temper E.
3. Finally, EAQ has only four temper groups and is dominated by D1 (n = 11) which makes up 60% of the samples studied. The remaining samples are largely composed of D2 (n = 5) and B (n = 3), while one sample has temper C. Like ERA, Dickinson (2004b) identified two samples with the pyroxenic non-placer tempers (equivalent to temper E), likely indicating that five temper groups were employed at the site.

In summary, the temper suites from the three assemblages are dominated by D tempers which make up the majority of samples in ERA and EAQ and half of those in ERC. However, variability occurs with regards to the presence and abundance of the three variants of this temper group. ERA and ERC contain all three of the D temper variants, while EAQ is lacking D3. Proportionally, only D1 is abundant in all three assemblages, while D2 is common in ERA and to a lesser extent EAQ.

While the D tempers suggests a significant amount of similarity in the temper being employed to manufacture pottery at the three sites, one difference is present: including the additional temper groups identified by Dickinson, ERA and ERC both contain samples with D3 temper which is lacking in EAQ, while ERA also contains the unique temper A.

Taken together, the number of temper groups (6+1) in the early assemblage of ERA when compared to the middle assemblages of ERC (6) or EAQ (4+1), provides support for Summerhayes' model (2000a, 2003), theorising a reduction in mobility as reflected in the procurement of fewer clays and tempers over time. This topic will be discussed in greater detail in the discussion section below.

Temper groups and CPCRU

This section relates the results of the newly constructed temper groups back to the results of the clay matrix analyses of the same sherds provided by Hennessey (2007) and Hogg (2007) to examine the combination of different clay sources (CPCRU) and tempers in the various sites.

Kamgot (ERA)

Ten CPCRUs were defined by Hennessey (2007: 56–64) for the early assemblages from ERA of which five (CPCRU 1, 3, 4, 5, 6) were deemed to be major groups by their presence in five or more samples. For the remainder, only one (CPCRU 8) occurred in more than one sample, while the rest were argued to be single sample outliers.

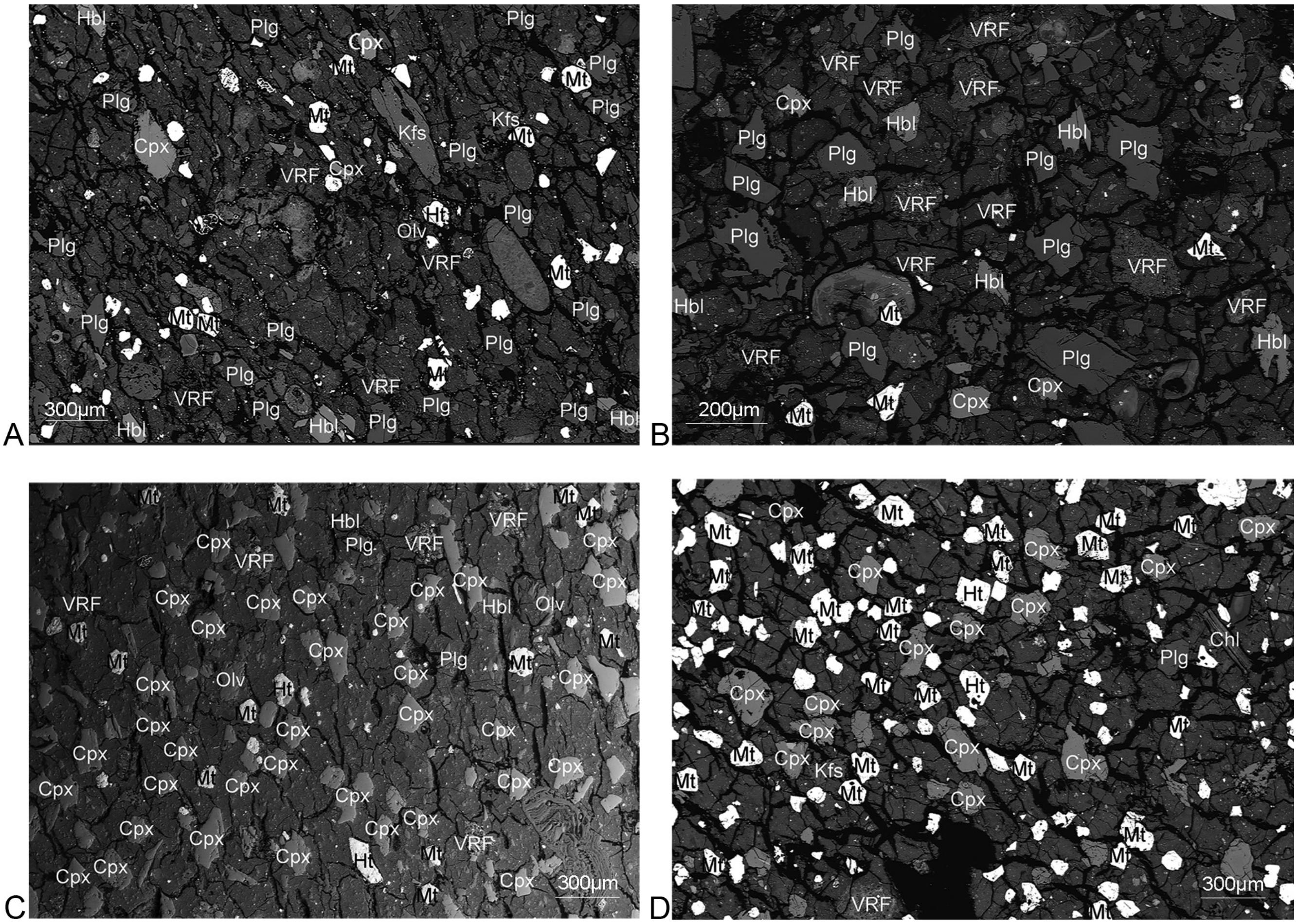

Figure 7. Microprobe photomicrographs of sherds from various temper groups. (*a*) Feldspathic-hornblendic-pyroxenic temper (temper B), sherd ERC-1926, 40×; (*b*) hornblendic-lithic temper (temper C), sherd ERA-625, 80×; (*c*) pyroxenic placer with dominant pyroxene (temper D1), sherd EAQ-167, 40×; and (*d*) pyroxenic placer with dominant iron oxides (temper D3). Abbreviations: *Chl*, chlorite; *Cpx*, clinopyroxene (augite); *Hbl*, hornblende; *Ht*, hematite; *Kfs*, alkali feldspar; *Mt*, magnetite; *Olv*, olivine; *Plg*, plagioclase; *VRF*, volcanic lithic fragments.

Table 7. New temper groups from the sites ERA, ERC, and EAQ.

temper group	temper group Code		temper description	ERA	ERC	EAQ	total	%
calcareous	A		Sands of bioclastic reef debris/reef detritus.	2 (4.7%)	0 (0.0%)	0 (0.0%)	2 (2.5%)	2.5
feldspathic-hornblendic-pyroxenic	B		Dominant plagioclase feldspar (30–45%), subordinate hornblende, pyroxene, iron-oxides and volcanic lithicfragments (10–20%). Moderately sorted, angular to sub-angular.	3 (7.0%)	7 (38.9%)	3 (15.0%)	13 (16.0%)	16.0
hornblendic-lithic	C		Dominant volcanic (50%), subordinate plagioclase feldspar (20%), minor iron–oxides (10–20%), hornblende (10%) and pyroxene (0–10%). Moderately to well sorted, sub-angular.	1 (2.3%)	1 (5.6%)	1 (5.0%)	3 (3.7%)	3.7
pyroxenic placer	D	D1	Dominant pyroxene (55–70%), minor volcanic lithic fragments, plagioclase feldspar and iron oxides (5–20%).	17 (39.5%)	6 (33.3%)	11 (55.0%)	34 (42.0%)	42.0
		D2	Dominant pyroxene (40–55%), subordinate iron oxides (30–40%), and trace volcanic lithic fragments, plagioclase, hornblende.	16 (37.2%)	1 (5.6%)	5 (25.0%)	22 (27.2%)	27.2
		D3	Dominant iron oxides (55%), subordinate pyroxene (40–45%).	4 (9.3%)	2 (11.1%)	0 (0.0%)	6 (7.4%)	7.4
feldspathic-pyroxenic non-placer	E		Dominant plagioclase feldspar (40%) and volcanic lithic fragments (30%), subordinate pyroxene (20%) and minor iron oxides (5%) Moderately sorted, sub-angular to angular.	0	1 (5.6%)	0 (0.0%)	1 (1.2%)	1.2
totals				43	18	20	81	

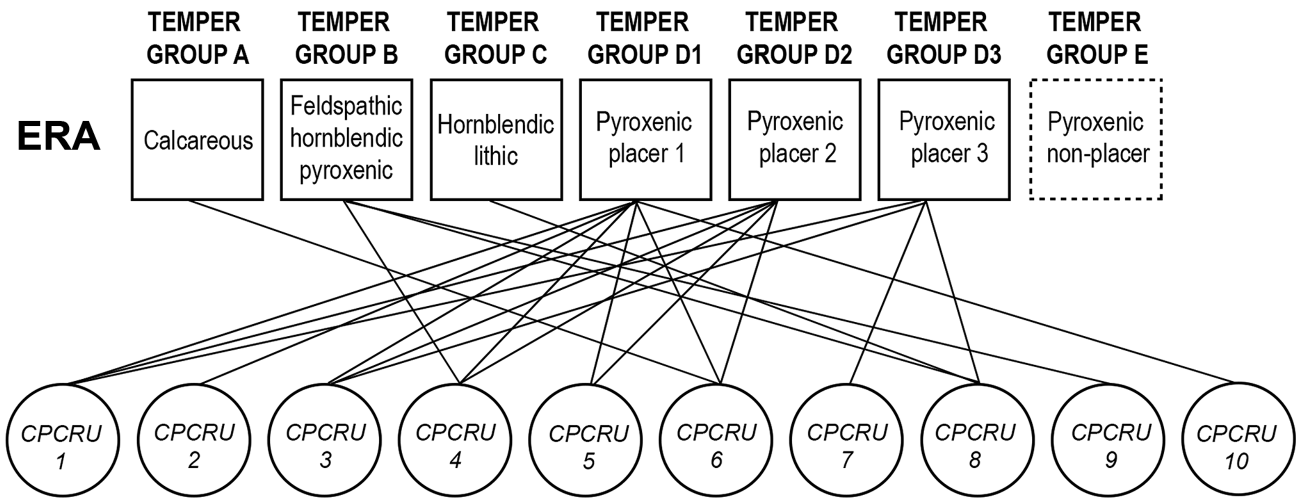

Figure 8. Pottery production model for the Early site of ERA. Temper groups A, B, C, D1, D2, and D3 found in this research, while temper E was identified by Dickinson (2004b).

Table 8. CPCRUs from site ERA by temper group.

CPCRU	A	B	C	D1	D2	D3	E	total
1	—	—	—	2	4	1	—	7
2	—	—	—	1	—	—	—	1
3	—	—	—	4	4	1	—	9
4	—	1	—	4	4	—	—	9
5	—	—	—	4	2	—	—	6
6	2	—	—	1	2	—	—	5
7	—	—	—	—	—	1	—	1
8	—	1	1	—	—	1	—	3
9	—	1	—	—	—	—	—	1
10	—	—	—	1	—	—	—	1
totals	2	3	1	17	16	4	0	43

As expected, the majority of the tempers mixed with each CPCRU are dominated by the D tempers (Table 8, Fig. 8). CPCRUs 1, 3 and 5 exclusively contain such temper sands but differ depending on the presence of temper variants D1–D3 and their proportions. CPCRU 1 and 3 both contain D1–D3 but whereas CPCRU 3 has D1 and D2 in equal abundance with D3 in one sample only, in CPCRU 1 D2 is dominant and D1 and D3 are found in lesser amounts. CPCRU 5 only contains D1 and D2 and is dominated by the former.

Like CPCRU 5, CPCRUs 4 and 6 primarily contain D1 and D2 tempers, but unlike the former they also contain unique tempers. In the case of CPCRU 4 the majority of samples contain the aforementioned tempers, while one sample has rare B temper. CPCRU 6 has two sherds with temper D2, one with D1 and two with the unique site-specific A temper.

CPCRU 8 was not considered a major grouping by Hennessey as it only contains three sherds. Interestingly, it is very varied with each sample belonging to a different temper group, including D3, the rare B temper and the only example of a C temper identified in the assemblage.

Balbalankin (ERC) and Malekolon (EAQ)

Two CPCRUs were defined by Hogg (2007: 54) for the middle assemblages of ERC and EAQ. CPCRU 1 was site-specific to ERC, while CPCRU 2 was, with the exception of one sample, specific to EAQ (Table 9 and Fig. 9). This suggests that ERC 40 with D2 temper sands may have derived from EAQ, or alternately that the sample was produced using the same clay as those from EAQ.

Lastly, it is important to reiterate that the main difference between the two assemblages relates to the tempers employed, as both sites primarily exploited a single clay source to manufacture pottery, but ERC appears to have used a broader suite of tempers to produce such wares.

Table 9. CPCRUs from sites ERC and EAQ by temper group.

site	CPCRU	A	B	C	D1	D2	D3	E	total
ERC	1	—	7	1	6	—	2	1	17
	2	—	—	—	—	1	—	—	1
EAQ	2	—	3	1	11	5	—	—	20
	totals	0	10	2	17	6	2	1	38

Reinterpretation of the temper groups associated with the clays (CPCRUs) identified in Hennessey (2007), supports the original results for ERA, where a large number of clays was used in combination with a number of temper groups. However, while EAQ shows a reduction in the number of tempers used with one clay source, as identified by Hogg (2007), ERC instead shows a different pattern, with a large number of tempers used with one or two clay sources. The Middle Lapita assemblages are thus more variable than expected, which suggests that while changes in production indeed occurred over time, they were not as universal as originally thought.

Discussion

Form and decoration

Based upon research conducted into Lapita assemblages from western New Britain, Summerhayes (2000a) argued that the dentate stamped component of Lapita ceramic assemblages can be considered a specialised component of the Lapita ceramic suite, which changed substantially over time when compared to other components. Within the western New Britain assemblages, this temporal change is reflected in a proportional decline in open bowls and stands (and vessels with attached stands) which are dominant in assemblages from early sites, and an increase in carinated jars from those derived from mid-late sites. This decline also arguably had a direct impact on the dentate stamped component, which also decreased over time. Comparison between the western New Britain assemblages and those studied in this paper from the Anir Islands allows the following points to be made.

Firstly, the results from ERA Test Pit 1 concerning vessel forms and decoration show a similar pattern to the early sites of the Arawe Islands and Mussau, where open bowls

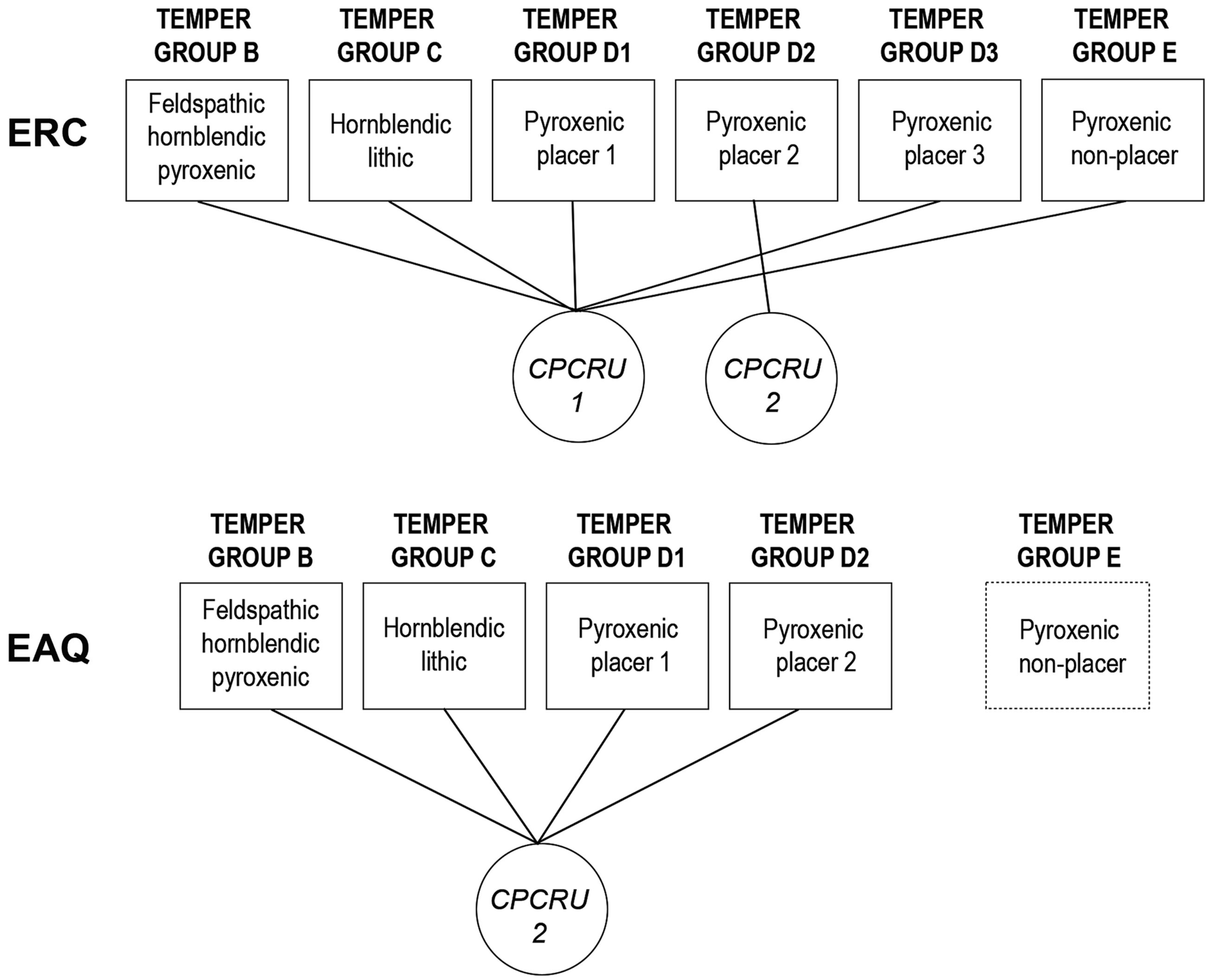

Figure 9. Pottery production model for the Middle/Late Lapita sites of ERC (top) and EAQ (below). Temper groups B, C, D1, and D2 found in EAQ in this research, while temper E was identified by Dickinson (2004b).

and stands are the most common vessel forms and dentate stamping is the dominant decoration. Comparison between the ERA Test Pit 1 results and the preliminary ERA results from Test Pits 1, 2 and 17 (Summerhayes, 2001b) indicates a considerable difference in the proportions of open bowls and carinated jars and types of decoration between the two datasets, which points to variability in vessel form and proportions of decoration type between the test pits. Despite this, both datasets show that the dominant decoration is dentate stamping and that the vessel forms from the site largely consist of open bowls/cups and pot stands.

Secondly, the results from the mid-late sites of ERC and EAQ also match those identified from mid-late sites in western New Britain and the Mussau Group, whereby carinated jars are the dominant vessel form, and dentate stamping has proportionally decreased in relation to other decoration types. Comparisons between vessel form and decoration data from ERC and EAQ presented here do not show any marked differences with data from the preliminary study discussed above. This indicates the validity of the original data.

To conclude, the results from this study complement those from Summerhayes (2000a, 2001b, 2003) and reinforce his conclusions that a marked change occurred over time with regards to the form and decoration of Lapita ceramic assemblages. While the pattern of change is apparent, the reasons for such changes is much less so. It is generally accepted that dentate stamped Lapita wares played a socially significant role within Lapita society, and that the proportional decline of such vessels over time likely related to changes occurring with regards to this particular role (Kirch, 1997: 160–161, 2017: 95–96; Spriggs, 1997: 201; Summerhayes, 2000a: 232; Chiu, 2005, 2007, 2015, 2019).

Indigenous or exotic?

A critical question of any study of pottery is where the materials for pottery production or, if traded in, the complete vessels were being sourced. Drawing upon the previous work of Dickinson (2000, 2004b, 2006) and the new temper groups defined in this research, a detailed picture of the origin of the Anir Islands samples can be drawn.

Dickinson's results showed that the temper groups identified were indigenous to the Anir Group within the TLTF island chain. This provided a baseline for comparing results for the larger assemblages analysed from the three sites in this paper. These comparisons reinforced Dickinson's results. Temper sands indigenous to the Anir Group can be delineated by focusing upon the abundance of certain diagnostic minerals within them, including plagioclase feldspars, clinopyroxenes (specifically the greenish augite), olivine and hornblende minerals.

Studying the temper groups, we argue that four identify source localities while one, temper A, is non-diagnostic, as is the case with all such tempers present within Oceanic pottery assemblages (Dickinson, 2006: 3; Dickinson *et al*., 2013: 11). The compositions of major minerals within temper groups B–E closely match those predicted by the work discussed above, whereby all groups have an abundance of clinopyroxene minerals, in this case exclusively augite, and plagioclase feldspars, primarily albite, oligoclase and andesine antiperthite, while some groups have smaller amounts of hornblende (B and C) and olivine (D1–D3). The results of the chemical analyses of the non-plastic inclusions provide no basis to suggest an exotic source for temper sands at ERA, ERC or EAQ, but do suggest some potential for the movement of materials or completed pottery between sites within the Anir Group and further afield in the TLTF chain to the Tanga Islands.

Movement of materials/complete vessels or shared temper collection localities are suggested by small numbers of samples from ERC and EAQ including one sample (EAQ 439) of temper B which has distinctively high hornblende content that makes it identical to samples from the same temper group in ERC. Additionally, the single samples of temper C in ERC and EAQ are indistinguishable in regards to composition and texture but do differ from that found in ERA because of the latter's better-sorted temper and higher density of grains. Finally, chemical analysis of the clay employed to manufacture a vessel from ERC (sample ERC 40) suggests it may have derived from EAQ or that the two sites occasionally shared the same clay collection locale. Interestingly, this latter sample is the only example of D2 temper in ERC, while EAQ has five of such samples, which tentatively supports the above result.

Pottery transfers from the Anir Island group

Movement of pottery from the Anir Group to the Tanga Group has been suggested in the past (Dickinson, 2004a, 2006; Cath-Garling, 2017). Among the 39 Tanga sherds submitted to Dickinson for petrographic analysis by Garling (2007) for her doctoral thesis, Dickinson (2004a, 2006: 78) identified six to be of Anir origin. Subsequently she argued that a number of the exotic wares identified in her research were 'vestiges from the earlier occupation of the island group during the Early-Middle Lapita period' and, that 'these early Exotic Wares probably originated from multiple communities on Anir and/or possibly some other locales within the TLTF chain of island groups' (Cath-Garling, 2017: 158).

Also noteworthy, one dentate stamped sherd (ETM 996) from Angkitkita, with Type F temper reported as being from Anir by Dickinson (2004a), has an almost identical composition to sherds of temper C from Ambitle sites EAQ (EAQ 1967) and ERC (ERC 1185) in this study, suggesting that this vessel may have been produced at one of these sites. Unfortunately, it is unclear whether the remaining five sherds examined by Dickinson are of Lapita or post-Lapita origin.

Comparison of the newly-constructed temper groups for ERC and EAQ with those identified for sites in the Tanga Islands (primarily ETM) strongly supports arguments for the movement of vessels between sites in the two island groups during the Middle Lapita period (Dickinson, 2004a, 2006; Garling, 2007; Cath-Garling, 2017). Furthermore, ERC and EAQ may have been involved in the production of some of the exotic Tanga vessels. Unfortunately, it was not possible to compare directly the pottery fabrics from the sites in question, and thus it cannot be said unequivocally that the two sites produced the exotic Tanga wares.

Population mobility and settlements

As noted above, a distinct change in pottery production occurred between the Early and Middle/Late periods in western New Britain and arguably also in the Mussau Group, which sees an overall reduction from a large number of clays being combined with a variety of fabrics to a small number of clays with a small number of fabrics. Summerhayes (2000a) argues this pattern relates to a decrease in mobility of the Lapita populations leading to a sedentary community as seen today, and not from a reduction of pottery imported from fewer production localities over time as argued for the Mussau Group (Kirch, 1990, 1997). This research follows Grainger *et al*. (2020) in viewing 'mobility' as a process that involves the small-scale movements of populations around the landscape. They suggest that the high mobility of the populations of the Early Lapita period, representing new arrivals into the region, represents an adaptive mechanism which allowed such populations to rapidly gain an understanding of their local environment, its resources and their properties. Following the end of the colonising phase, populations had successfully adapted to the unique environment of the region and had gained a thorough understanding of its associated resources, and thus became more sedentary, reflected in a greater emphasis on the procurement of materials from the immediate vicinity of their settlements. What do our results indicate about the settlements of the Anir Islands' Lapita populations?

Lapita populations during the Early Lapita period at ERA employed a very wide range of clays mixed with a variety of locally sourced temper sands to produce a number of complex vessel forms, particularly bowls and stands. The selection of clays and tempers was not conservative as seen with potting communities today that consistently use the same resources to produce pots. Reference to the work of Summerhayes (2000a) suggests that such a pattern is one of a highly mobile population that moved around the Anir Islands, and potentially even around the TLTF chain of islands, procuring sands and also likely clays to produce a range of locally-produced complex vessels; the decoration and forms of which are strikingly similar to those identified in other Early Lapita settlements of the Bismarck Archipelago, indicating a high degree of interaction between Lapita communities of the period.

By the Middle/Late Lapita periods the Lapita populations at ERC and EAQ appear to have changed to a more sedentary lifestyle which is reflected in the use of one to two likely locally sourced clays and less varied temper sands. However, while both sites show a decrease in the number of temper sands employed as compared to the earlier assemblage of ERA, the decrease is much less apparent at ERC than it is at EAQ. ERC appears to show a pattern that is in-between the two extremes set by ERA and EAQ. As in the early period, vessel forms are strikingly similar amongst the sites with similar proportions of forms and decoration types. Populations in these later sites like those that occupied ERA previously remained in contact with other populations but did not strike out as far for resources as in previous periods.

Conclusions

The data presented in this study allows for the following conclusions:

1 The results of the formal and decoration analysis on the early assemblage of ERA and the Middle/Late Lapita assemblages of ERC and EAQ closely match those originally identified by Summerhayes (2000a) in western New Britain, suggesting that such patterns are not region specific and likely relate to broad changes occurring within Lapita society with regards to the societal role played by dentate stamped pottery.

2 Results of the temper and CPCRU analysis for the three Anir Islands' sites closely match those identified by Summerhayes (2000a) in western New Britain, in showing a reduction in the number of clays and separate tempers used in the process of local pottery production between Early and Middle/Late Lapita sites. While our data support the overall model, the two sites of ERC and EAQ appear to show some variability likely existed with regards to the number of tempers employed by Middle/Late potters to produce pottery as reflected by the larger number of such tempers employed at ERC. We suggest that this change indicates a shift from highly mobile to sedentary settlements. However, it is important to note that the pattern identified in the Anir Islands' sites differs from that identified in the Mussau Group sites that contain largely exotic pottery.

3 Comparisons of tempers identified in the Ambitle sites of ERC and EAQ with the same in the Tanga Group support previous arguments (Dickinson, 2004a, 2006; Garling, 2007; Cath-Garling, 2017) for the possible movement of vessels between the Anir and Tanga Island groups, and suggests that ERC and EAQ may have been directly involved in the production of such vessels during the Middle Lapita period.

4 Significant changes occurred over time within Lapita society which can be seen in both the form and decoration of ceramic assemblages in these sites. At the same time there is also a large amount of evidence for continuing interaction and cultural continuity between dispersed Lapita communities. This is reflected in both the synchronised nature of the aforementioned changes occurring to pottery assemblages across the Bismarck Archipelago, and with regards to the argued movement of pottery within the TLTF Island chain.

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References

Ambrose, W. 1973. 3000 years of trade in New Guinea obsidian. *Australian Natural History* 17(11): 370–373.

Anson, D. 1983. *Lapita Pottery of the Bismarck Archipelago and Its Affinities*. Unpublished PhD thesis, University of Sydney.

Anson, D. 1986. Lapita pottery of the Bismarck Archipelago and its affinities. *Archaeology in Oceania* 21(3): 157–165. https://doi.org/10.1002/j.1834-4453.1986.tb00144.x

Bedford, S. 2006. *Pieces of the Vanuatu Puzzle: Archaeology of the North, South and Centre*. Terra Australis 23. Canberra: ANU Press. https://doi.org/10.22459/PVP.02.2007

Bishop, R. L, and R. L. Rands. 1982. Maya fine paste ceramics: a compositional perspective. In *Analysis of Fine Paste Ceramics. Excavations at Siebal,* ed. J. A. Sabloff, pp. 283–314. Memoirs of the Peabody Museum of Archaeology and Ethnology 15. Cambridge (Mass.): Peabody Museum of Archaeology and Ethnology.

Bishop, R. L, R. L. Rands, and G. R. Holley. 1982. Ceramic compositional analysis in archaeological perspective. *Advances in Archaeological Method and Theory* 5: 275–320. https://doi.org/10.1016/B978-0-12-003105-4.50012-1

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1): 337–360. https://doi.org/10.1017/S0033822200033865

Cath-Garling, S. J. 2017. *Evolutions or Revolutions? Interaction and Transformation at the 'Transition' in Island Melanesia*. University of Otago Studies in Archaeology 27. Dunedin: Department of Anthropology and Archaeology, University of Otago.

Chiu, S. 2005. Meanings of a Lapita face: materialized social memory in ancient house societies. *Taiwan Journal of Anthropology* 3(1): 1–47.

Chiu, S. 2007. Detailed analysis of Lapita face motifs: case studies from the Reef/Santa Cruz sites and New Caledonia Lapita site 13A. In *Oceanic Explorations: Lapita and Western Pacific Settlement*, ed. S. Bedford, C. Sand, and S. P. Connaughton, pp. 241–264. Terra Australis 26. Canberra: ANU E Press. https://doi.org/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. W. S. Hogg, pp. 185–206. Archeologia Pasifika 4. Noumea: Institute of Archaeology of New Caledonia and the Pacific.

Chiu, S. 2019. Measuring social distances with shared Lapita motifs: current results and challenges. In *Debating Lapita: Distribution, Chronology, Society and Subsistence*, ed. S. Bedford and M. Spriggs, pp. 307–334. Terra Australis 52. Canberra: ANU Press.
https://doi.org/10.22459/TA52.2019.15

Dickinson, W. R. 2000. Petrography of Temper Sands in Lapita Sherds from the Kamgot Site on Ambitle in the Feni Islands of the TLTF Chain Northeast of New Ireland. Petrographic Report WRD-200 (30 December 2000).

Dickinson, W. R. 2004a. Petrography of Sand Tempers in Sherds from the Tanga Islands. Petrographic Report WRD-239 (5 July 2004, revised 12 July 2004).

Dickinson, W. R. 2004b. Petrography of Sand Tempers in Lapita Sherds from the Balbalankin site on Anir (Ambitle) in the TLTF Chain off New Ireland. Petrographic Report WRD-244 (15 December 2004).

Dickinson, W. R. 2006. *Temper Sands in Prehistoric Oceanian Pottery: Geotectonics, Sedimentology, Petrography, Provenance*. Special Paper 406, Geological Society of America. Boulder (Colorado): Geological Society of America.
https://doi.org/10.1130/2006.2406

Dickinson, W. R. 2007. Discriminating among volcanic temper sands in prehistoric potsherds of Pacific Oceania using heavy minerals. In *Heavy Minerals in Use*, ed. M. A. Mange and D. T. Wright, pp. 985–1005. Developments in Sedimentology 58. Amsterdam: Elsevier.
https://doi.org/10.1016/S0070-4571(07)58039-8

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.

Garling, S. J. 2007. *Post-Lapita Evolutions or Revolutions? Interaction and Exchange in Island Melanesia: The View from the Tanga Islands*. Unpublished PhD thesis, The Australian National University, Canberra.

Grainger, A., G. R. Summerhayes, and C. Gosden. 2020. 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.
https://doi.org/10.1080/03122417.2020.1840489

Hennessey, M. 2007. *On the Move: Mobility Pattern of the Early Phase Lapita Site at Kamgot*. Unpublished BA (Hons) thesis, University of Otago, Dunedin.

Hogg, N. W. S. 2007. *Settling Down: Mobility Patterns of three Mid-Late Lapita Sites in the Anir Group, Papua New Guinea*. Unpublished BA (Hons) thesis, University of Otago, Dunedin.

Horz, K. H., T. J. Worthington, K. Winn, and P. Stoffers. 2004. Late Quaternary tephra in the New Ireland Basin, Papua New Guinea. *Journal of Volcanology and Geothermal Research* 132(1): 73–95.
https://doi.org/10.1016/S0377-0273(03)00421-9

Hunt, T. L. 1989. *Lapita Ceramic Exchange in the Mussau Islands, Papua New Guinea*. Unpublished PhD thesis, University of Washington, Seattle.

Kirch, P. V. 1990. Specialization and exchange in the Lapita complex of Oceania (1600–500 B.C.). *Asian Perspectives* 29(2): 118–133.
http://www.jstor.org/stable/42928219

Kirch, P. V. 1997. *The Lapita Peoples: Ancestors of the Oceanic World*. Cambridge (Mass.): Blackwell Publishers Inc.

Kirch, P. V. 2017. *On the Road of the Winds: An Archaeological History of the Pacific Islands before European Contact*. Revised and expanded edition. Oakland: University of California Press.
https://doi.org/10.1525/9780520968899

Licence, P., J. Terrill, and L. Fergusson. 1987. Epithermal gold mineralisation, Ambitle Island, Papua New Guinea. In *Proceedings of the Pacific Rim Congress* 87, *Gold Coast, 26–29 August 1987*, pp. 273–278. Melbourne: The Australian Institute of Mining and Metallurgy.

Lindley, I. D. 2015. Late Quaternary geology of Ambitle volcano, Feni Island Group, Papua New Guinea. *Australian Journal of Earth Sciences* 62(5): 529–545.
https://doi.org/10.1080/08120099.2015.1076033

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, Australian National University.

Reimer, P. J., E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, C. E. Buck, H. Cheng, R. L. Edwards, M. Friedrich, P. M. Grootes, T. P. Guilderson, H. Haflidason, I. Hajdas, C. Hatté, T. J. Heaton, D. L. Hoffmann, A. G. Hogg, K. A. Hughen, B. F. Kaiser, B. Kromer, S. W. Manning, M. Niu, R. W. Reimer, D. A. Richards, E. M. Scott, J. R. Southon, R. A. Staff, C. S. M. Turney, and J. van der Plicht. 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon* 55(4): 1869–1887.
https://doi.org/10.2458/azu_rc.55.16947

Spriggs, M. 1997. *The Island Melanesians*. Oxford: Blackwell Publishers Ltd.

Summerhayes, G. R. 2000a. *Lapita Interaction*. Terra Australis 15. Canberra: Department of Archaeology and Natural History and the Centre for Archaeological Research, Australian National University.

Summerhayes, G. R. 2000b. Recent archaeological investigations in the Bismarck Archipelago, Anir—New Ireland province, Papua New Guinea. *Bulletin of the Indo-Pacific Prehistory Association* 19: 167–174.

Summerhayes, G. R. 2000c. What's in a pot? In *Australian Archaeologist: Collected Papers in Honour of Jim Allen*, ed. A. J. Anderson and T. Murray, pp. 291–307. Canberra: Coombs Academic Publishing.

Summerhayes, G. R. 2001a. Defining the chronology of Lapita in the Bismarck Archipelago. In *The Archaeology of Lapita Dispersal in Oceania*, ed. G. Clark, A. J. Anderson, and T. Vunidilo, pp. 25–38. Terra Australis 17. Canberra: Pandanus, Books Research School of Pacific and Asian Studies, Australian National University.

Summerhayes, G. R. 2001b. Lapita in the far west: recent developments. *Archaeology in Oceania* 36(2): 53–63.
https://doi.org/10.1002/j.1834-4453.2001.tb00478.x

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 (Proceedings of the International Conference for the 50th Anniversary of the First Lapita Excavation, Koné-Nouméa 2002)*, ed. C. Sand, pp. 135–158. Nouméa: Département Archéologie, Service des Musées et du Patrimoine de 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. In *A Pacific Odyssey: Archaeology and Anthropology in the Western Pacific. Papers in Honour of Jim Specht*, ed. V. Attenbrow and R. Fullagar, pp. 145–156. *Records of the Australian Museum, Supplement* 29.
https://doi.org/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, pp. 141–184. Taipei: Academia Sinica.

Summerhayes, G. R. 2010. Lapita interaction—an update. In *2009 International Symposium on Austronesian Studies*, ed. G. Z. Masegseg and Hsiu-man Lin, pp. 11–40. Taitong (Taiwan): National Museum of Prehistory.

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, pp. 97–122. Terra Australis 26. Canberra: ANU E Press.
https://doi.org/10.22459/TA26.2007.05

Summerhayes, G. R., K. Szabó, M. Leavesley, and D. Gaffney. 2019. Kamgot at the lagoon's edge: site position and resource use of an early Lapita site in Near Oceania. In *Debating Lapita: Distribution, Chronology, Society and Subsistence*, ed. S. Bedford and M. Spriggs, pp. 89–104. Terra Australis 52. Canberra: ANU Press.
https://doi.org/10.22459/TA52.2019.04

Szabó, K., and G. R. Summerhayes. 2002. Worked shell artefacts—new data from early Lapita. In *Fifty Years in the Field. Essays in Honour and Celebration of Richard Shutler Jr's Archaeological Career*, ed. S. Bedford, C. Sand, and D. Burley, pp. 91–100. New Zealand Archaeological Association Monograph 25. Dunedin: The New Zealand Archaeological Association.

Wallace, D. A., R. W. Johnson, B. W. Chappell, R. J. Arculus, M. R. Perfit, and I. H. Crick. 1983. *Cainozoic Volcanism of the Tabar, Lihir, Tanga, and Feni Islands, Papua New Guinea: Geology Whole-Rock Analyses, and Rock-Forming Mineral Compositions*. Australian Bureau of Mineral Resources Report 243. Canberra: Australian Government Publishing Service.
https://d28rz98at9flks.cloudfront.net/15154/Rep_243.pdf

White, J. P., and J. Specht. 1971. Prehistoric pottery from Ambitle Island, Papua New Guinea. *Asian Perspectives* 14: 88–94.
https://www.jstor.org/stable/42927747

Woolley, A. R. 2019. *Alkaline Rocks and Carbonatites of the World, Part 4: Antarctica, Asia and Europe (excluding the former USSR), Australasia and Oceanic Islands*. London: The Natural History Museum.
https://doi.org/10.1144/MPAR4