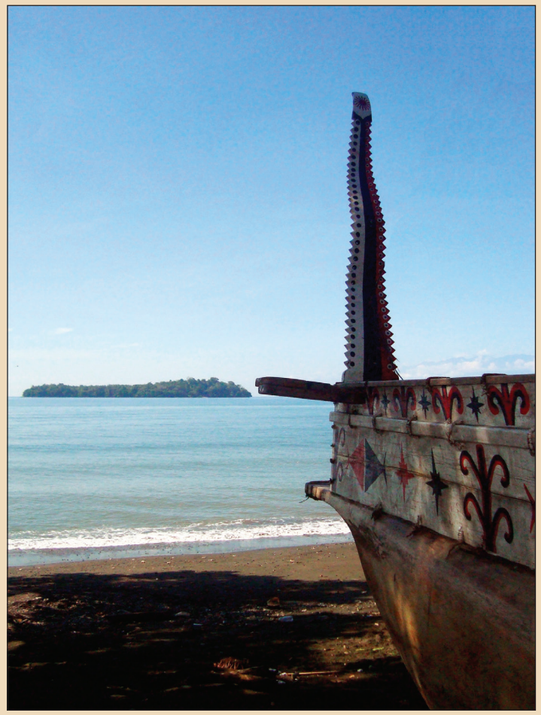


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MATERIALISING ANCESTRAL MADANG:
Pottery Production and Subsistence Trading on the Northeast Coast of New Guinea

Dylan Gaffney



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Richard Walter
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Dylan Gaffney
Magdalene College
Cambridge
October 2020



Chapter 1. Introduction

Follow the materials; learn the movements; draw the lines
— Tim Ingold (2011)[1]

It is within production and exchange networks that objects are made, products are moved, and communities are bound. By unravelling something about how materials are transformed within these networks, and how they vitalise and shed meaning along the way, we can begin to understand broader social, technological, and economic relationships within the landscape. Perhaps more than anywhere else in the world, ethnographic examples from Melanesia have cast light on diverse modes of material culture manufacture and distribution, which have been crucial to theoretical and methodological developments in the wider discipline (e.g. Gell 1992a; Gregory 1982; Mauss 1925; Sahlins 1972; Thomas 1991). The coastal fringe and offshore islands, in particular, played host to unique arrangements of these networks in the recent past, involving annual cycles of cropping, specialist craft production, and long-distance trade voyaging, which redistributed objects hundreds of kilometres from their point of manufacture to geographically disparate consumers. This is particularly well known from Malinowski's (1922) foundational description of the *Kula* exchange network, which still operates today, and sees named shell valuables moving in various directions around the Massim, off the southeastern tail of New Guinea. Equally important examples describe shell exchange in the Bismarck Archipelago (Counts 1979; Parkinson 1887; Salisbury 1966) and Solomon Islands (Cooper 1971; Woodford 1908), *Hiri* pottery trade on the south coast of Papua (Chalmers 1887; Dutton 1982; Groves 1960; Seligmann 1910), Siassi middlemen in the Vitiaz Strait (Harding 1967), and the red-feather money of Santa Cruz (Beasley 1936; Pycroft 1935).

Many of these groups occupied ecologically marginal zones and lacked 'landesque capital' – the potential to modify and invest labour in gardens with the intention that the land itself will then provide increased yields (see Bayliss-Smith and Hviding 2015; Clark and Tsai 2013; Kirch 2007; Widgren and Håkansson 2014). Equally importantly, these groups also lacked much of the arable land from which social relations could be generated. For instance, along the Rai Coast land stores the creative potential for generating all kinds of interpersonal and political alliances, with claims to the control of, or centrality to, these sets of relations being paramount (Leach 2003: 216–217, 2012). Not so for those specialist producers and middlemen groups who often had limited cultivatable land at their disposal, and for whom networks of production and exchange became key to their access to utilitarian goods, raw materials, and food. For these 'subsistence traders' (Allen 1985), attending to exchange relationships was not only socially motivated, but importantly required for subsistence maintenance, ensuring the population's ongoing survival.

In some places, subsistence traders came to thrive economically by holding sway over the movement of materials, despite occupying ecologically marginal zones. Controlling these networks allowed some subsistence trading groups to not only acquire surplus foodstuffs, but also valuable and exotic items necessary for socio-political manoeuvring and the renewal of important life-cycle stages (Martin 2019). Sahlins (1972: 282) notes that although many of these specialist trading groups were marginally situated with regard to the larger island of New Guinea, often possessing scarce resources for crop production, they were usually the most materially affluent in the area, as a result of their extensive social networks and ability to control the flow of goods and exchange rates, and so occupied a precarious but privileged position off the coast. Coastal exchange networks then formed crucial conduits for people's social connectivity and subsistence, and, at the regional level, allowed for the ratcheting of production and consumption, while reducing pressure on locally scarce resources.

Despite these important contributions from Melanesian ethnography, the long-term evolution of these networks prior to the colonial period is patchily understood, and many of our interpretations remain ahistorical (Kirch 1991). By examining the temporal dynamics of how craft production and subsistence trading transformed over the centuries it should be possible to model the interrelation-

1 Tim Ingold (2011: 1–20) in *Redrawing Anthropology: Materials, Movements, Lines*

ship between social, economic, and technological change – and how this is manifested archaeologically – amongst small-scale, lowly-stratified groups in the area. Moreover, to better appreciate the vibrant communities and material cultures that characterise the region today, we must explore the pre-colonial past, and the distinct, historically contingent processes that brought these interaction networks to life. As such, the present volume traces production and exchange back through time on New Guinea's northeast coast. Specifically, it is an archaeological study that examines the emergence of the Madang exchange network over the last half-millennium before present, which was one of the most extensive, but perhaps least well-known, interaction systems around coastal Melanesia during the recent past. It is within this crucial period that many of the exchange networks observed ethnographically around New Guinea began to take form, and when specialised pottery making shifted increasingly towards mass production to fuel these networks (Skelly and David 2017: 522).

In 1871–1872, when the Russian scientist Nikolai Miklouho-Maclay first explored the northeast coast, the Bilbil speaking Bel groups that today live around coastal Madang (Fig. 1.1) produced brilliant red-slipped pottery and commanded an expansive trading network (referred to here as the Madang exchange network), which redistributed material culture around the coast, between islands, and into the interior (Harding 1967). Potsherds ancestral to these red-slipped vessels have been found scattered across hundreds of kilometres, from Karkar Island in the north (Egloff 1975), along the northeast New Guinea coast (Lilley 1986), into the Bismarck Archipelago (Summerhayes 2001a), and even to the Central New Guinea Highlands (White 1972), suggesting that this network was in operation, and flourishing, prior to Europeans. However, very little work has been carried out around Madang itself, the nucleus of this network. For this reason, the deeper history of the Bel groups and their pottery-making, along with how their exchange network emerged, remain crucial but unanswered questions in Melanesian anthropology.

To begin to address these questions, this volume will investigate Bel ceramic technology from its pre-colonial inception around Madang, up until the present day, taking an explicitly anthropological approach to technological production and exchange. The first chapter of this monograph will introduce the necessary background literature that 1) models pre-colonial production and exchange around the northeast coast of New Guinea, 2) describes important contextual aspects of Bel culture history, and 3) informs the underlying theoretical perspective. The chapter will conclude by outlining specific research objectives along with the approaches taken in this volume to address them.



Figure 1.1. Madang, the study area, in Near Oceania. Significant ethnographic trading networks redrawn from Lilley 2017 and Skelly and David 2017.

Production and exchange on the northeast coast of New Guinea

Ethnographic configurations

On New Guinea's northeast coast, a number of interconnected trading networks operated with a locational focus on the Vitiaz Strait, Dampier Strait, Astrolabe Bay, and the Huon Peninsula. Harding (1967) has described these networks as involving a large number of low-density, relatively acephalous groups that contributed specialised products and foodstuffs to a larger Vitiaz Strait social sphere or 'super-system' (see Lilley 1986:35). This super-system relied both on coastal production, as well as the import of goods from 'ethnic blocks' in the interior, via hinterland middlemen, to port communities, and *vice versa* (Fig. 1.2). Once objects reached the port communities, they would be distributed by specialised long-distance traders: across the Vitiaz and Dampier Straits by the Siassi Islanders (Harding 1967), to the Huon Gulf by the Tami Islanders (Hogbin 1947), and to Astrolabe Bay and Madang by the Bel[2] groups (Lawrence 1964; Mennis 2006a). Because many social groups produced a variety of different specialised material culture, we can view the broader northeast coast as being a landscape in which the diversification of production had itself stimulated the ongoing movement of products.

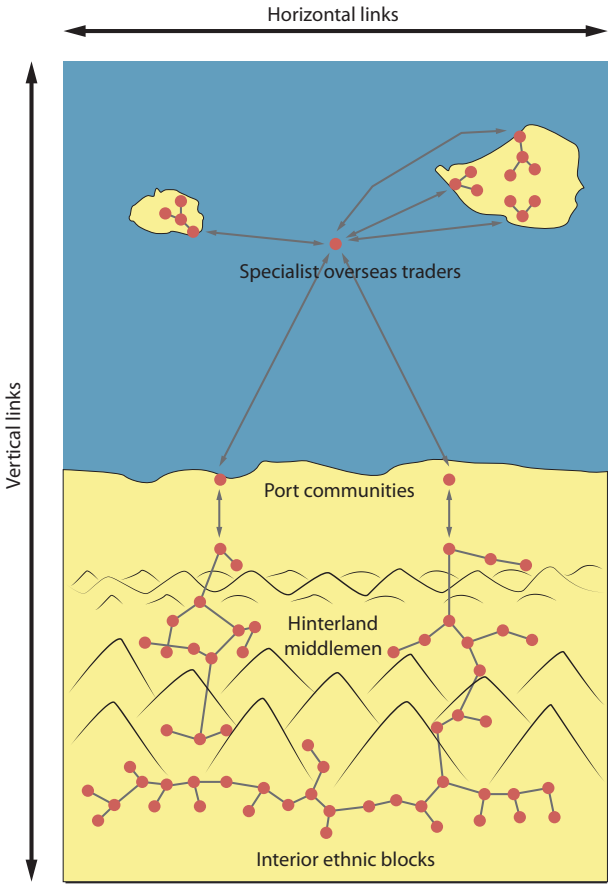


Figure 1.2. Model of production & exchange networks operating around northeast New Guinea (adapted from Lilley 1986:36, 2017; see also Harding 1967:16).

The impetus for the movement of materials in this network was both economic and social (Harding 1967:165). It was economic in the sense that specialised production and exchange was essential to the survival of many island groups, including the Siassi, Tami, and Bel subsistence traders, who needed to exchange objects such as pottery for crops and animals to support their populations, which often exceeded the agronomic capacities of their small islands. In fact, some communities on the mainland even under-produced crops to create intentional food shortages that attracted subsistence traders bringing exotic goods, which could become politically efficacious objects or be used in further exchange with inland groups (Harding 1967). Trading was also social in the sense that many groups imported variations of items that they themselves made, or could have easily produced, as a means to enter into the super-system and maintain social connectivity. These connections were taken seriously, and exchange partnerships were often cultivated over multiple generations, inherited from father to son. This sometimes even involved the adoption of a trade friend's son from an early age, which encouraged people to become fluent in the language of their counterparts. Terrell and Welsh (1997:555) call these 'inherited friendships,' as they are termed along the Sepik coast. Around the Vitiaz Strait, these fictive kinship bonds established how people would behave in trading relationships, and allowed individuals not necessarily related by blood or marriage to act with familial and affinal qualities (Harding 1967:166). In particular, these bonds allowed trade friends to participate in gift-giving and delayed reciprocity; although giftings were seen as distinct and unconnected events, an immediate return would be highly inappropriate as it did not create the potential for a return visit (Sahlins 1965).

As well as being maritime traders, the Bel groups in particular were set apart from the Siassi and Tami in that they were also specialist pottery producers. In this way they approximate the Motu pottery makers, who maintained the *hiri* trade links along the south coast of Papua (Mennis 2014). Within the *hiri* system, women would produce earthenware pottery, while men would assemble trading canoes and sail them along the coast, exchanging the pots for large quantities of sago and other crops produced by groups living to the west in the Gulf of Papua (Dutton 1982). A similar schedule of carefully timed pottery production and trade voyaging was in play amongst the Bel, who sailed on *waing* voyages to undertake *dadeng* (trade) with horticulturalists along the Rai Coast and beyond.

Archaeological models

Archaeological research around coastal Melanesia has attempted to track these practices back through time. This corpus of work suggests that production and exchange in the Late Holocene was just as vibrant as these ethnographic observations would have us believe; a crucial

2 Elsewhere referred to as Bilbil/Bilibili.

time of change, featuring socio-political transformation, population migration, and cultural diversification (Spriggs 1997:154–161). From about 2000 years ago, there was a gradual breakdown of the long-distance kinship and exchange connections that characterised the Lapita period in the third and fourth millennia before present (Cath-Garling 2017; Summerhayes 2007). By the last millennium, these had been replaced by smaller, but highly complex, regional exchange networks. Jim Allen (1982, 1984b, 1985) developed a model, based on work along the south coast of Papua, which suggested periods of trading that gradually became more intense punctuated the last few millennia. This intensification was due to accelerating production to acquire surplus goods and increasing consumer demand, which led to interaction becoming unstable, eventually breaking down. As depicted in Figure 1.3, Allen's model suggests production and exchange networks became increasingly complex, but reliably disintegrated into a series of geographically smaller networks through time. This has been likened to speciation by network decay, whereby regional socio-technological processes gradually fragmented and diversified to form the complex networks of people and materials seen at ethnographic contact (Thomas 2009).

In revisiting the pre-colonial Vitiaz Strait networks, Lilley (2017) describes 'proto-systems' in which the configuration of pottery production and exchange were markedly different to that observed ethnographically by Harding (1967). Along the northeast coast at Sio and in the Siassi Islands of the Vitiaz Strait, a low intensity production and exchange of Lapita pots around 3000 years ago was followed by a ceramic hiatus until 1700 years ago, which in turn was followed by the emergence of standardised pottery designed for increasingly complex exchange networks. Although the precursors to ethnographic pottery production and trading can be seen as far back as the early second millennium before present, these networks only took on their recent configuration within the last millennium, intensifying within the last 300 years. Lilley sees these changes around the northeast coast as consistent with Allen's (1985) model for southern Papua, with the far-reaching, highly mobile Lapita period breaking down into a set of smaller but substantially more complex local and sub-regional networks, characterised by Type X, Sio, and Madang style potteries.

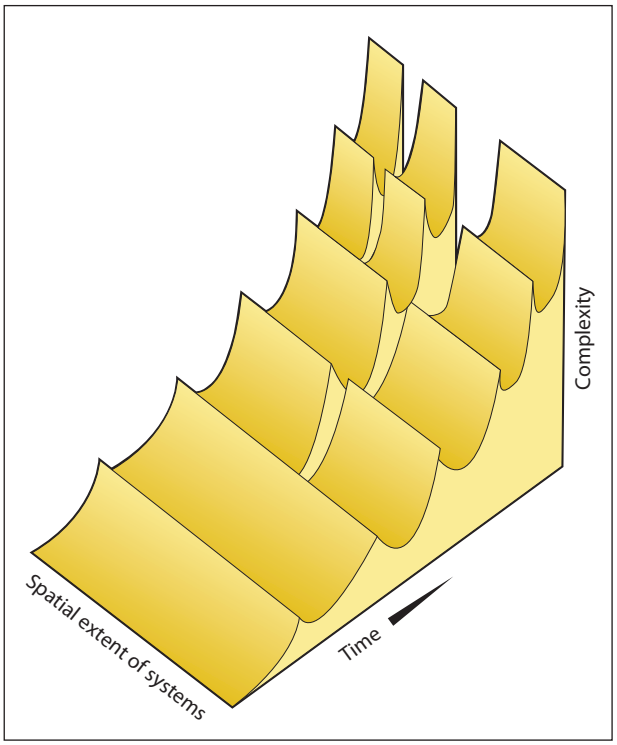


Figure 1.3. Allen's wave-like model for the intensification and divergence of trade networks through time (adapted from Allen 1984b).

Although numerous research projects along the south Papuan Coast (Allen 2017; Bulmer 1979; David *et al.* 2010; Egloff 1979; Irwin 1985; Skelly and David 2017; Summerhayes & Allen 2007; Urwin *et al.* 2018), in the Massim (Bickler 1998; Chynoweth *et al.* 2020; Shaw 2016; Shaw and Dickinson 2016; Shaw *et al.* 2016, 2020), around the Huon Peninsula (Lilley 1988a), and on the Sepik north coast (Beaumont *et al.* 2019; Gorecki *et al.* 1991; Swadling *et al.* 1989; Terrell & Schechter 2011a), have previously described the emergence of complex pottery production and exchange networks, until very recently almost nothing has been known archaeologically about the Madang area. Most of what we do know about Madang's pre-colonial past stems from linguistic, oral history, and geological evidence. This existing evidence will now be briefly presented to frame our current understanding of Bel history and how these groups have come to occupy their unique position along the coastal margin and on offshore islands around Madang.

Bel culture history

Language

On the northeast coast of New Guinea, Non-Austronesian languages that typify the interior of the island, including those of the 'Madang' and Trans-New Guinea families, result from the divergence and interaction of communities within New Guinea throughout the past 50,000 years (Foley 2000; Pawley 2006; Wurm 1983). The comparatively recent occurrence of the Oceanic sub-branch of the Austronesian language family, associated with Lapita pottery, emerged in the Bismarck Archipelago having split from the Eastern Malayo-Polynesian languages spoken in Cenderawasih Bay between 4000–3000 years ago (Blust 2013; Kirch 1997). The presence of Oceanic languages on the northeast coast of New Guinea today may represent traces of these initial Austronesian-speaking migrant communities as they moved eastward along the north coast, but, if that is the case, they have been mostly overwritten by subsequent westward 'backwashes' from the Bismarck Archipelago (Hooley 1971; Pawley & Ross 1993; Z'Graggen 1975:39).

Ross (1988) subdivides the large Oceanic subgrouping of Austronesian into three genetically linked clusters, all

with a central origin in West New Britain: the Meso-Melanesian Cluster, the Papuan Tip Cluster, and the North New Guinea Cluster (Fig. 1.4).[3] The North New Guinea Cluster covers all of the Austronesian languages along the northeast coast including Madang, the Huon Peninsula, the Sepik, and most of New Britain west of the Willaumez Peninsula. These speech communities are primarily restricted to the coastal margins and offshore islands, representing their more recent arrival to the mainland (Fig. 1.5). Based on linguistic reconstructions, it is likely that North New Guinea Cluster Austronesian speakers initially moved from West New Britain to the northeast coast of New Guinea, perhaps settling Manam Island before moving westward along the Sepik coast (forming the Schouten Chain). Following this there was a southward movement from West New Britain to the Huon Gulf area (forming the Huon Gulf family). Later still, some groups moved from West New Britain across the Vitiaz Strait and around coastal Madang (Ross 1988:160–183; see also a summary in Lilley 1999). This formed the Ngero/Vitiaz language network, which stretches from Karkar Island to West New Britain and the Tami Islands, and comprises five sub-families, including Bel (Fig. 1.6).[4] The Bel sub-family is spoken around coastal Madang Province, from Karkar in the north to the Rai Coast in the south. This sub-family is further subdivided into individual languages as defined by the Bel people: Gedaged and Bilbil around Madang town, Takia on Bagabag Island and the south side of Karkar Island, Megiar and Matukar on the adjacent mainland, Ham inland between the Gogol and Nuru Rivers, and Mindiri, Biliau, and Wab on the Rai Coast. Within Gedaged there are four dialects, Siar, Riwo, Sek, and Kranket, and these are mutually intelligible (Z'Graggen 1976).

Oral tradition

Oral histories give some insight into the restricted distribution of these North New Guinea Cluster languages around Madang. The most common etiological story reported by the Bel refers to the disappearance of their homeland; an island generally known as Yomba (Mennis 1980b, 1981a, 1981b). This homeland is reported to have been located somewhere beyond Madang, in the Bismarck Sea, but sunk into the waves many generations ago, forcing the occupants to flee to the northeast coast. The most detailed accounts describe a full sequence of events: large earthquakes, Yomba's eruption, subsidence of the island into the sea, and a resulting tsunami (Mennis 2006b; Fig. 1.7).

3 Greenhill and Gray (2009) group only the North New Guinea, Papuan Tip and Willaumez portion of the Meso-Melanesian Cluster together using phylogenetic reconstruction, but more recent analyses at the Max Plank Institute, using lexical data with a Bayesian algorithm, confirm Ross' (1988) groupings based on morphological and phonological innovations, bracketing the Papuan Tip, Meso-Melanesian and North New Guinea clusters strongly together (Simon Greenhill pers. comms 2015; Malcolm Ross pers. comms 2015).

4 Following Ross (1988:121); cf. Hooley (1971) and Z'Graggen (1975), who define the near-equivalent 'Siassi Family,' extending from Karkar to the Huon.

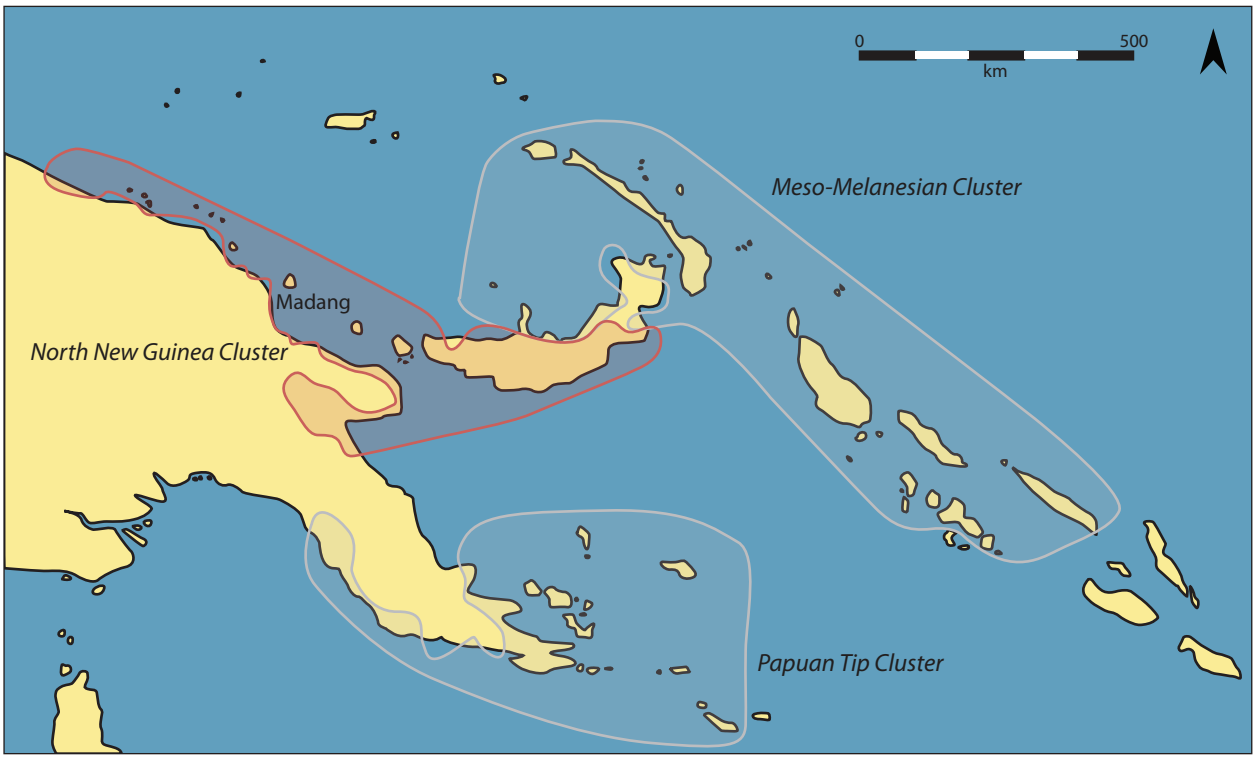


Figure 1.4. Austronesian language clusters within the West Melanesian Oceanic subgroup (adapted from Ross 1988).

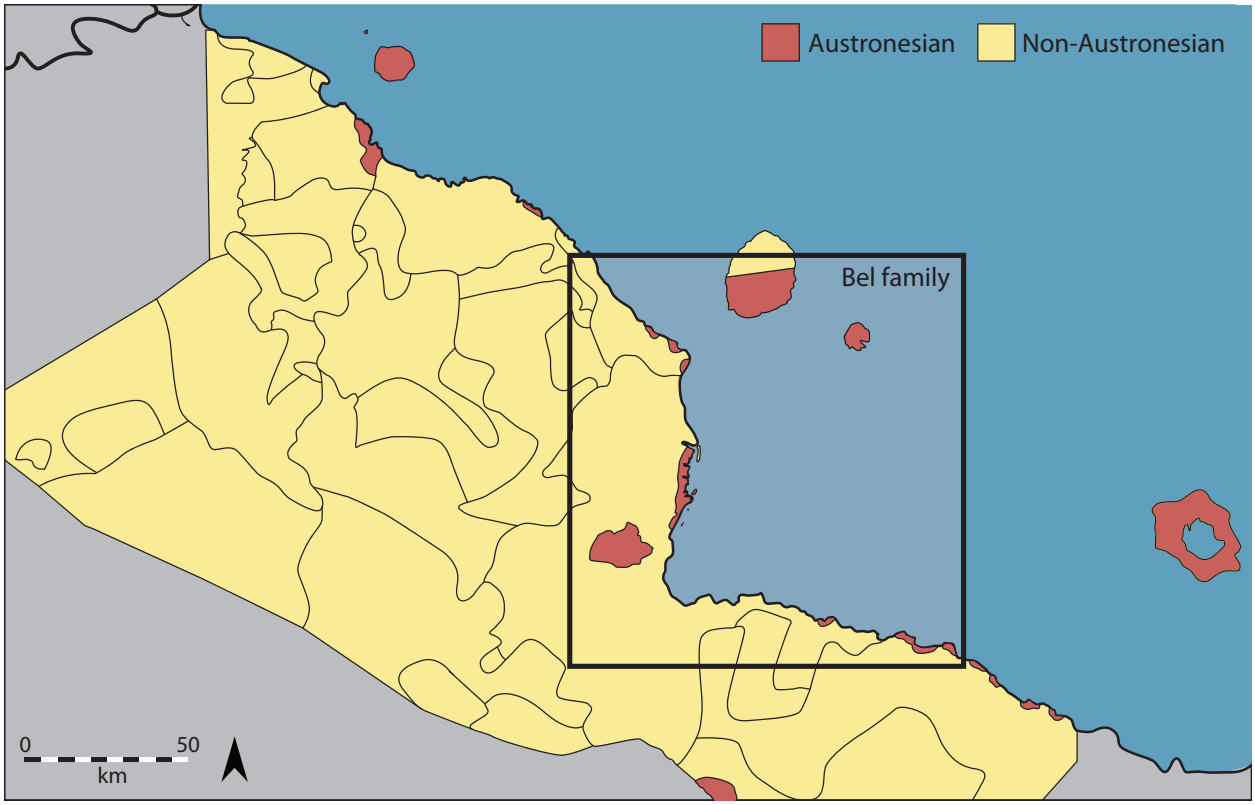


Figure 1.5. Major language stock boundaries in Madang Province including the Bel language family (adapted from Z'Graggen 1975).

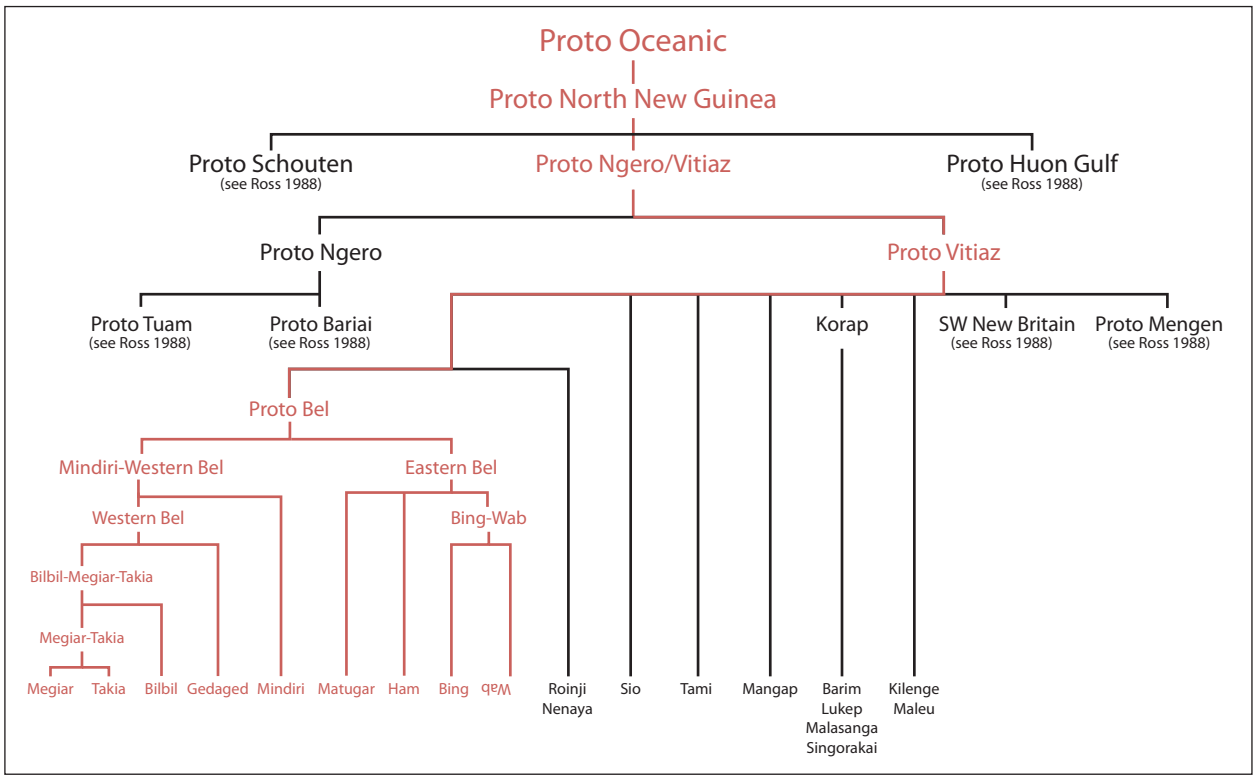


Figure 1.6. Bel languages branching from North New Guinea Cluster (adapted from Ross 1988, 2008).

Some informants referred specifically to Hankow Reef, situated between Bagbag Island and Crown Island along the Bismarck Volcanic Arc, as the former Yomba Island. Many were less clear on the location or said it was behind Kranket Island or Yabob Island, closer to the Madang coast. Others mention three islands close together that sank –

Kinemba, Yomba, and Kerata – while others again say these were all clan areas on one larger island. It definitely was not the same place as Arop/Long Island and its destruction occurred prior to the major Arop/Long eruption in the mid-1600s. The Arop/Long eruption was the most significant volcanic event around New Guinea's northeast coast within the last millennium, effecting both coastal and highland populations and coming to be known as the 'time of darkness' (see Chapter 2). The Bel people, at that time already based around coastal Madang (Mennis 1978, 2006a: 5–13, 2006b), recall stories of Arop/Long Island erupting and the subsequent 'time of darkness' in which the ash fell for three straight days, landing on gardens and house roofs. People were afraid that their houses would collapse so had to frequently brush the ash away, and there was a food shortage as many gardens were spoiled.

In the present volume 'Yomba' will be used as a heuristic to refer to a possible ancestral homeland occupied somewhere beyond Madang, prior to the movement of Bel speakers onto the mainland. This acknowledges the histories attested to by local Bel groups, while also paying attention to the complexity and contradictions inherent in the oral history records (see Damm 2005 and Mason 2000 for methodological discussions).

Geology

Although Hankow Reef has been argued to be the remnants of Yomba Island (Mennis 2006b), sonar survey at the reef demonstrates it has not erupted within the last 100,000 years (Silver *et al.* 2009), and no Yomba ash layer has so far been identified in stratigraphic profiles as it has for the Arop/Long eruption (Blong *et al.* 2018; Johnson 2013). This conflicts with many of the oral testimonies, which suggest that Yomba's sinking was associated with an eruption and subsequent ash fall. Smaller hydromagmatic eruptions caused by superheated groundwater, along with frequent earthquakes around Madang, were proposed to have caused lateral collapse of the reef causing tsunami, similar to that which affected Ritter Island in 1888 (Mennis 2006a). However, this does not align with marine mapping in 2004 which showed no signs of a major gravitational collapse (Simon Day pers. comm. 2015). The mapping did show evidence that the reef was subsiding and Hankow may have formerly supported one or more smaller islands resting on the coral base. Ongoing research is aiming to solve the Yomba conundrum by linking the oral histories, to their likely geological correlates (Mennis & Day in prep.).

All of these strands of evidence provide a good working framework, but it remains for archaeology to put forward testable hypotheses that critically examine population history along the northeast coast and untangle how, and perhaps why, the complex production and exchange networks around Madang emerged.

Ceramic technology

We can begin to model the events immediately leading to Bel occupation around Madang by putting forward a series of scenarios, which can be tested through archaeological

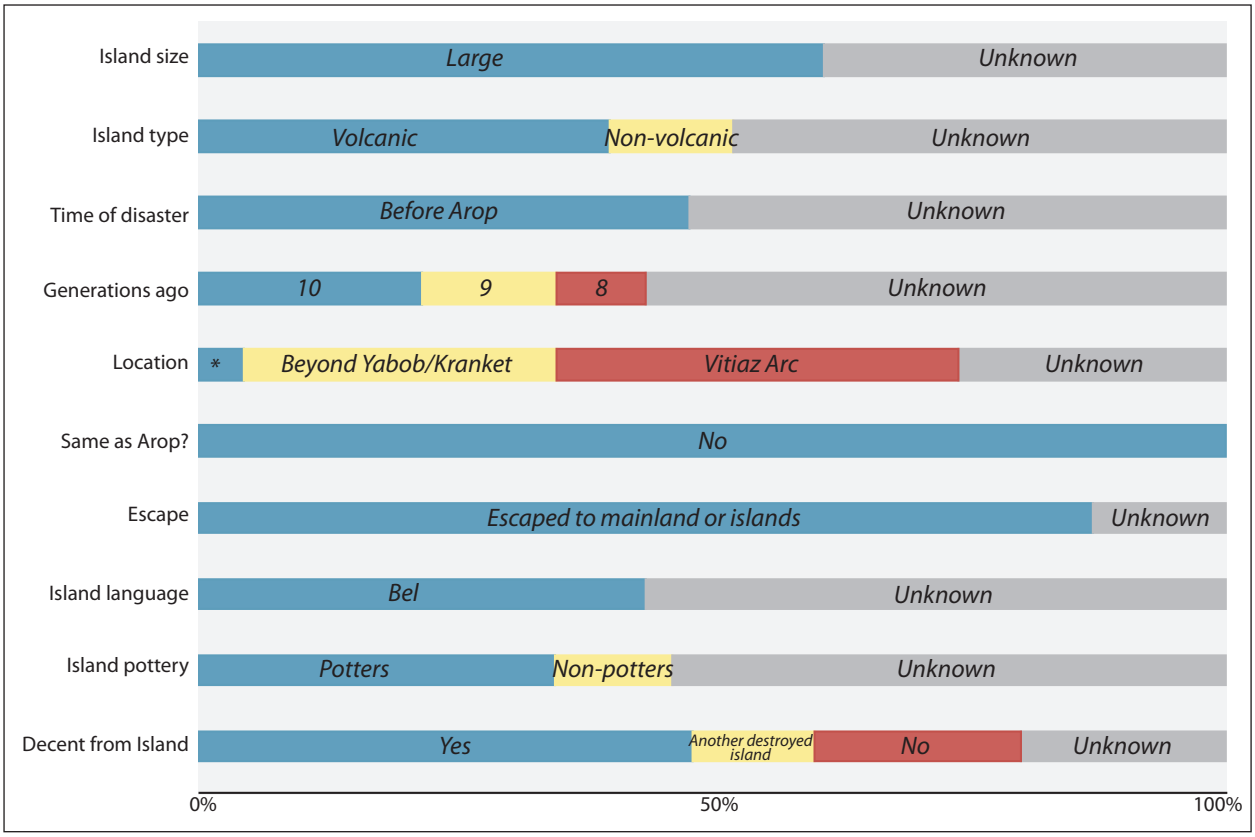


Figure 1.7. Oral testimonies of 23 Bel speakers regarding Yomba Island. *near Madang (adapted from Mennis 2006a: 10).

excavation, radiometric dating, and ceramic analysis. Figure 1.8 illustrates four possibilities, relating Bel migration scenarios to their expected archaeological signatures: a) if there was a catastrophic, single migration of Bel speakers from a 'Yomba' homeland we would perhaps expect to find a handful of pots salvaged from Yomba and an abrupt start to locally-made pottery production in Madang, lining up chronologically with geological and oral history evidence. This would then be followed by a gradual change to local ceramic manufacture over the centuries; b) if there was trade between Yomba and Madang prior to that Bel migration, we would expect exotically made Madang style pots, with an abrupt change to local production at Yomba's disappearance; c) alternatively, if there was a gradual diaspora to Madang, we would expect to see locally produced Madang style vessels prior to Yomba's disappearance; and d) if this diaspora was characterised by high levels of ceramic transfer between the two potting centres, we would expect both locally and exotically produced Madang style pots around Madang itself, prior to Yomba's disappearance.

More broadly, other archaeologists have previously attempted to understand the movement of Austronesian-speakers onto the north and northeast coast of New Guinea, alongside transformations to maritime trade networks. Most notably, Lilley (1988a) described the dramatic increase in pottery production and exchange around the Vitiaz Strait in the recent pre-colonial past, leading up to ethnographic contact. He also suggested the archaeological evidence supports a generally westward push of

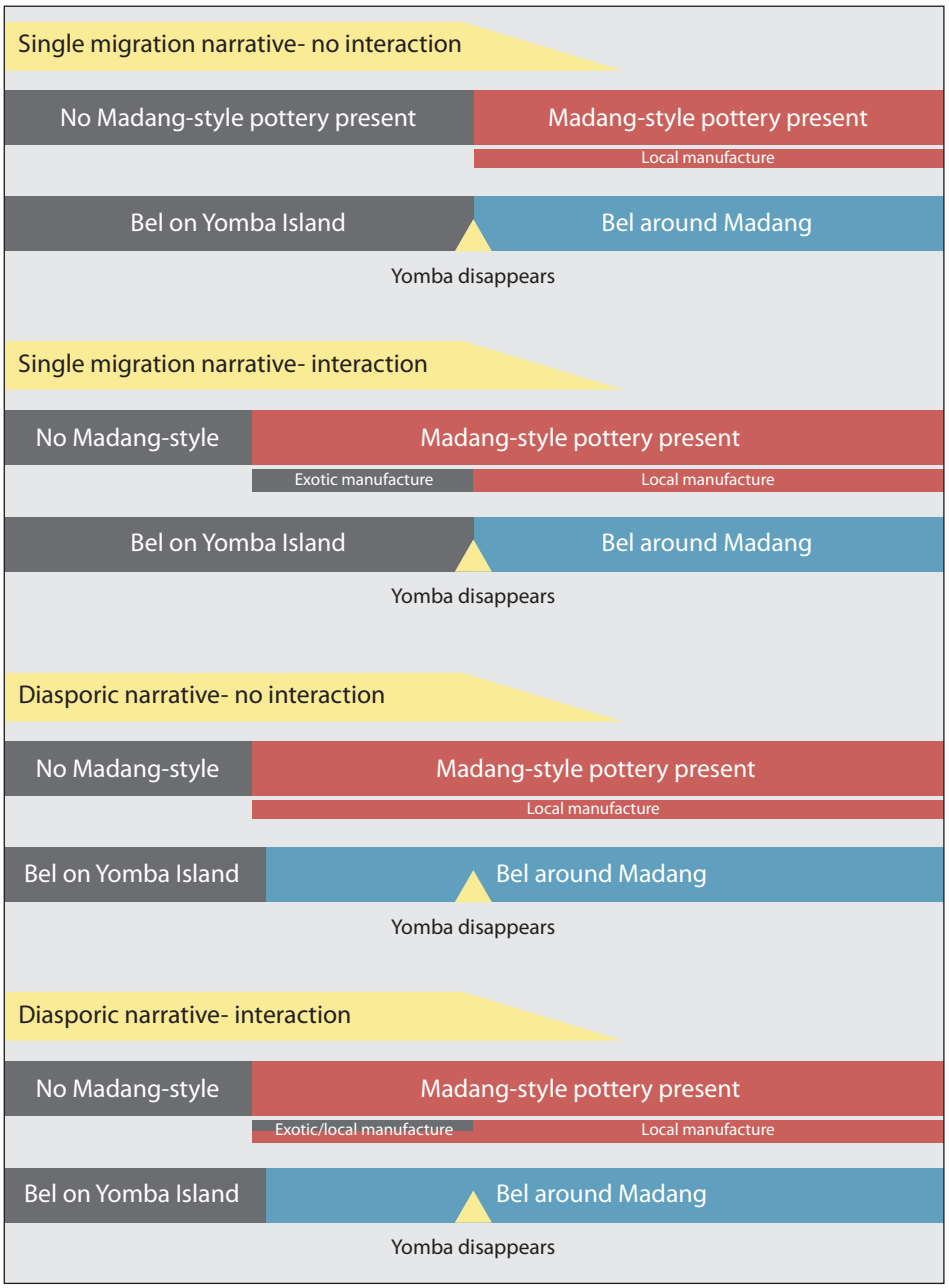


Figure 1.8. Four timelines illustrating possible Bel movement from a Yomba homeland to Madang with their associated archaeological signatures.

Austronesian-speaking groups from New Britain back onto northeast New Guinea, in accordance with linguistic reconstructions (Lilley 1999). However, this is contested by other archaeologists who see the emergence of the first red-slipped ceramics in the area resulting from a generally eastward expansion of potters along the north coast. Terrell & Welsch (1997) initially speculated that apart from tentative traces of Lapita pottery, with links ultimately to the Bismarck Archipelago, the earliest evidence for the spread of pottery traditions on the Sepik north coast occurred around 2000 years ago and arrived from the west. These early Sepik ceramics were seen to have strong affinities with Metal Age red-slipped pottery from the Moluccas and West Papua. Moreover, in an examination of modern ceramic manufacture around New Guinea, Pétrequin and Pétrequin (1999, 2006) also suggest that the origins of the Madang traditions were certainly from the west (i.e. Island Southeast Asia). The Pétrequins cluster together the Bel pottery production sequences into a larger group: the technique of paddle and anvil with the preassembly of a rim-neck preform. These industries require high levels of skill and an extended learning process, especially for larger vessels. Other groups that use these techniques occur in south and central Maluku (Indonesia), and on the north New Guinea coast at Sapij and Tumleo Island. Clearly this contradicts the narrative described above based on language, oral history, and geology (Fig. 1.9). To examine how the Madang potting traditions articulate with these various models of population movement and technological change, we require a more detailed understanding of how technological practices are intertwined with social boundaries and group interaction, and, moreover, what these processes might look like in the archaeological record.

Theoretical foundations

The production, use, and exchange of objects such as earthenware pots can represent fairly mundane, habitualised activities on the day-to-day scale. However, over a lifetime they become central processes that shape an individual's cognition, physique, and sociality: they help make people who they are (Dobres 2010; Gosden 2008; Ingold 1993a, 2000: 406–419; Latour 1993; Malafouris 2010, 2013; Sofaer 2006). As will be argued in the following section, these activities generate and transform not only the material world itself, but the manufacturers, consumers, and traders that inhabit these worlds (Gaffney 2019; Gosden 2012). Perhaps more importantly for understanding diachronic change, the reproduction of these activities across generations constitute technological processes, which can become diagnostic of production groups and their unique genealogies of practice.

Aspects of production

To examine how ceramic manufacture originated and transformed through time along the northeast coast, we need to understand some foundations of craft production and knowledge generation. Fundamentally, it is through habitual material engagement that the parameters of human thought, movement, and action are established (Inoue 2006; Sterne 2003). These parameters, internalised and expressed as bodily dispositions, were originally described by Mauss (1934) as 'techniques of the body.' When these dispositions are dictated by purpose, formed through on-going processes of closely related technical activities (Bloch 1991), they are more often labelled as 'tacit knowl-

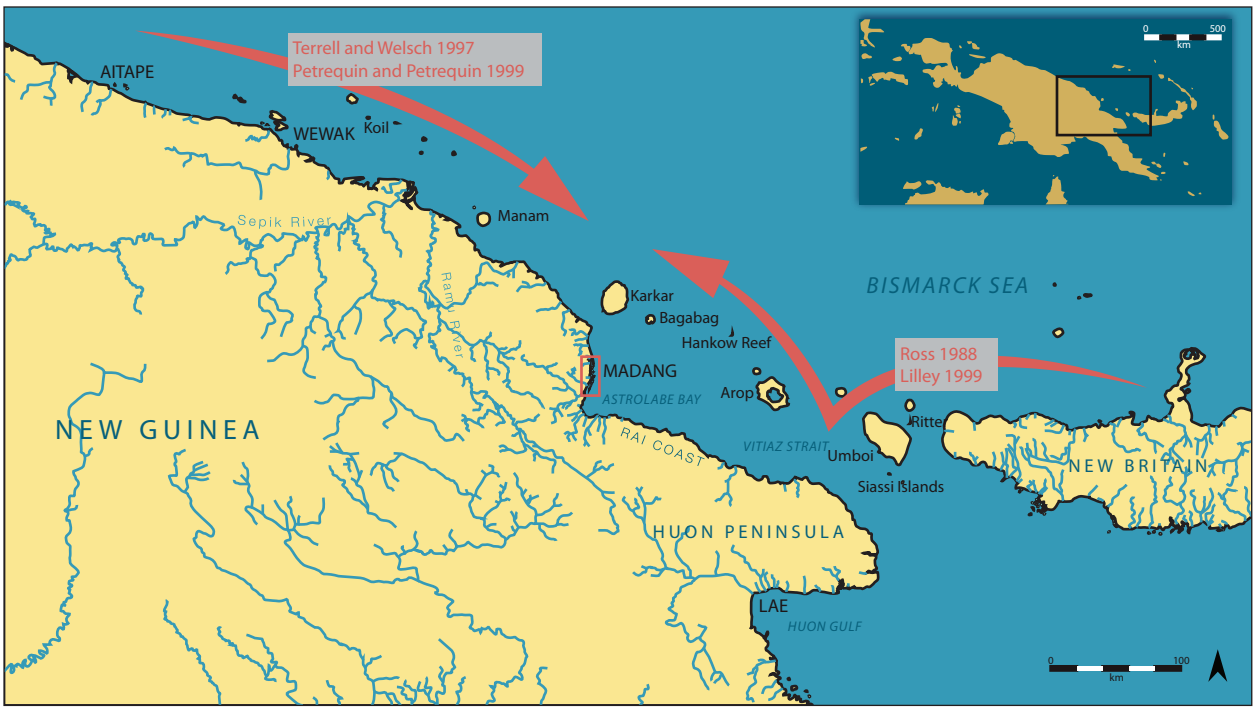


Figure 1.9. Two competing scenarios for the movement of potting communities and Austronesian languages onto the northeast coast.

edge' (Polanyi 1966), 'generative know-how' (Lemonnier 1992), or 'motor habits' (Arnold 1998; Crown 2001; Minar 2001; Minar & Crown 2001). Here, the term 'embodied knowledge' is used throughout the book as a gloss for the variable ways to describe knowledge generated by routines of habitual action, and expressed as rhythm, movement, and dexterity (Jørgensen 2013; Sofaer & Budden 2013).

Embodied knowledge is difficult to codify and share between individuals through speech or depiction and must be experienced to be acquired. It is also knowledge that increases with degrees of engagement and is very difficult to unlearn (Stark & Longacre 1993). In this way, expert craftspeople are often disposed to think *with,* rather than *about,* their body and tools (Ingold 2000:157–171, 406–419). For instance, as new movements or objects are first encountered in the learning process they are conspicuous to the user and consciously considered, but after degrees of habitual engagement they become invisible extensions of the self, except upon key moments of reflection (see Heidegger's 1927 concepts of 'availableness' and 'occurrentness'). Central to the expression of embodied knowledge is this concurrent interplay between conscious intentionality and routinised action.

The production groups in which craftspeople live, understood here to operate within larger communities of practice that share common ways of doing and making things (following Lave & Wenger 1991), create culturally specific boundaries within which to experience the social and material world (Gosden 1994; Keller & Keller 1996; Mahias 1993). As individuals actively engage with embodied knowledge, they attach themselves to, or distance themselves from, particular social forms in these communities of practice (Dobres & Hoffman 1994; Kohring 2013; Shilling 2005:187). In this way, the production process is not a closed system, but interrelated with, and inseparable from, other technological and social practices within the community, be they material, political, ideological, economic, or symbolic (Dobres 2000). Embodied knowledge can then distinguish specific social groupings within broader communities of practice.

This knowledge, despite being differentiated between social groups, would be unchanging were it not for people's ability to creatively respond to technical challenges and opportunities (Chomsky 1982; D'Agostino 1984; Daley 1982). Such creativity – the human capacity for sensory improvisation and imagination – produces variation, and gradually modifies the boundaries of the social aesthetic and the technological practice (Gaffney and Zmigrod forthcoming). In recent archaeological literature embodied knowledge has been projected onto both the bodily timescales of the single craftsperson, as well as deeper in archaeological time, interpreted in the framework of practice theory (Dobres 2000) and process philosophy (Gosden and Malafouris 2015), to understand how an individual's productive activities can generatively shape and transform technological processes through time.

In this sense, technology is not inert but always in flux (Roux 2003). This thinking derives from the French school of *Techniques et Culture* that describes technology as the study of techniques, which can be codified as the *chaîne opératoire* (operation sequence): the step-by-step technical choices and actions that underlie the procurement, manufacture, distribution, use, and discard of material culture (Lemonnier 1986, 1992, 1993; Leroi-Gourhan 1943, 1945). By recording the *chaîne opératoire,* whether from participant observation or archaeological analysis, it allows us to sketch out how embodied knowledge is generated amongst individual craftspeople, and how the techniques of production come to form historically contingent technological processes, unique to specific social groups. The dramatic increase in Anglophone scholarship examining production as a dynamic technological process over the last three decades is testament to the traction of this approach (e.g. Bar-Yosef & van Peer 2009; Chazan 2009; Chilton 1998; Conneller 2008; Edmunds 1990; Hitchcock & Bartram Jr. 1998; Jeffra 2015; Jones 2002; Knappett 2005a; Kreiter *et al.* 2014; Schlanger 1990, 1994; Stark 1998b; Stark *et al.* 2000; Walls 2016; for summaries see Lemmonier 2013; Loney 2000).

Aspects of exchange

Sharing technical knowledge is one form of exchange that occurs within and between social groups. This participatory learning is foundational to the community of practice, because novices and experts facilitate ongoing correspondence by attuning themselves to shared ways of learning. Over time, embodied knowledge in the form of habitualised technical activities can be shared across the generations. There are several modes of participatory learning: 'vertical learning', involving the creation of knowledge between parents and children; 'oblique learning' involving adults not immediately related to the child (e.g. extended kin or unrelated adults); and 'horizontal learning,' which occurs between people of similar age and standing within the same production group, or between different groups (Hosfield 2009: 46). These modes of learning are usually engaged through processes of teaching and pedagogy, or observation and imitation.

In the case of crafts such as pottery making, Shennan (2002) asserts that learning usually occurs vertically or obliquely, rather than horizontally (see also Shennan & Steele 1999). In a similar way, most studies that try to understand the distribution of Pacific pottery take the unstated view that specific motifs were shared vertically by production groups, and hence can be used to trace group lineages. Conversely, more recent evolutionary approaches have argued that the transmission of Lapita design was horizontal, passed between island groups, through unbiased or biased forms of social replication (Cochrane & Lipo 2010; cf. Summerhayes 2001b). Although this literature working at the macro-scale has emphasised how 'transmission' processes can lead to the proliferation of ideas and cultural elements (e.g. Cochrane 2002; Cochrane *et al.* 2013), the present study tries to tease apart

the specific mechanisms of how technical elements may be shared across space and time, and understands knowledge exchange in the context of socialisation and enskillment (see Crown 2001; Huntley 2006; Minar & Crown 2001; Van Keuren 2006). In this way, at the micro-scale, the exchange of decorating practices probably involved an intricate and socially modulated arrangement of vertical, oblique, and horizontal learning. Ethnographic case studies, for instance, demonstrate that modes of learning are situated and change as the student moves through the society, grows older, generates embodied knowledge, and particularly, as is often the case in Melanesia, as the individual moves between social groups within the community of practice (e.g. Hewlett *et al.* 2011; Jordan & Shennan 2003; Tehrani & Collard 2009).

More tangible forms of exchange, involving objects for objects, also occur between individuals and groups. These exchanges materialise social bonds, reciprocity, and the logic of the economy, and so shared practices of object exchange are essential to the community of practice (Thomas 2009). These practices represent another aspect of the technological process – another link in the *chaîne opératoire* – and therefore it is not simply the formation of abstracted social relations, but the materiality of exchange itself, that circumscribes bodily dispositions and cognitive frameworks.

Knappett (2011) categorises material exchanges as taking place at different scales: within micro-networks (within the social group), meso-networks (locally), and macro-networks (regionally). Exchange objects themselves tend to acquire, produce, and shed meaning as they pass through these different scales of network (Gosden & Marshall 1999; Clarke & Torrence 2011). Although Malinowski's (1922) study of *kula* demonstrated that some objects of exchange are inalienable from their own life histories and the life histories of their previous owners (see also Weiner 1992), Aswani and Sheppard (2003) show that trade items can be viewed as inalienable gifts or alienable commodities (following Mauss 1925) depending on the specific social context of the exchange and the relationship between trading partners.

In this way, like production technology, exchange networks are far from static; they morph and mutate through time as social relationships are tended to, cultivated, and severed (Strathern 1996). In this vein, Knappett (2005b: 66) notes that exchange networks are only temporary organisational forms, which are produced by the on-going flow of materials and the movement of traders. Although, these trade links can regulate broader socio-political relationships, while nodes of interaction, whether in the household, at the specified trading point, or across the landscape, often acquire fixed locations and meanings (Ingold 1993b), these systems are all prone to gradual modification across intergenerational time.

In archaeology, examining the materials of exchange provides the physical evidence for these past interactions, and how these interactions have changed through the centuries. It is important to distinguish these different processes of interaction in the archaeological record, be it the sharing of cultural knowledge or the exchange of tangible objects, because it has implications for the organisation of the community of practice and the extent of interconnectedness between past social groups. As the quote from Ingold (2011) at the beginning of this chapter states, we must follow the materials through their life-histories and learn the movements that energise and transform these materials if we are to understand something of how technological processes can inform us about transformations to society through time.

Objectives and approach

Research objectives

Having begun to untangle *how* the processes of production and exchange take place in society we are better equipped to examine the core research concerns of this book: the history of the Bel people and how their production and exchange network emerged. However, it is often more difficult for an archaeologist to investigate *why* (as opposed to *how*) technological changes took place in the past owing to the multitude of factors affecting internal/external change and variation, including gender dynamics (Kramer 1997; Mahias 1993), social identity (Gallay 2007; Gosselain 2008), or community fragmentation (Scheans 1977). Despite these challenges, and because archaeology is both a theory-building and narrative-building discipline, the explicit objectives of this volume are twofold.

The monograph aims first to explore *how* processes of pottery production and exchange emerged amongst the Bel in the pre-colonial past. This will involve describing the materials and techniques of production, and the movements of finished products. Using an approach derived from the French school of technology, the *chaîne opératoire*, the social groups producing pots within broader communities of practice will be systematically distinguished, along with the nature of exchange between groups. The *chaîne opératoire* is an effective method for addressing technological processes and the generation of embodied knowledge in the past (Knappett 2011). In this way, we can build up a picture of how the Madang network emerged, and how changes to production and exchange occurred over time.

Second, the study is designed to describe the specific sequence of events leading up to ethnographically documented production and exchange networks (i.e. *why* technological changes took place). This will investigate the origins of the Bel on the northeast coast of New Guinea: a crucial area of human population movements into and around Melanesia. This seeks to place the communities of practice around Madang in the broader pre-colonial context. The current research is concerned with the timing of Bel occupation around Madang and the direction of migrations (from east or west; 'Yomba' or somewhere else). This will involve investigating the local distribution

of former settlement areas, the nature of material culture remains, and the timing of trade and exchange between different communities. This requires the provisional construction of a temporal framework, based on chronometric, environmental, linguistic, historical, and material culture evidence, which can then be used as an interpretive foundation to address Bel culture history.

The monograph is composed of eleven chapters. It progresses in three stages to achieve the objectives outlined above. Because production and exchange are historically contingent processes, the first stage necessarily presents the unique local and regional context. Chapter 2 introduces the physical landscape of the study area, providing a background to major resource zones available for production, and dramatic events, which punctuated Bel culture history. Chapter 3 outlines the ethnographic and oral history evidence for production and exchange along the northeast coast, providing an ethnohistorical analogue to trace earlier processes of production and distribution back in time. Chapter 4 describes ethnographic fieldwork I carried out to record modern pottery production among the Bel communities. Ethnography can be a central interpretive tool for investigating past technologies and provides another modern analogue for the past, a detailed ceramic *chaîne opératoire* to be compared to pre-colonial objects. Chapter 5 is a review of all available archaeological literature dealing with Madang ceramics. This presents what is known about raw material, form, decoration, and the timing of Madang production & exchange around northeast New Guinea and identifies major gaps in our knowledge.

Empirical investigations of ceramic production and exchange are then presented in the second stage, in an attempt to delineate production groups operating within larger communities of practice. Chapter 6 describes new archaeological investigations around Madang, giving context to the pottery artefacts examined in the volume. Survey around the Madang area is discussed, and the excavation of two sites – Nunguri and Tilu – is described in detail with especial reference to their stratigraphy, dating, and material remains. Chapters 7, 8, and 9 (supplemented by online Appendices A and B) outline the technological analyses of pottery from the field investigations. The technological classification of pottery is completed systematically in three parts (one part per chapter) in order to target specific aspects of the technological process. First, Chapter 7 examines pottery-forming processes. This develops the theory and methodology behind technological analysis and outlines the results of the analysis. This classification sorts specific sherds into groups, based on the techniques used to form them. Chapter 8 then outlines the method and results behind the second stage of classification, which focuses on raw material procurement and finished pot distribution. This uses geochemical techniques to subdivide formal artefact classes into similar provenience groups based on clay and mineral tempers. Chapter 9 compares formal and geochemical groups with decoration and surface treatment. This chapter then summarises the pottery results to establish whether specific raw materials are associated with specific forming or decorating techniques, contributing to specific technological/stylistic groupings.

The third stage of the monograph sees these archaeological analyses discussed with reference to models of Melanesian production and exchange (e.g. Allen 1985; Harding 1967; Lilley 2017), information on Bel culture history, and technological process theory. Chapter 10 is a discussion of the Madang ceramic classification in the context of process theory. The nature of pottery production and technological knowledge is examined during different chrono-stratigraphic periods. The Madang results are then compared to other available datasets around northeast New Guinea to distinguish how exchange changed through time. Chapter 11 is the concluding chapter that ties together the local context of landscape, language, oral history, ethnography, and archaeology in an attempt to distil a cohesive Bel culture history. This chapter addresses the crucial themes introduced in Chapter 1 about eastern/western population movements and the story of Yomba and concludes with some broader implications for Melanesian anthropology and archaeology.

Chapter 2. The Archipelago of Contented People

> *We found the mainland opposite Bilbil very fertile and mainly flat. Surrounded by low ranges of hills, it is covered by tropical forest.*
> — Otto Finsch (1888)[1]

The Madang coast is a dynamic and changing landscape, both in terms of natural transformations and cultural processes. This chapter describes the physical landscape of the study area as people inhabited and experienced it in the pre-colonial past. In this way, the place specificity of Madang is described, with an especial reference to those factors that facilitated production and exchange. Physical aspects of Madang's environment, land systems, and geology are explored, as these factors have pivotal effects on resource procurement, manufacture, and distribution. Major geophysical processes including tectonic and volcanic events are also presented, as they punctuate Bel social memory and may be essential to understanding something of the society's pre-colonial culture history.

Physical geography of Madang

Local setting

Madang lies on the northeast coast of the large island of New Guinea, adjacent to the Bismarck Sea in the South Pacific (Fig. 2.1). The coral reef and lagoon system that fringes the shoreline is the largest on the north coast. In this area, there is a dichotomy between the expansive mainland on the one hand and an archipelago of small offshore islands around the lagoon on the other, described as the archipelago of contented people by early explorers. To the south, Astrolabe Bay forms the physical and social connection between Madang and the Rai Coast, which the locals nowadays divide into the *Nambawan* Rai Coast and the *Nambatu* Rai Coast.[2] The Rai Coast as a whole extends from Erima Harbour in the west, to the Huon Peninsula in the east. Further out to sea lies a string of island volcanoes, which act as stepping-stones across the Vitiaz and Dampier Straits into the Bismarck Archipelago. To the north lies the long stretch of the Sepik north coast and the estuaries of the Sepik and Ramu Rivers.

The coastal region of Madang District runs from Sek Island in the north to Balima village in the south, forming the western coast of Astrolabe Bay. Alignment is approximately north-south, between latitude 5° 00′ and 5° 20′ south of the equator. In the centre, the modern town of Madang lies on the small Schering Peninsula, which forms the southern edge of Madang Lagoon, a large reef system of bays, islands, and the mouths of rivers draining the nearby hills. The lagoon is an even 30–40 m deep but there are numerous shallow patch reefs and coral rubble islands that support fringing reefs, all encompassed by a large barrier reef on the seaward side (Jebb & Lowry 1995). Five major passages allow for access through the barrier reef into the Bismarck Sea. The coastal plains inland of the lagoon border steep foothill areas immediately to the west and the Adelbert Range lies beyond that. To the south of the lagoon are the mouths of the Gum and Gogol rivers, and four offshore islands: Yomba[3] (also called Mareg), Yabob, Urembu, and Bilbil (Fig. 2.2–2.3).

Raw material zones

Land systems

This study area lies across several major land systems, characterised by different soils and underlying clays suitable for pottery making (Fig. 2.4). The poorly drained Madang Land System, which forms an almost continuous stretch of land 1–2 km wide running from Madang town in the south to Hansa Bay, adjacent to Manam Island, in the north consists of raised coral platforms, beach ridges, and minor lagoon fills (Haantjens *et al.* 1976: 22). Near the coast, shallow soils overlie coral bedrock, and on the inland side, young, fine-textured alluvial soils predomi-

1 Translated by Christiane Harding in: 'Archipelago of the Contented People? Madang (Friedrich-Wilhelmshafen) in 1884,' edited by Mary Mennis, 1996.

2 Referring to the 'first' and 'second' Rai Coast.

3 Not to be confused with the legendary Yomba Island, the ancestral homeland of many groups on the Madang coast today (see Chapter 1). The name 'Yomba' to refer to the island north of Yabob (and also an area on the Schering Peninsula) is a later translocation.



Figure 2.1. Madang on the northeast coast of New Guinea. Dashed blue line marks plate boundary.

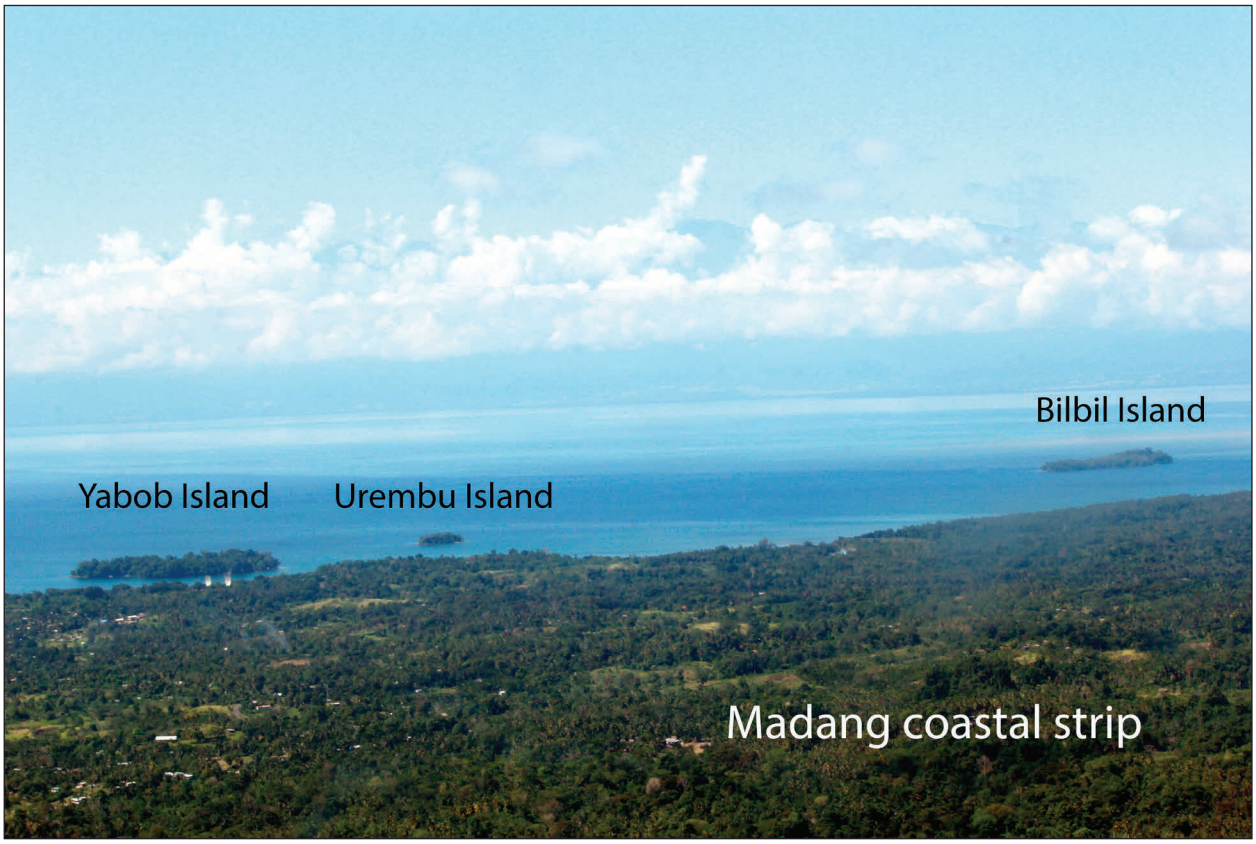


Figure 2.2. Aerial view looking east over coastal plains to Yabob Island, Urembu, and Bilbil Island (2015).



Figure 2.3. Coastal Madang District, northeast New Guinea.



Figure 2.4. Land systems of the Madang District (Haantjens *et al.* 1976).

nate but lack substantial clay deposits. Shingle and sandy beaches and small mud flats dominate the coastal margins. To the south is the Nubia Land System with broad beach ridges occurring close to the mouth of the Gogol River. On older inland ridges, organic topsoils overlie clay deposits, which in turn overlie sandy alluvial soils (Haantjens 1976: Table 10; Haantjens *et al.* 1976:50). The southernmost area comprises the Astrolabe Land System, formed by the alluvial plains of the Gogol and Nuru Rivers. This land system consists of colluvial aprons on the inland side and alluvial soils overlying good clay deposits, with minor reef corals and marine sands on the coastal side (Haantjens *et al.* 1976:46). At the mouth of the Gogol itself is the minor Papul Land System with clayey alluvial soils. Inland, the mountainous country of the Adelbert Ranges, with weathered red-brown clay soils, forms the Gal Land System.

Geology

The geology of coastal Madang is relatively young and most of its development took place during the mid–late Tertiary and in the Pleistocene (Fig. 2.5; Reiner and Mabbutt 1976:73). This underlying geology structures the distribution of clay and temper sands used for pottery along with raw stone materials. Structurally, the region is part of the Palaeogene Volcanic Arc (Bain 1973), which accounts for most of the physiographic features of the area (Loffler 1977:7). Madang Lagoon lies in the Pleistocene–Holocene Wandokai Limestone, a coral limestone plateau, which extends from the northernmost extent of the lagoon to the confluence of the Gogol and Nuru Rivers in the south (Robinson *et al.* 1976:3). This formation comprises massive crudely bedded and cavernous biocalcirudite, calcarenite, calcilutite, and mudstone, with subordinate arenite clasts, and conglomerates, most of which are unsuitable for lithic manufacture but offer the potential for calcareous sand tempers along the water's edge.

More suitable stone resources for artefact manufacture are located inland from the lagoon, where several rivers drain through the Tertiary deposits of the Finisterre Volcanics, with basalt and andesite flow breccia, tuffaceous greywacke, tuff, agglomerate, argillite, and minor limestones. The Meiro and Gum Rivers drain through the Gusap Argillite, with red and green cherty argillite, chert beds, greywacke, siltstone, subordinate basalt and andesite breccia, dolerite dykes, and cherty limestone. South of the lagoon is a recent Holocene alluvial deposit which extends from just north of the Gum River mouth to the Rai Coast in the southeast. These deposits are formed by the floods from major rivers draining the Adelbert and Finisterre Ranges and commonly comprise gravel, sand, silt, and mud, along with good clay deposits. The Gogol River and its tributaries drain inland deposits of the Kabenau Beds, which extend to the Sek River, containing well-bedded calcareous clasts, siltstone and mudstone, conglomerate, and minor limestone and lignite. Sand mineral grains around these river mouths are predominantly magnetite admixed with volcanic pyroxene, olivine, and amphiboles (Robinson *et al.* 1976:20). The beaches along the mainland, south of Madang are typified by these black volcanic minerals, while the offshore islands feature white sands derived from coral and limestone foundations.

Geophysical processes

Tectonic activity

A series of geophysical processes have structured the development of these land systems and underlying geological zones around Madang and reverberate in Bel oral tradition. Most influentially in both contexts, the Madang coastline is generally emergent, defined by the long-term uplift of well-preserved reef deposits forming the coastal ranges (Haantjens *et al.* 1976:21; Robbins 1976:14). Similar Quaternary reef exposures are evident on the Huon Peninsula, east of Madang. Average uplift rates of 3.5 mm per year have persisted there for the past 300,000 years (Chappell 1974; Chappell & Polach 1991; Chappell *et al.* 1996). However, around Madang intermittent subsidence caused by large earthquakes has been proposed to account for the lack of massive coastal terraces found on the Huon (Tudhope *et al.* 2000).

Analysis of the exposed Holocene reef deposits along the coast suggests a series of uplift and possible subsidence events against a backdrop of gradually falling sea levels (Tudhope *et al.* 2000: Fig. 5). These coseismic land movements have caused changes to Late Holocene relative sea levels around Madang to be more rapid than eustatic sea level change. About 3000 years ago, uplift caused reef terraces to rise by over 4.5 m, while possible subsidence caused reefs to descend about 1.5 m at 2400 years ago and more than 0.5 m about 1200 years ago. Most recently, further uplift caused raised terrace elevations of 2–3 m sometime in the last 1000 years (Morgan *et al.* 2005; Tudhope *et al.* 2000). Recent research along Madang Lagoon suggests that the latest uplift event can be dated to about 550 BP by marine radiocarbon.[4] The oldest dated geological deposits on offshore islands are only about 3000 years old, suggesting that the initial uplift of ~4.5 m was the event which first raised the reef systems significantly above sea level (Day 2012; Mennis & Day in prep; Morgan *et al.* 2005).

The seismic events responsible for these past land movements resulted from the rapid convergence of the Pacific and Australian plates (Baldwin *et al.* 2012). This convergence continues today, so Madang is host to large earthquakes and volcanic eruptions. The ranges west of Madang are particularly unstable even during relatively small earthquakes (Pain 1972), which are a significant factor in landform development (Loffler 1977:161). In 1970, a vio-

4 Note that U-series dating is needed in order to calibrate the marine reservoir effect on coral derived C^{14} dates, especially because upwelling deep water along the Rai Coast mixes with Madang waters and there is a very thin surface layer of brackish water outflowing from the Gogol River (Simon Day pers. comm. 2015). The ~550 BP date uses a DR of 0, so any variation to the modeled marine reservoir will be problematic.

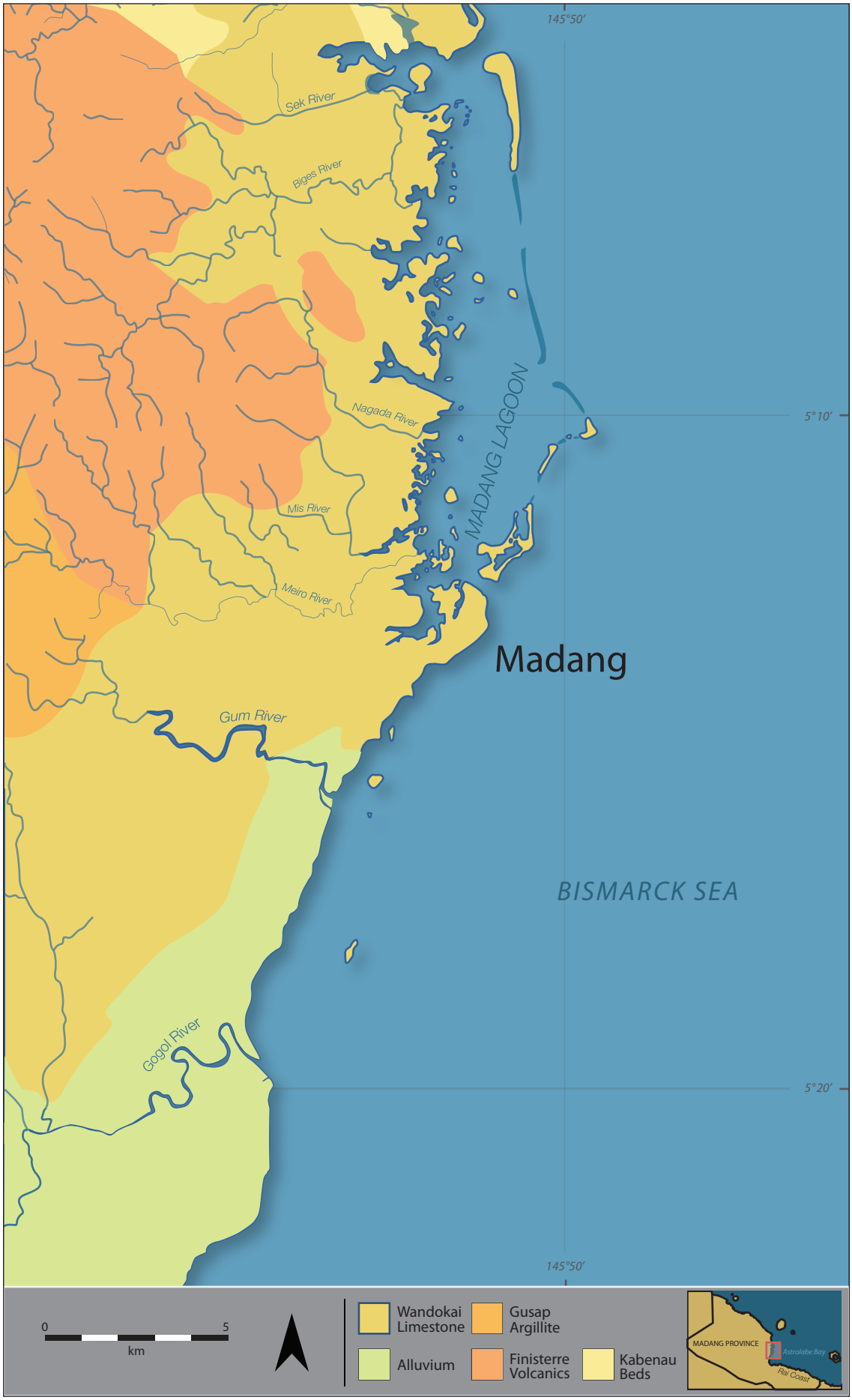


Figure 2.5. Geological zones around Madang District (Robinson *et al.* 1973).

lent magnitude-7.0 earthquake in the Madang area led to landslides that removed over 60% of vegetation in some catchments (Johns 1986). An earthquake of magnitude 6.0 or above strikes Madang about every three years (Everingham 1975).

Volcanic activity

The Bismarck Volcanic Arc, comprising island volcanoes such as Manam, Karkar, Bagabag, Lotin/Crown, Arop/Long, Umboi, and Ritter, lies to the north and east of Madang at the boundary of the Pacific and Australian plates. The islands are made up of thick, extensively reworked pyroclastics with basalt and andesite rocks (Johnson *et al.* 1972). Many of these volcanoes were active in the human past and remain active today (Jebb and Lowry 1995), and Karkar and Manam continue to pose a high risk for people on the coast (Davies 2012).

In the last millennium, the most significant eruption event around New Guinea's northeast coast was that of Arop/Long. The dating of the last major eruption is problematic, but following several lines of evidence, both Blong (1982; Blong *et al.* 1982) and Polach (1981) prefer a date of the mid seventeenth century, and Haberle (1998) further narrows it to 305–270 cal. BP (i.e. AD 1645–1680). This eruption is estimated to have had a value of six on the volcanic explosivity index, on par with Krakatoa, and had significant effects on the New Guinea region. The associated ash fall, forming the Tabito Tephra and recorded through oral histories in the Highlands as the *Tudak* (Time of Darkness), prevented crop growth, caused starvation, and collapsed houses. In some areas closer to the coast, large rocks fell from the sky, killing people and animals (Blong 1982: Table 18). On Arop/Long itself, most if not all of the macrobiota were eradicated; only those humans who fled to the mainland survived (Thornton 2001). Whether this eruption had significant impacts on trade networks and communications is not known. However, we do know that it was a central event in people's recent past and it appears as an important story around New Guinea, including Madang.

As uplift around the Madang coast is usually coupled with offshore subsidence, seismic and volcanic activity can also result in significant tsunami hazards. Historical documentation for tsunami events in the Bismarck Sea is abundant (Morgan *et al.* 2005). For instance, in AD 1888 a tidal wave originating from Ritter Island resulted in up to 3000 deaths (Paris *et al.* 2014). The Ritter tsunami was caused by the lateral collapse of the island, which sent deadly 8 m high waves onto the mainland (Ward & Day 2003). Other significant tsunamis occurred in AD 1857, originating near Umboi Island, and in the mid seventeenth century AD, associated with the Arop/Long eruption. The recent ~550 BP and ~3000 BP uplift around Madang are also associated with significant tsunami events and waves may have broken at over 2 m in height around the lagoon's barrier reef (Mennis & Day in prep.; Morgan *et al.* 2005).

Summary

Throughout the Late Holocene, the Madang coast has been characterised by dramatic physical change. Over time, the landscape mosaic would have been reimagined through shifting cultivation, burning, hunting, collecting, erosion, and deposition. This gradual landscape change over the *longue durée*, not always observable on the bodily timescale, was punctuated by dramatic events that had profound impact on social groups over comparatively short time periods. These particularly include volcanic eruptions (with associated ash fall and tsunami) and earthquakes (with associated uplift, subsidence, collapse, sea level shifts, and tidal waves). The impacts extend beyond the initial force, also comprising aftereffects and recovery time. Such events perforate the social memory of the coastal people: the Yabob are still shown the level that the Arop/Long tsunami came up to on their island (Mennis 1981b: 23), while the Bilbil point out the tree into which a man and his canoe were thrown during a tsunami; when he climbed down, the ground was littered with fresh fish (Mennis 1981b: 17).

The landscape also expedited or inhibited local production. It is important to note the environmental disparity between the Madang Lagoon area and that south of the Schering Peninsula near Yabob and Bilbil Islands. Those groups living adjacent to the alluvial Astrolabe or Nubia Land Systems would have had more direct access to pottery producing clay than those living around the coral derived Madang Lagoon area. A variety of different temper sands both volcanic and calcareous would have been abundant particularly around river mouths and coastal margins. On the other hand, quality stone material for the production of flaked tools or ground axes would be found further inland near the Finisterre Volcanics and the Gusap Argillite, or even further afield on the Rai Coast.

This chapter has described the transformative physical landscape around Madang, with a focus on land systems and geological zones, which will be important for teasing apart the procurement processes of Bel potters and the distribution of trade ceramics discussed in following chapters. This chapter also emphasised the dramatic tectonic activity that has typified the coast, having real and lasting effects on Bel culture history that will be revisited in Chapter 11. The next chapter focuses on the dynamic social processes which occurred in Madang's pre-colonial past.

Chapter 3. Bel Production and Exchange

> *There were many things that the Bilbils could buy with their pots. The Bilbils worked to get all these things.*
> — Pall Tagari of Bilbil (1978)[1]

Production and exchange are central cultural processes operating within Bel social groups and between the Bel and their trade friends. This chapter provides a new synthesis about how these processes played out in the recent pre-colonial past, surveying available ethnographic, ethnohistorical, and oral history evidence regarding Bel production and exchange as it occurred from just prior to European contact through to WWII, when coastal trade networks were severely disrupted by the conflict. Although these processes have diverged and co-modified over the past *c.* 150 years of European contact, colonialism, and post-independence change, examining their nature at the end of the pre-colonial period allows us to develop a valuable analogue for earlier times, and track some of these processes back into the archaeological record.

People of the coast

Settlement

In Madang District, there are those who identify as belonging to the coast and emphasise the seascape and long-distance trading voyages in their stories (Suwa 2005). They refer to themselves collectively as the Bel people and speak Austronesian languages. This marks a deliberate distinction from the 'other'; the autochthonous 'bush people' who live in the Madang hinterlands between the sea and the Adelbert Ranges, and who assert 'we were here first, they came later.' The Bel people, however, share a collective origin linguistically and culturally. These connections are consciously reaffirmed through the knowledge of a common tongue, intermarriage, shared rituals, and the production and exchange of material culture.

Amongst the Bel, settlements are organised by named groups of patrilineal decent (hereafter called clans), known as *temaleng* in Gedaged or *tamalen* in Bilbil (cf. Mager 1952; Mennis 1977). Multiple clans often cluster within the physical and census boundaries of a single modern village or island, but in the pre-colonial period the term 'village' may suggest a degree of centralisation that did not exist (Gosden 1989: 52; Hogbin and Wedgewood 1953: 253).[2] Land rights to specific places are usually regulated by genealogical relationships. Belonging to a specific clan entails rights to utilise certain land for hunting, fishing, collecting, production, and social gatherings for exchange. Although every clan has a great-man who is looked to as a leader, a council of senior males decides land matters (Morauta 1972: 12).

In the time before Europeans, each clan presided over their own sleeping quarters, often housing extended families (Fig. 3.1–3.2), along with the men's house (Gedaged = *dazem*, Bilbil = *darem*). In many clan areas, houses sat on the ground, but on Bilbil Island, owing to its stony ground, households sat on stilts made from tree stumps. These stumps were brought over from the mainland and lashed together with vine (Mennis 1981a: 38, 62). The *darem* was a large, ornately decorated structure (Fig. 3.3). Otto Finch described the building as having a roof extending all the way to the ground and a partially open front supported by a 6 m high, carved pole called the *aimaka*. Within the *darem* were musical instruments, shields, pig jaws, trade valuables, and places for men to sleep (Finsch 1888).

Today, coastal Bel settlements are primarily established along the shoreline or on nearby islands. There are several important areas of habitation that act as nodes in a network of interrelationships along the coastline: Sek, Riwo, Malmal, Siar, Bilia, Kranket, Yabob, and Bilbil (see Chapter 2, Fig. 2.3). These places identify as 'Bel' on a broad level but have developed unique identities of their own, with slight variations in myth, language, oral traditions, and

1 Quoted in Mennis (1981b: 54).

2 The impression from the oral historical accounts collected by Mennis (1980b, 1981a, 1981b) is that, prior to the colonial period, the Bel clans did not group themselves as villages but as a collection of clans, differing in geographic proximity to one another. The village names may have been applied by Europeans and have been retroactively imposed on the past by the informants.



Figure 3.1. Stilted houses on Bilbil Island, illustrated by Nikolai Miklouho-Maclay 1872 (Miklouho-Maclay 1982: 253).



Figure 3.2. A stilted house used as a school on Kranket Island. Photo: Lajos Biro (scan courtesy of M. Mennis).

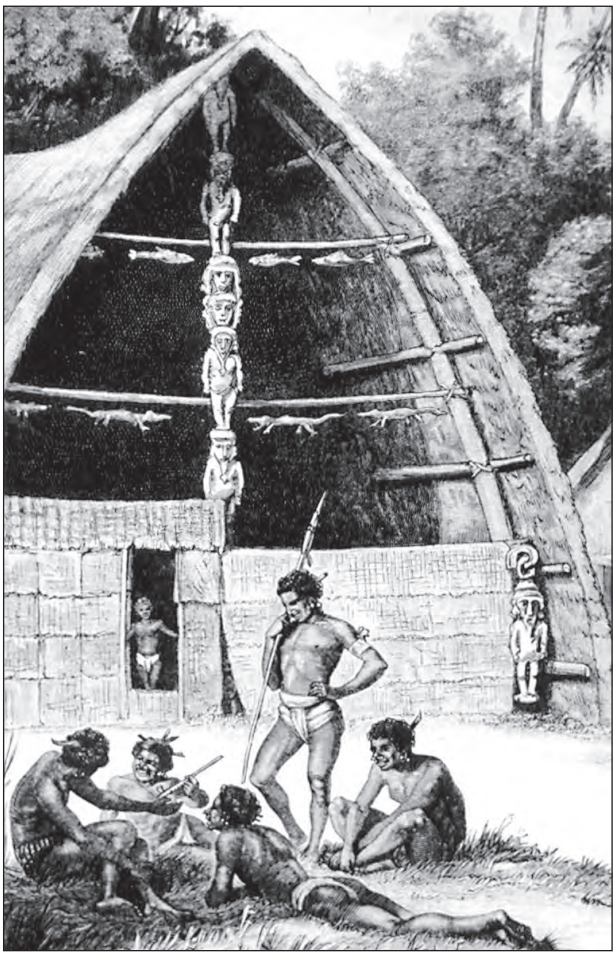


Figure 3.3. A *darem* (spirit house) on Bilbil Island (Finsch 1888: 75).

economic specialisations. Many modern villages, such as Riwo, represent an amalgamation of clans with different origin stories; some citing Yomba Island as their homeland, others claiming to have descended from groups previously living around the coast or inland. Other groups such as the Bilbil and Yabob represent groups of clans all claiming to have originated on Yomba Island.

Aspects of Bel production

It is in the contexts of this physical and social organisation that the processes of pre-colonial production and exchange operated. In the past, many Bel clans could not meet their subsistence needs through tending their own land. Therefore, the production of pottery was both an economic necessity and a desirable means to maintain social bonds and assert primacy along the coast. This was completed alongside the local manufacture of canoes, which were essential to distribute pots and return home with trade goods.

Food

Bel subsistence in the past was bounded by two central concerns: the planting and harvesting of several key crop species, and the supplementation of the former by regular and strategically timed trading expeditions to acquire food. Tuberous, starchy plants dominated the diet (Table 3.1), but local production was not sufficient to match the Bel population's carrying capacity. Women would tend to gardens of yam and taro, often spending all day there. Some islands such as Siar and Kranket had their own gardens, while others like Bilbil had plots on the mainland (Mennis 1981a: 72). On offshore islands, canarium and coconut trees were grown sparsely, supplementing the high-in-carbohydrate root crops (Mennis 1981a: 38). These practices of gardening and agroforestry helped to structure Bel temporality as important seasons were defined by the action of planting or harvest. The yam season in June–August coincided with the rising of the constellation Pleiades, marking the New Year (Mennis 1981a: 72, 2006a: 17). At this time, people came out at night to watch the stars, the positions of which indicated that it was time to uproot. In cel-

Table 3.1. *Important subsistence crops on the northeast coast.*

Bilbil name*	Gedaged name**	English name	Taxon	Procurement sources
mangi	*magi*	Taro	*Colocasia esculenta*/ Alocasia sp.	Mainland Madang Karkar Island Rai Coast
dabel	*dabel*	Yam	*Dioscorea alata*	Mainland Madang Karkar Island Rai Coast
rengrangg	*zegazag*	Sago	*Metroxylon sagu*	Mainland Madang Gogol River valley
–	–	Banana	Musa sp.	Mainland Madang
–	–	Canarium	Canarium sp.	Mainland Madang Offshore islands Karkar Island Rai Coast
niu	*niu*	Coconut	*Cocos nucifera*	Mainland Madang Offshore islands
ge	*ge*	Pandan	Pandanus sp.	Mainland Madang

* Mennis (1977); ** Mager (1952)

ebration, people would wash their hands and bathe in the sea (Mennis 1981b: 6). The yams would be prepared and stored in a dedicated building, the *bad*, creating a supply that lasted the community several months (Fig. 3.4).

The Bel also kept small numbers of domesticates for consumption: pigs, dogs, and chickens (Table 3.2; Mennis 1981a: 72). Pigs were a status food; the central component of feasts, bride prices, and prestige hunting. On Bilbil Island, stone walls were constructed as pig fences in the Gad clan area (Mennis 1981a: 67). Dogs and chickens were also kept as pets and for food. Smaller animals were hunted and collected. Flying foxes were killed with bows and arrows (Mennis 1980b: 72). Birds were hunted by constructing small hides called *saleb* in trees, from where people would then wait to ambush the perching animals by hand or using slings (Mennis 1980b: 82). Reef fish were caught with baskets or with nets called *malala* or *raj* (Fig. 3.5), while larger pelagic fish such as tuna and sharks were targeted with spears and arrows (Mennis 1980b: 85, 1981a: 72). Women and children would collect shellfish, which were abundant around the mangrove swamps of the coast and around the sandy intertidal zone of offshore islands (Mennis 1980b: 55).

Eating was communal but strongly gendered. Plates and pots would be lined up on a palm or banana leaf mat and the food shared out evenly to each family. During a feast the women would serve the men and take a small share back to the house for themselves and the children. If a meal were to take place in the *darem*, women would bring the food to the entrance, and the men would take it inside. Once inside, the food had to stay there; it was forbidden for scraps to be taken back to residences (Mennis 1981b: 33). As eating utensils, shell and cassowary bone were fashioned into spoons and spatulas, while coconut husks were used as bowls by children and old people (Mennis 1981b: 34; Fig. 3.6).

Pottery

Pottery production, known as *vai* in Bilbil, was practiced amongst several Bel clans – those on Yabob and Bilbil Islands (Fig. 3.7–3.8) – in part because local gardening was not sufficient to meet subsistence needs. The pots produced could be used for local consumption or regional exchange. These ceramics were produced using the paddle and anvil technique: one of the two major production methods used in New Guinea, alongside the coiling method (May & Tuckson 2000). Among modern potting groups, paddle and anvil production tends to be restricted to the coast, is often associated with manual tempering, and has strong correlations with Austronesian languages, such as Bel (May & Tuckson 2000).



Figure 3.4. Women at Bilbil village preparing newly harvested yams for storage (2014).

Table 3.2. *Important subsistence animal species on the northeast coast.*

Bilbil name*	Gedaged name**	English name	Taxon	Procurement sources
bor	*boz*	Pig	*Sus scrofa*	Mainland Madang Offshore islands Karkar Island Rai Coast
–	–	Chicken	*Gallus gallus*	Mainland Madang Offshore islands
guan	*guan*	Dog	*Canis familiaris*	Mainland Madang Offshore islands
deb	*deb*	Fish	various	Madang coast Open sea
rot/wonggazau	*zot/wonggazau*	Shellfish	various	Madang coast
kodor	*kodoz*	Possum	*Phalanger* sp.	Mainland Madang Karkar Island Rai Coast
melabo	*melabo*	Flying fox	unknown	Mainland Madang Offshore islands Karkar Island Rai Coast
kuje/buntannes	*kuje/buntannes*	Birds	various	Mainland Madang Offshore islands Karkar Island Rai Coast

* Mennis (1977); ** Mager (1952)



Figure 3.5. Fishing nets, called *raj* in Bilbil. Bongu village, Astrolabe Bay (Biro 1899).

Miklouho-Maclay, first observing pottery making on Bilbil Island in March 1872, saw that every family group engaged with manufacture. Under the roof of every house stood rows of finished and partly finished pots, all approximately the same form but varying in size (Sentinella 1975:131). The Russian was visiting during a time of mass pottery production, with many pots being made in anticipation of the times of hunger and extensive trading trips along the Rai Coast in May and June (Mennis 2006a:18). Miklouho-Maclay recorded the production sequence of these pots as follows (Nikolai Miklouho-Maclay, 1872, in Sentinella 1975:131):

> The implements used for the manufacture of pots are limited to two or three small boards and a pair of round stones, somewhat flattened on both sides. At first, with the aid of the small piece of flat wood, the upper rim is made from clay, which is then left to dry in the sun. When it had hardened somewhat, the rest of the sides of the pot are added bit by bit and smoothed out. The correct shape is given to the pot by holding it on the knees, the woman inserting her left hand with a round or flat stone in the pot, holding it against the internal surface of the wall and with the right hand striking on the corresponding place on the exterior with a flat piece of wood, evening out at the same time the surface and the thickness of the pot. When the pot is ready, it is first dried in the sun and then baked on a layer of brushwood covered with leaves and then sticks, etc. After stacking the pots in several rows one on top of the other, and covering the whole pile with light brush, it is set alight.

Bel oral traditions are almost unanimous that the art of pot making was imported from the survivors of the Yomba disaster (Mennis 2006a: 30; see Chapter 1). In some places, such as Kranket Island, the practice disappeared within one generation of the Bel's arrival as there were no appropriate clay sources on the island, and those on the mainland could not be accessed. At Kranket, which later specialised in building canoe hulls instead of pots, there are stories of potters who married into the island, spending short periods on Yabob or Bilbil in order to produce pots, which could then be exchanged. On Bilbil and Yabob islands, pottery continued to be produced, as clay was accessible from the adjacent mainland. However, in several traditions, and all of those recounted to me, the Bilbil and Yabob assert that people were living on their islands prior to the arrival of pottery production. There is consensus among the potters that the culture hero Honpain arrived at Yabob Island making the first pots and teaching the Yabob women the skill (Mennis 1981a: 6, 1981b: 65). Honpain was a light-skinned migrant from the stars who eventually climbed back up to the heavens with her son, following a disagreement. The place of Honpain's first manufacture in the centre of Yabob Island is still remembered. According to oral tradition, pottery production was later brought to Bilbil, and then Mindiri, from Yabob. As Mennis (2006b) notes, this does not preclude the possibility that Yomba Islanders migrated to Bilbil and Yabob with pot-making, prior to its destruction.

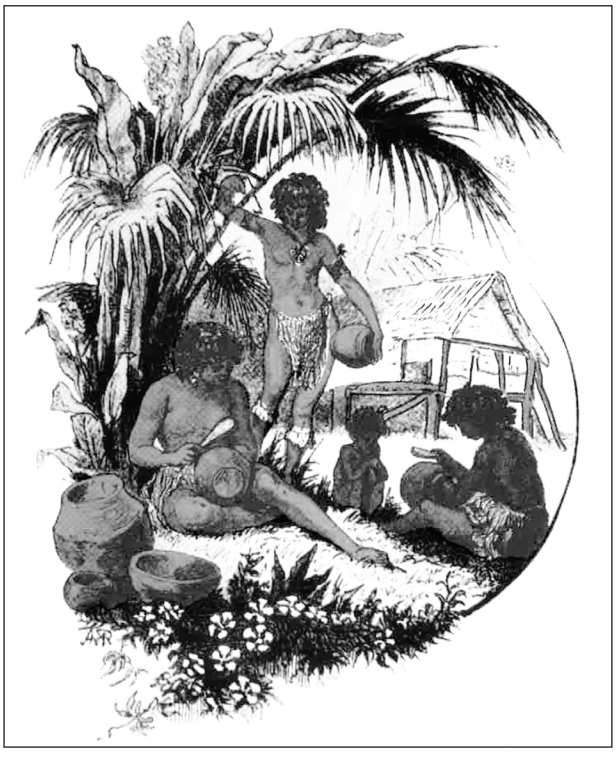


Figure 3.7. Bilbil Island potters observed by Otto Finsch (1888).

Amongst the Bel, pottery making was, and continues to be, a protected practice over which the Yabob and Bilbil communities hold domain. Production is an exclusively female occupation and although women from various clans along the archipelago frequently marry into other clans, only those living at Yabob or Bilbil may learn to pot. For instance, if a Yabob or Bilbil potter married into another village, she would be prohibited from continuing to make pots (Kakubayashi 1978). Most Bilbil women can pot and girls start learning at about four to six years old if born into the village. Women from other areas who marry into Bilbil can learn to pot if they choose. Conventionally these women derive from the Rai Coast, Karkar, or other Bel groups, but, more recently, Highland women are also marrying into the village and are training as potters. The potters assert that potting is not a difficult skill to learn if one has teachers to observe.

This guarded practice acts as a means to regulate the relations amongst the Bel, limiting the number of production centres and thereby producing set rules for the roles that each group maintains in order to perpetuate exchange in the Madang area. This pattern was established prior to European contact. For the Bilbil and Yabob, the control of specialised pot production was essential to maintaining trade and exchange partners, thus ensuring a steady supply of food. As both Yabob and Bilbil Islands had limited arable land, the inhabitants supposedly specialised in making pots, which could then be exchanged for subsistence crops, among other things. This is paralleled in other areas with limited access to productive land (Curtis 1962; Groves 1960; Kramer 1985).

The manufacture of pots reinforces a gendered division of labour: women collect clay and temper, produce pots, and tend to gardens. Men produce canoes, sell the pots and fish, and, in the past, went on trading voyages. Scheduling commitments mean that, today, potters might only produce pots one day per week, in which time a skilled potter could make five large pots. On other days (except Sundays), women will tend to their gardens, cook meals,

and look after their children, or more recently, work in Madang town.

Canoes

Canoe production was just as important as pottery making to the Bel, as it enabled them to extend their mobility hundreds of kilometres to the north, south, and east. In this way pots could be transported relatively quickly and without much energy to people on Karkar Island, in Astrolabe Bay, and along the Rai Coast. Today, small canoes are used for fishing and short journeys, but motorboats have all but replaced canoes for long distance travel. Despite this shift, the Bilbil own and maintain one 'traditional' canoe that is used for welcoming incoming cruise ships.

In the recent past, the Bel produced two types of large trading canoe for long distance travel: a double-masted



Figure 3.8. A sample of Bel pottery: D703, a small *bodi* and D705, a large *you-bodi*, collected by Miklouho-Maclay at Bilbil Island, 1870s (Macleay Museum); FE564, a large *bodi* cooking pot dated before 1912 (Te Papa); E67039, a modern *magob* tourist pot, and E64578 a recent three spouted you-*bodi* collected by Margaret Tuckson 1975 (Australian Museum); 46100, a standard *bodi* pot, 1973 (Auckland Museum).

Balangut (Fig. 3.9 a–b, d),[3] and the slightly smaller but more common *Lalong* (Fig. 3.9 c), with one mast (Mennis 2011:14). Mennis (1980a, 1982, 2011) has documented the complete production sequence for building the Bel *Lalong*. Bush material was collected with the help of the inland groups: vines for lashings were gathered and dried out, the bark of the *dim* tree, later soaked and scraped, was collected to make putty for caulking the hull (Mennis 1980b:10), and large roots would be cut and fashioned into the ornate breakwater (Mennis 2011:28). To produce the large hulls, the men would burn the base of tree to make it easy to cut and then use an axe. A group of men would pull the timber to the beach and float over to their island (Mennis 1980b:24). Once on the island the tree would soak in water for a week and then the men would begin hollowing out the hull (Mennis 1980b:25). Stone axes and planes would be used to smooth the side of the hulls and shells used to shine the hull (Mennis 1980b:26).

The division of labour by gender and clan groupings extended to canoe production. The men from the lagoon groups – the Riwo, Kranket, Sek, and Siar – specialised in canoe hull production and would be asked by the Bilbil and Yabob to produce hulls in exchange for pots and other items. The Bilbil and Yabob would then build the structures on top of the hulls that housed the sailors and their produce during trading trips (Mennis 1980b:24).

Magic

Magic was a central technological component in reproducing processes of production. All initiated Bel men would use some degree of magic in their everyday routine. The knowledge of how to produce magic was entangled with the technical knowledge of canoe building and pottery distribution. For instance, secret words would be recited to allow one to hollow a canoe correctly or to sail without harm (Hannemann 1944:5). Certain Bel groups were said to possess the knowledge of specific magic; the Bilbil and Yabob could not hull canoes because they did not possess the magic with which to carry it out. Although not well documented in oral traditions and ethnographic accounts[4] there are also indications that pottery production was bound up in magic. The red slipped vessels of the Bel

3 The term *Palangut* has previously been used, but Mennis (2014) now suggests that *Balangut* is a more accurate spelling.

4 Probably owing to a gender bias in the collection of this data. Few women have been questioned about the belief systems behind pottery, and, moreover, they may not be permitted to divulge such information.

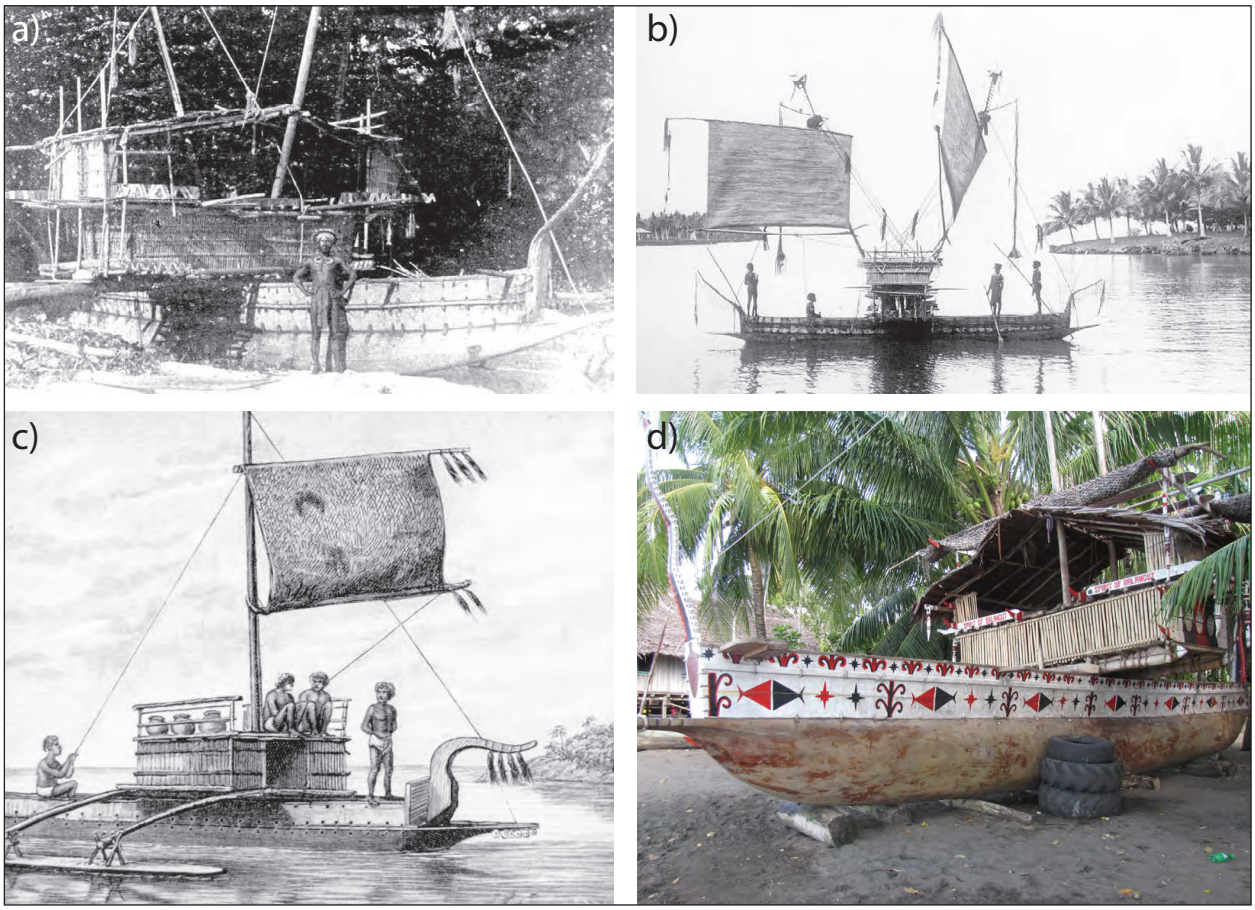


Figure 3.9. Bel canoes from the Madang coast: a) *Balangut* canoe at Yabob in the 1930s (Mennis 2011); b) *Balangut* canoe in Astrolabe Bay, 1905 (Bethke 1905, in May & Tuckson 2000:162); c) *Lalong* canoe in Astrolabe Bay in the 1880s (Finsch 1888:84); d) *Balangut* canoe, constructed in 2013 for independence day celebration, ashore at Bilbil village (2014).

were said to be like young men painted with red during their initiation (Mennis 2014:141), while the anvil stones used in pot production had magical properties necessary for driving out spirits from the raw clay. The source of these stones on the Rai Coast is perhaps the home of positive ancestral spirits (Tuckson 1966). As such, magic may have been an integral tool in the pot production chain.

Bel magic revolved around animism and ancestor worship. It invoked the strength of the *tibud* (nature spirits) and the *meziab* (ancestral spirits) in everyday routine. *Tibud* were spirits that inhabited the natural realm: every tree, each point of land, the sea, and animals. Developing a familiarity with the local landscape required one to learn the *tibud* for different objects and places, and to negotiate these supernatural agents in daily life. The *meziab* were spirits of the ancestors, compiled into a singular social unit with the authority to protect and punish. Different *meziab* existed for each clan line. Totems sacred to clans were hung above the *darem* (as can be seen in Fig. 3.3) as well as on each trading canoe (Mennis 1980b:27). The *meziab* would customarily reside in the *darem,* but they would accompany their canoe during trading expeditions to preside over their kin (Mager 1952). The *darem* seems to have allowed the council of initiated males to control and reproduce the *meziab* belief system.

A secret language was used in every stage of canoe building: from sharpening axes, to the hollowing of logs, attaching the storage compartment, and putting on the sail (Mennis 1980b:24). For instance, the Bel would pray to the *tibud* inside a tree before cutting it down to use for canoe production. Aufinger (1942) described two types of secret language used by the Bel: one of metaphor and innuendo; and another of magic words – some borrowed from other languages, others invented – with which people would speak to exclude the uninitiated from conversation. The latter was originally created so that sailors could speak freely while on the canoe. Evil water *tibud* were familiar with Bel language and would listen in on conversations. This could prove detrimental to the trading trip.

In this context, pots and canoes must be seen as intertwined with the broader social processes of belief, ritual, and magic. Without specific magic being enacted and specific ceremonies taking place, the canoe could not take form or complete trading voyages (Mennis 2011:11).

Aspects of Bel exchange

The production processes described above are inexorably bound up with the distribution, redistribution, and exchange of goods around the coast. The following section describes the social and technological basis for Bel exchange systems in the recent colonial and pre-colonial past.

Trade systems

The Bel have two words to describe their trading system: the *waing* and the *dadeng* (Mennis 2014). The *waing* refers to a journey overseas, while the *dadeng* is the act of exchanging goods (Mager 1952). At European contact, this maritime exchange system was one of the most extensive on the northeast coast and allowed the Bel to trade goods up to 160 km east and west (Bogrodi 1959:270). Oral traditions suggest mobility was even more expansive in the pre-colonial past, with the Bilbil visiting Arop/Long Island and Siassi (Hanneman 1944:10),[5] while the Yabob got as far as Singorokai (Mennis 1981a:28). The Rai Coast was a major trade zone, which attracted the attentions of the Bel traders, as well as the communities of Arop, Sio, and Siassi, and the hinterland people inland from the Rai Coast (Fig. 3.10). In this way, the people of the narrow coastal strip were key mediators of long-distance trade and redistribution (Kakubayashi 1981). As noted earlier, the coast is divided in two by its occupants: the westerly *Nambawan* Rai Coast from Mingming to Saidor, and the easterly *Nambatu* Rai Coast from Saidor to Gali.[6] The Bel visited the *Nambawan* Rai Coast on day trips, leaving Bilbil in the morning and returning by nightfall, but longer trips right along the Rai Coast in May–July allowed the Bel to stop at multiple settlements. On other shorter trading trips, the Bel would travel to Bongu and nearby settlements in Astrolabe Bay, or voyage north to Karkar Island via Sek Island and Matuka on the coast.

Modes of exchange

The nature of exchange in pre-colonial Melanesia is a debated topic. Since the systemic and functionalist perspectives of Malinowski (1922) and Mauss (1925) there has been a tendency to distinguish ceremonial gift exchange from commodity exchange and barter. However, because there was no quantitative exchange rate in many areas of Melanesia, some researchers have viewed all forms of pre-colonial exchange as forms of gift exchange (e.g. Strathern 1988, 1992) involving inalienable objects (see Weiner 1992). From this standpoint, the gift was a metaphorical extension of the giver, which carried the identity of previous owners with it, forming integral components in meaning-making systems of social relations. Others, however, view

5 There is substantial variation in the oral accounts about how far east the Bel sailed. Oral histories collected by Mary Mennis from Madang state that the Bel traveled as far as Sio or even Siassi, but those collected by Kakubayashi (1981) from the Rai Coast state the Bel only reached Malamalai. However, this is reconcilable if Hannemann (1944:10) is accurate, as he states that some particularly courageous Bel made Siassi trade friends at Sio, which allowed them to venture further east than would usually be safe territory. This was likely a rare but notable occurrence. There are similar rare accounts of the Siassi traveling to Madang (Aufinger 1950; Mennis 1981b:25, 95)

6 The Rai Coast is sometimes described as stretching from Astrolabe Bay in the west to Kwama River near Sio in the east (cf. Harding 1967:8; Lilley 1986:14), but Kakubayashi (1981) raises the point that Harding has misinterpreted Miklouho-Maclay's description of the village of Talyata, which was the eastern extent of the trade voyage conducted by Maclay and his Bilbil friend, Kain.

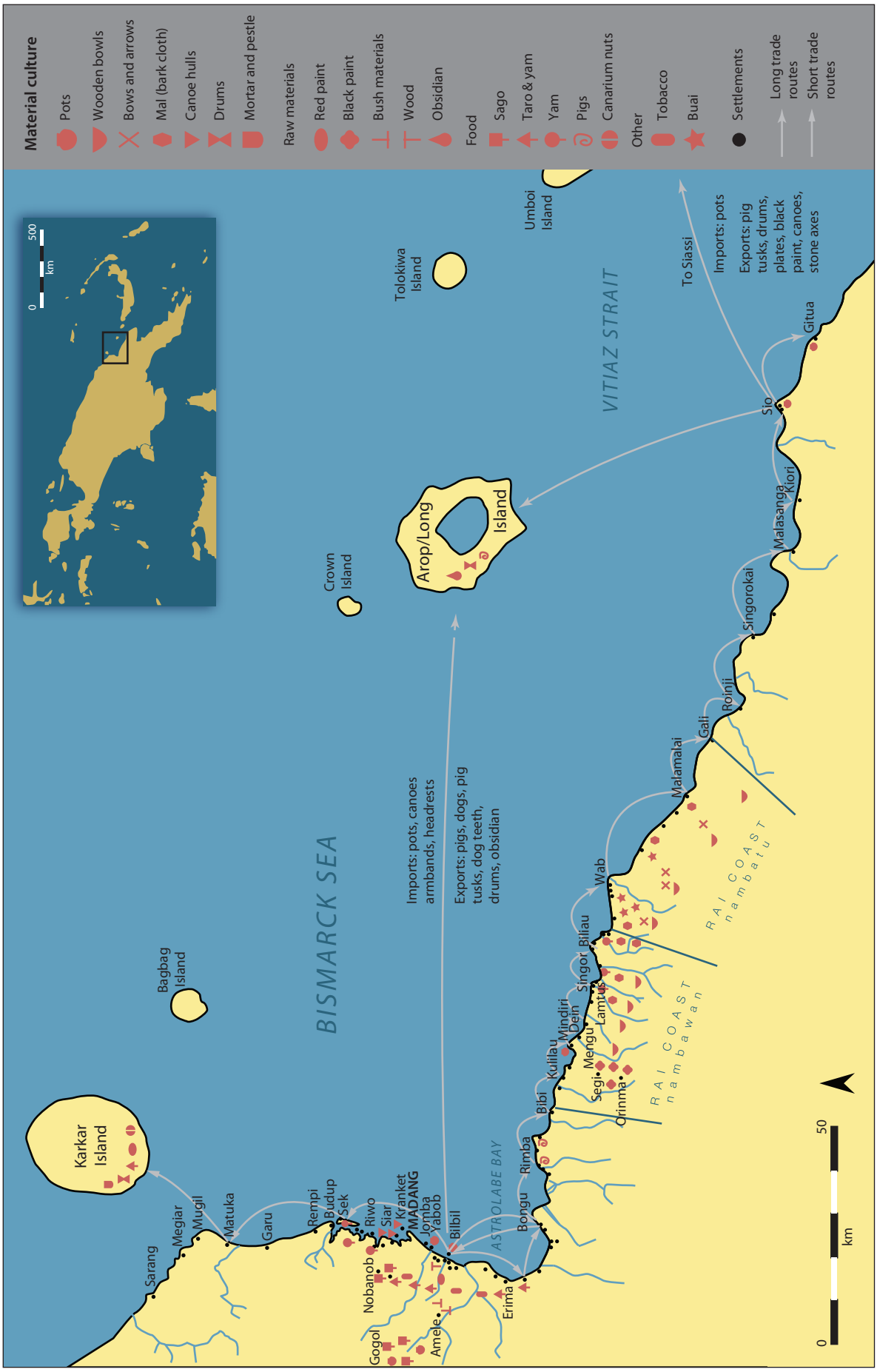


Figure 3.10. Coastal trade networks in northeast New Guinea (adapted from P. J. Edwards in Mennis 2006a: 54–55).

a disjuncture between gift exchange, based on positive or neutral reciprocity, and commodity exchange based on the premise of negative reciprocity and keeping one's trade partners unaware. Gell (1992b) asserts that barter existed in the pre-colonial past because exchange was often focused on acquiring highly valuable material possessions in exchange for less valuable ones. Gorlich (1998a, 1998b) takes this further and suggests that barter existed in the past but must be understood as dialectic between gift and commodity exchanges with social meaning created by uncertainty about the object's availability and risk of non-transactions or personal harm. Modern Bel informants certainly stress that commodity exchange existed in the past, directly paralleling the money economy around Madang today. This is particularly apparent in Pall's quotation at the beginning of this chapter. However, it would be difficult to determine if this is accurate, or if the modern situation has retroactively influenced perspectives on the past. Accounts from the Rai Coast also suggest that there was a simple but accepted exchange rate for different objects in different contexts (Kabuyashi 1981).

The Bel use several words for their different modes of exchange, which seem to primarily describe gift exchange. *Ziang* is a gift or a donation (Mager 1952: 299). This refers to an item given in generalised and positive reciprocity. *Dadom* are gifts without expectation of return, made in reconciliation. A *wou* in Gedaged or *vou* in Bilbil is a non-physical gift, but which carries the rights to reproduce some physical aspect of culture (Mager 1952: 350). For instance, the *vou* might include the right to create a trade item in a certain style, perform a dance or song, or plant certain foods. Apart from the Bilbil and Yabob, Bel clans are not permitted to produce pots because they have not received the *vou*. *Suzuzum* refers to a gift given to somebody holding a feast (Mager 1952: 298). This is a form of delayed reciprocity and a return gift is later expected. A *wodeng* in Gedaged or *odeng* in Bilbil is another form of return gift, which is given to a trade friend in exchange for something else (e.g. betelnut, tobacco) (Mager 1952: 348). The *dinau*[7] was a system used by the Bel, whereby if a group did not have pots to give at the time of transaction, they could owe a set number of pots (Mennis 1981b: 59). This was a form of delayed payment that would have benefited many of the Bel clans during times of hunger. Those groups who did not believe in the *dinau* were not considered good trade friends (Mennis 1981b: 59). This system operated reciprocally between Bel groups and inland 'bush people.'

Trade friends

Although not necessarily related by blood or marriage, trade friends along the coast were considered the same as brothers (see Hogbin 1964: 49). This is reflected by the Gedaged term for trade friend, *gai*, which is a general kinship term to denote closeness. Hannemann (1944: 10) describes several other terms in the friendship system: a *kadoi* was a highly esteemed friend often within the same clan or language group, with whom pigs and other valuables would be exchanged; *tizan* were trade friends whose village lay across the sea and new *tizan* could be acquired; *matau* represents the system of mutual aid, which would sometimes appeal to large groups, much like the modern *wantok* system.[8]

New Guinea's northeast coast, along which Bel traders voyaged, was a linguistically diverse place, today comprising about fifty distinct languages. The Bel traders could communicate with many of their trade friends and interaction between these groups was made possible because at least some individuals in each group were multilingual (see Hogbin 1947 for a similar example in the Huon Gulf). As on the Sepik north coast, boys were left for short periods of time in the host communities of their family's trade friends to learn their language (Welsch *et al.* 1992). This was used to maintain trade relationships in other villages over multiple generations. Moreover, in order to learn the nature of trading from a young age, boys from different Bel groups would go with their fathers alongside the Bilbil and Yabob for trade voyages (Mennis 1980b: 17).

The different Bel languages around Madang (Gedaged and Bilbil) were mutually intelligible and the non-Bel languages on the mainland and around Astrolabe Bay were spoken by many Bel (see Sentinella 1975). To the north on Karkar and the adjacent coast, the Bel traded only with the Takia, not the non-Austronesian speaking Waskia, and so limited their interactions to other Bel speakers (Mennis 1980b: 76). There were some Bel words in common with the Tuam languages of the Siassi Islands, which were also part of the Ngero/Vitiaz linkage, but the languages were not mutually intelligible (Mennis 1981b: 97).

Sailing

The Bel traders were adept sailors who had developed a distinct lore regarding various environmental factors along the coast, which largely informed the timing and extent of their voyages. The Bel used the stars to navigate during the night and noted the different points of land and river mouths during the day (Mennis 1981a: 15). The winds, which were all named (Fig. 3.11), were a 'consuming interest' of the Bel (Mennis 2006a: 67) and their strength, direction, and timing were well understood. The *Yawarti* wind blew down from Karkar Island while the *Dadau* blew from Amele, an inland village northwest of Madang. These winds were active during the wet season in January and February and were used to take the Bel to Rimba, Kul, and Singor. *Dadau Dere* was also active during January and February but was prone to changing direction. The *Dolo Yawarti,* blowing from Siador in May–July, was used by

7 *Dinau* is a Tok Pisin word for debt. This word seems to be used by informants in the oral histories to refer to an equivalent Bel system of expectation and obligation.

8 *Wantok* is a Tok Pisin term meaning 'one talk' and denotes a person with whom one has a strong social bond, often deriving from the same language group, clan, or family.

the Bel to return from the Rai Coast. However, *Karag,* the brother of *Dolo Yawarti*, was regarded with apprehension by the sailors and was a dangerous wind on which to travel. There were particular dangers associated with sailing on the wrong winds at the wrong times, especially if they blew sailors into enemy territory, but such challenges were carefully managed, alongside concerns regarding subsistence needs, and the placement of trade friends.

Magic

Just as magic pervaded the everyday production of objects, so too did it form an integral part of Bel exchange and was a key component of the *waing*. Within each Bel group there were specialised practitioners of magic named *likon*. *Likon* could recite spells to heal sores and cure sickness, improve gardens, and settle conflicts. They possessed magic stones, described as rounded black rocks, to help carry out their tasks (Mager 1952). These men were particularly necessary in controlling the weather during trading trips: they had power to start, change, and calm the winds (Hannemann 1939). It appears that the *likon* was an exclusively male role, and a hereditary skill passed down from father to son, whereby children would be selected and trained in different lore (Mennis 2006a: 40). The head *likon* presided over subordinates who held different elemental domains. These lesser *likon* have taken on a mythical status, reportedly being strange little beings that would hide away if anyone entered their house (Mennis 1981a: 41). Weather *likon* could use spells to turn the rain into sunshine or quieten a stormy sea. They used to predict the winds for the next day and sang out to the *tibud,* inhabiting each point of land along the coast to ensure safe passage. Alternatively, rain spells were recited after dry periods to encourage crop growth. In this instance, the *likon* would strip the bark of a thin tree, then take the sword shaped leaves of a particular shrub along with some tree branches, binding them together with the oily bark. He then put this in the nearest fresh flowing river and rubbed it with stones, simultaneously reciting a spell inherited from his father (Aufinger 1939).

Ceremonial displays were also necessary for the trade voyage to commence. Upon departure, the 'father' of the canoe would swim out with the canoe and fight it with a branch. The young men would stand on the platform, decorated with feathers and *mal* (bark cloth loincloths), while the leader would stand in the cabin, drumming the *vongu* drum, speaking magic, and blowing on the conch shell (Mennis 1980b: 44).

Pots, canoes and magic were bound together even during voyaging. For instance, broken potsherds would always be carried in a basket inside the canoe, and if the canoe was in rough weather the men would take the sherds out and heat them over a fire before throwing them into the sea to calm the waves and any malignant *tibud* (Mennis 1980b: 44).

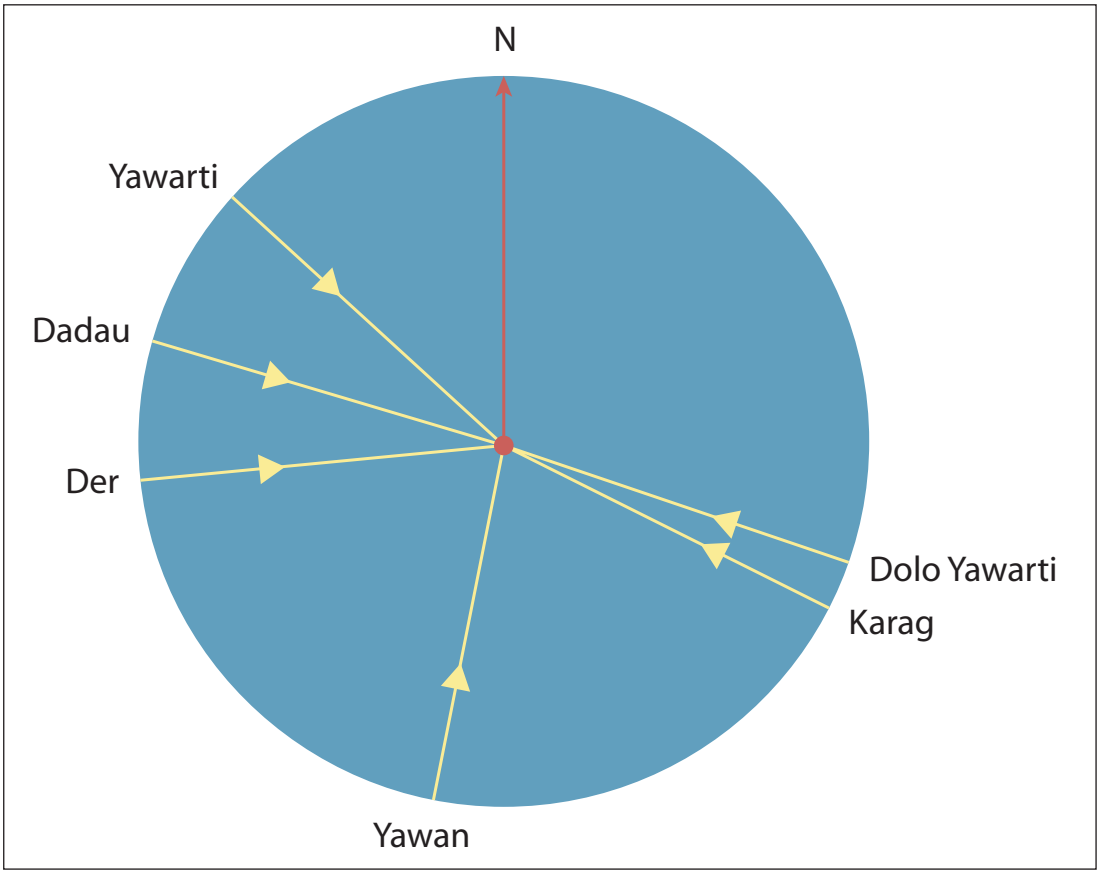


Figure 3.11. Wind chart showing major sailing winds used by Bel traders (adapted from Mennis 2006a: 66).

Food

Food was an essential goal of the *dadeng,* required to support the Bel community's large populations. The acquisition of food through trade was both informal and strategic; localised and long distance. Throughout the year, the Bel on offshore islands would travel to the Madang coast to exchange pots, smoked fish, and other desirable items for crops, pigs, and bush material with the mainlanders. The most frequently traded crop was taro, but sago, banana, pandan, and yams were also exchanged. The mainlanders used numerous other plants for medicine, decoration, poison, and magic but it is unknown if the Bel engaged with the same plants for these purposes (Miklouho-Maclay 1885; Petir *et al.* 1997). The bush people would light fires on the beach to signal that they wanted to trade, or market days would be timed by the counting down of coconut fronds; each day a frond would be cut off until it was the day of trade (Mennis 1981b: 79).

The time of local planting embedded the ground with new growth but marked the beginning of the time of hunger (Table 3.3). Small amounts of sago, taro, and sugarcane might still be collected locally, and trade with the adjacent mainland would assist subsistence to a degree, but to fully support their large populations the offshore Bel, particularly the Bilbil and Yabob, had to turn elsewhere to acquire food (Mennis 1981b: 23). In these times, the Bel travelled along the Rai Coast to acquire pigs, smoked fish, red sugar cane, and root crops (Mennis 1981b: 24). They would also go north to Karkar to get pigs and canarium nuts. Pigs could either be purchased as meat or as live animals, brought back to Madang strapped to logs (Mennis 1981b: 19). While on trading expeditions the young men would go hunting in the bush with their trade friends for possums and feral pigs (Mennis 1980b: 27, 1981b: 26). Betelnut would be shared in small quantities or purchased in bulk on the return journey (Mennis 1981b: 55).

Material culture

Items of material culture were active in reproducing and shaping exchange, interaction and social meaning along the coast. The Bel, and particularly the Bilbil and Yabob, were remarked on by early Europeans for their material wealth (Table 3.4), compared to nearby groups who did not participate in the *dadeng* (Finsch 1888, quoted in Mennis 1996: 15).

Objects used in a *dadeng* were called *jabaz* in Gedaged or *jambar* in Bilbil. Bulk articles were also commonly known as *su*, because they were supported by *su* (supports) during transport. Trades of bulk goods could be enhanced by *samum*, rare things such as beads or grass skirts to make an exchange of food or pots more desirable (Meger 1952: 128). So, although the fundamental goal of the larger scale *dadeng* was to shift pots and food between groups for subsistence maintenance, smaller objects were essential to these movements.

Although the Bel were recognised as specialist potters along the northeast coast, they also traded for other pots made by different production groups. The nearest major production centres were located inland, in the Gogol River

Table 3.3. *Annual planting and trading cycle (adapted from Mennis 2006a: 68, 2014: 18).*

Month	Season	Planting	Winds	Trading
June	Dry	Harvest yams	Night: *Dadau* Day: *Dolo Yawarti*	Rai Coast (long trading trip)
July	Dry	Harvest yams	Night: *Dadau* Day: *Dolo Yawarti*	Rai Coast (long trading trip)
August	Dry		Day: *Karag* Late afternoon: *Yawarti*	Dangerous sailing Bogati, Saidor, Mindiri in afternoon
September	Dry		Day: *Karag* Late afternoon: *Yawarti*	Dangerous sailing Bogati, Saidor, Mindiri in afternoon
October	In between		Doldrums	Small scale trading
November	Wet	Hungry times	Day: *Dadau* or *Yawarti* Afternoon: *Dadau Dere*	
December	Wet	Hungry times	Day: *Dadau* Afternoon: *Yawan*	Not ideal for trading
January	Wet	Harvest small taro	Night: *Yawan* Day: *Dadau* and *Yawarti* Afternoon: *Dadau Dere*	Small scale trading inland
February	Wet	Plant yams	Night: *Yawan* Day: *Dadau* and *Yawarti* Afternoon: *Dadau Dere*	Rai Coast (short trading trip)
March	Wet	Hungry times	Early morning: *Yawan* Day: *Dadau Dere*	Rai Coast (short trading trip)
April	In between		Doldrums	Sek and Rimba
May	Dry	Harvest large taro	Night: *Dadau* Day: *Dolo Yawarti*	Rai Coast (long trading trip)

Table 3.4. *Trade items acquired by Bel according to oral testimonies and word lists.*

Bilbil name*	Gedaged name**	English name	Manufacture location	Place of acquisition
tabar *zagat* *bizag*	*tabaz* *zagat* *bizag*	Arrows	Inland villages	Bonga Malamalai Sel
vol	*wol*	Bows	Inland villages	Bonga Masamalai Sel
– *palapal* – – *sawar*	*kabu* *palapal* *mameng* *kidiai* *sawaz*	Spears	Karkar	Karkar
sapam	*sapam*	Round shields	–	–
madin	*dimui*	Long shields	Karkar	Karkar
–	–	Slings	Inland villages	–
–	–	Bone knives	–	–
unding	*uding*	Bone needles	–	–
– –	*adiu* *makak liwon*	Stone axe/adzes	–	Rai Coast Karkar
–	–	Shell axe/adzes	–	–
pat	–	Flaked stone	–	Rai Coast
jaling	*jaling*	Obsidian	Bismarcks	Arop/Long Island Umboi Island
–	*sinai*	Coiled pottery	Gogol Valley	Inland villages
bodi	*bod*	Paddle & anvil pottery	Sio/Gitua Mindiri	Sio/Gitua Rai Coast
kunap *sauang*	*kunap* *suang*	Mortar & pestles	Karkar	Karkar
–	*duaz (?)*	Round wooden bowls	Rai hinterlands	Numbawan Rai Coast
–	*suaz (?)*	Long wooden bowls	Rai hinterlands	Numbatu Rai Coast
sikor	*sikoz*	Turtleshell armbands	–	–
–	*papeng*	Turtleshell nose ornaments	–	–
–	–	Shell armbands	–	–
paspas	–	Woven armbands	Karkar	Karkar
ari	*azi*	Armlets	–	–
betambet	*bedabed*	Dog teeth necklaces	Arop/Long	Arop/Long
kolekole	*kalekale*	Dog teeth breast-pieces	Arop/Long	Arop/Long
pezamat	*paramat*	Pig tusk necklaces	Siassi Arop/Long	Rai Coast Arop/Long
kamatui gamun	*matui gamun*	Fish palatial bones	–	–
bul	*bul*	Shell ornaments	–	–
bililik	*bililik*	Hip ornaments	–	–
semarek	*mal*	Loincloths	Rai Coast	Rai Coast
–	*nai*	Grass skirts	–	–
si	*si*	Combs	–	–
bem	*bem*	Red ochre/paint	Karkar hills	Karkar
mumu	*mum*	Black paint	Rai Coast (Sel)	Rai Coast
–	*nanon*	Red dye	Karkar Madang mainland	Karkar Madang mainland
nong dadir *nong*	*nainal* *nalog*	Black dye	Siassi Rai hinterlands	Rai Coast
jang	*jang*	Yellow dye	–	–
*dim sol***	–	Pig bone tools	–	–
kau	*kau*	Lime	–	–
–	*kau adug*	Lime containers	–	–

Table 3.4 *continued.*

Bilbil name*	Gedaged name**	English name	Manufacture location	Place of acquisition
asi	*as*	Timber	Inland villages	Inland villages
–	–	Bush material	Inland villages	Inland villages
vongu	*dugwag*	Hourglass drums	Karkar Arop/Long	Karkar Arop/Long
do	*do*	Slit gongs	Rai Coast	Rai Coast
kongu	*kag*	Bottle gourds	–	–
aul	*aul*	Fishooks	–	–
raj	*aza* *kakang*	Fishnets	–	–

* Mennis (1977); ** Mager (1952); *** carved pig bone used to insert putty into the holes in canoes.

area with markets at Gonua, Boi and Atu. These pots were produced by male potters using coiling methods (see Fig. 3.12), and although many acknowledged them to be less durable than Bel pots, the coiled ones were considered better to cook sago in, as they gave the crop a sweeter taste (Mennis 1981b: 57). Along the Rai Coast at Mindiri another Bel group produced red-slipped pots broadly in the same style as the Bilbil and Yabob pots; however, a different, black clay source was used (Mennis 1981b: 25). There were also some technical differences; for instance, Bilbil pots heated food quicker than Mindiri pots (Mennis 1981b: 24). Further along the coast, at Sigawa Island (Sio), at Nambariwa on the adjacent coast, and at Gitua there was another distinct potting tradition (May & Tuckson 2000: 148). The Sio/Gitua potters continue to make pottery today and use paddles and anvils during the forming stages. The pots are morphologically very similar to Bel pots; they are globular with decoration restricted to above the shoulder (Lilley 1986: 194). However, technologically the Sio/Gitua pots are distinct in that they do not contain temper (May & Tuckson 2000: 150).

Stone axes were traded in primarily from the Rai Coast and less commonly Karkar Island (Mennis 1981a: 58). It appears that axes were not produced by the Bel around Madang owing to a lack of suitable raw material and all were imported (similar to Fig. 3.13). Stone axes collected from Astrolabe Bay have previously been described as diorite-porphyry (Kunst & Buchdruckerei 1886: 9), which suggests the raw material was procured from the hills behind the Rai Coast. However, further north, near Aitape, stone axes were differentiated by their users based on the stone's sharpness and the positioning of the haft rather than the type of stone or the shape (Biro 1899: 181).

Today's older generations around Madang never used flaked stone tools, but their origins and functions have been passed down as oral traditions. According to my interlocutors around Madang, flakeable sedimentary stone was imported primarily from the Rai Coast. Obsidian was also imported and the Bel today cite Arop/Long Island as the origin. Mager's (1952: 123) dictionary specifies Rook Island (Umboi) as the source, which suggests that the Bel knew that obsidian derived from the east, towards the Vitiaz Strait, but its ultimate source, now known to be in the Bismarcks (Gaffney and Summerhayes 2019), was not revealed to them.

Shell tools were also used in everyday routine and traded in from afar. Miklouho-Maclay described the use of simple unmodified shell (*Cardium* sp.) scrapers called *arur* with serrated edges used for scraping coconut (Sentinella 1975: 86). Small shell adzes made from *Tridacna* sp. may also have been used as taro peelers (Egloff 1975: 34).

Bone tools were common around the coast. Miklouho-Maclay describes *dongan* which were pig-bone knifes, along with a variety of other sharpened bones (especially cassowary) used as knifes, levers, lancets, or awls (Sentinella 1975). Bone needles called *uding* were also made from thin flying fox bones. *Dim sol* were carved pig bones with the specific function for inserting putty to caulk holes in canoes. This simple tool was integral to canoe building and maintenance.

The Bel exchanged pots for a variety of weapons, and they were not hesitant to use them for retribution or to maintain dominance over pot production and trade voyaging. The mainlanders around Madang in particular, and those on Karkar Island and the Rai Coast, were major suppliers of various spears, bows and arrows, and large battle shields, which were round or oblong, with raised carvings and coloured with paint (Fig. 3.14).

Many other wooden items figured substantially in exchange around the coast. Hardwood items such as pestles and mortars were imported from Karkar Island (Fig. 3.15), while wooden bowls were procured from the Rai Coast. These bowls were produced on Tami Island, the Siassi Islands, and in the Rai hinterlands, behind the coastal villages (Harding 1967: 38; Schmitz 1955: 306). Round wooden bowls were characteristically obtained from the *Nambawan* Rai Coast, while elongate wooden bowls were typically procured from the *Nambatu* Rai Coast or Siassi (Fig 3.16) (Christensen 1975; Kakubayashi 1981).

Additionally, Hagen (1899: 257) suggested on the basis of stylistic similarities between wooden totems, known as *silum* in Gedaged or *sulum* in Bilbil, that there was a common production centre at Bongu in Astrolabe Bay (Fig.

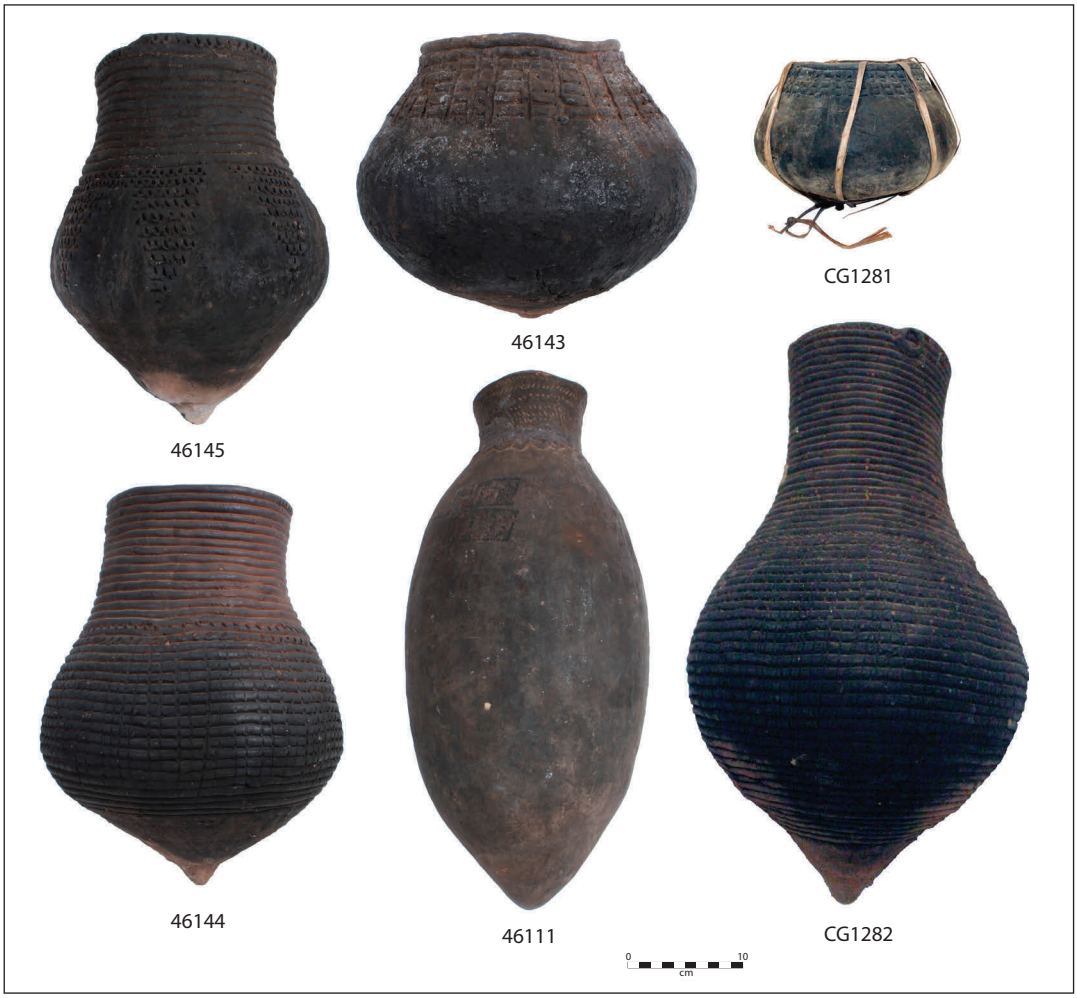


Figure 3.12. A sample of inland Madang pottery: 46145- large cooking pot purchased at Guman village by S. Bulmer, 1967; 46144- large cooking pot made at Guman; 46143- cooking pot, unknown provenience; 46111- large cooking pot purchased by G. Johnston at Begasain (all Auckland Museum); CG1281- small cooking pot from Gonua village; CG1282- large cooking pot, unknown provenience (both Te Papa museum)



Figure 3.13. Stone axe from the Huon, collected by Richard Neuhauss, #VI 29995 (Kulturbesitz Ethnologisches Museum, Berlin).



Figure 3.14. Jangar, an elder of Bilbil Island with shield from Karkar Island. Lajos Biro (scan courtesy of M. Mennis).

3.17).[9] However, owing to small variations in form and the fact that each clan or family group had specific names and meaning attached to the objects, it is more likely that each group produced their own (Bodrogi 1959:54). Carved animals, known as *mazoz* in Gedaged and *maror* in Bilbil, were used as emblems by each clan and attached above the *darem* and on canoe masts. These were certainly made on Kranket Island and in the lagoon area, but it is not known if they were then exchanged with the Bilbil speakers to the south, or if they manufactured their own.

Much of the Bel's clothing and ornamentation was also imported (Mennis 1977), and such adornments readily distinguished them from other groups along the northeast coast (Sentinella 1975:36). Miklouho-Maclay described his first encounters with the Bel while in residence near Garagassi in Astrolabe Bay. Their hair was carefully coloured by red ochre with foreheads, noses, and backs painted in the same colour (Sentinella 1975:40). Loincloths known as *mal* were worn around the waist, obtained from the Rai Coast. Armbands made from turtle shell (Fig. 3.18), marine shell, and plant products were worn, especially during dances and initiations (Mennis 1980b:30). According to modern Bel groups, shell ornaments were not locally produced but were trade items from Siassi, Arop/Long Is-

9 *Silum* are described as *telum* by Miklouho-Maclay who uses the Bongu term, but 's' and 't' may be rather interchangeable with regard to their Russian and English transliteration (Sentinella 1975:349).



Figure 3.15. A pestle and mortar for crushing sago, Karkar Island, German New Guinea (D25.2432, Otago Museum).



Figure 3.16. Two wooden bowls from Astrolabe Bay. A round bowl (D24.3049) typical of the Numbawan Rai Coast and an elongate bowl (D24.3048) typical of Siassi. (Otago Museum).

land, and the Huon. Eligible men and women wore small woven armlets produced by cooking and dying the bark of a climbing palm (*Calamus* sp.) (Mager 1952: 9). Necklaces, headbands, and hip decorations were produced from shell, fishbone, pig and dog teeth (Fig. 3.22; Sentinella 1975: 81). Pig tusks, known as *pezamat* in Gedaged or *paramat* in Bilbil, were bound in pairs as men's festive ornaments. The most impressive and valuable of these pig-tusk decorations, in which each tusk came together in a perfect circle, could be exchanged for a whole pig and were used as brideprices (Mager 1952: 247). In early encounters, Miklouho-Maclay attempted to trade a steel knife for a *paramat,* but the Bilbil men did not wish to part with it, despite desiring the knife very much (Sentinella 1975: 41).

Negotiating colonial disruptions

The previous sections have attempted to approximate Bel production and exchange just prior to the colonial period. However, much of what exists today is also bound up with significant events and alterations that took place in the late 19th and early 20th centuries. Contact with Europeans around the northeast coast, as in most places in New Guinea, was sudden and astonishing (Burton 1999: 14). On the 20th September 1871, Nikolai Miklouho-Maclay, the Russian scientist-explorer, landed at Astrolabe Bay with his two servants (Fig. 3.20). The first encounters with local people that he describes conjure up fear, fascination, intimidation, and excitement (Sentinella 1975: 15). His encounters were generally made favourable by tapping into the existing gift exchange systems that operated amongst the Bel and nearby groups. The Bel were particularly fond of his gifts of metal nails. Later, he would gain favour by healing many of their sores while they were visiting for a *singsing*[10] (Sentinella 1975: 82). The Russian therefore figures substantially in many Bel oral traditions and legends.

However, ten years later in 1881, Otto Finsch, an ornithologist, laid the foundations for the *Neu Guinea Kompagnie* to establish plantations around Madang (Fig. 3.21), and by 1884 the German standard flew above a new colony (Mennis 2006a: 123). Finschafen, on the Huon Peninsula, was the Neu Guinea Kompagnie's initial base of opera-

10 A singsing (Tok Pisin) is a gathering or festival involving dance and music.

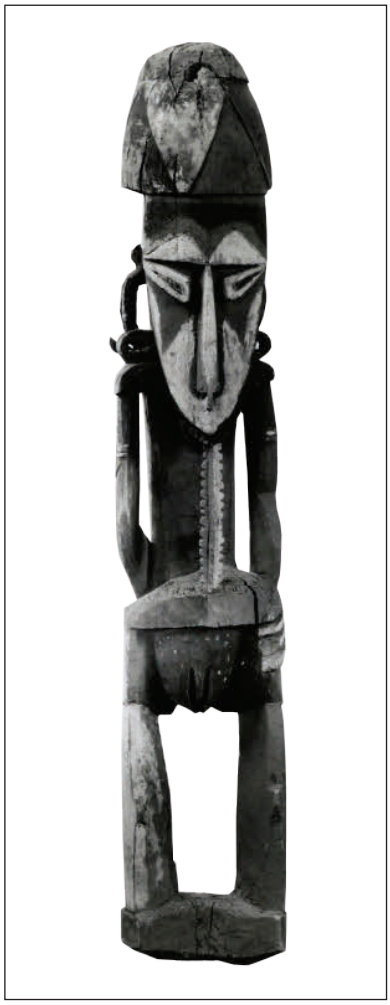


Figure 3.17. Wooden ancestor figure, Bilbil Island, collected by Otto Finsch, #VI9336 (Kulturbesitz Ethnologisches Museum, Berlin).

tions in the late 1800s, but this was moved to Friedrich-Wilhelmshafen (now Madang) in 1892 (Molnar-Bagley 1993: 18). Although many Europeans subsequently set out for Madang under the auspices of science and ethnology, communication difficulties between the Germans and the Bel, alongside German disregard for local customs and land ownership, led to a number of issues. For instance, Lutheran missionaries revealed secrets to the uninitiated and burned objects such as the *meziab* flutes or sacred stones, in an attempt to convert the people to Christianity, forcibly imposing the Western dogma and cosmology on the indigenous belief systems (Lawrence 1956; Mennis 1980b: 45). The magic spells from Yabob recorded by Aufinger (1939) only a few decades after significant European contact were already being forgotten, and with them the technical skills to produce canoes and control the weather to undertake safe trading expeditions.

On two occasions the Bel were forcibly moved from their clan areas by the Germans, which caused a severe disjuncture and inhibited customs of potting and canoe making (Mennis 1980b: 68). This first occurred in 1904, after a local revolt. The leaders of the revolt were blindfolded and shot to demonstrate German superiority (Mennis 1980b: 31). This was despite intra and inter-communal violence being outlawed under the German administration, partially as a Christianising effort, and partly to offer a measure of personal safety for the missionaries. The Siars were then sent to Mindiri, the Yabob to Yeimas, the Biliau to Suit, and the Kranket to Wab (Mennis 1981a: 6–9). The Bilbil were not banished, but their elders were sent to Baining in east New Britain (Mennis 1981a: 9). Mennis (2014: 67) suggests, quite plausibly, that the revolt was instigated by the Bilbil when the Germans had implemented a new monetary system, challenging the Bilbil's trade monopoly.



Figure 3.18. Turtle shell armbands from Astrolabe Bay (Oldman Collection, Otago Museum).

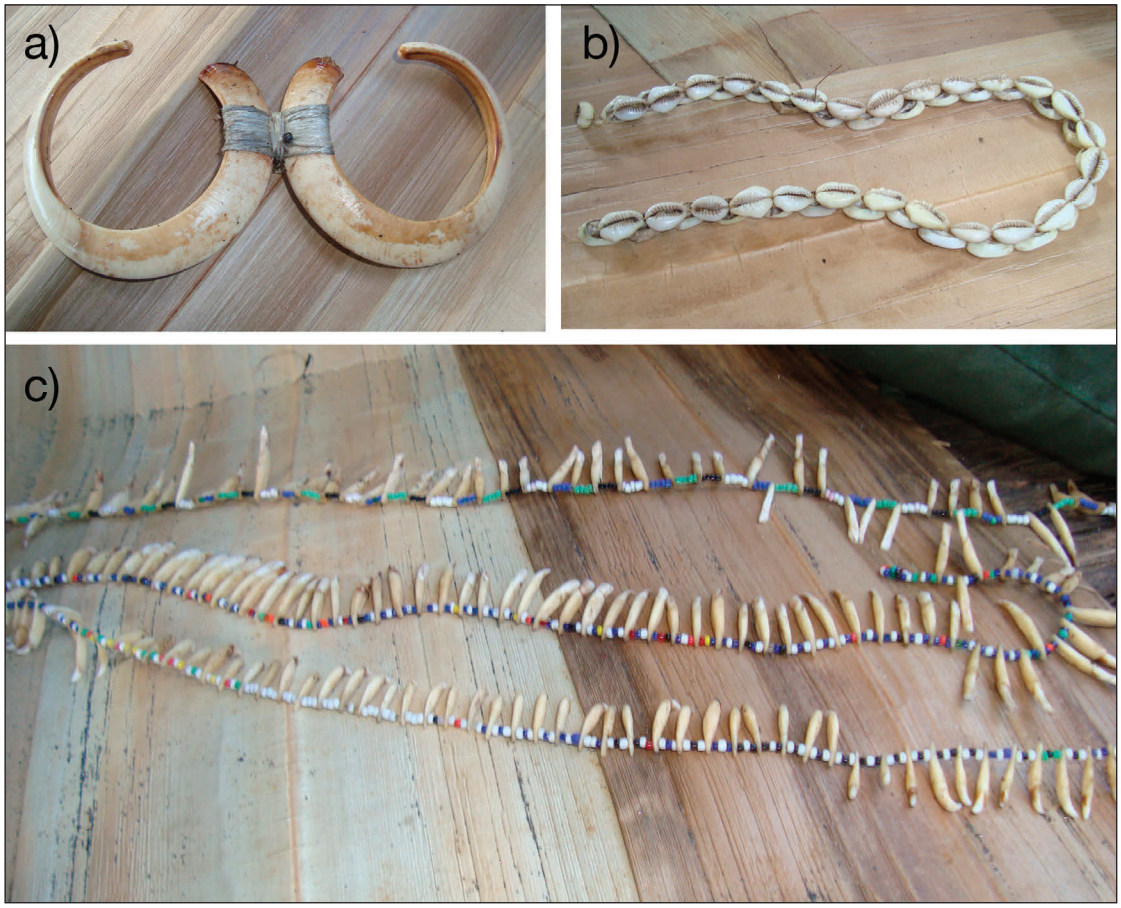


Figure 3.19. Trade valuables from Arop/Long Island: a) pig tusk necklace; b) cowry shell armband; c) dog teeth necklace (photos: M. Mennis 2014).



Figure 3.20. Nikolai Miklouho-Maclay meets local people in Astrolabe Bay (Source: Russian Academy).



Figure 3.21. The people of Riwo Island (also called Ruo) with Paul Boether (left) and Bergmann (right) during German administration. Photo: Lajos Biro (scan courtesy of M. Mennis).

The Bilbil asserted on the basis of oral traditions that the pots were their money (and livelihood) and any attempt to undermine this understanding faced retribution. Many canoes rotted during their elder's absence in Baining and on their return the Bilia, Kranket and Siar made only small canoes rather than large trading ships. The second relocation, onto the Rai Coast, occurred some years later when rumours of another revolt began to circle. After returning from the Rai Coast, the Bilbil relocated permanently to the adjacent mainland, using the island as a place to collect canarium nuts and coconuts, or to rest during fishing excursions (Mennis 1981a: 39).

The Germans later established Malay and Chinese communities around Madang and sometimes Chinese junks would accompany *Balangut* on trade voyages. The Yabob even purchased a Chinese junk, as they were more durable than Bel canoes, and the Bilbil ended up renting three of these craft. This relegated the lagoon Bel to minor partners in trade expeditions as they were no longer required to produce canoe hulls (Mennis 1981a: 13, 1981b: 11). The Chinese were also employed to deforest the mainland around Madang (Mennis 1980b: 79–80), which exacerbated this situation as suitable trees for canoe hulls became scarce. A shift to selling pots for money that was used to buy crops and even boats further reconfigured the local gift (and possibly barter) economy.

Colonial introductions of new foods from Europe and Asia also saw a dramatic shift in the Bel diet over the last 130 years. The Germans brought pineapple, pawpaw, watermelons, and corn seeds, and the locals were instructed to plant and manage these new crops (Mennis 1981b: 1). Rice from Asia in particular has become a major carbohydrate contributor in Madang town. In many areas outside Madang town, however, pre-colonial crops such as yam continue to structure the local yearly cycle, and, along with sago and taro, contribute significantly to the diet.

Finally, global conflicts during the early 20th century shifted the balance of power around the northeast coast of New Guinea. During the First World War, Australia came to occupy the former German colony and it was later administered as a League of Nations mandate territory by Australia (Sinclair 2005). During the Second World War when Japanese forces occupied the area, the Bel groups could not complete trading trips along the Rai Coast as it had become too dangerous (Mennis 1980b: 3). In particular, in 1942 the Japanese destroyed a number of trading canoes for firewood and used paddles for carrying cargo

(Mennis 1981b: 54). Moreover, many coastal groups were encouraged by Australian propaganda airdrops to relocate inland in order to avoid bombings, while many of those living on offshore islands were moved to the coast by the Japanese (Mennis 1980b: 3, 6). In this way the geographical pockets which the Bel inhabit today do not accurately reflect pre-war distributions.

Summary

This chapter has surveyed existing information regarding pre-colonial Bel production and exchange, drawing on oral traditions, ethnography, early explorers' accounts, and museum collections. The emphasis has been on thoroughly describing the production and exchange of material culture during the early contact and colonial periods, but with the finding that: 1) the nature of material production and exchange is entangled with subsistence strategies, settlement patterns, sailing technology, magic, and the physical environment, and 2) a series of European administrations have altered the trajectories of production and exchange, and particularly how these processes are remembered in oral history, recorded in ethnography, and collected for museums. The next chapter will focus its analytical lens onto the pottery production process itself, the key component in Bel production and exchange, and the subject of the present archaeological investigation.

Chapter 4. Modern Potting Communities

It is easy to learn to make pots, if you have the right teacher.
— Sentie Noah of Bilbil (2015)

Modern pottery production and exchange remains an important activity among the Bel groups, particularly at Yabob and Bilbil where manufacture still takes place. This chapter is an ethnographic study of this pottery making, known locally as *vai.* The *vai* was documented with interpretations of the production sequence informed by interviews with the Madang potters and elders living in these villages. The *chaîne opératoire,* following resource procurement, production, use, reuse, and discard of contemporary Bel ceramics is presented in detail, using ethnographic observations made in 2014 and 2015 while visiting Yabob and Bilbil villages. This provides an essential modern analogue for the archaeological pottery of Madang (see Fewster 2006; Roux 2007). Later in the book, the *chaînes opératoires* of archaeological pottery will be compared with these modern iterations to identify technological changes in production and exchange from the pre-colonial to the modern.

Production groups

Yabob pottery

The homeland of the Yabob people is Yabob Island, but there are now Yabob communities not only on the island itself but also on Yomba Island,[1] and at two locations on the mainland: Yabob-up-top, located on a hill that overlooks the sea, and Yabob-down-below (also known as Morelan Hamlet), situated next to a beach looking out to Yomba Island. The Yabob Islanders, who were making pottery at European contact, were forced to abandon their homes during Japanese occupation in World War II and resettlement of the island did not begin until after Papua New Guinea's independence in 1975 (Suwa 2005). On Yabob Island the importance of potting to their ancestors is recollected through oral traditions, although the knowledge of how to pot has been lost. Despite this, the sacred area where the culture hero Honpain made the first pots is remembered. At this place she taught the Yabob people to pot, and from there the potters then took the skill on to Bilbil Island.

Production continued into the 21st century only at Yabob-up-top (Fig. 4.1). At the time of fieldwork only three older women at Yabob-up-top village knew how to produce Madang style pots using the paddle and anvil method: Yuk, Yamoi, and Yeyeg and only one of these potters, Yeyeg of the Nob clan, was still practicing, albeit very seldom. Some younger women previously made ceramics but their potter's wheel had rusted and they were unable to make pots by hand moulding. These potters and their families were enthusiastic for researchers and tourists to record and spread word of their pottery, which they lamented to be a dying art as the young Yabob girls were uninterested in learning the art from their grandmothers.

Bilbil pottery

The Bilbil people live in a large village composed of four clans, which stretches along the coast several kilometres south of Madang. At European contact the Bilbil were living and producing pots offshore, but as punishment for a planned revolt against the Germans in 1904, people were displaced from Bilbil Island to the mainland (Mennis 1981b: 4). Many were shot and houses were burned. Later, under Australian administration following WW1, some Bilbil people returned to their island home to continue potting, but this did not last. Today, Bilbil Island is uninhabited, but each clan retains claim to their ancestral space there. Pottery is now produced at Bilbil village on the mainland where production is thriving (Fig. 4.2). Many women in the village produce pots on a regular basis. There is a sense of economic and social empowerment among the Bilbil potters, in contrast to the disempowerment felt at Yabob at the loss of their customary practice. The potters at Bilbil actively engage in the same practice as their ancestors, and as with other aspects of their material culture (see Chapter 3), pot production is important to represent their past in a highly visual manner.

1 Not to be confused with Yomba Island, the legendary homeland of the Bel people (see Chapter 1).



Figure 4.1. Yabob-up-top potting village (photo: M. Mennis, 2014).



Figure 4.2. Bilbil potting village. A view from offshore (photo: M. Mennis, 2014).

Defunct production centres

Finsch (1888) noted at the end of the nineteenth century that Yomba and Bilia Island women also made pots, but if this is accurate, production has since ceased. Mindiri village (formerly Medize or Mediseh) on the Rai Coast has been recorded as the most distant place of Madang style pottery manufacture (May & Tuckson 2000: 163–164), but according to the Bilbil villagers who travel to that area regularly, this village is no longer producing. This means that Bilbil village is now the only extant production centre of Madang style ceramics, and during the course of the 19th–21st centuries, the number of these centres has reduced from perhaps five (or more) to just one.

Procurement

Clay

The Bel use a variety of clay sources, collectively referred to as *ganal* or *rar*, to produce pots. At Yabob, the potters use six distinct clay types, which are differentiated by colour. One of these, the 'red' clay, is close by the village, while the others require a slightly longer walk. At the red clay source, situated in a modern *kaukau* (sweet potato) garden, the young boys[2] extracted the clay by using a metal digging stick to cut through the topsoil and expose the underlying clay deposit (Fig. 4.3). The clay was then extracted by hand and inspected by the elder potters for appropriate texture and lack of inclusions with larger clods of about 20–30 cm being selected (Fig. 4.4). The collection was then carried back to the village in a *bilum*[3] and banana leaves were placed over the clay source to prevent it from drying out.

As at Yabob, the Bilbil potters differentiate clays primarily by colour. The Bilbil potters select from only two clay sources, about one kilometre southwest of their village. This consists of a 'yellow' clay named *rarmand*, next to a small creek (Fig. 4.5) and a 'black' clay, *rarsaran*, that is dug out of the ground near a garden patch, only about 50 m away (Fig. 4.6). The yellow clay is lighter in colour than the black, but both have similar fine, clayey textures. The clay sources are covered with leaves to keep them from drying out while not in use. These sources have been in use for at least three generations as the modern potters say that their grandmothers were using the same clays. Both sources are considered equally good and are used to make the complete suite of vessel forms. Both clays can sometimes even be combined to make a single paste.

During collection, the clay is dug out of the ground by hand and rolled into small balls, before being carried back to Bilbil in a *bilum*. There it is compacted into larger balls

2 The boys extracting the clay were probably for demonstration only. In the 1970s the women exclusively dug for the clay in large groups (Mennis 2006a: 79-80), but Mager (1952: 341) does mention that men would also gather clay and help with clay preparation. The men certainly accompanied women to the mainland in pre-colonial times; however, it is not known how much involvement they had with procurement. In other areas of New Guinea the production process of paddle and anvil wares is dominated by women, but in inland areas of Madang labour is sometimes shared (May & Tuckson 2000: 18).

3 String bag



Figure 4.3. Extracting the 'Red' clay near Yabob-up-top (2014).



Figure 4.4. Yeyeg (left) selects appropriate clay from the 'Red' source near Yabob-up-top (photo: M. Mennis, 2014).



Figure 4.5. Dorcas rolls the 'Yellow' clay into a portable ball, near Bilbil village (photo: J. Field 2014).



Figure 4.6. The 'Black' clay source near Bilbil village (2014).

and stored in a cool area under a house (Fig. 4.7). These clay balls then facilitate the production of pots for several weeks or months.

During my study, clay samples were collected from the six sources near Yabob-up-top and the two clay sources near Bilbil village (Table 4.1). According to the potters, these represent all of the clay types in current use. I visited *Bilbil 1–2* and *Yabob 1*, but at the request of the Yabob people, *Yabob 2–6* were not visited and samples were collected on my behalf.

At Yabob and Bilbil the emic classifiers of clay type by colour correlate to etic classifications derived from chemical characterisation. An energy dispersive x-ray fluorescence analysis at the XRF laboratory, Department of Anthropology and Archaeology, University of Otago, successfully delineated separate chemical signatures for the modern clay sources.

Clay from each source was separately pulverised in a mortar and wet with distilled water. Each clay type was then moulded into three approximately 1 cm^3 briquettes and left to dry at 30°C for two days. For each clay type, one briquette was fired in a muffle furnace for one hour at 700°C, one at 1000°C, and one was left unfired (Table 4.2). Ethnographic observations in the Massim suggest open firing,



Figure 4.7. Balls of clay stored after collection, Bilbil village (2014)

Table 4.1. *Clay sources in use by Bilbil and Yabob potters, Madang.*

Clay code	Bel name	English name*	Munsell code**	Source location
Bilbil 1	rarmand	Yellow	10YR 5/6 yellowish brown	E362533, N9415371
Bilbil 2	rarsaran	Black	2.5Y 4/2 dark grayish brown	E362483, N9415368
Yabob 1	Unknown	Red	10YR 4/6 dark yellowish brown	E364915, N9419816
Yabob 2	Unknown	–	2.5Y 4/3 olive brown	Unknown
Yabob 3	Unknown	–	2.5Y 3/1 very dark gray	Unknown
Yabob 4	Unknown	–	2.5YR 4/8 red	Unknown
Yabob 5	Unknown	–	2.5Y 4/2 olive brown	Unknown
Yabob 6	Unknown	–	5Y 6/2 light olive gray	Unknown

* used by the potters to describe clay colour; ** wet, unfired clay (Munsell Soil Colour Chart, 2009)

Table 4.2. *Colour* of Bilbil and Yabob clays: unfired, 700°C and 1000°C.*

Clay code	Unfired (dried)	700°C	1000°C
Bilbil 1	10YR 6/6 brownish yellow	5YR 4/6 yellowish red	2.5YR 5/6 red
Bilbil 2	2.5Y 5/3 light olive brown	5YR 4/6 yellowish red	5YR 5/8 yellowish red
Yabob 1	10YR 4/6 dark yellowish brown	10R 3/1 dark reddish gray	2.5YR 3/1 dark reddish gray
Yabob 2	2.5Y 4/2 dark grayish brown	5YR 4/6 yellowish red	2.5YR 5/6 red
Yabob 3	2.5Y 3/1 very dark gray	5YR 4/4 reddish brown	5YR 5/6 yellowish red
Yabob 4	2.5YR 4/6 red	10R 4/6 red	2.5YR 4/6 red
Yabob 5	2.5Y 4/3 olive brown	2.5YR 4/6 red	2.5YR 5/6 red
Yabob 6	2.5Y 6/4 light yellowish brown	5YR 5/6 yellowish red	5YR 6/8 reddish yellow

*(Munsell Soil Colour Chart, 2009)

similar to that used around Madang, may reach between 700°C to <900°C (Lauer 1972).

Each briquette was then shot for 300 seconds with XRF (Bruker AXS Tracer III–V portable XRF) using a vacuum setting with no filter (15kVper channel, filament ADC = 45μA) to measure isotopes of ten light elements (Na, Mg, Si, Ti, Al, Fe, Mn, Ca, K, P) and again with green filter settings (40kV per channel, filament ADC = 24μA, filter = 12milAl+1milTi+6milCu) for ten heavy elements (Mn, Fe, Zn, Ga, Th, Rb, Sr, Y, Zr, Nb). XRF was considered appropriate to characterise the chemical differences between clays owing to the scarcity of natural mineral inclusions that cause interference in tempered ceramics.

Discriminant function analysis of the calibrated chemical data plotted eight distinct clay groups in line with the eight Yabob and Bilbil clay sources (Fig. 4.8). The effect of the firing process was minimal and the group centroid for each clay type separated clearly from others regardless of whether the sample was fired at 700°C, 1000°C, or left unfired. Importantly, the two Bilbil clays separate from the Yabob clays suggesting that location within the clay alluvium may play a part in the chemical variations observed.

Slip

Madang style ceramics are noted for their bright red appearance, caused by the application of a slip (a suspension of clay particles in water). Although the earliest red-slipped ceramics in New Guinea are Lapita, the Yabob and Bilbil potters are the only modern industries in the region that use the technique. There are two sources of clay used to produce slips: one near Yabob-up-top village, and another closer to Bilbil, at Hudini village. These clays are called *main*. Although the sources of these slips were not visited, samples were collected on my behalf. Experimentation with each slip showed that they were hard and not ideal for pot production, but when mixed with water could be applied and manipulated easily. Upon firing, the slip would transform from a dull orange-red paste to a bright red coating.

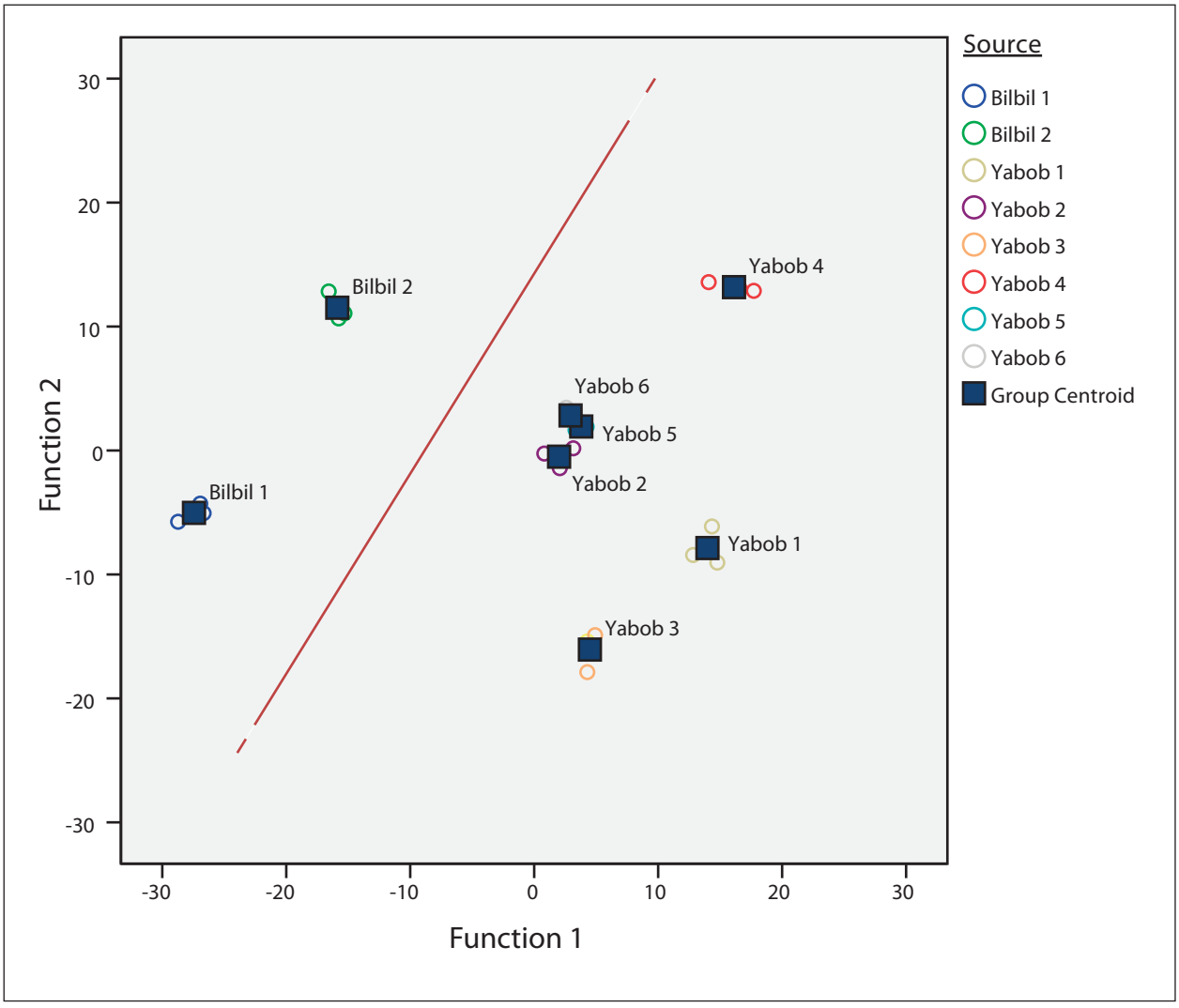


Figure 4.8. Canonical discriminant functions (1 and 2) of clay samples from Bilbil and Yabob. Circles indicate each sample (unfired, 700°C, 1000°C) and squares indicate the group centroid of those three samples.

Temper

Both the Yabob and Bilbil potters manually temper their clays with mineral inclusions before vessel forming. Potters currently select black beach sand for temper because it is available immediately adjacent to their villages on the mainland (see Chapter 2). At Yabob-up-top, potters must descend down a steep track from the cliff to reach the beach and collect temper. At Bilbil village, sand is collected from the shoreline, only 10–20 m from many potters' houses. Before, when people lived offshore, the potters say white beach sand was used from the islands, as it was more accessible. The Bilbil potters consider both white and black sand to be of 'one kind' as they are equally good for production. This is in contrast to observations in other areas of New Guinea where potters preferentially select black sand (May and Tuckson 2000). In order to produce a fine and malleable paste, the sand must be dried before mixing with the clay. Crushed coral, shell, or ceramic are not recognised as temper by the modern potters.

Temper samples were collected from the two beaches/river mouths used by the Bilbil and Yabob potters (Table 4.3). This included black beach sand from Bilbil and Yabob villages. Petrographic analysis for each sand grain assemblage was completed by James Scott at the Department of Geology, University of Otago, and revealed a relatively homogenous range of minerals. Each temper is primarily comprised of clinopyroxene and lithic fragments, and the Bilbil sand also contains rare calcareous grains.

Table 4.3. *Ethnographic sand tempers collected from Bilbil and Yabob areas, Madang.*

Location	Colour	Inclusions
Bilbil village	Black	Lithic fragments, clinopyroxene, calcareous (rare)
Yabob-up-top	Black	Lithic fragments, clinopyroxene

Modern potters at Bilbil and Yabob preferentially select production resources that are immediately available. This minimises labour requirements and reduces risk. Importantly, although the clays separate out chemically, they are not very far apart geographically. This is illustrated most clearly by the close proximity of the Bilbil yellow clay to the chemically distinct Bilbil black (Fig. 4.9). The Bilbil clays are within about 300 m of the village and the slip is only about 1 km away. Although the exact locations of the Yabob clays and slip are unknown, the one known source of red clay falls in the same pattern as the Bilbil raw materials, being very close to the village (Fig. 4.10). For the purposes of describing the Bel clays, the term 'source' will refer to an individual pit dug for the extraction of raw materials, which generally seem to be chemically distinct. When viewed in the geological context (see Chapter 2), the Bel



Figure 4.9. Local ceramic resources used by modern Bilbil potters.

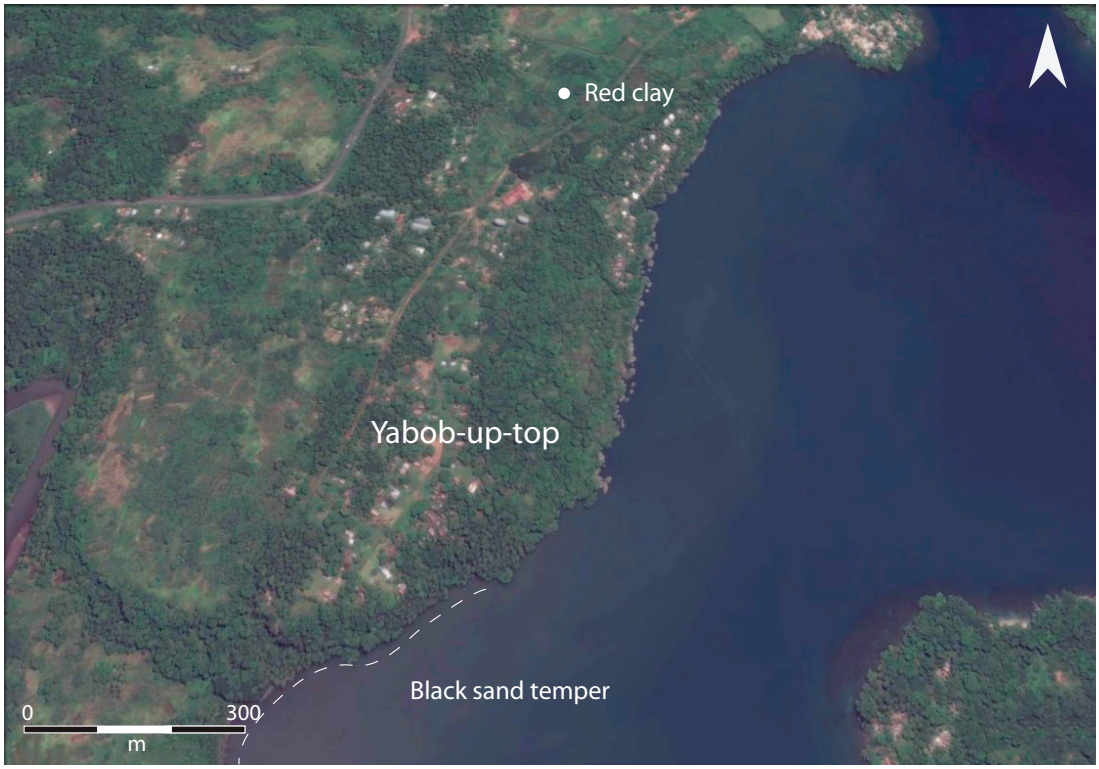


Figure 4.10. Local ceramic resources used by modern Yabob potters. Note that the source of Yabob clays 2–6 and the source of Yabob slip could not be recorded.

clay sources seem to be restricted to the alluvial deposit bordering the coastline, south of Schering Peninsula and modern Madang town (Fig. 4.11). Importantly, the resource spaces of the Yabob and Bilbil do not seem to overlap as they are restricted to about 1 km.

Production

Emic typologies

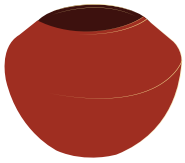
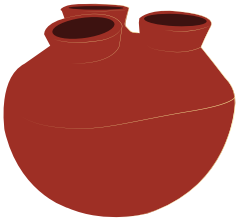
The Madang potters classify their ceramics based on a few significant attributes, such as size and rim form (Table 4.4). The Bilbil potters differentiate four different vessel types. The *bodi* is the most common cooking pot, with a globular body, everted rim and shoulder carination. Variant, and less common cooking pots include the *magob*, which is similar to the *bodi* but lacking an everted rim, and the *tangeng*, identical to *bodi* except much larger in size. The *you-bodi* (pronounced yo-body) is very rarely produced. It is a large, globular water pot consisting of one to three small orifices with everted rims (spouts) at the top of the vessel. At Yabob-up-top in 1994, Mennis (2014: 141) observed only two pot types still in production: the *bodi* and the *nombu* (an equivalent to the Bilbil *you-bodi*). Twenty years later, in 2014, only the *bodi* was still in production, albeit extremely rarely. Although there is variation between individual potter's techniques, the potters all work within the recognised technological framework for producing one of these distinct forms.



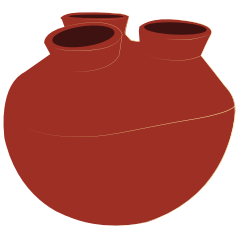
Figure 4.11. Range to ceramic resources used by modern Bel potters near Madang. Note that the source of Yabob clays 2–6 and the source of Yabob slip could not be recorded.

Table 4.4. *Emic pottery classification at Bilbil and Yabob.*

Bilbil village

Bel name	Emic classifier	Example	Primary function
bodi	Everted rim		Cooking
magob	Direct rim		Cooking
tangeng	Large		Cooking
you-bodi	Small orifice(s)		Water storage

Yabob-up-top

Bel name	Emic classifier	Example	Primary function
bodi	Everted rim		Cooking
nombu	Small orifice(s)		Water storage

Within each pot type, potters can distinguish technical variations and even identify individual potters. For instance, some potters make slightly longer everted rims, others, short everted rims. However, only women who pot can tell these differences, along with differences in quality; non-potters usually just recognise the object as a Madang pot. Similarly, Yabob and Mindiri pots are slightly different from Bilbil pots. The Yabob/Mindiri pots are often not as smooth and polished between the carination and the rim as the Bilbil pots.

Cognitively, the Bel potters divide the vessel into several structural units. This includes the *bodi*, referring to the body and the pot as a whole, the *bodi aen*, which equates to the rim, running around the opening, and the *bodi avan*, which refers to the orifice itself, especially used to discriminate the size. The Mindiri pots are said to have much smaller *bodi avan* than Bilbil vessels, for instance.

The change of vessel morphology is entangled with the desires and expectations of the market along with recent historical endeavours to monopolise on production. In the 1960s a Danish potter set up a pottery workshop at Yabob-up-top and encouraged the women to use a potter's wheel and kiln firing. When this potter left, the Yabob reverted to traditional pot making (Mennis 2006a: 277). However, this disruption seems to have resulted in changes to vessel form, especially the accentuation of the shoulder carination. Precise differences between modern and pre-colonial production processes are, as yet, unclear.

Further, over the past few decades, the Bilbil pots are being made smaller and smaller to cater to tourists who do not want to travel encumbered with large *bodi*, while larger forms are still sold for cooking on the Rai Coast and around Madang. The tourists also more often buy pots that have a decorative flair such as with additional spouts, geometric perforations, and inscriptions noting the place of manufacture. The way the potters produce pots has altered, and a wider range of experimentation within the general 'Madang style' is encouraged. That is, so long as someone can tell from the bright red slip or the general shape that the pot is 'Madang,' the potters feel free to experiment with decoration and form where possible. We might assume that similar consumer selection would have affected the morphology of vessels produced in the pre-colonial period. However, the significant difference is that nowadays people visit Bilbil and select what to purchase or exchange for, while in the past the Bilbil would select what to take to others as they loaded their canoes for trading voyages.

Clay preparation

When production is to take place, clay is broken off the larger nodules and prepared for use. Large rock inclusions and roots are extracted by hand but smaller inclusions with the teeth. Clay is mixed with sand temper and pounded with an anvil on a bark mat until a few centimetres thick (Fig. 4.12). This mixture is called *isol,* where the correct mix is established not by set ratios but by feel and experience: the mix that does not stick to the hand



Figure 4.12. Yeyeg mixes clay and temper at Yabob-up-top (2014).

and can be rolled easily is preferred. It is then soaked in a trough or old canoe hull until saturated. The aqueous clay is then removed from the water, kneaded, and placed under a house in thick rolls to drain for about a week, after which it is ready for forming.

Roughing out and forming

Vessel forming of a *bodi* pot was observed at Bilbil village (with Dorcas Kana) and at Yabob-up-top (with Yeyeg Kola). Although there is variation between each potter's techniques, the overall method was observed to be consistent. The rim is moulded first. The clay body, *isol,* is compacted into a sphere about the size of a coconut, and rotated, using the thumb to create the orifice, in a process called *bodi badi* (Fig. 4.13). This rotation is rapid and gives the impression of a wheel-throwing technique. Fresh water is used sparingly to moisten the clay when required; saltwater is never used. Once the rim preform is roughly moulded it can be left for a day or two to harden slightly.

Secondary working forms the vessel body. *Pati*, or anvils are used to pound a concavity through the rim preform, shaping out the body. These anvils are ellipsoid river pebbles from the Rai Coast which are valued objects passed down from mother to daughter in law, teacher to apprentice. They are said to contain ancestral spirits, which drive the *tibud* (spirits) out of the clay. Fingers are used to smooth the interior of the rim, holding the pot from the inside, whilst simultaneously using a paddle, known as a *hunuah* (~30 cm long, rectangular piece of wood) to form the outer neck and lip. Then, placing an anvil inside the vessel, the outside is beaten into shape with a longer paddle (~40 cm half-cylinder). The next step uses a shorter, flatter paddle (~20 cm long, thick rectangle) to flatten and smooth the outside of the pot. At the end of this stage the shoulder carination begins to form about one third of the way down the vessel (Fig. 4.14). In all three stages, potters frequently touch the paddles with fresh water to moisten the clay.

Decoration

After the final forming stages, the pot is further smoothed with a paddle to produce a good working surface between the neck and carination. The potter decorates this surface using a bamboo tool (~15 cm long, pointed at each end) to create impressions and incisions. First, to decorate the circumference of the neck, the bamboo is held about 5 cm from the point, between the thumb and forefinger, as the potter presses the tool into the clay at a steep angle (Fig. 4.15; Method 1 in Fig. 4.16). This decoration is described as *bodi duam* because the technique leaves balls of raised clay under the rim, just like the fruit of the *duam* tree.



Figure 4.13. Yeyeg moulds rim preform at Yabob-up-top (2014).



Figure 4.14. Yeyeg using a short, thick paddle to form shoulder carination, Yabob-up-top (2014).



Figure 4.15. Yeyeg demonstrates decorating the neck with impressions, Yabob-up-top (2014). Note the potter is exhibiting the technique on an already slipped and fired pot.

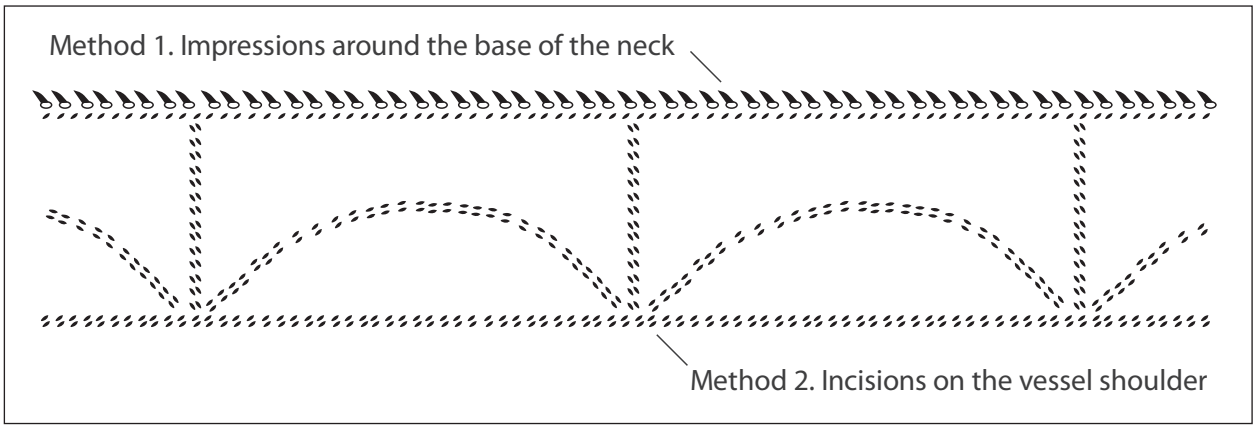


Figure 4.16. A common decoration applied by modern Bilbil and Yabob potters involving incision and impressions.

Next, the potter holds the bamboo with a pinching grip about 1 cm above the point, making gash incisions in linear and semi-circular arrangements around the pot, just above the carinated shoulder (Method 2 in Fig. 4.16). The pot, having taken form and now decorated, is then left for two days to a week, until leather hard (Fig. 4.17). Once a pot has received its decorative additions it is considered *bodi jumusek*.

Decorations on recent Bilbil pots are visibly different from archaeological examples that people find on the ground, and the potters are aware of these differences. The stories regarding pre-colonial decorations have not been passed down. The modern decorations of double incised semi circles placed just above the shoulder carination seem to be arbitrary and do not have any particular significance to the potters. The potters cannot remember when this modern design originated, but it has been in use for at least a few generations. In recent years tourist decorations have also come into fashion. Certain designs that seemed to please tourists, or in some instances were even requested by tourists, have now been added to the design system.

Slipping

After the decorating stage is complete, the slip, *main*, is applied. The *main* is mixed with fresh water and applied by hand across the whole vessel and inside a small portion of the rim and neck (Fig. 4.18). Beginning as an orange-red colour, it is left to dry, and only upon firing does the slip take on its brilliant red characteristics.

Firing

The firing process is two-stage. First, a group of pots are placed amidst a small, low temperature fire, made from a few sticks of soft wood or *pitpit*.[4] This small firing hardens the slip and tests the pot to see if it will crack when exposed to higher temperatures. Those pots with cracks at the end of the first firing are removed and put in fresh water to remodel, and smooth out any apparent weaknesses. Once all the cracks have been repaired, the pot is transferred to the large fire. The size of this large fire is dependent on the number of pots in the batch. An enclosure of dry palm wood is built up, one on top of another, with pots being placed in the centre. When the fire is hot, *Kunai* grass is placed on top of the pots until they turn red with the heat, after which, the fire is allowed to cool. Once fired, the vessel is considered *bodi ibul damanginau* and has become as a young man, just like the young men who emerge from the fires of initiation decorated with red paint.



Figure 4.17. Kasare Dadau of Murpat Clan holds a decorated *magob* pot awaiting slipping and firing, Bilbil village (2015).

4 A type of wild sugarcane/cane grass.



Figure 4.18. Dorkas Kana applying slip to unfired vessels (photo: M. Mennis 2014).

Finishing techniques

To complete the production sequence, the pots are later polished. Sago paste is mixed with water over a fire to produce a semi-transparent, glue-like substance (Fig. 4.19). This is then applied to the fired pot using a banana leaf or cloth (Fig. 4.20). The paste acts as a varnish and gives the red pots a lustrous shine. The paste dries on the pot within a few minutes, which is then ready for distribution or use.

Distribution

Although the Yabob no longer distribute pottery, finished pots are sold or exchanged at Bilbil village. The pre-colonial arrangement saw the Yabob and Bilbil people sail to other groups along the coast to distribute pottery (see Chapter 3). According to some potters interviewed, prior to European contact the Bilbil people traded mostly south to the Rai Coast and Astrolabe Bay, not north towards Yabob. In pre-colonial times, two or three pots could be traded with certain trade-friends for a lot of food or even pigs. Pots could also be used to pay bride prices with non-potting groups.

Distribution of pottery has changed significantly over the past century. Now that motorboats are common, people come from various places, especially the Rai Coast, to acquire the pots at Bilbil Village. Pots can be bought or exchanged for other items or food. They can also feature in brideprices to other villages. Tourists visiting Madang or on cruise ships also come to Bilbil to buy pots for good prices: a *bodi* or tourist pot would cost approximately 15–30 PNG kina. Bilbil has styled itself as a tourist village and



Figure 4.19. The sago paste ready to be applied to the unpolished vessel, Bilbil village (2015).



Figure 4.20. Sentie Noah of Murpat Clan polishes a fired *bodi* using sago paste (2015).

as tour buses park outside the village, potters lay out their wares in front of them for purchase (Fig. 4.21).

In recent years, Bilbil potters would sometimes take their wares into Madang town centre, or even to Lae or Port Moresby for sale (Fig. 4.22). Within the last decade, the geographic mobility of Bilbil pots has extended even further, as the pots collected by tourists are sold online for inflated profits with foreigners acting as middlemen (Fig. 4.23).

Consumption

At Bilbil, despite metal vessels becoming more popular, a lot of women still cook with clay pots, which are said to infuse the food with a better flavour than metal. Other nearby villages also cook with pottery but less frequently. The *bodi* is the most common cooking pot used for boiling rice, taro, banana, yam, sweet potato, and other vegetables, along with pig and chicken. This is used for everyday home cooking. The *magob,* a less common cooking pot, is used for the same function as the *bodi*. *Tangeng* are used for boiling the same foods as *bodi* and *magob*, but typically at larger gatherings owing to their increased size. Pig, in particular, is cooked for feasts in *tangeng*. In the event of such feasts, supports in the form of two split logs called *langalang* are placed parallel and slightly apart on the ground, along which multiple pots can be placed for cooking. The *you-bodi* is used specifically for water collection and storage. The role of this vessel type seems to have diminished more than cooking vessels, perhaps owing to the introduction of more durable containers. Prior to the colonial period, the potters say that these pots had exactly



Figure 4.21. An assortment of standard *bodi* and *tangeng,* alongside tourist pots, laid out for sale at Bilbil village. Some have small pricetags attached (photo: M. Mennis, 2014).



Figure 4.22. Dorkas Kana sells her pots in Port Moresby (Source: emtv.co.pg).



Figure 4.23. Tourist pots for sale online (Ebay.com: search "bilbil pot" 2015).

the same uses, excepting the introduction of rice and other overseas imports. Leaves, known as *uzak*, can be used to line the insides of pots to stop the food burning. A herb called *bilikuk* can be used for the same function but also adds spice to the food. Other leaves such as *bidifun* would cover the mouths of pots, which would then be covered with a coconut shell, called a *bekuten,* to boil.

Reuse and discard

Madang pots are reasonably durable and can last several years while in use, but they are still prone to breakage from heat fracture during cooking or impacts. When a pot is damaged it becomes a *su*. This is turned upside down and arranged in groups of three to form a tripod stand, supporting in-use *bodi, magob,* or *tangeng* whilst cooking (Fig. 4.24). The fire is placed in between the three *su,* which heats the cooking pots from below. When the *su* is further broken to the point that it can no longer support in-use pots it is considered fully broken and it is replaced for a less damaged *su*. Sometimes these broken vessels will be filled with soil and planted around the village as flowerpots (Fig. 4.25), but it is not clear when this tradition started. If either an in-use pot or a *su* is dropped on the ground and breaks into pieces, it is left as is, or is swept onto the rubbish pile (depending on where the pot has been dropped).

Summary

Vai: a Madang style *chaîne opératoire*

The *vai* represents the unique Bel production process from procurement to vessel forming and finishing. Conventionally, men would accompany women to collect the clays while women would prepare the raw materials, form the pots, and finish the vessels. In the past, men would then have the primary role in the distribution of pots (see Chapter 3), but recently this role has shifted to both men



Figure 4.24. Three *su* (broken pots) are arranged to support an in use *tangeng* cooking vessel. The fire is placed in between the *su*, below the cooking vessel. Bilbil village (2015).



Figure 4.25. Several *bodi* being reused as flower pots, Bilbil village (2014).

and women or solely women. During the forming process women use specific techniques and specialised tools at different stages to consciously produce different attributes of the finished pot. Figure 4.26 depicts Yeyeg with examples of each stage in the forming sequence: from the rim preform (left) to the finished pot (right). These represent the emic links in the production sequence, identified as necessary to produce a finished *bodi* pot (see also Fig. 4.27). The *chaîne opératoire* for the *taneng, magob*, and *you-bodi* were not observed; however, we could expect that the *tangeng* sequence would be identical to the *bodi*, except much larger in scale, while the *magob* and *you-bodi* sequences would require a different rim forming technique. These embodying technological processes both reproduce and maintain the practice of pottery production, as well as illuminate the patterns of exchange and discard which are observable in the archaeological record through the study of potsherds.

Although production and distribution is no longer the economic necessity as it was in the past (Mennis 2014), and consumption is ever diminishing owing to the wide availability of metal cooking vessels, pot-making persists as a significant factor in community strategies of re-presenting their past to others and re-affirming their own identities as skilful pot-makers. It is not the finished pots but rather the technological processes which carry meaning, reframing the 'traditional' in order to negotiate the fluid nature of the modern pottery market (cf. Colombo Dougoud 2005; Graburn 1976, 1979). In recent years, production has diversified as a result of the tourist-driven market economy, but 'traditional' pots, of a style said to derive from the pre-colonial period, are still manufactured and exchanged regionally and locally (Gaffney 2018). This chapter has recorded the *chaînes opératoires* of these 'traditional' pots, providing the necessary analogue to trace these lines back in time. The remainder of this volume focuses on changes to the *vai* through time by investigating pre-colonial ceramic *chaînes opératoires*, including their archaeological context, forming and decorating techniques, raw material constituents, and distribution. This begins in the next chapter, which surveys existing archaeological evidence for Madang ceramic production and exchange and identifies important differences between the modern and pre-colonial times.



Figure 4.26. A display of the vessel forming sequence, Yabob-up-top (2014).

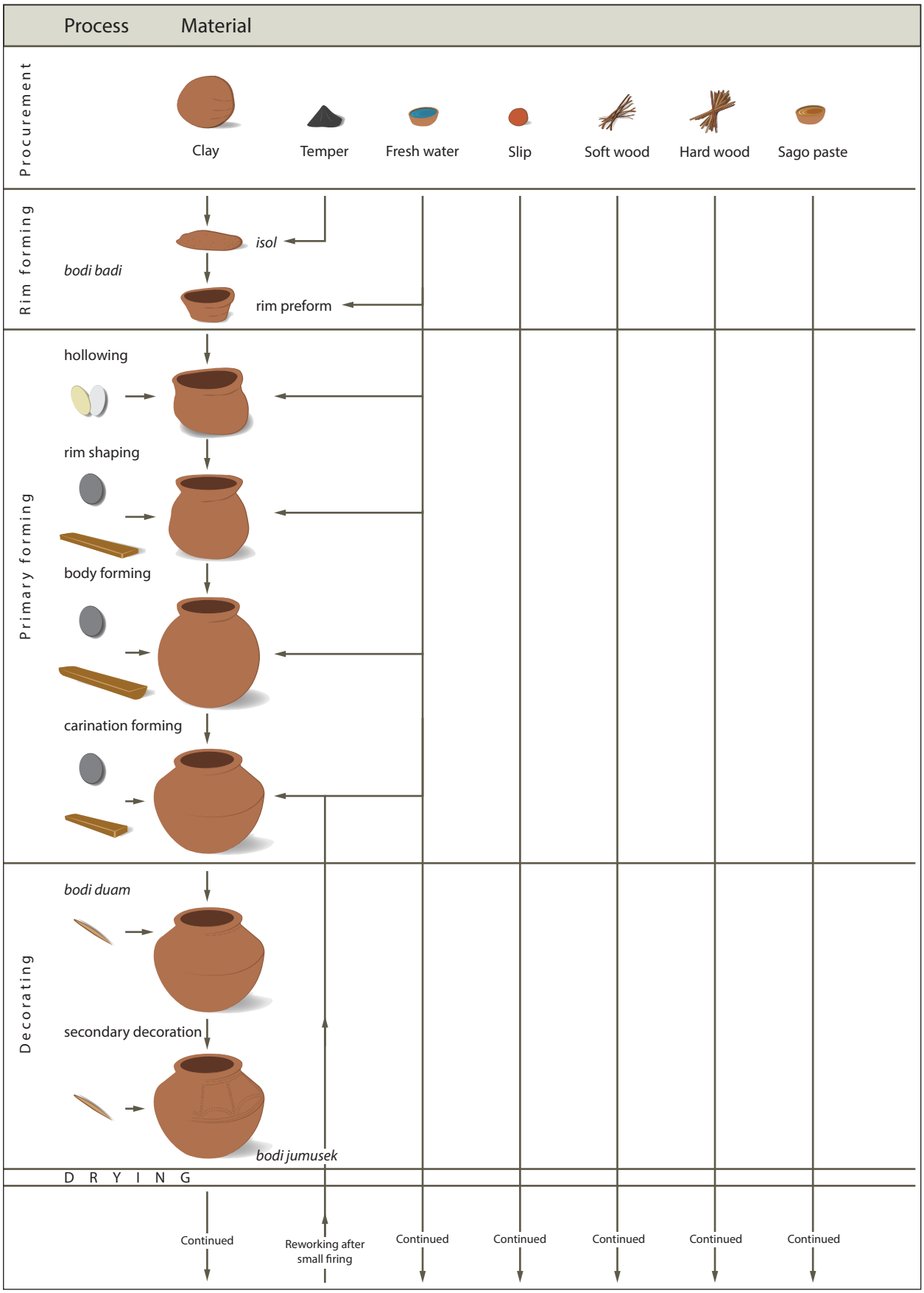


Figure 4.27. A *chaîne opératoire* of a modern Madang style *bodi* pot (*continued over*).

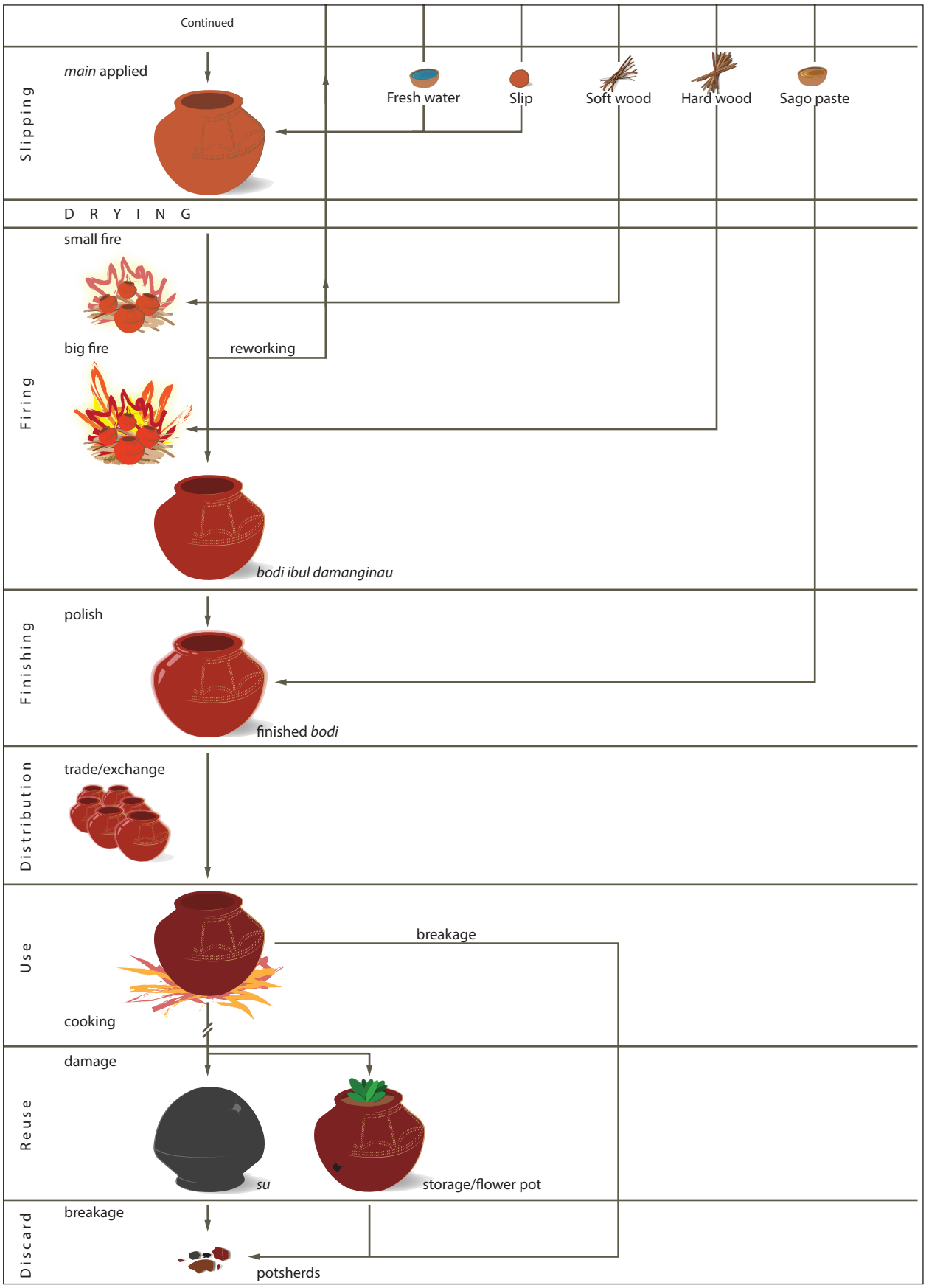


Figure 4.27 (*continued*). A *chaîne opératoire* of a modern Madang style *bodi* pot.

Chapter 5. Traces of the Past

> *The sequence of site occupation in the coastal Madang area remains to be determined.*
> — Brian Egloff (1975)

Little has changed since Egloff's statement over 40 years ago – anthropologists still know little about the pre-colonial occupation, production and exchange along the Madang coast. Our knowledge of Madang culture history and archaeology stems from a handful of provisional investigations along with larger scale operations outside of the area. However, all of these studies have drawn attention to the striking consistencies, but also subtle differences, between the archaeological and the ethnographic pictures. On that basis, this chapter surveys the current state of knowledge regarding pre-colonial production and exchange around Madang, with a particular focus on previously excavated ceramic assemblages. This follows on from the discussion of recent production and exchange presented in chapters 3 and 4 by extending the scope deeper in time. First, the chapter examines archaeological investigations near Madang itself in order to assess the nature of pre-colonial ceramic production. Secondly, it looks at the wider New Guinea area where Madang style pottery has been identified, in order to demonstrate the extent and influence that Madang's material culture had in exchange at a regional level as these ceramics passed through different social networks. Lastly, it draws together chronological evidence for Madang ceramic manufacture to establish a tentative time depth for the style and the origins of Bel potting around the northeast coast.

Archaeological anthropology around Madang

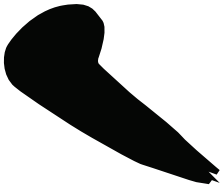
Published archaeological investigations into pre-European social life around Madang itself are limited. In 1969 Jim Allen, then at the Department of Anthropology and Sociology, University of Papua New Guinea, collected artefacts near Bilbil village (Allen 1971), and in 1973 and 1974 Brian Egloff, then at the Papua New Guinea National Museum and Art Gallery, conducted non-intensive survey and excavation at various locations from Karkar Island in the north to Bilbil Island in the south (Egloff 1975). These studies led to tentative attempts at artefact typology with the conclusion that further work was required to refine the ceramic sequence and settlement patterns in the area.

Allen collected 120 rims and decorated sherds from the disturbed deposit of a road cutting near Bilbil (PNG site code: JAE). Stratified pottery was noted to 40 cm deep in the cut face of what would have been an old village mound. The site was assumed to have 'no great antiquity' but probably predated European occupation. The pottery examined was all red slipped or blackened from the firing process and related in fabric to the modern Madang industries. Excluding ornamental pots designed for tourism, Allen observed only one form of vessel being produced at Bilbil: the *bodi,* a globular cooking pot with everted rim and carinated shoulder, decorated with geometric incision before slipping (see Chapter 4). However, from the collected sherds, he established four types (A–D) based on rim form (Table 5.1), decorated not just with incision but also applique, suggesting much greater variation in pottery design features in the past. Allen's Type A and B are similar to the modern *bodi* and *tangeneg*, while Type C is related to the *magob* in rim form. Type D is unlike those pots produced ethnographically (see Chapter 4).

Just a few years later, Egloff attempted to construct a rudimentary culture history for the area as part of a broader ethnographic study (Egloff 1973). He recorded 17 sites along the coast and on islands near Madang, six on Karkar Island, and one at Sarong village (Table 5.2; Fig. 5.1). Pottery directly ancestral to modern Madang pottery was found at 19 of these sites. A single piece of obsidian collected from Yabob was sourced to Talasea, West New Britain (Bird *et al.* 1981) demonstrating interaction with trade links in the Vitiaz Strait. Surface collections or small test pits were implemented at most sites, but at Tilu (JCA), a clan area of Malmal village, excavation of two large anthropogenic mounds was undertaken.

In 1973, Egloff dug a 1 × 1 m test pit into Tilu, Mound A, to 120 cm deep, and in 1974 he returned to dig a 1 × 2 m unit into Mound A to 75 cm deep, and Mound B to 110 cm deep (Fig. 5.2). The deposits lacked defined stratigraphy, apart from occasional yellow and grey ash lenses, so arbitrary 20 cm spits were excavated until dense coral gravel

Table 5.1. *Allen's (1971) ceramic types based on a surface collection near Bilbil village.*

Type	Classifier	Description	Example	No. of sherds	% of collected
A	Everted rim	Variation in angle of eversion and rim cross-section. Most rims straight, but some curve upward and others have grooves on the interior surface of the upper rim.		44	52%
B	Everted rim with squared lip	Variation in angle of eversion. External face of the rim bevelled to produce a square section.		6	7%
C	Collared	Most commonly small and rounded collar. Collar attached separately after completion of body.		33	39%
D	Other	Wide rims above a groove on the external face where the body joins the rim.		2	2%

was reached at the base of each pit. These ash lenses may relate to repeated eruptions of nearby Karkar, Arop/Long, or possibly the Yomba Island referred to in Bel oral history (cf. Chapter 2). Radiocarbon determinations indicate Tilu was occupied sometime between ~300 and 700 years ago (Table 5.3), and pottery present from the basal layers would suggest that the Madang style ceramics were already well established by this time. The conventional age of 550 BP at Tilu has been said to conflict with oral traditions regarding Yomba's disappearance (e.g. Mennis 2006a:78); however, it should be noted that the 2σ range for each of Egloff's dates do not specifically contradict the genealogical chronologies, and the lines of evidence overlap at ~300 years ago, assuming no complications in generational length or elision.

The subsequent ceramic analysis of collected material described significant formal variation within, and beyond, the four major classes already established by Allen (1971). In particular, incurving rim forms and complex outcurving-incurving forms were added to the known rim types (Table 5.4). Egloff's description of rim forms highlights the variation present in Madang style ceramics but does not correlate with the emic classification of pots as Allen's typology does, based as the latter was on a few key classifiers. An attribute analysis was used to suggest that formal types were essentially represented by decorative techniques (Table 5.5). Body decoration was associated with a suite of attributes including rim form, lip decoration, interior rim notching, and red slipping. Further, these decorative types were spatially restricted. For instance, punctate sherds

Table 5.2. *Summary of sites recorded near Madang by Egloff (1975).*

Site code*	Local name	Location	Description of site	Work completed	Material culture recorded	Madang sherds
JBA	Tadilon	Bilbil Island (SE coast)	Natural shallow midden	Test pit excavated	Potsherds	Yes
JBB	Luahor	Bilbil Island (E coast)	Number of middens extending to cliff	1×1m test pit excavated to 90 cm.	Potsherds, obsidian, tapa beater, mollusc	Yes
JBC	—	Bilbil Island (N coast)	Large midden being eroded by sea	Collection from eroding face ~2m deep	Potsherds	Yes
JBD	—	Bilbil Island (W coast)	Historic habitation area	Surface collection	Potsherds	Yes
JBE	Idwan	Sek Island (W coast)	Beach	Surface collection	Potsherds	Yes
JBF	—	Migajpanad Island	—	Surface collection	Potsherds	Yes
JBG	Manip	Yabob Island (centre of Is.)	Historic habitation area	0.5×1m test pit excavated to 105 cm	Potsherds, shellfish	Yes
JBK	Sarong	Sarong village	Modern village	Surface collection	Potsherds	No
JBL	Kabai	Karkar Island (hills on SE side of Is.)	Hill-top garden	Surface collection	Potsherds	Yes
JBM	Madip	Karkar Island (hills on SE side of Is.)	Coconut plantation on hill crest	Surface collection	Potsherds	Yes
JBN	Wabef	Karkar Island (S side of Is.)	Pig root, pre-German habitation	Surface collection	Potsherds	Yes
JBO	Babu	Karkar Island (S side of Is.)	Pig root, pre-German habitation area	Surface collection	Potsherds	Yes
JBP	Kamalong	Karkar Island (S side of Is.)	Historic habitation area	Surface collection	Potsherds	Yes
JBQ	Wasmak	Karkar Island (S side of Is.)	Garden, historic habitation area	Surface collection	Potsherds	No
JBR	Vidar	Vidar	Plantation worker's housing	Surface collection	Potsherds	Yes
JBS	—	St. Fidelis Seminary	Seminary	Excavated to 40 cm.	Potsherds, mollusc	Yes
JBT	—	Nagoda Plantation	Coral mine, pre-German habitation	Surface collection	Potsherds	Yes
JBU	—	Tabad Island	Modern house on raised mound	Test pit excavated to 70 cm.	Potsherds	Yes
JBV	—	Riwo Island (NE of Is.)	Modern village	Surface collection	Potsherds	Yes
JBW	Malamal Udou	Island near Malmal village (SW side)	Midden	0.5×0.5m test pit excavated to 65cm	Potsherds	Yes
JBX	—	Malmal Island	Midden (in village pig sty)	Surface collection	Potsherds	Yes
JBY	—	Malmal village	Midden next to copra drying building	Surface collection	Potsherds	Yes
JBZ	—	Yabob Island** (SW coast)	Rise behind the beach	Test pit excavated to 90 cm	Potsherds	Yes
JCA	Tilu	Malmal village	Two large midden mounds	One 1×1m and two 1×2 m test pits excavated to varying depths	Potsherds, obsidian, bone, shell artefacts, shellfish, taro peeler, human remains	Yes

*recorded in the Niugini Archaeological Survey, Papua New Guinea National Museum and Art Gallery.
** Yabob Island (cf. site record form in Papua New Guinea National Museum and Art Gallery), contra. Egloff (1975), which incorrectly states Bilbil Island.

were never found with impressed sherds. These restrictions could relate to selectivity in exchange, activity areas on site, or temporal changes. The material composition of the sherds was not considered by Egloff, but he noted that compositional variation might 'delineate significant cultural features' (Egloff 1975: 17).

The investigations by Allen (1971) and Egloff (1975) were exploratory and coarse grained in nature. Limitations on sample sizes and a lack of direct dating precluded construction of a local cultural sequence. However, the descriptions of pot forms, decorations, and attributes laid the foundations for comparative studies further afield.

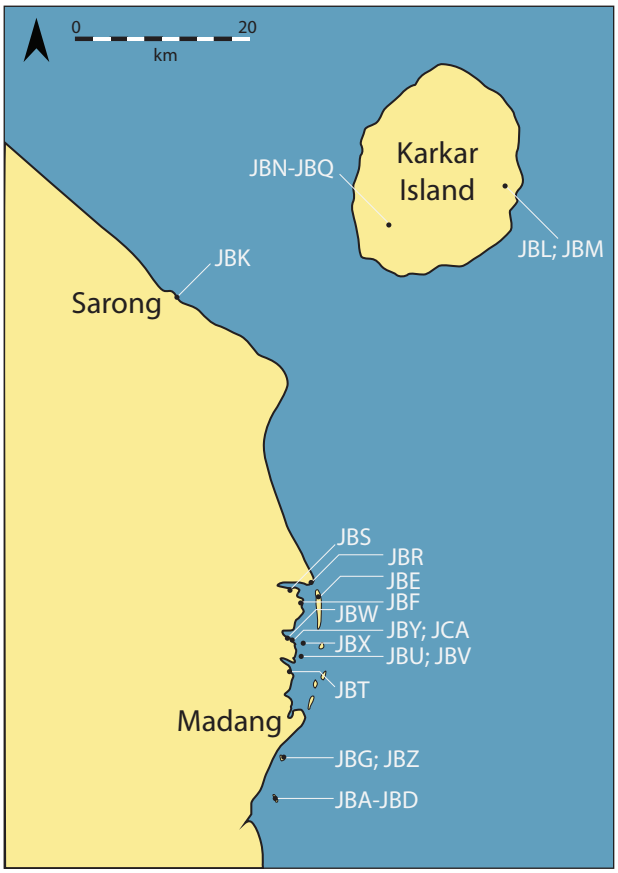


Figure 5.1. Archaeological sites around coastal Madang, examined by Egloff (1975: Map 1).

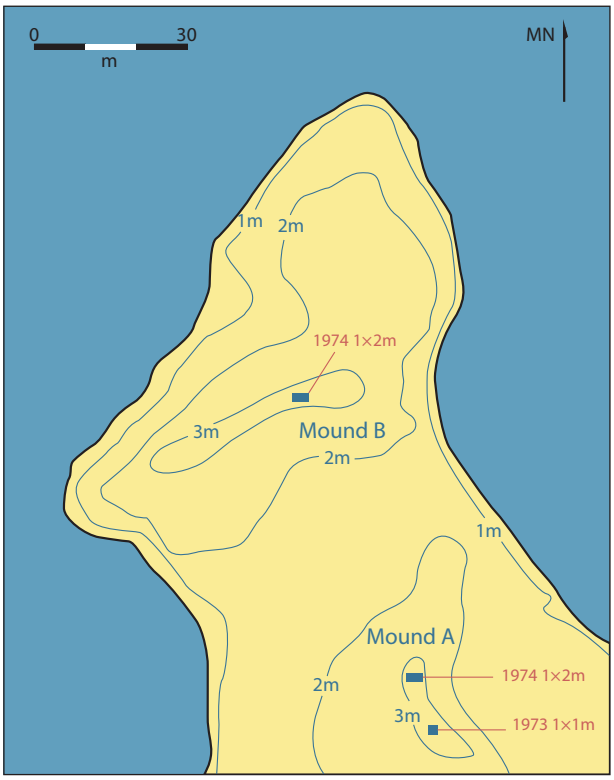


Figure 5.2. Previous excavations at Tilu (JCA) site (Egloff 1975: map 2).

Table 5.3. *Radiocarbon dates for Tilu Mound A and Mound B (Egloff, 1975).*

Laboratory code	Location	Excavation unit	Excavation level*	Depth below surface (cm)	Conventional age BP**	Date range cal. BP (2σ)***
GX3561	Mound A	1×1 (1973)	5 and 6	80 & 100–120	550±115	314–678
GX3633	Mound A	1×2 (1974)	4	75	540±110	315–672
GX3632	Mound B	1×2 (1974)	6	100 & 105	555±125	302–697

* GX3561 and GX3632 are combined charcoal samples from varying levels and depths.
** as reported by Egloff (1975).
*** $\delta^{13}C$ correction not originally made. Here an estimate of -25.0+-2 is applied to Egloff's C14 age for charcoal before calibration (Stuiver *et al.* 2005: Chapter 5, Table 1).

Ancestral Madang exchange networks

At European contact, the Yabob and Bilbil Island potters around Madang were the major pottery providers for the northeast coast and linked with the Vitiaz Strait trade networks. The distribution of archaeological sites containing Madang style potsherds indicates a similar scenario was operational in the past as well. Ancestral Madang pots perforated a number of distinct socio-economic fields: north to Karkar Island (Egloff 1975), south into the Central Highland ranges (Coutts 1967; Hughes 1977; White 1972), and east into Arop/Long Island (Egloff & Specht 1982), the Sio/Gitua area (Lilley 1986), the Siassi Islands (Lilley & Specht 2007), the Tami Islands off the Huon Peninsula (Abramson 1969), and as far as the Arawe and Kove Islands in New Britain (Gosden & Webb 1994; Lilley 1991; Summerhayes 2001a) (Fig. 5.3).

North

As mentioned in Section 5.1, Egloff (1975) recorded Madang style pottery reaching as far north as Karkar Island. Although these finds are undated, some of the Karkar sherds were decorated with linear appliqué indicating they are probably pre-contact in age, given this attribute never occurs on colonial or modern pots (Egloff 1975: Appendix 1). Further Madang style sherds were recovered from 2018 excavations at Kulili on the north side of Karkar, and Krabat and Ngus on the south side of the island (Gaffney *et al.* 2018b). The villages on the southeastern half of Karkar

Table 5.4. *Variation in Madang rim forms identified by Egloff (1975)*

Type	Example	Allen (1971) type	Type	Example	Allen (1971) type
1		A	12		Absent
2		A	13		Absent
3		A	14		Absent
4		A	15		C
5		A	16		Absent
6		B?	17		A/B?
7		A	18		A/C?
8		Absent	19		D
9		A/B?	20		Absent
10		Absent	21		C
11		A/C?	22		Absent

Table 5.5. *Madang ceramic decorative techniques, identified by Egloff (1975).*

Technique	Description
Carved paddle impressed	Slight angular or straight impressions made with a carved paddle.
Nubble applique	Heavy blobs of red slip applied to the pot surface.
Incised	Thin incisions applied after slipping.
Linear applique	Thin lines of red slip applied to the pot surface.
Punctation	Large shallow punctations arranged in broad geometric patterns.
Plain	Not decorated, but red slip may be present.

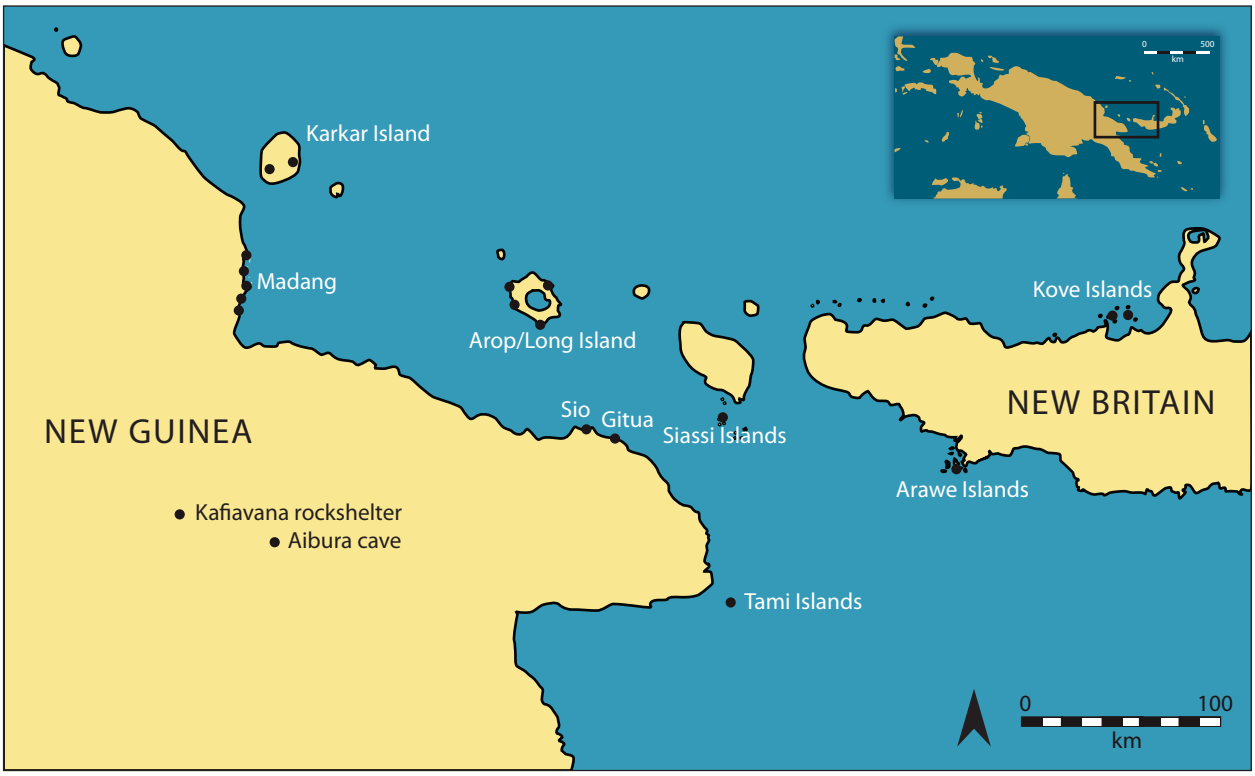


Figure 5.3. Location map showing sites in the northeast New Guinea region where Ancestral Madang sherds have been reported.

Island belong to the Bel language group, speaking Takia, in the Bel sub-family of languages (see Chapter 1). For these Karkar Islanders, the exchange of pots up from coastal Madang would have played an important role in maintaining links with the Bel speakers to the south. It is notable, however, that no Madang sherds were recorded at Sarong village, another Bel group on the mainland adjacent to Karkar, where distinctive, deeply incised Sarong-style potteries instead dominated (Egloff 1975: Fig. 1). This suggests that Sarong and nearby areas along the northeast coast lay outside the interactive network that was clearly operative between Karkar and Madang, which conflicts with oral traditions. No Madang sherds have yet been reported from the Sepik north coast.

South

Madang pottery may have reached the Central Highlands by 800 years ago. A 3.5–5 mm thick hand-made ware excavated from a horizon dated to 770 ± 110 BP (GaK-622)[1] at Aibura cave (NAE) in the Eastern Highlands probably derives from the Madang coast (White 1972: 62). Two sherds, in which beach sand with an Upper Tertiary volcanic base was used for temper, contained well-sorted fresh angular pyroxene, feldspar, and rounded basalt tempers. One sherd also contained marine shell fragments. This was petrographically consistent with a reference sample from Yabob (Key 1973). Similar sherds were also found on the surface at Kafiavana rockshelter (NBZ) further west (White 1972: 95).

By some ethnographic accounts (Coutts 1967; Hughes 1977), Madang pots were traded along the Ramu River, up into the Upper Ramu plains in the Eastern Highlands and then dispersed into Chimbu Province and beyond. The importance of 'hinterland middlemen' in the transfer of ceramics into the Highlands in the pre-colonial past is supported by surface finds of Madang style pottery at three find spots – Muli, Wul, and Wapain – near the Gogol River, about 15 km inland from the Madang coast (Gaffney *et al.* 2018c). In other recordings (Keil 1973), pottery reached the Benabena in the Eastern Highlands through the Rawa, who obtained pots from the northern Finnistere Ranges, where in turn people obtained them from traders on the Rai Coast: a process of down the line trade over several hundred kilometres of rugged country and involving numerous middlemen (Fig. 5.4). Despite pottery being of not much consequence to most areas of the Highlands, where people prefer to use more durable cooking and storage devices (Hughes 1977: 116; May and Tuckson 2000: 154), in areas where pots were manufactured such as the Agarabi in the Eastern Highlands, these Madang trade pots were often prized over others (Coutts 1967: 487).

Bulmer (1977, 1985, 2007) ascribed one sherd at the site of Wañelek (JAO) in the Kaironk Valley to the Madang style owing to external red slipping, evidence of paddle form-

1 A number of determinations generated by the Gakushuin radiocarbon dating laboratory prior to GaK-7000 have been questioned as being too old or too young (see Spriggs 1989). It is not known how this effects the Aibura sequence.



Figure 5.4. Madang pot traded into Megabo, Eastern Highlands, shortly after WWII. Decorated with gash-punctations around the neck (Photo: D. Keil, 1970s).

ing, and incision. Geochemical and petrographic analyses suggest that this sherd was produced at a source somewhere on the northeast coast, but not necessarily with the same manufacturing origin as the modern industries owing to the presence of orthopyroxene, absent in comparative samples from Bilbil and Yabob Islands (Gaffney *et al.* 2015, 2016). Importantly this sherd derives from a secure posthole feature with lower fills dating to 2865 ± 90 BP (I-6859) and overlying deposits dating to 2840 ± 90 BP (I-6861) (Bulmer 1977: Table 8.1). This is inconsistent with established dates from the coast, including within the Madang area itself, suggesting the sherd does not necessarily represent Ancestral Madang. Excavations of other ceramic-bearing sites in the Kaironk and Simbai valleys, led by Glenn Summerhayes and Judith Field, are beginning to clarify this problem

East

A series of investigations in the Vitiaz Strait throughout the 1970s–1980s illuminated much about the extent and age of Madang style potteries east of Madang itself. A multidisciplinary project on Arop/Long Island aimed to describe recolonisation of an island environment following the major seventeenth century eruption attested in oral traditions (Specht *et al.* 1982). The archaeological component, completed in 1973 by Brian Egloff and Jim Specht, investigated material recovered from five archaeological sites on the island: JCB (Biliau), JCC (Bara), JAB (Poin Bare), JCT (Kairu Point), and JCW (Patauru) (Egloff & Specht 1982). The pottery found at these sites was all imported, deriving from five clay types (A–E), and could be divided into four distinct style groups (I–IV). The majority of sherds collected were classified as 'Style Group I' and considered 'Ancestral Madang.' Sherds of this style were found at each of the five sites. This style was formed only from Clays A–B, and consisted of Rim Profiles 1, 3, and 4 (Table 5.6), with thin direct and everted rim courses and interior rim notching. These were decorated with appliqué, incision, and punctuation, and covered by a red slip. Appliqué and incision never occurred on the same sherd, however. Style Group I is associated with a mixed charcoal date of 350 BP (ANU-1307) from JAB/B.

Table 5.6. *Arop/Long Island style groups I & IV rim forms (Egloff & Specht 1982).*

Style group I		
Rim form 1	Rim form 3	Rim form 4
		

Style group IV			
Rim form 7	Rim form 7a	Rim form 8	Rim form 8a
			

Style IV, formed only of Clay B and comprising Rim Forms 7–8 (Table 5.6) is not considered to be of the Madang style by the excavators, but the rim forms certainly fall within Allen's (1971) Type B and C and seem to correlate with many of the forms identified by Egloff (1975; see Table 5.4). There is a date of 1040 BP (ANU-1308) that may be associated with a single Style Group IV sherd from JCB/A. However, the excavators warn that the charcoal date may relate to the soil matrix, not the sherd itself, presumably owing to assumed disturbance (Egloff & Specht 1982: 430). Thermoluminescence dating on the same sherd (Sample 1027) indicated it was at least 360 years old.

The Arop/Long Island material awaits thorough stylistic and compositional analysis; however, from the evidence presented, the majority of sherds do derive from the Madang potting tradition. These pots certainly reached the island's shores by at least 350 years ago, although a re-examination of the local sequence and refined radiocarbon dates would be required to determine just how and when the importance of Madang wares changed on the island over time. Although oral traditions in Madang do not mention Arop/Long being directly part of the Madang trade networks, modern recipients of the pots on Arop/Long state that the objects derive from the Rai Coast, suggesting a down the line exchange (Fig. 5.5). This form of exchange may have operated in the distant past as well. On the other hand, the island also had strong connections to the east and seems to be placed at the crossroads of the Madang and the Vitiaz Strait trade networks. Obsidian sourcing, for instance, showed that all of the Arop/Long specimens derived from Talasea in West New Britain (Egloff & Specht 1982: 432). The Vitiaz Strait presents another possible route of entry for ceramics into Arop/Long Island.

Madang pottery penetrated further east, probably through down the line trade along the Huon Peninsula and into the Siassi Islands. Extensive archaeological investigations in the Vitiaz Strait by Ian Lilley in the 1980s illuminated more about the age and extent of Madang ceramics than any other study to date (Lilley 1986). This work demonstrated that Ancestral Madang pots were moved to Sio (KBP and KBQ) and Gitua (KBZ) on the Huon Peninsula, and later the Siassi Islands (KLJ) sometime after about 1300–1000 years ago (Lilley 2004a, 2017). The earliest dated context for Madang pottery anywhere is at KBQ site around Sio where a shell date (ANU-4607) from 260 cm deep gave a radiocarbon date of about 1500 years old. A charcoal sample (ANU-4337) from the same site also returned a date of 1300 years old. These dates are significantly older than anything recorded in the Madang area, lending weight to the idea that the Madang potters originated somewhere outside of Madang, such as the Yomba Island cited in oral histories (see Chapter 1). Based on a similarity in mineral inclusions between Ancestral Madang sherds and Ancestral Sio sherds, Specht, Lilley, and Dickinson (2006) have also suggested a Huon source for Ancestral Madang pottery.

It was not until later in time that Madang pottery acquired characteristics of high-volume production and exchange, reaching its greatest extent, crossing the Vitiaz Strait and filtering into the Bismarck Archipelago (Lilley 2004a). Madang sherds have been found at two sites (FPD and FPF) on Kalapiai, in the Kove Islands off the north coast of New Britain, dating to almost 800 years old (Lilley 1991). These sherds occur in contexts also containing recent Sio-style sherds. Similarly, in the Arawe Islands off the south coast of New Britain, Madang sherds have been recovered from contexts of about 900 years old (Gosden & Webb 1994).



Figure 5.5. Woman and children on Arop/Long Island with Madang trade pot used for cooking (photo: M. Mennis 2014).

On the four Tami Islands, off the eastern tip of the Huon Peninsula, preliminary research has described various imported potteries collected from the surface, some of which appear to be Madang style (Abramson 1969). Abramson's Types IB and IE with nubble and linear appliqué certainly appear to be Madang, while Type IC with horizontal relief bands may also derive from Madang (Abramson 1969: plate IA, b, c, f, h, i, j, IB, e). This represents the furthest extent southeast that Madang sherds have been recorded; however, the finds are as yet undated.

Lilley (1999) compares the linguistic evidence of east-west population movement from West New Britain to the New Guinea north coast (see Chapter 1) with the archaeological evidence, suggesting that the two modes of evidence align. If he is correct, then the predecessors of the Madang industries have an origin somewhere in the Vitiaz Arc and, ultimately, the Bismarck Archipelago.

Lilley (1988a) argues that the ethnographically observed levels of production and trade intensity originated only in the last few hundred years, when the movement of Madang pots was concurrent with the movement of Sio and Type X ceramics. Type X pottery may have been in production somewhere on the eastern Huon from about 1000 years ago until about 500 years ago (Lilley 1988b; Lilley & Specht 2007). It is hypothesised that Type X and Madang ceramics share a common technological origin, ultimately from Palau, owing to the mutual presence of grog tempering (Specht, *et al.* 2006). This possible Micronesian connection should not be casually dismissed. As Specht, Lilley, and Dickinson (2006) note, kava drinking, which, in north New Guinea, is only practiced in Madang and Manus is thought to have originated in Vanuatu and later spread via West Polynesia into Micronesia, and thence to New Guinea. An interesting further connection between Manus and Madang, is the mutual production and use of multi-spouted water vessels, otherwise unique in New Guinea (see Chapter 4; Egloff 1977: 82-83; May & Tuckson 2000: 11).

In an attempt to delineate significant stylistic indicators on the pots themselves, Lilley (1986) revised the provisional classification systems established by Allen (1971) and Egloff (1975). He avoided an absolutely typological approach and instead focused on designating three analytical classes, based on distinct lip attributes (Table 5.7). Class 1 rims include everted and vertical rims with rounded lips. Class 2 rims have bevelled exterior faces and pointed lips. Class 3 rims have flat lips. Although it is not explicit why lip attributes were chosen to delineate each class, the effect was to streamline the method of analysis – Egloff's 22 types were reduced to three major classes.

Table 5.7. *Lilley's (1986) Madang style rim classes based on sherds excavated from the Vitiaz Strait.*

Class	Classifier	Description	Example	Allen equivalent type	Egloff equivalent type	% of classified
1	Round lip	'…short, thick, vertical to everted forms with round lips.'		A, C, D	1, 2, 3, 7, 8, 10, 12, 13, 15, 16, 17, 19	61%
2	Pointed lip	'similar in most respects to…Class 1 but have a more pointed lip'		B, C	5, 6, 9, 11, 14, 18	31%
3	Flat lip	'…distinctive flat lips…'		C	4, 20, 21, 22	8%

Significant chronological indicators were not identified through Lilley's analysis. Contrary to Egloff (1975), Lilley (1986: 210) states that there is no clear association between rim form and decoration. However, in addition to the decorative types described by Egloff (1975), Lilley also identified 'obliquely-incised appliqué,' although this was only identified on 1% of decorated sherds (Lilley 1986: 206). Attributes delineating time or place within the Madang style ceramics remain to be found.

Chronologies

To summarise the research presented above, Table 5.8 compiles the published radiocarbon dates in contexts associated with Madang style potsherds around New Guinea. Here, terrestrial dates are calibrated using IntCal13 (Reimer *et al.* 2013). A northern hemisphere curve is preferred as each site lies only about 4° to 6° south of the equator. Shell samples are calibrated using the Marine13 curve (Reimer

Table 5.8. *Published radiocarbon dates in association with excavated Madang sherds.*

Site	Unit	Layer	Depth (cm)	Lab #	Material	Conventional age	Calibrated date (2σ)	Reference
Paligmete, Pililo Island, Arawe Islands, West New Britain province								
FNY	2	1 (base)	100	ANU-4982	Charcoal	900 ± 140 BP*	562–1173 cal BP	Gosden and Webb 1994
Kove Islands, West New Britain province								
FPD	1	5	–	Beta-26264	Charcoal	350 ± 60 BP	302–507 cal BP	Summerhayes 2001a
FPF	4	5	–	Beta-26268	Shell	750 ± 50 BP	290–460 cal BP	
Arup/Long Island, Vitiaz Strait, Madang province								
JAB/B	–	–	–	ANU-1307	Charcoal	350 ± 70 BP	286–518 cal BP	Egloff and Specht 1982
JCB	–	Biliau beds	–	ANU-1308	Charcoal	1040 ± 80 BP	787–1174 cal BP	
JCC	–	Mud flow	–	ANU-1309	Charcoal	470 ± 240 BP	0–900 cal BP	
Sigwa Island, Sio, Huon Peninsula, Morobe province								
KBP	I	K	75–80	NSW-86	Charcoal	360 ± 100 BP	0–622 cal BP	Egloff and Specht 1982
Sio, Huon Peninsula, Morobe province								
KBQ	I	2	57	ANU-4970	Shell	940 ± 80 BP	423–665 cal BP	Lilley 1986
			115	ANU-4332	Charcoal	670 ± 60 BP	540–699 cal BP	
		3	152	ANU-4330	Charcoal	340 ± 90 BP	0–537 cal BP	
			175	ANU-4329	Charcoal	300 ± 100 BP	0–525 cal BP	
			232	ANU-4606	Charcoal	510 ± 60 BP	466–654 cal BP	
		4	260	ANU-4607	Shell	1500 ± 70 BP	913–1216 cal BP	
	II	1	20	ANU-4335	Charcoal	Modern	–	
		2	62	ANU-4334	Charcoal	400 ± 90 BP	156–627 cal BP	
		3	99	ANU-4336	Charcoal	950 ± 70 BP	705–980 cal BP	
			109	ANU-4337	Charcoal	1290 ± 100 BP	980–1368 cal BP	
			123	ANU-4338	Charcoal	1160 ± 90 BP	930–1274 cal BP	
Malai Island, Siassi Islands, Vitiaz Strait, Morobe province								
KLJ	TP	–	35	ANU-3821	Shell	680 ± 70 BP	145–471 cal BP	Lilley 1986
		–	64	ANU-3820	Shell	800 ± 70 BP	291–529 cal BP	
		–	75	ANU-3819	Shell	540 ± 70 BP	0–285 cal BP	
		–	127	ANU-3822	Shell	680 ± 70 BP	145–471 cal BP	
		–	155	ANU-3800	Shell	990 ± 70 BP	480–676 cal BP	
		–	191	ANU-3801	Shell	740 ± 70 BP	264–496 cal BP	
	I	2	–	ANU-4344	Charcoal	180 ± 100 BP	0–437 cal BP	
			67	ANU-4341	Charcoal	Modern	–	
			75	ANU-4333	Charcoal	Modern	–	
			83	ANU-4342	Charcoal	Modern	–	
			121	ANU-4343	Charcoal	Modern	–	
			191	ANU-4345	Charcoal	Modern	–	
			232	ANU-4346	Charcoal	270 ± 170 BP	0–540 cal BP	
	II	1	17	ANU-4339	Charcoal	Modern	–	
		5	182	ANU-4340	Charcoal	Modern	–	
Aibura cave, Central Highlands, Eastern Highlands province								
NAE	VII	4	–	GaK-622**	Charcoal	770 ± 110 BP	551–920 cal BP	White 1972

*The association between the basal date and the Madang pottery is not stated in detail.
**Note problems associated with Gakushuin radiocarbon lab results (cf. Spriggs 1989).

et al. 2013) with a ΔR offset of 0.[2] However, as ΔR values for the southwest Pacific are variable (Petchey *et al.* 2004), any irregularities in the marine reservoir between locations may skew interpretations of chronology. It is clear that most dates cluster within the last millennium before present, but several dates may extend the origins of Madang style pottery to about 1300 cal. BP. Figure 5.6 presents radiocarbon distributions based only on charcoal samples from Table 5.8 (to eliminate any concerns of variable and unknown ΔR values). This illustrates that although most dates fall within, or after, the 2σ range of dates from Tilu (GX3561, GX3633, and GX3632) in Madang Lagoon, some contexts pre-date this, namely: JCB on Arop/Long Island, and the lower deposits of KBQ site at Sio.

2 Following Lilley & Specht 2007, in preference to the –400 as suggested for the Huon Peninsula by Chappell & Polach 1991, working before the modeled -400 was built into calibration programs. Other reports on ΔR from modern (post 1950 AD) samples suggest wildly variable values from the Sepik north coast to the Vitiaz Strait (McGregor *et al.* 2008; Petchey & Ulm 2012); however, because the nature of these variations in the pre-colonial past are unknown, a ΔR of 0 is still the most conservative approach.

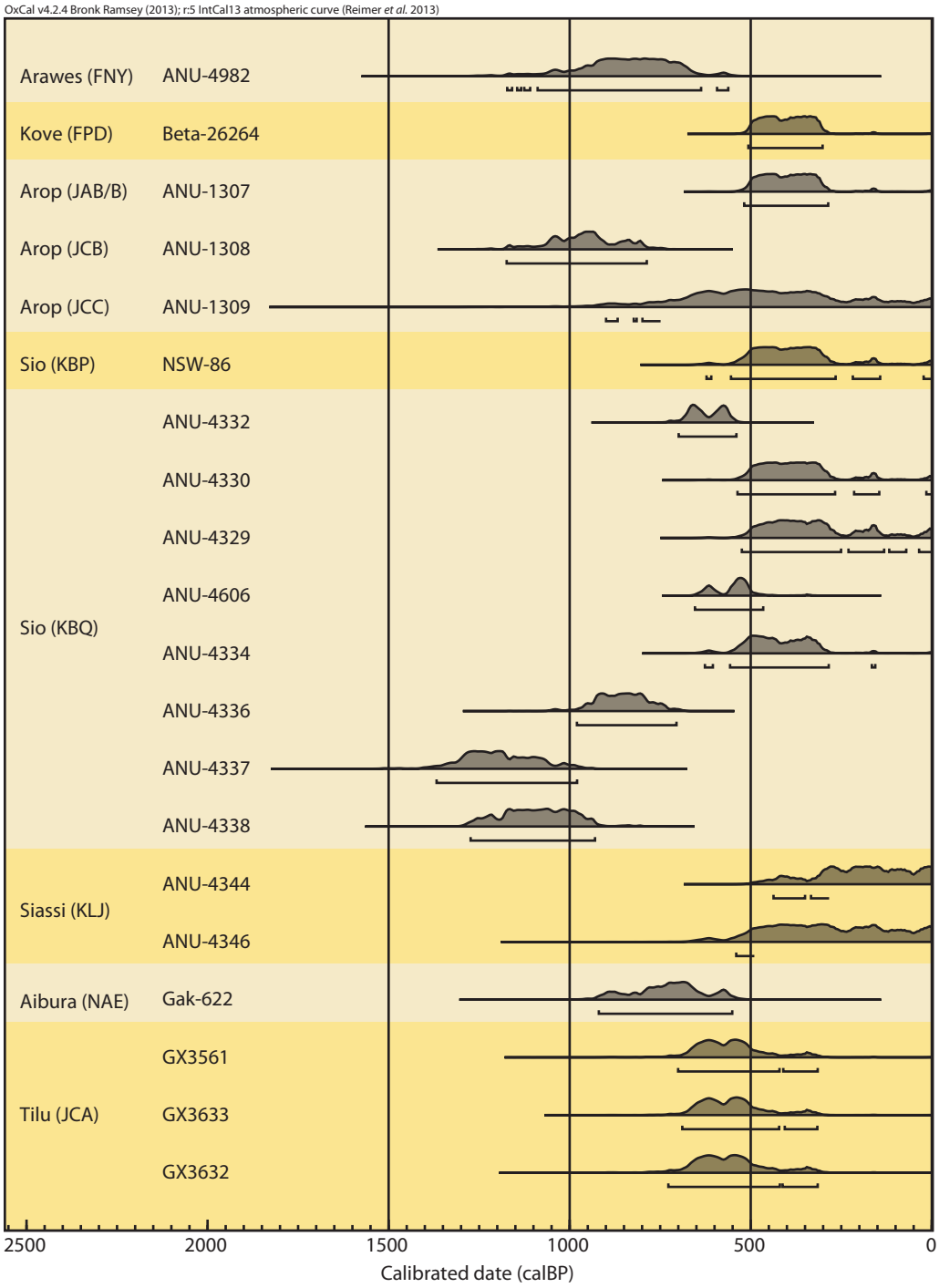


Figure 5.6. Radiocarbon distributions with 2σ confidence, based on wood charcoal in association with excavated Madang sherds.

Madang style ceramics occur in more places around New Guinea contemporaneous with habitation at Tilu. Modern or very recent dates at sites such as those at Sio and Siassi in association with abundant Madang sherds demonstrate that the movement of pots was accelerating in quantity and extent within the last few centuries before European contact on the coast. These pots probably fed into the already established Vitiaz Strait trade networks via the Rai Coast. Madang style pots, however, reached Arop/Long in the Vitiaz Strait between 800 and 1200 years ago, and Sio on the Huon Peninsula between about 1000–1300 years ago. This hints at the trading of Madang ceramics significant distances east, prior to occupation at Tilu. Lilley (2004a) suggests that this is indicative of a divide between intensive production of recent Madang style pots in Astrolabe Bay, and less intensive production of Ancestral Madang style pottery somewhere in New Guinea, possibly at Madang, possibly elsewhere. The origins of Madang style ceramic production, however, do not appear to be older than 1300 years old.

Summary

This chapter has surveyed all available archaeological information regarding the pre-colonial ceramics of Madang. At present, the evidence suggests Bel ceramic production and exchange was occurring around the northeast coast prior to the first evidence for these ceramics around Madang. It also suggests that there was a recent upwelling of production and exchange intensity leading to the ethnographic period, but that the ceramic technology itself was subtly different from that observed around Madang today. Despite this research, the history of the Bel potters remains elusive and speculative. Do their origins lie on a now destroyed Yomba Island in the Vitiaz Arc, do they lie further east on the mainland, sharing decent with Type X pottery, or are they closer to modern Madang township representing a practice unbroken from the contemporary Yabob and Bilbil potters? The archaeological investigations presented in the following chapters will address these questions in an attempt to refine chronology and classification, and to fill these key gaps in our knowledge regarding Bel culture history, production, and exchange.

Chapter 6. Archaeological Investigations

The island of Bilbil is full of stones. If you dug there for one day you would feel like dying.
— Damun of Yabob (1977)[1]

To build a picture of Madang ceramic technology in the pre-colonial past, new archaeological fieldwork was completed around Madang District, shedding light on this much-neglected area of the New Guinea coast. The aims of the fieldwork were to search for material relating to 1) the initial occupation by Austronesian-speaking peoples in the Late Holocene, and 2) changing production and exchange in these ancestral societies, leading to the ethnographic present. As has been introduced in Chapter 1, Madang is strategically located to assess pre-colonial movements of peoples and ideas from west to east, along a coastline where it is possible that Austronesian-speakers passed, during their movements some 3400–3300 years ago (Terrell & Welsh 1997; White 2014), and east to west in subsequent journeys out of the Bismarck Archipelago along the northeast coast of New Guinea (Lilley 1999; Ross 1988). Furthermore, as the heart of Bel ceramic manufacture and ethnographic trading, coastal Madang is central to understanding how pre-colonial production and exchange networks developed.

Because little was known of these movements and subsequent production and exchange along this part of New Guinea's coastline, fresh archaeological fieldwork was considered a priority. This research represents the first archaeological investigations along the Madang coast since preliminary reports in the mid-1970s (Allen 1971; Egloff 1975). Specifically, surface survey of several key ancestral areas in the local Madang area was undertaken, followed by systematic excavations at two clan areas: Tilu at Malmal village within the Madang Lagoon, and Nunguri on Bilbil Island, just south of Madang town. This chapter describes in detail the procedures of this survey and excavation along with the results of radiocarbon determinations and a broad summary of the material assemblages collected to refine the culture history for the area. This provides the important archaeological context of the ceramic assemblages used to explore production and exchange in this monograph.

1 Quoted in Mennis 1981a: 28.

Madang area survey

Several island and coastal locations were first targeted for ground survey to assess the potential for surviving archaeological deposits. This survey was selective and provisional in nature, with locations being selected based on both accessibility and promising descriptions in site record forms completed by Brian Egloff during his 1973 fieldwork. The areas chosen were Kranket Island, Siar Island, and Malmal village in the Madang lagoon, and Yabob Island and Bilbil Island south of Madang town (Fig. 6.1). All of the islands visited comprise uplifted coral on their northeast flanks, with small sandy beaches on the southwest, protected from the wave pounding and abrasion of the Bismarck Sea. Furthermore, all of the areas surveyed were occupied by speakers of Bel languages and considered themselves *Bel* people, with familial and cultural affinities to each of the other sites.

Kranket Island

Kranket Island (JLH), the largest in Madang harbour, lies 200 m northeast of Schering Peninsula and the modern Madang town (Fig. 6.2). The island is over 2 km long with a large saltwater lagoon dominating the centre. Sandy soil overlies a thick coral bed, which is uplifted about 3.5 m above high tide level. Arable land lies mostly on the southern and western portions of the island. Kranket is home to seven clans living in two villages, most occupants of which subsist on fishing or by working on the mainland, but some horticulture is also practiced where the land is good. The western side of the island was investigated on foot and pottery surface collections taken from beside a new school where upturned garden rubbish had been swept (E0368588, N9424500)[2]. Pottery was observed in only a few other gardens, but according to the local people,

2 GPS coordinates given in text are as they relate to the AGD66 datum and the Madang topographic map (Ed. 1.AAS, Series T683) published by the National Mapping Bureau 2002. DigitalGlobe images retrieved from Google Earth display these coordinates taken from a Garmin Montana 650t GPS recorder with a correction made for the WGS84 datum and entered under into Google Earth in UTM mode.



Figure 6.1. Archaeological places investigated during the 2014 field season.

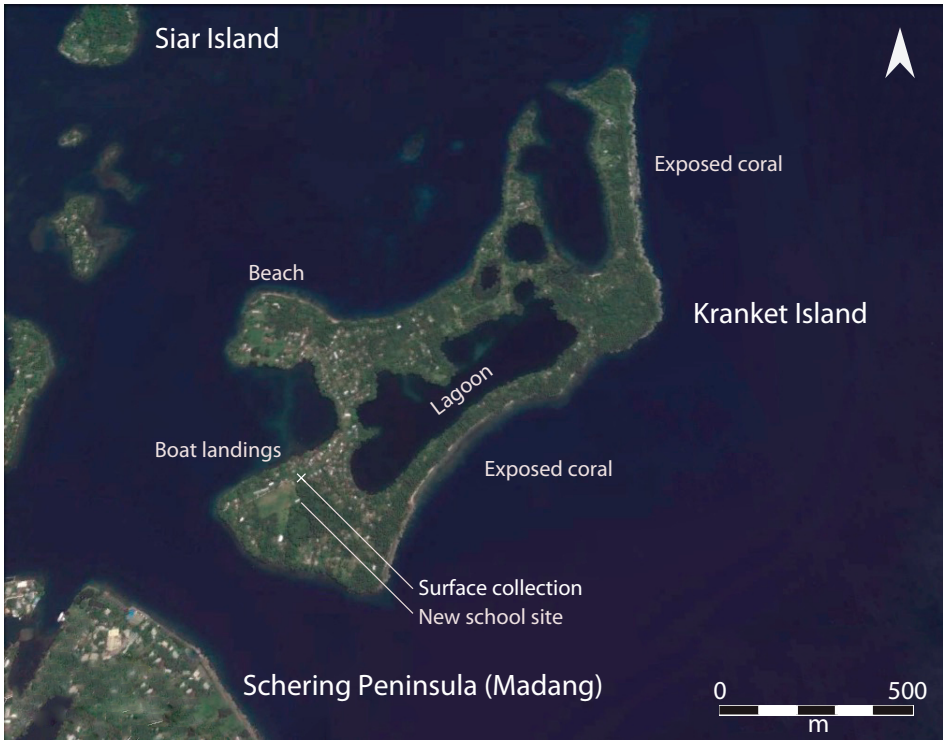


Figure 6.2. Aerial photograph of Kranket Island (DigitalGlobe 2015).

about 30–40 years ago the whole island was littered with broken pottery. Since then, the practice of sweeping rubbish out to sea and the disuse of pottery in the 1980s mean there are now only a few places where potsherds are still visible on the surface. The island was circled by boat but there were no extant shoreline deposits visible.

Siar Island

Siar Island (JAD) has strong familial connections to Kranket. The Siar and Kranket people both speak the Gedaged language of Bel, and Siar was formerly used as a burial site for all nearby islands. The island is approximately circular, just under 300 m wide and 400 m long. The southwestern side is dominated by a low-lying, sandy shoreline suitable



Figure 6.3. Aerial photograph of Siar Island (DigitalGlobe 2015).

for canoe landings, while the eastern side is badly eroded by wave action, leaving only coral, uplifted several metres (Fig. 6.3). Pottery surface samples were collected near the sandy beach on the west side of the island (E0367454, N9426375) (Fig. 6.4a). The elders on the island still occasionally used pottery to cook with, but not often as metal has all but replaced clay. Possible mounded archaeological deposits were observed amongst the gardens in the interior of the island, but these were not extensively investigated.

Yabob Island

Yabob Island (Fig. 6.5), 800 m offshore and several kilometres south of Madang town was the home to the Yabob potters at European contact, but pottery is no longer made on the island. It is about 300 m wide and roughly circular. In the centre of the island there is an anthropogenic mound (JBG), approximately 3 m in diameter, where, according to oral traditions, the first ever pots were made by Honpain



Figure 6.4. Survey of the Madang District, 2014: a) Siar Island beach site looking back towards Kranket Island in the south; b) a historical German coral wall next to where several lithic artefacts were found, Yabob Island; c) a selection of siliceous (foreground) and obsidian (background) lithic artefacts collected by local children on Yabob Island; d) a view from Tilu, Mound A, northeast towards Malmal Island; e) section of eroding midden, west side of Bilbil Island. Thick ashy soil overlies exposed coral bedrock; f) fresh water springs forming Jacob's Well, Bilbil Island (Photos: D. Gaffney 2014).

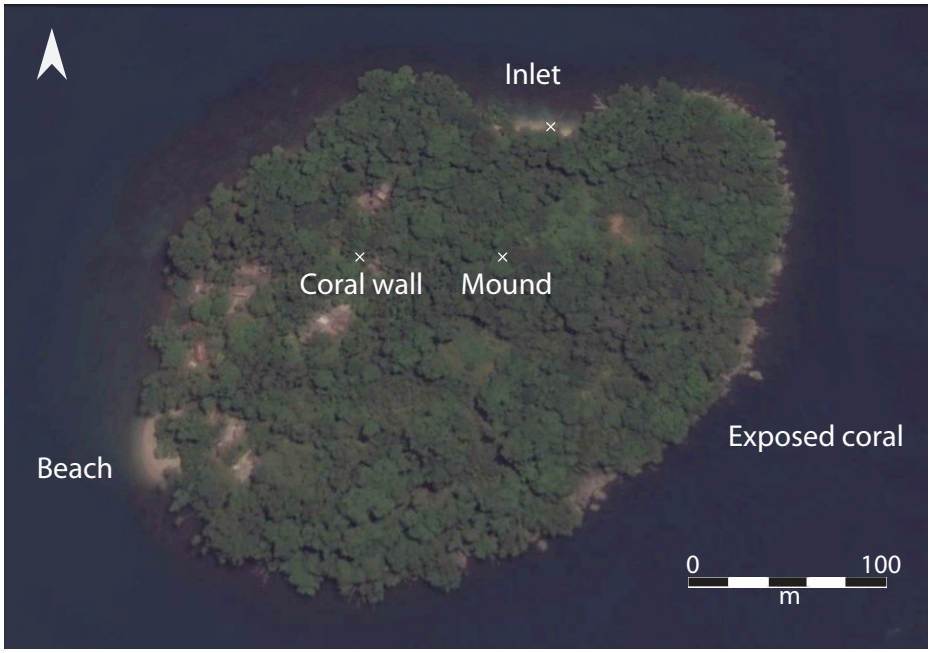


Figure 6.5. Aerial photograph of Yabob Island (DigitalGlobe 2015).

(see Chapter 3). A sample of pottery was collected midway up the mound from a pig rooting (E0365427, N9418754). At a sandy inlet on the north coast of the island (E0365443, N9418845) a sherd was collected, with a clay and design dissimilar to those at the mound along with two pieces of water-rolled obsidian, and a charcoal sample from a thin soil eroding out of a bank. Obsidian, slate, and a stone axe fragment were found near a small mound by an early twentieth century German coral wall in the centre of the island (E0365335, N9418754) (Fig. 6.4b). Numerous obsidian and other siliceous lithics, enthusiastically collected by the local children at the find locations noted, were also accepted as samples (Fig. 6.4c). The Yabob Islanders say they used to get their obsidian from West New Britain.

Malmal village

Malmal village is situated 12 km north of Madang township (Fig. 6.6). Tilu (JCA) clan area, previously excavated by Egloff (1975), consists of two elongated mounds ~20 m



Figure 6.6. Aerial photograph of Malmal area showing Tilu site (DigitalGlobe 2015).

long, demarking the north and south of the hamlet. These two central mounds (A and B) remain a central and well-preserved component of the site, which overlooks the Madang Lagoon to the north and east, and is landlocked to the south (Fig. 6.4d). A sandy canoe harbour lies about 20 m north of Mound A, allowing access from Malmal Island, several hundred metres to the northeast. Land access to the site is via a dirt road from the south, or through Malmal village proper, 200 m to the east. Given sea levels were around 3 m higher in the late Holocene (Tudhope *et al.* 2000), Tilu would have probably been an island during occupation about 550 BP (Egloff 1975). A sample of sherds was collected from the ground surface. Posthole backfill from recent construction of a structure, just north of Mound A, indicated potsherds, obsidian and fire ash were present to some considerable depth. At the time of survey, Tilu was used for coconut and betelnut production, with plantations around most of the area.

Bilbil Island

Bilbil Island (Fig. 6.7) is a 600 m long coral island, located 9 km south of Madang, and 1.8 km east of Bilbil potting village on the mainland. At the time of survey, the island was covered with vegetation including fruit trees and systematically planted coconut trees, making the interior of the island very cool and shaded. A small sandy beach on the southwest side of the island is the only point of canoe access. No cultural material was observed in this area; however, a modern fresh water well was present at the north end of the shore. An eroding midden about 50 m north of this beach had been observed by Mary Mennis and several Bilbil people many years earlier (Fig. 6.4e). The exposure that we observed was over 2 m high, with the top metre being a volcanically derived soil containing unidentified long bones and pottery. Below this soil was coral bedrock exposed through uplift and extensive wave action. In the lowest levels of the coral no *in situ* artefacts were observed, although a few water-rolled sherds were present, mixed with coral gravel, below the exposure.

In the interior, several parallel mounds lay in the northern two thirds of the island suggesting the location of former clan areas. Just 20 m north of the eroding midden were two high linear mounds (1–2) on the western side of the island both about 1.5 m high and covered with potsherds and stone flaking debris. Further east, two other parallel mounds (3–4) were located. Pottery and lithic remains, including an axe fragment were found, some of which was brought to the surface by extensive crab bioturbation. At the south of the island lay a series of freshwater springs named 'Jacob's Well,' used by the Bilbil Islanders during German occupation and possibly earlier (Fig. 6.4f). The Bilbil villagers unanimously claim that the high point on the island, just east of Jacob's Well, is the former location of Miklouho-Maclay's house from 1872. There were no material remains to suggest this was the case, but a stack of concrete bricks inscribed from 1910 was present at the top of the hill (E0364710, N9413987), probably the remnants of the rest house the German Navy built in that location. The

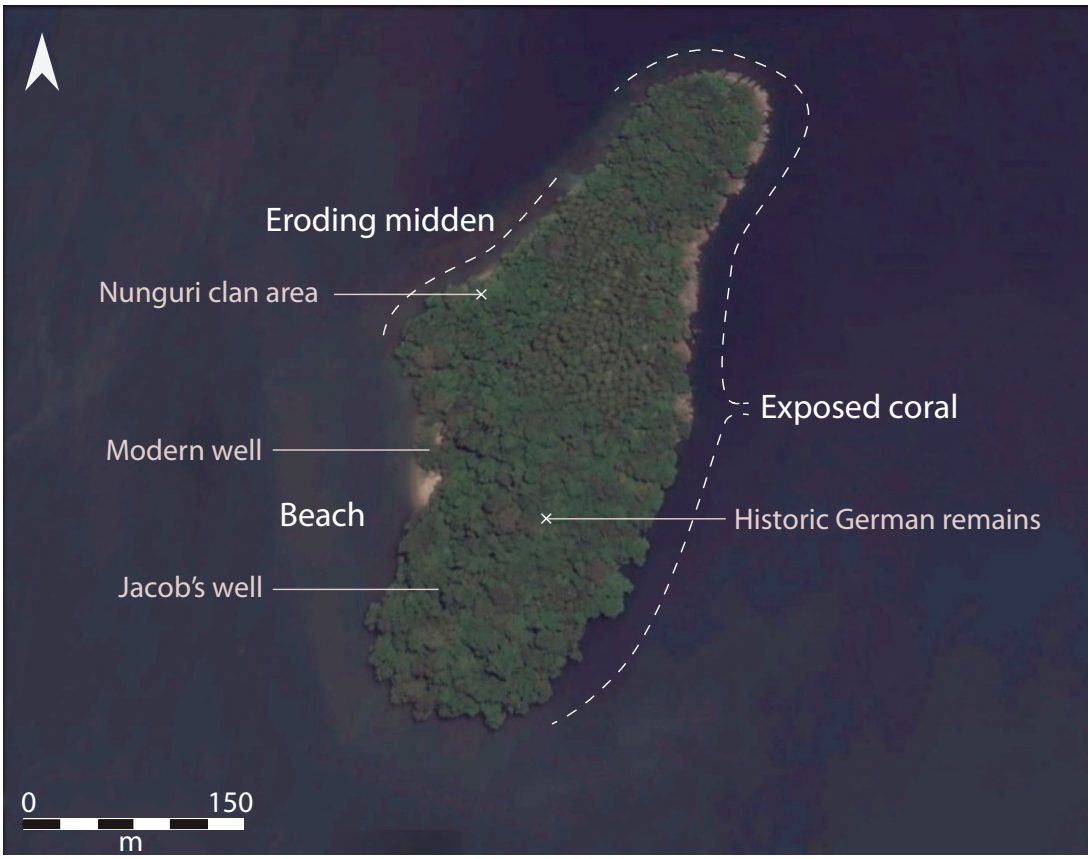


Figure 6.7. Aerial photograph of Bilbil Island (DigitalGlobe 2015).

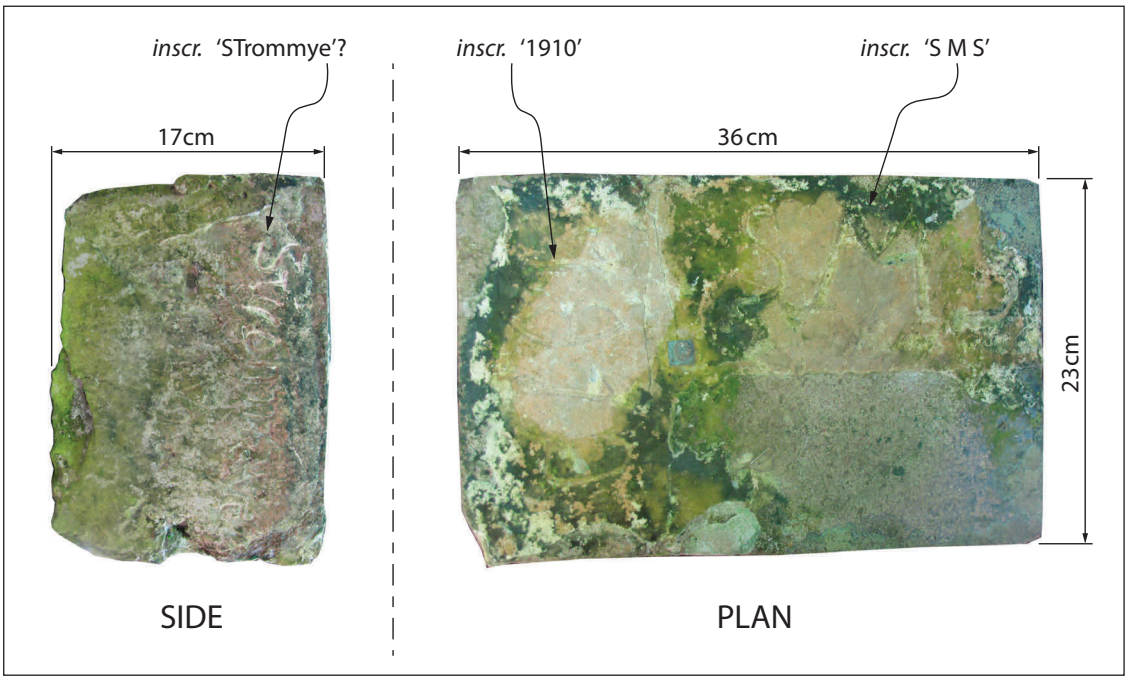


Figure 6.8. Inscribed German brick, highest point of Bilbil Island.

inscription 'SMS' is likely the designation of an Imperial German Navy ship, *Seiner Majestät Schiff* meaning "His Majesty's Ship" (Fig. 6.8; see Mennis 1981a: 38).

Surface collections

The main aim of the surface collection was to recover a small number of diagnostic potsherds from the broader study area to compare both in style and fabric with those from excavated contexts to build a summary picture of ceramic variation around Madang. The artefacts collected from the surface survey were suggestive of pre-colonial habitation in each area (Table 6.1). This included decorated and undecorated pottery sherds, predominantly connected to the Madang style (see Lilley 1986: 193), with red slip, appliqué, and incised decoration, and everted rims. These pottery finds allude to the dominance of the style in local production and exchange systems. The pottery is examined further in Chapters 7–9.

Both obsidian and sedimentary flaked lithics were also collected and suggest the use of heterogeneous local and regional rock types from the mainland, supplemented by obsidian from sources further afield. The single axe fragment collected at Yabob is small and does not preserve any diagnostic landmarks but is made from a black volcanic rock. The obsidian and other stone assemblages have been analysed separately at the University of Otago and the results are reported in Gaffney and Summerhayes (2019). The collection of surface finds during the survey was unsystematic and does not accurately reflect the distribution of different artefact classes in the study area, but rather gives an idea of locations likely to preserve deep chronological sequences. Significant undisturbed deposits were only observed at three places: Yabob Island, Bilbil Island, and at Tilu, Malmal Village. At each of these areas, large mounds were present indicating the locations of previous sustained settlement.

Excavation procedures

Following the surface survey, two areas were selected for excavation owing to their potential for stratified archaeological deposits relating to the recent Madang ceramic style: Nunguri clan area (Mound 1) on Bilbil Island, a former place of pottery production, and Tilu clan area

Table. 6.1. *Summary of surface collections made during 2014 survey.*

Site code	Place name	Pottery	Axe fragments	Obsidian	Non-obsidian lithics	Total
JLH	Kranket Island	10	0	0	0	10
JAD	Siar Island	6	0	0	0	6
JBG	Yabob Island	7	1	28	10	46
JCA	Tilu, Malmal	86	0	1	0	87
JBD	Bilbil Island	0	0	0	1	1
Total		**109**	**1**	**29**	**11**	**150**

(Mound A) at Malmal village, the pottery consuming village where Egloff (1975) had previously dug. At each location the area was mapped and one 1 × 1 m unit was laid out along the cardinal axes and cleared of surface vegetation. A datum was set up nearby each unit. Excavations were placed at the top of the anthropogenic mounds in order to maximise the depth of archaeological deposit and potential chronological sequence. At both sites there were deep deposits with few visible stratigraphic boundaries, indicating a rapid accumulation of sediments. Arbitrary 10 cm and 20 cm excavation spits were excavated with hand trowels or shovels.

Soil samples were collected for each spit. Where possible, charcoal was sampled *in situ* and without being handled, with depth measurements taken. All material was passed through 4 mm sieves and sorted into primary classes in the field before being bagged and shipped back to the University of Otago, Department of Archaeology and Anthropology. The material is currently stored in the department, on temporary loan from the National Museum and Art Gallery. All stone artefacts were bagged individually, while other artefact classes were bulk bagged. The excavation depths were limited at each site by safety concerns and the acceptance that the lowest deposits were culturally sterile. At both sites the local communities were actively involved in the fieldwork and discussions about the material findings. Ethnographic and historical information gathered from village elders during the course of the excavations allowed for more contextualised interpretations of these areas.

Nunguri excavations

Nunguri, Bilbil Island

Nunguri clan area is centred around an anthropogenic mound on the western interior of Bilbil Island, just back from the eroding midden running along the western side of the island (E0364656, N9414189) (Fig. 6.9–6.10). This mound was selected for excavation in preference to other mounds on the island owing to the scarcity of tree roots and the proximity to the eroding section, which would give a good indication of subsurface deposits within the mound. The groundcover consisted of leaf litter from overhanging trees, but very little other vegetation. Nunguri (formerly Nigeri, Nguri, or Ngur) was the clan area of Kain, friend of Miklouho-Maclay (Mennis 1981b: 37). Kain and others were supposedly buried under their houses in this area, but many of the bones have been swept out to sea (Mennis 1981a: 54).

Excavation

Excavation of a 1 × 1 m unit (Test Pit 1) on Nunguri mound consisted of seventeen spits over two stratigraphic layers (Fig. 6.11–6.12), taken to a maximum depth of 2.53 m below surface. Spits 1–10 were controlled 10 cm units, while Spits 11–14 were increased to 20 cm using a shovel owing to time constraints, and Spits 15–17 were sectioned to 0.5 × 1 m in the south end of the unit. By Spit 16 at ~2.35 m below surface there was very little pottery present, some small shell, and no obsidian, and by Spit 17 there was no cultural material except a few tiny sherds that were probably intrusive



Figure 6.9. Looking east at Bilbil with beach at south and Nunguri site in the centre (2014).

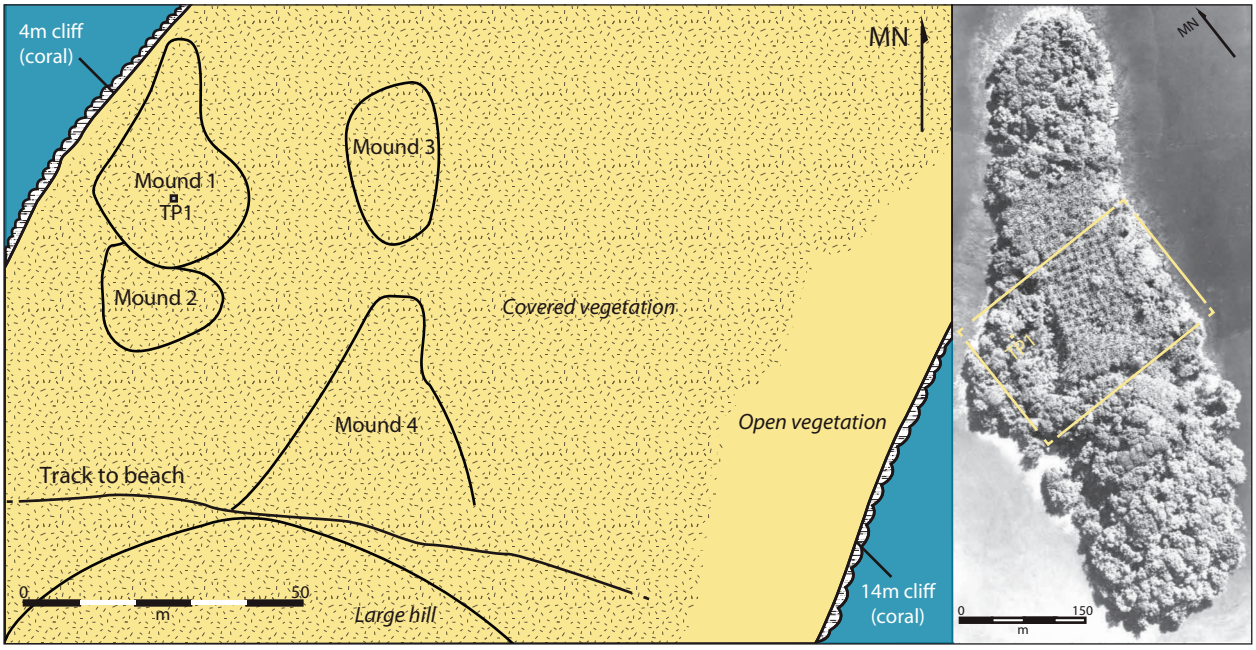


Figure 6.10. Plan of excavations at Nunguri clan area, Bilbil Island (plan: G. Summerhayes; aerial photograph: B. Mennis).

from above. Digging was stopped owing to safety concerns at depth in loose sediments and although bedrock was not reached, the deposit was convincingly sterile.

Stratigraphy

Layer 1: is represented by Spits 1–15 and consists of a thick soil layer, transitioning, albeit without definite stratigraphic boundaries, from loamy black topsoil (5YR 2.5/1) through a very dark brown ashy soil (10YR 2/2), to a sandy light brown soil (2.5Y 3/2), mixing with Layer 2 below. Tree roots, coral gravel and boulders were common. From Spit 2–13 grey and white ash was mixed usually without definite feature boundaries, suggesting numerous single and multiple use fires. This had disturbed the layer, especially in the northwest corner of the unit, but this was difficult to control for during excavation. A possible rubbish pit of loosely packed ashy soil (Feature 1) was present in the NE



Figure 6.11. Excavations at Test Pit 1, Nunguri site, Bilbil Island (Photo: D. Gaffney 2014).

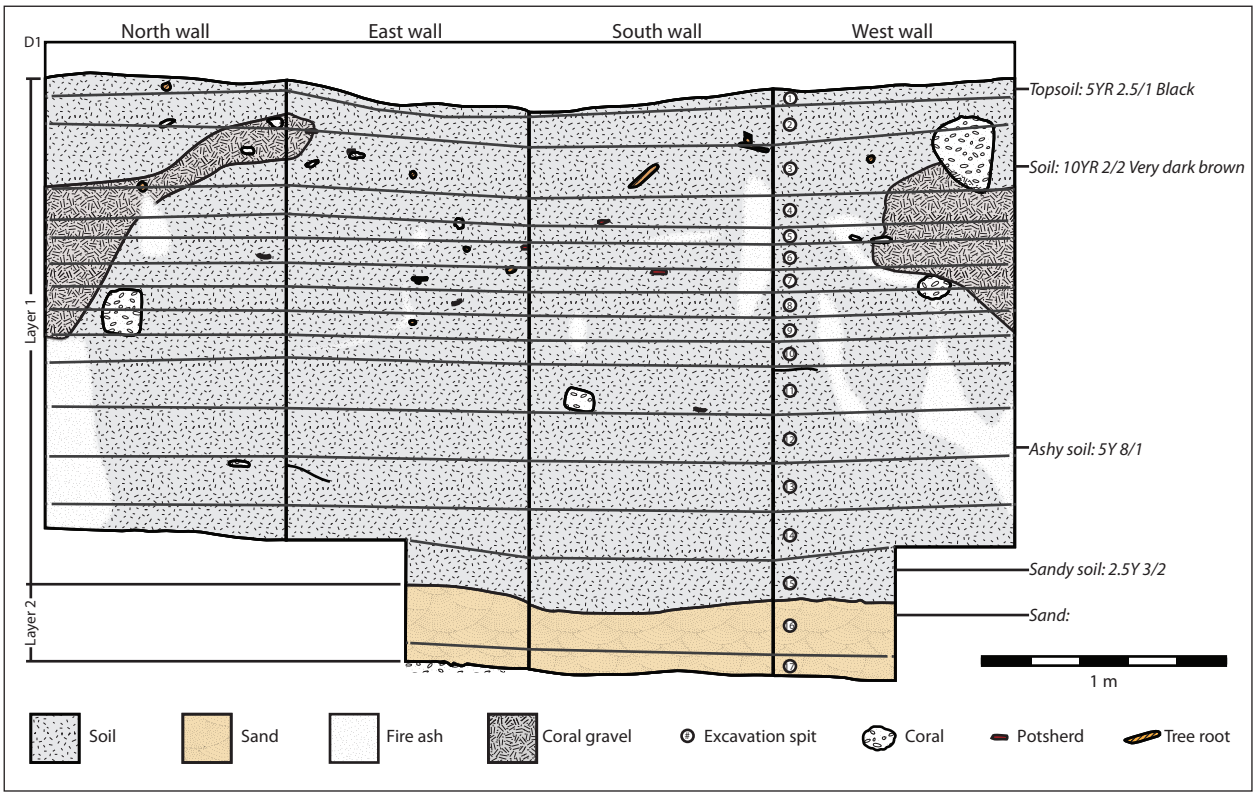


Figure 6.12. Stratigraphy of Test Pit 1, Nunguri site, Bilbil Island

corner of the unit in Spits 2–3, heavily mixed with pottery and coral gravel. Alternatively the presence of large, loosely distributed coral boulders between Spits 2–9 may suggest the edge of a deflated coral wall, similar to that observed on Yabob Island (see above), but the test pit was too small to ascertain if this was the case. From Spits 11–16, mixing of soil and sand suggests a transitional period between sandy beach and habitation deposit over many years.

Layer 2: is pale yellow beach sand mixed with coral gravel, represented by Spits 16–17 (~2.15 m–2.5 m below surface). This layer represents the original beach deposit prior to significant uplift and before significant habitation at the mound. The base of excavation was laid with tarpaulin before the site was backfilled completely.

Chronology

Six charcoal samples from Nunguri, Test Pit 1, were submitted to the Australian Institute of Nuclear Science and Engineering (AINSE), at Lucas Heights (Fink *et al.* 2004), for radiocarbon dating (Table 6.2; Fig. 6.13–6.14). Samples that had been collected *in situ* and with known depth measurements were selected preferentially. It was not possible to identify charcoal samples to species owing to a lack of local reference collections. Dates were calibrated using IntCal13, which has been used for samples from other areas of New Guinea and the Western Pacific (Petchey *et al.* 2014; Shaw 2014). The radiocarbon dates suggest two major phases of site activity spanning a period of about 500–600 years.

Table 6.2. *Radiocarbon determinations from Test Pit 1, Nunguri site, Bilbil Island.*

Lab code	Sample type	Spit	Depth below Datum 1 (cm)	δ (^{13}C) per mil	Conventional radiocarbon age (BP)	Calibrated range (2σ) (cal. BP)*
OZS559	Wood charcoal	3	40–60	–26.2 ± 0.1	200 ± 25	0–299
OZS558	Wood charcoal	5	71	–26.5 ± 0.3	210 ± 25	0–304
OZS557	Seed charcoal	6	80–90	–30.9 ± 0.2	Modern	—
OZS556	Wood charcoal	11	131	–24.6 ± 0.1	495 ± 20	508–539
OZS555	Wood charcoal	13	170–190	–25.9 ± 0.1	530 ± 20	515–623
OZS554	Wood charcoal	14	207	–26.4 ± 0.1	540 ± 20	520–626

*Intcal13 atmospheric curve (Reimer *et al*. 2013); Oxcal 4.2.4

Initial site occupation occurred around 500–600 years ago. Samples OZS556, OZS555, and OZS554 are statistically identical and suggest the earliest phase of occupation comprised permanent settlement and a rapid build-up of sediment. This occupation spanned at least Spits 11–14 from 1.21 m to 1.97 m below surface. The median age increases with depth, which may indicate that there is a stratigraphically secure sequence from Spit 11 down. The second phase, from at least Spit 1–6, dates to within the last few centuries. It is difficult to assess the true age of samples OZS558 and OZS559, which cover plateau regions of the calibration curve, extending the calendar age ranges (Blackwell *et al.* 2006; Lilley & Specht 2007). The 'Modern' result for OZS557 in Spit 6 refers to the fact that the corrected age is within the last 200 years. This sample has no inbuilt age, being from a carbonised seed pod (*Canarium* sp.), and the fact that the overlying samples OZS558 and OZS559 date to ≥200 BP suggest there is a small amount of inbuilt age on these wood charcoal fragments. Significantly, the upper part of the deposit is not older than about 300 years, while the lower portion is older than 500 years old. It is not clear if there was a break in settlement at around 400 years ago, but dating carbon from Spits 7–10 would resolve this question.

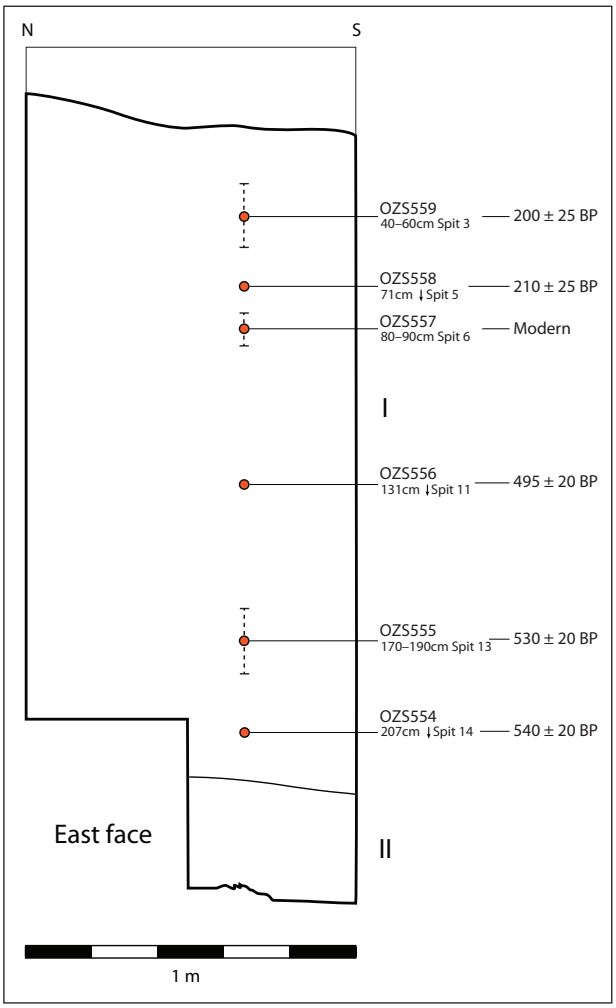


Figure 6.13. Charcoal samples submitted to AINSE for dating, Nunguri, Bilbil Island.

Excavated material

All material was individually washed, dried at 20°C, and sorted at the University of Otago. At Nunguri, pottery was the dominant artefact class (Table 6.3–6.4). Potsherds were divided into plain body sherds, decorated body sherds, rims, necks, and bases. All artefacts were re-bagged individually and catalogued, apart from plain body sherds, which were bulk bagged, counted and weighed. Midden shell, lithic flakes, animal bone, possible pottery anvils (identified as such by the Bilbil people assisting with excavation), pigments (used for decoration and marking measurements in producing canoes), shell beads, carved shell armbands, fire-cracked rocks (*mumu*[3] stones), and shell adzes with associated debitage, were also present

3 *Mumu* (Tok Pisin) are earth ovens dug into the ground and heated by oven stones.

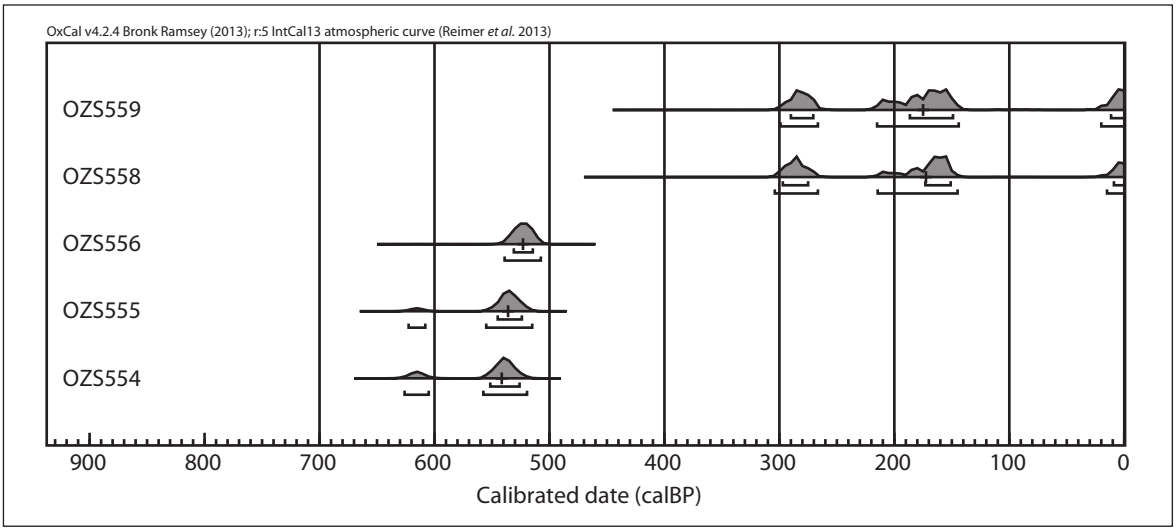


Figure 6.14. Plot of calibrated date distributions with 1σ, 2σ, and median age from Test Pit 1, Nunguri site, Bilbil Island (Oxcal 4.2).

Table 6.3. *Material by weight (g) recovered from Test Pit 1, Nunguri site, Bilbil Island.*

Spit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Sieved deposit (kg)	50.44	224.05	225.46	161.25	60.50	105.00	79.25	90.25	80.00	94.15	180.60	116.00	173.85	140.20	128.40	111.21	40.15	**2060.76**
Pottery	2316.83	10750.85	10904.25	7702.74	2772.73	5310.61	3095.43	2943.49	2605.27	2674.76	4034.94	2861.64	3406.01	4208.35	2119.53	40.93	10.61	**67758.97**
Obsidian	5.64	25.12	6.54	15.81	3.99	13.67	5.47	9.20	10.12	4.78	8.81	7.68	5.43	10.40	4.90	0.00	0.00	**137.56**
Non-obsidian lithic	0.34	24.95	10.85	9.63	14.07	11.41	34.34	1.89	23.60	2.85	12.23	1.77	6.11	180.23	0.00	0.00	0.00	**334.27**
Animal remains	0.00	16.50	9.14	79.90	13.80	11.73	5.49	6.74	14.94	14.34	12.06	1.51	1.25	3.97	0.00	0.00	0.00	**191.37**
Human remains	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	4.80	0.64	0.00	0.00	0.00	0.00	0.00	0.00	**6.31**
Shell midden	188.05	940.80	887.15	718.30	248.40	493.80	474.40	409.85	398.15	367.95	785.55	476.75	720.90	598.20	448.80	54.54	72.60	**8284.19**
Shell adzes	0.00	0.00	53.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.95	0.00	0.00	0.00	**59.10**
Shell ornaments	0.00	1.49	0.00	2.79	5.27	0.00	2.33	2.46	0.00	0.36	4.71	1.35	2.06	0.00	0.00	0.00	0.00	**22.82**
Shell debitage*	4.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.05**
Fire-cracked rocks	0.00	1056.54	101.68	38.25	384.39	615.81	0.00	0.00	221.12	26.43	428.59	0.00	76.58	44.94	0.00	0.00	0.00	**2994.33**
Pottery anvil (?)	181.79	0.00	222.18	0.00	0.00	0.00	202.90	0.00	0.00	0.00	0.00	0.00	0.00	322.11	0.00	0.00	0.00	**928.98**
Grinders	0.00	107.42	0.00	0.00	0.00	14.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**121.48**
Pigment	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	4.33	0.00	0.00	2.22	0.00	0.00	0.00	0.00	**7.88**

* Preliminary inspection- numbers expected to increase following thorough inspection of shell midden.

Table 6.4. *Material by number (n) recovered from Test Pit 1, Nunguri site, Bilbil Island.*

Spit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Pottery	1613	5493	4875	2755	1062	3465	1736	1938	1485	1580	2752	1795	2466	2412	1288	36	16	**36,767**
Obsidian	16	44	17	38	10	25	13	18	16	14	15	11	13	24	9	0	0	**283**
Non-obsidian lithics	2	10	4	6	7	6	2	2	6	3	5	2	6	6	0	0	0	**67**
Shell adzes	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**2**
Shell ornaments	0	1	0	1	1	0	1	1	0	1	1	1	2	0	0	0	0	**9**
Shell debitage*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Fire-cracked rocks	0	10	3	2	2	7	0	0	3	2	2	0	1	3	0	0	0	**35**
Pottery anvils (?)	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	**4**
Grinders	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**2**
Pigment	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	**3**
Total	**1632**	**5560**	**4901**	**2802**	**1082**	**3505**	**1753**	**1959**	**1510**	**1601**	**2775**	**1809**	**2489**	**2447**	**1297**	**36**	**16**	**37,173**

* Preliminary inspection- numbers expected to increase following thorough inspection of shell midden.

throughout Layer 1 (Fig. 6.15–6.16). Sparse human remains are present in Spit 1 and in Spits 9–11 (see Gaffney *et al.* 2018a). Layer 2 contained only small fragments of pottery and unmodified shell midden. Towards the lower spits of the deposit, the mass of pottery (g) gradually decreased, relative to the mass of sieved deposit (g), while the mass of shell midden (g) was constant (Fig. 6.17). Figure 6.18 shows that obsidian (g) and non-obsidian (g) flaked lithic material was also relatively consistent throughout Layer 1, although the small sample size and presence of a single large core in Spit 14 effects the variance in the non-obsidian line.

As an indicator of environmental change around the site, the number of water-rolled potsherds increased gradually in Layer 1 down to Spit 15 and then dramatically in Layer 2 (Table 6.5, Fig. 6.19). This suggests that in the past the clan area was much closer to the sea, probably owing to uplift events within the last 500 years (Morgan *et al.* 2005). Spits 11–15, which date to the first phase of occupation, around 500–600 years ago, contained significantly more water-rolled sherds than Spits 1–6, which represent more recent habitation. Spits 16–17, consisting of mixed soil and beach sand, would presumably have originally been close to sea level, accounting for the high proportion of water-rolled sherds in the layer. The presence of minor water-rolled sherds in the upper deposit may be related to redeposition in the deposit or occasional significant wave action, given Nunguri's proximity to the eroding cliff.

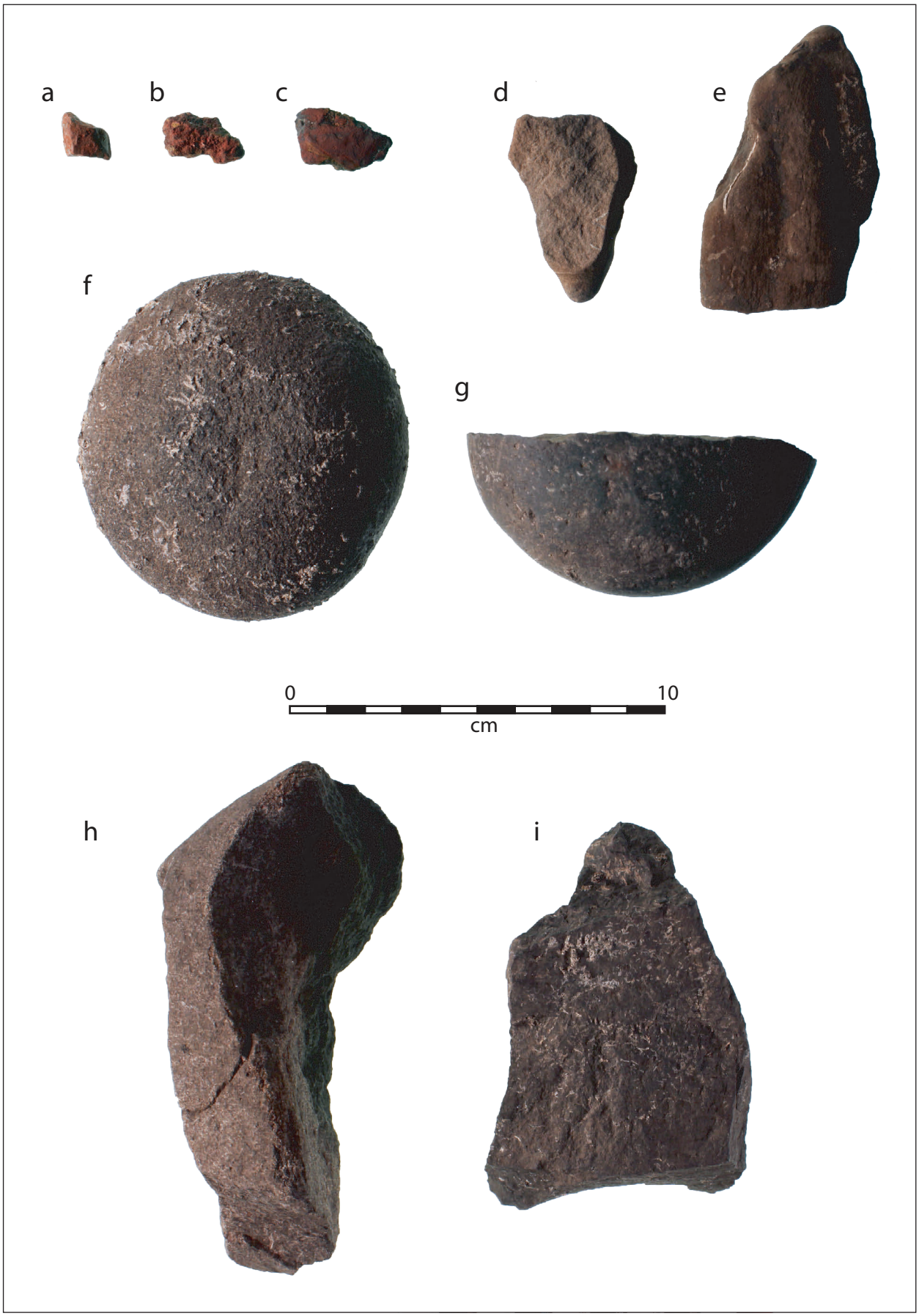


Figure 6.15. Stone artefacts from Test Pit 1, Nunguri site, Bilbil Island. Pigment: a. N-5351-Spit 6; b. N-5353-Spit 13; c. N-5352-Spit 10. Boring tool/grinder: d. N-5312-Spit 6; Grindstone: e. N-5354-Spit 2. Pottery anvils (?): f. N-5359-Spit 14; g. N-5357-Spit 3 (broken). Fire-cracked rock: h. N-5367-Spit 2; i. N-5375-Spit 5.



Figure 6.16. Shell artefacts from Test Pit 1, Nunguri site, Bilbil Island. Shell adze fragments: a. N-5504-Spit 3 (blade end); b. N-5517-Spit 14 (butt end). Shell beads: c. N-5516a-Spit 13; d. 5516b-Spit 13; e. N-5513-Spit 10. Shell armbands: f. N-5507-Spit 5; g. N-5512-Spit 8; h. N-5502-Spit 2; i. N-5506-Spit 4; j. N-5511-Spit 7.

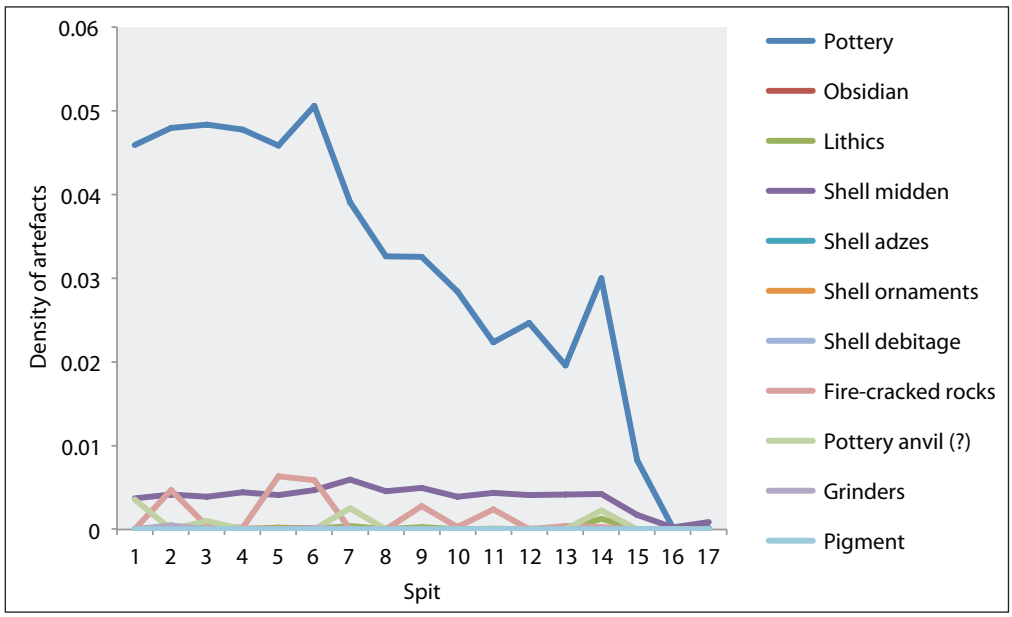


Figure 6.17. Density of artefact types to sieved deposit (g), Test Pit 1, Nunguri site, Bilbil Is.

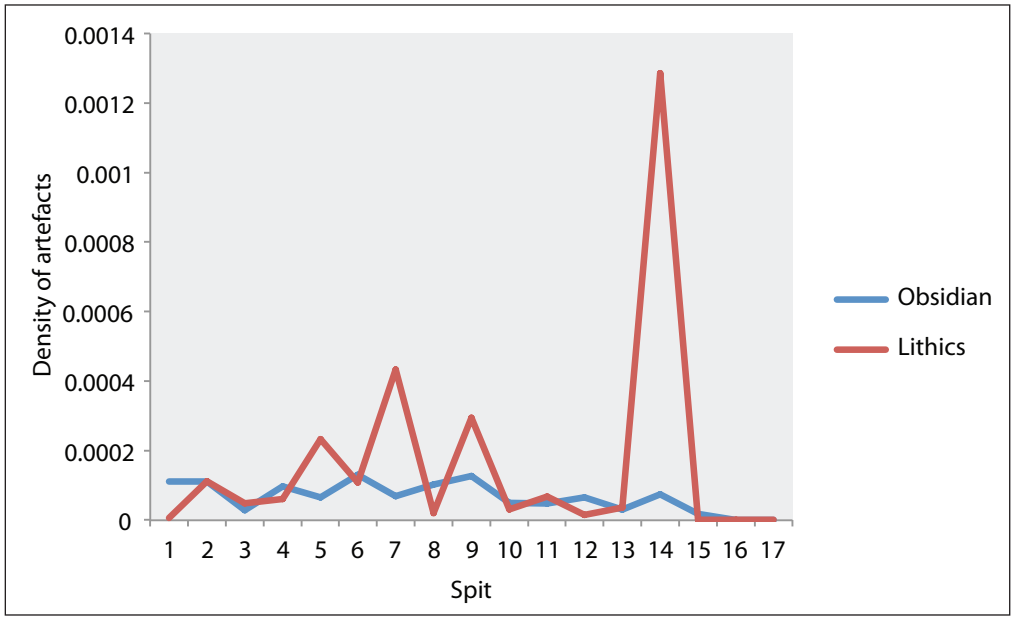


Figure 6.18. Density of obsidian and non-obsidian lithics to sieved deposit (g), Test Pit 1, Nunguri site, Bilbil Island.

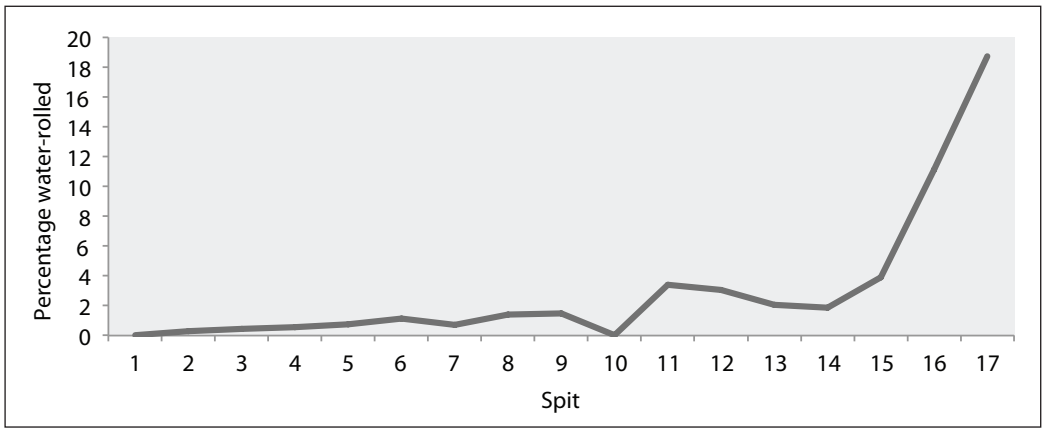


Figure 6.19. Water-rolled pottery sherds, Test Pit 1, Nunguri site, Bilbil Island.

Table. 6.5. *Water-rolled pottery sherds, Test Pit 1, Nunguri site, Bilbil Island.*

Spit	Water-rolled potsherds (n)	% of total sherds
1	0	0.00
2	16	0.29
3	21	0.43
4	15	0.54
5	8	0.75
6	39	1.13
7	12	0.69
8	27	1.39
9	22	1.48
10	0	0.00
11	93	3.38
12	55	3.06
13	51	2.07
14	45	1.87
15	50	3.88
16	4	11.11
17	3	18.75
Total	**461**	**1.25**

Tilu excavations

Tilu, Malmal village

Excavation was undertaken at Tilu (JCA), Malmal Village, in an attempt to clarify Egloff's original dating for the site and to produce a finer resolution examination of material culture change through time. This change would then be compared to the sequences present at Nunguri, Bilbil Island. Mound A was selected as the focus for excavation owing to the large quantity of surface artefacts in the area (Fig. 6.20–6.21).

Excavation

A 1×1 m excavation (Unit 1) was undertaken at Mound A, 2.88 m above the high tide mark (E0367062, N9433104) and was dug twelve spits to a maximum depth of 2.5 m below surface, where the water table was reached and coral bedrock began to inhibit excavation, indicating the level of the natural coral uplift (Fig. 6.20a-c). Spits 1–8 began as 10 cm thick contexts but were increased to 20 cm from Spit 9. Owing to time constraints, Spit 12 was a ~100 cm thick and almost entirely culturally sterile unit. Two dis-



Figure 6.20. Excavations at Tilu site, 2014: a) A view south towards Mound A, Tilu clan area, Malmal village (photo: G. Summerhayes 2014); b) Unit 1 excavations, Mound A, Tilu (photo: G. Summerhayes 2014); c) Teppsy Beni and Feli excavate Unit 1 at Tilu (photo: D. Gaffney 2014); d) Elias (centre) from Tilu clan area digs Shovel Pit 1, while Herman Mandui (left) records (photo: D. Gaffney 2014).

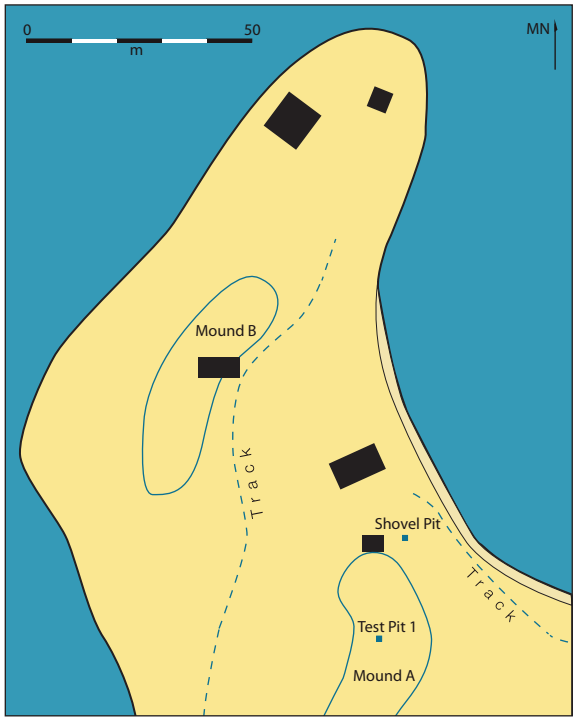


Figure 6.21. Plan of excavations at Tilu clan area, Malmal village (G. Summerhayes 2014).

tinct stratigraphic layers were identified in the excavation, very similar to those at Nunguri. Downslope from Mound A, a separate 1 × 1 m shovel pit (Shovel Pit 1) was dug unsystematically with a crow bar/metal digging stick to assess the horizontal extent of the deposit (Fig. 6.20d). This pit was dug to about 120 cm deep, where the water table was reached. The same two major layers of stratigraphy were observed in Shovel Pit 1 as in Unit 1. Collections made from this shovel pit were limited to diagnostic potsherds and lithic artefacts, hand picked from unsieved deposit.

Stratigraphy

Layer 1: comprised Unit 1, Spits 1–10, and was ~130 cm thick, with a gradual change from loamy dark grey soil (5Y 3/1) to ashy dark grey soil (5Y 4/1, 5Y 2.5/2) but without clear divisions in stratigraphy (Fig. 6.22–6.23). The layer contained coral boulders and gravel and was interwoven with roots from nearby trees. Feature 1 (Spits 5–6) was a scatter of charcoal, oven stones, and burnt pottery with undefined boundaries, about 0.6 m below surface, indicated a fire. A thin and undefined grey ashy lens (10YR 6/1) was present (Spits 9–10) 1.1 m below surface and seems to represent a single use fire. Pottery and shell midden were abundant in Layer 1, along with substantial amounts of

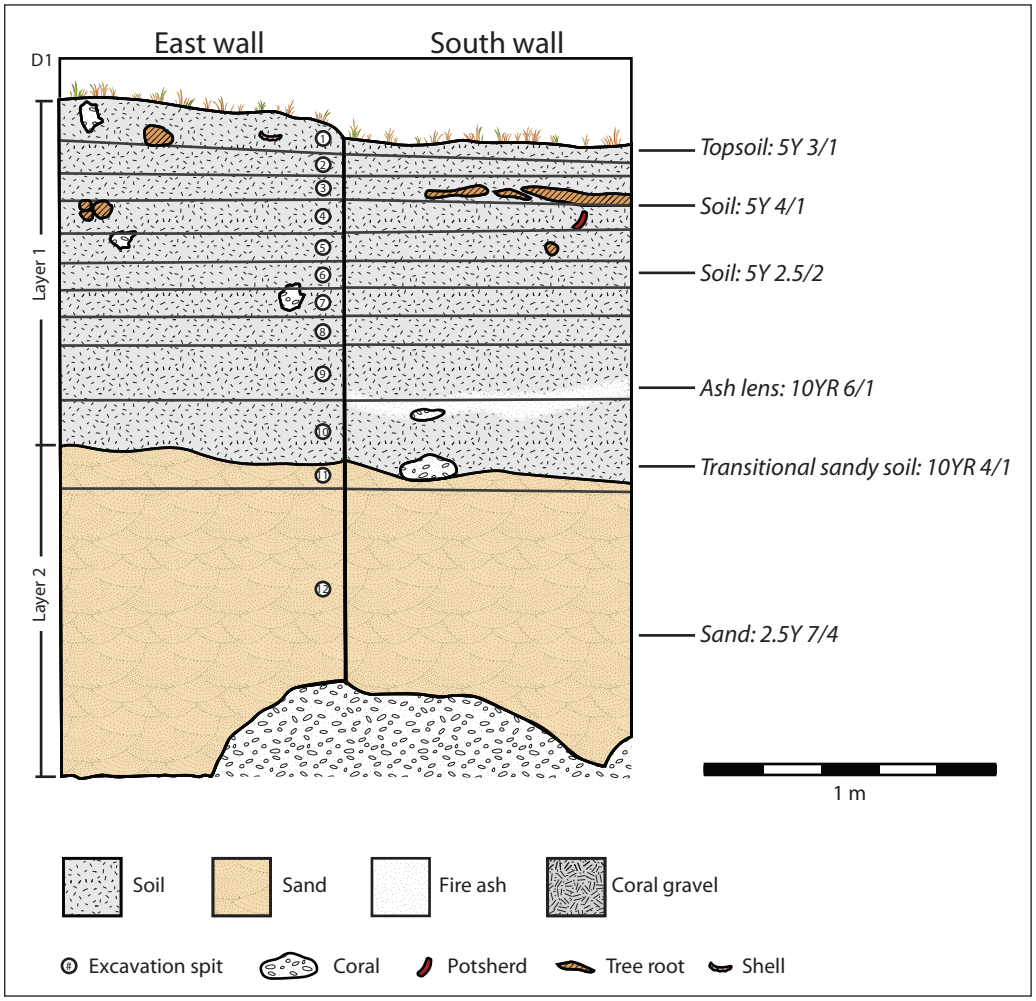


Figure 6.22. Stratigraphy of Unit 1, Tilu site, Malmal village.

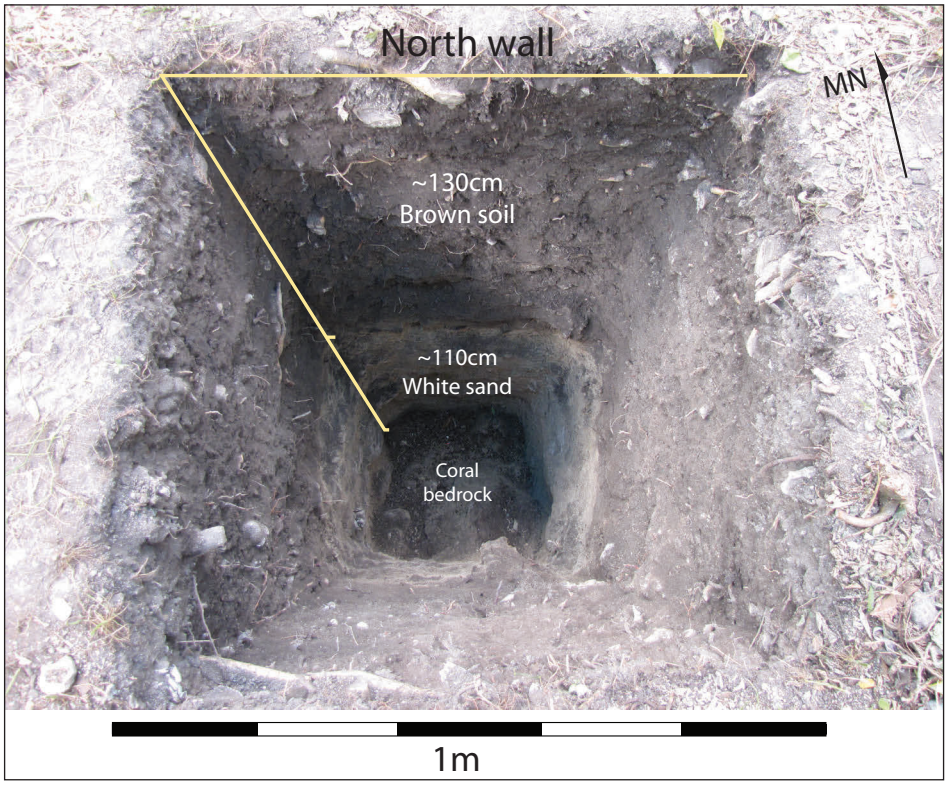


Figure 6.23. North wall of completed Unit 1, Tilu site, Malmal village.

obsidian. In contrast to Nunguri on Bilbil Island, almost no non-obsidian stone flaking debris was recovered at Tilu. Disarticulated human and animal bone was present but uncommon. A small amount of mixing between layers was present in Layer 1 from about 1.1 m below surface but otherwise the layers were distinctly separated.

Layer 2: comprised of Spits 11–12, from about 1.3 m below surface to base of excavations, was a pale yellow sand (2.5Y 7/4), representing the former beach, assuming increased relative sea levels in the past owing to uplift. Basal deposits were culturally sterile with no significant indicators of habitation. The quantity of pottery drastically reduced in Layer 2, no obsidian was found, and most of the shell was non-cultural, as indicated by several large bivalves still in articulation. Pottery was not present below about 1.7 m below surface.

Chronology

Seven wood charcoal samples from Tilu, Unit 1, were submitted to AINSE for radiocarbon dating (Fig. 6.24–6.25; Table 6.6). The same sampling procedures were applied as for the Nunguri samples. The dates provide a robust chronology in order to interpret site occupation. Samples OZS552, OZS551, OZS550, OZS548, OZS547, and OZS546 are statistically identical and suggest a single phase of site occupation about 550–650 years ago, with rapid sediment build up. This is consistent with the three dates already published for the site (GX3561, GX3633, and GX3632), but the new dates provide much more precision in error ranges. Occupation at Tilu is contemporary with, or slightly

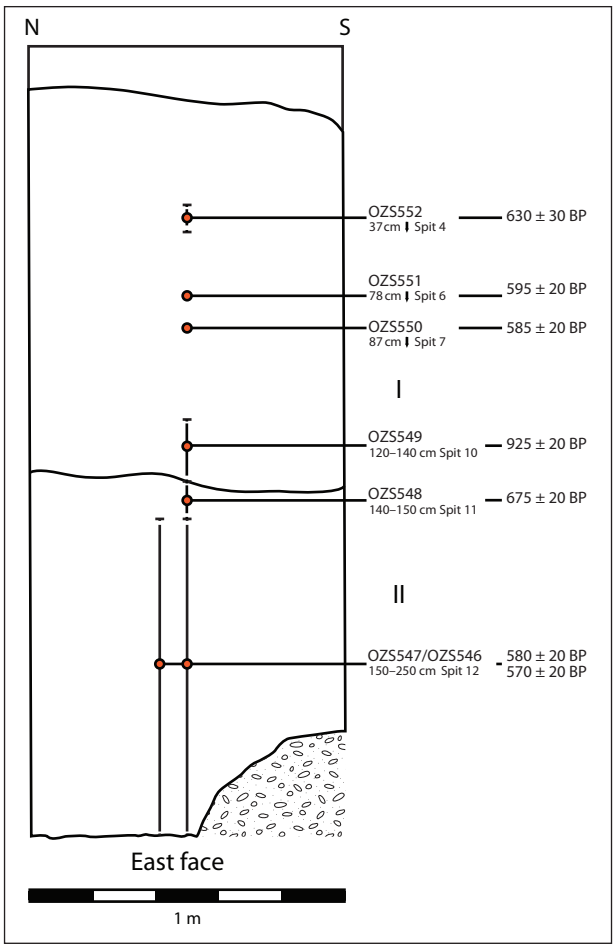


Figure 6.24. Charcoal samples submitted to AINSE for dating, Tilu, Malmal village.

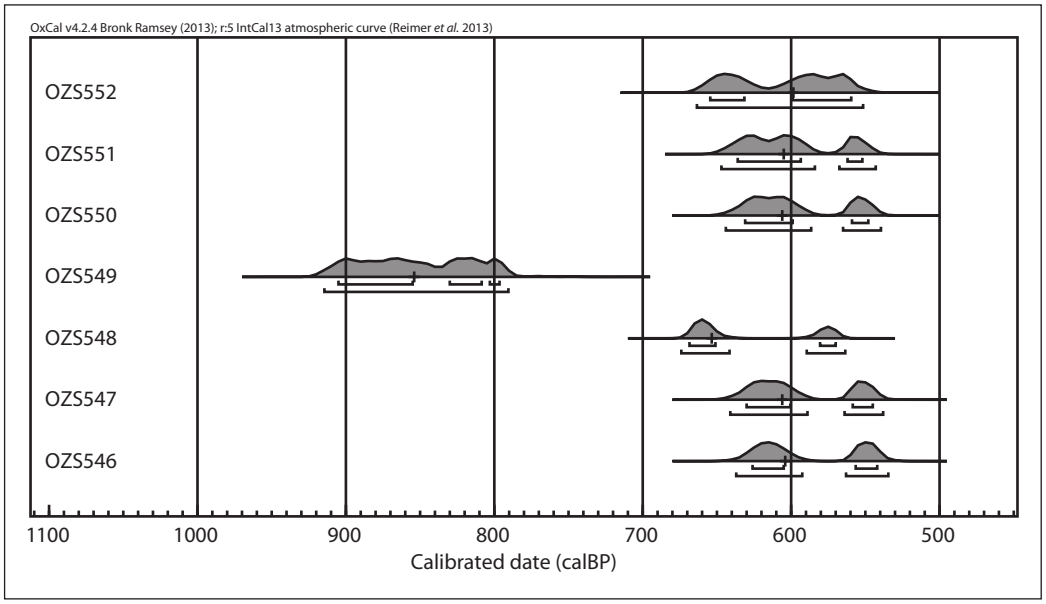


Figure 6.25. Plot of calibrated date distributions with 1σ, 2σ, and median age from Unit 1, Tilu, Malmal village (Oxcal 4.2).

Table 6.6. *Radiocarbon determinations from Unit 1, Tilu site, Malmal village.*

Lab code	Sample type	Spit	Depth below Datum 1 (cm)	δ (^{13}C) per mil	Conventional radiocarbon age (BP)	Calibrated range (2σ) (cal. BP)*
OZS552	Wood charcoal	4	37	–28.1 ± 0.1	630 ± 30	552–664
OZS551	Wood charcoal	6	78	–25.9 ± 0.1	595 ± 20	543–647
OZS550	Wood charcoal	7	87	–26.5 ± 0.1	585 ± 20	540–644
OZS549	Wood charcoal	10	120–140	–24.1 ± 0.1	925 ± 20	791–915
OZS548	Wood charcoal	11	140–150	–27.7 ± 0.1	675 ± 20	564–674
OZS547	Wood charcoal	12	150–250	–24.5 ± 0.1	580 ± 20	538–641
OZS546	Wood charcoal	12	150–250	–24.4 ± 0.1	570 ± 20	535–637

* Intcal13 atmospheric curve (Reimer *et al.* 2013); Oxcal 4.2.4

earlier than, the first occupation phase at Nunguri. The slightly older date, OZS549, is anomalous given it is bracketed by 550–650 year old dates in what was observed to be an undisturbed part of the deposit. It is possible that the older date represents inbuilt age on the wood or an earlier occupation in the area that has been redeposited.

Excavated material

All material was cleaned and catalogued in the same manner as the Nunguri material. At Tilu Unit 1, the dominant material recovered by weight was midden shell (Table 6.7). Pottery was the most significant artefact by number and was of a similar style to that on Bilbil Island (Table 6.8). However, the mean weight of potsherds relative to sieved deposit was much less at Tilu, (=0.01 kg of ceramic per 1 kg of sediment), compared to Nunguri (=0.03 kg ceramic per 1 kg of sediment). Obsidian and sparse sedimentary lithics, human and animal bone, and shell artefacts were present in minor amounts throughout Layer 1. In Layer 2 the only artefacts present were very fragmentary potsherds and a single drilled shell ornament. In contrast to Nunguri, only two potsherds from Tilu showed evidence of water-rolling, suggesting the site was less affected by the nearby shoreline.

Through the spits, pottery (g) steadily became less frequent, relative to sieved deposit (g), while shell midden (g) became much more dense relative to deposit (g) from Spits 7–9, becoming sparse in Layer 2, Spits 11–12 (Fig. 6.26). This demonstrates that the majority of material disposed in the area was shellfish food waste.

Stone material was predominantly fire-cracked rock and obsidian flaked artefacts. Down to Spit 10, fire-cracked rock, the result of oven stones being used to heat *mumu,* were made of water-rolled basalt cobbles with large pyroxene phenocryst inclusions, indicating they were likely sourced from local streams. Today, *mumu* stones are collected from the Tagog stream nearby to the site. There were no possible pottery anvils recovered, perhaps suggesting that Tilu was at no point a local production centre like Bilbil. Obsidian at Tilu (mean weight = 0.37g) was generally smaller than those collected at Nunguri (mean weight = 0.54g), and much fewer in number. All of these obsidian pieces originally derive from the Talasea source in West New Britiain (see Gaffney and Summerhayes 2018). Sedimentary flaked lithics, like those at Nunguri, were rare.

Animal bone recovered from Layer 1 includes pig and possibly dog remains with clear cutmarks suggestive of butch-

Table 6.7. *Material by weight (g) recovered from Unit 1, Tilu site, Malmal village.*

Spit	1	2	3	4	5	6	7	8	9	10	11	12	Total
Sieved deposit (kg)	119.00	98.00	108.00	117.00	75.50	116.00	128.00	88.00	146.00	117.00	84.00	594.00	**1791.00**
Pottery	3088.01	2568.00	2506.29	1928.61	1146.29	2075.38	1634.58	867.22	1878.67	657.27	56.58	19.45	**18426.35**
Obsidian	6.99	3.00	2.49	2.68	2.87	4.17	2.73	1.74	2.21	2.40	0.00	0.00	**31.28**
Non-obsidian lithic	0.00	4.93	19.87	0.00	0.00	0.00	0.00	0.19	0.61	0.00	0.00	0.00	**25.60**
Animal remains	14.28	59.36	34.76	9.39	12.50	23.07	6.76	8.14	51.87	16.51	17.60	0.00	**254.24**
Human remains	0.00	0.00	35.90	5.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**41.18**
Shell midden	1682.20	1569.25	1726.55	2326.77	1429.53	1657.45	4578.00	2221.30	6255.85	1403.57	275.98	258.40	**25384.85**
Shell adzes	0.00	0.00	0.00	7.06	0.00	0.00	0.00	0.00	37.32	0.00	0.00	0.00	**44.38**
Shell ornaments	0.00	22.79	0.00	16.54	0.00	0.18	0.00	4.73	0.00	0.00	0.00	0.08	**44.32**
Shell debitage*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.22	0.00	0.00	0.00	0.00	**7.22**
Fire-cracked rocks	26.33	57.70	14.57	3.03	163.92	0.00	733.26	15.27	268.20	226.23	0.00	0.00	**1508.51**

* Preliminary inspection- numbers expected to increase following thorough inspection of shell midden.

Table 6.8. *Material by number (n) recovered from Unit 1, Tilu site, Malmal village.*

Spit	1	2	3	4	5	6	7	8	9	10	11	12	Total
Pottery	1568	1255	1173	1126	764	1377	785	470	819	352	40	21	**9750**
Obsidian	24	8	5	9	8	17	4	4	7	5	0	0	**91**
Non-obsidian lithics	0	1	1	0	0	0	0	1	2	0	0	0	**5**
Shell adzes	0	0	0	1	0	0	0	0	1	0	0	0	**2**
Shell ornaments	0	1	0	3	0	1	0	1	0	0	0	1	**7**
Shell debitage*	0	0	0	0	0	0	0	1	0	0	0	0	**1**
Fire-cracked rocks	4	5	1	1	3	0	4	2	6	1	0	0	**27**
Total	**1596**	**1270**	**1180**	**1140**	**775**	**1395**	**793**	**479**	**835**	**358**	**40**	**22**	**9883**

* Preliminary inspection – numbers expected to increase following thorough inspection of shell midden.

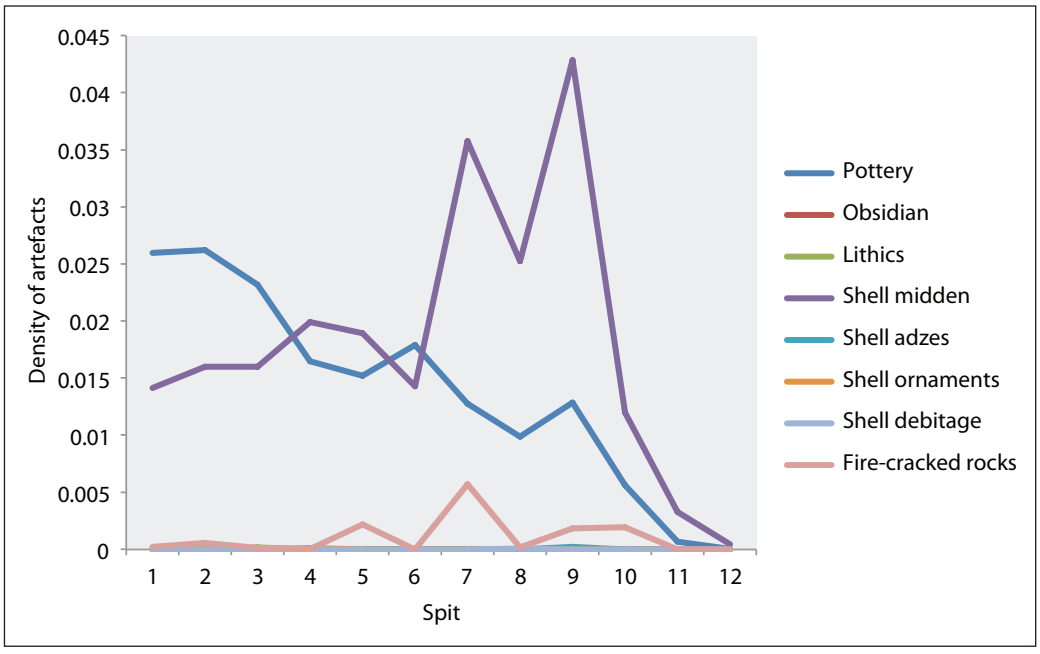


Figure 6.26. Density of artefact types to sieved deposit (g), Unit 1, Tilu site, Malmal village.

ery, as well as reef fish, birds, and reptiles (see Gaffney *et al.* 2020). A similar range of shell midden and artefacts was present at Tilu as at Nunguri, including shell adzes and ornaments (Fig.6.27). Human remains from Tilu were rare and include two mandibular fragments from Spit 3 and two disarticulated teeth from Spit 4 (see Gaffney *et al.* 2018a).

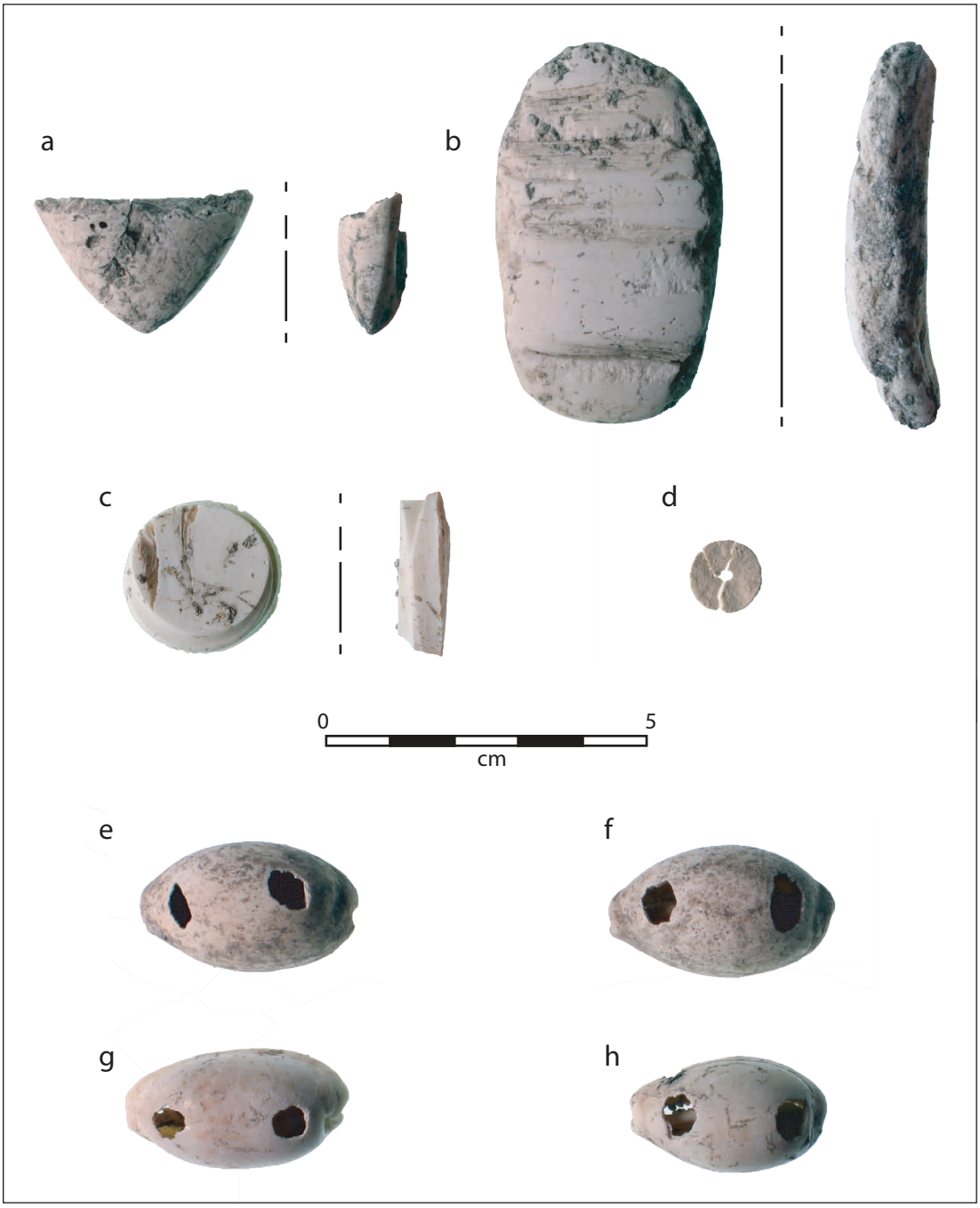


Figure 6.27. Shell artefacts from Unit 1, Tilu site, Malmal village. Shell adzes: a. T-1509-Spit 4 (butt end); b. T-1528-Spit 9. Shell core debitage: c. T-1523-Spit 8. Shell beads: d. T-1533-Spit 12; e. T-1513a-Spit 4; f. T-1513b-Spit 4; g. T-1512-Spit 4; h. T-1524-Spit 8.

Potsherds and fire-cracked rocks were the only material types recovered from Tilu Shovel Pit 1 (Table 6.9). The pottery recovered was identical to that excavated at Unit 1 apart from a unique ring base collected 60 cm below the surface.

Table 6.9. *Material by number (n) and weight (g) recovered from Shovel Pit 1, Tilu site, Malmal village.*

Depth below surface (cm)	Potsherds (n)	Weight (g)	Fire-cracked rock (n)	Weight (g)
45	22	362.16	0	0.00
60	18	344.31	1	126.91
70	9	34.13	1	284.60
80	1	78.07	0	0.00
120	6	31.85	0	0.00
Total	**56**	**850.52**	**2**	**411.51**

Summary

The initial fieldwork aims were partially addressed by the 2014 investigations. No evidence was located for Lapita age settlements around the Madang coast that could shed light on the directions of migration around New Guinea

by early Austronesian-speaking potters. Neither was there any evidence for immediately post-Lapita occupation, even directly after 1300 BP, which Lilley and Specht (2007) identify as the date that Ancestral Madang ceramics materialise in the Vitiaz Strait. As people have been active on the northeast coast since the Late Pleistocene (Groube *et al.* 1986), this lack of older deposits on the coast is likely owed to the dynamic physical landscape (see Chapter 2). The Madang coast would be unlikely to preserve places relating to early occupation, especially within the lagoon area and offshore islands, which are only 3000 years old at the earliest. Subsequent disturbance to deposits through uplift, earthquakes, or tsunami would also bias the distribution of sites along the coast. Lilley (1986: 31), for example, notes that the Ritter Island tsunami disturbed coastlines on north and east Umboi Island so much that it was often not possible to locate prehistoric occupation areas.

The ceramic styles observed both in survey and excavations around Madang were almost exclusively red-slipped, paddle and anvil made, manually tempered wares that appear to be directly ancestral to the modern Madang style potteries produced at Bilbil and Yabob. Excavations carried out at both Tilu and Nunguri recovered sufficient artefactual evidence in stratigraphic position to construct a concise and fine resolution sequence for the Madang area in the last half millennium before present. Radiocarbon dating at both sites revealed occupation spanning the last 550–650 years, associated with a full 'Austronesian-style' assemblage of pottery, obsidian flaked stone, polished axe/adzes, shell adzes, shell ornaments, and pig and dog bone. The following chapters present the analyses carried out on pottery recovered from the 2014 surface survey and excavations to investigate changes to ceramic production and exchange leading up to the ethnographic present.

Chapter 7. Pre-Colonial Potting I: Production

Knowledge is only rumour until it lives in the muscle.
– New Guinea proverb

The next three chapters describe the analysis of Madang ceramics and the pre-colonial *chaîne opératoire,* including production technology (Chapter 7), procurement and distribution (Chapter 8), and decorating procedures (Chapter 9). These chapters attempt to systematically classify the pottery assemblages presented in Chapter 6, whilst addressing important research aims at each step. This chapter is designed to assess the forming stage undertaken by pre-colonial Madang potters and has two specific aims. The first is to describe the complete diversity in pre-colonial forming technologies, which gives clues to the number of production groups operating in the past, and if they were all working within a broader community of practice (i.e. producing the same types of pot using the same techniques). Second, the study seeks to describe minor variations to pottery forming over time, which may give insight into the nature of innovation and interaction between production groups. From a culture history perspective, particular variations in the forming technology may also be limited to specific timeframes and so be useful as chrono-stratigraphic markers.

These specific aims will contribute to addressing the broader research objectives presented in Chapter 1. For instance, if there was a recent migration of Bel potters to Madang, entering into an existing manufacturing centre, we might expect to see abrupt changes to some aspects of the production sequence as the newcomers introduced their own techniques of forming vessels. However, if the earliest pottery around Madang represents the initial arrival of 'Yombans,' we would expect pottery to arrive around Madang suddenly, followed by gradual innovations over time.

To address these aims, firstly, methodological issues pertaining to ceramic classification are discussed and the technological approach to ceramics is described. The analytical procedures of the Madang formal analysis are then presented, including the nature of classification and attribute analysis. Lastly, the results of these formal analyses are presented. Pottery from each excavated assemblage and surface survey is treated separately to describe ceramic technology on-site. These results will then be synthesised in the discussion of production and exchange in Chapter 10.

Methodological issues

Style and production groups

The concept of style has dominated New Guinea ceramic analyses, echoing the style–function debates of the latter 20th century (see Plog 1995; Pollock 1983; Sackett 1977; Wobst 1977), and inspired by studies on highly decorative Lapita pots (e.g. Anson 1986). Such stylistic approaches have been popular in Near Oceania owing to the centrality of prehistoric exchange, group mobility, and interaction in explaining culture change (e.g. Cochrane & Lipo 2010; Green 1996, Irwin & Holdaway 1996; Lilley 2004a, 2004b; Summerhayes 2001b; Terrell & Welsch 1990). The definition of style in New Guinea has largely been derived from Specht (1969: 64), who suggested it is the intuitive 'content and appearance' of a pottery industry or industries distributed across time and space. Lilley (1986:160) takes this further and notes that intra-community variation in style will be negligible compared to inter-community variations. This is important because the 'style-groups' of each production community are then thought to be so intuitively distinct that they could not be mistaken for another, either by an archaeologist or an indigenous consumer. For instance, in 'Madang style' ceramics, the most obvious technical element is the brilliant red slipping, which immediately distinguishes it as 'Madang.' In short, the more communicative aspects of technology such as surface decoration, shape, and visual style are assumed to give insights into the ethno-linguistic group identities of the producers. The implicit assumption here is that intuitive styles can be matched to specific communities of practice.

The concept of isochrestic style can elucidate these basic assumptions. Isochrestic style is the range of shapes and forms which could be used, with near-equal efficacy, for a specific function (Sackett 1986). For instance, a cooking pot may be globular like that of the Bel or long and tubular like those of inland Madang groups (see Chapter 3).

Within a community, potters will be aware of only a few isochrestic styles and may choose to produce even fewer, largely dictated by the technological practices they work within (Sackett 1990). Lechtman (1977) notes that it is then the techniques used to produce decoration and form that are stylistic as opposed to the object itself. In this way, the individual's decisions during manufacture can be thought to have style, rooted in social practice and in technological choice (Gosselain 1992; Lemonnier 1992: 90; Latour & Lemonnier 1994). So, two pots could be remarkably similar in form, as many recent New Guinea ceramics are, but represent distinct isochrestic variation in technological choice. These technological choices are not necessarily discursive or even reflected upon by the individual but represent the specific technological trajectories of different communities among a myriad of possible options (Lemonnier 1993, 2013; Levi-Strauss 1960: 16). Often these choices are arbitrary or even illogical to outsiders, but are influenced by historically contingent social preferences, beliefs, representations, aesthetics, and ideas (Dobres & Hoffman 1994). This is to say that style is technological; technology is stylistic.

Technology as methodology

We now return more explicitly to the concepts of embodied knowledge and technological process to clarify how archaeological observations can be used to investigate precolonial production. As outlined in Chapter 1, technology is a dynamic process. Technology materialises, and is the materialisation of, embodied knowledge; it comprises the processes operating between the boundaries of enculturated habit and the technical choices of individuals and social groups (Lemonnier 1992; Pigeot 1990). Therefore, technology – a study of techniques – can be used as the methodological link to investigate everyday routine and human enculturation into specific communities of practice (Knappett 2005a, 2011: 98).

The methodological apparatus developed by the French school to investigate technological choice throughout the production process is known as the *chaîne opératoire* (Haudricourt 1968; Leroi-Gourhan 1943, 1945). A *chaîne opératoire* describes the sequence of operations, or techniques, which brings a raw material from an unmodified state to a manufactured state (Cresswell 1976: 6), or, more broadly, the series of operations involved in any transformation of matter by (usually human) beings (Lemmonier 1992). Individual *chaînes opératoires* act as idiosyncratic strands of broader technological processes, specific to communities. They emphasise every stage in an artefact's production, extending archaeological enquiry from the single object to longer processes, both on the bodily time scale and over the *longue durée,* enhancing the archaeologist's ability to interpret past technological practices and how they have changed over time (Martinon Torres 2002).

The *chaîne opératoire* is complementary to the North American behavioural chain, which focuses on not only production, but the entire life history of an artefact (Hollenback & Schiffer 2010; Schiffer 1995; Skibo & Schiffer 2008). The conceptual advantage of the *chaîne opératoire,* however, is that it preferences technological and social processes over transformations to the artefact (Knappett 2012; Lemonnier 1992). Objects are very rarely intended to become socially inert at the end of the production process, nor does technology, as a mode of engagement between people and things, cease to acquire or create meaning during distribution, use, and discard (Pelegrin 1990; Sellet 1993; Sillar & Tite 2000). A consumer of pottery, for instance, engages embodied knowledge during cooking or while storing the pot in such a way that it will not break. As such, these aspects of material engagement can be viewed as necessary and meaningful links in technological processes. For this reason, more pragmatic approaches have expanded the *chaîne opératoire* beyond the realms of making things to include using, unmaking, and remaking (Naji 2009). Although technological processes represent a continuum, for analytical purposes the *chaîne opératoire* can then be subdivided into phases of procurement, production, distribution, consumption, alteration, re-use, and discard (Fig. 7.1; Gaffney 2019).

The phases of a *chaîne opératoire* can be deconstructed further. Here, a 'technical element' is the smallest analytical unit of study, formed by the interplay between a gesture, an intention, and matter (modified from Lemonnier 1992: 31). As technical elements are repeated, through habitual material engagement, the boundaries between gesture, intentionality, and matter become blurred, creating embodied knowledge (see Malafouris 2008). The *chaîne opératoire* is an arrangement of technical elements in order. The community specific sequences of these elements are known as 'technical syntaxes,' which are, of course, regulated by broader social and technological conventions. These distinctions are important because technical elements are more fluid in terms of sharing (i.e. transmission) and are often passed horizontally within or between communities of practice, while syntaxes are more conservative and are likely to be passed from parent to child, teacher to pupil (Apel 2008; Apel & Darmark 2007). Because decorative elements or minor technical variations are less reliant on extended syntaxes, they are more readily shared across social boundaries than vessel forming techniques (Arnold 1985, 1998; Mayor 2005). Thus, individual elements may be widely distributed, while syntaxes are usually specific to production groups.

Variation within technical elements illustrates the range of what constitutes socially appropriate forms within the community of practice (Lemonnier 1983: 17; Mahias 1993). By examining specific variations in the technical syntax, however, different social/production groups may be identified (Roux & Courty 2005). On the other hand, elements in the syntax that are invariant may be seen as necessary and cannot be modified without jeopardising the chain for either social or physical reasons (van der Leeuw 1993).

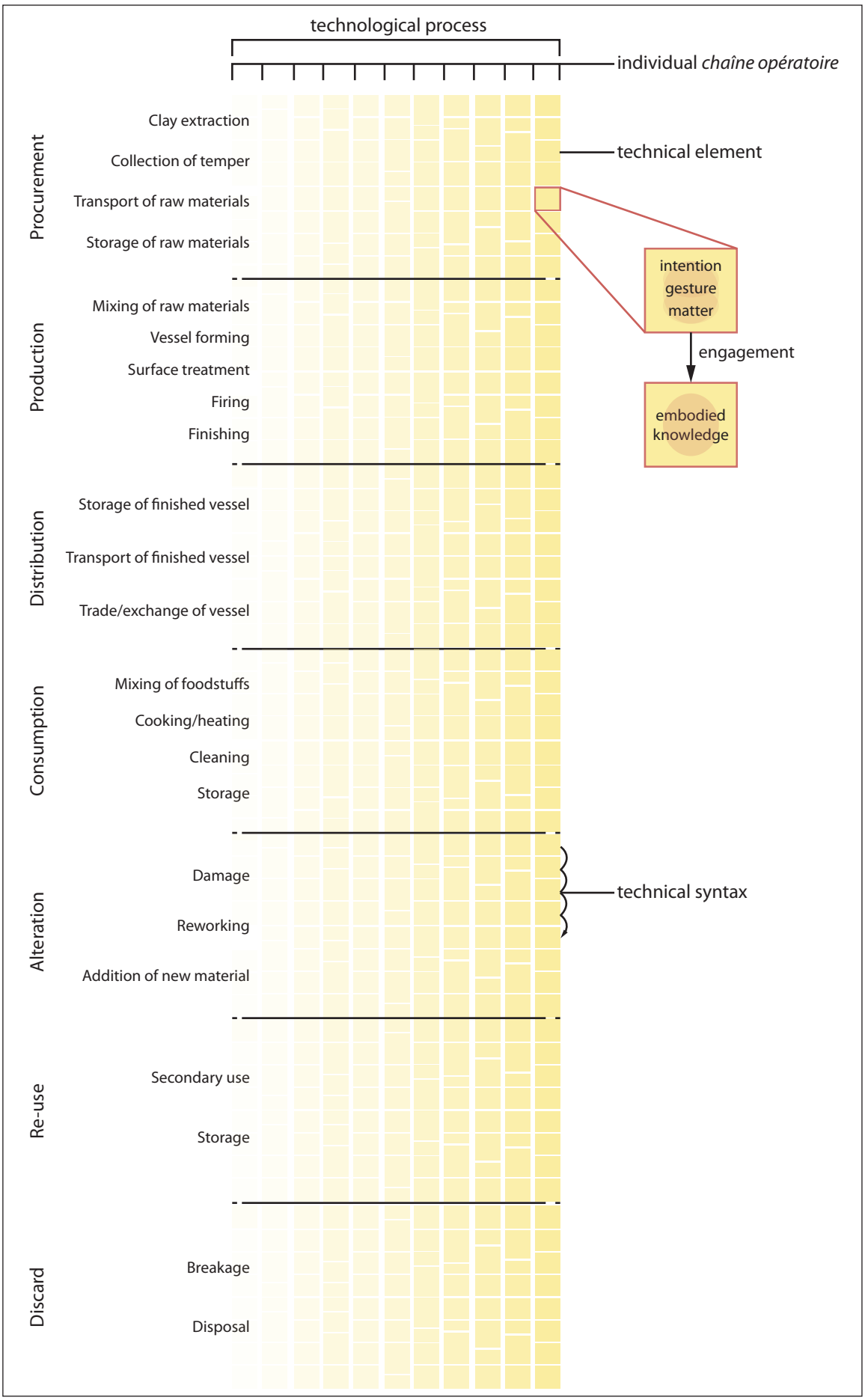


Figure 7.1. Analytical terminology of a ceramic *chaîne opératoire* (after Gaffney 2019).

Approaches to New Guinea pottery classification

Conventionally, the study of archaeological ceramics in New Guinea has attempted formal classification. Such approaches stem, particularly, from foundational North American classification systems (Gifford 1960; Rouse 1951, 1960, 1965; Shepard 1963, 1965; Willey 1945), which advocated the use of polythetic attribute analyses to group artefacts. Ceramic attributes, first used in the New Guinea area by Specht (1969) and described as the smallest unit of analysis that an artefact can be reduced to (e.g. lip profile, rim course, orifice diameter), have become fundamental to pottery classification. This emphasis on classification derives from the real need to establish historical sequences in new areas of archaeological research. Without such regional sequences, based on pottery attributes and absolute dating, interregional comparisons would be difficult.

The analytical procedures behind classification have been variable and assemblage-specific. However, the practice of constructing categories to sort artefacts into, creating mutually exclusive units for further analysis and interpretation, has been similar. In this volume, the term 'classification' denotes the most general kind of categorisation of artefacts into matching sets, with the possibility of contrast and similarity to other sets, while 'typology' is a specific kind of classification designed to sort limited groups of artefacts into mutually exclusive categories (following Adams 1988; Adams & Adams 2007). In this sense, nearly all 'classifications' in circum-New Guinea ceramic analysis, variously referred to as types, styles, classes, groups, forms, and wares, are typological in some way.

Often, intuitive typological sorting allows an assemblage to be subdivided into more manageable units before further sorting or classifying based on specific attributes (see Bulmer 1978; Lilley 1986; Terrell & Schechter 2011). Other times, types will first be defined based on specific geometries and rim attributes, before classification and correlation with further attributes such as decoration, metric data, or fabric groups (see Garling 2007; Hogg 2011; Kaplan 1976; Lauer 1970a; Rhoads 1980; Skelly 2014; Specht 1969; Summerhayes 1996, 2000; Vanderwal 1973; Wickler 2001). Others again have hierarchically sorted artefacts into more or less inclusive units of analysis based on specific attributes (Egloff 1971, 1979; Irwin 1977, 1985). Hierarchical classifications (or 'taxonomies') can then be arranged by cluster/network analyses to form types (Renfrew & Strerud 1969; Sokal & Sneath 1963). However, such approaches have been cautioned against as not all attributes have equal weighting in the classification system (Christiansen & Read 1977; Dunn & Everitt 1982; Read 1989). Lastly, a more recent study has avoided typology and classified sherds based on stratigraphy before undertaking an attribute analysis (Shaw 2014), but this is unique in New Guinea archaeology.

It should be acknowledged that typologies and classifications need not have fixed, empirical meaning; they are pragmatic constructs to help order and interpret observations rather than an objective reality (Adams & Adams 2007: 5; Bedford 2006a: 73; Hill & Evans 1972). In such a way, Lilley's (1986) classification of Madang ceramics was appropriately used as an analytical device to order large amounts of information, rather than an attempt to reconstruct emic type-systems (see Chapter 5). Further, in no way are such analyses free from value judgments or subjectivity (Keighley 1973; contra Sokal & Sneath 1963 [influential for Egloff 1979 and Irwin 1985]). However, the clear explication of how attributes are measured and described does much to alleviate concerns of intra-observer variation and makes inter-observer comparisons more accessible and accurate (Whittaker *et al.* 1998).

Technological classification

The methods behind New Guinea ceramic classification certainly do not need to be reinvented, but methodological justifications linking higher-order theory and low-level attributes are here repositioned to focus on the technological (and social) processes of production as opposed to style and classic typology. As Pétrequin and Pétrequin (1999) point out, examining the subtleties of pottery technology delineate past production communities in a more systematic manner than stylistic approaches to shape and decoration. These archaeologists are the only ones in New Guinea to attempt a typology of ceramic technological traditions, comparing ethnographic and archaeological *chaînes opératoires* around the New Guinea region to examine broad movements and interactions of past communities. The Pétrequins' typology is hierarchical, sorting ceramic traditions with increasing levels of exclusiveness based upon significant technical elements and their syntaxes in the technological process.

Consequently, social approaches to technology are not necessarily divorced from typology, but the conceptual procedures behind classification are different. To identify a *chaîne opératoire* through pottery artefacts, a hierarchical typology based on three successive strategies of eight steps is required (Fig. 7.2). Firstly, formal classification distinguishes clusters of attributes pertaining specifically to vessel forming to demonstrate elements and syntaxes diagnostic of different *chaîne opératoire* and technological processes. This establishes technical classes and their variants based on production techniques, which should delineate specific communities of practice. Secondly, sherds belonging to different technical classes/variants are then sorted into distinct fabric groupings and further classified by a geochemical examination of tempers and clays (Roux & Courty 2005; see also Summerhayes 2000). The result of this hierarchical procedure are techno-compositional classes that are then, thirdly, compared with morphological variations and decorative elements to establish techno-style groups, diagnostic of specific production groups within the broader communities of practice (see Roux 2011). This chapter describes the results of the first stage of this hierarchical classification (steps 1–4), aiming to identify specific technological processes and the variation within them during the production phase.

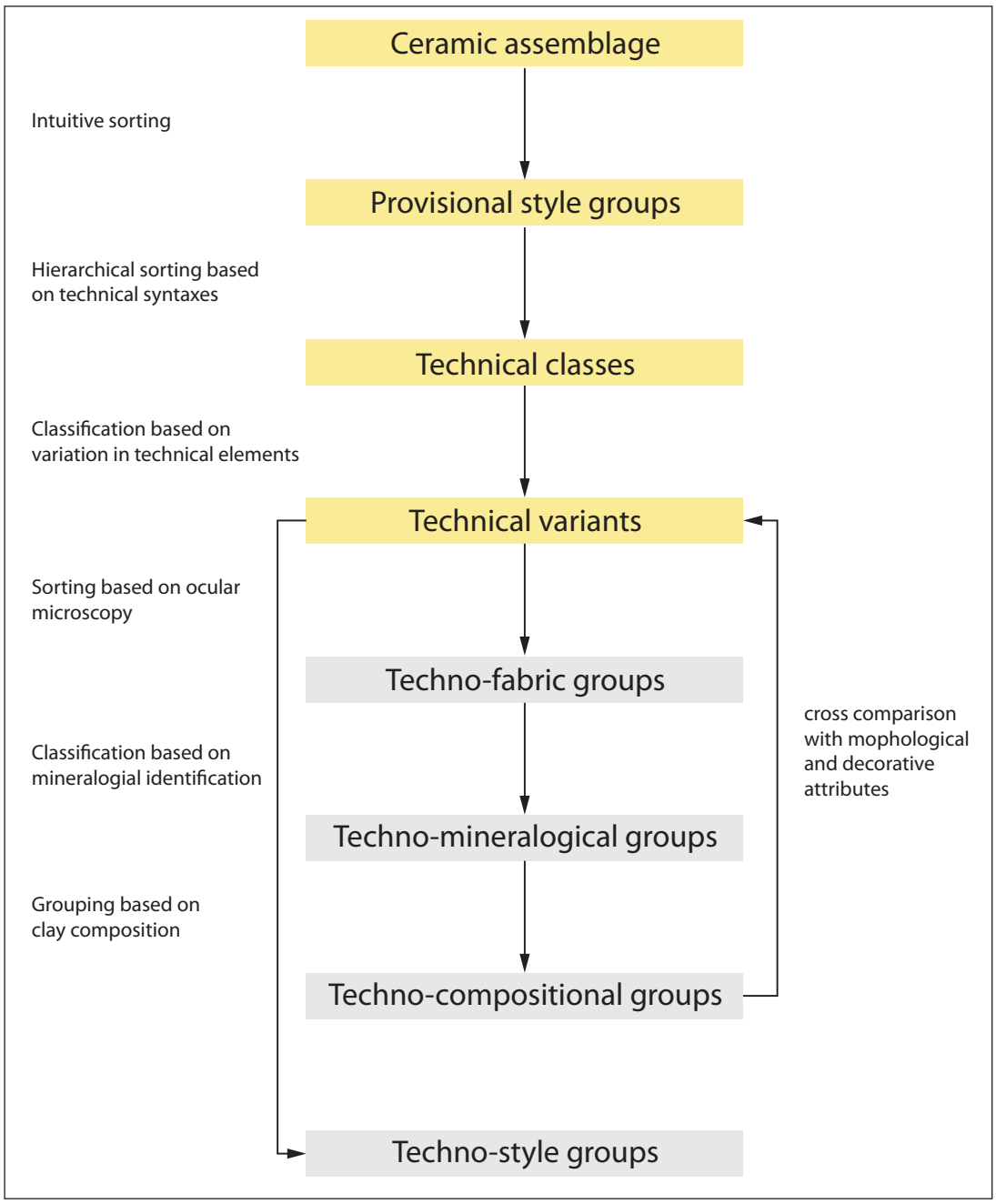


Figure 7.2. Procedures of a technological classification (adapted from Roux 2011). The procedures examined in this chapter are highlighted yellow.

Method

The Madang classification

To classify the Madang assemblages, all sherds were first sorted intuitively based on internal and external surface features which would be common to the entirety of the vessel, such as forming method and surface treatments to the exterior. This was a necessary step to deal with the large volume of artefacts, and separated sherds into provisional style groups. For consistency in the classification of northeast New Guinea pottery, the broad style groupings assigned by Lilley (1986:160) are retained. So, the red-slipped, manually tempered, paddle and anvil constructed, globular pots common around coastal Madang are described as 'Madang style.' Intra-group stylistic variations in the technological process (e.g. between clan lines, or between different potters within a clan) are assumed to be minor compared to inter-group variation (e.g. between Madang style and exotics). 'Exotic' non-Madang styles were present but extremely rare at both Tilu and Nunguri and in surface collections. For this reason, the emphasis of this chapter is on the forming technologies of Madang style ceramics, with exotics only mentioned in passing.

After describing broad style groupings, the sherds were then sorted by portion (Fig. 7.3). Rim sherds were considered those that displayed a lip. Necks were those that

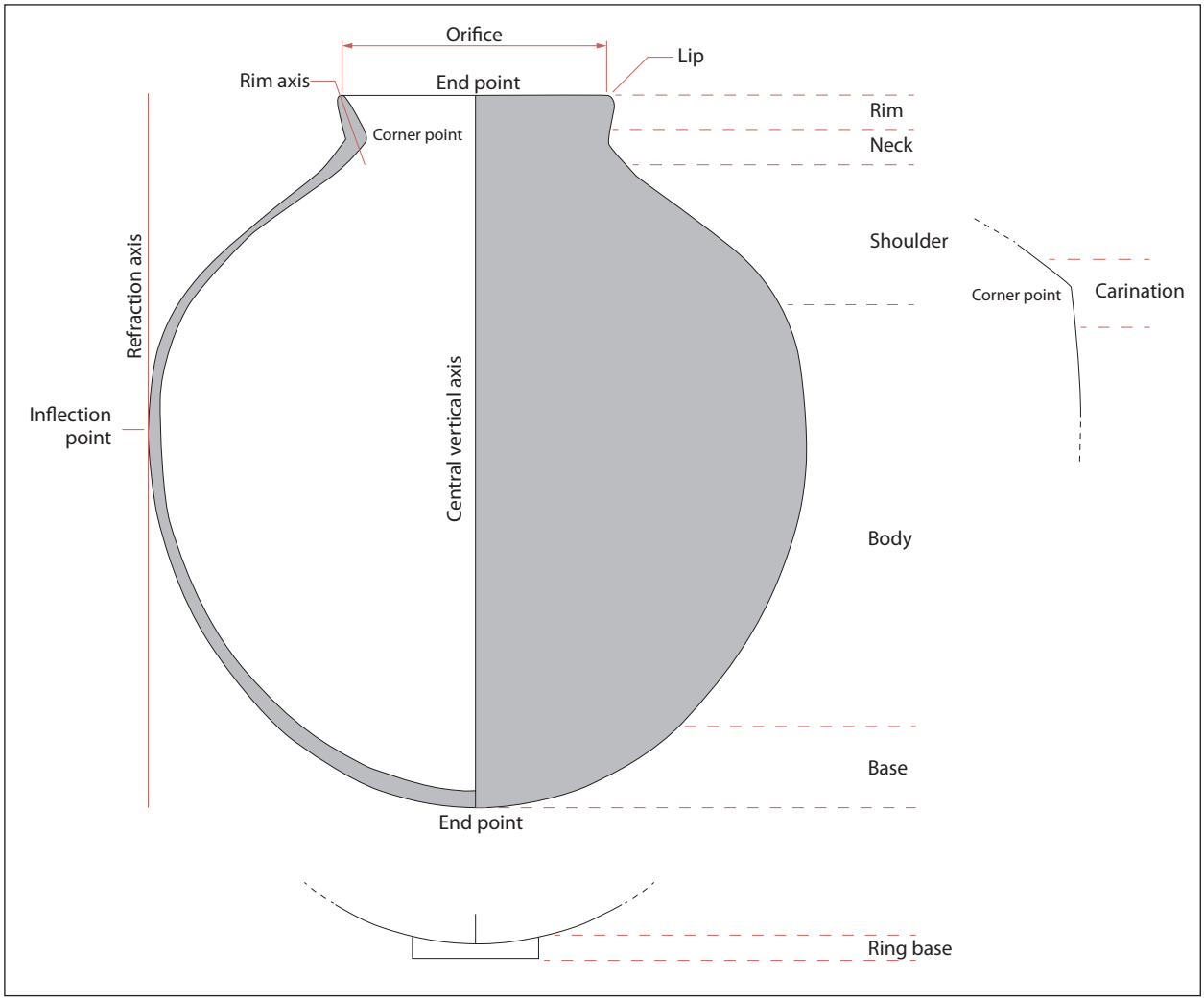


Figure 7.3. Anatomical landmarks of a Madang style pot.

displayed a corner point and an abrupt change to vessel course between the body and lip. Shoulder carinations were those that displayed a corner point and an abrupt change to vessel course between the body and shoulder. Ring bases were those with a distinct circular moulding acting as a stand. Plain body and base sherds were not further considered in the analysis as all appeared to belong to the Madang style group and did not provide significant information about the production process.

The Madang style rims and necks were then hierarchically sorted into 'technical classes,' based on diagnostic technical syntaxes in the *chaîne opératoire* (Fig.7.4). Again, for consistency with established literature, the numbering of these classes follows Lilley (1986) rather than hierarchical closeness pertaining to the *chaîne opératoire.* Rim Classes 1–3 are retained, with minor alterations to their descriptors, and Classes 4 and 5 are added, as they were not represented in the Vitiaz Strait assemblages, but are described by Egloff (1975) around Madang. Here, Class 1 represents vessels that likely began with an everted rim preform, with the body subsequently being shaped using an anvil up to the interior corner point where the body meets the rim. Class 5 vessels followed the same *chaîne opératoire,* but with an inverted neck, fashioned either in the body forming stage or during preforming. Class 2 vessels followed a similar *chaîne opératoire* to Class 1, but a paddle was used to bevel the exterior of the rim, probably during the body forming stage. Class 3 rims are distinct from Classes 1, 5, and 2 in having a very thick internal collar and neck, with a body thickness abruptly thinner than the collar. This internal collar is formed by the gentle hitting of the anvil on the interior corner point of the rim during body forming (see Tuckson 1966). Lastly, Class 4 is distinguished from Classes 1, 2, 3, and 5 by the possible absence of a rim preform and interior smoothing using an anvil up to the lip. This results in thin bodies with restricted necks and no abrupt change in incurving vessel course. It is worth noting that Classes 1, 2, and 3 all represent *bodi* or *tangeng* within the current Bel type-system (see Chapter 4), despite following different technical syntaxes. Class 4 is equivalent to the *magob* and Class 5 is equivalent to single spouted *you-bodi*.

Technical attributes

Following hierarchical sorting of Madang style sherds into major technical classes, attribute analysis was used to

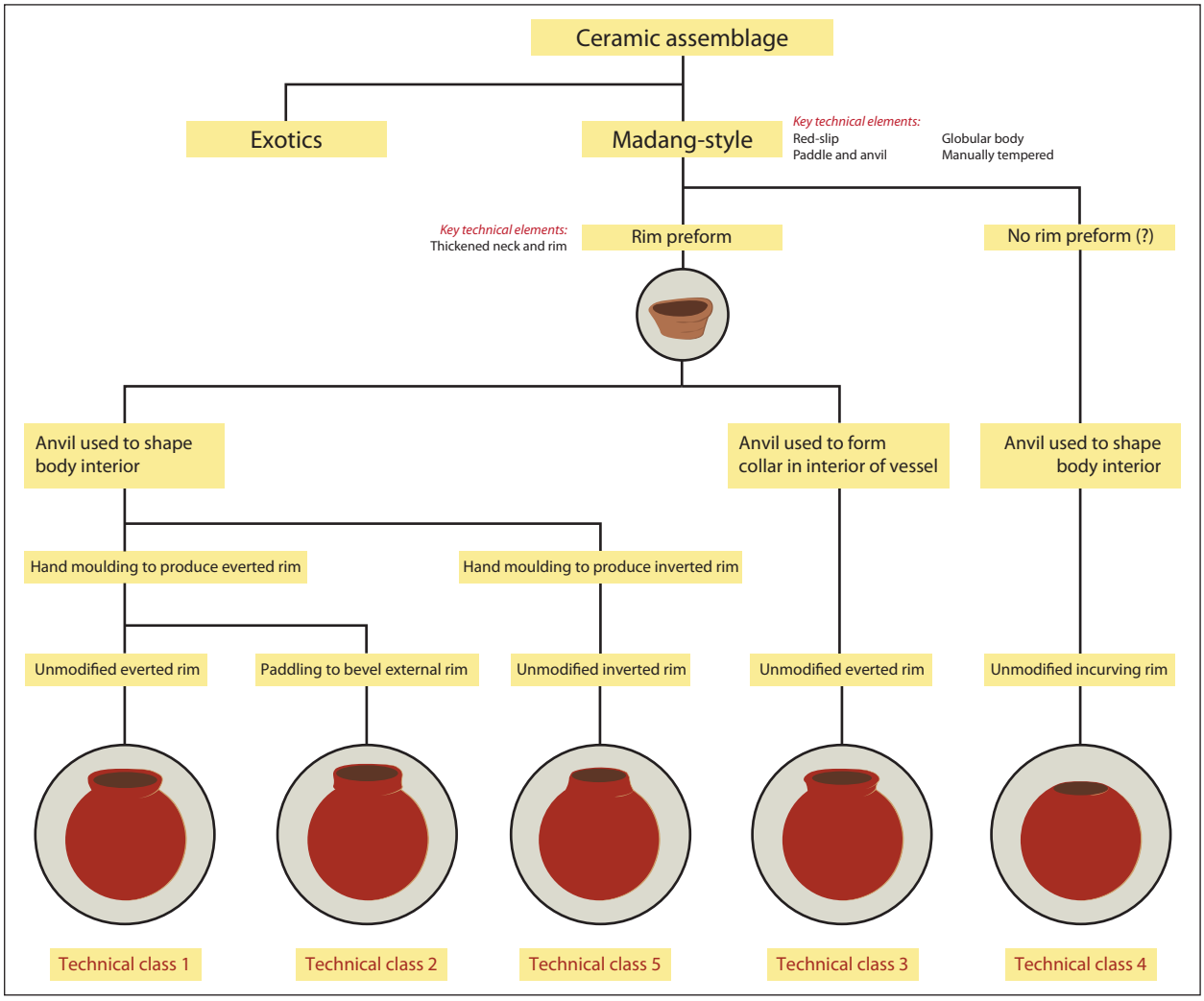


Figure 7.4. Classificatory procedures to distinguish Madang style technical classes based on *chaîne opératoire*.

investigate variations in specific technical elements and to define 'technical variants.' For instance, minute differences in rim or lip shapes give insight into the individual potter's gestures and intentionality on the clay – that is, embodied knowledge – and levels of enculturation into the production group (Kohring 2013). Importantly, owing to isochrestic variation, not all possible combinations of attributes will be represented. Those variants that are present will represent the extent of technological choice, while those not represented will indicate the boundaries of technological processes. By examining the variation within specific attributes, we can also describe which elements had tight social regulation in production and those with more relaxed controls. Moreover, specific technical elements may be spatially or temporally linked to specific production communities, which can then be used as chrono-stratigraphic indicators of technological change.

Rims, necks, shoulder carinations, and ring bases (hereafter 'formal sherds') were examined to investigate variation of technical elements within different technical classes. Rim sherds provide the most information about vessel form (Poulsen 1987: 870), and so the majority of selected attributes concern rim morphology. The formal attributes entered into the Madang pottery database comprise both discrete (I–VI) and continuous (VII–XI) variables and are laid out as follows:

I. *Rim direction* describes the general relationship between the rim and body shape (Summerhayes 2000: 35). Correct rim direction can be determined by placing each rim under a horizontal surface and moving the sherds at different orientations until the lip contacts the horizontal plane most completely (see Rice 1987: 222; Summerhayes 2000: 35). This allows the rim direction of very fragmentary sherds, only preserving the lip, to be determined. Note that direction was not recorded for rims that did not preserve enough circumference to be confidently orientated. Four rim directions were observed in the Madang assemblages: everted, inverted, incurving, and direct. Everted rims are those with an interior corner point (C.P.) and an abrupt change in vessel course forming a distinct rim and neck that projects away from the central vertical axis (Fig. 7.5). Inverted rims are those with an interior corner point (C.P.) and an abrupt change in vessel course forming a distinct rim and neck that projects towards the central vertical axis. Incurving rims are recognised by the presence of an inflection point (I.P.) and no corner point, con-

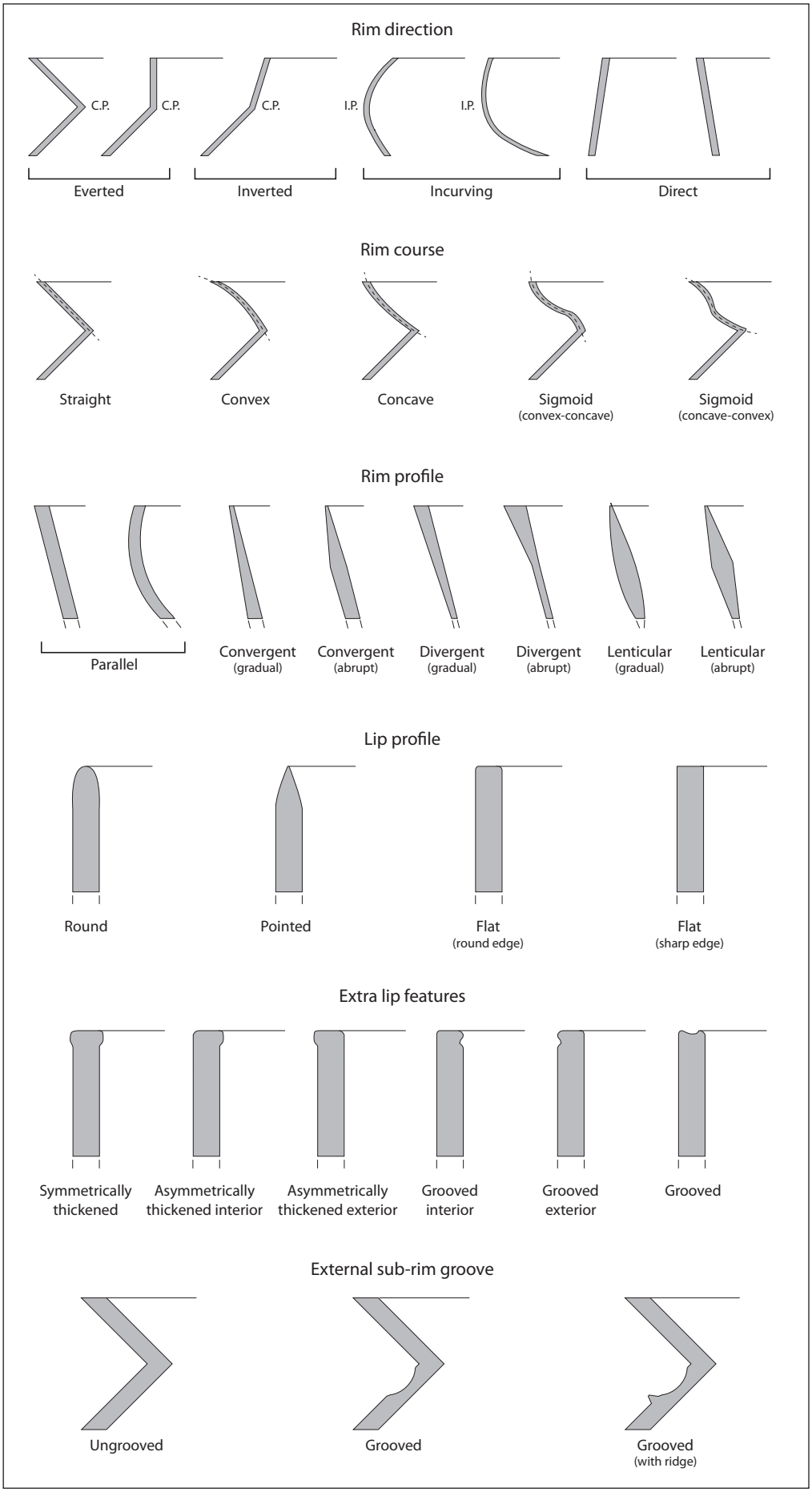


Figure 7.5. Discrete technical attributes recorded in the ceramic database.

touring towards the central vertical axis. Direct rims, only observed on exotics, are straight with no evidence of corner or inflection points, but may project parallel, towards, or away from the central vertical axis.

II. *Rim course* is defined as the general line through the rim axis, between the lip and body (see Irwin 1985:105). A rim course is either straight or curved (Fig. 7.5). If it is curved, it is either concave or convex relative to the central vertical axis, or it is sigmoid (convex–concave or concave–convex). This course is often defined by how the potter spins the rim in her hands while preforming or moulding the body.

III. *Rim profile* is the cross-section of a rim, representing the relationship between the interior and exterior surfaces of the rim walls (Frankel *et al.* 1994:15; Summerhayes 2000:36). Seven rim profiles were observed in the Madang assemblages (Fig. 7.5): parallel, with interior and exterior surfaces of constant thickness; convergent (gradual or abrupt), with walls tapering towards the lip; divergent (gradual or abrupt), with thickening towards the lip; and lenticular (gradual or abrupt), with the interior and exterior surfaces diverging and then tapering towards the lip.

IV. *Lip profile* is the cross section of the lip at the end point of the rim (Summerhayes 2000:36). Four lip profiles were identified: round, pointed, flat (round edge), and flat (sharp edge) (Fig. 7.5.).

V. *Extra lip features* are a category for additional morphological attributes that are not covered by the lip profile category. This includes elements that are largely inconsequential to the forming process but can describe the peculiar movements of the individual potter as they moulded the lip. Lips can be symmetrically thickened, asymmetrically thickened on the interior surface, asymmetrically thickened on the exterior surface, grooved (along the circumference of the lip), grooved around the exterior of the lip, or grooved around the interior. In the Madang style, these variations appear to be caused primarily by the pinching of the clay and the position of the fingers while forming the preform or holding it while paddling the body.

VI. *External sub-rim grooves* are produced by deliberate paddling to form a groove or sometimes a groove with associated ridge, below the rim and neck (Fig. 7.5). These are rare and only observable on especially well preserved rims.

VII. *Thickness* was measured at three distinct points with Vernier callipers. Rim thickness, recorded on all incurving rims, everted and inverted rims of sufficient preservation, was considered the maximum distance between the interior and exterior rim walls, perpendicular to the rim axis (Fig. 7.6). Neck thickness, only recorded on everted and inverted rims and necks, was the distance between exterior and interior surfaces immediately below the rim, perpendicular to the body course. Body thickness, measured on decorated body sherds only, was the maximum distance between exterior and interior surfaces (Fig. 7.6).

VIII. *Rim length*, measured with callipers on everted and inverted rims only, was taken as the distance between the lip and the neck running through the rim axis.

IX. *Rim orientation* was measured by an adjustable protractor attached to a horizontal surface (see method used by Skelly 2014:104), recording the angle between the central vertical axis and the rim axis (Irwin 1985: Fig. 43). Note that positive orientation is not always possible on fragmentary samples. Here, orientation for those rims with < 5% circumference was not recorded.

X. *Rim inclination* was measured on everted and inverted rims by goniometer, taken as the angle between the rim axis and the body course.

XI. *Diameter* was calculated for both rims and ring-bases. Orifice diameter is the maximum width of the vessel mouth from rim axis to rim axis. This measure is obtained by orientating the lip correctly (as above) on a diameter-recoding sheet which has concentric circles marked at 1 cm intervals (see Rice 1987: 223; Skelly 2014:105; Summerhayes 2000:36). Orifice diameter can indicate primary function (e.g. *bodi* cooking pots have larger orifices than *you-bodi* water pots) or technological variation between communities (e.g. modern Bilbil *bodi* usually have wider mouths than Mindiri *bodi*). Ring-base diameter is the maximum width of a circular stand, placed on the same diameter-recording sheet.

Assemblage composition

In total, 46,682 pottery sherds were recovered in the 2014 field season and are examined in the current study. This includes 46,573 sherds from excavated contexts and 109 from surface survey (Table 7.1). Prior to laboratory processing, starch and phytolith residue samples were extracted from 44 Tilu sherds and 12 Nunguri sherds. Micro-botanical analysis by Judith Field, Sindy Luu, and Adelle Coster indicate starchy foods were being cooked in some of the pots at Tilu (Gaffney *et al.* 2020). All ceramics were then individually washed through 2 mm sieves, cleaned with brushes, and dried at 20°C in the Archaeology Laboratories, University of Otago. Plain body sherds were bulk bagged and weighed, while decorated and formal sherds were individually bagged and assigned catalogue numbers. The decorated and formal assemblages were analysed and later reexamined to develop a clear idea of the variation that existed within the assemblage and to ensure internal consistency throughout the analysis.

At both Tilu and Nunguri, the ratio of sherd portions is consistent throughout Layer 1. However, in Layer 2 the small sample sizes are problematic resulting in few formal and decorative sherds being represented (Fig. 7.7–7.8). Generally, however, both excavated assemblages produced comparable proportions of rims, necks, decorated body sherds, and plain body sherds for analysis. Plain sherds dominate the assemblages, comprising 90% of the total sherd count (n = 41,826), while decorated sherds consti-

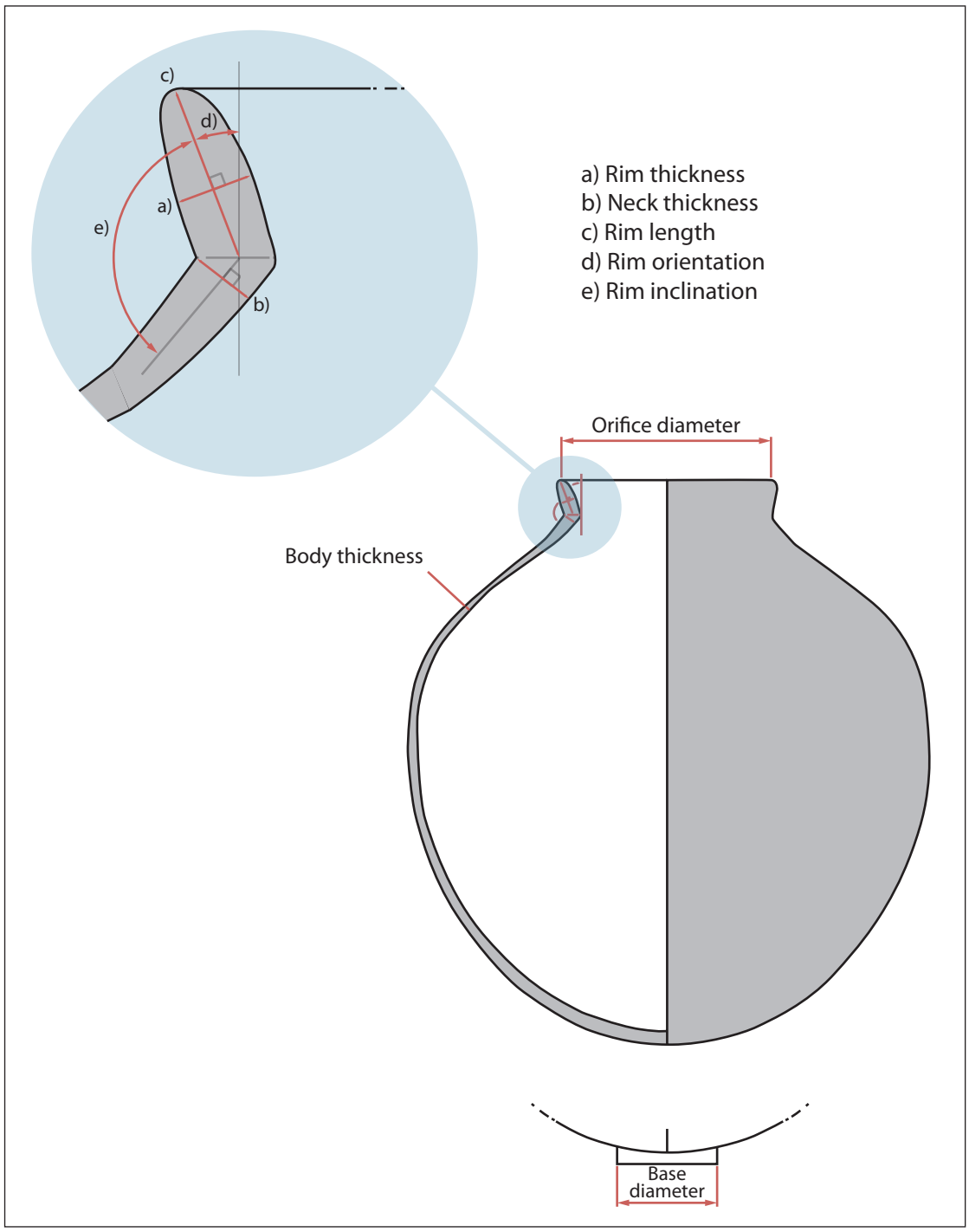


Figure 7.6. Metric technological attributes recorded in the ceramic database.

tute 8% (n = 3637), rims constitute 2% (n = 1090), and necks, bases, and carinations < 1%.

Rims were visually compared and refitted during processing and analysis to give a minimum number of vessels (MNV) per spit (see Goodby 1998; Specht 1969:72). These values constitute all sherds assignable to a single vessel and can be used to assess whether artefacts are in primary deposition and to reduce concerns of taphonomic bias, caused by differential breakage patterns, when quantitatively comparing potsherds and associated attributes through time (Table 7.2). At Tilu, refitting determined that there was little redeposition and vertical disturbance. Although rim sherds from the same vessel were collected from base of Spit 1 and top of Spit 2, one sherd in Spit 9 refitted with two from Spit 10, and one from Spit 1 refitted with another from Spit 4, all other sherds refitted with others from their own spit. In the case of multiple sherds refitting from different spits, the MNV count was assigned to the spit most frequently represented. In the case that two sherds from different spits rejoined, the MNV count was assigned to the lower spit. Owing to the large number of surface sherds around Tilu, redeposition was considered more plausible than downward movement through the deposit. At Nun-

Table 7.1. *Madang ceramic assemblages by number (#) and weight (g).*

Site	Spit	Rim		Neck		R. base		Carination		Decorated body		Plain body		Total	
		#	g	#	g	#	g	#	g	#	g	#	g	#	g
Nunguri Test Pit 1	1	22	314.85	5	33.54	–	–	–	–	95	282.84	1491	1685.60	**1613**	**2316.83**
	2	149	2132.81	17	124.24	–	–	–	–	425	1490.31	4902	7003.50	**5493**	**10750.85**
	3	135	1929.10	14	76.55	–	–	–	–	403	1378.69	4323	7519.91	**4875**	**10904.25**
	4	92	1843.99	10	49.80	–	–	–	–	251	989.98	2402	4818.97	**2755**	**7702.74**
	5	37	468.06	9	76.64	–	–	–	–	103	424.26	913	1803.77	**1062**	**2772.73**
	6	64	539.87	11	86.64	–	–	–	–	227	656.16	3163	4027.94	**3465**	**5310.61**
	7	49	404.78	4	30.76	–	–	–	–	158	484.44	1525	2175.45	**1736**	**3095.43**
	8	29	239.09	2	25.58	–	–	–	–	140	460.55	1767	2218.27	**1938**	**2943.49**
	9	35	375.04	7	36.62	–	–	–	–	107	376.59	1336	1817.02	**1485**	**2605.27**
	10	39	424.35	1	1.78	–	–	–	–	116	417.55	1424	1831.08	**1580**	**2674.76**
	11	53	676.31	3	22.50	–	–	–	–	191	512.04	2505	2824.09	**2752**	**4034.94**
	12	43	391.57	5	20.16	–	–	–	–	154	505.43	1593	1944.48	**1795**	**2861.64**
	13	40	313.63	6	44.50	–	–	–	–	219	795.23	2201	2252.65	**2466**	**3406.01**
	14	47	744.88	5	34.81	–	–	–	–	239	763.36	2121	2665.30	**2412**	**4208.35**
	15	46	595.67	4	10.51	–	–	–	–	120	335.34	1118	1178.01	**1288**	**2119.53**
	16	1	7.27	–	–	–	–	–	–	–	–	35	33.66	**36**	**40.93**
	17	–	–	–	–	–	–	–	–	–	–	16	10.61	**16**	**10.61**
Sub-total		**881**	**11401.27**	**103**	**674.63**	**–**	**–**	**–**	**–**	**2948**	**9872.77**	**32835**	**45810.31**	**36767**	**67758.98**
Tilu Unit 1	1	25	333.72	3	13.80	–	–	–	–	131	602.69	1409	2137.80	**1568**	**3088.01**
	2	30	348.61	4	53.12	–	–	–	–	93	480.81	1128	1685.46	**1255**	**2568.00**
	3	15	288.58	5	28.4	–	–	–	–	100	428.87	1053	1760.44	**1173**	**2506.29**
	4	14	191.48	1	5.55	–	–	–	–	74	334.34	1037	1397.24	**1126**	**1928.61**
	5	6	70.18	2	2.81	–	–	–	–	40	119.32	716	953.98	**764**	**1146.29**
	6	15	267.52	3	23.67	–	–	1	1.21	66	215.80	1292	1567.18	**1377**	**2075.38**
	7	23	306.99	2	11.16	–	–	–	–	54	242.63	706	1073.80	**785**	**1634.58**
	8	5	126.60	3	15.08	–	–	–	–	14	70.07	448	655.47	**470**	**867.22**
	9	24	426.05	1	0.65	–	–	–	–	69	289.39	725	1162.58	**819**	**1878.67**
	10	5	56.82	–	–	–	–	–	–	21	106.24	326	494.21	**352**	**657.27**
	11	–	–	–	–	–	–	–	–	1	1.87	39	54.71	**40**	**56.58**
	12	–	–	–	–	–	–	–	–	4	4.72	17	14.73	**21**	**19.45**
Sub-total		**162**	**2416.55**	**24**	**154.24**	**–**	**–**	**1**	**1.21**	**667**	**2896.75**	**8896**	**12957.60**	**9750**	**18426.35**
Tilu Shovel Pit 1	45 cm	8	170.72	–	–	–	–	–	–	3	28.59	11	162.85	**22**	**362.16**
	60 cm	5	174.58	–	–	1	29.6	–	–	2	12.42	10	127.71	**18**	**344.31**
	70 cm	–	–	–	–	–	–	–	–	–	–	9	34.13	**9**	**34.13**
	80 cm	1	78.07	–	–	–	–	–	–	–	–	–	–	**1**	**78.07**
	120 cm	1	15.83	–	–	–	–	–	–	–	–	5	16.02	**6**	**31.85**
Sub-total		**15**	**439.20**	**–**	**–**	**1**	**29.6**	**–**	**–**	**5**	**41.01**	**35**	**340.71**	**56**	**850.52**
Kranket Is.	Surf.	7	170.20	–	–	–	–	–	–	3	45.21	–	–	**10**	**215.41**
Siar Is.	Surf.	4	68.66	–	–	–	–	–	–	1	23.49	1	4.23	**6**	**96.38**
Yabob Is.	Surf.	6	324.23	–	–	–	–	–	–	1	15.42	–	–	**7**	**339.65**
Malmal	Surf.	15	430.22	–	–	–	–	–	–	12	182.94	59	314.92	**86**	**928.08**
Sub-total		**32**	**993.31**	**–**	**–**	**–**	**–**	**–**	**–**	**17**	**267.06**	**60**	**319.15**	**109**	**1579.52**
Total		**1090**	**15250.33**	**127**	**828.87**	**1**	**29.6**	**1**	**1.21**	**3637**	**13077.59**	**41826**	**59427.77**	**46682**	**88615.37**

guri, fewer sherds could be accurately refitted suggesting more horizontal displacement, whether cultural or natural. No Nunguri rims refitted with those from different spits.

The next section describes the results of the attribute analysis with regard to forming techniques. This first examines formal sherds from Nunguri, Tilu, and surface survey followed by a summary comparison at the end of the section. This section can be used in conjunction with Appendix A, which illustrates a wider range of technical variation in the assemblages.

Table 7.2. *Rims by number of sherds and minimum number of vessels.*

Site	Spit	Number of rim sherds	Minimum number of vessels*
Nunguri Test Pit 1	1	22	21
	2	149	141
	3	135	129
	4	92	88
	5	37	35
	6	64	60
	7	49	40
	8	29	26
	9	35	31
	10	39	33
	11	53	39
	12	43	30
	13	40	30
	14	47	36
	15	46	37
	16	1	1
	17	–	–
Sub-total		**881**	**777**
Tilu Unit 1	1	25	16
	2	30	23
	3	15	12
	4	14	12
	5	6	6
	6	15	12
	7	23	15
	8	5	4
	9	24	13
	10	5	4
	11	–	–
	12	–	–
Sub-total		**162**	**117**
Tilu Shovel Pit 1	45 cm	8	7
	60 cm	5	3
	70 cm	–	–
	80 cm	1	1
	120 cm	1	1
Sub-total		**15**	**12**
Kranket Is.	Surf.	7	7
Siar Is.	Surf.	4	4
Yabob Is.	Surf.	6	6
Malmal	Surf.	15	15
Sub-total		**32**	**32**
Total		**1090**	**938**

* Calculated by refitting and visual inspection. Note that rims that do not preserve enough information to be classified into a distinct technical class are also excluded from this count.

Results: Nunguri

Test Pit 1

In the Nunguri assemblage, Madang style rims are abundant through Layer 1 (Spit 1–15). A single rim is present in Layer 2 (Spit 16–17). Overall, Class 1 rims are the most frequent technical class present, followed by Class 2, 4, 3, and 5 rims (Table 7.3), but the relative percentages of these classes changes through the excavation spits (Fig. 7.9). A single 'exotic,' non-Madang style rim form was identified at Nunguri, in Spit 15.

Different technical classes are more common in different spits, and therefore at different times in the past. A Pearson's Chi-squared Test, using a Monte-Carlo simulation owing to low cell counts for Class 5 rims, supports these results showing that there is a significant association between excavation spit and technical class ($X^2 = 145$ df = 60 $P < 0.01$). A crosstabulation of these test results shows that the observed value deviates from the expected value in several instances where adjusted Pearson residuals are >2 or <–2 (see Agresti 2002: 81). Of particular note, observed Class 4 rims are substantially fewer than expected in Spit 2 (adj. residual = –3), and in Spit 4 (adj. residual = –2.1), towards the top to the excavated sequence. Towards the base of the sequence in Spit 11 (adj. residual = 2.8) and Spit 13 (adj. residual = 2.4), Class 4 rims are substantially more common than expected. On the other hand, observed Class 3 rims are substantially fewer than expected in Spits 14 and 15 (adj. residuals = –2.3), and more common than expected in Spits 4–6 (adj. residuals = 3.5). This suggests that Class 4 rims were more frequently produced and con-

Table. 7.3. *Technical classes represented at Nunguri, Test Pit 1 by* MNV *and excavation spit.*

		Technical class						
Spit	Cal. BP	1	2	3	4	5	Exotic	Total
1		8	7	3	1	2	–	**21**
2		78	28	21	12	2	–	**141**
3	0–299	73	18	13	22	3	–	**129**
4		41	16	21	8	2	–	**88**
5	0–304	14	5	11	5	–	–	**35**
6		24	2	16	16	2	–	**60**
7		20	6	5	8	1	–	**40**
8		17	3	–	6	–	–	**26**
9		14	13	2	2	–	–	**31**
10		17	8	1	7	–	–	**33**
11	508–539	10	13	2	13	1	–	**39**
12		11	10	1	8	–	–	**30**
13	515–623	15	5	–	10	–	–	**30**
14	520–626	18	8	–	10	–	–	**36**
15		23	9	–	4	–	1	**37**
16		1	–	–	–	–	–	**1**
17		–	–	–	–	–	–	**–**
Total		**384**	**151**	**96**	**132**	**13**	**1**	**777**

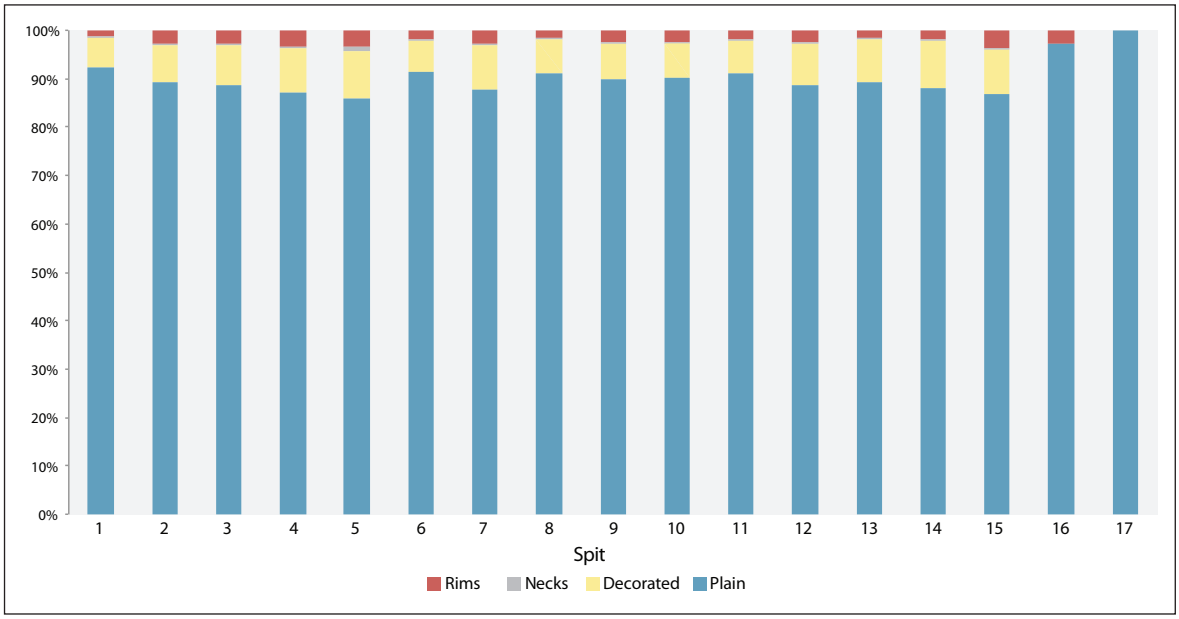


Figure 7.7. Portions of ceramic vessels represented at Nunguri, Test Pit 1, by number.

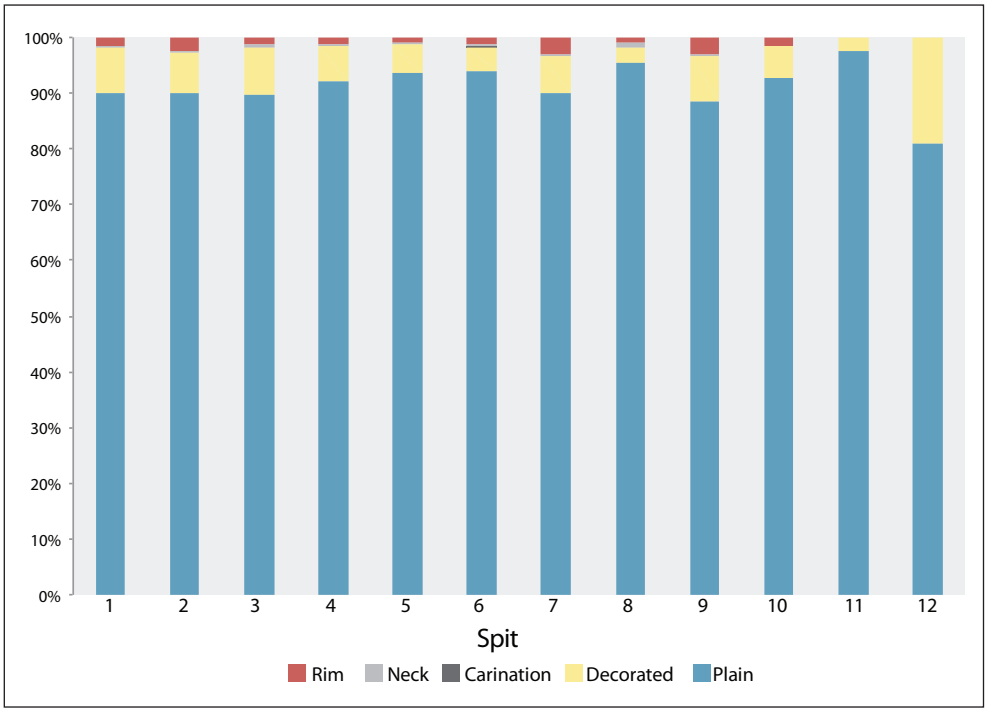


Figure 7.8. Portions of ceramic vessels represented at Tilu, Unit 1, by number.

sumed earlier in the sequence ~500 cal. BP, while Class 3 rims are more frequent later in time, between 0–300 cal. BP.

Nunguri rim attributes vary by technical class. All Class 1, 2, and 3 vessels have everted rims, with an interior corner point (Fig. 7.10–7.12) while Class 5 rims are inverted (Fig. 7.14), and Class 4 vessels have incurving rims, with an inflection point but no corner point (Fig. 7.13). Class 1 rims display the most variation in rim form attributes and are similar to Class 2 rims, while Class 3, 4, and 5 rims display less variation.

Nunguri Class 1 rim courses usually follow a straight line, but can also be convex, flaring outward or, occasionally, concave. There are four rare instances of Class 1 rims with sigmoid rim courses, but these comprise less than 1% of Class 1 rims (Table 7.4). Over half of the observed Nunguri Class 1 rim profiles are parallel, but gradually convergent, divergent, and lenticular forms are also common, while abruptly convergent, divergent, and lenticular forms are rare. Class 1 lip profiles are generally round, but can also be flat or pointed, and extra lip features are usually absent although grooved, grooved interior, grooved exterior,

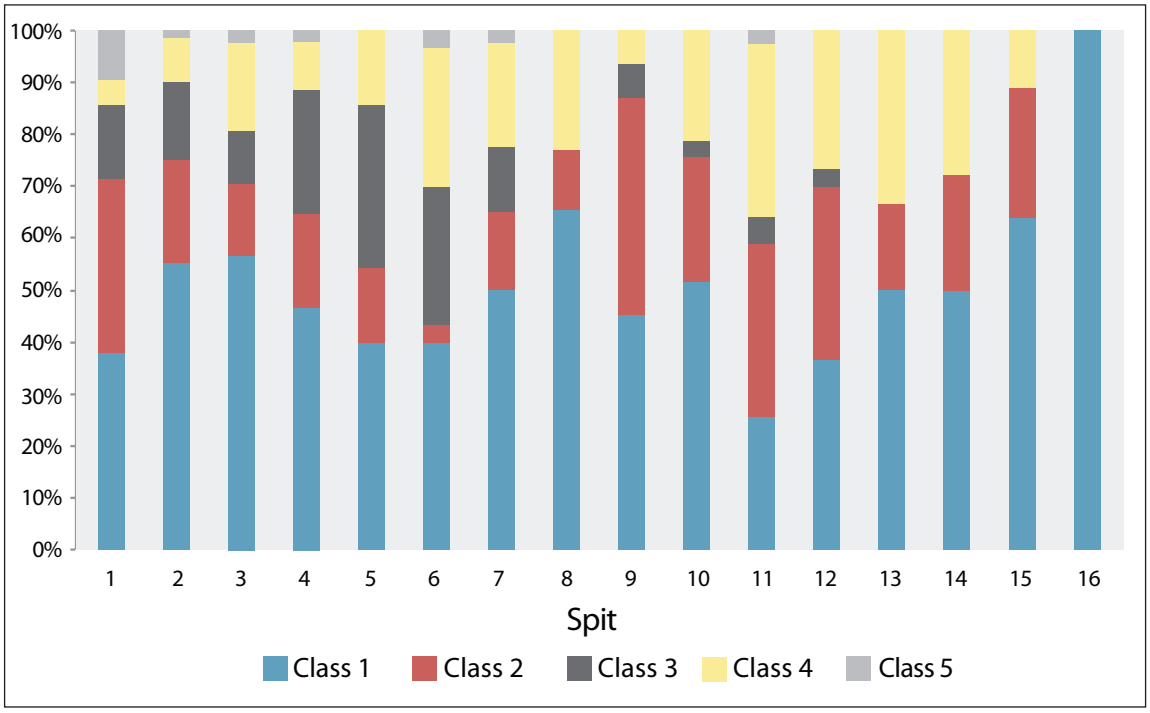


Figure 7.9. Percentage of Madang style technical classes at Nunguri, Test Pit 1 by excavation spit.

symmetrically thickened, and asymmetrically thickened exterior lip features also occur owing to irregularities in potter's handling of the rim (Fig. 7.15–7.16).

Nunguri Class 2 rims display a similar variety of rim courses to Class 1, usually being straight, less often being convex and concave, and, rarely, sigmoid. Rim profiles are more often abruptly convergent or lenticular, owing to external paddling to create a bevel, but can sometimes be parallel, with the paddling producing a distinct change in vessel course at the bevel. Less often, Class 2 rim profiles are gradually convergent, divergent, and lenticular, or abruptly divergent. Lip profiles are usually round but can sometimes be pointed, or flat with a round edge, while extra lip features are usually lacking, although several instances of grooving and asymmetric thickening to the exterior were observed.

Class 3 rims almost always follow a straight rim course owing to the collar being extended as the potter ran an anvil or hand around the inside of the neck. However, rare examples follow a convex or concave course. Their rim profiles are usually divergent (abrupt or gradual) but can also be parallel. Lips are usually flat but sometimes round, and usually asymmetrically thickened on the exterior.

Class 4 rims follow a concave or straight rim course. Note that many of those observed to be straight almost certainly derive from vessels with an incurving and concave rim course, but too little of the rim survives to assign it as concave. Three examples are convex towards the lip. Profiles are usually gradually divergent or parallel but can also be gradually convergent or abruptly divergent. Lips are usually flat, but can sometimes be pointed or round, while extra features are almost always absent, although asymmetrical thickening can occur.

Fewer Class 5 rims were deposited at Nunguri (n = 13). Those observed have straight, convex, or concave rim courses, with parallel, lenticular, divergent or convergent profiles, flat or rounded lips, and are lacking extra lip features apart from one instance of asymmetric thickening to the exterior.

Sub-rim grooves and grooves with associated ridges are common on Class 5 rims, with 60% (n = 6) displaying this technical attribute (Table 7.4). These grooves are rare on Class 1 and 2 rims, being present on < 5% of the sherds. No examples of Class 3 and 4 rims with these grooves are present. Stratigraphically, the earliest example of this attribute comes from a single Class 1 rim in Spit 11, which displays a sub-rim groove with ridge, but most examples are present from Spit 1–7 (n = 15).

Based on these discrete formal attributes, an attempt was made to demonstrate that specific combinations of technical elements were more associated with each technical class. A multiple correspondence analysis (MCA) was used to investigate underlying structures in this data. MCA can analyse the pattern of relationships of several categorical dependent variables (Abdi & Valentin 2007), and is broadly synonymous with optimal scaling, appropriate scoring, and homogeneity analysis. MCA can then be viewed as a generalisation of principal component analysis for categorical data. Such an approach is borrowed from other social sciences, which have attempted to relate different

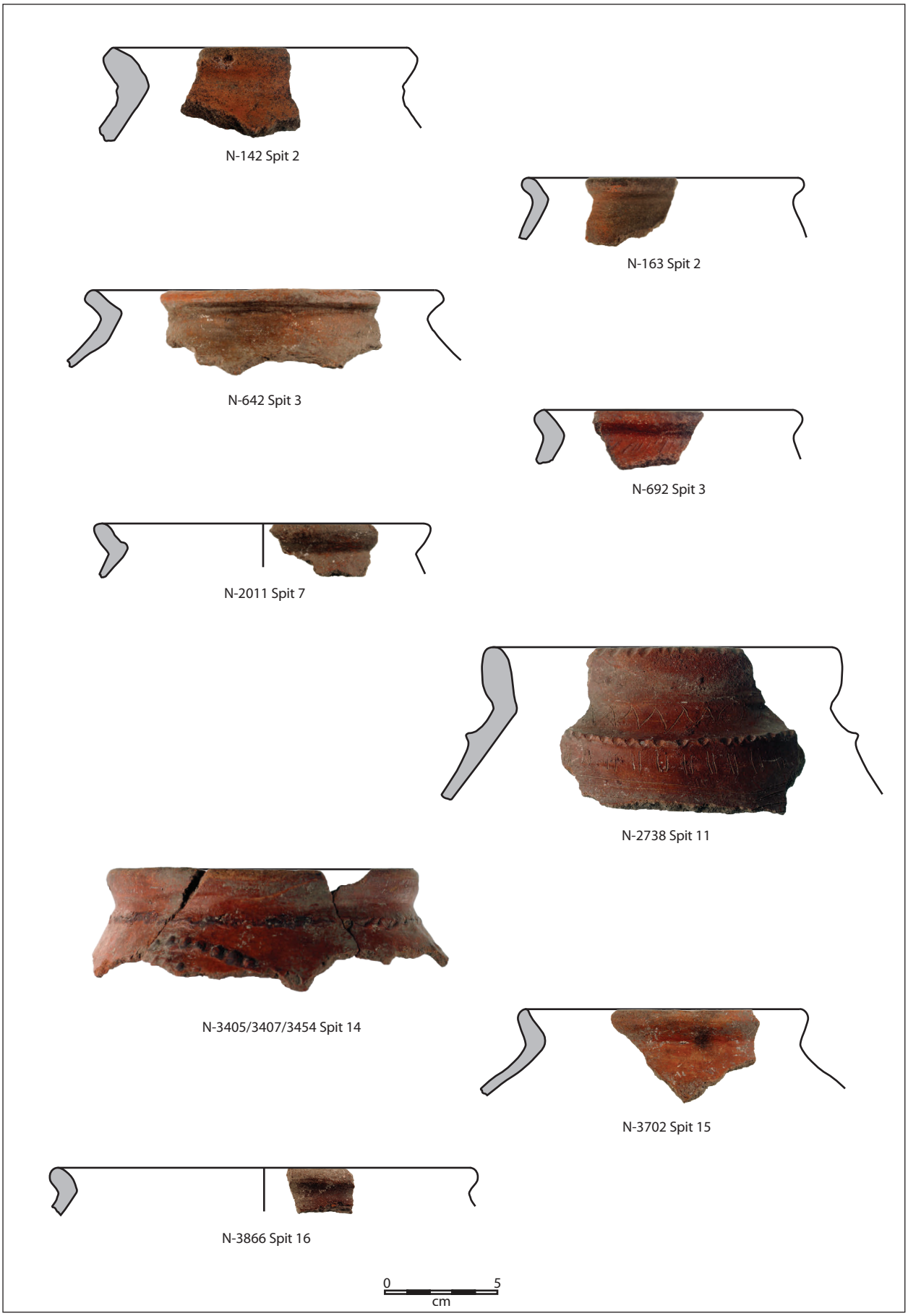


Figure 7.10. Class 1 Madang style rims at Nunguri, Test Pit 1.

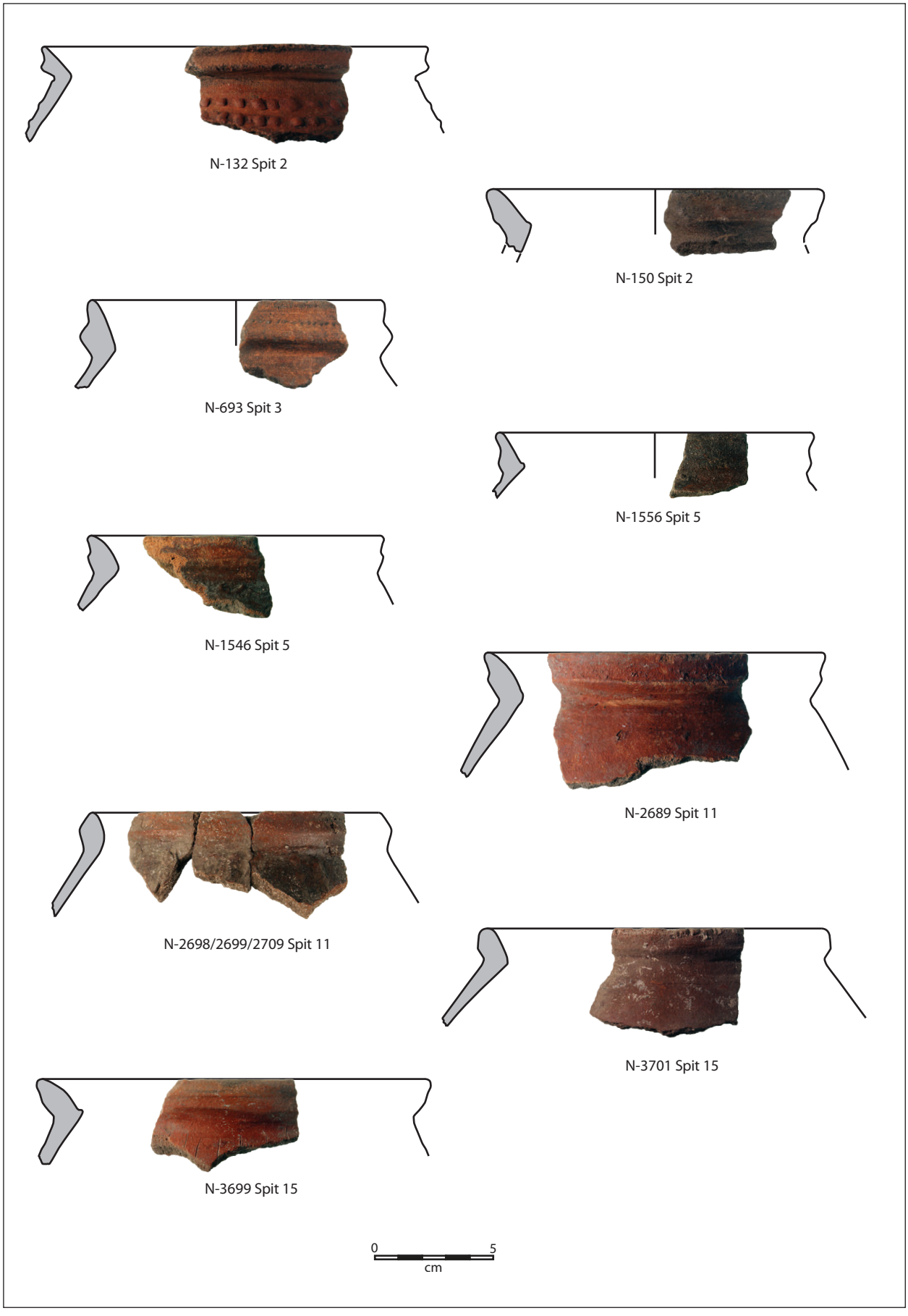


Figure 7.11. Class 2 Madang style rims at Nunguri, Test Pit 1.

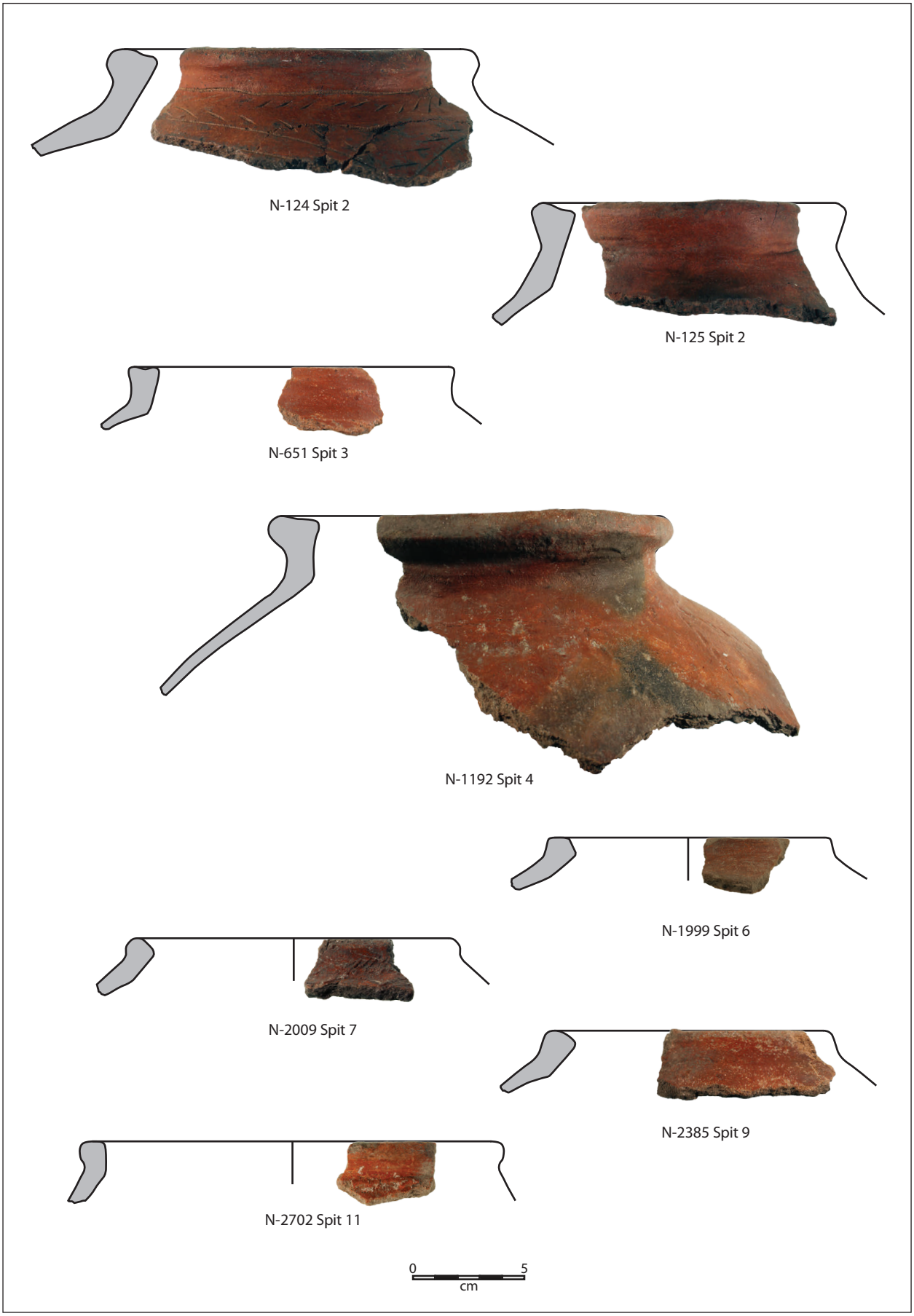


Figure 7.12. Class 3 Madang style rims at Nunguri, Test Pit 1.

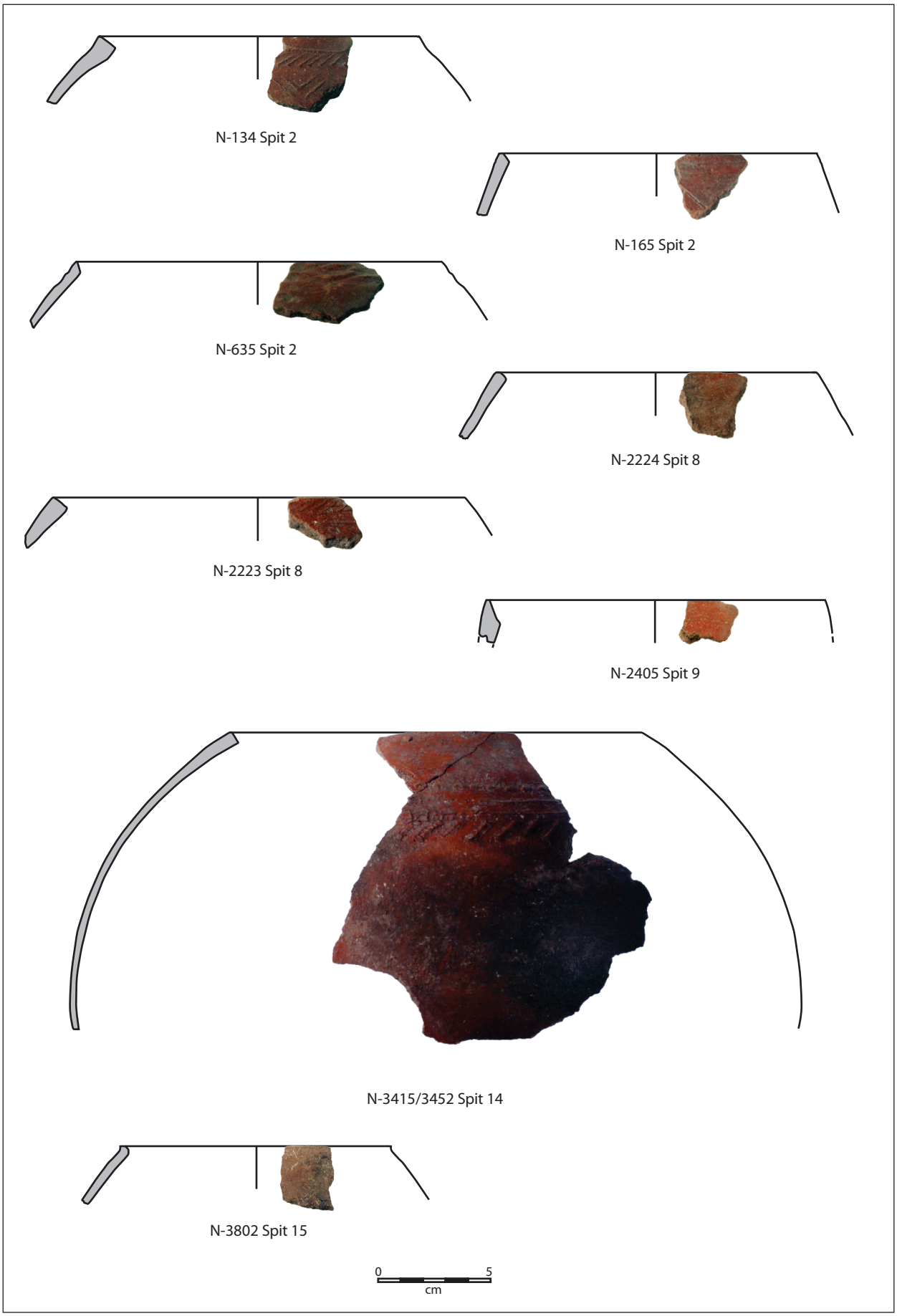


Figure 7.13. Class 4 Madang style rims at Nunguri, Test Pit 1.

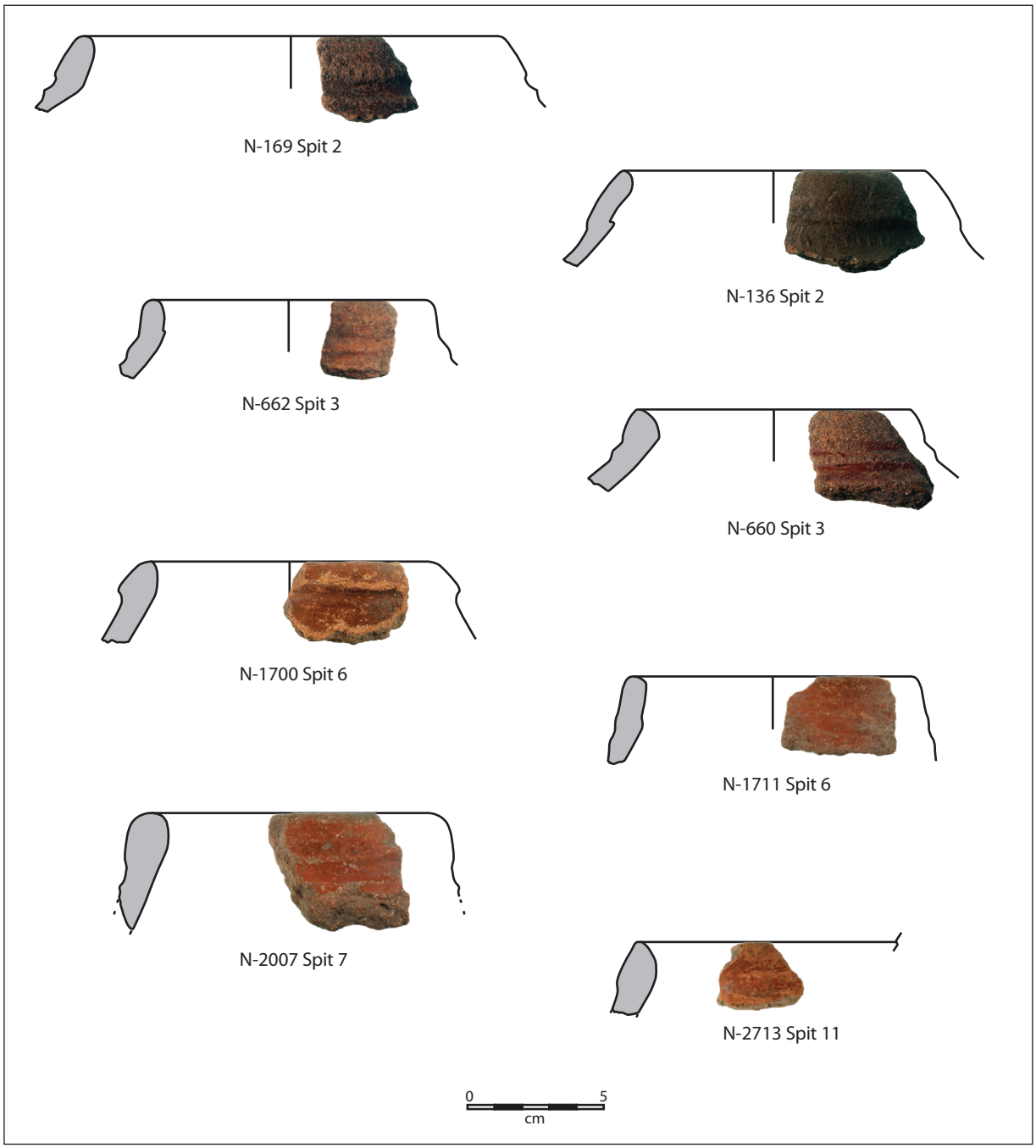


Figure 7.14. Class 5 Madang style rims at Nunguri, Test Pit 1.

social attributes across space or time (e.g. Bourdieu 1979, 1988, 1998). Figure 7.17 plots an MCA with dependent variables (rim course, rim direction, rim profile, lip profile, lip feature, and technical class) using the 'FactoMineR' package developed by Le and colleagues (2008). This applied the MCA algorithm to a 'Burt table' – a symmetrical matrix of all two-way cross-tabulations between the variables – to show that multiple technical elements are related to the forming of each technical class. In the plot (bottom left), Classes 1, 2, and 5 group closely together and overlap, while Class 3 and 4 group apart and tend not to overlap. Class 3 rims, for instance, are usually everted, divergent abrupt with asymmetrically thickened exteriors and flat round lips. As these attributes represent sections in the overall technological process (see above, Fig 7.1), similarities in multiple elements hint at similar manufacturing sequences. In this way the forming sequence of Class 1, 2, and 5 rims can be argued to be more similar than the sequence for Class 3 or Class 4 rims, which follow different technical processes. It is also important that no cluster coded by technical class separates into two distinct clusters, which would justify separation into technical variants based on different technical processes.

Several continuous attributes were measured within these classes. Rim thickness varies by technical class at Nunguri. Classes 1, 2, 3, and 5 overlap at one standard deviation (SD) from the mean (Table 7.5), while Class 4 overlaps only with

Table. *7.4. Rim and lip forms by technical class at Nunguri, Test Pit 1 (note some rims not represented where attributes could not be confidently recorded).*

	Class 1		Class 2		Class 3		Class 4		Class 5	
	n	%	n	%	n	%	n	%	n	%
Rim course										
Straight	248	68	83	56	87	91	59	47	8	62
Convex	93	25	52	35	7	7	3	2	2	15
Concave	21	6	10	7	2	2	65	51	3	23
Sigmoid (convex-concave)	2	<1	3	2	–	–	–	–	–	–
Sigmoid (concave-convex)	2	<1	1	<1	–	–	–	–	–	–
Rim profile										
Parallel	204	56	17	12	2	2	63	49	6	46
Convergent abrupt	4	1	61	41	–	–	–	–	–	–
Convergent gradual	96	26	11	7	–	–	1	1	1	8
Divergent abrupt	4	1	1	1	38	40	1	1	3	23
Divergent gradual	42	11	3	2	49	52	63	49	1	8
Lenticular abrupt	5	1	52	35	–	–	–	–	2	15
Lenticular gradual	13	4	3	2	–	–	–	–	–	–
Lip profile										
Round	336	88	115	78	16	17	7	5	10	77
Flat (round edge)	23	6	6	4	78	82	13	10	3	23
Flat (sharp edge)	2	1	–	–	1	1	111	84	–	–
Pointed	19	5	26	18	–	–	1	<1	–	–
Extra lip features										
Absent	334	89	134	93	15	16	121	93	12	92
Grooved	6	2	–	–	3	3	–	–	–	–
Grooved exterior	3	<1	2	1	–	–	–	–	–	–
Grooved interior	12	3	7	5	1	1	–	–	–	–
Symmetrically thickened	14	4	–	–	1	1	1	1	–	–
Asymmetrically thickened exterior	8	2	2	1	75	79	8	6	1	8
Asymmetrically thickened interior	–	–	–	–	–	–	–	–	–	–
Sub-rim groove										
Absent	167	97	71	95	81	100	131	100	4	40
Grooved	2	1	1	1	–	–	–	–	2	20
Grooved with ridge	4	2	3	4	–	–	–	–	4	40

Table. *7.5. Average rim and neck thickness (mm) by technical class at Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Rim thickness					
Mean	9.50	11.06	15.53	6.41	10.07
SD	1.86	1.85	4.24	1.76	2.07
CV	20%	17%	27%	27%	21%
Neck thickness					
Mean	7.47	7.79	10.22	N.A.	8.20
SD	1.82	1.67	2.09	N.A.	1.73
CV	24%	21%	20%	N.A.	21%

Class 1 and 5 at 1 SD. Generally, Class 3 rims are the thickest, followed by Class 1, 2, and 5 rims, while Class 4 rims are much thinner (Fig. 7.18). A Kruskal-Wallis test, which is a non-parametric one-way analysis of variance, using a Monte-Carlo simulation owing to small sample sizes in Class 5, shows that there are significant differences in rim thickness between technical classes (Table 7.6). The effect size (η^2) of 49.79% shows that almost half of the variation in rim thickness is accounted for by technical class. A post hoc Kruskal-Wallis test run between each class (e.g. Class 1–Class 2, Class 1–Class 3, Class 1–Class 4, etc.) shows that significant differences exist between each class except Classes 2 and 5 (Table 7.7).

Table. *7.6. Kruskal-Wallis test of rim thickness (mm) by technical class at Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
No. of cases	376	149	94	127	13
Mean rank	352.67	496.65	646.66	114.38	500.08

$X^2 = 377.372$, df = 4, $\eta^2 = 49.79\%$, $P<0.01$



Figure 7.15. Rim course and profile by technical class at Nunguri, Test Pit 1 (note some rims not represented where attributes could not be confidently recorded).

Table. *7.7. Post hoc test of rim thickness (mm) comparing individual technical classes at Nunguri.*

	Technical class									
	1–2	**1–3**	**1–4**	**1–5**	**2–3**	**2–4**	**2–5**	**3–4**	**3–5**	**4–5**
N	525	470	503	389	243	276	162	221	107	140
X^2	69.505	149.218	167.684	8.492	69.785	175.701	0.008	155.116	12.280	31.483
df	1	1	1	1	1	1	1	1	1	1
P	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.93	<0.01	<0.01	<0.01
η^2	13.24%	31.81%	33.40%	2.19%	28.84%	63.89%	0.00%	70.51%	11.58%	22.65%

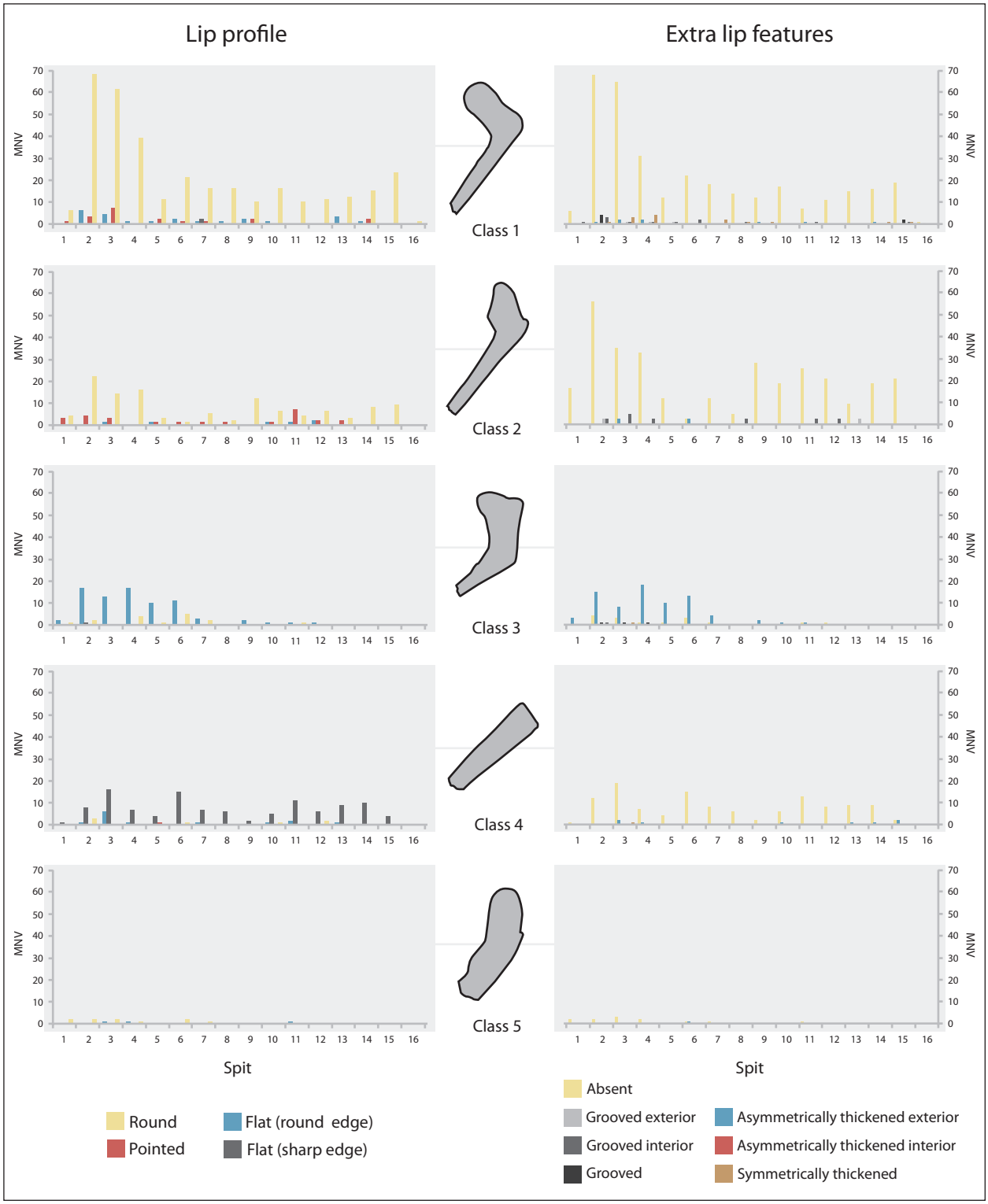


Figure 7.16. Lip profile and extra lip features by technical class at Nunguri, Test Pit 1 (note some rims not represented where attributes could not be confidently recorded).

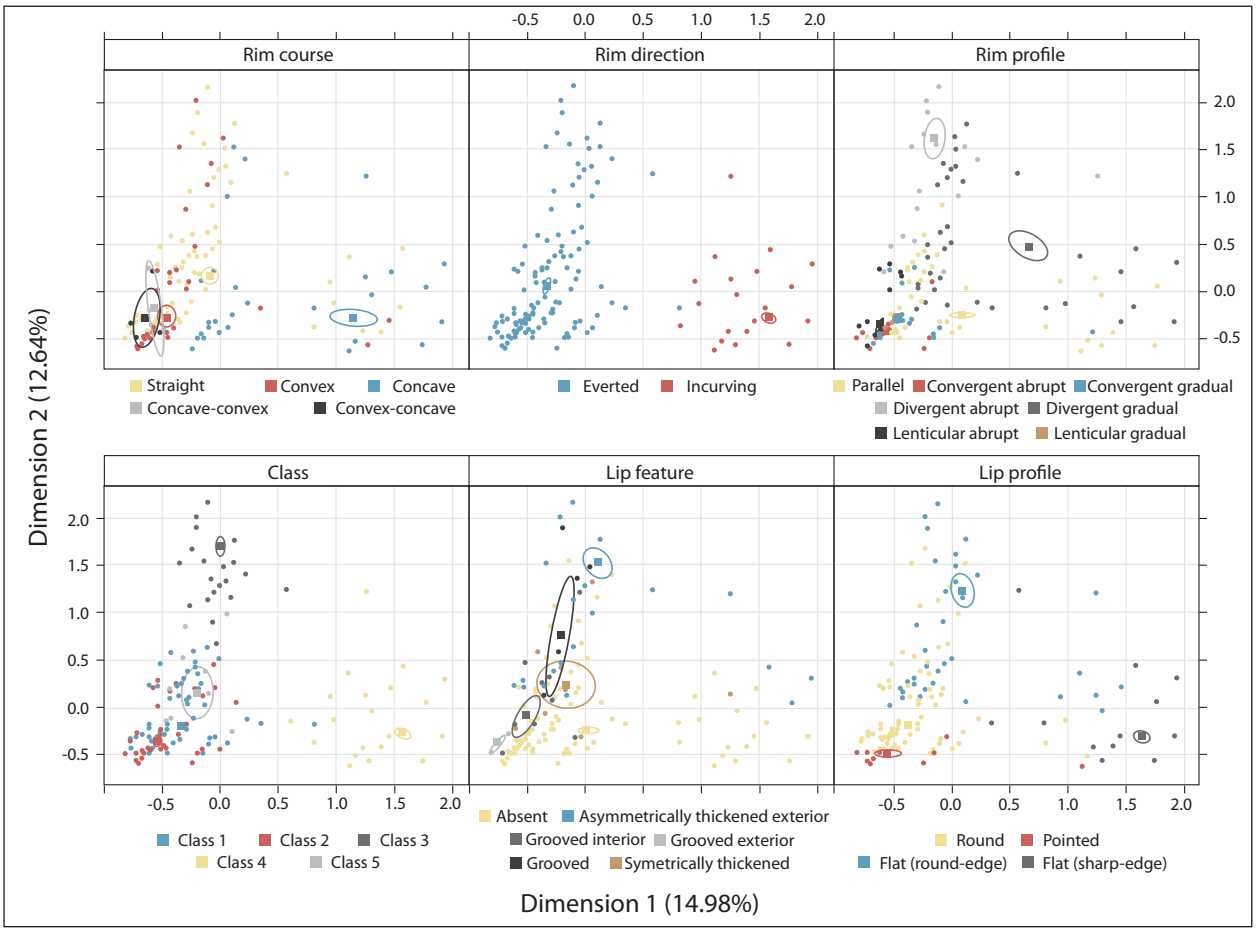


Figure 7.17. MCA of discrete formal attributes for Madang style rims, Nunguri, Test Pit 1.

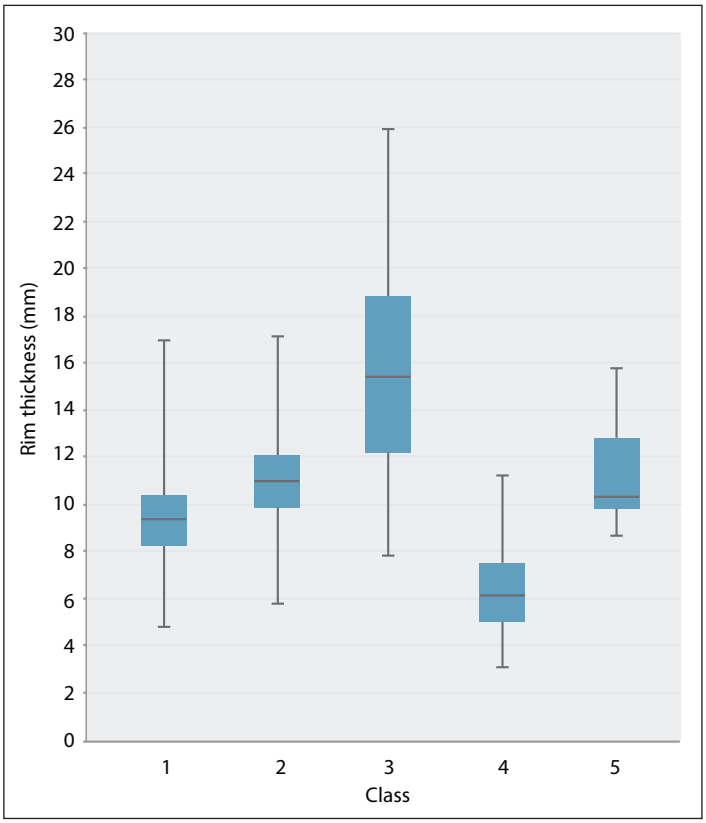


Figure 7.18. Rim thickness by technical class at Nunguri, Test Pit 1

The coefficient of variation (CV) expresses dispersion of data as a percentage and is used to describe standardisation in pot form, with lower percentages being more standardised, and higher percentages being less standardised (Arnold 1991; Longacre 1999; Masson & Rosenswig 2005). At Nunguri, Class 1, 2, and 5 rim thicknesses show similar CV at *c.* 20%, while Class 3 and 4 are higher at 27%, suggestive of less standardisation in rim thickness (Table 7.5). Ethnographic observations from elsewhere in the world have equated 5–10% CV with full time craft specialists with tight social regulations on form, while ≥15% has been equated to part time producers with embodied knowledge that is less frequently engaged (Benco 1988; Longarcre *et al.* 1988).

Rim shape can be assessed by plotting different combinations of attributes. Figure 7.19. charts rim thickness against neck thickness showing that rim thickness increases with neck thickness in a linear manner. Classes 1, 2, and 5 overlap, while Class 3 sherds generally have much thicker rims and slightly thicker necks. Figure 7.20 plots rim length against rim thickness showing that Class 1, 2, and 5 overlap, while Class 3 are thicker and shorter.

Rim direction, orientation, and inclination also vary by technical class. Class 1 and 2 rims are everted and always project away from the central vertical axis at the lip. Class 3 rims are everted and their orientations form a continuum. Most Class 3 rims project inwards, towards the central vertical axis (70%, n = 24, mean = 37°), although some project slightly outwards (30%, n = 56, mean = 22°). Class 4 rims are always incurving, with rims projecting towards the central vertical axis. Class 5 rims are inverted and always project towards the axis (Table 7.8).

Figure 7.21 illustrates the range in rim orientation and direction of each technical class. The mean rim orientation and inclination of Class 1, 2, and 3 rims are similar, while Class 4 and 5 rims are generally higher in their orientation (Table 7.9). The CV of orientation for all Classes is more than for thickness[1] while inclination is less and similar to thickness. Figure 7.22 plots orientation against inclination showing a general trend for inclination to decrease as orientation increases.

Orifice diameter also varies between technical classes. Class 1, 2, 3, and 4 all overlap at 1 SD from the mean (Table 7.10). Class 1 rims are between 5 cm–20 cm wide with a mean and mode of 14 cm. Figure 7.23, which plots MNV

1 Note, there is no test of significance for differences between CV

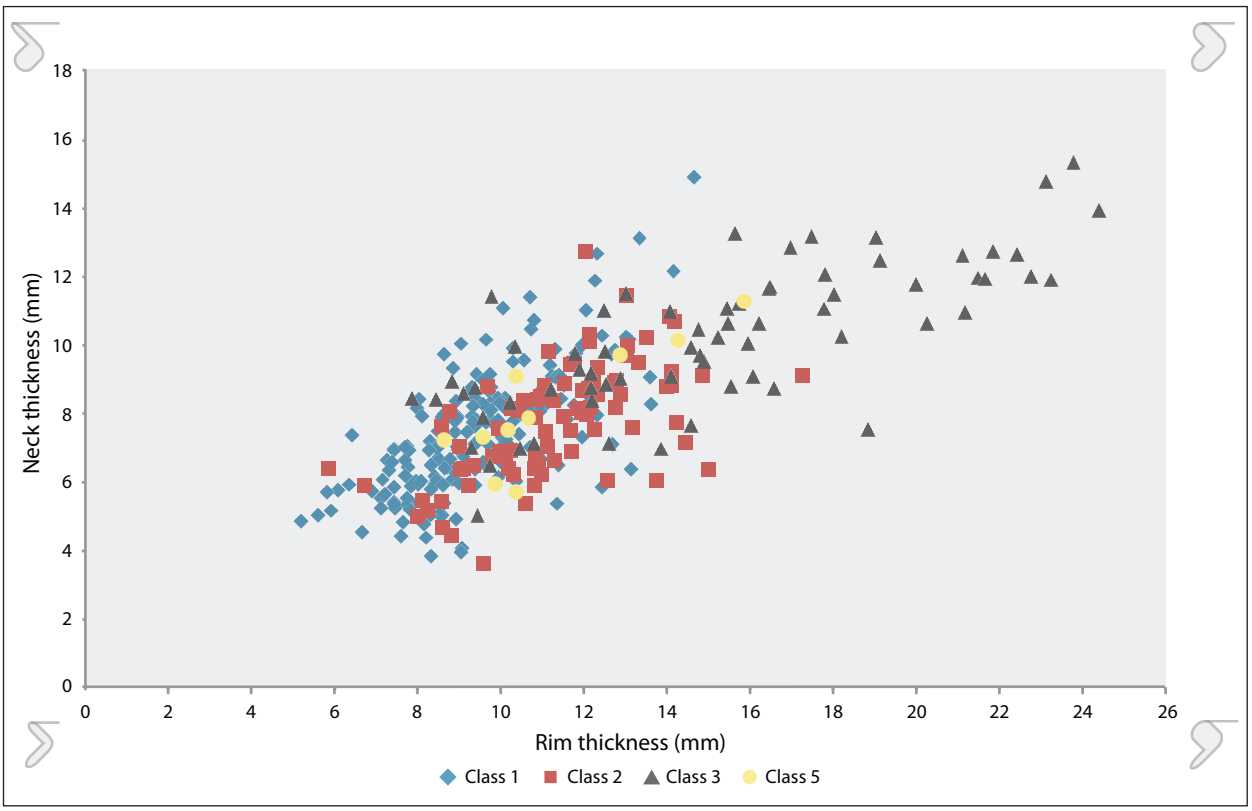


Figure 7.19. Relationship between rim and neck thickness by technical class at Nunguri (note some rims not represented where attributes could not be confidently recorded).

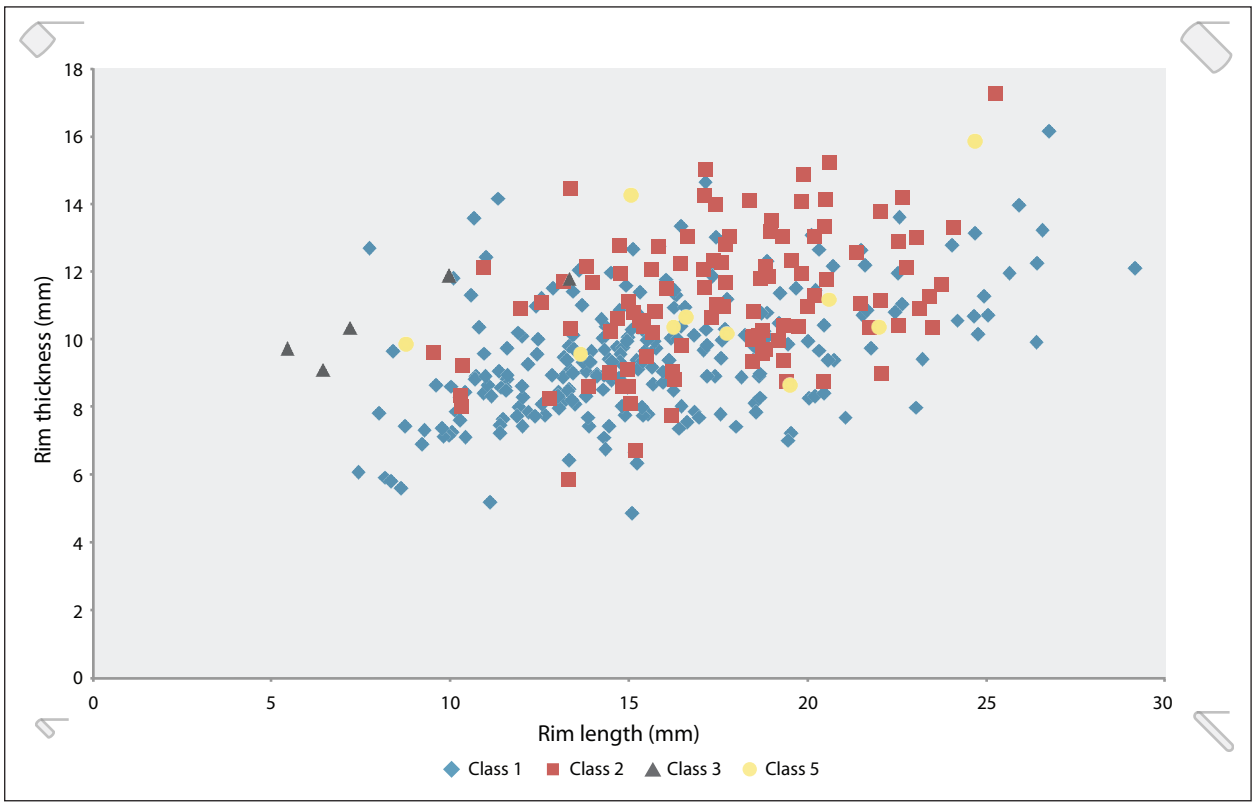


Figure 7.20. Relationship between rim length and thickness by technical class at Nunguri, Test Pit 1 (note some rims not represented where attributes could not be confidently recorded).

Table. *7.8. Rim direction (MNV) by technical class and excavation spit at Nunguri, Test Pit 1.*

Spit	Class 1		Class 2		Class 3		Class 4		Class 5	
	↙	↗	↙	↗	↙	↗	↙	↗	↙	↗
1	6	0	5	0	–	–	–	–	–	–
2	61	0	20	0	3	14	0	11	0	2
3	56	0	17	0	4	9	0	17	0	3
4	33	0	11	0	6	12	0	5	0	1
5	11	0	5	0	4	5	0	2	–	–
6	19	0	2	0	4	10	0	12	0	2
7	19	0	5	0	2	3	0	7	0	1
8	13	0	2	0	–	–	0	6	–	–
9	13	0	9	0	0	1	0	2	–	–
10	14	0	8	0	0	1	0	5	–	–
11	10	0	11	0	1	0	0	10	0	1
12	8	0	9	0	0	1	0	6	–	–
13	15	0	5	0	–	–	0	7	–	–
14	15	0	8	0	–	–	0	10	–	–
15	22	0	9	0	–	–	0	3	–	–
16	1	0	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–
Total	**316**	**0**	**126**	**0**	**24**	**56**	**0**	**103**	**0**	**10**

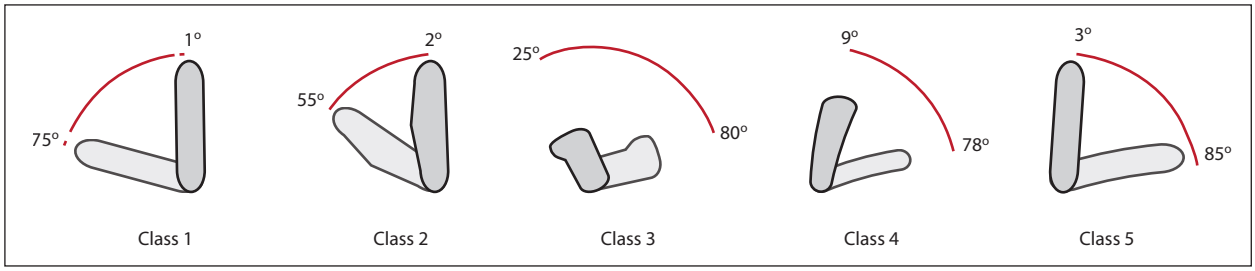


Figure 7.21. Minimum and maximum rim orientation by technical class at Nunguri, Test Pit 1.

Table 7.9. *Average rim orientation and inclination (°) by technical class, Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Orientation					
Mean	32	31	33	43	57
SD	13	12	20	15	22
CV	41%	39%	61%	35%	39%
Inclination					
Mean	121	134	130	N.A.	160
SD	22	22	22	N.A.	3
CV	18%	16%	17%	N.A.	2%

Table 7.10. *Average orifice diameter (cm) by technical class, Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Mean	14	14	14	15	10
SD	2	2	2	3	2
CV	17%	16%	16%	19%	20%

by orifice diameter, suggests the Class 1 distribution may be bimodal. If this is correct, small Class 1 rims (5–6 cm) might represent the spouts of *you-bodi* water pots, while wider rims (8–20 cm) may be equivalent to modern *bodi* and *tangeng*. No examples of Class 2, 3, or 4 rims smaller than 9 cm are present, and their distributions in Figure 7.23 are unimodal, overlapping with the larger Class 1 distribution.

A Kruskal-Wallis test using a Monte-Carlo simulation shows that there are significant differences between the means of each class with regard to orifice diameter (Table

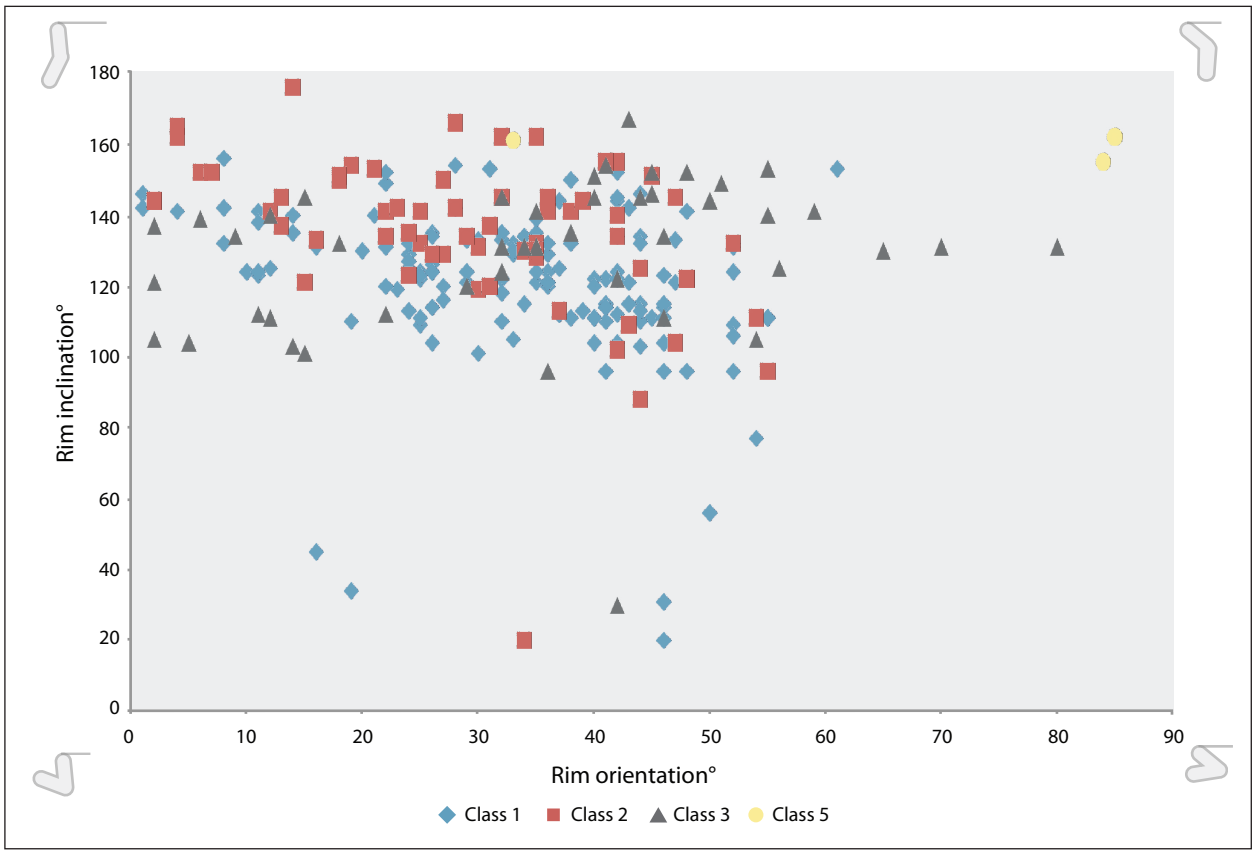


Figure 7.22. Relationship between rim orientation & inclination by class, Nunguri, Test Pit 1 (note some rims not represented where attributes could not be confidently recorded).

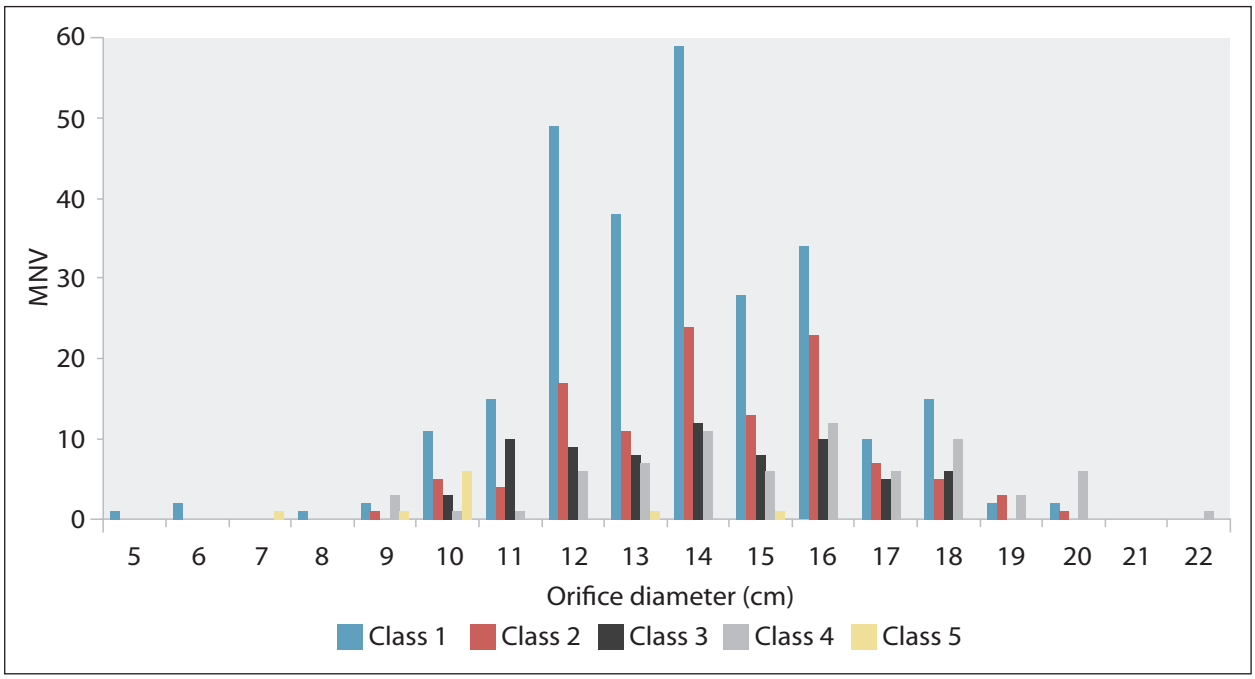


Figure 7.23. Vessel orifice diameter by technical class, Nunguri, Test Pit 1.

7.11). Mood's test confirms these results showing there are significant differences between the medians of the classes (Table 7.12). The effect size (η^2), however, is small showing that only 7.49% of orifice variation is accounted for by technical class. A post hoc Kruskal-Wallis test indicates that there are significant differences in orifice diameters between each class, except Class 1 and 3 and Class 2 and 3 ($\alpha = 0.05$) (Table 7.13).

Exotics

A single exotic rim form was identified in the Nunguri assemblage, in Spit 15 (Fig. 7.24). Although similar to Madang style Class 4 rims, this example lacks the red-slip on the interior and exterior surfaces and is formed from a distinct fabric (see Chapter 8). The rim derives from a restricted, incurving vessel with parallel profile, flat sharp edged lip with asymmetrical thickening on the exterior.

Table 7.11. *Kruskal-Wallis test of orifice diameter by technical class at Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
No. of cases	269	114	71	73	10
Mean rank	250.49	286.14	261.45	345.08	69.65

$X^2 = 40.167$, df = 4, $\eta^2 = 7.49\%$, $P < 0.01$

Table 7.12. *Mood's test of orifice diameter by technical class at Nunguri, Test Pit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Number of cases	269	114	71	73	10
Diameter > median	91	52	29	44	1
Diameter ≤ median	178	62	42	29	9

Median = 14, $X^2 = 21.928$, df = 4, $P < 0.01$

Table 7.13. *Post hoc test of orifice diameter comparing individual technical classes at Nunguri.*

	Technical class									
	1–2	**1–3**	**1–4**	**1–5**	**2–3**	**2–4**	**2–5**	**3–4**	**3–5**	**4–5**
N	383	340	342	279	185	187	124	144	81	83
X^2	4.798	0.239	21.656	15.504	1.080	7.857	17.199	10.407	15.678	17.325
df	1	1	1	1	1	1	1	1	1	1
P	0.03	0.63	<0.01	<0.01	0.30	<0.01	<0.01	0.01	<0.01	<0.01
η^2	1.26%	0.07%	6.35%	5.56%	0.06%	4.20%	13.87%	7.23%	19.36%	20.87%

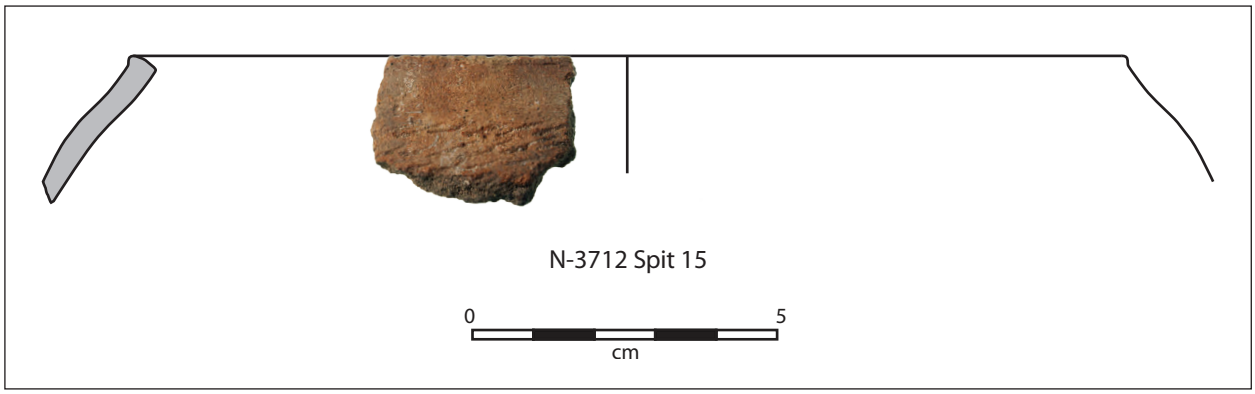


Figure 7.24. Exotic rim from Nunguri, Test Pit 1.

Results: Tilu

Unit 1

At Tilu, Unit 1, Madang style rims dominate the formal assemblage in Layer 1 (Spits 1–10). Class 1 rims are most common, with Class 2 being next most frequent (Table 7.14; Fig. 7.25). Class 3 and 4 rims are rare and only present in or above Spit 2, and only one Class 5 rim is present, in Spit 4. Two exotic rim forms were also recovered, in Spit 2 and Spit 4. No formal sherds were found in Layer 2 (Spits 11–12).

Table 7.14. *Technical classes represented at Tilu, Unit 1 by* MNV *and excavation spit.*

		Technical class						
Spit	**Cal. BP**	**1**	**2**	**3**	**4**	**5**	**Exotic**	**Total**
1		10	3	–	3	–	–	16
2		16	4	1	1	–	1	23
3		10	2	–	–	–	–	12
4	552–664	10	–	–	–	1	1	12
5		5	1	–	–	–	–	6
6	543–647	10	2	–	–	–	–	12
7	540–644	11	4	–	–	–	–	15
8		3	1	–	–	–	–	4
9		10	3	–	–	–	–	13
10	791–915	4	–	–	–	–	–	4
11	564–674	–	–	–	–	–	–	–
12	535–641	–	–	–	–	–	–	–
Total		**89**	**20**	**1**	**4**	**1**	**2**	**117**

A chi-squared test under the same conditions as above (see pg. 212) shows that at Tilu there is no significant correlation between spit and class ($X^2 = 32$, df = 36, P = 0.584). A correspondence analysis confirms this lack of correlation ($X^2 = 32.136$, inertia = 0.279, P = 0.908). However, crosstabulation shows that the observed Class 3, 4, and 5 rims are substantially more than expected in every instance (adj. residuals = ≥2), owing to their absence in most spits, especially below Spit 4. Although the sample sizes are small, it is possible that Classes 3 and 4 in particular are chronologically more recent than Classes 1 and 2.

A range of rim forms is presented in Figures 7.26–7.28. Tilu Class 1 rims display the most variation in rim form, with Classes 2–5 showing less variation, in part due to unequal sample sizes (Table 7.15). Although Class 1 rims are most commonly straight, they can also be convex or, less often, concave; their rim profiles are usually parallel, but can also be lenticular, convergent, or divergent (Fig. 7.29). Class 1 lip profiles are almost always round but can be flat with round edges or pointed. Usually, extra lip features are absent on Class 1 rims but, occasionally, lips are symmetrically and asymmetrically thickened or grooved around the lip or the exterior of the lip (Fig. 7.30).

Class 2 rims are most commonly straight, but can also be concave, and, rarely, convex. The concave rim course has seemingly been produced by the potter running her fingers around the inside of the rim wall while paddling the exterior to produce the bevel. Class 2 rims are always abruptly lenticular or abruptly convergent owing to this external bevelling. Their lips are round and occasionally display interior grooving.

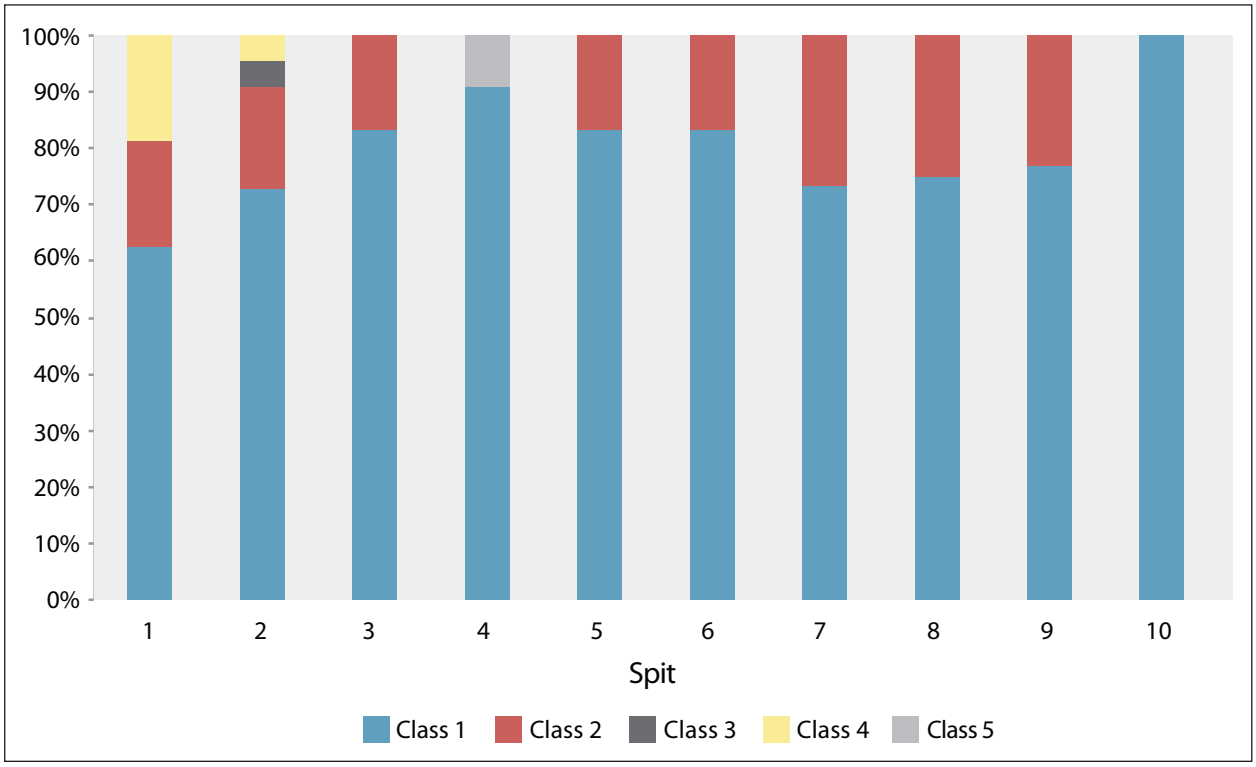


Figure 7.25. Percentage of Madang style technical classes at Tilu, Unit 1 by excavation spit.

The sole Class 3 rim from Tilu, Unit 1 has a straight rim course with a gradual lenticular profile. Its lip is flat with round edges and asymmetrically thickened on the exterior. It is worth noting that this rim (T-168) is identical to N-2702 from Nunguri in Spit 11, one of two that are the earliest Class 3 rims from that site. Class 4 rims are straight or concave, gradually divergent, thickening slightly towards the lip. All Class 4 rims exhibit internal beveling produced by running the finger or anvil around the interior lip. As such the lip is flat with either sharp or round edges, and never grooved or thickened. The single Class 5 rim at Tilu has a concave rim course with abruptly lenticular profile. Its lip profile is round and lacking extra features.

No examples of sigmoid or abruptly divergent rims are present at Tilu, Unit 1. Sub-rim grooves are rare in the assemblage, only observed on two Class 1 rims and single Class 2 and Class 5 rims. There are no examples of sub-rim grooves with associated ridges.

As per the Nunguri discrete attributes, an MCA was applied to the Tilu data to demonstrate that specific technical elements were repeated and more associated with different technical classes. This used the same FactoMineR package (Le *et al.* 2008). The Tilu data plot slightly differently to the Nunguri set, in part owing to smaller sample sizes for Classes 3, 4, and 5. Here, the Class 2 and 5 rims plot closely together (Fig. 7.31, bottom left), while Class 1 plots slightly apart. The Class 3 rim plots closer to Class 1 than at Nunguri and Class 4 clusters further from the others owing to its tendency to have gradually divergent rim profiles and flat sharp lips. This implies that the technical process used to produce Class 4 vessels is more different than that required to produce Class 1, 2, 3, and 5 vessels. These MCA plots give a general appraisal of technical relatedness between classes and illustrate the relatedness of different technical elements. However, it can only be viewed as an appraisal, given the percentage of data variation explained by the first dimension (X axis) is 33.49%, and only 17.72% on the second dimension (Y axis). This is much less than would be acceptable for a principal component analysis using continuous data, but it is not unexpected for a MCA.

Rim thickness in the Tilu, Unit 1 assemblage was assessed by technical class. Class 1, 2, 4, and 5 rims all overlap at one standard deviation (SD) from the mean (Table 7.16). However, the single Class 3 rim sherd is much thicker and does not fall within the total range of thicknesses for Class 1, 2, 4, vessels (Fig. 7.32). The coefficient of variation (CV) is similar for Class 1 and 2 at *c.* 15%, suggestive of a relatively standardised thickness for these two classes, while Class 4 has a higher CV resulting from a small sample size. A Kruskal-Wallis test, using a Monte-Carlo simulation, shows that there is significant variation in mean rim thickness between Classes 1 and 2 ($\alpha = 0.05$, $X^2 = 4.501$, $df = 1$, $\eta^2 = 7.76\%$, $P = 0.031$). Class 3–5 rims were not tested owing to small sample sizes.

Figure 7.33 describes the shape of the rim by plotting rim and neck thicknesses. This shows that Class 1, 2, and 5 overlap, and neck thickness increases with rim thickness, although the rim is generally thicker than the neck. Class 3 rims are thicker than most Class 1, 2, and 5 examples

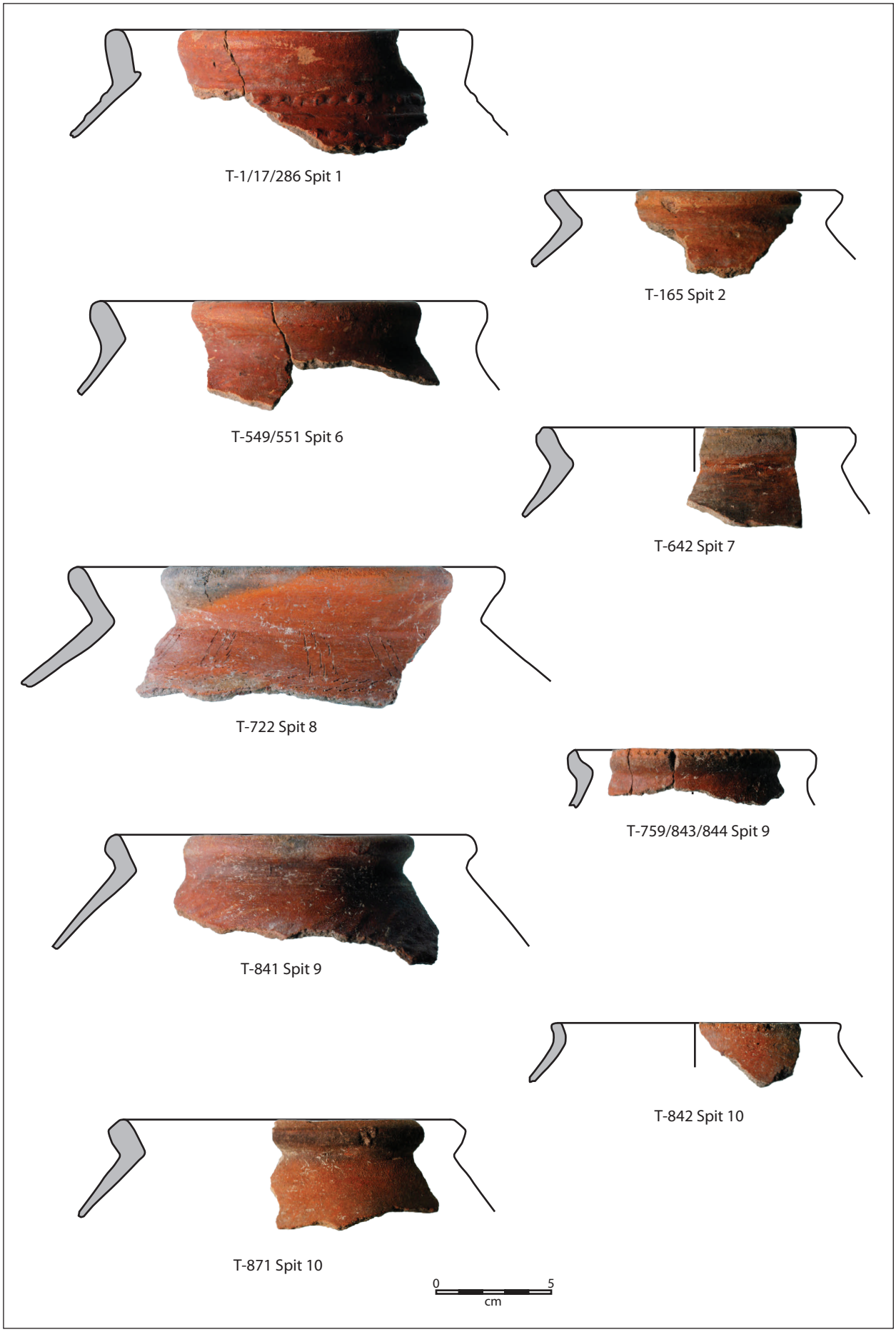


Figure 7.26. Class 1 Madang style rims at Tilu, Unit 1.

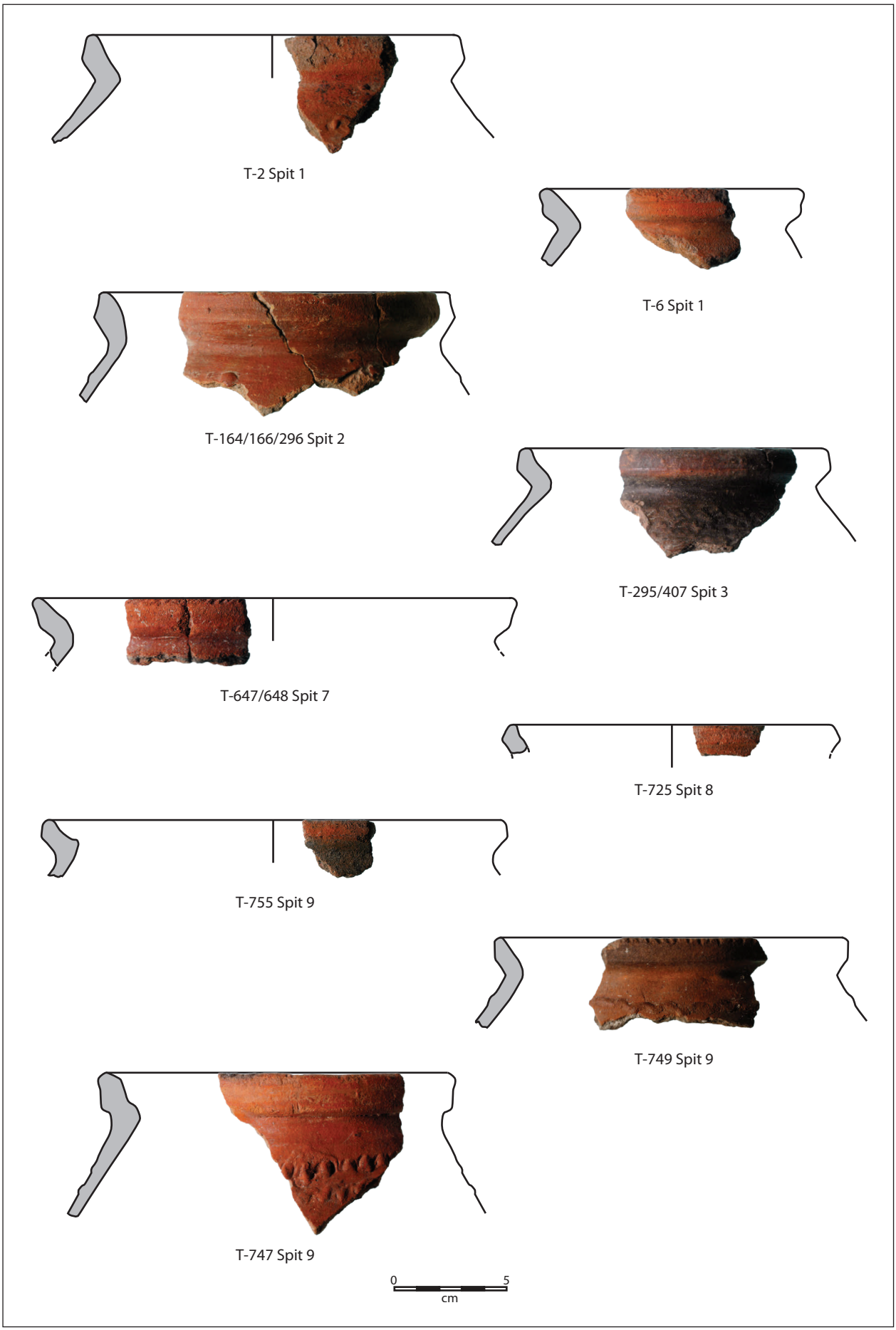


Figure 7.27. Class 2 Madang style rims at Tilu, Unit 1.

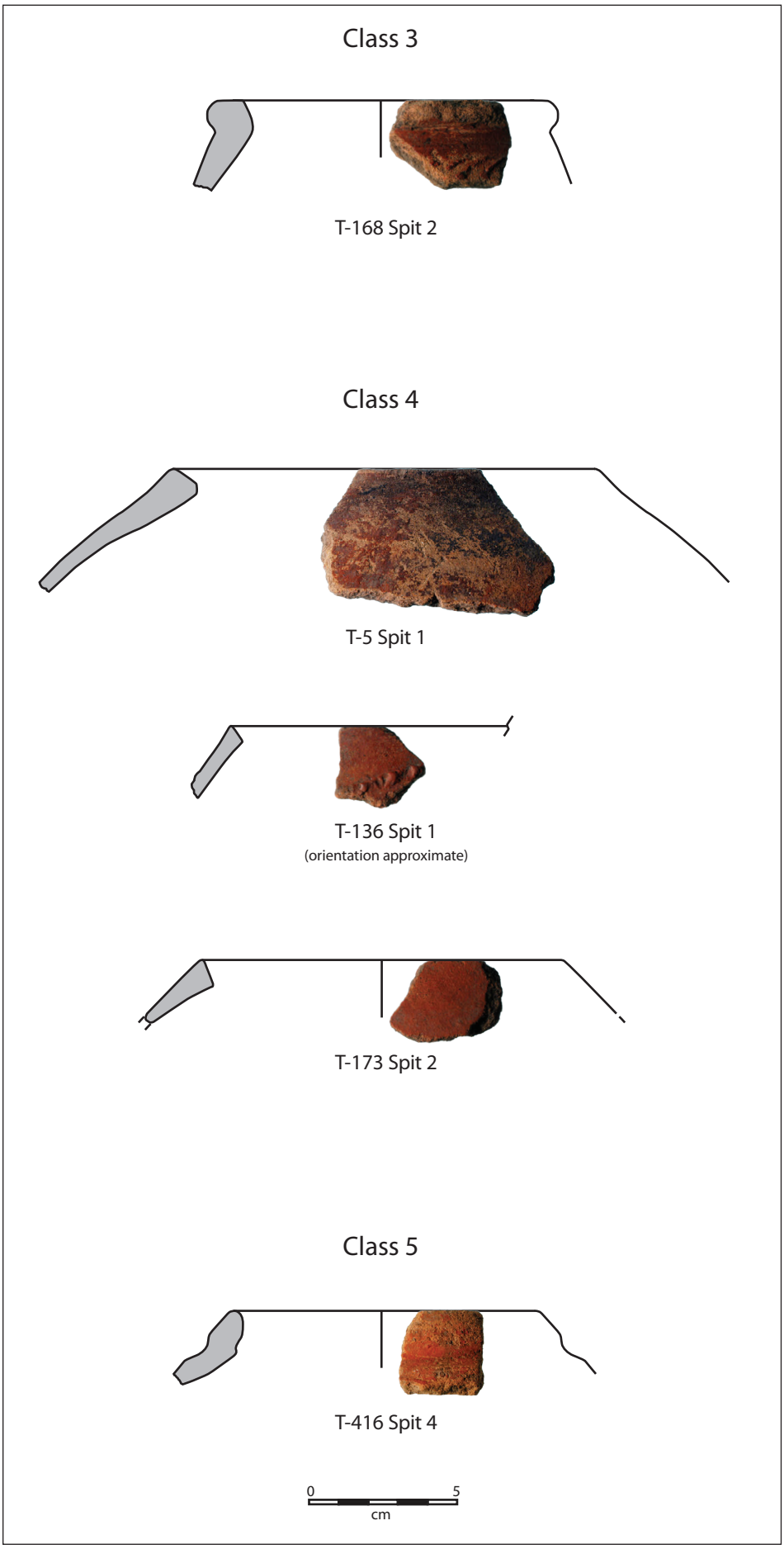


Figure 7.28. Class 3–5 Madang style rims at Tilu, Unit 1.

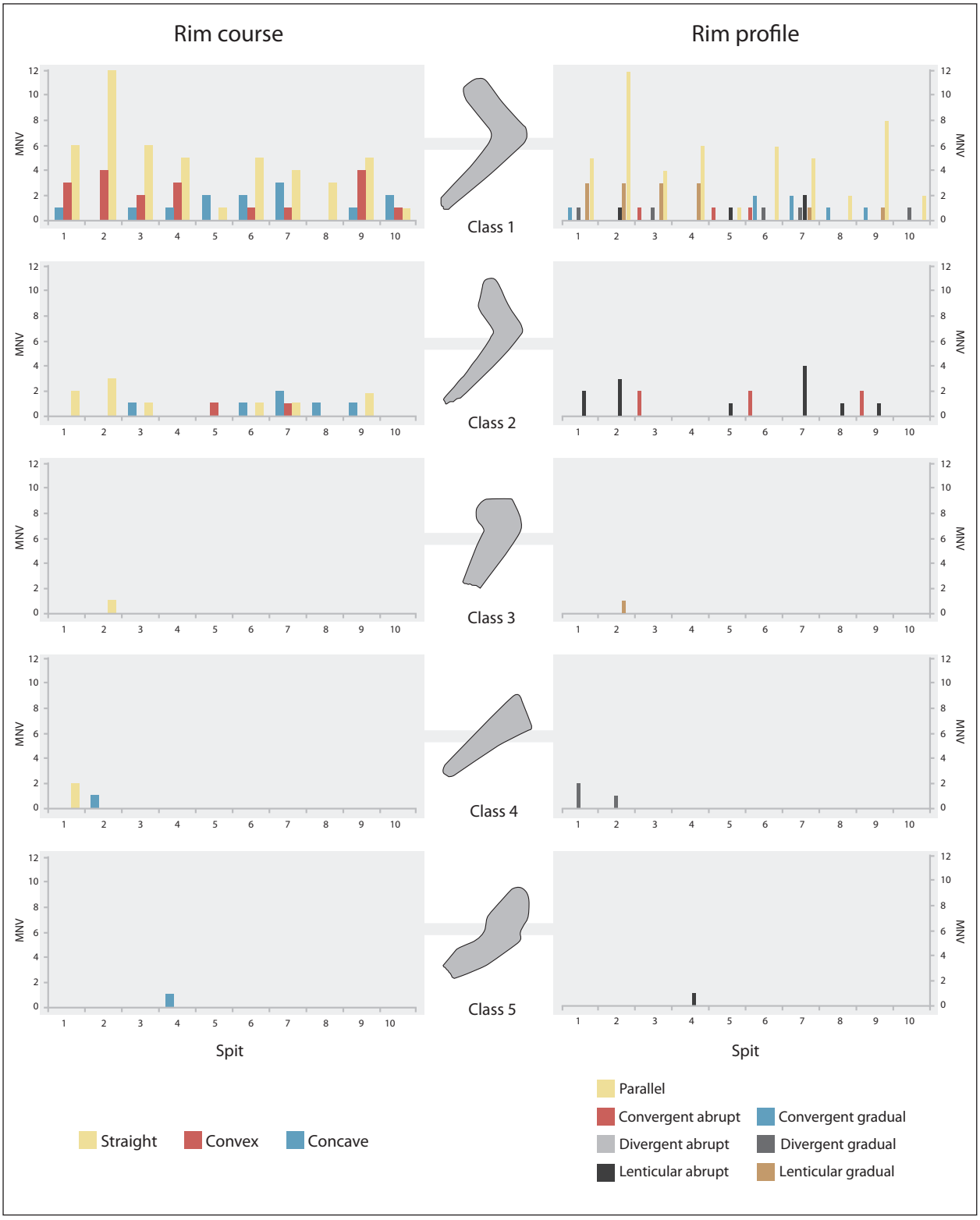


Figure 7.29. Rim course and profile by technical class at Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded).

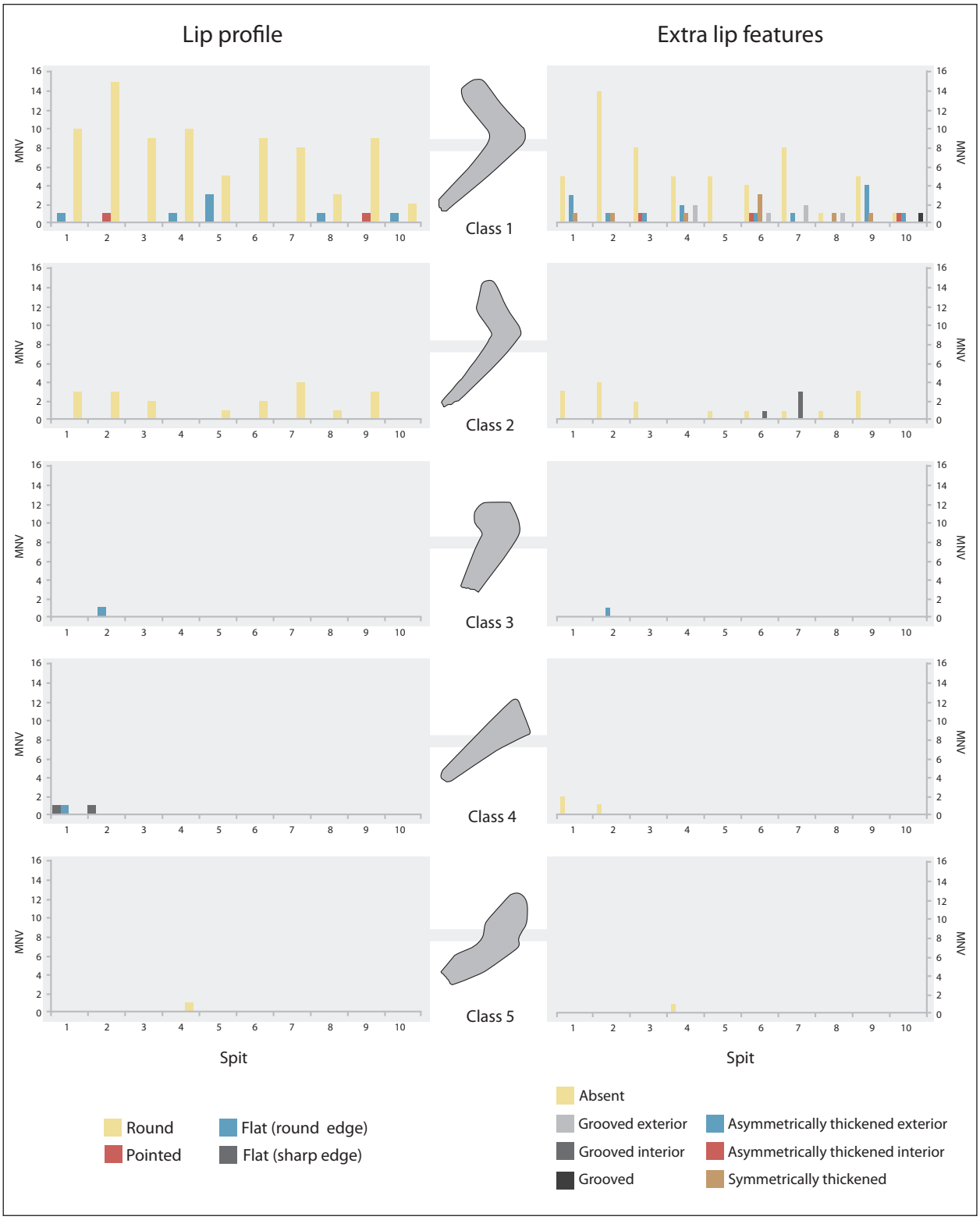


Figure 7.30. Lip profile and extra lip features by technical class at Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded).

Table 7.15. *Rim and lip forms by technical class at Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded).*

	Class 1		Class 2		Class 3		Class 4		Class 5	
	n	%	n	%	n	%	n	%	n	%
Rim course										
Straight	48	60	10	56	1	100	2	67	–	–
Convex	19	24	2	11	–	–	–	–	–	–
Concave	13	16	6	33	–	–	1	33	1	100
Rim profile										
Parallel	51	61	–	–	–	–	–	–	–	–
Convergent abrupt	3	4	6	33	–	–	–	–	–	–
Convergent gradual	7	8	–	–	–	–	–	–	–	–
Divergent abrupt	–	–	–	–	–	–	–	–	–	–
Divergent gradual	5	6	–	–	–	–	3	100	–	–
Lenticular abrupt	4	5	12	67	–	–	–	–	1	100
Lenticular gradual	14	17	–	–	1	100	–	–	–	–
Lip profile										
Round	80	90	19	100	–	–	–	–	1	100
Flat (round edge)	7	8	–	–	1	100	1	33	–	–
Flat (sharp edge)	–	–	–	–	–	–	2	67	–	–
Pointed	2	2	–	–	–	–	–	–	–	–
Extra lip features										
Absent	56	64	16	80	–	–	3	100	1	100
Grooved	1	1	–	–	–	–	–	–	–	–
Grooved exterior	6	7	–	–	–	–	–	–	–	–
Grooved interior	–	–	4	20	–	–	–	–	–	–
Symmetrically thickened	8	9	–	–	–	–	–	–	–	–
Asymmetrically thickened exterior	14	16	–	–	1	100	–	–	–	–
Asymmetrically thickened interior	3	3	–	–	–	–	–	–	–	–
Sub–rim groove										
Absent	57	97	13	93	1	100	3	100	1	100
Grooved	2	3	1	7	–	–	–	–	–	–
Grooved with ridge	–	–	–	–	–	–	–	–	–	–

Table 7.16. *Average rim and neck thickness (mm) by technical class at Tilu, Unit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Rim thickness					
Mean	9.87	10.51	14.64	10.40	9.99
SD	1.67	1.58	–	3.40	–
CV	17%	15%	–	33%	–
Neck thickness					
Mean	6.98	7.43	9.99	N.A.	6.51
SD	1.28	1.10	–	N.A.	–
CV	18%	15%	–	N.A.	–

(Class 4 is not considered as neck thickness could not be measured). Figure 7.34 further describes rim shape, plotting rim length against thickness. This demonstrates that, again, Class 1, 2, and 5 overlap, while the Class 3 rim is distinctly thicker and shorter.

Rim orientation values are similar for Class 1–5 rims, overlapping at 1 SD (Table 7.17), but Classes 1–3 project away from the central vertical axis, while Classes 4–5 project towards it. Here the CV for Class 1, 2, and 4 rims are much greater than for rim thickness indicating more variation in orientation angle. Figure 7.35 plots rim inclination against

Table 7.17. *Average rim orientation and inclination (°) by technical class, Tilu, Unit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Orientation					
Mean	28	31	21	25	35
SD	11	14	–	21	–
CV	41%	44%	–	85%	–
Inclination					
Mean	120	125	104	N.A.	159
SD	15	14	–	N.A.	–
CV	13%	11%	–	N.A.	–

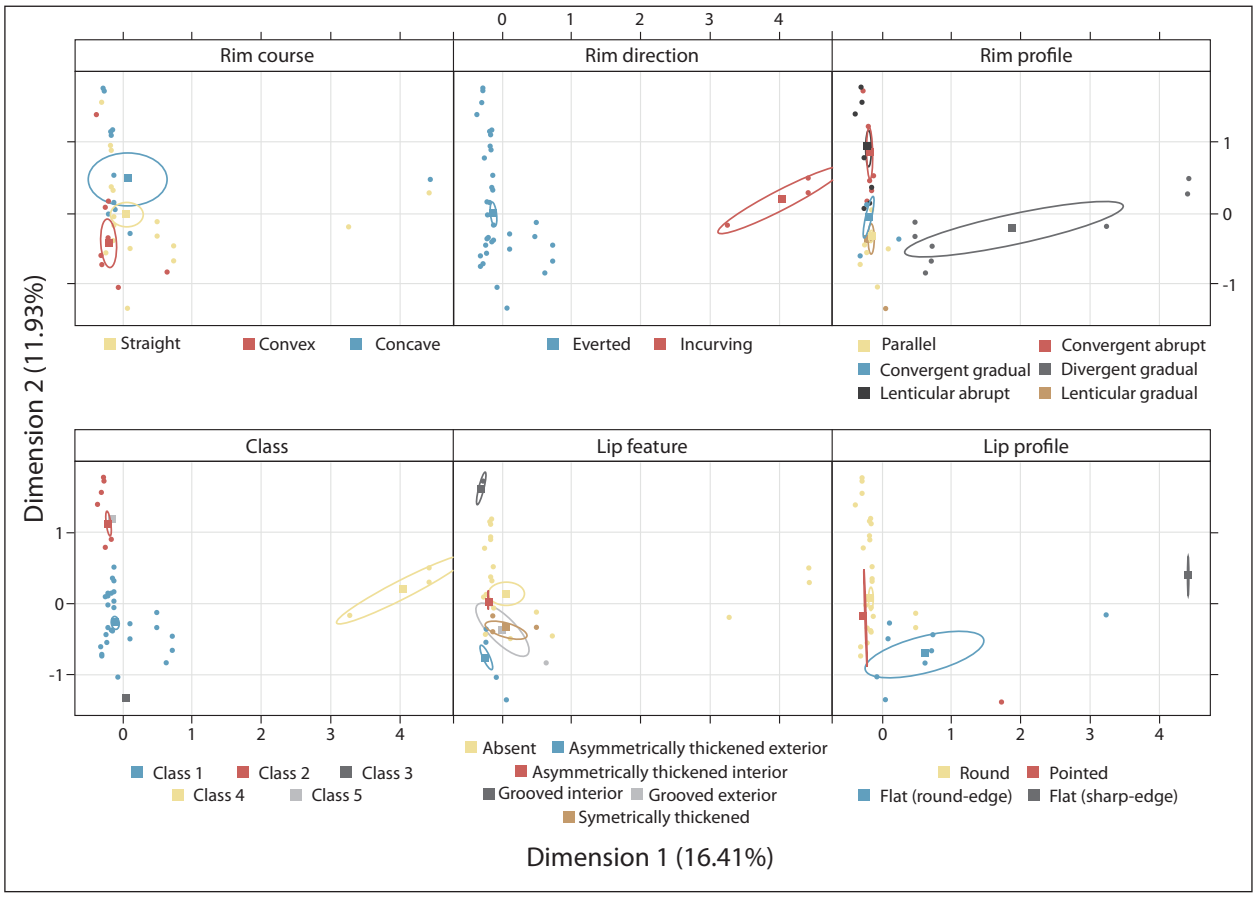


Figure 7.31. MCA of discrete formal attributes for Madang style rims, Tilu, Unit 1.

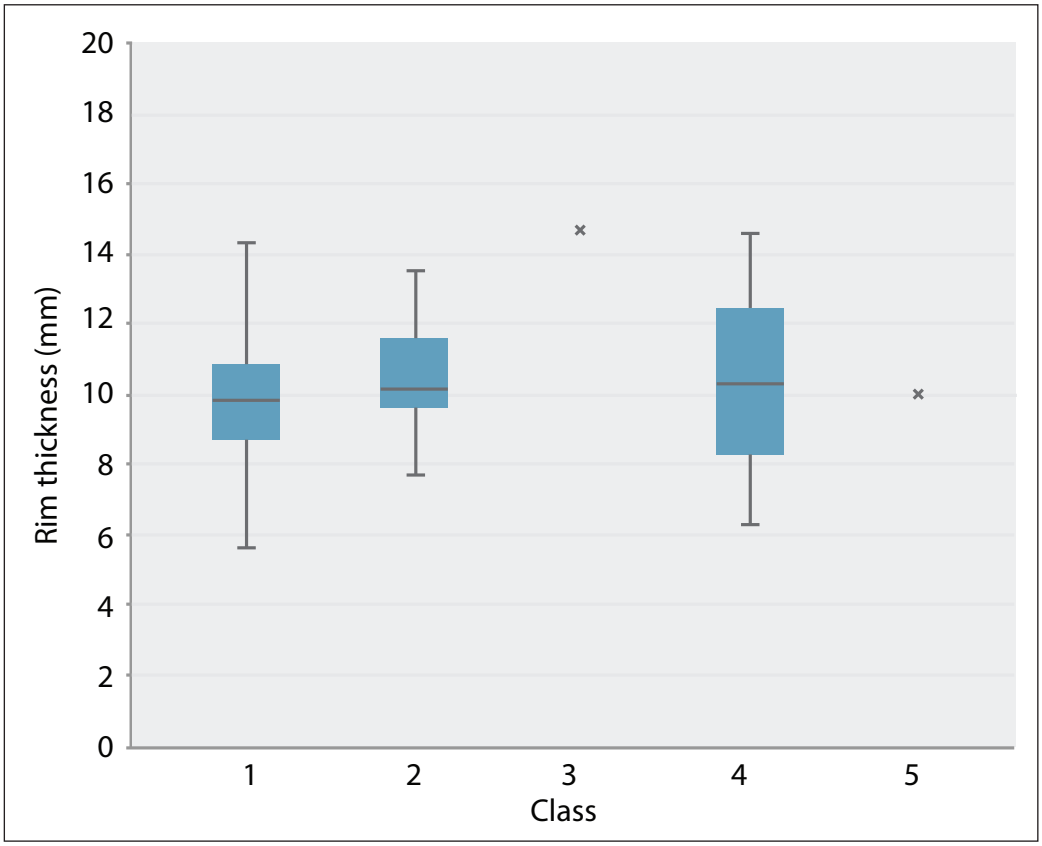


Figure 7.32. Rim thickness by technical class at Tilu, Unit 1.

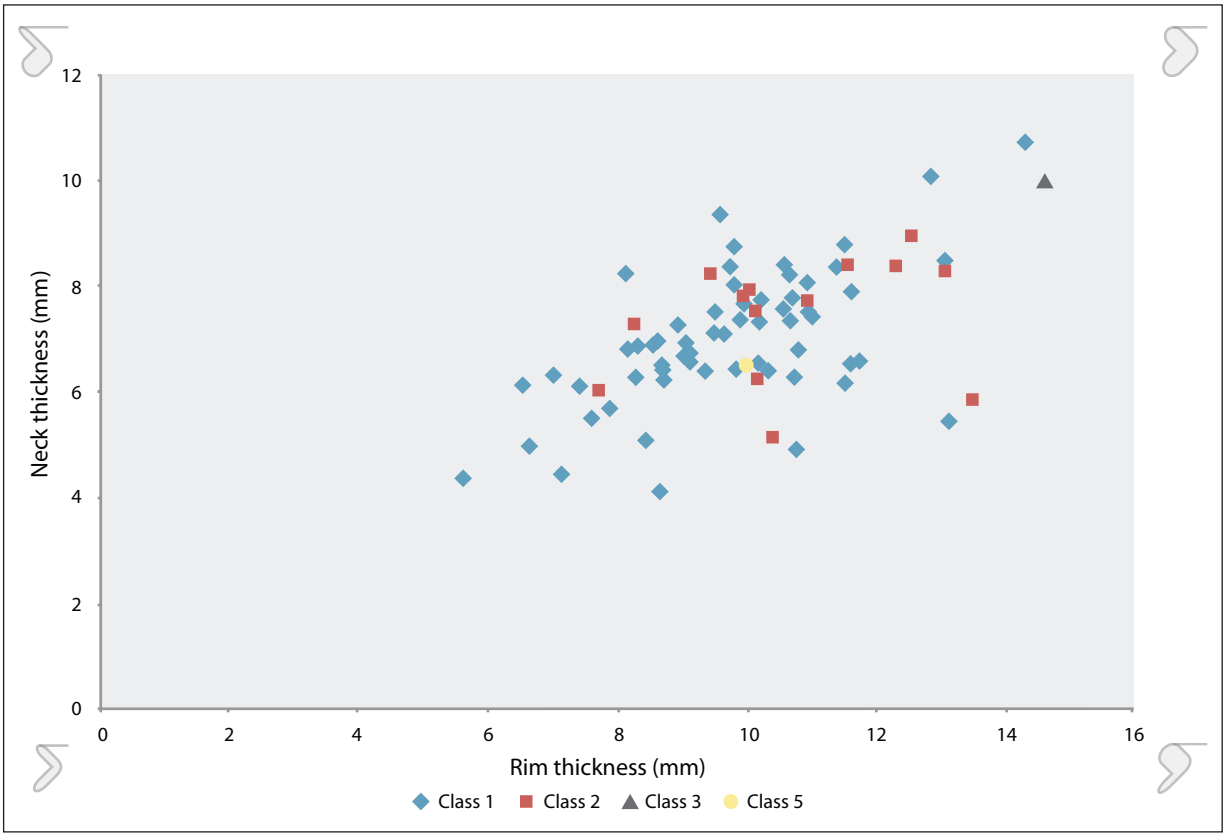


Figure 7.33. Relationship between rim and neck thickness by technical class at Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded).

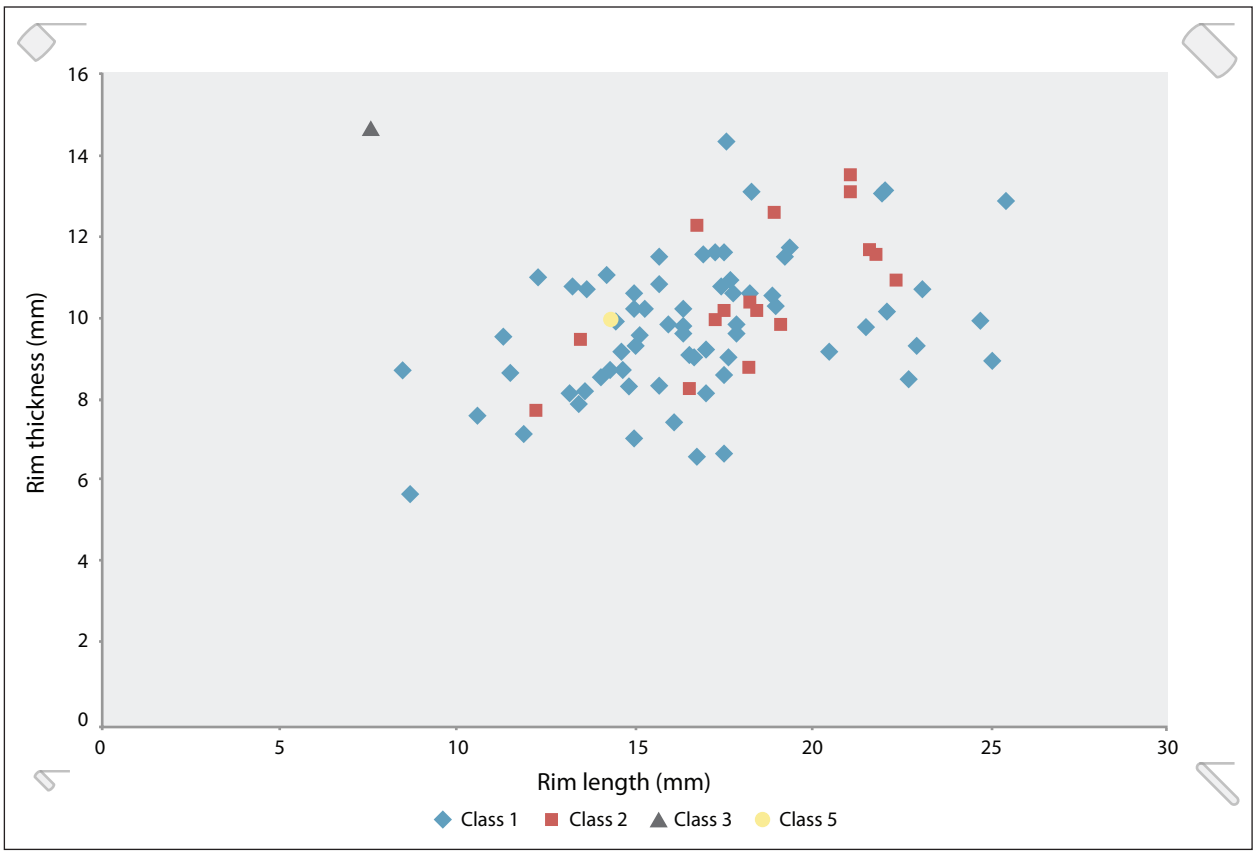


Figure 7.34. Relationship between rim length and thickness by technical class at Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded).

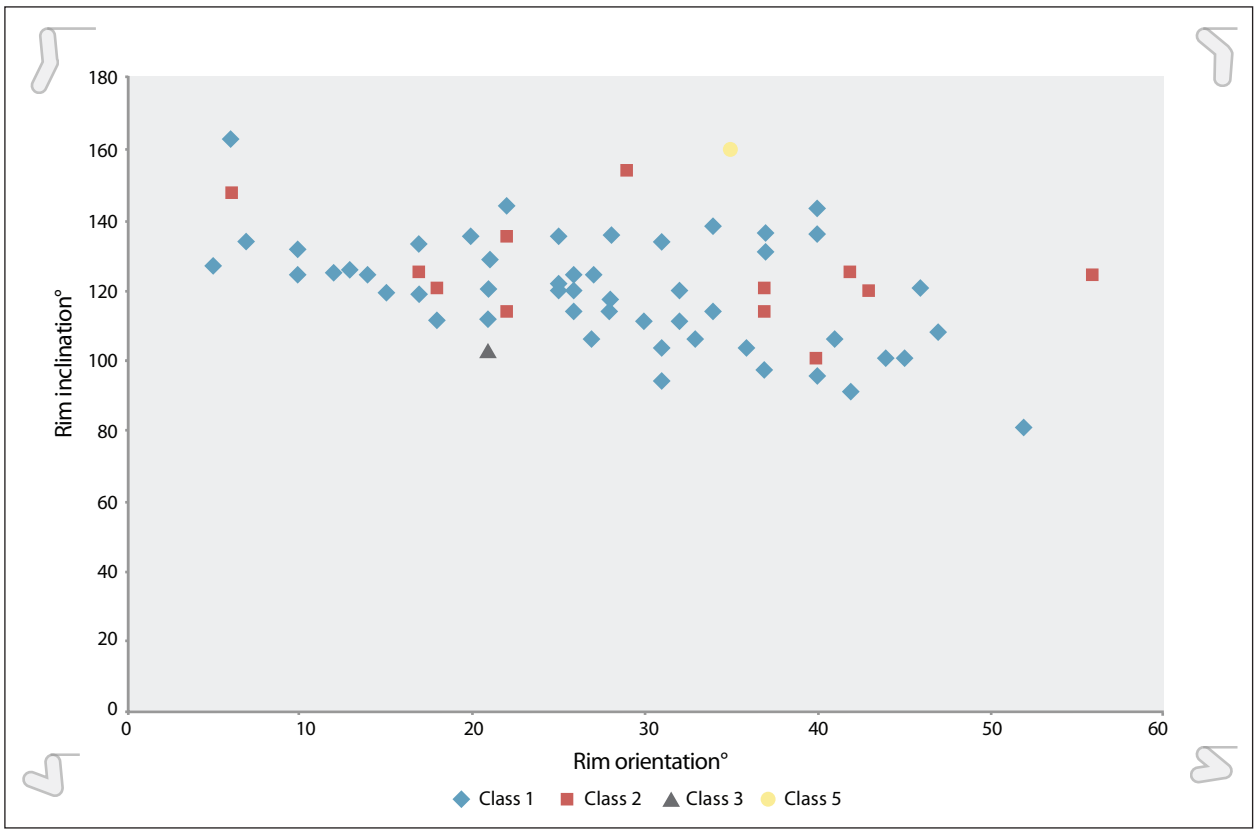


Figure 7.35. Relationship between rim orientation and inclination by technical class, Tilu, Unit 1 (note some rims not represented where attributes could not be confidently recorded)

orientation, showing Classes 1, 2, 3, and 5 clustering. The chart also shows that there is a general trend for rim inclination to decrease as orientation increases.

Orifice diameter also shows variation between technical classes. Class 1 orifices are 9–18 cm wide with a peak between 12–16 cm wide and mean of 14 cm (Table 7.18). This appears to follow a unimodal distribution with no clear subgroupings (Fig. 7.36). Class 2 rims are between 11–21 cm wide, with a mean of 15 cm. These also appear to follow a normal distribution, but the Class 2 samples with orifices 19–21 cm wide may either represent the tail of a unimodal distribution, or a bimodal distribution. A Kruskal-Wallis test using a Monte-Carlo simulation suggests that there are no significant differences between the means of Class 1 and 2 orifice diameters ($X^2 = 3.075$, $df = 1$, $\eta^2 = 5.30\%$, $P = 0.083$).[2] However, Mood's test suggests that there is a significant difference between median orifice diameters for these two classes (Median = 14, $X^2 = 5.102$, $df = 1$, $P = 0.042$). Sample sizes of Class 3, 4, and 5 rims were difficult to assess confidently owing to small sample sizes and so were not tested; however, the individual Class 3 and 5 rims are smaller than most Class 1 and 2 rims.

Table 7.18. *Average orifice diameter (cm) by technical class, Tilu, Unit 1.*

	Class 1	Class 2	Class 3	Class 4	Class 5
Mean	14	15	11	13	10
SD	2	3	–	1	–
CV	15%	18%	–	8%	–

Exotics

Two exotic rims were recovered from Tilu, Unit 1 (Fig. 7.37). Each appear to be derived from distinct technical traditions. T-188, from Spit 2, is a direct rim, projecting towards the central vertical axis, with straight rim course, parallel profile, and round lip. It has an orifice diameter of 10 cm and could represent a small restricted cup, or part of a longer vessel. T-410, from Spit 4, is a direct rim with straight rim course, parallel profile, and flat, sharp-edged lip with grooving. It has a larger orifice diameter of 18 cm and appears to be from an open bowl. Beyond this, neither sherd preserves significant evidence of manufacturing technique.

Shovel Pit 1

From Shovel Pit 1 at Tilu a small selection of rims were collected from various depths below surface (Table 7.19). These are all assignable to Madang style technical Classes 1,

2 Note that as Kruskal-Wallis tests assume similar distributions of data, a non-parametric Levene's test was applied to determine that the distributions were not statistically different ($F = 1.393$, $df = 4$, $P = 0.248$).

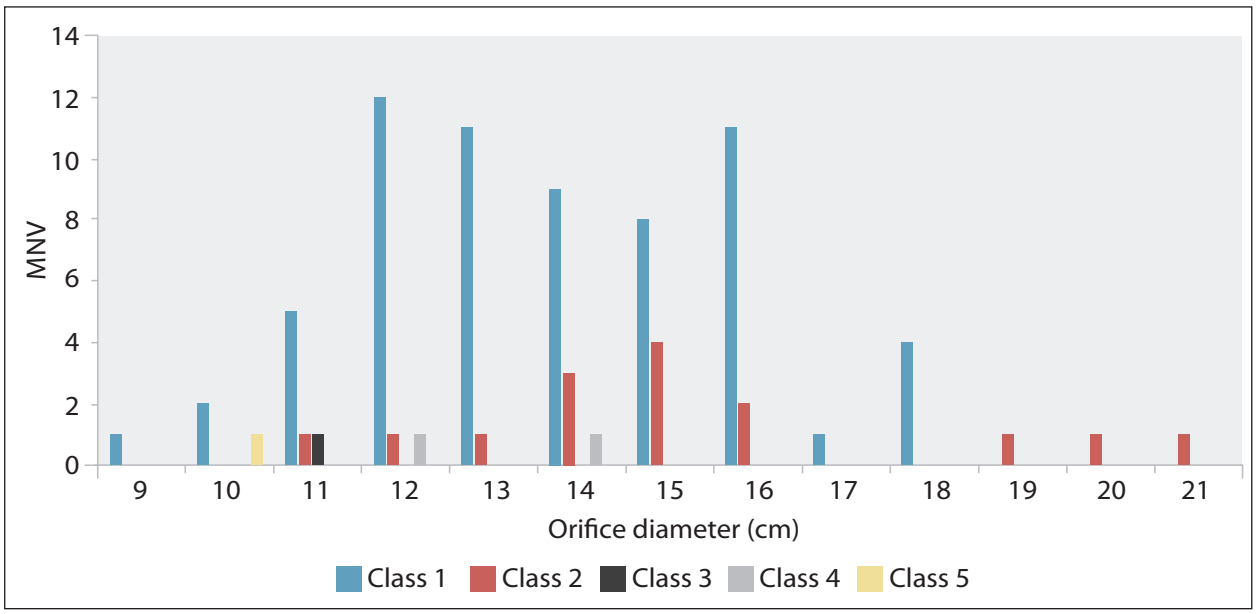


Fig. 7.36. Vessel orifice diameter by technical class, Tilu, Unit 1.

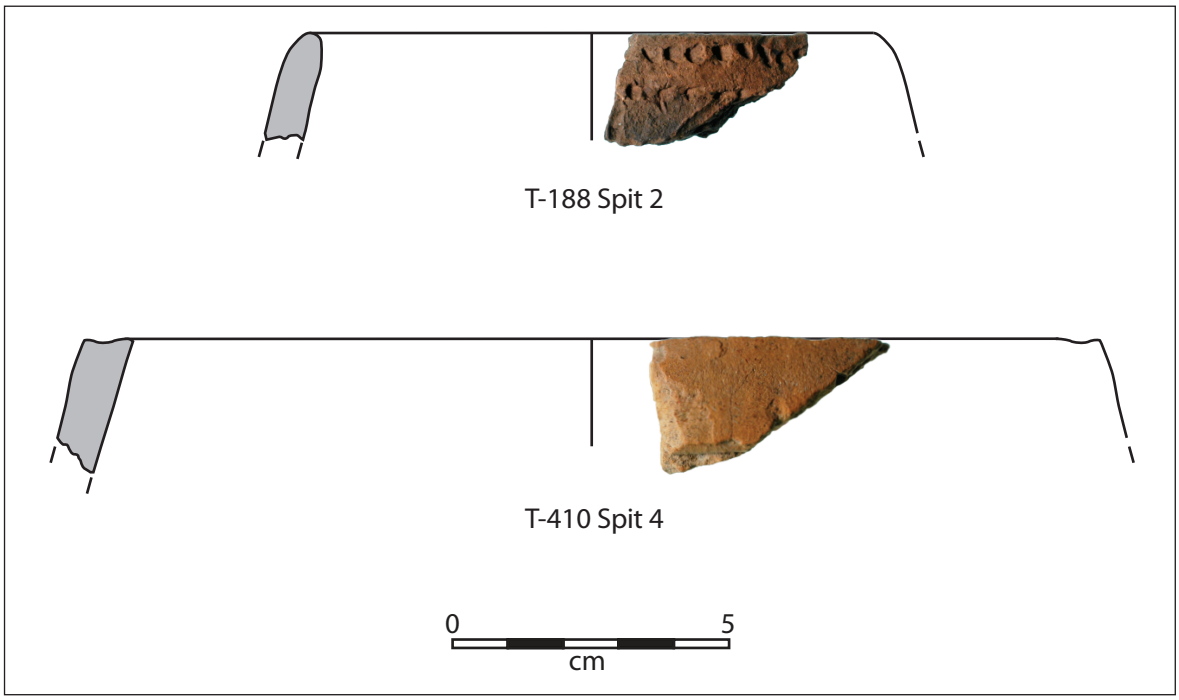


Figure 7.37. Exotic rims from Tilu, Unit 1.

2, or 3. One instance of a Class 3 rim is present from 60 cm below surface, which is slightly deeper (>20 cm) than that from Unit 1. These rims were excluded from the analytical Unit 1 sample owing to an uncertain chronology. No exotic rim forms were recovered, but a distinct ring base was found from 60 cm below surface (Fig. 7.38). It is not assignable to the Madang style. This sherd has a base diameter of 4 cm, standing the body about 0.5 cm off the ground.

Table 7.19. *Technical classes represented in Tilu, Shovel Pit 1 by* MNV *and depth.*

	Technical class						
Depth	**1**	**2**	**3**	**4**	**5**	**Exotic**	**Total**
45 cm	6	1	–	–	–	–	**7**
60 cm	2	–	1	–	–	–	**3**
70 cm	–	–	–	–	–	–	**–**
80 cm	–	1	–	–	–	–	**1**
120 cm	1	–	–	–	–	–	**1**
Total	**9**	**2**	**1**	**–**	**–**	**–**	**12**



Figure 7.38. Ring base from 60 cm below surface, Tilu, Shovel Pit 1.

Results: Surface survey

In total, 32 rims were collected from surface survey around Madang. This includes seven from Kranket Island, four from Siar Island, six from Yabob Island and 15 from Tilu at Malmal Village (Table 7.20). Almost all (n = 31) of these rims fit firmly within the Madang style, being assignable to Classes 1–5, but one sherd, from a sandy inlet on the north side of Yabob Island (see Chapter 6) is distinct and appears to derive from a different technical tradition (Fig. 7.39). This sherd (Y-5) is red-slipped on the external surface and appears to come from an outcurving bowl with concave rim course, gradually divergent rim profile and round lip, similar to the exotic rim (T-188) from Tilu, Spit 2.

Table 7.20. *Technical classes represented in surface collections by* MNV *and location.*

	Technical class						
Site	**1**	**2**	**3**	**4**	**5**	**Exotic**	**Total**
Kranket Is.	5	0	2	0	0	0	**7**
Siar Is.	1	1	1	0	1	0	**4**
Yabob Is.	2	2	0	1	0	1	**6**
Malmal	9	4	1	0	1	0	**15**
Total	**17**	**7**	**4**	**1**	**2**	**1**	**32**

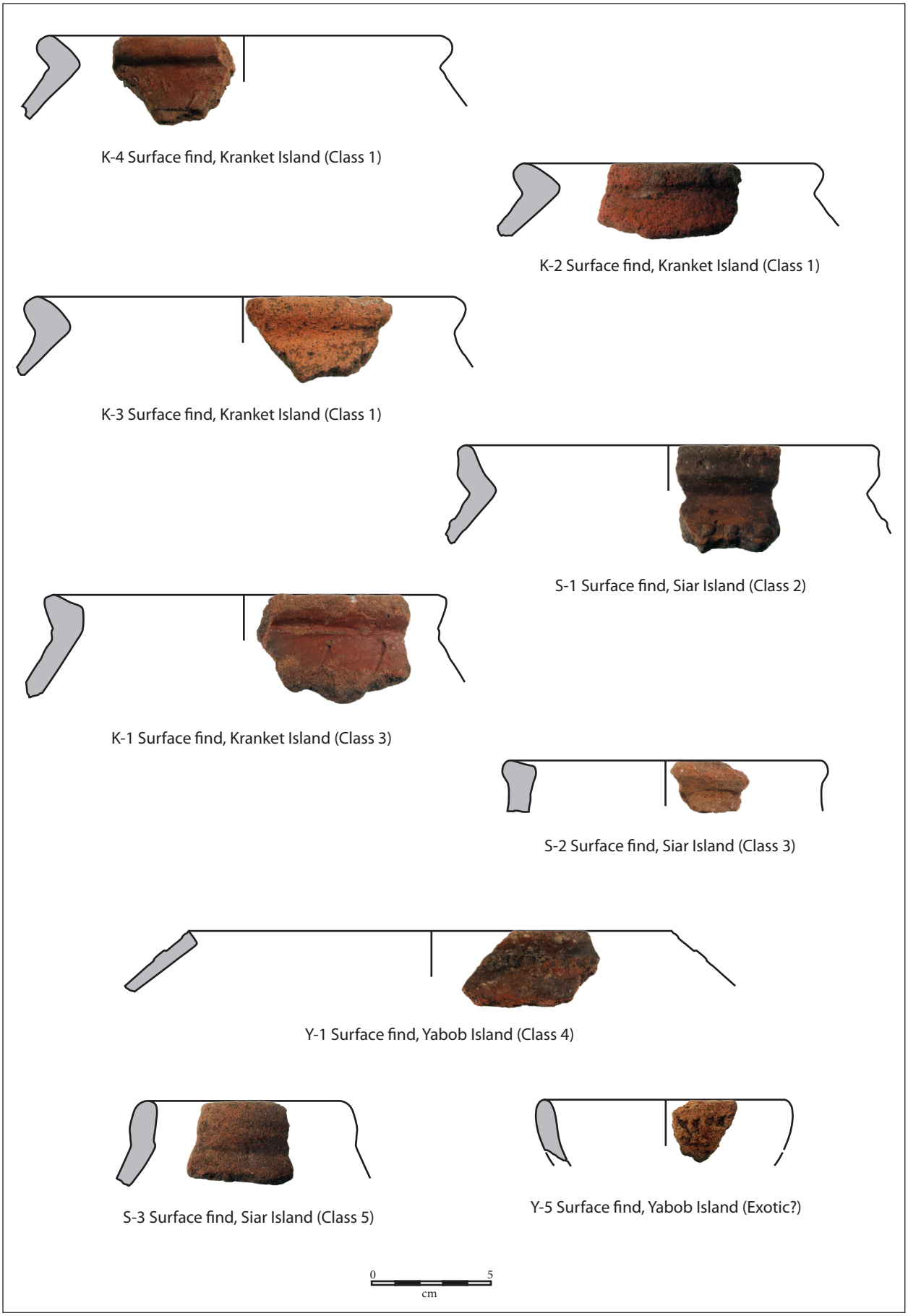


Figure 7.39. Rims collected from surface survey, Madang 2014.

Summary

This chapter has described the diversity of pre-colonial ceramic *chaînes opératoires* to start to distinguish the production groups working within broader communities of practice. The formal sherds represented at Nunguri, Tilu, and from surface survey show that about 96% of the ceramic vessels consumed locally are assignable to the Madang style. This Madang style is a technological tradition, composed of a number of distinct technological classes. Class 1 and 2 are almost identical in shape except for an additional bevelling stage in forming. Class 3 vessels are thicker, especially around the rim and produced by an extra stage of paddling around the interior of the rim. This is a procedure used by modern Bel potters. Class 4 vessels are incurving and lack a neck, similar to modern *Magob*, but where the *Magob's* rim profile diverges towards the lip, Class 4 rims are often parallel. It is not clear whether pre-colonial Class 4 vessels began with a rim-preform like modern Madang pots. Class 5 vessels are inverted and probably represent water-pots with restricted necks. As the MCA plots hint at (see Fig. 7.17 & Fig. 7.31), Class 1, 2, and 5 rims represent more similar technical processes than do Class 3 and 4 rims. This may indicate that Class 1, 2, and 5 were produced in the same production groups, while Class 3, and 4 derive from related but different groups.

Although there were five technical classes in pre-colonial Madang style pottery which were repeated in production through time, within each class there was a lot of variation in form. This variation gives insight into innovations within production groups and demonstrates a great deal of leniency for individual potters to create difference within more regulated technological processes. It is also relevant that Class 3, 4, and 5 occur later in the sequence at Tilu and Nunguri, perhaps reflecting changing preferences in forming technology across generations. It may also represent interaction and knowledge exchange between production groups.

The next chapter will continue the ceramic classification by examining procurement & distribution. This work attempts to distinguish the number of production groups making Madang style pots, including the source of their raw materials and the distribution of their pots around the Madang area. The results will further tease apart some possibilities raised in this chapter, such as if certain *chaînes opératoires* were used by specific production groups within a broader community of practice, or if multiple groups engaged with multiple *chaînes opératoires*, and if Classes 3, 4, and 5 represent introductions from distinct production groups or internal innovations.

Chapter 8. Pre-Colonial Potting II: Procurement and Distribution

> [The Bilbil] *would come to get clay for their pots. They would beach their canoes and fill them with the clay.*
> – Nagida of So village (1978)[1]

Geochemical characterisation of ceramic fabrics has the potential to delineate changes to raw material procurement and discriminate between local and exotic products. This chapter is the second stage of the technological analysis laid out in Chapter 7, and uses geochemical techniques to address questions about procurement and distribution. The analysis of these stages of the *chaîne opératoire* is a necessary step to assess changes to production and exchange over time.

The study of the chemical composition of Madang ceramics has two specific aims: (1) to establish the incipience of local production and subsequent adjustments to technological organisation in terms of changing resource procurement, and (2) to assess how changes occurred in local and regional pottery distribution over the last 500–600 years. These aims feed into broader research objectives investigating the history of the Bel around the mainland of New Guinea and subsequent movements, interactions, and exchanges. For instance, if there was a single migration of Bel speakers to the coast we would expect the earliest pottery to be predominantly made from local raw materials, but if there was more gradualistic diaspora and interaction between an insular homeland and the New Guinea mainland we might expect to see local and exotic raw materials used to produce Madang style pots, followed by the replacement and eventual complete cessation of exotic materials. Following initial Bel settlement, we can also explore if forming techniques became associated with specific raw material zones used by certain production groups, or if multiple Bel groups, using different raw materials, engaged with various forming techniques.

To address these aims, the chapter first presents the methodological links to assess procurement and distribution through chemical compositional analysis. This is based on technological theory and previous ethnoarchaeological studies, supplemented with ethnographic observations of modern potting around Madang and reference samples of known clay and temper sources (see Chapter 4). Next, the method of sampling, chemical analysis using scanning electron microscope (SEM), and statistical treatment of the data are presented. Finally, the results of the chemical compositional analysis are described in detail, including macroscopic fabric analysis and chemical analyses of mineral inclusions and clays. This work illustrates how changes in technological processes and exchange relationships are reflected in the archaeological ceramics.

Methodological issues

Foundations

Amongst the Bel, the manufacture of pots involves several essential materials. That includes clay, non-plastic minerals, slip, water, and firing fuel, along with several tools used to procure these materials: the digging stick for extraction, banana leaves to lie the raw clay on, string bags for transport, and so on. Two of these constituent parts – clay and non-plastic minerals – can be examined mineralogically and chemically to classify archaeologically useful groupings.

The first of these, potting clay, consists of reconstituted aluminium silicates, formed from the decomposition of non-plastic minerals (Guggenheim & Martin 1995). Generally, clay is derived from common rock types, which break down into different mineral grains such as feldspars, spinels, micas, quartz, amphiboles, and pyroxenes (Deer *et al.* 1992: 354). When these grains are sufficiently weathered into particles less than 2μm in size, they are defined as pure clay minerals: illite, kaolinite, smectite, or chlorite (Velde & Meunier 2008: 3). Naturally occurring clays are usually combinations of these pure clay minerals. More resilient grains are often not completely broken down but remain in the clay as non-plastic inclusions or are redeposited through wind and water action in the sediment (Arnold 1974).

For clay to be workable it cannot be overly plastic. Although most potting communities in New Guinea do not need to alter their clays (May & Tuckson 2000: 22), the

1 Quoted in Mennis (1981b: 79).

Bel potters manually add temper owing to the paucity of naturally-occuring non-plastic inclusions in their clays. As presented in Chapter 4, modern Bel potters use local black beach and river-mouth sands as tempers. Manual tempering can also make the ceramic more resistant to thermal shock during initial firing and cooking by reducing shrinkage and can prevent the clay cracking when the water content evaporates (Rye 1981:16).

Pacific temper sands are broadly defined as terrigenous, deriving from exposed bedrock, or calcareous, which represents calcium carbonate debris from marine reef systems (Dickinson 2006:3). Terrigenous tempers are particularly useful in describing source locations, forming diagnostic components of their original bedrock derivations (Dickinson 1998). Although calcareous tempers present more of a problem owing to the uniformity of reef deposits, their presence in a pottery fabric is usually a good indicator of manual tempering because of their relative absence in clay deposits. The firing temperatures reported for the New Guinea region, no higher than 1000°C, do not usually affect the mineralogy of terregenous inclusions (Dickinson 2006:4).

Although grog tempering is a technique unknown to modern Madang potters, it has been reported in archaeological Madang style ceramics (Specht *et al.* 2006). Grog constitutes small grains of crushed pottery reused in the production process, or small grains of fired and crushed clay specifically designed to temper clays (Vincent 1988:88).

Thus, within the clay matrix of the archaeological ceramic, non-plastic mineral or rock grains may be present as naturally occurring fragments from the underlying geology or may have been manually added as a temper. Conventionally in archaeology the two lines of evidence, clay and temper, are compared to known reference material and geological information to 'triangulate' the probable manufacturing areas of different groups (Arnold 1980; Bishop *et al.* 1982). This is the basic aim of such studies and allows important variables to be understood: the distance from production group to source or resource zone; the number of sources used by production groups; and the distance from one group's sources to other production groups or settlements.

Geochemical analyses and New Guinea ceramics

To better understand production and distribution, ceramic technologists have long advocated for the supplementation of formal and stylistic analyses with detailed studies of clay and temper (Arnold 1985; Rice 1982:51; Rye 1981; Rye & Allen 1980; Shepard 1980:320). At the start of the 21st century, Summerhayes (2000:30) noted that in the Pacific, although temper analyses had become commonplace in the Pacific particularly through the masterly work of the late Bill Dickinson (e.g. Dickinson 1998, 2006; Dickinson & Shutler Jr. 1971), clay compositional studies were largely lacking (exceptions being Ambrose 1992, 1993; Anson 1986, 1999; Irwin 1985; Lilley 1986; Hunt 1989; Summerhayes 1987). Since then, geochemical studies of pottery have come into the mainstream, now being seen as a necessary step in any analysis, especially as analytical machines become more widely accessible (e.g. Cochrane & Neff 2006; Eckert & James 2011; Gaffney *et al.* 2015, 2016, 2019; Golitko 2011; Golitko & Terrell 2012; Hogg 2007; Leclerc 2015; Shaw 2014; Shaw *et al.* 2016; Summerhayes 1997, 2000; Sutton 2016; Sutton *et al.* 2016; Teele 2011; Vilgalys & Summerhayes 2016). Despite this progress, theoretical developments have not kept pace with advances in materials science (Summerhayes 2015).

The general aim of characterisation studies in New Guinea archaeology has been to distinguish the geographic organisation of pottery production and distribution and to measure how this organisation changed through time. As noted above, this includes the number of production centres, the number of sources or resource zones, the proximity of production groups to these sources, the proximity of the consumer to the production group, and so on. These factors are usually then built into broader models of changing procurement strategies, resulting from changes to mobility or restrictions to territory, and changing distribution patterns, resulting from the reorganisation of production and exchange networks. However, some characterisation studies lack bridging concepts between observed chemical data and higher-order theories and models. That is, there is a lack of middle-range theory in the form of experimentation or analogy (Arnold 2015). How, for instance might we interpret a reduction in the number of clay sources being used at a certain time, or a change from calcareous to terrigenous tempers?

Technology as methodology

There is not necessarily an inherent link between technological choice, production and consumption groups, and mineralogical/compositional variability, so one must demonstrate, rather than assume, that the physical properties of the archaeological potsherd have social significance (Arnold 1998, 2000; Summerhayes 2015). In Madang, as elsewhere in the Indo-Pacific (see Aronson *et al.* 1994; Stark *et al.* 2000), the technological decision-making underlying the selection of raw materials has been shown to be equally affected by socio-political factors such as personal and social relationships or range of mobility, as it is by technical factors such as clay workability (see Chapter 4; Mennis 2006a:81). Similar social concerns are in play as finished products are then distributed from production groups to consumers.

But is it possible to distinguish these relationships through the chemical analysis of pottery? By asking these types of questions we begin to problematise the assumptions that underlie geochemical analysis, which is used so frequently to understand past technologies. Here, the methodological framework of the *chaîne opératoire* informed by ethnographic observation is used to bridge the raw chemical data and the broader concerns of this monograph regarding the nature of production groups in pre-colonial Ma-

dang and the technological processes operating within and between these groups. More simply, this chapter addresses how pottery procurement and distribution was organised in the past, and the possible reasons for specific technological choices within a myriad of possibilities (following Tite 1999).

Procurement

We return, again, to the concepts of technological process and embodied knowledge. Very few studies have attempted to integrate similar theoretical concerns and ceramic compositional analysis (exceptions being Jones 2002, 2004; Sillar & Tite 2000; Stark *et al.* 2000; Tite 1999, 2008). It is clear that procurement is one technological phase of the ceramic *chaîne opératoire* and as such must be composed of a series of socially specific techniques and material engagements. The social and cognitive processes informing which clay and temper sources the potters select should therefore be produced and reproduced in a similar way to those processes guiding the forming stage.

As a technological process, raw material procurement involves the interplay between intention, gesture, and matter. The regular engagement with this interplay – the routine of collecting clay and temper – required the repeated movement from the household to the raw material, the digging and extraction of raw materials, and the transport of the material back to the household for forming. These actions all represent technical elements and syntaxes that are informed by the learning process and become embodied through habitual action. Such routines would have produced a specific kind of embodied and technological knowledge, a procedural knowledge that only became apparent when inadequate materials were encountered, the source was exhausted, or a new source was sought.

Although the emic selection of raw materials is partly based on physical properties such as colour and workability (Arnold 1971), the specific place (or source) for procurement of these materials is as much a part of the technological choices made (Jones 2002: 87). The materials and the source location are enmeshed in culturally significant concepts of place. In this way, the choices to procure different raw materials from different locations are not only women-made transformations of the local landscape (Arnold 1985: 17), but socially constituted and culturally meaningful decisions related to the potters' experience of becoming, learning, and remembering, within the local landscape.

Around Madang, young Bel girls observe and assist their mothers, aunts, grandmothers and other experienced potters revisiting the same trusted deposits. The Bilbil clay sources, for instance, have been in use for three generations at least. The experienced potters also instruct, discursively or otherwise, which properties to be aware of when selecting the raw material. Many of these technical syntaxes such as the repeated collection of the same clays and tempers are archaeologically visible as technical attributes: the mineralogical inclusions and chemical signatures of the potsherd. Other learned syntaxes, such as how much clay to extract, how to dig it from the ground, and the manner of transport are not necessarily visible as technical attributes.

The Bilbil potters collect clay from two chemically distinct pits within close proximity of each other (see Chapter 4). As an alluvial clay underlies much of Bilbil land, it is apparent that clay selection is constrained not by the natural occurrence of the raw material. However, the distance from the village to the source, kin relations with the landowners, and the location of good quality gardening plots all appear to guide decision-making. In contrast, Yabob potters used six clay sources. It is possible that some of these clays were used for wheel thrown pottery when the industry changed briefly in the 1970s and it is not known how many sources were in use by either Bilbil or Yabob prior to European disruptions to pot production. However, it is worth noting that the discrepancy in the number of clay sources in use does not relate to range of territory or restrictions on access to raw material, but may relate to the intensity of collection and the standardisation of procurement (Bilbil nowadays pot more frequently than Yabob), or other factors. It is also important to note that changes to chemical pastes or slightly different tempers do not necessarily imply distinct changes to the organisation of procurement (Arnold 2000)

Distribution

As mentioned in Chapter 7, technological processes do not become inert after the procurement and production stages (Pelegrin 1990; Sellet 1993; Sillar & Tite 2000). Rather, ceramic technology continues to create meaningful human engagements throughout distribution, consumption and discard. However, as technologies pass through different stages in space and time, and objects pass through different social groups and communities of practice, they acquire and create different meaning (Knappet 2005a, 2005b). In the case of the Bel, ceramic production would not exist without the socially and economically enticing stages of distribution and consumption. It is in these stages that locally produced ceramics can be exchanged for food or a variety of objects, providing the necessary excuse to maintain social bonds and remain dominant on the playing field (see Welsch & Terrell 1998). Owing to the reciprocal dependency of trade friends that characterises New Guinea exchange (Mauss 1925; Thomas 1991: 14), including the Madang network (Mennis 2006a), the identification of exotic ceramics implies meaningful interrelations with other social groups, which were presumably maintained, if possible, through time.

The ways in which humans interact with ceramics throughout distribution and consumption can also be viewed as embodied processes, produced through habitual engagements. In the case of Bel distribution, technical syntaxes would incorporate the loading of pots into *balungut*

canoes, the storage of these pots on the *balungut,* stacked up in pyramids, the sprinkling of broken pots into the sea to quell malignant spirits, and the technical knowledge of sailing. The technological processes of ceramics and canoes become more conspicuously entwined at this point. Importantly, the distribution phase of the Bel ceramic *chaîne opératoire* moves from the female domain to the male domain.

Many of these technical choices relating to distribution cannot be assessed through compositional analysis. One set of choices that *can* be assessed, however, relates to the groups receiving and distributing goods locally around Madang, along with possible exotic materials being introduced into the area. Lilley's (1986) work in particular has already demonstrated that Bel ceramics were being exchanged all along the northeast coast prior to Europeans. The current study, limited to several sites around Madang, cannot assess the distribution of Bel ceramics to regional groups, but it can give insight into other types of ceramics being exchanged into, and consumed by, the Bel groups. In this sense the research questions pertaining to distribution are: what was the organisation of local Bel distribution, and, perhaps also, why were certain types of pots distributed to different groups.

Arnold (1980) makes the point that regional and sub-regional exchange should be possible to distinguish compositionally as the resource spaces of each group are unlikely to overlap. His model assumes that the resources used by specific production groups are distributed as patches. In the case of local exchange, however, it will only be possible to distinguish when resource spaces of different production communities do not overlap. There are interpretive problems that arise if these spaces do overlap. Figure 8.1. illustrates four scenarios of local production in which trade and exchange will be convoluted owing to an overlap in resource spaces. In each of these scenarios, both production communities could feature pots with the same raw material signatures.

Ethnographic data suggest that the Bilbil and Yabob procurement zones do not overlap and that they should be chemically distinguishable (see Chapter 4). However, in the past, resource spaces and the number of production groups may have been different.

Method

The Madang classification

To address these questions about procurement and distribution, the Madang ceramics will be further classified. A ceramic assemblage can be viewed as the product of one or more production groups (Roux & Courty 2005) operating within broader communities of practice. The aim

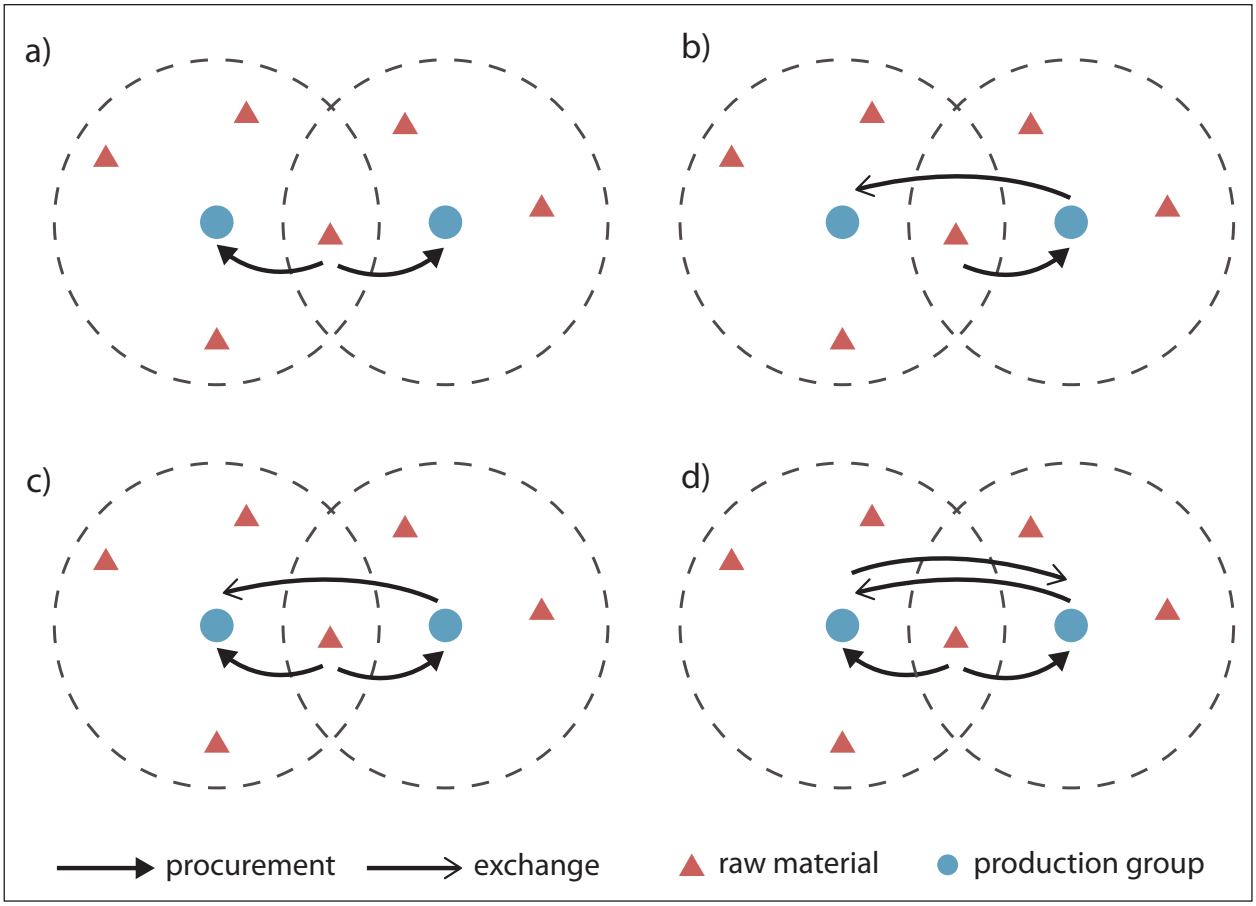


Figure 8.1. Several scenarios in which local exchange is difficult to chemically distinguish.

of the present classification is to identify those specific production groups who were using distinct raw materials within the broader community practice of forming and decorating pots using similar *chaînes opératoires*. Most compositional studies attempt to distinguish interregional variation in raw materials to infer distribution. It is less common for such studies to attempt to distinguish procurement and distribution at the level of the local production group. However, some studies on coarseware ceramics have been successful at delineating local variation (see Stark *et al.* 2000).

Here, the classification of Madang style ceramics continues the hierarchical typology outlined in Chapter 7 (adapted from Roux 2011). This approach seeks to identify ceramic *chaînes opératoires* through eight successive procedures (Fig. 8.2). This chapter deals specifically with procedures 5–7 and will distinguish techno-compositional groupings within the formal technical classes (1–5) assigned in Chapter 6. First, techno-fabric groups are provisionally sorted optically, then, techno-mineralogical groupings are classified based on geochemical assessments of each fabric's inclusions, and, lastly, techno-compositional groups are created by a geochemical and statistical analysis of the clay matrix itself. By examining clay and temper sources and paste preparation techniques, these technical classes indicative of specific forming processes may be subdivided to delineate specific production groups engaging with these technological processes. The specific analytical procedures are described below.

Macroscopic fabric analysis

All formal and decorated sherds were first examined optically under 40x magnification for mineral inclusions to allow for primary sorting into different techno-fabric groups. This techno-fabric study was designed to give a general appraisal of the fabrics only, and allow for preliminary classification, facilitating further geochemical analysis. All Madang style sherds comprised similar or the same types of inclusions, but in varying proportions. Allocation into groups was based on visual estimates of the mineral

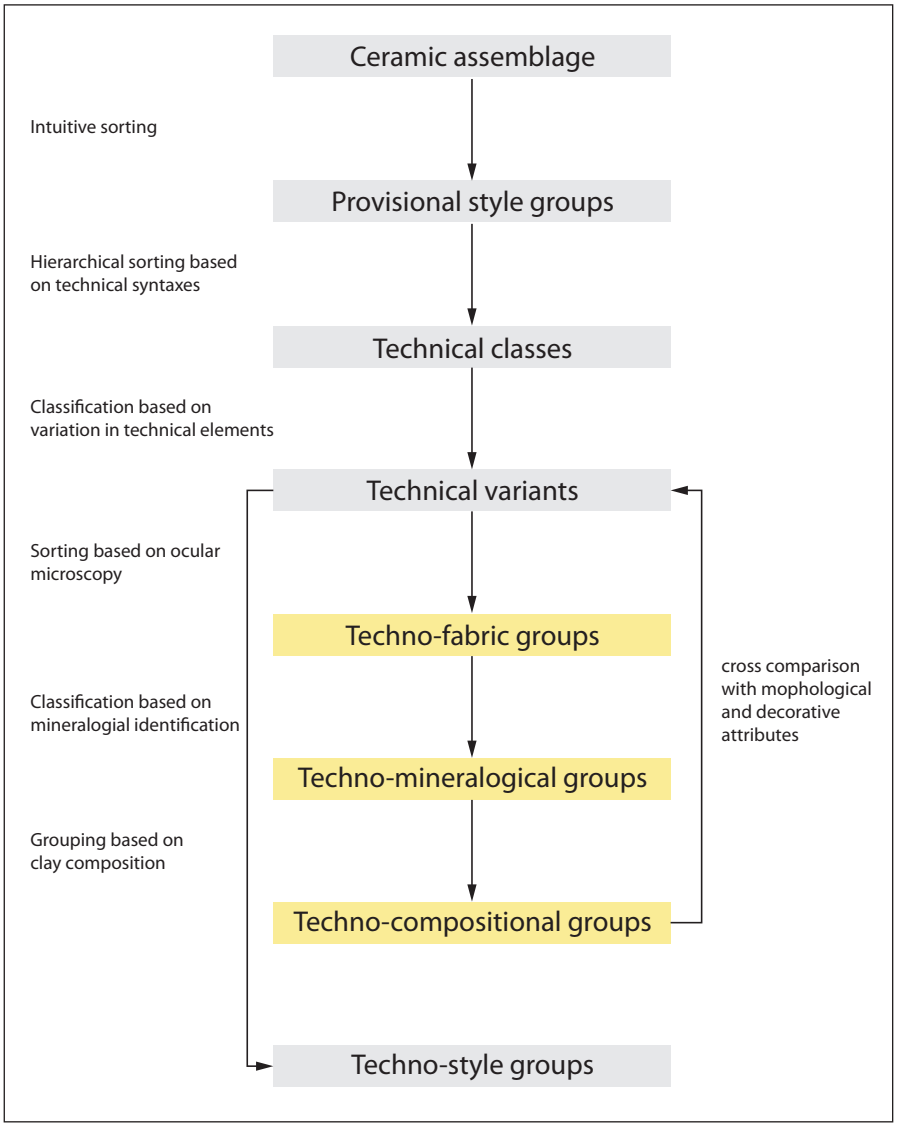


Figure 8.2. Procedures of a technological classification (adapted from Roux 2011). Those procedures examined in this chapter are highlighted yellow.

Table 8.1. *Macro-tempers of Madang style ceramics.*

Macro-fabric group	Dominant inclusions	Possible minor inclusions
1- Ferromagnesium	Fe oxides/pyroxene	Quartz, feldspars, coral, shell, grog, lithic
2- Light	Quartz/feldspars	Fe oxides, pyroxene, coral, shell, grog, lithic
3- Calcareous	Coral/shell	Quartz, feldspars, Fe oxides, pyroxene, grog, lithic
4- Grog	Grog	Quartz, feldspars, Fe oxides, pyroxene, coral, shell, lithic

grain types of greatest abundance in each sherd. A total of four macro-tempers were identified (Table 8.1).

Clay colour was also recorded for all rim sherds, which likely reflects both geochemical variation in clay sources, occasional mixing of pastes, and differential firing temperatures (see Chapter 4, Table 4.1–4.2). This assigned rims into several informal categories: orange, red, brown, yellow, and grey. To reduce intra-observer error in the analysis, each of the informal categories was assigned a Munsell colour reference, which would then be used as a control (orange = 5YR 5/6; red = 2.5YR 4/6; brown = 5YR 4/6; yellow = 10YR 6/6; grey = 10YR 6/4).

Black and grey surface alteration can be caused by firing, cooking, or re-use as *su*. Under oxidising firing conditions, discolouration of the potsherd's core in cross-section is primarily owing to the presence of organic material (Rye & Allen 1980). Both surface and core blackening were recorded as presence or absence attributes.

Sampling procedures for geochemical analysis

To further establish groupings, a total of 121 sherds was selected for geochemical analysis. It is necessary to explicate clearly the method of selection, from which interpretations of chemical and mineralogical variability in each assemblage will be based. Sherds were chosen by selective stratified sampling procedures, using decreasing orders of inclusiveness: site, spit, vessel portion, technical class, techno-fabric grouping and clay colour. This sampling procedure applies to those stratified sherds assigned to the 'Madang style' at Nunguri and Tilu only. Overall, 100 Madang style sherds from Nunguri and Tilu were sampled from excavated contexts to provide a robust temporal dimension to raw material procurement. Owing to the small proportion of sherds being selected compared to the total recovered in excavation, comprehensive random sampling was not considered viable as it insufficiently represented rare, but potentially important, technical classes. The guidance of selective sampling was preferred as it ensured that the widest range of fabrics and forms was selected (see Summerhayes 1987: 138; Wilson 1978).

An equal number of sherds were selected from each excavated site: 50 from Nunguri and 50 from Tilu (Table 8.2). These numbers allow for a comparable investigation of geochemical variability at both sites. Five sample spits were chosen in each excavation. These spits were chosen deliberately to preference those with associated radiocarbon age determinations, while also selecting from approximately regular depth intervals. Ten sherds were selected from each of those five spits. The sampling was limited to rim sherds only, which formed a discrete population from which to select. This approach allowed for comparisons between composition and technical class. Sampling re-

Table 8.2. *Madang style sherds selected from Nunguri and Tilu for geochemical analysis. Number of sampled sherds with MNV present in each spit in brackets.*

Nunguri						
Spit	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Total**
2	2 (78)	2 (28)	2 (21)	2 (12)	2 (2)	10 (141)
5 (210 BP)	3 (14)	2 (5)	3 (11)	2 (5)	–	10 (35)
11 (495 BP)	2 (10)	3 (13)	1 (2)	3 (13)	1 (1)	10 (39)
13 (530 BP)	4 (15)	3 (5)	–	3 (10)	–	10 (30)
15	4 (23)	3 (9)	–	3 (4)	–	10 (36)
Total	**15 (140)**	**13 (60)**	**6 (34)**	**13 (44)**	**3 (3)**	**50 (281)**
Tilu						
2	5 (16)	3 (4)	1 (1)	1 (1)	–	10 (22)
4 (630 BP)	9 (10)	–	–	–	1 (1)	10 (11)
6 (595 BP)	8 (10)	2 (2)	–	–	–	10 (12)
7 (585 BP)	7 (11)	3 (4)	–	–	–	10 (15)
9	8 (10)	2 (3)	–	–	–	10 (13)
Total	**37 (57)**	**10 (13)**	**1 (1)**	**1 (1)**	**1 (1)**	**50 (73)**

strictions occurred in the basal deposits of Nunguri, Layer 2, Spits 16–17, and Tilu, Layer 2, Spit 12, in which there were fewer than ten rim sherds each. These spits were not sampled from. Rim selection was a broadly proportional representation of each technical class in each spit. Thus, if there were twice as many Class 1 rims present in a particular spit, then twice as many would be sampled. However, where very few examples of a particular class were present, they were purposively sampled so the complete diversity of rim forms could be included. Within each technical class, examples of each macro-temper and clay colour were selected to account for as much variability as possible. The minimum number of vessels (MNV) was calculated through metrical comparisons and refitting to ensure each rim sampled was from a different vessel (see Chapter 7).

To provide a spatial dimension to clay and temper variability in the Madang area, 13 rim sherds were also sampled from surface collections at Kranket, Siar, and Yabob islands. This represents over 80% of surface-collected rims from these islands (Table 8.3).

All eight sherds identified as possible 'exotics' in the formal analysis (see Chapter 7) were sampled in total to provide insight into the variety of fabrics being imported into Madang in the past. This includes one rim from Nunguri Test Pit 1, two rims and three decorated body sherds from Tilu Unit 1, a ring base from Tilu Shovel Pit 1, and one rim from Yabob Island (Table 8.4).

Samples of ethnographic clays from Yabob (1–6) and Bilbil (1–2), fired at 700°C and 1000°C, and several local beach sands (Bilbil Island, Bilbil Village, Yabob Village) were also analysed to give a modern baseline of raw materials in use around coastal Madang (see Chapter 4). Further, two sand samples from basal deposits at Nunguri (Test Pit 1, Spit 17) and Tilu (Unit 1, Spit 12) were also examined to demonstrate the immediately available sands at the two sites. By establishing a chemical and mineralogical 'fingerprint' for the Madang area before then examining artefactual material, the procedures in this chapter follow the ideal approach laid out by Earle and Erickson (1977).

Table 8.3. *Madang style rim sherds from surface collections for geochemical analysis.*

Provenance	Class 1	Class 2	Class 3	Class 4	Class 5	Total
Kranket Is.	5	–	2	–	–	**7**
Siar Is.	1	–	–	–	1	**2**
Yabob Is.	2	1	–	1	–	**4**
Total	**8**	**1**	**2**	**1**	**1**	**13**

Table 8.4. *Exotic sherds from excavation and surface collection for geochemical analysis.*

Provenance	Spit	Rim	Decorated body	Base	Total
Tilu, Unit 1	2	1	1		**2**
	4	1			**1**
	5		1		**1**
	6		1		**1**
Tilu, Shovel Pit 1	60 cm			1	**1**
Nunguri, Test Pit 1	15	1			**1**
Yabob Island	Surf.	1			**1**
Total		**4**	**3**	**1**	**8**

Geochemical characterisation

A geochemical analysis of the sampled sherds was undertaken to describe techno-mineralogical and techno-compositional groups. Quantitative chemical analysis of non-plastic minerals and the clay matrix was completed on a Zeiss Sigma Field Emission Gun Scanning Electron Microscope (SEM) in the Otago Centre for Electron Microscopy (OCEM), using an XMax20 Silicon Drift Energy Dispersive Spectrometer (EDS) detector and AZtec acquisition and processing software from Oxford Instruments. The SEM produces high-resolution images and detects contrasts between areas with different elemental compositions and surface topographies. The EDS allows spot-point analysis and determines the chemical composition of a point or zone on the sample to define which elements are present in that location (Froh 2004). Clay and mineral inclusions can then be separately analysed and considered as two different but complementary datasets. The spot point ability of the SEM is used in preference to other methods such as NAA, PIXE-PIGME, LA-ICP-MS, and XRF which produce chemical noise and erroneous values when clay and mineral inclusions are undifferentiated (Zuluaga *et al.* 2011). The SEM therefore has the added benefit of allowing quantitative analysis of the heterogeneity in prehistoric ceramics (Brissaud *et al.* 1985).

To produce scanning electron micrographs, the SEM bombards the sample with a focused electron beam; in this instance with 15kV Extra High Tension (EHT) accelerating voltage. A working distance of 8mm optimised the production of high-quality images. This distance, from the polepiece to the sample, affects the scanning angle of the electron beam, and hence depth of field and resolution. When the electron beam interacts with the sample, it dislodges backscattered electrons (energies between the incident beam and 50eV) and secondary electrons (energies less than 50eV) that are used for image formation (Reed 2005). Further, the interaction between the electron beam and nuclei produce x-ray photons with characteristic wavelengths, which are used for elemental analysis. When the EDS detector absorbs an x-ray photon, a voltage pulse is produced with peaks proportional to the x-ray energy received. These pulses are digitised and stored in a multichannel counter that produces a spectrum of all pulse heights simultaneously (Froh 2004).

To measure x-ray energy accurately, the target must be set at exactly 90° to the beam. Thus, all samples must be completely flat and polished with no surface irregulari-

ties (Reed 1975:177). All sherds were first comprehensively photographed, drawn and recorded before any destructive analysis took place. Samples were prepared by cutting the selected sherds on an 8-inch diamond blade and impregnating them with epoxy resin (Hillquist Thin-section Epoxy A and B) to form briquettes, which were polished to 1 micron, ultrasonicated in distilled water for 5 minutes, and cleaned with ethanol. These briquettes were then coated with carbon (using an Emitech K575X Peltier-cooled High Resolution Sputter Coater and Emitech 250x Carbon Attachment), which acts as a thin (10 nm) conductive layer to ensure an electrical path to ground. This prevents the sample 'charging' under the electron beam and producing an overexposed image. Carbon coating is preferred owing to its low atomic weight and minimal effect on x-ray intensities (Summerhayes 2000:38).

Two areas of each sample were selected for image capture and elemental analysis: one electron micrograph at 100x magnification for the non-plastic mineral inclusions analysis; and one at 2000x for clay matrix analysis. This approach attempted to target areas of the sherd that were oxidised, but the elemental analysis, along with the pXRF groupings presented in Chapter 4, indicate that there is no significant differentiation of results between the oxidised and non-oxidised areas of clay. Two different methods of analysis were used: (1) A spot-point analysis of the clay matrix which collected elemental data at five points per view, and (2) map-scanning, which obtained x-ray data for an entire 100x micrograph rather than particular points. Map-scans display the number of x-rays detected from specific energy ranges as phases, represented by colour-coded pixels. These images are useful in visually discriminating similar inclusions in the clay matrix.

Each spot-point collected data for 10 seconds with a processing time of 3 seconds, using pulse pile-up correction to eliminate peak overlap issues. In map-scanning, peak overlaps were eliminated using 'TruMap'; an algorithm that runs in real time to automate peak deconvolution. The TruMap was run for two cycles (10 minutes), with a pixel dwell time of 300µs and process time of three seconds. Chemical spectra were then collected from these map-scan phases and compared to the chemical composition of known reference samples to identify the mineral (using Deer *et al.* 2013).

For clay analysis, the spectra were limited to eight key elements: Na, Mg, Al, Si, K, Ca, Ti, and Fe. Similar studies (e.g. Hogg 2007; Summerhayes 1987, 2000) have found these lighter elements more useful than attempting to assess trace elements using EDS. Two elements, Cl and C, were excluded from the spectrum. Cl was excluded because it was the major constituent of the epoxy, which might be a cause of contamination. C was excluded because the samples were coated in this element.

Other elements are sometimes excluded from clay spectra. This is because several cultural factors can affect paste variability: firing, mixing with water, and post-depositional changes. Light metals such as Fe, Mg and Al can be affected by increased firing conditions. The water used to pot may add S, Mn, Cl, Br, and Fe (Allen & Rye 1982). Furthermore, several elements (Na, K, Mg, Ca, Ba) can leech out of or enrich into ceramics owing to different post-depositional conditions (Freeth 1967; Golitko *et al.* 2012). Although none of these alterations is usually sufficient to significantly alter chemical groupings, they must be borne in mind to address potential variation in the data. Factors that do significantly affect paste variability are usually natural geological variations in clay sources (Arnold 2000). Within homogenous geological zones, micro-variations in weathering, climate, and parent strata will produce a chemically heterogeneous resource zone (see Chapter 2, Fig. 2.5). The eight elements were converted to oxide weight, normalised, and exported. The spectra outputs provided the raw chemical data, which were then statistically transformed to allow for interpretation of clay compositional variability.

Statistical treatment of the clay chemical data

The central aim of statistical manipulations of the clay data is to investigate underlying patterns and create groupings that make mathematical, chemical, and archaeological sense (Beiber *et al.* 1976; Harbottle 1982; Summerhayes 2000:39). Here Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA), performed with SPSS ver.21, were used to construct techno-compositional groupings from the clay data. These approaches have previously been effective in distinguishing chemical groupings in Pacific ceramic studies (e.g. Gaffney *et al.* 2015; Garling 2007; Shaw 2014; Summerhayes 1987, 2000). However, it is important to justify clearly the choice of clustering analyses used. Many methods will generate clusters even when applied to random data (Dubes & Jain 1979), and some groupings can reflect the structure of the clustering algorithm rather than patterns in the chemical data itself. On that basis, multiple manipulations were undertaken and cross-compared to ensure internal consistency.

HCA attempts to group points in multidimensional space and investigate underlying structures in the clay chemical data (Dubes & Jain 1976), with the premise that clays of similar derivations will form clusters (Summerhayes 2000:40). Agglomerative HCA methods first plot all of the samples as points in multidimensional space (the number of dimensions being equal to the number of elemental variables). These individual points represent single clusters that are then merged with the next closest point in space to form more inclusive clusters. Pairs of clusters are successively merged as one moves up the hierarchy (Johnson 1967). The results of hierarchical clustering are then presented as dendrograms.

Here, two agglomerative methods – the Group Average method and Ward's method – were chosen to group samples into clusters. The Group Average method defines distance between groups as the average of the distances between every pair of points within each group (Everitt

1977:15). In this way group centroids (averages) of specific samples and groups can be calculated. Ward's (1963) method is different in that at each stage of agglomeration it merges only those two points the union of which results in the minimum increase in the error sum of squares.

Both Ward's and Group Average were clustered using Euclidean distance:

$$d = |x - y| = \sqrt{\sum_{i=1}^{n} |x_i - y_i|^2}$$

d= distance; x= point a; y= point b

The measure of distance will affect the shape of clusters as the points may be closer or further apart depending on the distance metric used. In 3D space Euclidean distance is the shortest distance between two points, but in >3D the generalised equation above still satisfactorily describes distance, especially when applied to quantitative variables such as chemical data (Manly 1986:106).

PCA is a common multivariate technique that reduces a large number of variables to a smaller number of artificial variables (Manly 1986) and allows a visual appraisal of the clusters formed by HCA. The PCA calculates orthogonal linear combinations of the auto-scaled variables (in this case each element oxide weight) by using a correlation matrix based on the maximum variance criterion (Baxter 1994:66). These linear combinations are referred to as principal component scores and each successive component (principal component 1, 2, 3… n) attempts to account for the maximum variance not accounted for by previous components. By plotting the regression scores of principal components 1, 2, and 3 in 2-D and 3-D space most of the total variance should be displayed. 'Loadings' are the coefficients of these principal component scores. The original variables are multiplied by these loadings to give new values, which can also be plotted to describe the correlation between each variable and the principal components (Bruno *et al.* 2000).

PCA must meet four assumptions to be considered valid. One assumption is that the data are normally distributed. Here, the unstandardised clay chemical values for the eight selected element oxide weights were first logarithm base-10 transformed ($\log_{10}x$), which approximates the normal distribution (following Bishop & Neff 1989). It also reduces the effect that larger values (such as Si) would have in dictating groupings.

Another assumption of PCA is that there are no significant outliers, which can have a disproportionate influence on clustering results. Here, outliers were identified by computing the Mahalanobis distance (see Beier & Mommsen 1994). For each sherd sample (5 spectra), those spectra with significantly ($P<0.01$) different Mahalanobis distances were identified as outliers and discarded.

A third assumption is sampling adequacy. Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA), which is the sum of partial correlations relative to the sum of correlations (Kaiser 1970; Kaiser & Rice 1974), was run on the entire dataset, and for each individual variable. To ensure reliable results, the sum of partial correlations should be small compared to the sum of the correlations, indicating that correlations are restricted and that there is clustering among only a few variables. A value of >0.5 is generally considered acceptable, while values closer to 1 are ideal (Cerny & Kaiser 1977; Dziuban & Shirkey 1974).

Lastly, the PCA assumes that the dataset is suitable for dimension reduction, meaning that there should be equal variances among the variables for them to be reduced to components. A correlation matrix was calculated to determine that each component was significantly correlated, indicating that the 'correlation matrix' was an 'identity matrix'. An identity matrix is a *nxn* diagonal matrix with ones in the diagonal position and zeros elsewhere. Bartlett's Test of Sphericity was similarly used to distinguish if the variables were from a population of equal variances and whether these variables were significantly ($\alpha=\leq 0.05$) correlated (Bartlett 1937; Sokal & Rohlf 1969).

The assignment of chemical groups is a very subjective process based on a visual appraisal of the PCA in three-dimensions. These groups are often lumped or split depending upon data quality and research interests. Here the term techno-compositional group is used as a heuristic label to describe these artificial groupings.

Results: ethnographic samples

The following sections present the results of the Madang mineralogical and compositional analyses. First, the ethnographic baseline is established by presenting the resources used by modern Bilbil and Yabob potters. Then, the pre-colonial pottery results are presented by site. The optical observations of macro-tempers and clay colour are described to give a broad overview of fabrics present in the assemblages. This subdivides technical classes based on rim form into several techno-fabric groupings. Second, the section presents the chemical results of non-plastic mineral grains. This clarifies techno-fabric groups, distinguishing specific techno-mineralogical groups. Third, the chemical analysis of the ceramic matrix is presented. Specific groupings are distinguished within each techno-mineralogical group to designate techno-compositional groups. The information summarised here can be used in combination with Appendix B, which presents illustrations of the mineralogical variation in selected sherds and clay samples.

Inclusions and tempers

The ethnoarchaeological clay sources (*Bilbil 1–2*, and *Yabob 1–6*) contain varying amounts of natural mineral inclusions with different grain sizes, both of which affect the texture of the clay and its workability. Generally, the Bilbil

clays are coarser, containing larger and more numerous inclusions of quartz. *Bilbil 1* contains quartz grains up to ~400µm and *Bilbil 2* contains quartz up to ~500 µm. Rare augite, epidote, and albite are present in *Bilbil 1* as smaller grains (~70–250 µm), along with minor Fe and Ti oxides (~25 µm). *Bilbil 2* contains minor amphibole grains (Table 8.5). By contrast, the Yabob clays are relatively fine grained with minor quartz inclusions ~50–300 µm in size. Many Yabob sources also contain ilmenite or Fe and Ti oxides (~20–30 µm), along with rare epidotic, lithic and feldspathic fragments (Table 8.6). All Yabob clays except *Yabob 3* contain the same distinct iron-rich rock fragments.

An examination of temper sands shows that the Bilbil Island beach sand is almost entirely calcareous, formed from the underlying reef coral. It is almost identical to sand excavated from basal desposits at Tilu and Nunguri and lends further support to the suggestion that both sites were uplifted coral islands at first occupation. There are also rare grains of clinopyroxene in each sample, and the Nunguri basal sand contains small foraminifera fossils. The Yabob and Bilbil village beach sands are distinct as they derive from mainland beaches and river mouths. Volcanic grains, particularly lithic fragments and augite dominate both sands. The Yabob sand also contains amphibole and ilmenite, while the Bilbil sand contains occasional calcareous grains.

It is clear that a range of minerals will be present in the pre-colonial Madang pottery if it is formed from similar constituents, namely quartz deriving from clay deposits, and lithics and pyroxenes from mainland black beach sands. If sands from offshore islands were used instead of mainland sands, calcareous grains will be almost exclusively present. Amphiboles, ilmenite, and calcareous grains may be instructive to assign sherds to different techno-mineralogical groups owing to their variable presence in local clays and sands from different geological zones and environments.

Clay composition

Chemically, the ethnographic clay sources tend to separate the Bilbil and Yabob resource zones. There is greater variation within each source (i.e. the Euclidean distance between samples fired at 700°C and 1000°C) compared with the preliminary pXRF analysis using heavier elements (see Chapter 4). However, the general structure of the data is the same. The two Bilbil clay sources separate out from the Yabob sources, and *Yabob 2*, *5*, and *6* cluster together, while *Yabob 1*, *3*, and *4* cluster away. Note that although the HCA clusters *Yabob 5* (1000°C) with the Bilbil clays, the PCA separates *Yabob 5* from the Bilbil samples (Fig. 8.3–8.5).

Table 8.5. *SEM results of mineral inclusions naturally present in Bilbil clay sources.*

		Source			
		1		2	
	Firing (°C)	700	1000	700	1000
Calcareous	Coral				
	Shell				
	Indeterminate				
Clinopyroxenes	Augite	X			
	Ferroan augite				
	Pigeonite				
	Indeterminate				
Orthopyroxenes	Enstatite				
Plagioclase	Anorthite				
	Bytownite				
	Labradorite				
	Andesine				
	Oligoclase				
	Albite	X	X		
Alkali feldspars	Orthoclase				
	Anorthoclase				
	Sanidine				
Amphiboles	Anthophyllite				
	Magnesio hornblende			X	X
	Ferrogedrite				
	Gedrite				
	Ferroglaucophane				
	Edenite				
	Kaersutite				
	Tschermakite				
	Tremolite				
	Inderminate				
Epidote	Anorthite	X			
Quartz	Quartz	X	X	X	X
Non-silicates	Ulvospinel				
	Magnesiochromite				
	Indeterminate				
	Ti oxide		X		
	Fe oxide		X		
	Ilmenite				
	Cu oxide				
Other	Rock				
	Mica?				
	Humite?				
	Titanite				
	Iron rich silicate (garnet?)				
Grog	Grog?				
Organic	Plant fibres				

Table 8.6. *SEM results of mineral inclusions naturally present in Yabob clay sources.*

		Source											
		1		2		3		4		5		6	
	Firing (°C)	700	1000	700	1000	700	1000	700	1000	700	1000	700	1000
Calcareous	Coral												
	Shell												
	Indeterminate												
Clinopyroxenes	Augite												
	Ferroan augite												
	Pigeonite												
	Indeterminate												
Orthopyroxenes	Enstatite												
Plagioclase	Anorthite												
	Bytownite												
	Labradorite												
	Andesine												
	Oligoclase												
	Albite				X								
Alkali feldspars	Orthoclase											X	
	Anorthoclase												
	Sanidine												
Amphiboles	Anthophyllite						X						
	Magnesio hornblende												
	Ferrogedrite												
	Gedrite												
	Ferroglaucophane												
	Edenite												
	Kaersutite												
	Tschermakite												
	Tremolite												
	Inderminate												
Epidote	Anorthite					X							
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel		X										
	Magnesiochromite												
	Indeterminate												
	Ti oxide				X								
	Fe oxide				X								
	Ilmenite			X		X	X		X	X	X		
	Cu oxide												
Other	Rock	X	X	X				X	X		X	X	X
	Mica?												
	Humite?												
	Titanite												
	Iron rich silicate (garnet?)												
Grog	Grog?												
Organic	Plant fibres												

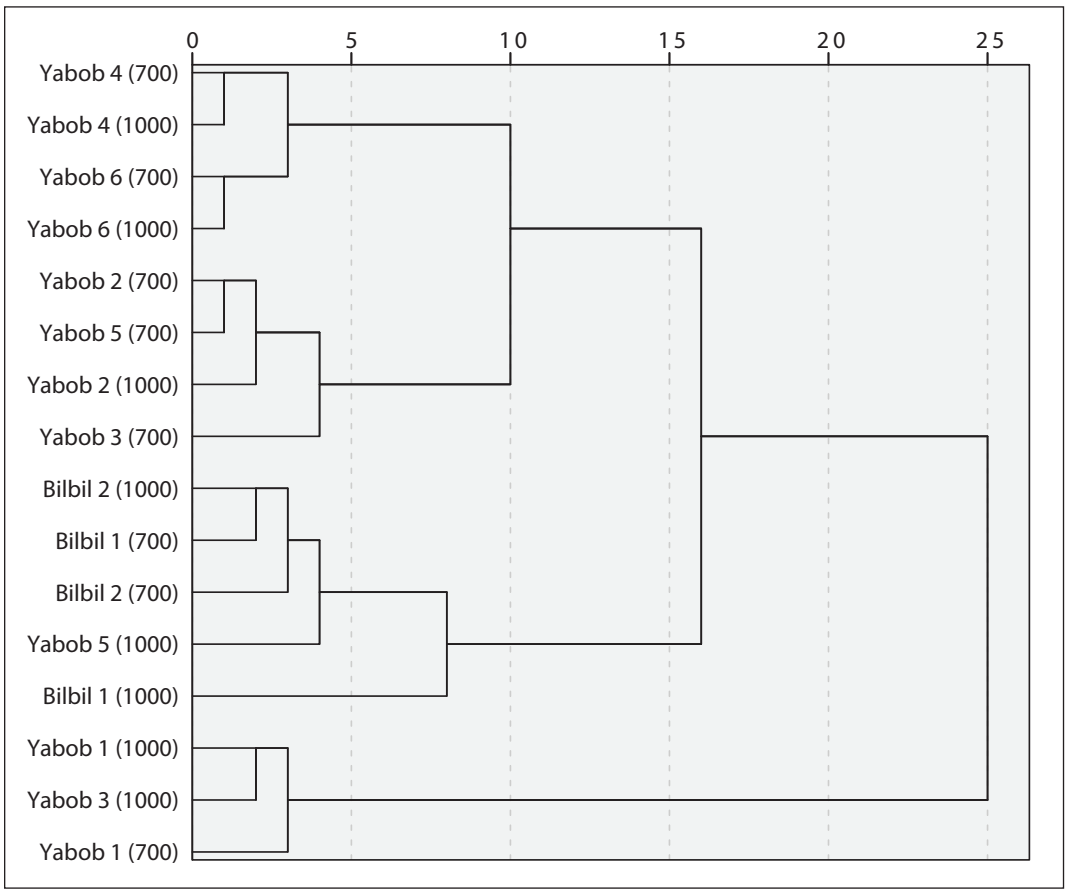


Figure 8.3. Ward's HCA of eight ethnographic clay sources.

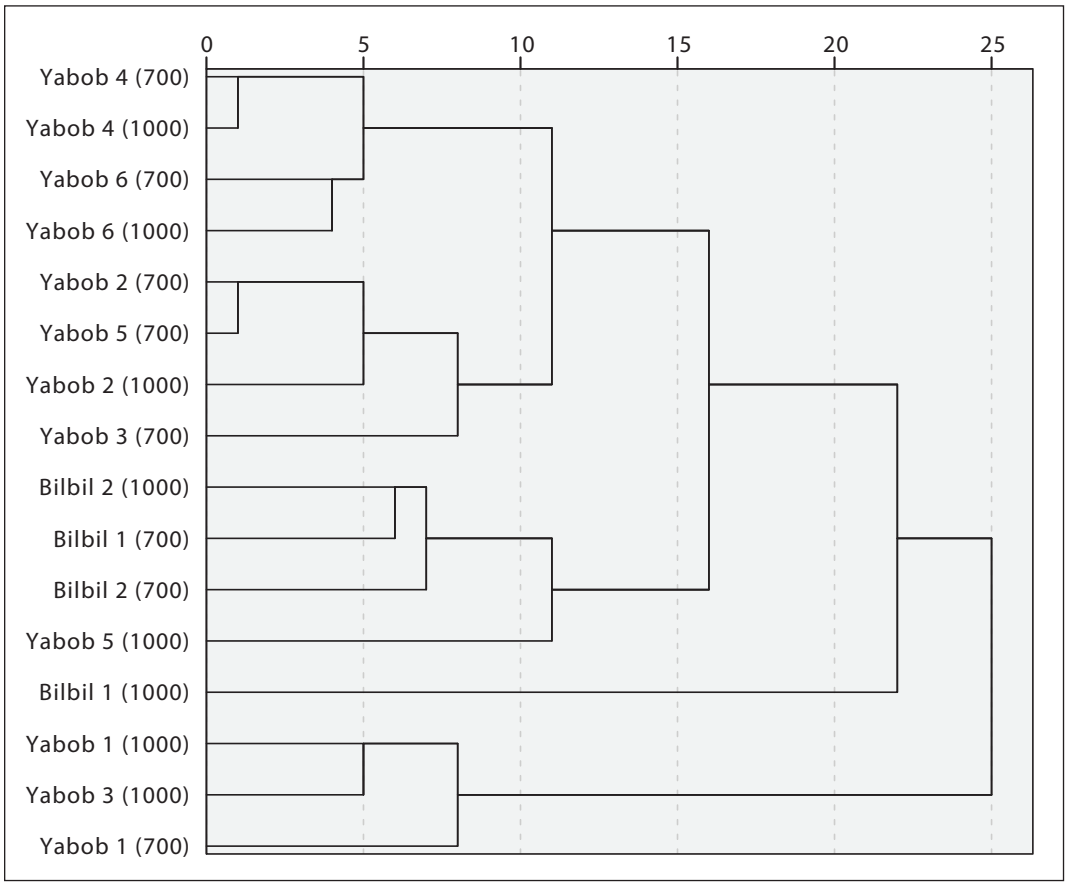


Figure 8.4. Group average HCA of eight ethnographic clay sources.

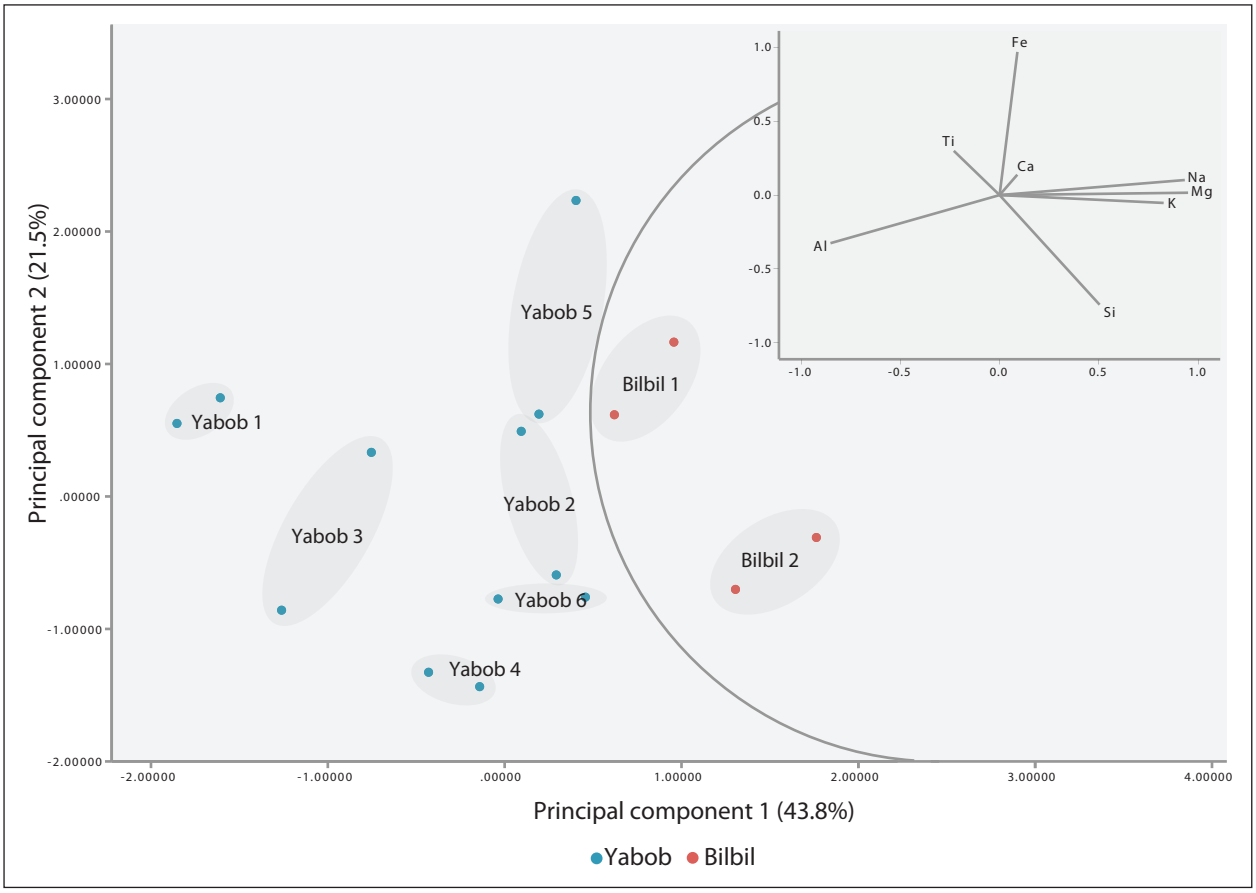


Figure 8.5. PCA showing clay compositional data from eight ethnographic clay sources.

Results: Nunguri

Nunguri ceramics were formed using locally available raw materials. The majority of sherds were tempered with black beach sand and probably produced using clays from the Bilbil Village area.

Techno-fabric groups

Throughout Nunguri's occupation, potters used black ferromagnesium beach sands in preference to 'light' (quartz and feldspathic; see Summerhayes 2000), calcareous or grog tempers. However, proportionally, the abundance of light tempers decreases while calcareous tempers increases (Fig. 8.6–8.7). This may reflect a trend towards using immediately available beach sands from Bilbil Island. Grog is rare, and it is often difficult to discern whether small grains of clay are deliberate grog inclusions or accidental incorporations of clay grains from the pottery working floors. Unlike the tempers of Type X ceramics, no Nunguri sherds contained grog temper alone.

Overall, there are statistically significant associations between technical-classes and the fabric groups (Pearson's Chi-Squared using Monte Carlo simulation: X^2=52.519, df=12, P<0.01). Each class was formed predominantly using ferromagnesium tempers, with light, calcareous, and grog tempers contributing less (Fig. 8.8). Statistically, more Class 3 rims are composed of calcareous-dominant tempers than expected based on the sample size. This is because Class 3 rims are more abundant in the upper spits, which contain more calcareous sherds in general.

When Spits 1–5 (~0–300 cal. BP) are examined separately there are clear correlations between technical class and fabric (Pearson's Chi-Squared using Monte Carlo simulation: X^2=50.156, df=12, P<0.01). During this period, Class 2 rims are more frequently than expected tempered with Fe-Mg grains (adj. residual= 3.2) and less frequently with calcareous inclusions (adj. residual= –2.6). Class 3 rims are less frequently tempered with Fe-Mg (adj. residual= –5.2) and more frequently with light (adj. residual= 3.5) or calcareous inclusions (adj. residual= 3.9). Class 5 rims show a similar pattern and are less frequently Fe-Mg tempered than expected (adj. residual= –2.8) but more frequently tempered with calcareous grains (adj. residual= 3.0). Provisionally this implies that during this time Class 2 rims were unlikely to be tempered with island beach sands, but Class 3 and 5 were more likely, though mainland sands were still preferred. When Spits 11–16 (~500–600 cal. BP) are considered separately there is no clear correlation between technical class and fabric (Pearson's Chi-Squared using Monte Carlo simulation: X^2=12.369, df=12, P=0.417). This may suggest a trend towards diverging procurement strategies associated with different forming techniques through time.

Techno-mineralogical groups

Tables 8.7–8.11 summarise the identification of mineral inclusions by technical class and techno-fabric in five excavation spits at Nunguri. This confirms the preliminary sorting of techno-fabric groups. All sherds contain augite, and nearly all sherds contain quartz. Calcareous tempers are usually non-diagnostic, but some coral grains were observed. This suggests that the calcareous tempers derive from the local beach rather than being actively manufactured from crushed shell as has been observed elsewhere in the Pacific (e.g. Rye 1976; Takayama & Shutler Jr. 1978). Epidote is present in 44% of samples (n=22) and amphibole is present in 36% of samples (n=18). Rock

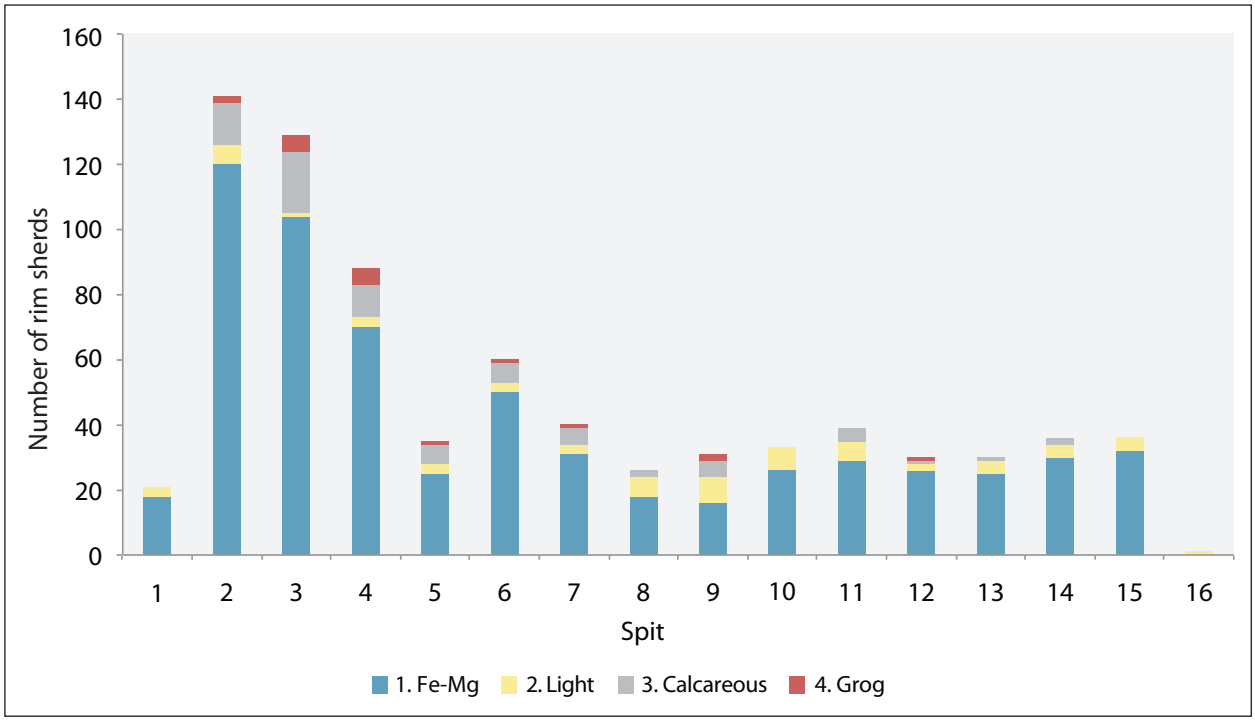


Figure 8.6. Nunguri rim sherd techno-fabric groupings by excavation spit.

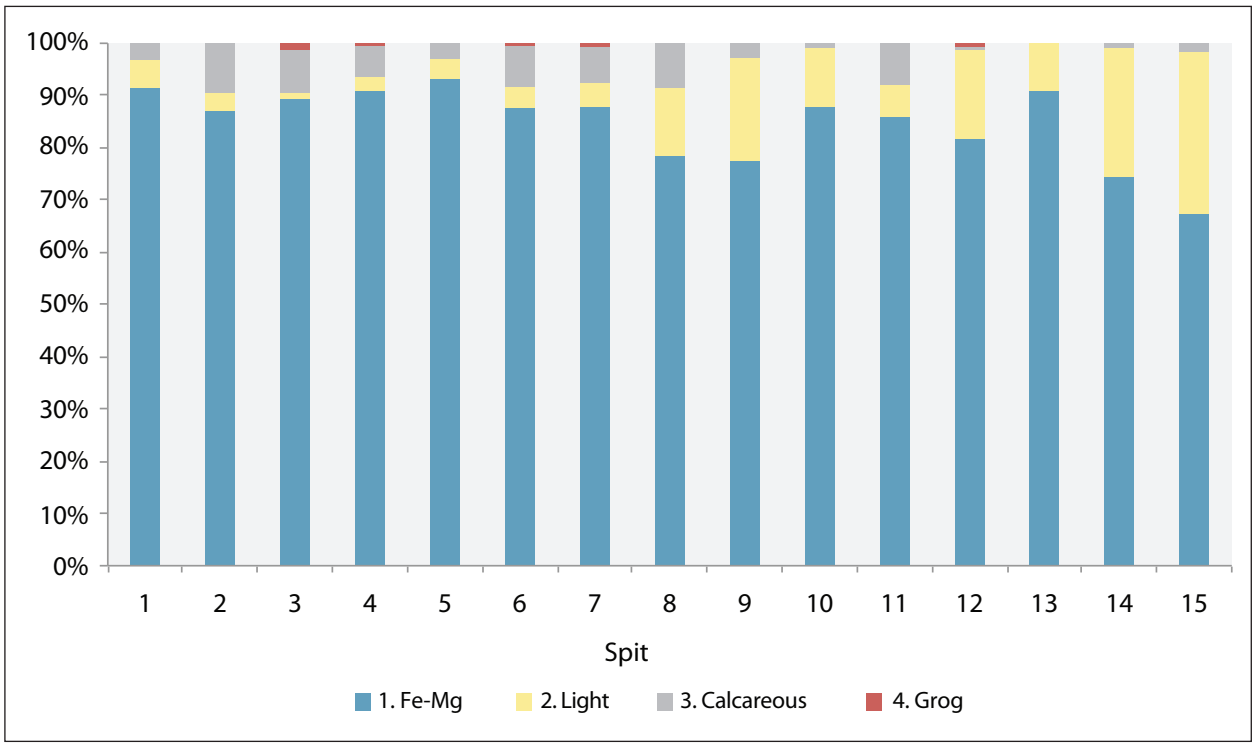


Figure 8.7. Nunguri decorated body sherd techno-fabric groupings by excavation spit.

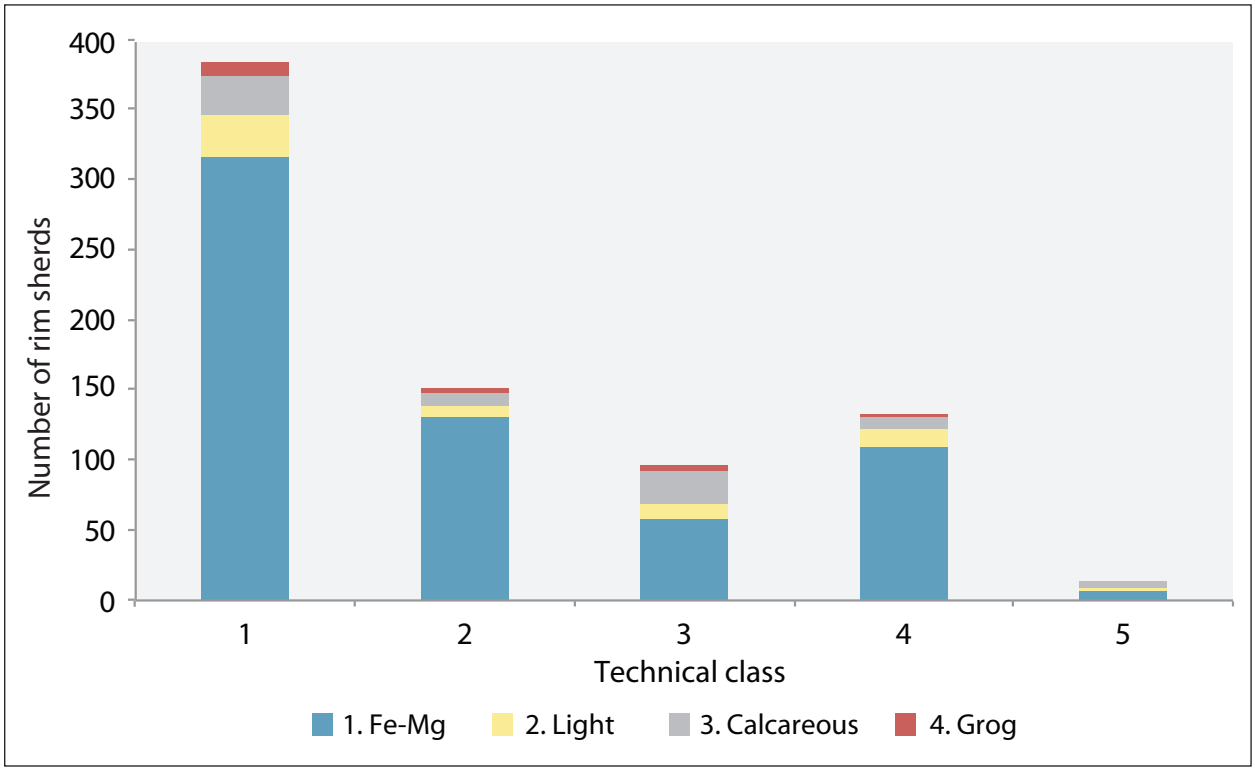


Figure 8.8. Nunguri rim sherd techno-fabric groupings by technical class.

grains, some clearly volcanic, were also common. All of these mineral inclusions potentially derive from local raw clays or temper additives.

Techno-compositional groups

The Nunguri clay chemical data suggest that most sampled sherds were derived from similar clay deposits. Figures 8.9 and 8.10 display the dendrograms produced using two different HCA methods. No clear patterning can be distinguished to subdivide techno-mineralogical groupings into distinct techno-compositional groupings. Figures 8.11–8.13 show the PCA plots of these compositional data relative to excavation spit, technical class, and techno-fabric groups. There is substantial overlap between each of these variables, suggesting that similar clay deposits were being used in the production of pots throughout Nunguri's occupation. These pots were usually tempered with black beach sands but were sometimes tempered with calcareous sands from offshore islands or light sands from an unknown location. This may represent multiple production groups using the same clays but different tempers, or the same production group making do with different tempers owing to variations in availability.

The use of calcareous tempers usually requires the addition of salt rather than fresh water to prevent cracking (Rye 1976). This indicates either that different production groups had developed slightly different procurement and production choices, or that a single production group was adept at engaging with various *chaînes opératoires* during procurement and production.

Figure 8.14 shows a PCA plot of the Nunguri sherds alongside the modern clay samples collected from Yabob and Bilbil villages (see Chapter 4). The sherds predominantly cluster close to the Bilbil Village sources and provisionally suggests that potters were digging clay pits around the same area from c.500 years ago. Note that the outlier is sherd N-188, which tentatively was produced using different clay source, or was mixed from local clays in a different way.

Table 8.7. *SEM results of mineral inclusions in Nunguri, Spit 2 samples.*

		Sample									
		N-131	N-158	N-132	N-174	N-126	N-127	N-188	N-635	N-136	N-169
	Class	**1**	**1**	**2**	**2**	**3**	**3**	**4**	**4**	**5**	**5**
	Fabric	**1**	**4**	**1**	**3**	**1**	**1**	**2**	**1**	**3**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate				X		X			X	
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite						X				
	Pigeonite		X	X				X	X		
	Indeterminate										
Orthopyroxenes	Enstatite				X	X					X
Plagioclase	Anorthite							X	X		
	Bytownite								X		
	Labradorite	X		X							
	Andesine			X	X		X				
	Oligoclase									X	X
	Albite	X		X	X		X	X		X	
Alkali feldspars	Orthoclase								X		
	Anorthoclase							X		X	
	Sanidine			X						X	
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite	X				X				X	
	Ferroglaucophane										
	Edenite										
	Kaersutite						X	X			
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite		X			X		X	X	X	X
Quartz	Quartz	X	X	X	X		X	X	X		X
Non-silicates	Ulvospinel	X	X		X						X
	Magnesiochromite		X			X					X
	Indeterminate										
	Ti oxide										
	Fe oxide			X							
	Ilmenite										
	Cu oxide										
Other	Rock	X		X		X			X		
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)					X		X	X	X	
Grog	Grog?										
Organic	Plant fibres										

Table 8.8. *SEM results of mineral inclusions in Nunguri, Spit 5 samples.*

		Sample									
		N-1557	N-1548	N-1561	N-1556	N-1581	N-1551	N-1547	N-1558	N-1574	N-1562
	Class	**1**	**1**	**1**	**2**	**2**	**3**	**3**	**3**	**4**	**4**
	Fabric	**1**	**1**	**3**	**1**	**1**	**3**	**2**	**1**	**3**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate		X	X			X	X	X	X	
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite										
	Indeterminate										
Orthopyroxenes	Enstatite				X				X		
Plagioclase	Anorthite			X							
	Bytownite			X	X			X		X	
	Labradorite		X								
	Andesine										
	Oligoclase					X					X
	Albite		X		X	X	X	X	X	X	X
Alkali feldspars	Orthoclase						X				
	Anorthoclase			X	X			X			X
	Sanidine										
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite										
	Ferroglaucophane										
	Edenite										
	Kaersutite		X								
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite		X		X	X		X	X		X
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel									X	X
	Magnesiochromite								X		
	Indeterminate										
	Ti oxide										
	Fe oxide					X				X	
	Ilmenite	X	X						X	X	
	Cu oxide									X	
Other	Rock	X	X			X				X	
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)		X	X	X						X
Grog	Grog?										
Organic	Plant fibres										

Table 8.9. *SEM results of mineral inclusions in Nunguri, Spit 11 samples.*

		Sample									
		N-2711	N-2703	N-2689	N-2698	N-2707	N-2702	N-2690	N-2692	N-2729	N-2713
	Class	**1**	**1**	**2**	**2**	**2**	**3**	**4**	**4**	**4**	**5**
	Fabric	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**2**	**3**	**2**
Calcareous	Coral				X					X	
	Shell										
	Indeterminate	X			X					X	
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite		X					X			
	Indeterminate										
Orthopyroxenes	Enstatite								X		
Plagioclase	Anorthite										
	Bytownite	X		X			X	X			X
	Labradorite	X		X	X		X		X	X	X
	Andesine			X				X		X	
	Oligoclase										
	Albite		X	X			X	X	X	X	X
Alkali feldspars	Orthoclase										
	Anorthoclase			X	X						X
	Sanidine				X						
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite										
	Ferroglaucophane										
	Edenite										
	Kaersutite										
	Tschermakite		X								
	Tremolite						X				
	Inderminate										
Epidote	Anorthite	X		X					X		
Quartz	Quartz	X	X	X		X	X	X	X	X	X
Non-silicates	Ulvospinel				X				X	X	
	Magnesiochromite										
	Indeterminate										
	Ti oxide										
	Fe oxide		X								
	Ilmenite	X				X		X			
	Cu oxide										
Other	Rock			X			X	X	X		X
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)			X							
Grog	Grog?										
Organic	Plant fibres										

Table 8.10. *SEM results of mineral inclusions in Nunguri, Spit 13 samples.*

		Sample									
		N-3162	N-3141	N-3146	N-3153	N-3139	N-3142	N-3148	N-3159	N-3155	N-3140
	Class	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**4**	**4**	**4**
	Fabric	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate										
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite					X					
	Indeterminate										
Orthopyroxenes	Enstatite										
Plagioclase	Anorthite	X			X			X	X		
	Bytownite	X		X		X				X	
	Labradorite		X	X	X			X	X	X	
	Andesine		X								
	Oligoclase				X						
	Albite		X		X						
Alkali feldspars	Orthoclase										
	Anorthoclase			X				X			
	Sanidine				X					X	
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite		X		X	X					
	Ferroglaucophane										
	Edenite										
	Kaersutite										
	Tschermakite										
	Tremolite										
	Inderminate			X							
Epidote	Anorthite		X								
Quartz	Quartz	X	X	X	X		X	X		X	X
Non-silicates	Ulvospinel										
	Magnesiochromite								X		
	Indeterminate										
	Ti oxide										
	Fe oxide										
	Ilmenite	X					X				
	Cu oxide										
Other	Rock	X	X	X	X	X	X		X		
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)			X							X
Grog	Grog?			X			X		X		X
Organic	Plant fibres										

Table 8.11. *SEM results of mineral inclusions in Nunguri, Spit 15 samples.*

		Sample									
		N-3811	N-3810	N-3698	N-3696	N-3711	N-3701	N-3699	N-3802	N-3806	N-3798
	Class	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**4**	**4**	**4**
	Fabric	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**
Calcareous	Coral										
	Shell										
	Indeterminate	X						X			
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite	X									
	Indeterminate										
Orthopyroxenes	Enstatite										
Plagioclase	Anorthite										
	Bytownite			X					X		
	Labradorite		X		X		X				
	Andesine										
	Oligoclase										
	Albite	X		X		X		X			X
Alkali feldspars	Orthoclase					X		X			
	Anorthoclase					X					
	Sanidine									X	
Amphiboles	Anthophyllite				X						
	Magnesio hornblende										
	Ferrogedrite							X			
	Gedrite						X				
	Ferroglaucophane										
	Edenite										
	Kaersutite	X							X		
	Tschermakite										
	Tremolite										
	Inderminate									X	
Epidote	Anorthite	X		X				X	X	X	X
Quartz	Quartz	X	n*	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel			X			X		X		
	Magnesiochromite								X	X	
	Indeterminate										
	Ti oxide										
	Fe oxide				X			X			
	Ilmenite	X									
	Cu oxide										
Other	Rock		X	X	X	X	X		X		X
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)		X								X
Grog	Grog?										
Organic	Plant fibres										

*n = small grains naturally occurring in the clay

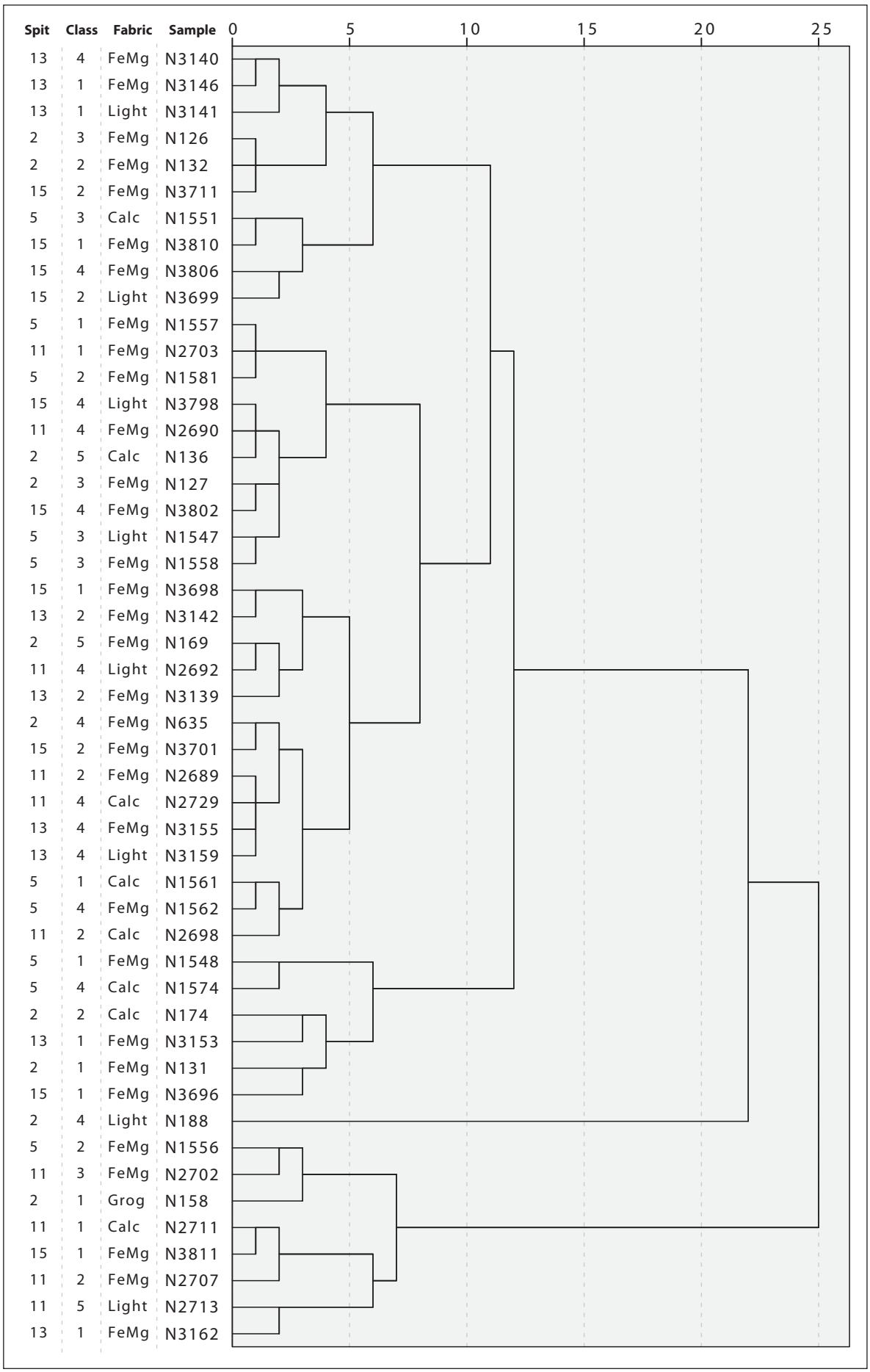


Figure 8.9. Ward's HCA of Nunguri sherds.

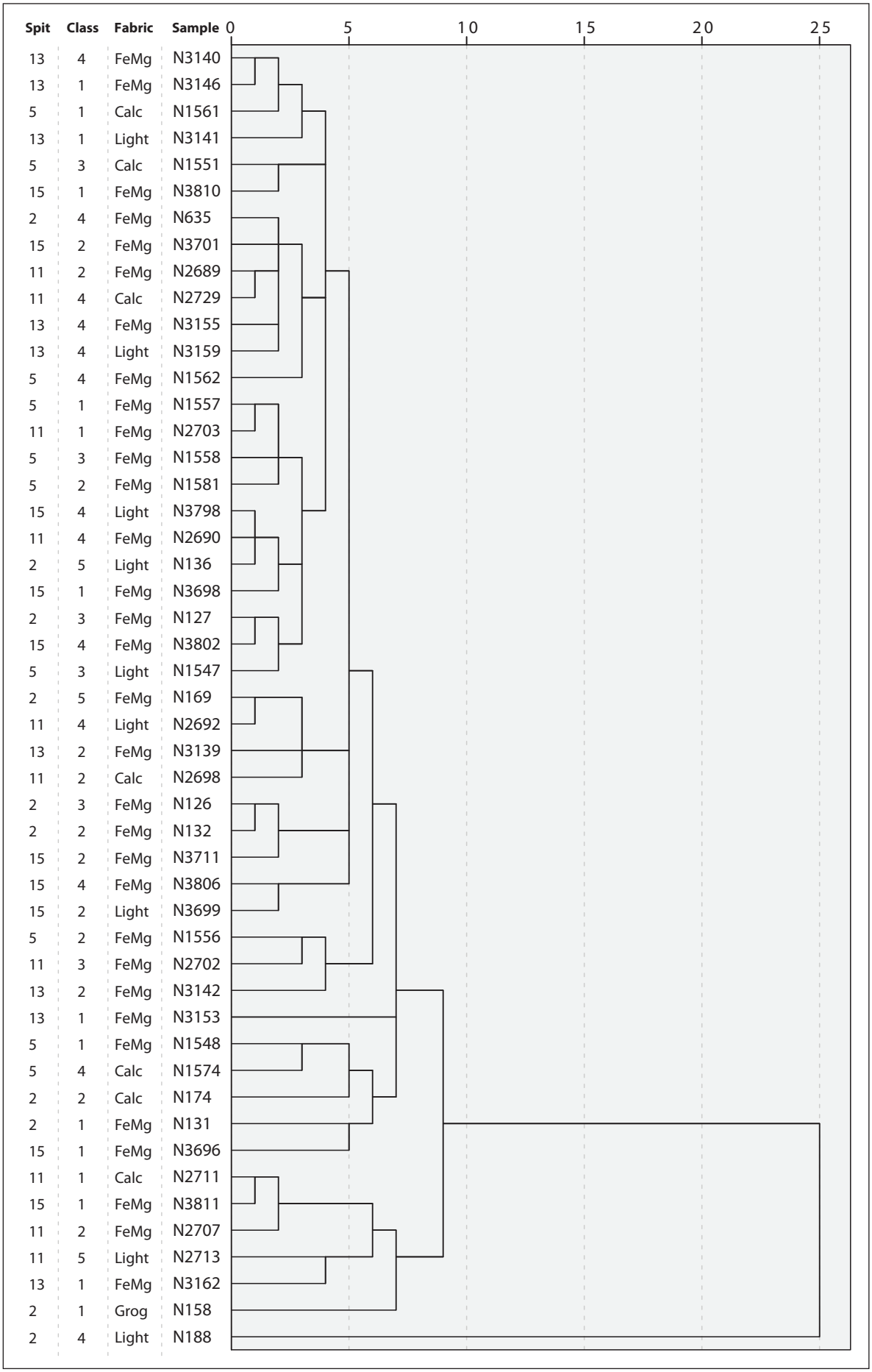


Figure 8.10. Group average HCA of Nunguri sherds.

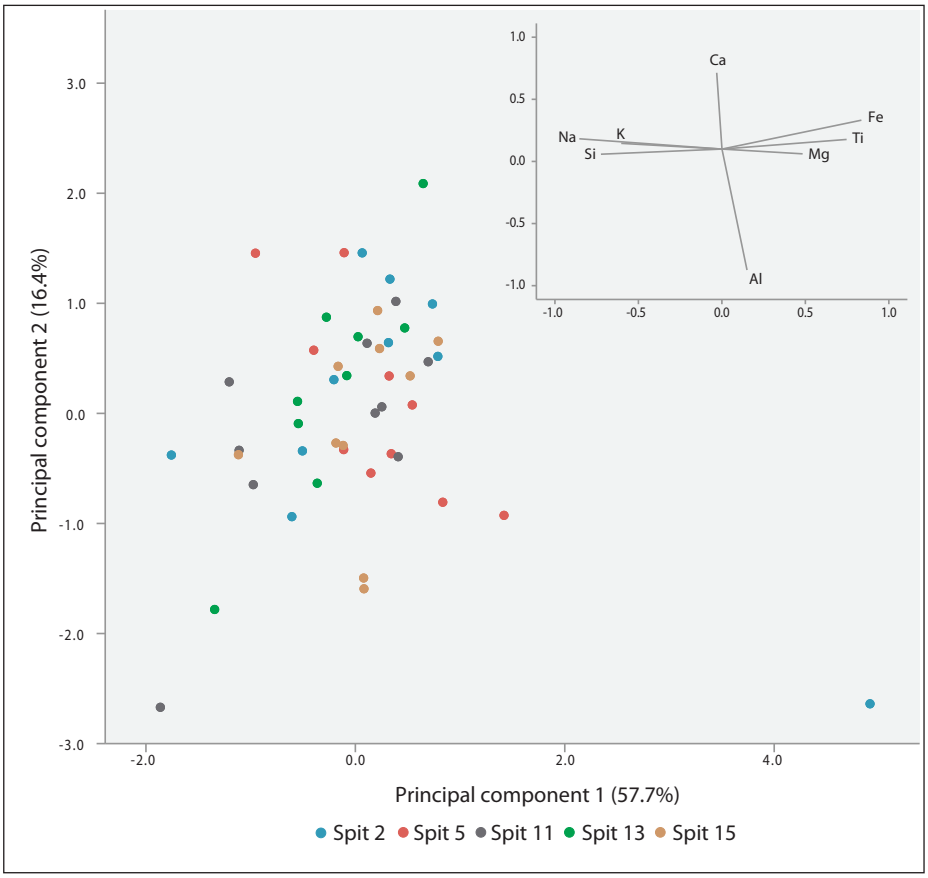


Figure 8.11. PCA showing clay compositional data from Nunguri sherds by excavation spit.

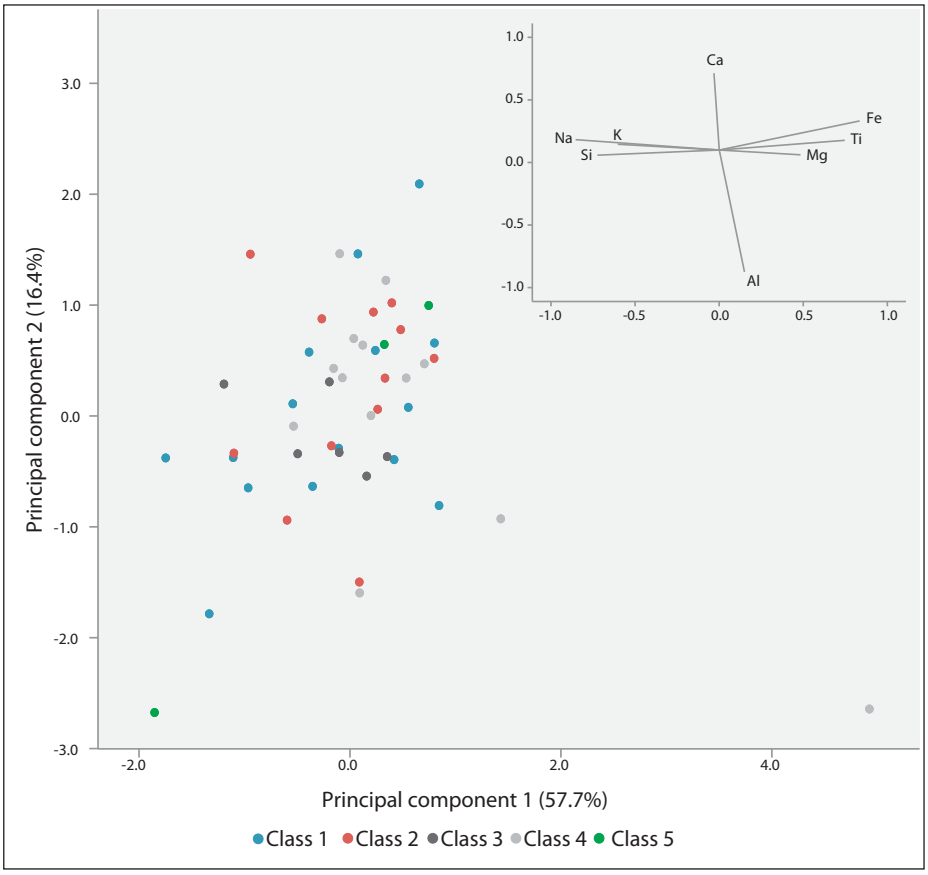


Figure 8.12. PCA showing clay compositional data from Nunguri sherds by technical class.

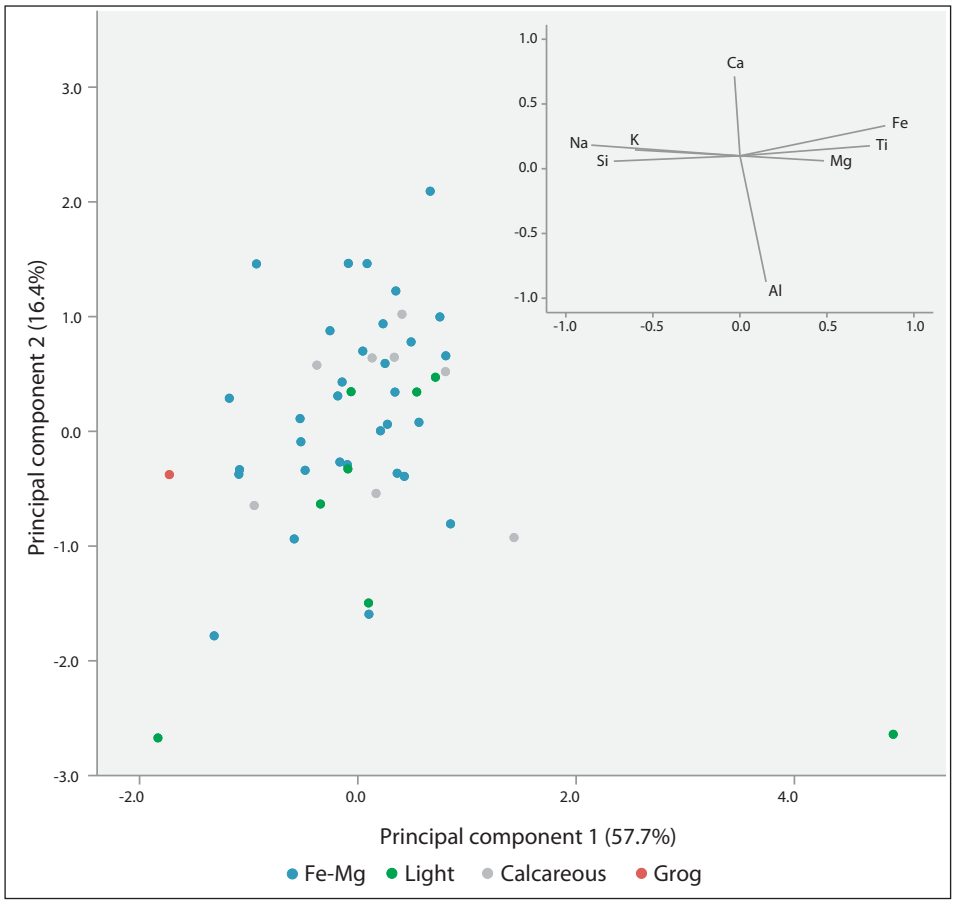


Figure 8.13. PCA showing clay compositional data from Nunguri sherds by fabrics.

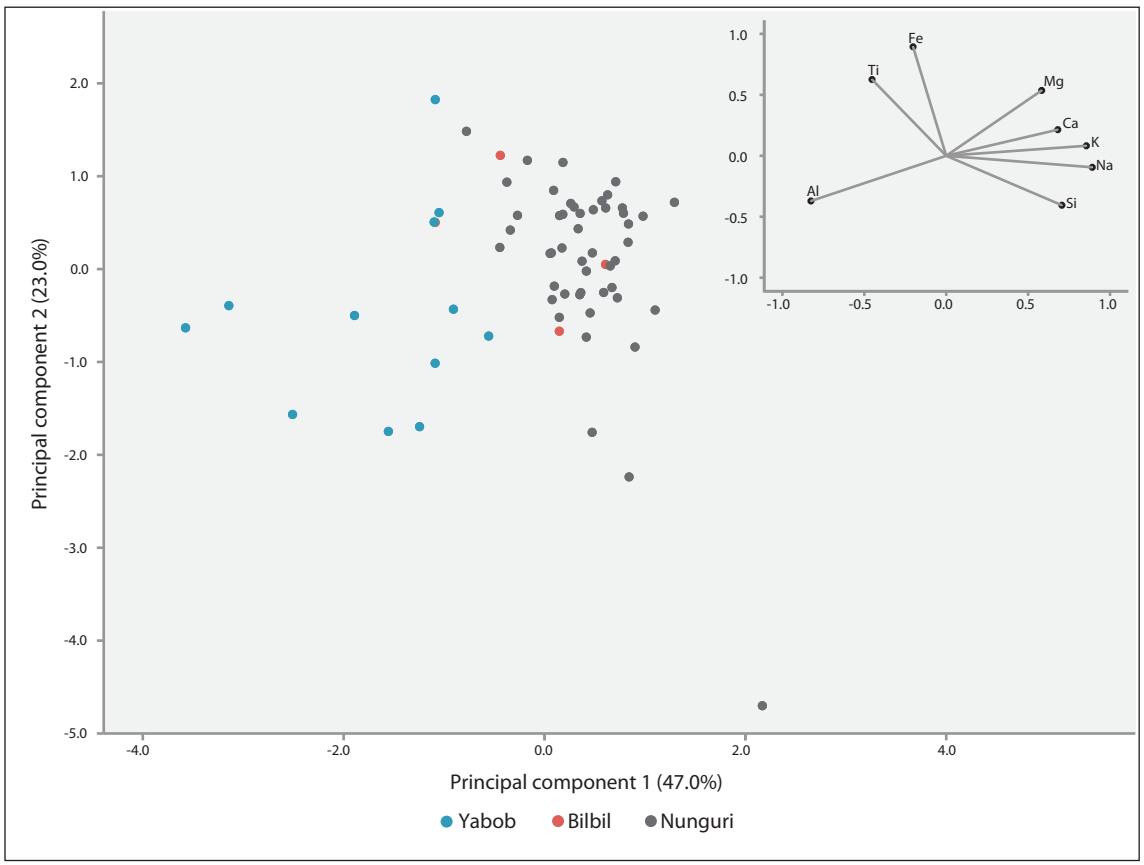


Figure 8.14. PCA showing clay compositional data of Nunguri sherds and ethnographic clays.

Results: Tilu

Compositionally, the Tilu sherds are almost identical to those from Nunguri. In general, Tilu pots were usually tempered with black beach sand and produced using local clays, probably from the Bilbil area.

Techno-fabric groups

Like at Nunguri, the sherds at Tilu predominantly contain black ferromagnesium sand grains (Fig. 8.15–8.16). Calcareous and light dominated tempers are present but form a minor contribution to the Tilu assemblage. There is no clear trend towards using calcareous tempers later in time (as at Nunguri), and, in fact, in the earliest spits (8–10) calcareous tempers are more prominent. Only one sherd (T-298) contains obvious grog that has used broken sherds for temper. However, Fe-Mg and light mineral inclusions are also present in this sherd. Again, no sherds are exclusively tempered with grog in the manner of Type X.

There are no statistically significant associations between technical-classes and the fabric groups at Tilu (Pearson's Chi-Squared using Monte Carlo simulation: X^2=3.167, df=12, P=0.862). Class 1 was formed predominantly using ferromagnesium tempers, with light, calcareous, and grog tempers contributing less (Fig. 8.17). Class 2 rims are also dominantly composed of ferromagnesium tempers with some instances of calcareous and grog tempering. Classes 3, 4, and 5 are only tempered with ferromagnesium tempers. However, as Classes 2–5 are comprised of a much smaller sample than Class 1, the absence of examples of certain temper types is not substantially less than expected given the number of cases (based on a cross tabulation of the Chi-Squared results).

Techno-mineralogical groups

The mineral inclusions present in Tilu rim sherds are consistent with those observed in the Nunguri sample. Tables 8.12–8.16 present the descriptive results of this analysis. Augite was observed in all but one sample (T-660). All sherds contained quartz and all but two sherds contained some type of plagioclase. Epidote is present in 32% of sampled rims (n=16) and amphibole is present in 22% of rims (n=11). An iron-rich silicate (possibly a garnet) is present in only 6% of samples (n=3), much less common than in Nunguri rims, of which 26% contain the same mineral (n=13). During the course of analysis, the rims from lower spits were observed to more frequently contain calcareous inclusions, especially in Spit 9. There is a significant correlation between excavation spit and presence of calcareous inclusions (Pearson's Chi-Squared using Monte Carlo simulation: X^2=13.33, df=4, P=0.006), and these inclusions are particularly more common than expected in Spit 9 (adj. residual= 3.1). One of these Spit 9 samples contains identifiable coral grains (T-762) and it is likely that all of the calcareous grains present in the Tilu samples represent coral detritus from offshore islands. For this reason, three sherds from Spit 10 were selected for supplementary mineralogical analysis. The small sample from Spit 10 demonstrates the same trend as two of the three sherds contain calcareous grains (Table 8.17).

Techno-compositional groups

At Tilu, there seems to have been a single resource zone for the procurement of potting clay. Figures 8.18–8.19 show the HCA results relative to excavation spit, class, and fabric. As at Nunguri, there is no clear patterning to suggest that specific techno-mineralogical groups can be subdivided

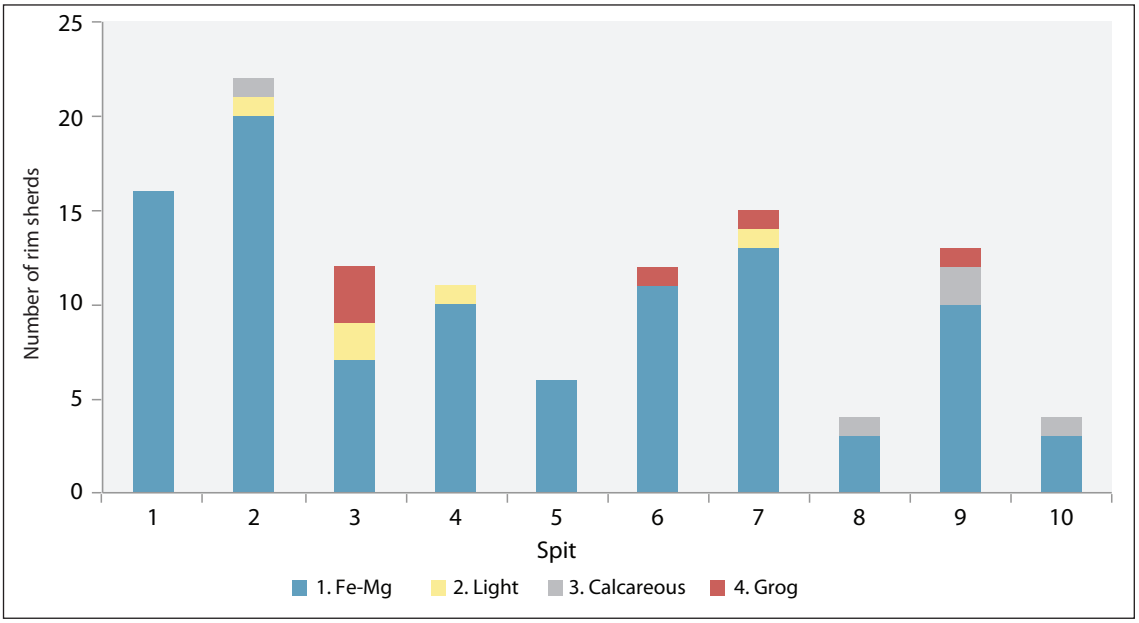


Figure 8.15. Tilu rim sherd techno-fabric groupings by excavation spit.

into different techno-compositional groupings. The PCA plots in Figures 8.20–8.22 coded by spit, class, and fabric also show substantial overlap within each variable and suggest a similar manner of procurement to the Nunguri sherds. Figure 8.23 shows that most of the Tilu sherds group with the ethnographic Bilbil clay sources rather than the Yabob sources. The single notable outlier is T-843 from Spit 10, which may have been produced using a clay from the Yabob area, or another currently unknown place. There are no ethnographic or oral history accounts of the Malmal (Tilu) people producing pottery. The results of the geochemical analysis suggest that many of the Tilu pots were imported from pottery producers to the south – particularly those using clays from around modern Bilbil Village.

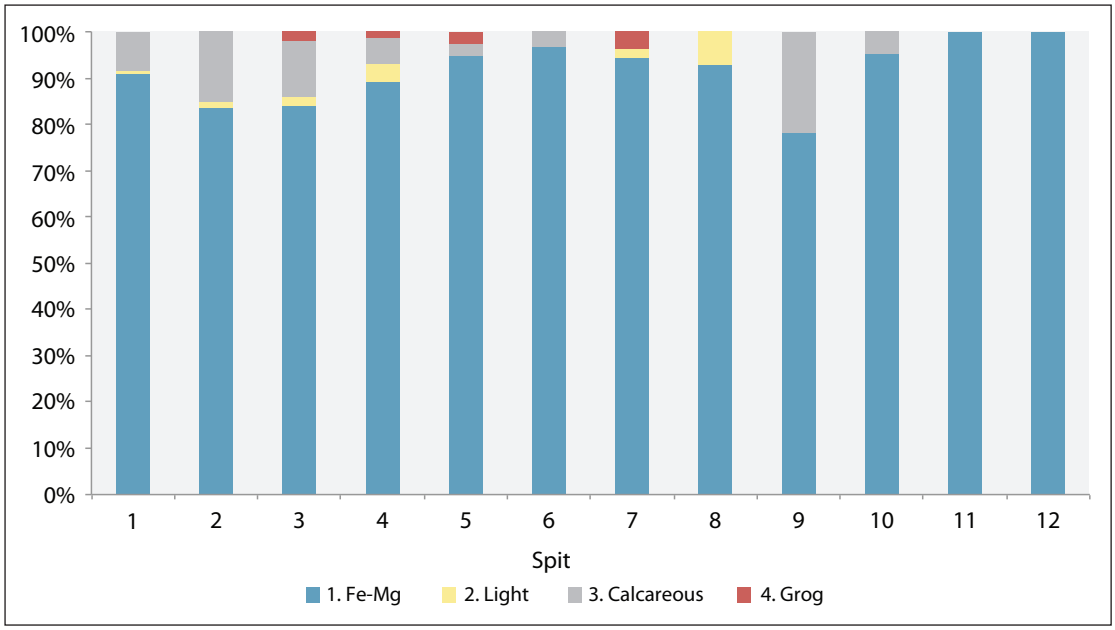


Figure 8.16. Tilu decorated body sherd techno-fabric groupings by excavation spit.

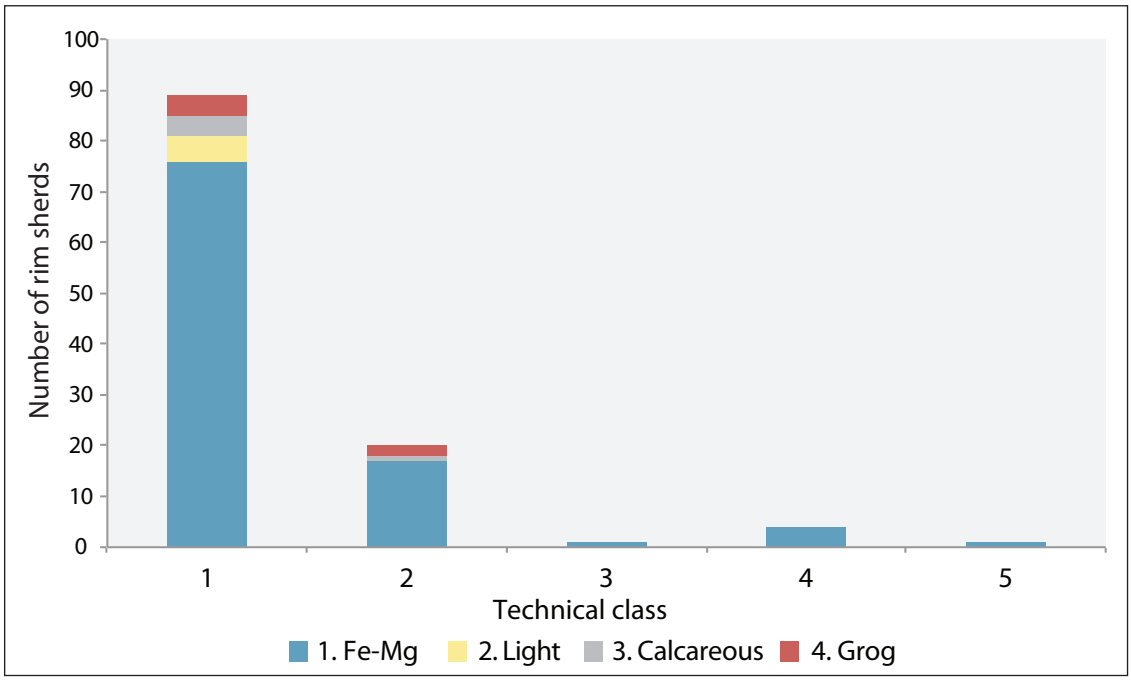


Figure 8.17. Tilu rim sherd techno-fabric groupings by technical class.

Table 8.12. *SEM results of mineral inclusions in Tilu, Spit 2 samples.*

		Sample									
		T-167	T-180	T-160	T-163	T-174	T-162	T-177	T-164	T-168	T-173
	Class	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**4**
	Fabric	**1**	**1**	**1**	**3**	**2**	**1**	**1**	**1**	**1**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate				X		X				
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite										
	Indeterminate										
Orthopyroxenes	Enstatite										
Plagioclase	Anorthite	X				X					
	Bytownite			X				X			
	Labradorite	X									X
	Andesine					X					
	Oligoclase										
	Albite		X	X	X	X		X	X	X	
Alkali feldspars	Orthoclase					X					
	Anorthoclase							X		X	
	Sanidine										
Amphiboles	Anthophyllite	X									
	Magnesio hornblende										
	Ferrogedrite									X	
	Gedrite			X		X					
	Ferroglaucophane										
	Edenite										
	Kaersutite							X			
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite		X			X					
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel										
	Magnesiochromite							X			X
	Indeterminate										
	Ti oxide										
	Fe oxide	X				X	X			X	X
	Ilmenite		X		X		X	X	X		
	Cu oxide										
Other	Rock	X	X			X		X			
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)										
Grog	Grog?				X	X					
Organic	Plant fibres										

Table 8.13. *SEM results of mineral inclusions in Tilu, Spit 4 samples.*

		Sample									
		T-409	**T-411**	**T-412**	**T-413**	**T-414**	**T-420**	**T-417**	**T-418**	**T-419**	**T-416**
	Class	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**5**
	Fabric	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate										
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite										
	Indeterminate										
Orthopyroxenes	Enstatite									X	
Plagioclase	Anorthite				X				X		
	Bytownite			X				X			
	Labradorite	X				X		X			X
	Andesine										
	Oligoclase	X									
	Albite			X	X	X	X	X		X	X
Alkali feldspars	Orthoclase						X				
	Anorthoclase						X		X		
	Sanidine										
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite										
	Ferroglaucophane										
	Edenite										
	Kaersutite										
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite		X	X	X			X	X		
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel										
	Magnesiochromite										
	Indeterminate										
	Ti oxide										
	Fe oxide								X		
	Ilmenite	X	X	X	X	X		X	X		X
	Cu oxide										
Other	Rock		X	X	X	X		X	X	X	X
	Mica?										
	Humite?										X
	Titanite										
	Iron rich silicate (garnet?)					X					
Grog	Grog?										
Organic	Plant fibres										

Table 8.14. *SEM results of mineral inclusions in Tilu, Spit 6 samples.*

		Sample									
		T-556	**T-549**	**T-559**	**T-552**	**T-550**	**T-553**	**T-555**	**T-639**	**T-554**	**T-558**
	Class	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**
	Fabric	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Calcareous	Coral										
	Shell										
	Indeterminate	X	X			X	X				
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite						X				
	Indeterminate	X									
Orthopyroxenes	Enstatite										
Plagioclase	Anorthite		X	X		X					
	Bytownite						X		X		
	Labradorite				X					X	
	Andesine										
	Oligoclase	X				X		X			
	Albite		X		X		X	X			X
Alkali feldspars	Orthoclase									X	
	Anorthoclase		X	X				X		X	
	Sanidine									X	
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite										
	Ferroglaucophane										
	Edenite										
	Kaersutite										
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite										
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel	X									
	Magnesiochromite										
	Indeterminate										
	Ti oxide										
	Fe oxide			X		X					
	Ilmenite						X		X	X	X
	Cu oxide										
Other	Rock							X	X	X	X
	Mica?										
	Humite?	X						X			X
	Titanite										
	Iron rich silicate (garnet?)										
Grog	Grog?										
Organic	Plant fibres										

Table 8.15. *SEM results of mineral inclusions in Tilu, Spit 7 samples.*

		Sample									
		T-644	**T-653**	**T-660**	**T-650**	**T-643**	**T-642**	**T-662**	**T-648**	**T-641**	**T-652**
	Class	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**
	Fabric	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**4**
Calcareous	Coral										
	Shell										
	Indeterminate			X	X						
Clinopyroxenes	Augite	X	X		X	X	X	X	X	X	X
	Ferroan augite										
	Pigeonite										
	Indeterminate										
Orthopyroxenes	Enstatite	X							X		
Plagioclase	Anorthite					X			X		
	Bytownite	X	X	X	X		X				X
	Labradorite		X							X	X
	Andesine										
	Oligoclase				X						
	Albite		X	X		X	X	X			
Alkali feldspars	Orthoclase				X						
	Anorthoclase										
	Sanidine					X					
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite										
	Ferroglaucophane										
	Edenite										
	Kaersutite				X	X					X
	Tschermakite										
	Tremolite										
	Inderminate										
Epidote	Anorthite		X					X	X	X	
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel	X									
	Magnesiochromite										
	Indeterminate					X		X			X
	Ti oxide										
	Fe oxide	X	X		X		X				
	Ilmenite	X	X		X				X	X	X
	Cu oxide										
Other	Rock	X			X			X	X		
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)										
Grog	Grog?				X						X
Organic	Plant fibres										

Table 8.16. *SEM results of mineral inclusions in Tilu, Spit 9 samples.*

		Sample									
		T-757	T-752	T-753	T-748	T-751	T-840	T-841	T-762	T-747	T-749
	Class	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**
	Fabric	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**3**	**1**	**1**
Calcareous	Coral								X		
	Shell										
	Indeterminate			X	X	X	X	X	X	X	
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X
	Ferroan augite	X					X				
	Pigeonite										
	Indeterminate										
Orthopyroxenes	Enstatite				X					X	X
Plagioclase	Anorthite						X		X	X	X
	Bytownite		X		X	X		X	X		
	Labradorite								X		
	Andesine										
	Oligoclase			X					X		
	Albite	X		X	X		X	X		X	X
Alkali feldspars	Orthoclase		X	X	X			X			
	Anorthoclase					X					
	Sanidine			X			X		X		X
Amphiboles	Anthophyllite										
	Magnesio hornblende										
	Ferrogedrite										
	Gedrite		X								X
	Ferroglaucophane										
	Edenite										
	Kaersutite				X						
	Tschermakite										
	Tremolite										
	Inderminate					X					
Epidote	Anorthite	X			X	X	X	X			
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel									X	
	Magnesiochromite										
	Indeterminate						X				
	Ti oxide										
	Fe oxide		X	X			X				X
	Ilmenite			X				X	X		X
	Cu oxide										
Other	Rock	X	X	X	X	X	X	X	X	X	
	Mica?										
	Humite?										
	Titanite										
	Iron rich silicate (garnet?)				X			X			
Grog	Grog?				X						
Organic	Plant fibres										

Table 8.17. *SEM results of mineral inclusions in Tilu, Spit 10 samples.*

		Sample		
		T-843	T-842	T-871
	Class	**1**	**1**	**2**
	Fabric	**1**	**3**	**1**
Calcareous	Coral			
	Shell			
	Indeterminate		X	X
Clinopyroxenes	Augite	X	X	X
	Ferroan augite			
	Pigeonite			
	Indeterminate			
Orthopyroxenes	Enstatite	X		
Plagioclase	Anorthite			X
	Bytownite		X	X
	Labradorite			
	Andesine		X	
	Oligoclase			
	Albite	X		
Alkali feldspars	Orthoclase		X	
	Anorthoclase			X
	Sanidine			
Amphiboles	Anthophyllite			
	Magnesio hornblende			
	Ferrogedrite			
	Gedrite		X	
	Ferroglaucophane			
	Edenite			
	Kaersutite			
	Tschermakite			
	Tremolite			
	Inderminate			
Epidote	Anorthite			
Quartz	Quartz	X	n*	X
Non-silicates	Ulvospinel			
	Magnesiochromite			
	Indeterminate			
	Ti oxide			
	Fe oxide	X		X
	Ilmenite			
	Cu oxide			
Other	Rock	X	X	X
	Mica?			
	Humite?			
	Titanite		X	
	Iron rich silicate (garnet?)	X		
Grog	Grog?			X
Organic	Plant fibres			

*n = small grains naturally occurring in the clay

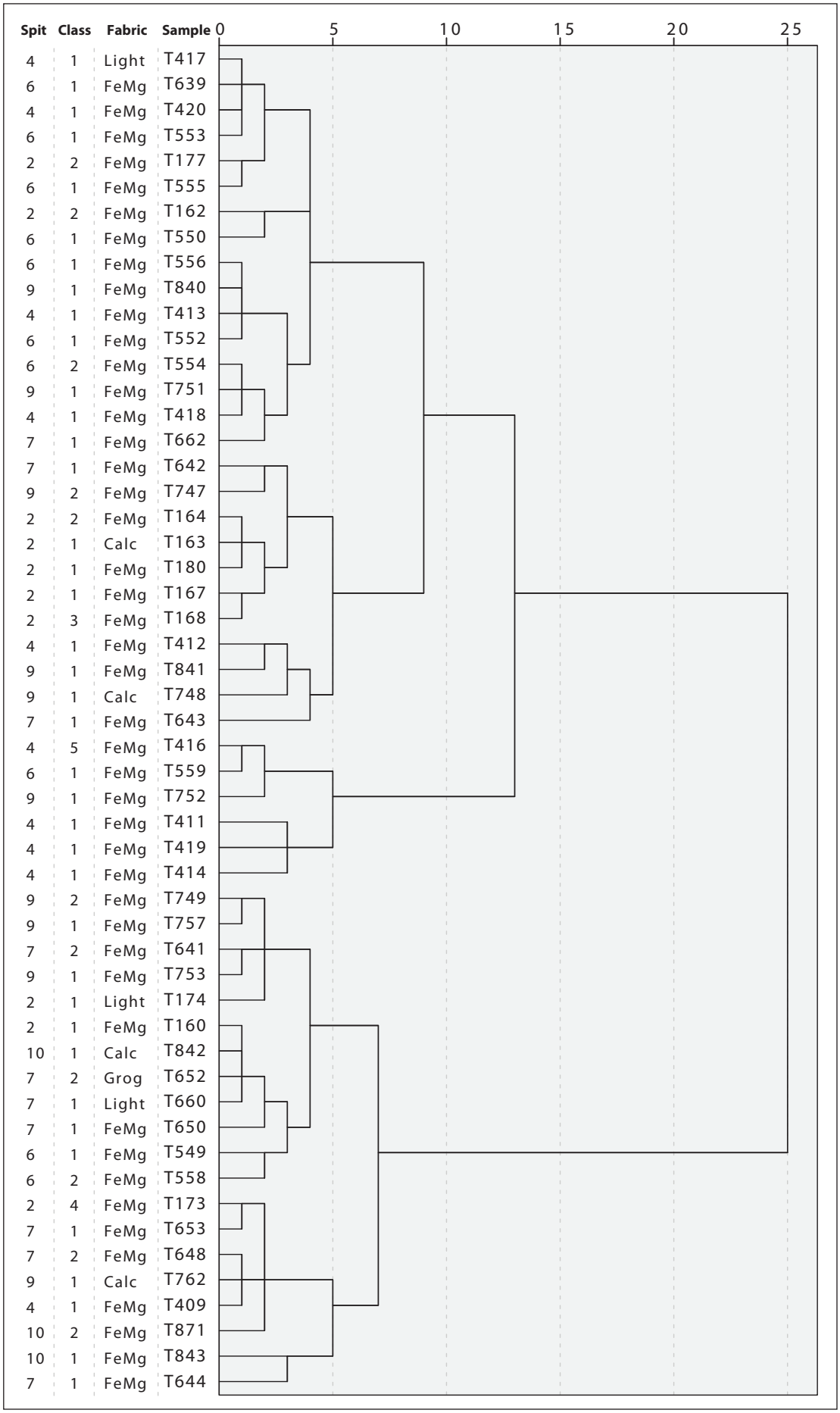


Figure 8.18. Ward's HCA of Tilu sherds.

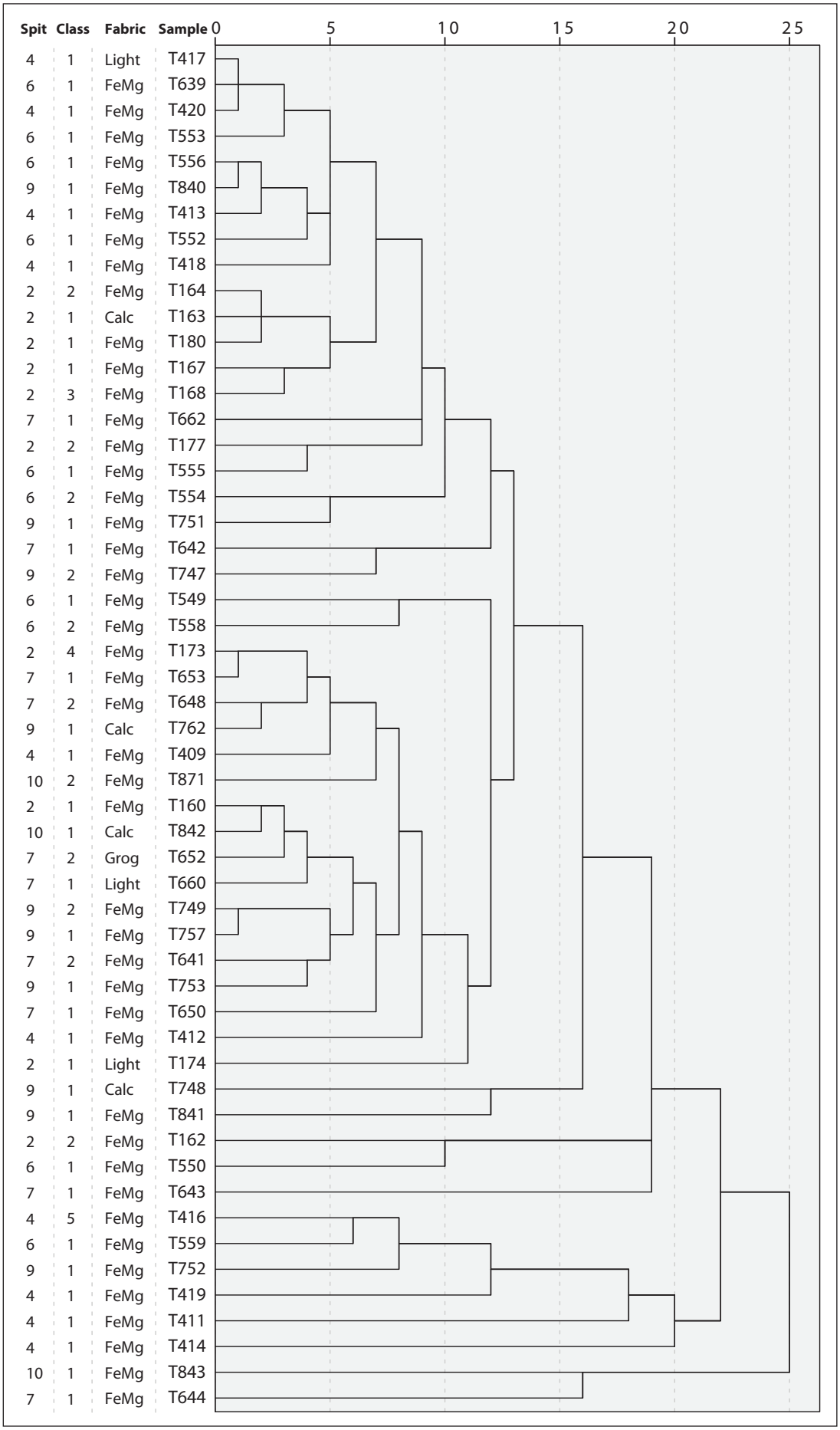


Figure 8.19. Group average HCA of Tilu sherds.

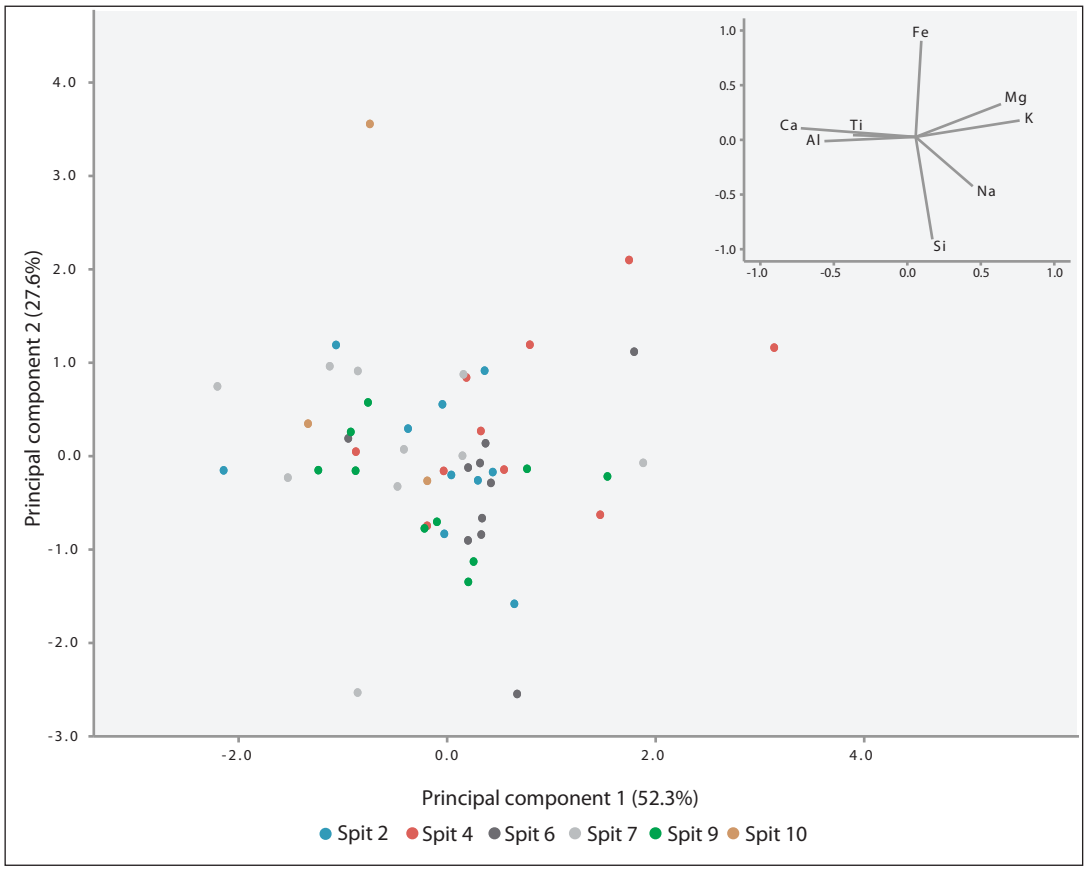


Figure 8.20. PCA showing clay compositional data from Tilu sherds by excavation spit.

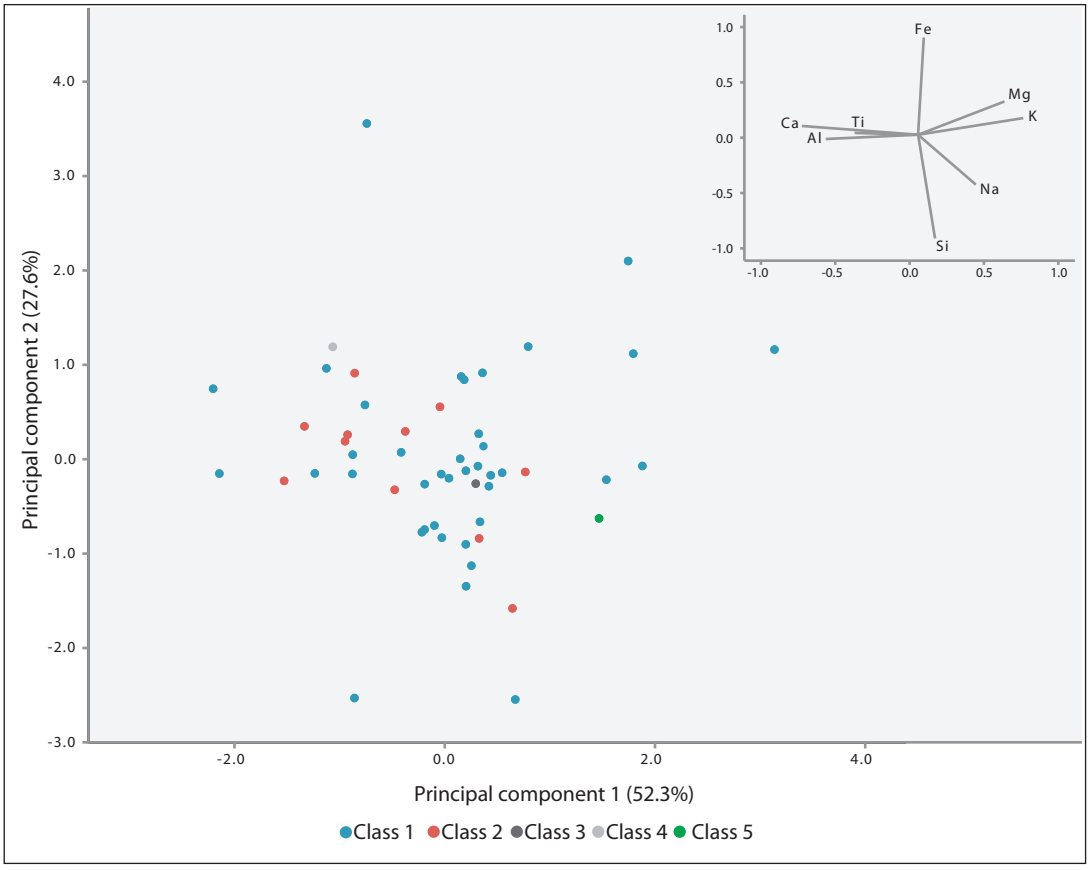


Figure 8.21. PCA showing clay compositional data from Tilu sherds by technical class.

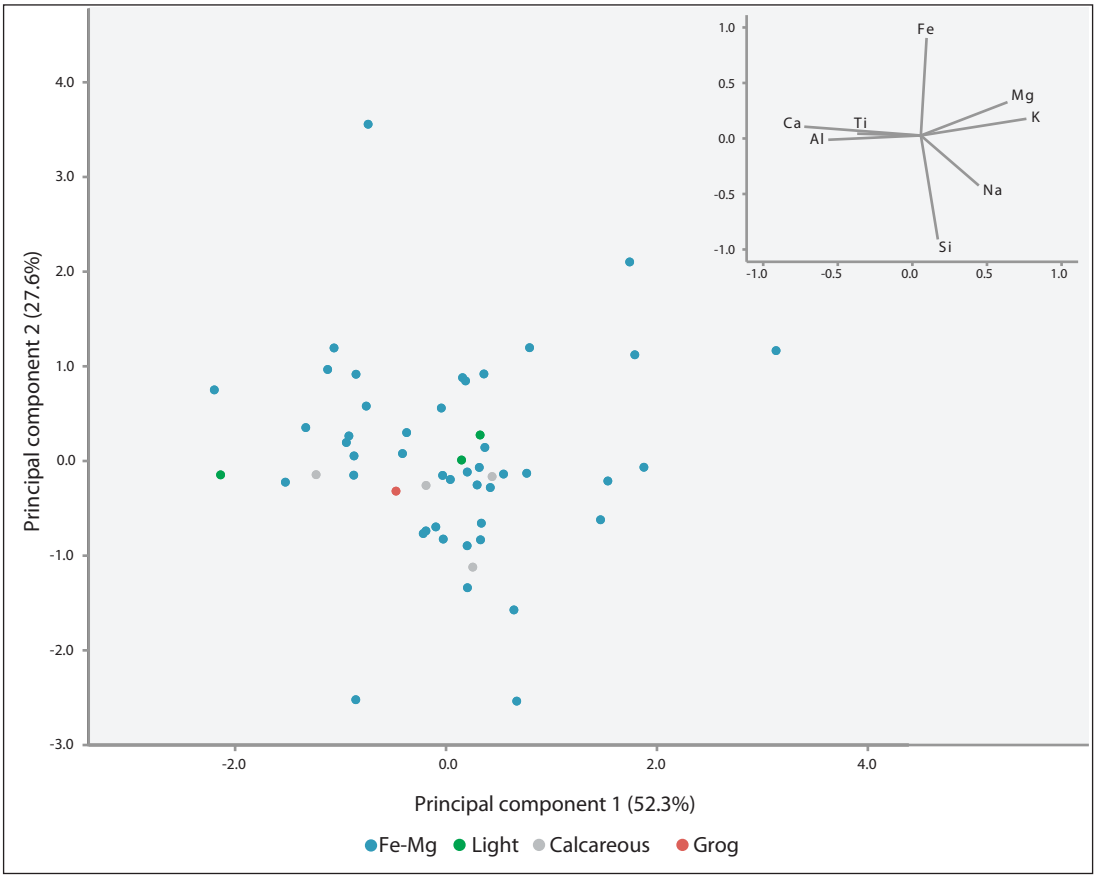


Figure 8.22. PCA showing clay compositional data from Tilu sherds by fabrics.

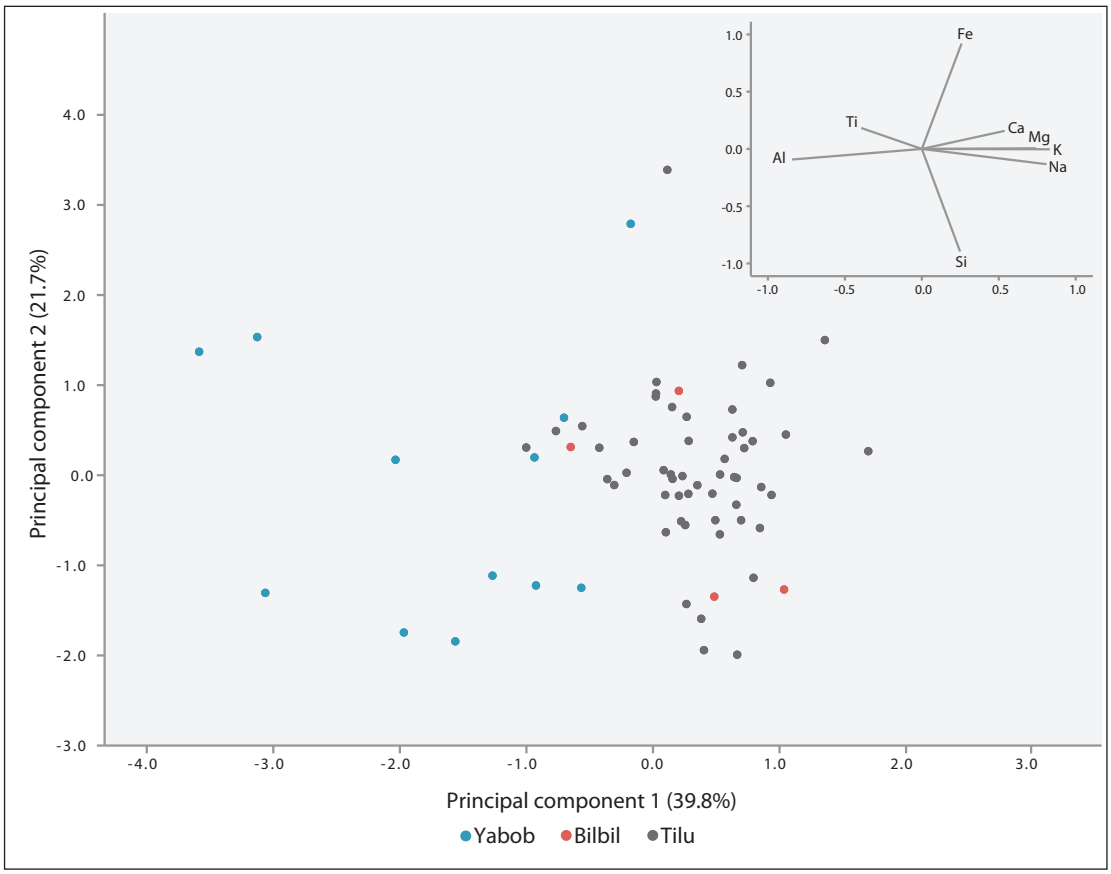


Figure 8.23. PCA showing clay compositional data of Tilu sherds and ethnographic clays

Results: surface survey

Sherds collected during surface survey are consistent in fabric and geochemistry with Madang style sherds from Tilu and Nunguri.

Techno-fabric groups

As per the excavated contexts at Nunguri and Tilu, surface-collected rims from the 2014 Madang survey are also primarily tempered with ferromagnesium grains (Table 8.18). Light dominant tempers are less common, while calcareous and grog tempers are rare.

Techno-mineralogical groups

The range of specific minerals in the survey sample is consistent with the suite of minerals identified at Nunguri and Tilu (Table 8.19). Every analysed rim contains augite and quartz. Plagioclase, epidote, amphibole, and ilmenite are also common.

Techno-compositional groups

The clay data illustrated as dendrograms in Figures 8.24–8.25 and as PCA plots in Figures 8.26–8.28 are limited owing to the small sample size. Most of the sherds overlap, and there are no clear associations between technical class and clay, or collection location and clay. However, it is notable that the two light tempered sherds (K-2 & K-7) group together in the HCA and cluster away from the Fe-Mg tempered sherds in the PCA. When the survey sherds are compared to ethnographic clay sources (Fig. 8.29), the majority of sherds cluster with the Bilbil sources, like the Tilu and Nunguri samples. However, two sherds (K-2 & K-7) group away from any of the reference sources suggesting that the specimens may have been produced using different clays. As these sherds were collected from an exposed beach, post-depositional alteration is another possibility for this anomaly.

Table 8.18. *Techno-fabric groups of survey collected sherds.*

	Techno-fabric group			
	1. Fe-Mg	**2. Light**	**3. Calcareous**	**4. Grog**
Kranket Island				
rims	5	2	–	–
decorated	1	2	–	–
Yabob Island				
rims	4	1	–	–
decorated	–	–	1	–
Siar Island				
rims	3	1	–	–
decorated	–	–	–	1

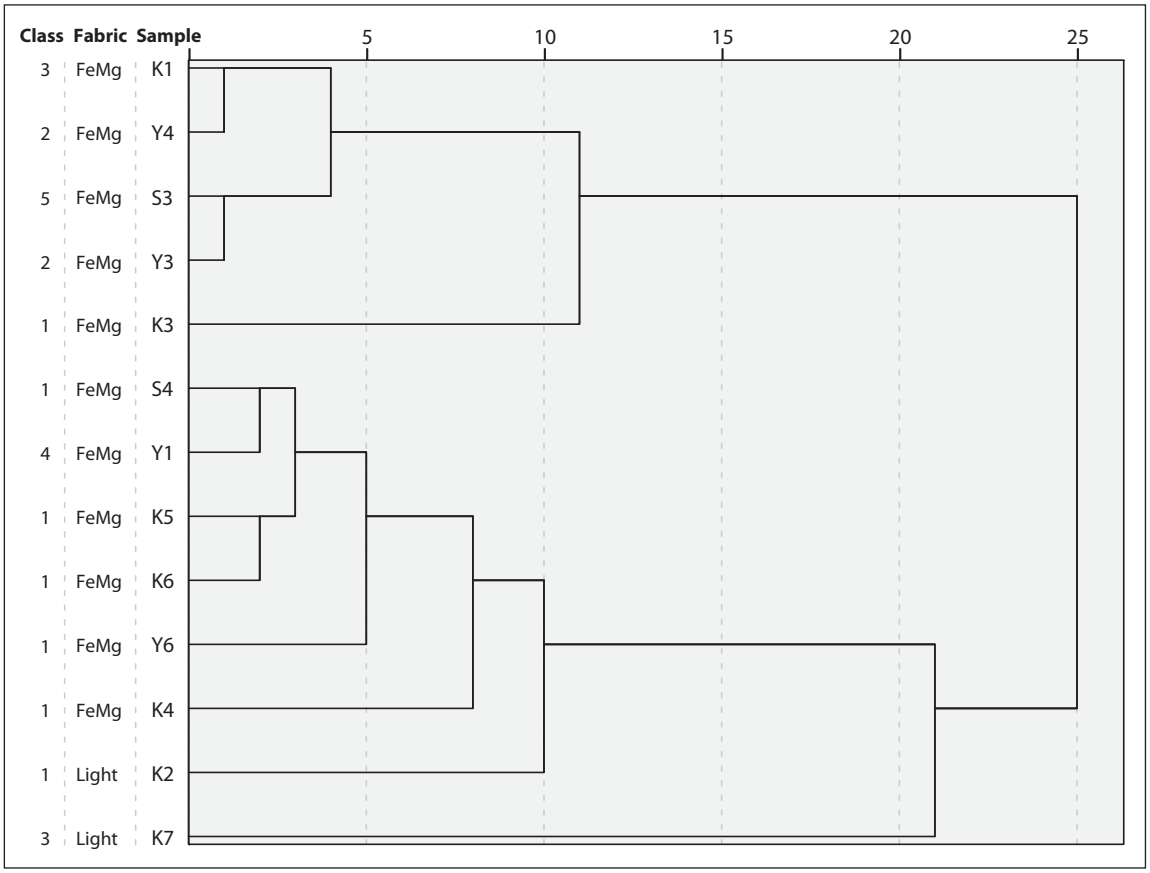


Figure 8.24. Ward's HCA of surface survey sherds.

Table 8.19. *SEM results of mineral inclusions in surface survey samples: Kranket Island, Siar Island, and Yabob Island.*

		Sample												
		K-1	**K-2**	**K-3**	**K-4**	**K-5**	**K-6**	**K-7**	**S-3**	**S-4**	**Y-1**	**Y-3**	**Y-4**	**Y-6**
	Class	**3**	**1**	**1**	**1**	**1**	**1**	**3**	**5**	**1**	**4**	**2**	**2**	**1**
	Fabric	**1**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**
Calcareous	Coral													
	Shell													
	Indeterminate	X							X	X				
Clinopyroxenes	Augite	X	X	X	X	X	X	X	X	X	X	X	X	X
	Ferroan augite													
	Pigeonite													
	Indeterminate													
Orthopyroxenes	Enstatite		X		X						X			
Plagioclase	Anorthite	X		X	X							X		
	Bytownite	X				X	X					X	X	
	Labradorite	X		X		X				X	X	X		
	Andesine													
	Oligoclase													
	Albite		X		X	X	X	X	X		X		X	
Alkali feldspars	Orthoclase													
	Anorthoclase		X					X			X	X		
	Sanidine					X								
Amphiboles	Anthophyllite									X				
	Magnesio hornblende													
	Ferrogedrite													
	Gedrite													
	Ferroglaucophane													
	Edenite													
	Kaersutite					X								X
	Tschermakite													
	Tremolite													
	Inderminate						X	X		X				
Epidote	Anorthite					X		X	X	X				X
Quartz	Quartz	X	X	X	X	X	X	X	X	X	X	X	X	X
Non-silicates	Ulvospinel		X					X		X				
	Magnesiochromite	X						X						
	Indeterminate	X												
	Ti oxide													
	Fe oxide							X						X
	Ilmenite	X			X	X	X	X	X		X	X	X	
	Cu oxide													
Other	Rock	X	X	X		X	X	X	X	X		X		X
	Mica?													
	Humite?	X												X
	Titanite				X									
	Iron rich silicate (garnet?)					X				X				
Grog	Grog?													
Organic	Plant fibres													

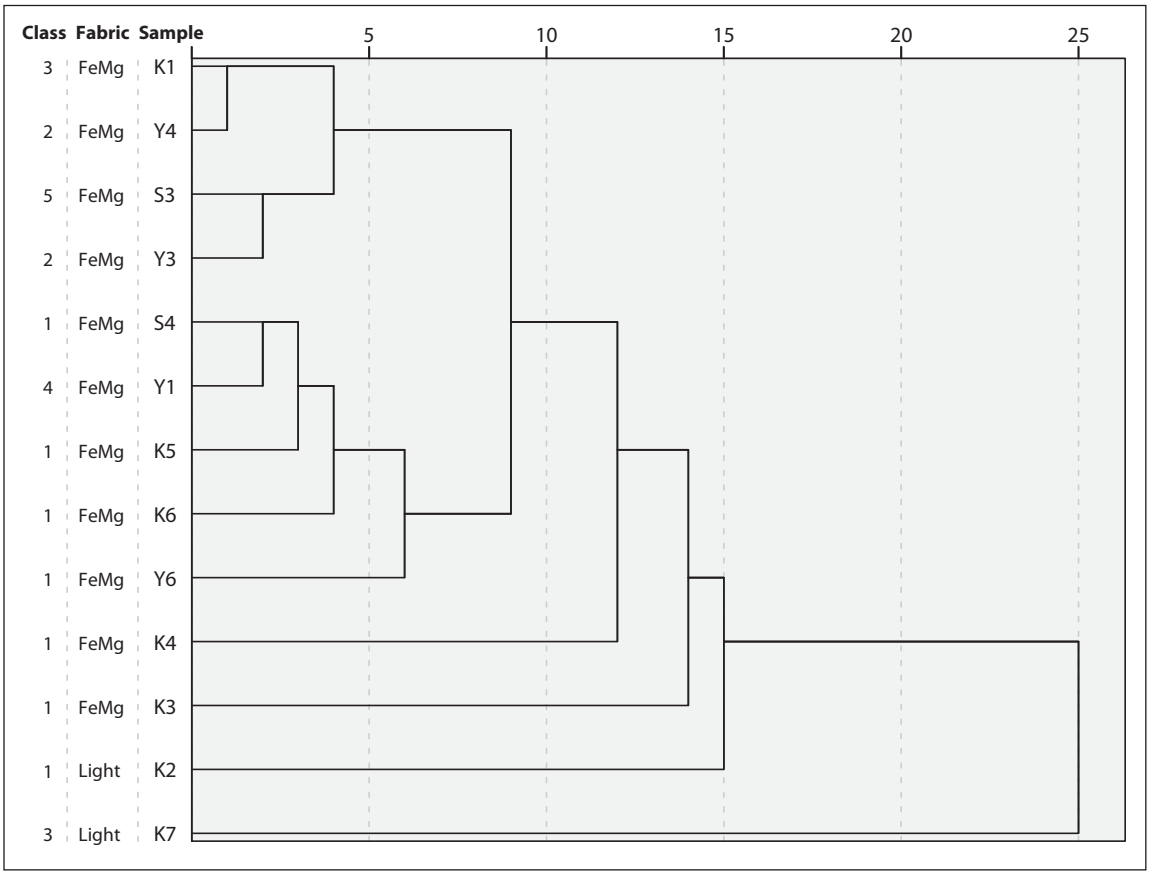


Figure 8.25. Group average HCA of surface survey sherds.

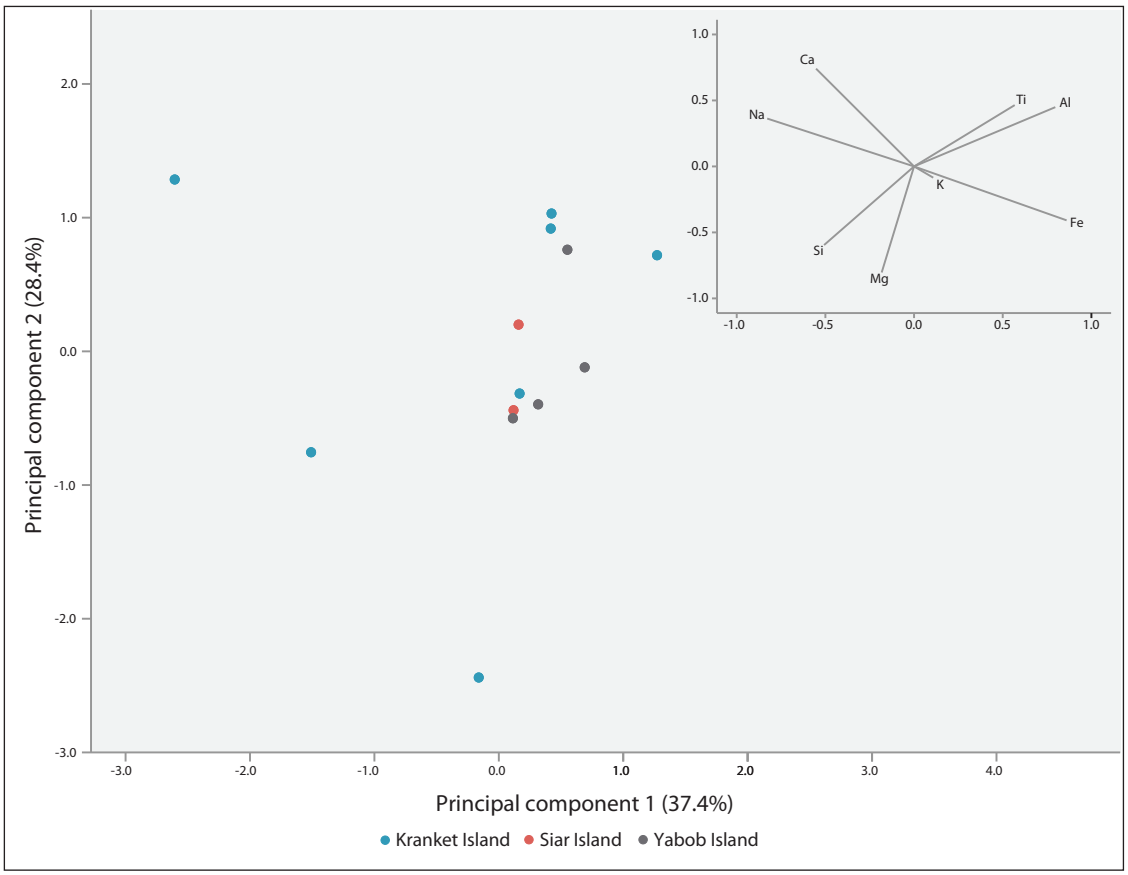


Figure 8.26. PCA showing clay compositional data from surface survey sherds by location.

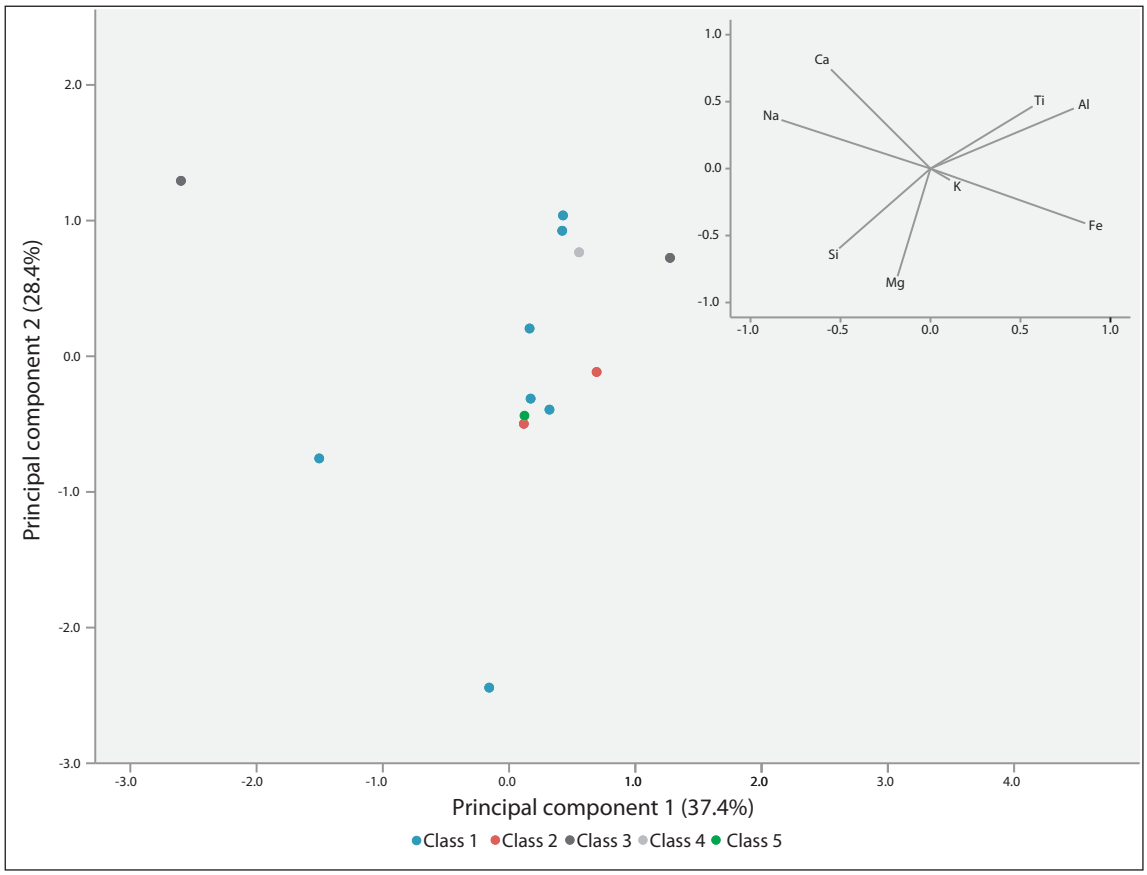


Figure 8.27. PCA showing clay compositional data from surface survey sherds by technical class.

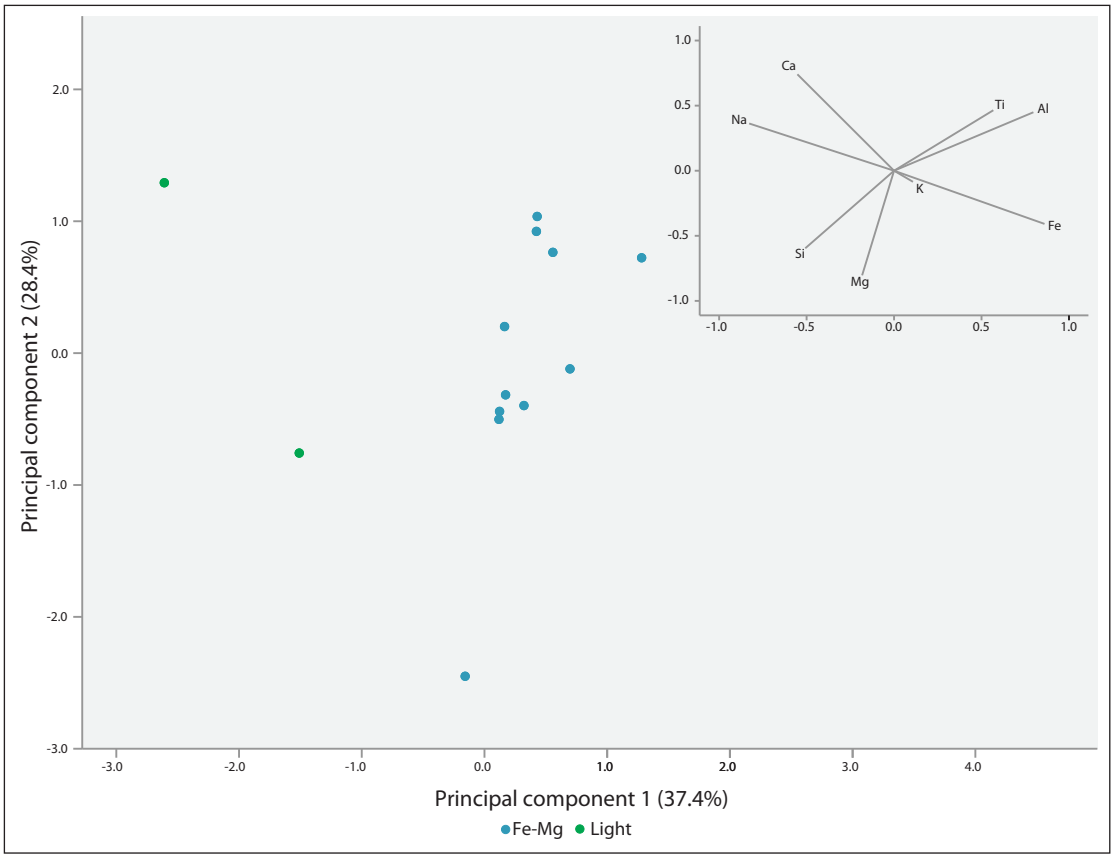


Figure 8.28. PCA showing clay compositional data from surface survey sherds by fabric.

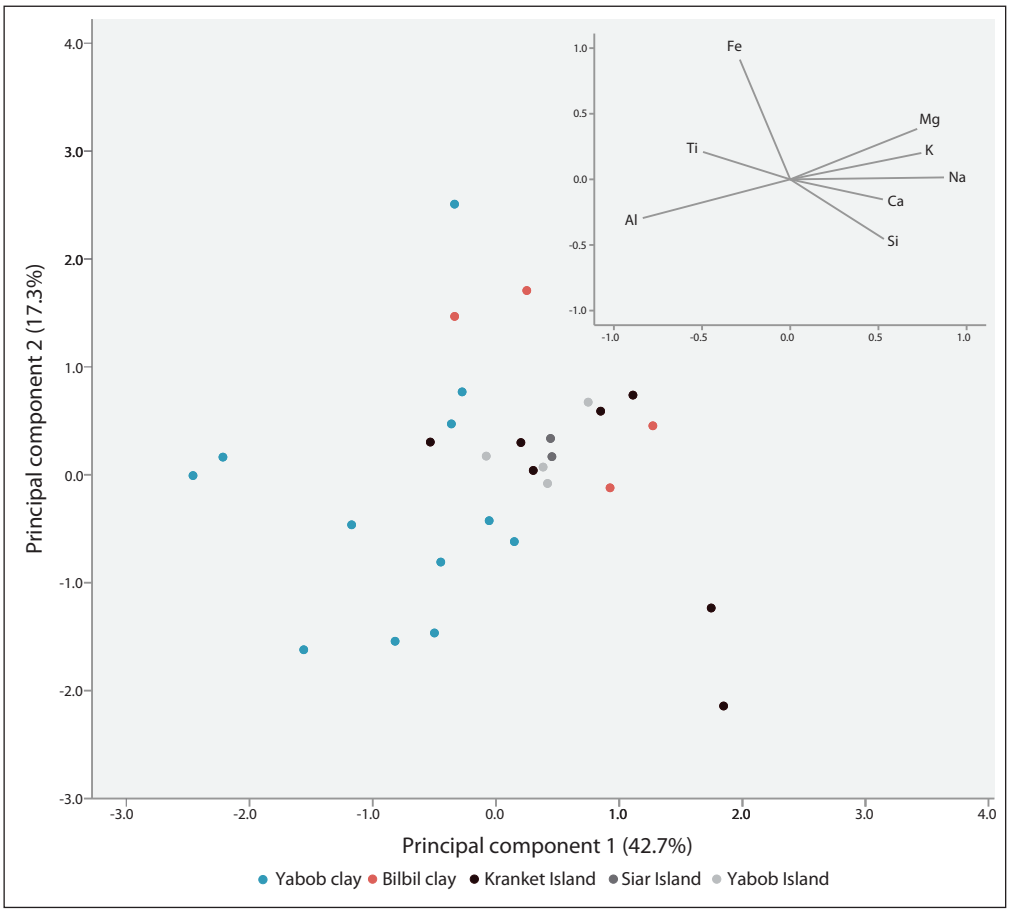


Figure 8.29. PCA showing clay compositional data of survey sherds and ethnographic clays.

Results: exotics

Many of the sherds identified as 'exotic' based on form and decoration are distinct from the Madang style sherds. Exotics were preliminarily examined under low powered magnification to identify grain types but they were not sorted into techno-fabric groups like those following the Madang style classification system. They were examined under SEM to distinguish mineral inclusions and clay chemistry.

Mineralogy

The single 'exotic' sherd from Nunguri (N-3712) contains similar minerals to Madang style sherds, namely augite, quartz, plagioclase and potassium feldspar, and spinels (Table 8.20). It is distinguished as an exotic based on formal differences and a lack of red slip, but it may alternatively represent a similar potting tradition in the Madang or northeast coast area owing to the similarities in tempers.

At Tilu, several sherds are distinctly exotic and 'non-Madang' based on their mineral components. T-188, T-230, T-410, and T-604 for instance contain sparse inclusions and are potentially non-tempered – the inclusions instead representing natural minerals in the clay source. Although T-188 and T-230 contain similar types of non-plastics to the Madang style rims, the small size of the quartz grains (~20 µm) indicates they are natural inclusions in the clay, dissimilar to the Madang style rims which contain much larger quartz grains. T-410 and T-604 also contain a similar range of mineral inclusions, but lack augite, which is almost always present in Madang style ceramics. T-520 and T-913 appear to be manually tempered owing to the large grain size of their inclusions, consistent with manually tempered Madang style ceramics. T-520 contains a range of minerals, consistent with the Madang style, but it is still considered to be non-Madang owing to inconsistencies in the decoration technique: it exhibits deep linear incision. This may represent another technical tradition in the Madang or northeast coast area, distinct from the Madang style. T-913, the unique ring-base, also appears to be manually tempered (or derived from a very coarse-grained clay source). The inclusions in the sherd are almost exclusively quartz, with some plagioclase and rare, but very small (< 50 µm), ilmentie and Fe-oxide grains.

The possible exotic sherd from Yabob Island (Y-5) contains minerals within the range of the Madang style suite, including augite, plagioclase, amphibole, quartz and ilmenite. Although the rim form does not fall within Technical Classes 1–5, it is red slipped. As such the sherd remains an unknown. It may represent a unique form of rim (or even

Table 8.20. *SEM results of mineral inclusions in exotic samples from Tilu, Nunguri, and Yabob.*

		Sample							
		T-188	T-230	T-410	T-520	T-604	T-913	N-3712	Y-5
	Designation	Rim	Body	Rim	Body	Body	Ring-base	Rim	Rim
	Spit	2	2	4	5	6	SP 60cm	15	Surf.
Calcareous	Coral								
	Shell								
	Indeterminate								
Clinopyroxenes	Augite	X	X		X			X	X
	Ferroan augite								
	Pigeonite								
	Indeterminate								
Orthopyroxenes	Enstatite								
Plagioclase	Anorthite						X		X
	Bytownite				X				
	Labradorite	X	X				X	X	X
	Andesine								X
	Oligoclase								X
	Albite		X	X	X		X	X	X
Alkali feldspars	Orthoclase				X	X			
	Anorthoclase								
	Sanidine							X	
Amphiboles	Anthophyllite								
	Magnesio hornblende								
	Ferrogedrite								
	Gedrite								X
	Ferroglaucophane								
	Edenite								
	Kaersutite								X
	Tschermakite								
	Tremolite								
	Inderminate		X	X		X			X
Epidote	Anorthite			X					
Quartz	Quartz	n*	n	X	X	X	X	X	X
Non-silicates	Ulvospinel								
	Magnesiochromite							X	
	Indeterminate								
	Ti oxide								
	Fe oxide	X					X		
	Ilmenite	X		X	X		X		X
	Cu oxide								
Other	Rock				X		X		
	Mica?								
	Humite?								
	Titanite								
	Iron rich silicate (garnet?)								
Grog	Grog?								
Organic	Plant fibres								

*n = small grains naturally occurring in the clay

a stand) in the Madang style or it may be derived from a separate technical tradition but utilising similar tempering sands. To resolve this, a larger sample of similar sherds is required, perhaps from future excavations on Yabob Island.

Clay composition

The clay chemical dataset for exotic sherds is again limited by a small sample size. Figures 8.30–8.31 show HCA dendrograms of these data, while Figures 8.32–8.33 show PCA plots of the same data, firstly focusing only on the sherds themselves, and then in comparison to ethnographic clay sources from around Madang. Interestingly, all of the exotic sherds cluster towards the Bilbil clay sources. This may suggest that some of the 'exotic' sherds were produced using clays from the Bilbil area and may in fact be local but deriving from distinct forming traditions.

Summary

The macroscopic and geochemical analysis of a sample of Madang sherds and clay sources was successful in distinguishing local raw material procurement and distribution. The results show that there is little clear evidence for the import of non-local ceramics into the area. Figures 8.34–8.36 show exotic sherds grouping within the range of locally produced Madang style pots. In each plot, K-7 and N-188 are clear outliers, but both fall within the range of Madang style technical groupings. These outliers are possibly derived from different clay sources. However, post-depositional alterations may also be at play. Importantly, the very earliest ceramics in the Madang style found in this study appear to be produced from locally available materials, supportive of a recent migration of Bel potters to the Madang coast with no evidence for previous trading from other source zones.

Overall, the PCA plots indicate no clear patterning relative to place of raw material collection, technical class, or fabric group, which suggests one or more production groups using local raw materials were making pots with a range of forming processes. The same sources appear to have been in use for the last 500–600 years. However, there is a tentative partitioning of Nunguri and Tilu samples in Figure 8.34. Elsewhere in the world, chemical clusters have shifted gradually within one potter's lifetime either through the use of different raw materials or differential mixing of the same raw materials (Arnold 2015). The incomplete separation of Nunguri and Tilu clusters may hint at similar minor changes to the location of clay pits over time, no more than a few generations. These differences are not expected to be substantial in terms of distance to the source but may relate to source exhaustion or relationships with landowners.

In the next chapter, the results of the geochemical analysis will be compared with forming and decorating techniques, which will complete the technological classification. Chapter 9 will examine procedure eight in this classification scheme, in an attempt to clarify techno-style groupings within the Madang style (following Roux 2011), distinguishing the number of production groups working within the broader community of practice.

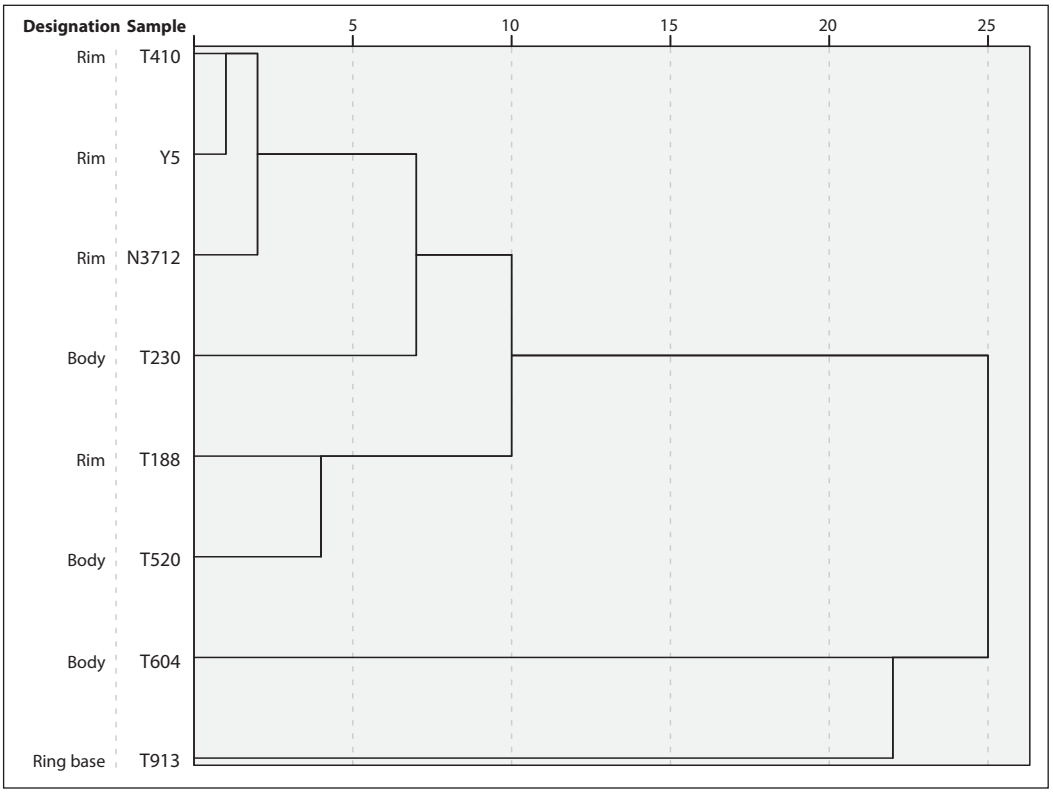


Figure 8.30. Ward's HCA of exotic sherds.

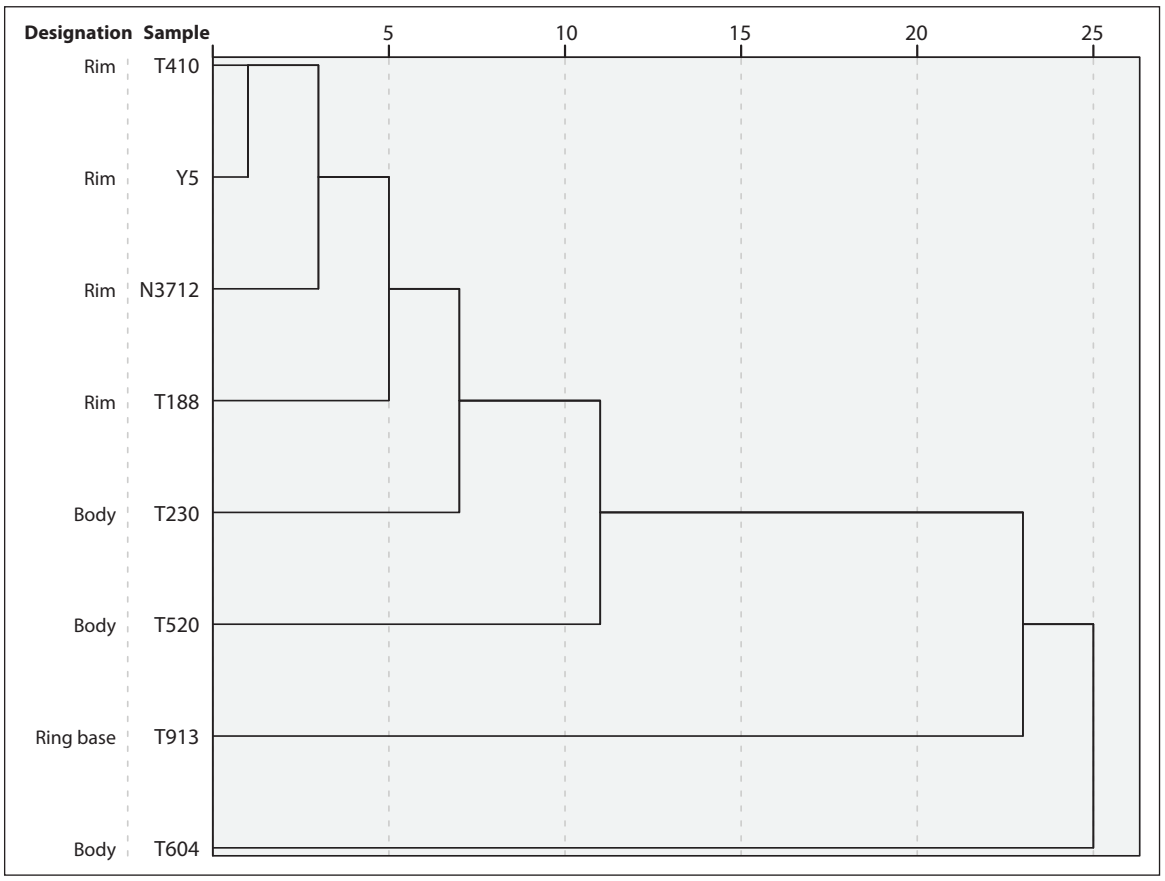


Figure 8.31. Group average HCA of exotic sherds.

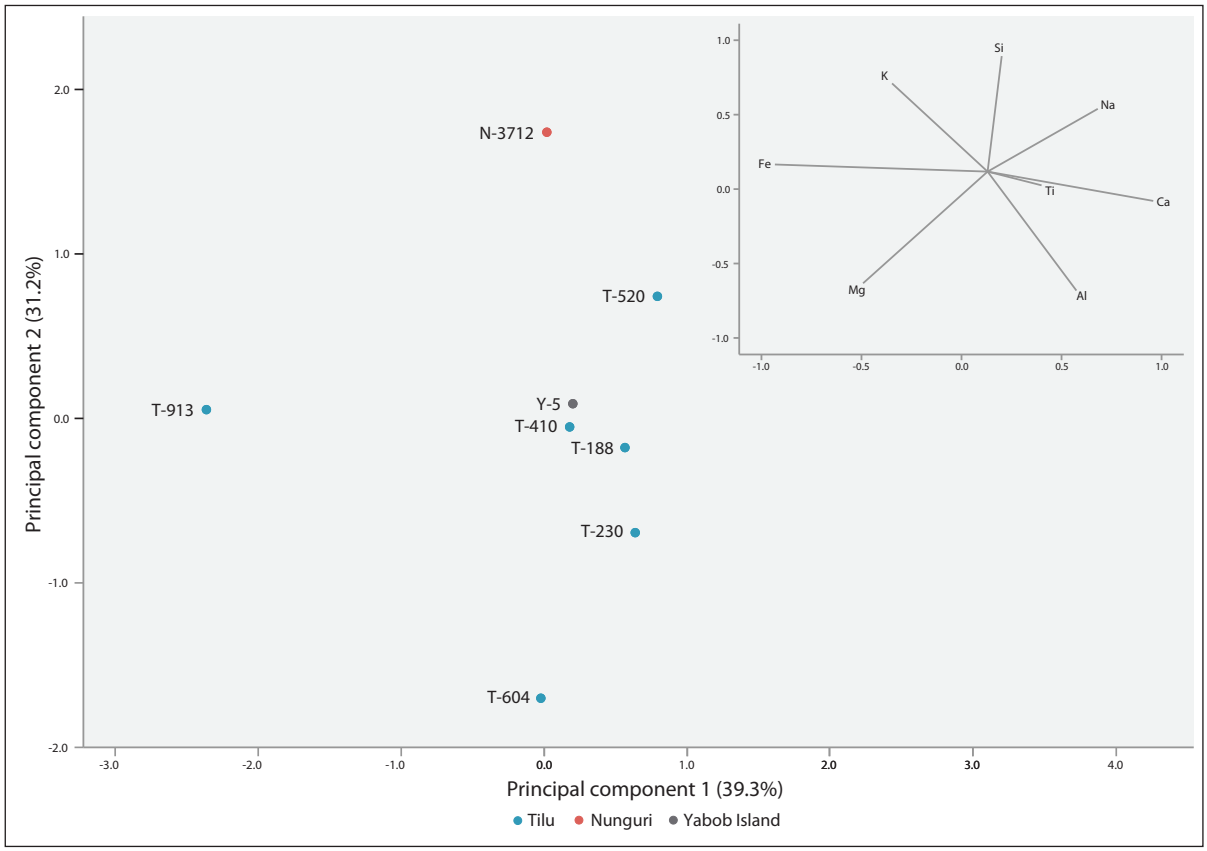


Figure 8.32. PCA showing clay compositional data from exotic sherds by location.

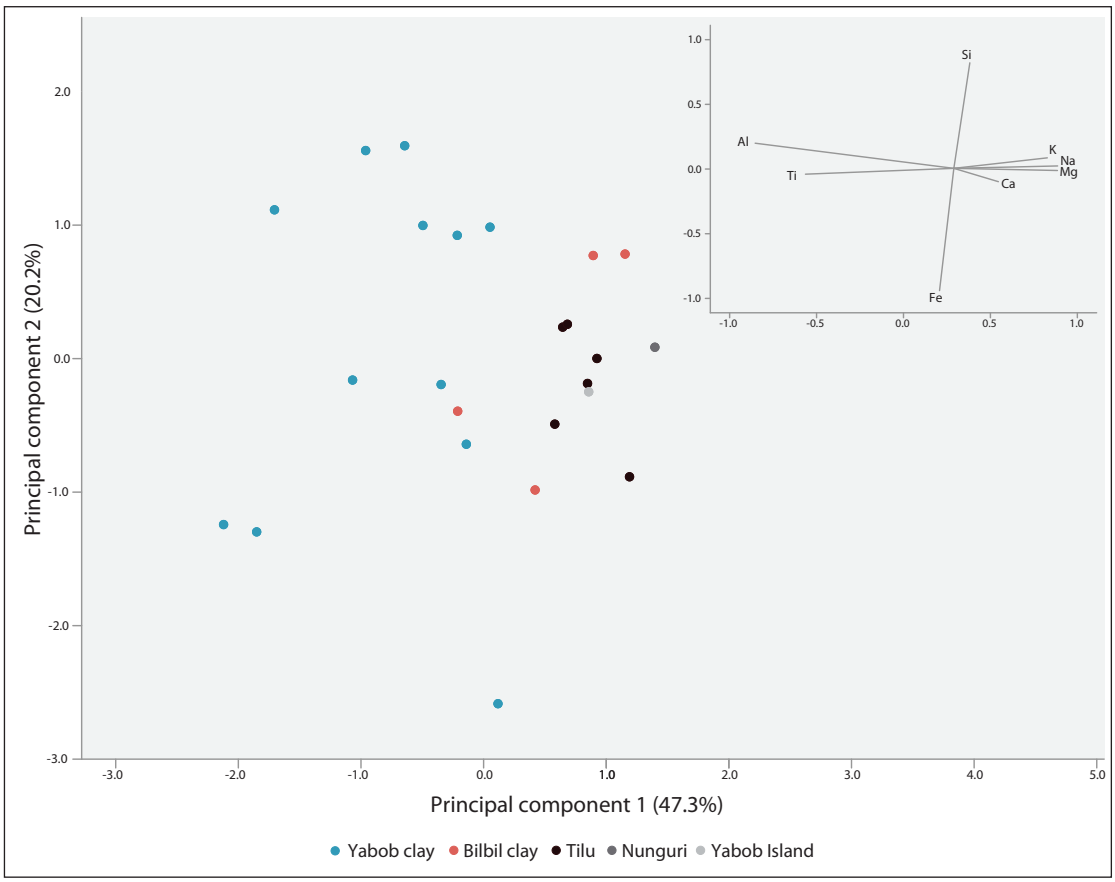


Figure 8.33. PCA showing clay compositional data from exotic sherds and ethnographic clays.

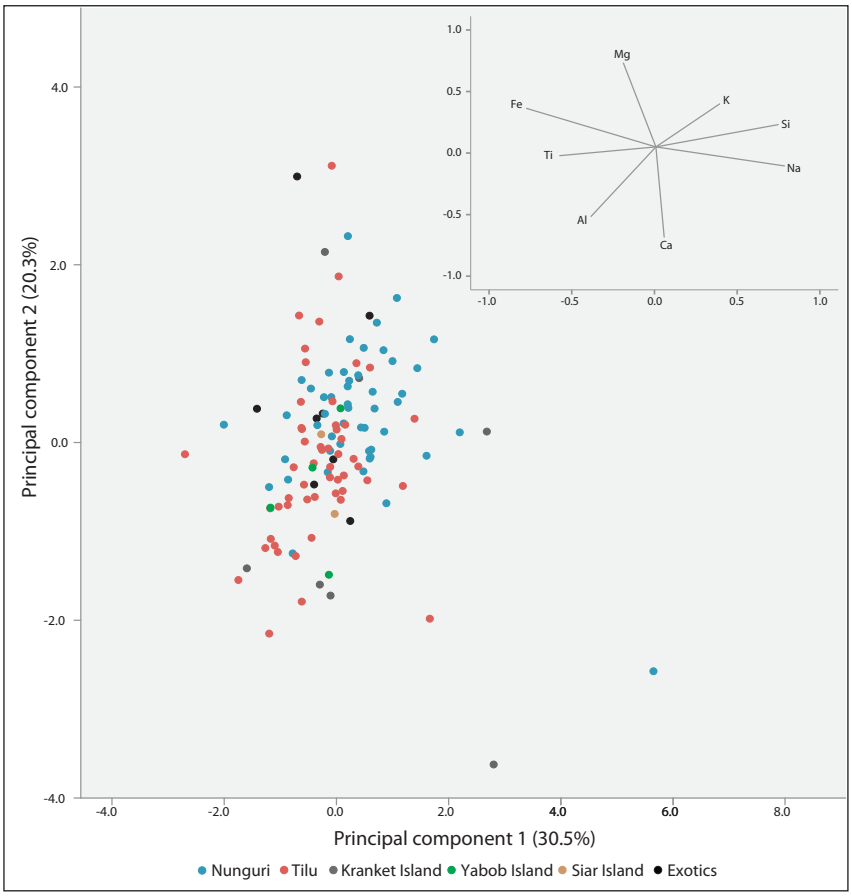


Figure 8.34. PCA showing clay compositional data from all sherds by location.

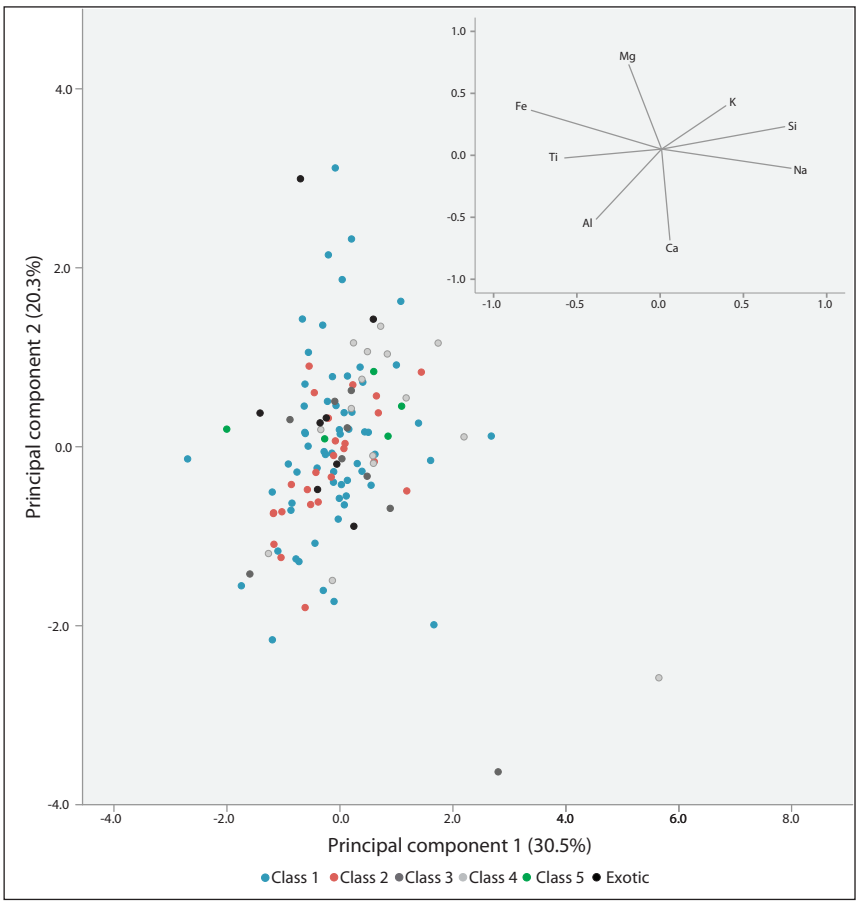


Figure 8.35. PCA showing clay compositional data from all sherds by class.

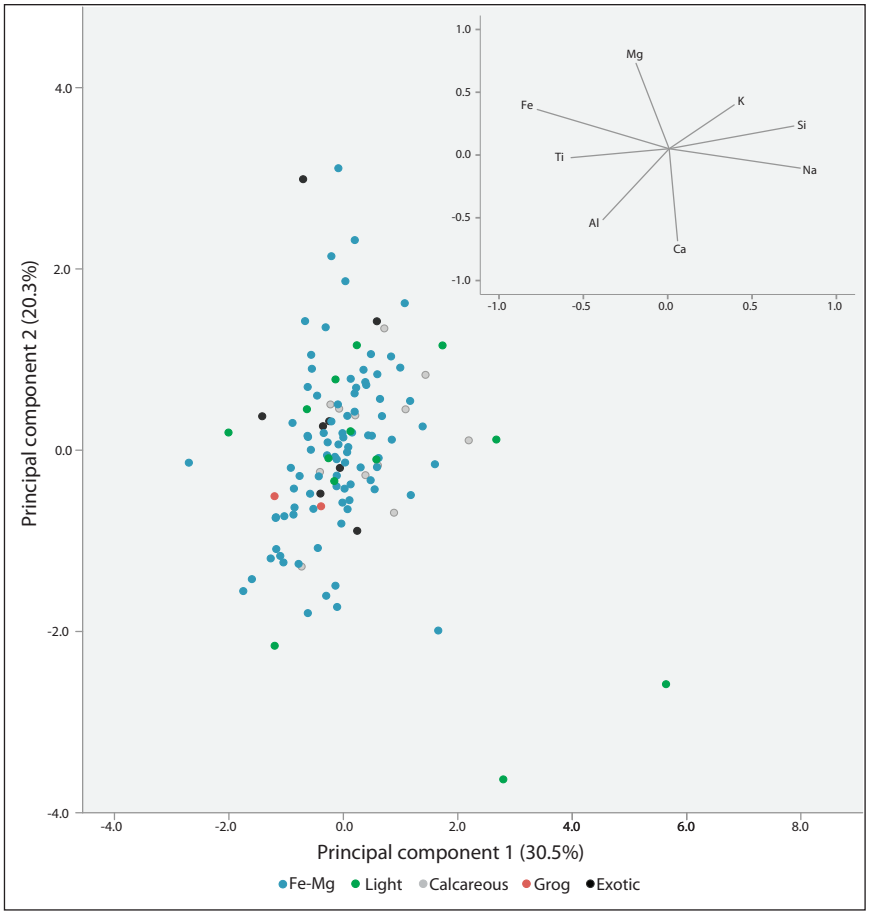


Figure 8.36. PCA showing clay compositional data from all sherds by fabric.

Chapter 9. Pre-Colonial Potting III: Decorating

> *Generally, a decorated piece…is preferred to one in its plain state, because grass-roots art pleases the eye, regales the mind, and reminds the viewer of …traditional concepts and ways of life.*
> — E.F. Hannemann, Madang (1968)[1]

Decoration is the final important aspect of technology for identifying group interaction and knowledge exchange. This chapter describes the decorating processes used by pre-colonial Madang potters in an attempt to clarify the groupings derived in the previous chapters. The specific aims of this chapter are: (1) to examine the decorating processes used by Madang style potters over the past 500–600 years, and (2) compare decorating techniques with compositional and forming techniques to distinguish if specific production groups used distinct decorations. These aims tie in to broader concerns about how technological change, innovation, and knowledge acquisition took place in the community of practice. From a culture history perspective, particular decorative processes may be peculiar to certain timeframes, acting as useful relative dating devices when comparing different ceramic assemblages around the northeast coast.

To address these concerns, methodological issues pertaining to the analysis of decoration are discussed and a social and technological approach is described. The analytical procedures of the Madang decorative analysis are then presented, including the nature of classification and attribute analysis. Lastly, the results of the decorative analysis are presented and compared to formal and compositional attributes. Pottery from each excavated assemblage and surface survey are treated separately, to describe pottery technology on-site. This will be tied together in the discussion of production and exchange in the next chapter.

Methodological issues

Decoration and New Guinea ceramics

Generally, decorative analyses of New Guinea-area ceramics have been, implicitly or explicitly, guided by the concept of style. As presented in Chapter 7, style is often acknowledged as the 'content and appearance' of a pot, including form and decoration (see Specht 1969: 64). However, unlike form, specific decorations are often viewed as important for understanding something of the maker's social identity and symbology (e.g. Allen 1984a; Rathje 1978). As such, decoration has often been used to distinguish chronologically restricted 'styles' (or synonymous terms) to construct regional sequences of social and technological change. The issue of decoration in particular has featured prominently in Lapita and post-Lapita sequences of the Bismarck Archipelago and abroad (e.g. Bedford & Clark 2001; Spriggs 2004; Summerhayes 2001c), in various ceramic phases and periods of the Massim (e.g. Bickler 1998; Egloff 1979; Lauer 1974), and in the Lapita, Early Papuan Pottery (EPP), and post-EPP sequences on the south coast of New Guinea (e.g. Allen 2016; Allen *et al.* 2011, Bulmer 1982; David *et al.* 2011; Skelly 2014; Summerhayes & Allen 2007). These approaches tend to be culture historical and invoke, often quite justifiably, diffusionist or migrationist paradigms.

Lapita decoration has received the most attention owing to its highly ornate decorative systems. Some studies have focused on the tools used to produce decorations (e.g. Ambrose 2007; Bedford 2006b; Best 2002: 47) or on the intersections of decorative processes with other technological processes such as tattooing (e.g. Green 1979; Kirch 1997: 131). Other studies have explored the range of motifs and their chronological and geographical distributions (e.g. Anson 1983, 1986, 2000; Chiu 2015; Sand 2007), the skill and standardisation of the decorations (e.g. Clark 2007; Clark & Murray 2006; Hogg 2011), or the social meaning behind specific motifs (e.g. Chiu 2005, 2007; Schechter & Terrell 2009). Lapita scholars have also long been aware that pottery decoration needs to be investigated from a structural rather than a purely descriptive perspective (Mead 1975; Sharp 1988; Leblanc 2016).

Decoration on recent New Guinea ceramics has received less serious attention (outside of several doctoral dissertations mentioned in chapters 7 and 8 and several papers by Bulmer 1970, 1971, 1985). Superficially, however, some decorative arrangements seem to be restricted to specific

1 In Hannemann (1969: 2), *Grass-Roots Art in New Guinea*.

places, while others bear distinct similarities that can be seen from the Sepik coast to the North Solomons, especially with regard to simple incised and applied techniques (see Schurig 1930).

Technology as methodology

So, pottery decorations, like vessel morphology, can closely resemble each other over large geographical distances and this is particularly the case in New Guinea (Petrequin & Petrequin 1999). Could this be because of interaction, common descent or convergent innovations? To evaluate such differences and similarities systematically, the concept of isochrestic variation (following Lemonnier 1992; Sackett 1986) is again useful. Similar decorative forms may in fact represent distinct technological choices pertaining to the tools employed, the gestures used, and the intention of the designers (i.e. technical elements). Within the framework of embodied knowledge, the boundaries between these tools, gestures, and intentions become increasingly blurred over time, increasing the durability of the technological process, and as multiple technical elements are patterned and interlinked they become technical syntaxes. The forms of the decorations in themselves represent the physical result of such processes. Singular technical elements and short syntaxes may be widely distributed within and between production groups owing to interaction and imitation (Mayor 2005; see Chapter 7, Fig. 7.1); however, it is assumed that more complex operations, involving extended syntaxes, will be less widely distributed and primarily passed on through learning and descent.

This point is important. Although technological syntaxes are more durable strands of materiality, those technological processes with shorter syntaxes (e.g. modern Madang decoration) are usually more prone to visible innovation resulting in variation to technical elements than longer syntaxes such as vessel forming (Hosfield 2009: 53). To dabble in evolutionary speculation, decoration may also be more likely to be innovative because the specific form of decoration is unlikely to affect the success of the forming and firing phase, necessary for the production group's wellbeing and ability to maintain social reciprocity. However, this does not clarify how or why innovations occur.

To further investigate the interplay between technology, knowledge, and innovation we return here to the learning process and modes of social learning. The nature of learning has been shown to affect the durability and transfer of specific technical syntaxes and elements. For instance, a recent review (Hosfield 2009) found a significant association between vertical learning and conservatism in technical knowledge, while horizontal learning between members of the same or different production groups was more often associated with innovation and change. As Gosselain (1992) points out, gestural innovation is unlikely to arise during vertical learning processes as the parent or teacher will correct movements that are considered mistakes, and there is less likelihood of major variations as these 'correct' procedures become embodied and increasingly subtle and unconscious to the potter. Describing the changing distribution of technical elements and syntaxes will then be an important proxy for determining the nature of cultural learning and sharing between production groups over time.

Although the processes of knowledge acquisition between generations and across social groups are universal occurrences, these processes are not invariant. Rather, they are locally and historically situated and different contexts of learning will affect the nature of knowledge acquisition and the distribution of technical elements (see Roux 2007). Ethnoarchaeological studies have shown that social learning is not straightforward. For instance, amongst the Kalinga in the Philippines, learning primarily occurs vertically, mother-to-daughter, but there is also a strong horizontal impact from peers of a similar age (Graves 1981; Longacre 2008). Further, ethnographic studies of social learning demonstrate that throughout a person's lifetime the nature of learning can change, from being predominantly vertical in early stages of life, to being primarily horizontal in later stages (e.g. Hewlett *et al.* 2011; Tehrani & Collard 2009).

The sharing of technical knowledge between production groups is not necessarily dictated only by geographic distance (contra Welsch *et al.* 1992), but also by kinship, gender, social relations, environment, belief, and language affinities. Sassaman and Rudolphi (2001) demonstrate an instance of this for some North American pottery traditions. As the potters in question were probably female, and assuming a similar kinship structure and exogamous marital system to today, then women would have commonly participated in at least two production communities in their life. First, in their natal communities, they began to learn pottery making from mothers, aunts, grandmothers, and sisters. Second, they would have continued to pot in their marital communities. The movement of women potters between different communities would have been a source of technical variation, introducing ideas from one group to the next relatively quickly, especially as these women began to teach their daughters and others in their marital communities.

Another source of variation is related to skill level and degrees of embodiment within the given technological process. Ethnoarchaeological studies elsewhere in the world suggest that variation will occur as very experienced potters consciously innovate and novices make mistakes (Dietler & Herbich 1998; Roux 1990; Roux *et al.* 1995). Whether these variations were adopted, tolerated, or counteracted would have depended upon the social regulations important to maintaining the processes of decorating.

It is tempting to apply similar frameworks to Madang. Today, sharing of technical knowledge is primarily vertical or oblique for Bel girls born into a potting village, but for those who marry in from non-potting villages, the process is different, being primarily horizontal. Those women who marry into potting groups and begin to learn the tech-

niques would introduce variation and innovation, drawing upon accumulated gestural knowledge and memories from other communities and technological processes. Conversely, the movement of experienced Bel potters into other production groups would introduce another source of innovation and difference but might also prevent divergent strands of technological process developing, maintaining similarities between groups. In the past, oblique and vertical learning may have been the major way in which potters learnt vessel forming and decorating techniques. If this were the case, gestures and tools may have been used in very consistent ways over the past 600 years. Individual technical elements may have changed rapidly owing to people's capacities to improvise, especially at the ends of the skill spectrum, but if there was a similar marriage and kin structure to today we would expect these innovations to be widespread amongst the community of practice.

Method

The Madang Classification

To address the organisation of production groups and the application of minor technical elements within this community of practice, this chapter will complete the hierarchical classification, which has featured throughout chapters 7 and 8. The previous chapters have distinguished groupings based on procurement and forming processes. This final stage of the technological classification will compare techno-compositional groupings (along with technical classes, techno-fabric/mineralogical groups) with minor technical variants – in this case decorating techniques. This analysis will distinguish whether particular decorations are associated with particular production groups or with particular forming techniques, used in multiple production groups. Doing so will establish techno-style groups and emphasise micro-technical traditions within the local Madang area if they exist (see Fig. 9.1).

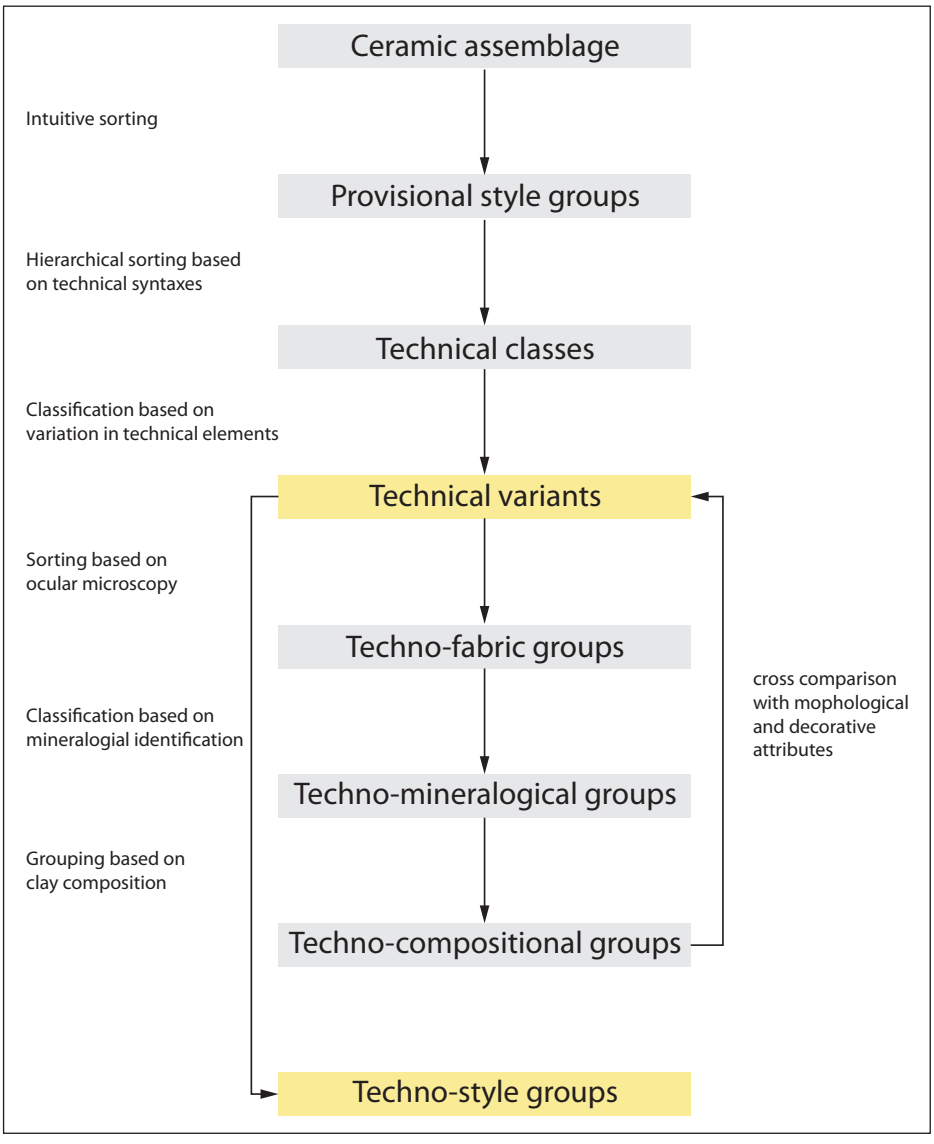


Figure 9.1. Procedures of a technological classification (adapted from Roux 2011). The procedures examined in this chapter are highlighted yellow.

Technical attributes

Single decorative forms are easily shared through group interaction and so are potentially poor indicators of more durable strands of cultural and technological similarities or difference. However, the structures behind decoration involving more extended syntaxes, including the combinations and placement of attributes, are probably more diagnostic of production communities (Arnold 1983, 1984; Friedrich 1970). The description of surface decoration should therefore describe 1) the application methods (i.e. gestures/tools) used, 2) the configurations of these technical elements (i.e. intentional use of specific shapes and patterns), and 3) the location of these configurations on the vessel (i.e. the intentional use of specific space). The presence and absence of different configurations on different areas of the pot are guided by social rules. Therefore, specific technical elements and their configurations may be spatially or temporally restricted such that they can be used as chronological indicators of specific production groups. Consequently, the following decorative attributes were recorded on all sherds exhibiting surface alteration.

I. *Application method* refers to the way in which decoration is applied to the surface of a pot. In the Madang assemblages, four broad application methods were identified, each with several sub-methods:

1. Appliqué is created by the addition of plastic clay or slip to the surface of a vessel using a tool or by hand (Irwin 1985:109). In the Madang style, appliqué appears to have been applied with a sectioned semi-circular piece of bamboo or similar tool. This broad group can be subdivided based on the gestures used to apply the clay/slip. 'Nubble appliqué' is formed by the application of small, discrete dots onto the vessel. 'Linear appliqué' is the application of thick or thin lines of clay/slip. 'Appliqué variant' is a category to describe the method of applying lines of appliqué, which are then scraped away at regular intervals to produce nubbins (see Egloff 1975:3). Some appliqué lines are not scraped but deliberately incised ('incised linear appliqué'), while others are impressed with the side or flat end of the tool ('impressed linear appliqué'). If preservation is only sufficient to determine the presence of appliqué and not the specific type, then the sample is designated 'appliqué (?).'

2. Incision is the cutting of the vessel surface, pulling the tool parallel or at an angle to the vessel surface (Orton & Hughes 2013:89). All incision in the Madang assemblages was completed prior to slipping and firing using a bamboo or wooden tool. Incision can be subdivided based on the specific gestures used in application. 'Linear incision' is a freehand technique, which uses a sharp tool to produce long thin lines. 'Groove-incision' is completed with a broader, blunter tool or part of the tool, which creates shallow and wide grooves (Rice 1987:146). 'Gash-incisions' are produced by cutting controlled, short (<5 mm) and sometimes deep dashes into the clay (Irwin 1985:109).

3. 'Impression' is formed by pressing a tool into the clay, perpendicular or at an angle to the vessel surface, but not moving it laterally (Skelly 2014:97). Impressions are usually shallow and imprint the form of the tool used to produce them. 'Punctation' is a form of impression caused by pushing a sharp object deeply into the clay, but not so far as to perforate the interior surface (Rice 1987:145). Egloff (1975) used the term 'inner rim notching' to describe impressions along the interior corner point. Here, this category is subsumed by the impression and punctation category (although Egloff's category will be considered later in the results).

4. 'Paddle impression' is here a separate method of impression owing to the different tools required and the different gestures used. Paddle impressions may be created through the use of specialised carved paddles for surface decoration or plain paddles may be used with different gestures to produce distinct linear impressions.

Body sherds were designated as 'plain' if they did not display any decoration, while formal sherds were conservatively designated as 'plain' only if a significant proportion of the neck and shoulder were preserved without decoration.

II. The decorative motifs of the Madang style have not previously been reported in detail. Here, a hierarchical approach is used to investigate the structure of decorating and the patterning of different application methods. *Design elements* are the smallest self-contained attributes under analysis, directly resulting from a single technical element (e.g. one deliberate scrape of the tool) (see Chiu and Sand 2005; Siorat 1990). *Design configurations* are arrangements of the same design elements to fit a spatial dimension on the pot (Friedrich 1970). *Design motifs,* on the other hand, combine two or more design configurations or design elements (this is here synonymous with Friedrich's 'secondary element use'). Motifs are cognitively different from configurations, as they require the repetition and patterning of multiple technical elements. The range of motifs exhibited describes which combinations of technical elements are considered correct within the specific social and temporal practice of decorating. A number of configurations (Fig. 9.2–9.3) and motifs (Fig. 9.4–9.6) was identified, which were coded numerically.

III. The *location of decoration* describes which design elements were publicly viewed and those that were only seen upon closer inspection or in use (Skelly 2014:100). This has important implications for examining the communicative and more readily imitated elements of design. Moreover, within different communities specific motifs or configurations might be appropriate on some parts of the vessel but not others. Decorative location was recorded on formal sherds, divided into discrete areas including lip, inside lip, outside lip, interior corner point, neck, sub-rim groove, sub-rim groove (ridge), and body/shoulder (Fig. 9.7). All decorated non-rims were designated as 'body/shoulder.'

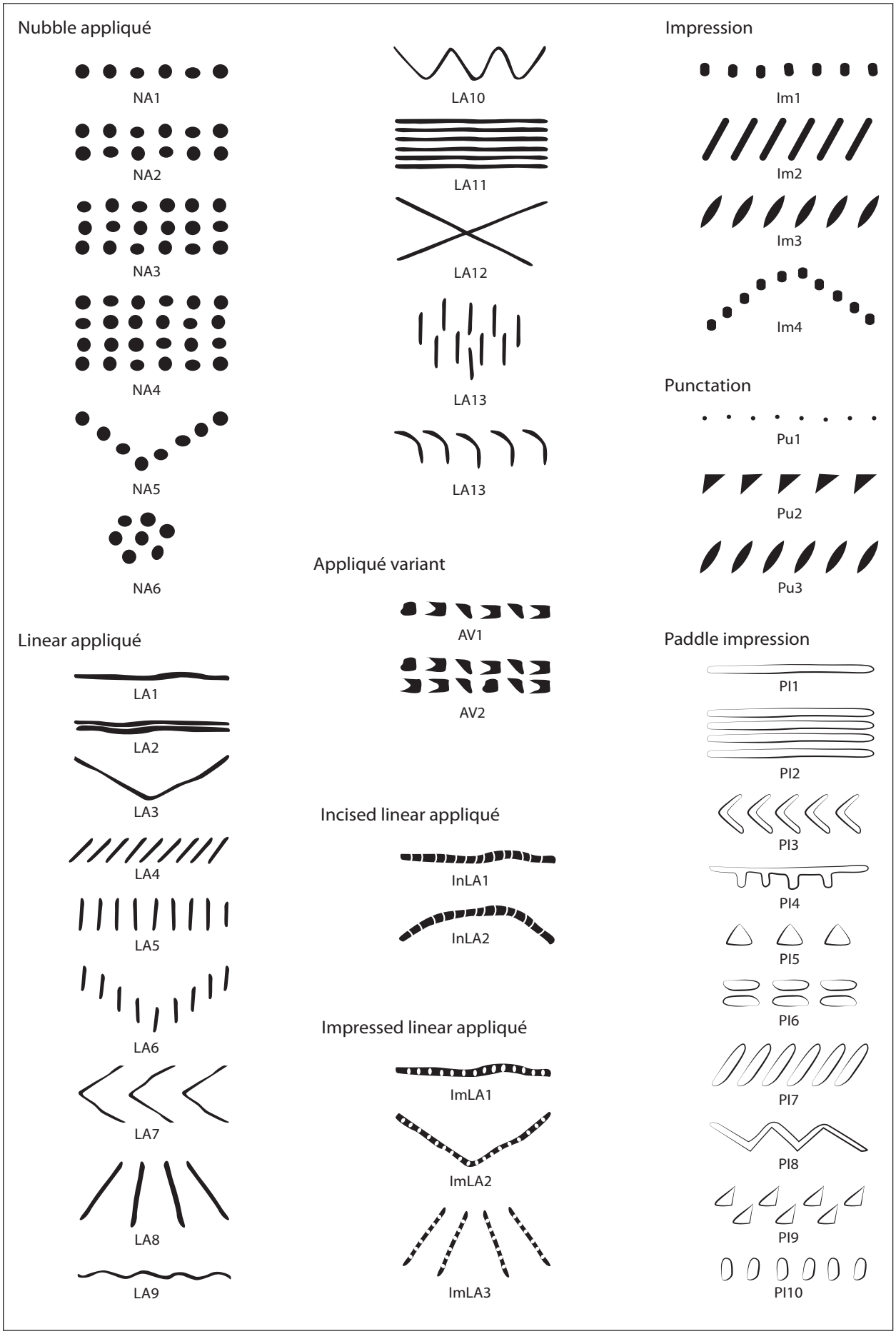


Figure 9.2. Design configurations represented in the Madang style.

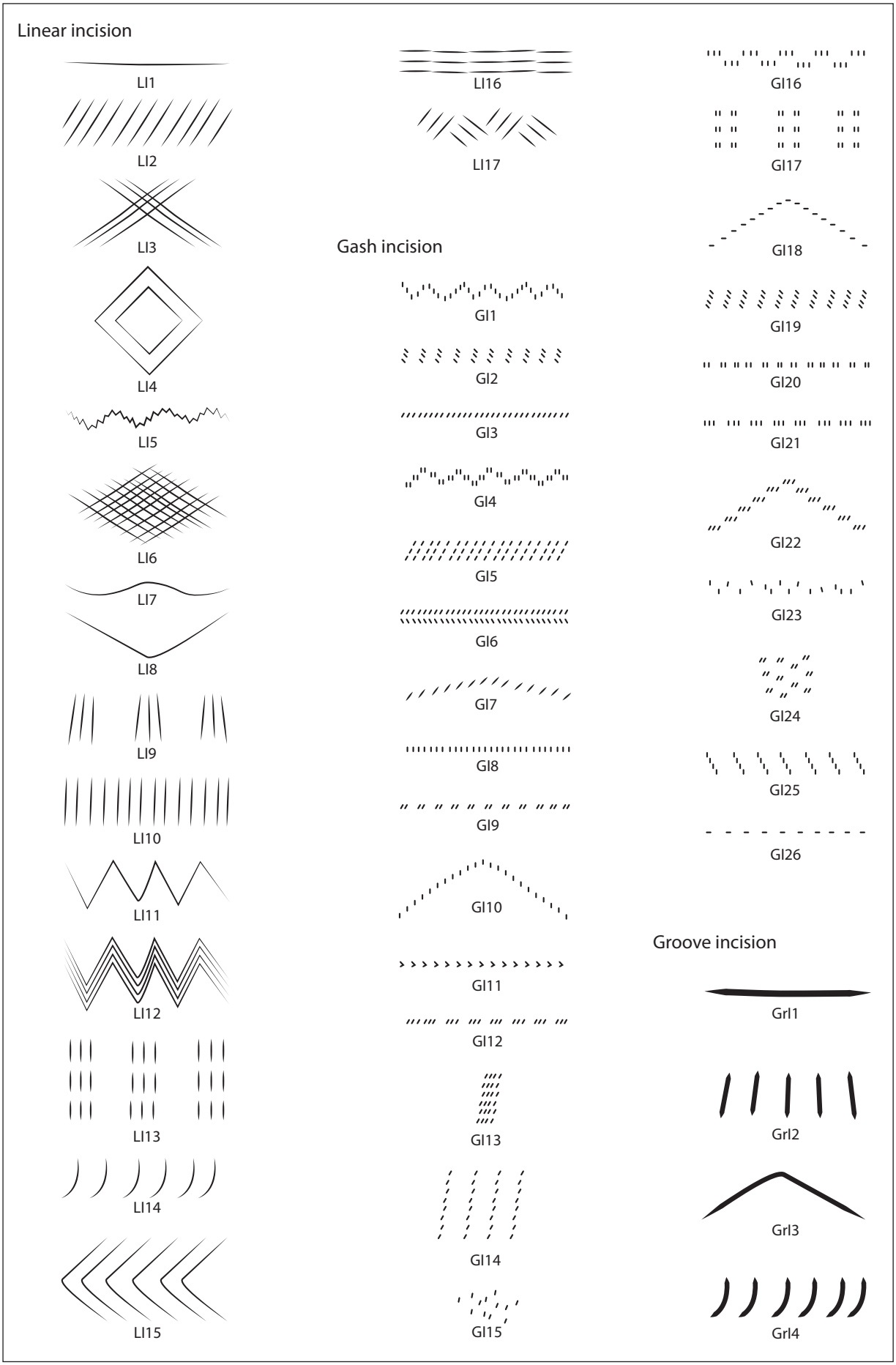


Figure 9.3. Design configurations represented in the Madang style (cont.).

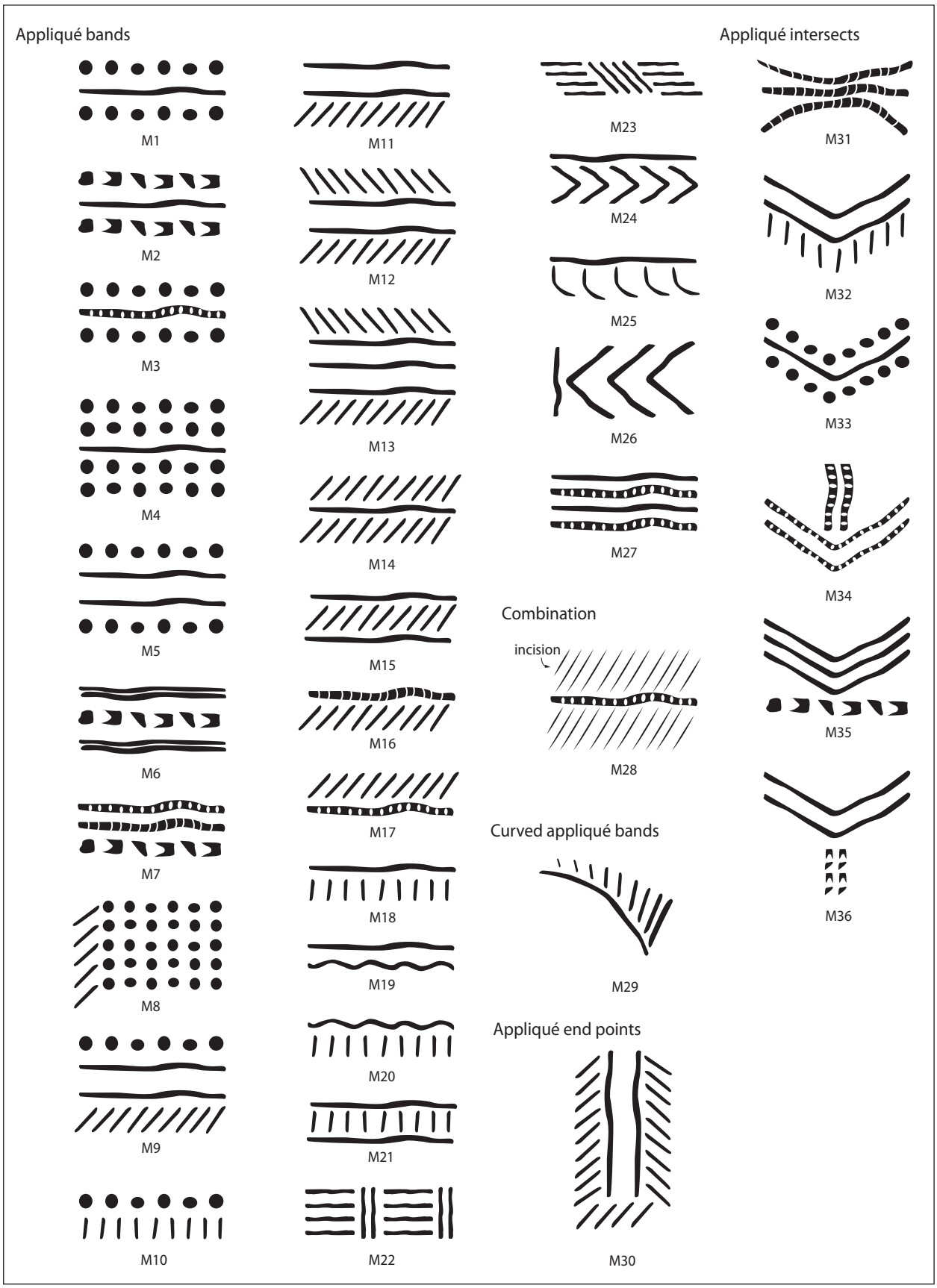


Figure 9.4. Appliqué design motifs represented in the Madang style.

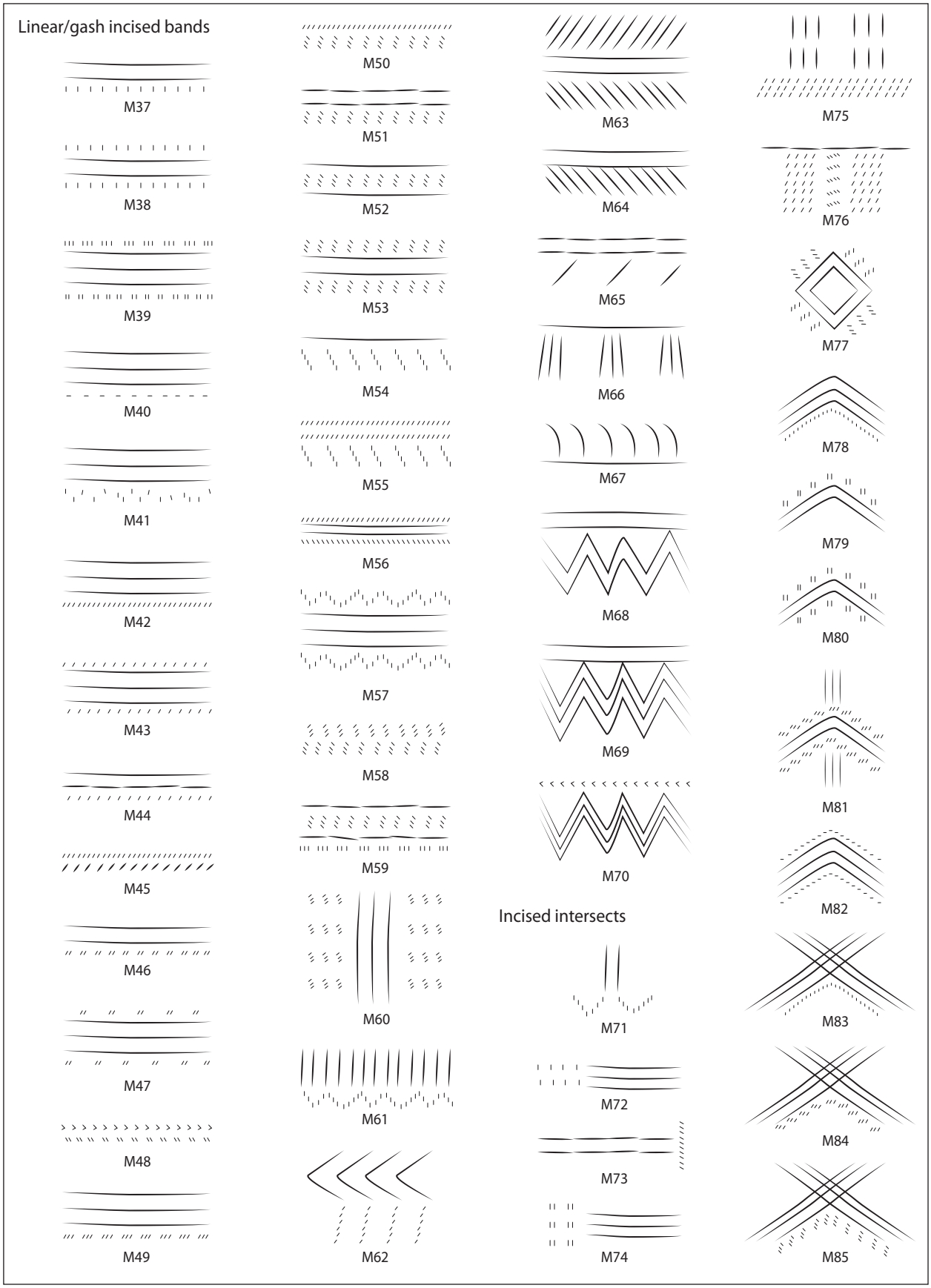


Figure 9.5. Linear-gash incised design motifs represented in the Madang style.

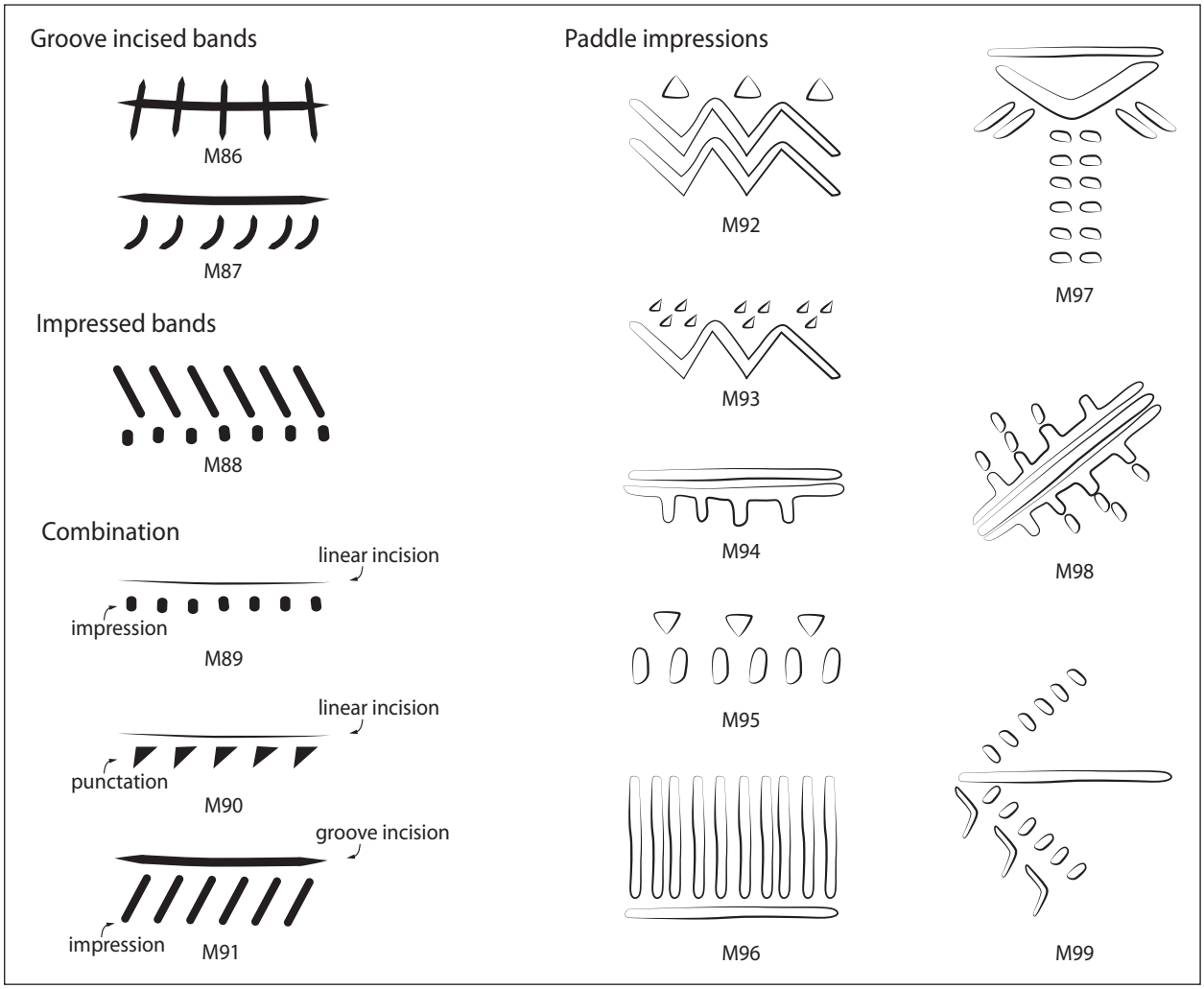


Figure 9.6. Groove incised, impressed and paddle impressed design motifs represented in the Madang style.

IV. *Slipping* is an important stage in a pot's production and initiation into the social world in Madang style ceramics (see Chapter 4). Slip was recorded as present or absent for both the interior and exterior surfaces of all formal and decorated sherds. The extent to which slip is applied to the interior surface in particular may be diagnostic of specific technical conventions.

Results: Nunguri

The following sections describe the results of the decorative analysis of body and rim sherds from Nunguri, Tilu, and surface survey around Madang. Nunguri ceramics were decorated using several different application methods (Table 9.1). In Layer 1 (Spits 1–15), appliqué (Fig. 9.8–

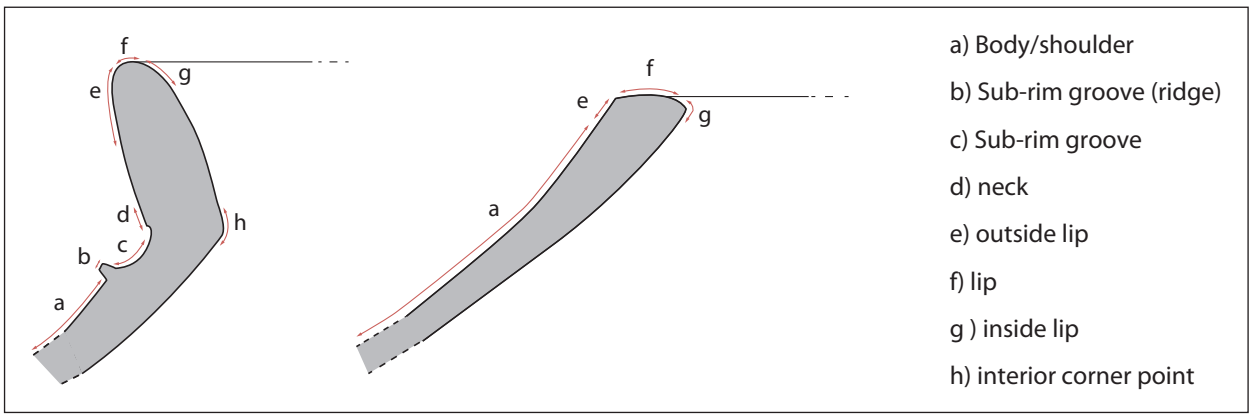


Figure 9.7. Locations of decoration on rim sherds.

Table 9.1. *Application methods represented at Nunguri, Test Pit 1 by excavation spit.**

	Excavation spit															
Application method	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Appliqué																
Nubble appliqué	8	67	54	27	18	30	28	26	28	38	63	49	76	87	44	643
Linear appliqué	29	175	192	132	58	112	63	45	47	32	62	42	61	97	38	1185
Appliqué variant	5	11	21	13	5	10	10	9	3	4	2	3	9	15	11	131
Incised linear app.	–	2	3	–	1	–	–	–	–	–	–	1	3	–	–	10
Impressed linear app.	–	15	17	10	4	6	3	4	–	–	–	2	–	1	2	64
Appliqué (?)	7	48	43	45	12	32	18	16	14	22	38	35	47	56	22	455
Subtotal	**49**	**318**	**330**	**227**	**98**	**190**	**122**	**100**	**92**	**96**	**165**	**132**	**196**	**256**	**117**	**2488**
Incision																
Linear incision	35	95	61	37	15	45	42	34	24	29	43	37	35	17	12	561
Gash incision	15	44	49	22	4	19	23	22	14	11	21	19	16	20	4	303
Groove incision	3	16	12	4	1	2	2	–	2	3	1	–	–	–	1	47
Subtotal	**53**	**155**	**122**	**63**	**20**	**66**	**67**	**56**	**40**	**43**	**65**	**56**	**51**	**37**	**17**	**911**
Impression																
Impression	13	92	74	55	21	35	21	16	21	14	11	11	15	20	26	445
Punctation	–	5	4	4	1	–	1	1	–	–	2	1	–	3	3	25
Subtotal	**13**	**97**	**78**	**59**	**22**	**35**	**22**	**17**	**21**	**14**	**13**	**12**	**15**	**23**	**29**	**470**
Paddle impression																
Paddle impression	12	18	9	14	2	6	1	4	–	3	3	1	–	3	9	85
Total	**127**	**588**	**539**	**363**	**142**	**297**	**212**	**117**	**153**	**156**	**246**	**201**	**262**	**319**	**172**	**3954**

* Note, the counts in this table refer to all observable cases of the application method, on both body and formal sherds. Thus, some sherds may preserve evidence of >1 application method.

9.10), incision (Fig. 9.11–9.14), impression, and paddle impression (Fig. 9.15) were used to decorate the exterior body or shoulder, while punctation and impression in particular were used to decorate other locations. No decorated sherds were recovered from Layer 2 (Spits 16–17).

Within each application method, several sub-methods are clearly distinguishable. For instance, appliqué was usually applied as a line or nubbin, but was also applied and subsequently impressed, inscribed, or scraped (appliqué variant). Incision was usually inscribed in long freehand lines or small gashes, and rarely as thicker grooves. Impression was particularly prominent on the interior corner point, while punctation was less common and usually limited to the lip. A substantial number of plain sherds was recovered from Nunguri (n = 32,835), but only eight rims were complete enough (including lip, rim, and body/shoulder portions) to be assigned as 'plain' with any certainty.

The proportion of each application method changes significantly over time relative to excavation spit (Pearson Chi-Squared test, $X^2 = 405.606$, df = 42, P<0.01). Figure 9.16 shows the general trend of this change, with appliqué becoming less common over time and incision, paddle impression, and impression becoming more common. Cross tabulation of the chi-squared results show that appliqué is substantially less common than statistically expected in spit 2 (adj. residual = –6.3), spit 3 (adj. residual = –11.1), and spit 8 (adj. residual = –2.6), but more common than expected in spits 5 (adj. residual = 2.3), 11 (adj. residual = 7.1), 13 (adj. residual = 3.9), 14 (adj. residual = 7.2), and 15 (adj. residual = 3.7). Conversely, incision is more common than expected in spits 1 (adj. residual = 4.9), 2 (adj. residual = 8.4), 7 (adj. residual = 2.9), and 8 (adj. residual = 2.4), and less than expected in spits 4 (adj. residual = –2.3), 5 (adj. residual = –2.6), 11 (adj. residual = –6.4), 14 (adj. residual = –5.2), and 15 (adj. residual = –3.6). Paddle impression and impression also both became more common over time. Cases of paddle impression are substantially more than expected in spits 1 (adj. residual = 5.8), 2 (adj. residual = 3.3), 4 (adj. residual = 2.4), and 15 (adj. residual = 2.8), and less than expected in spits 9 (adj. residual = -2), 13 (adj. residual = –2.7). Impression is substantially more common than expected in spits 2 (adj. residual = 4.8), 3 (adj. residual = 4.1), and 6 (adj. residual = 3.7), and less than expected in spits 10 (adj. residual = –2.4), 11 (adj. residual = –2.3), 12 (adj. residual = -2.5), 13 (adj. residual = –3.1), 14 (adj. residual = –3.8), and 15 (adj. residual = –2.8).

The relative proportion of sub-methods also changes through the excavation spits, indicating that the technique of decorating with each method changed. The sub-method of appliqué is significantly associated with excavation spit ($X^2 = 240.175$, df = 70, P<0.01). Importantly, impressed appliqué and linear appliqué both become more common over time, while nubble appliqué becomes less common. The sub-methods of incision ($X^2 = 46.454$, df = 28, P = 0.016), and impression ($X^2 = 40.133$, df = 14, P = <001), are also statistically significantly related to individual excavation spit, but there are no clear linear trends over time.

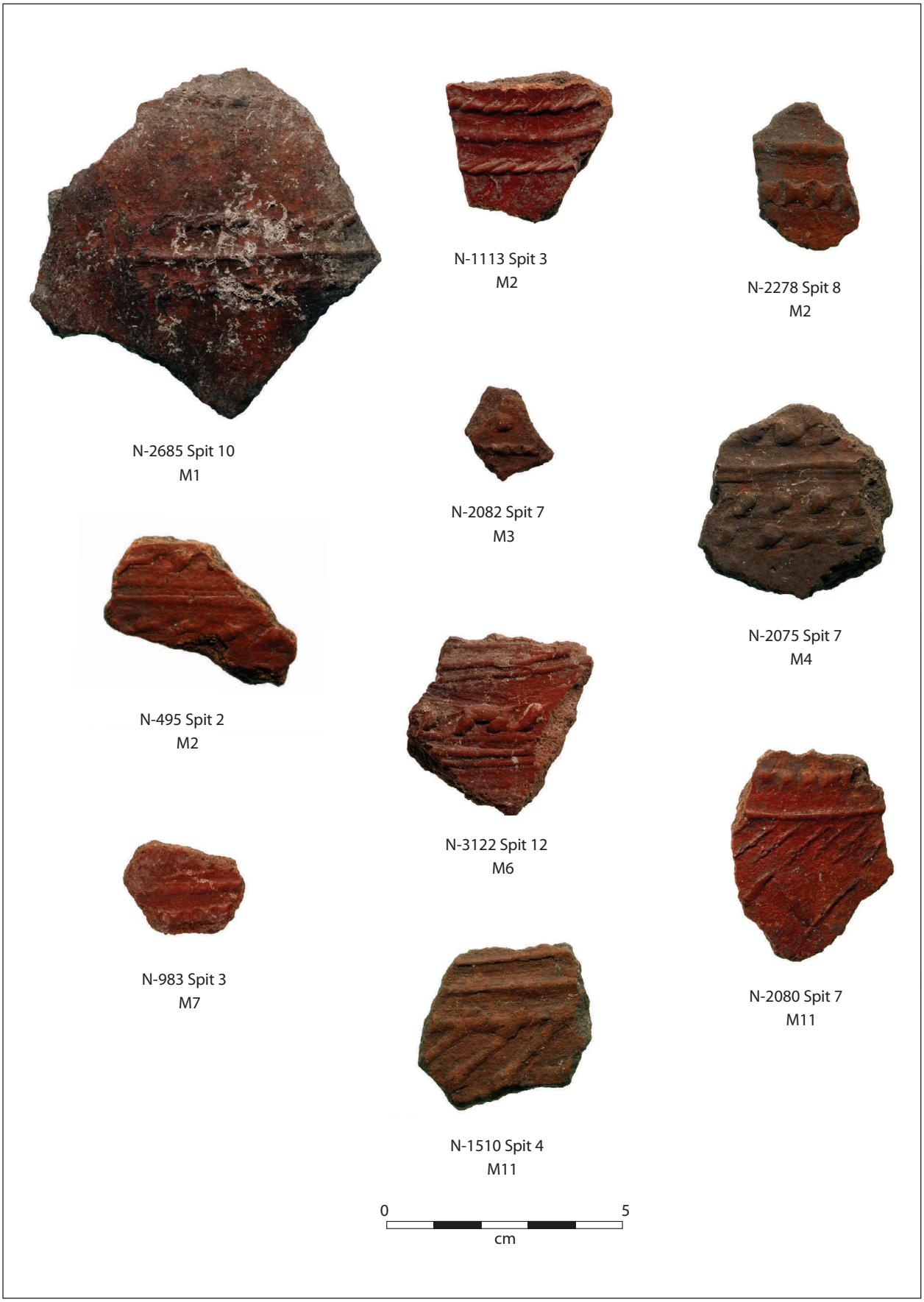


Figure 9.8. Examples of appliqué decoration on Madang style body sherds at Nunguri.



Figure 9.9. Examples of appliqué decoration on Madang style body sherds at Nunguri (cont.).

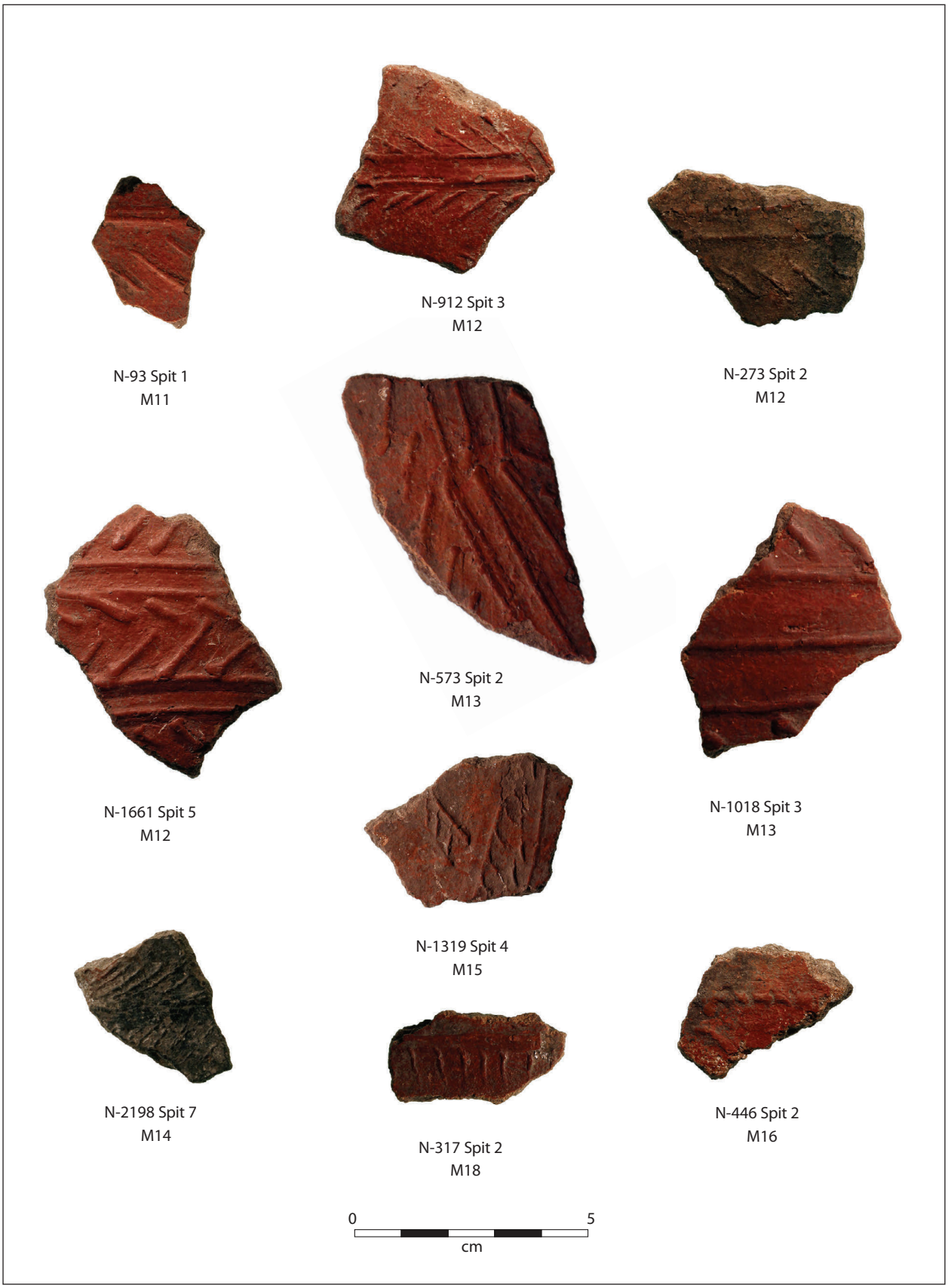


Figure 9.10. Examples of appliqué decoration on Madang style body sherds at Nunguri (cont.).

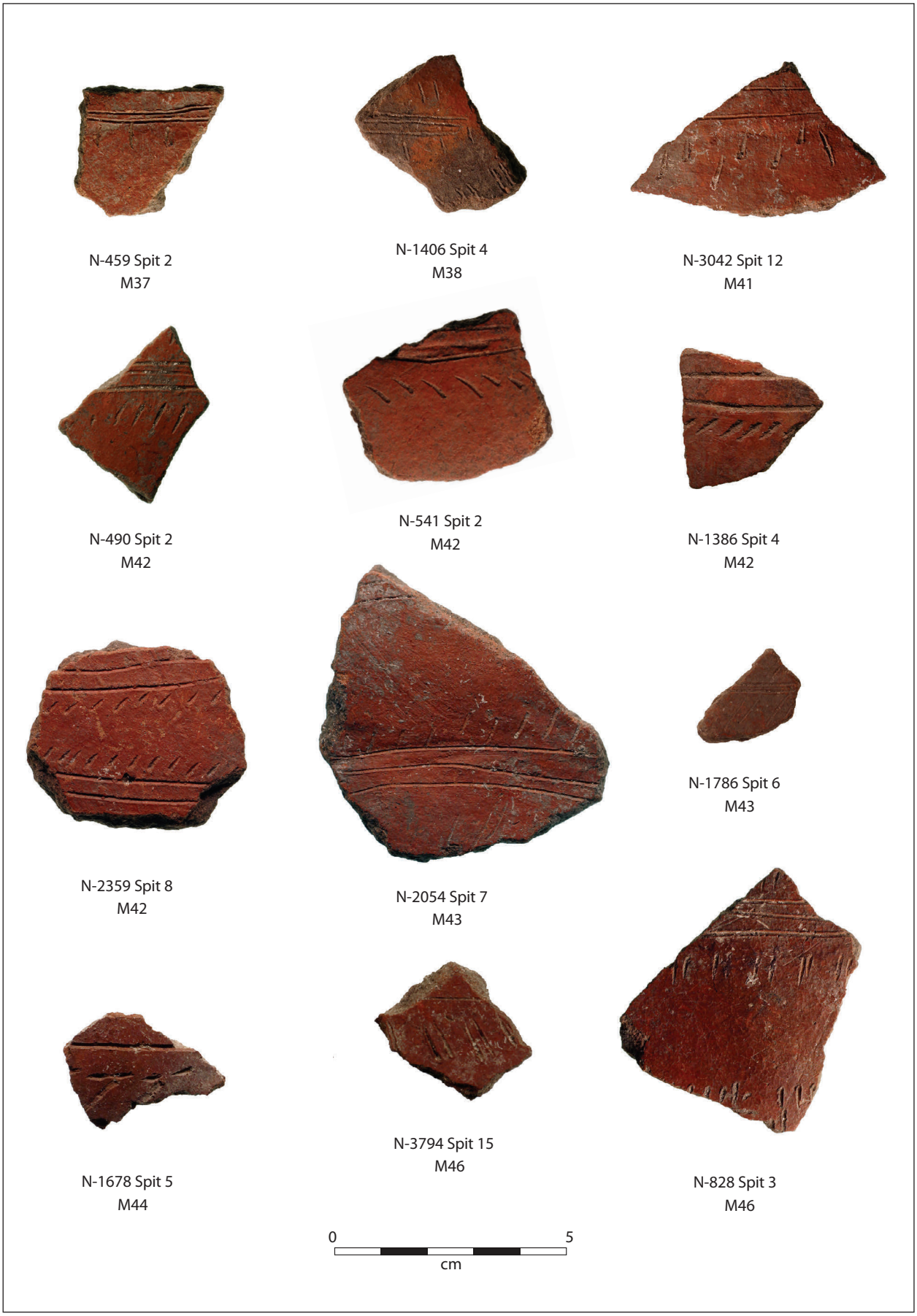


Figure 9.11. Examples of incised decoration on Madang style body sherds at Nunguri.

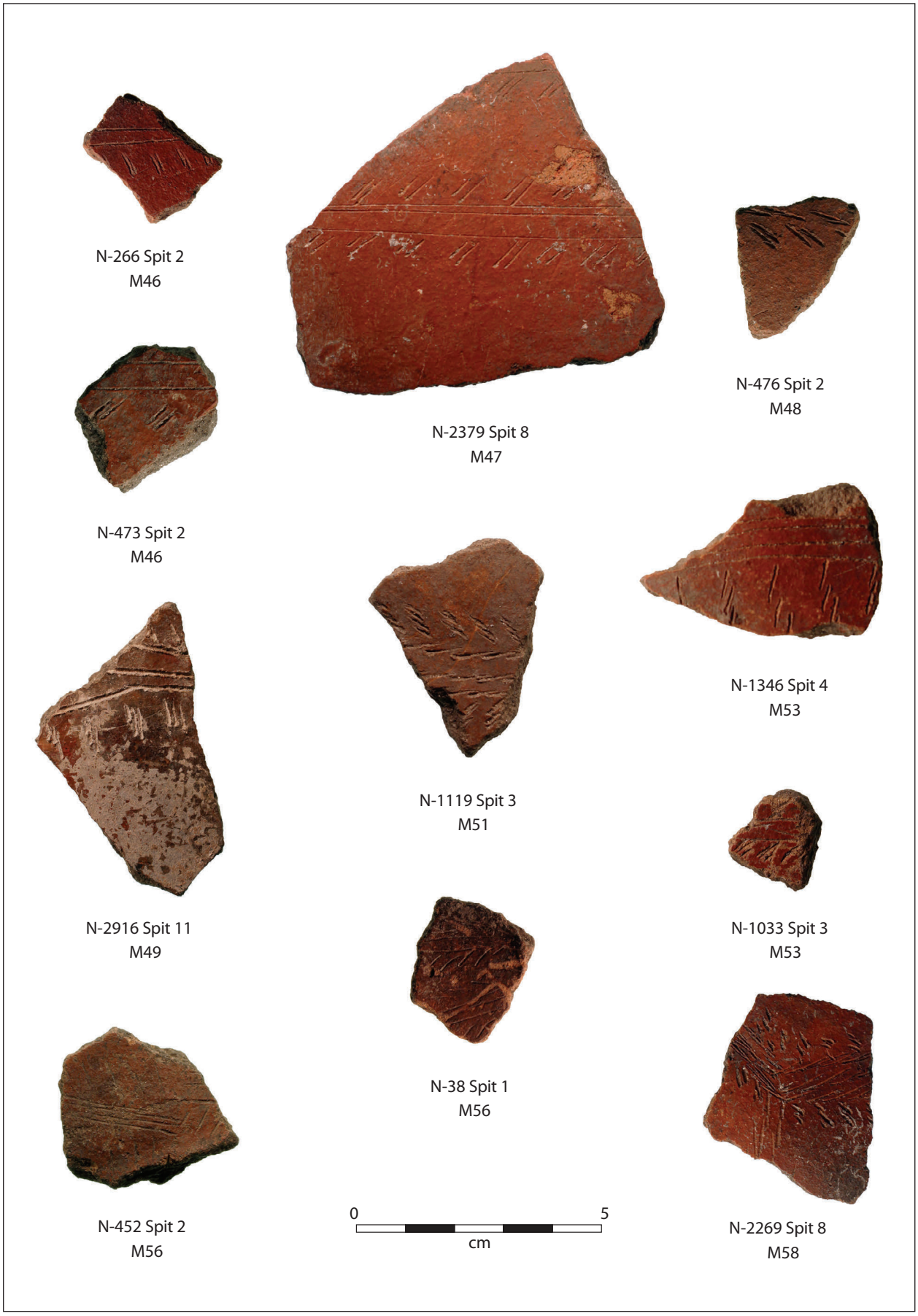


Figure 9.12. Examples of incised decoration on Madang style body sherds at Nunguri (cont.).

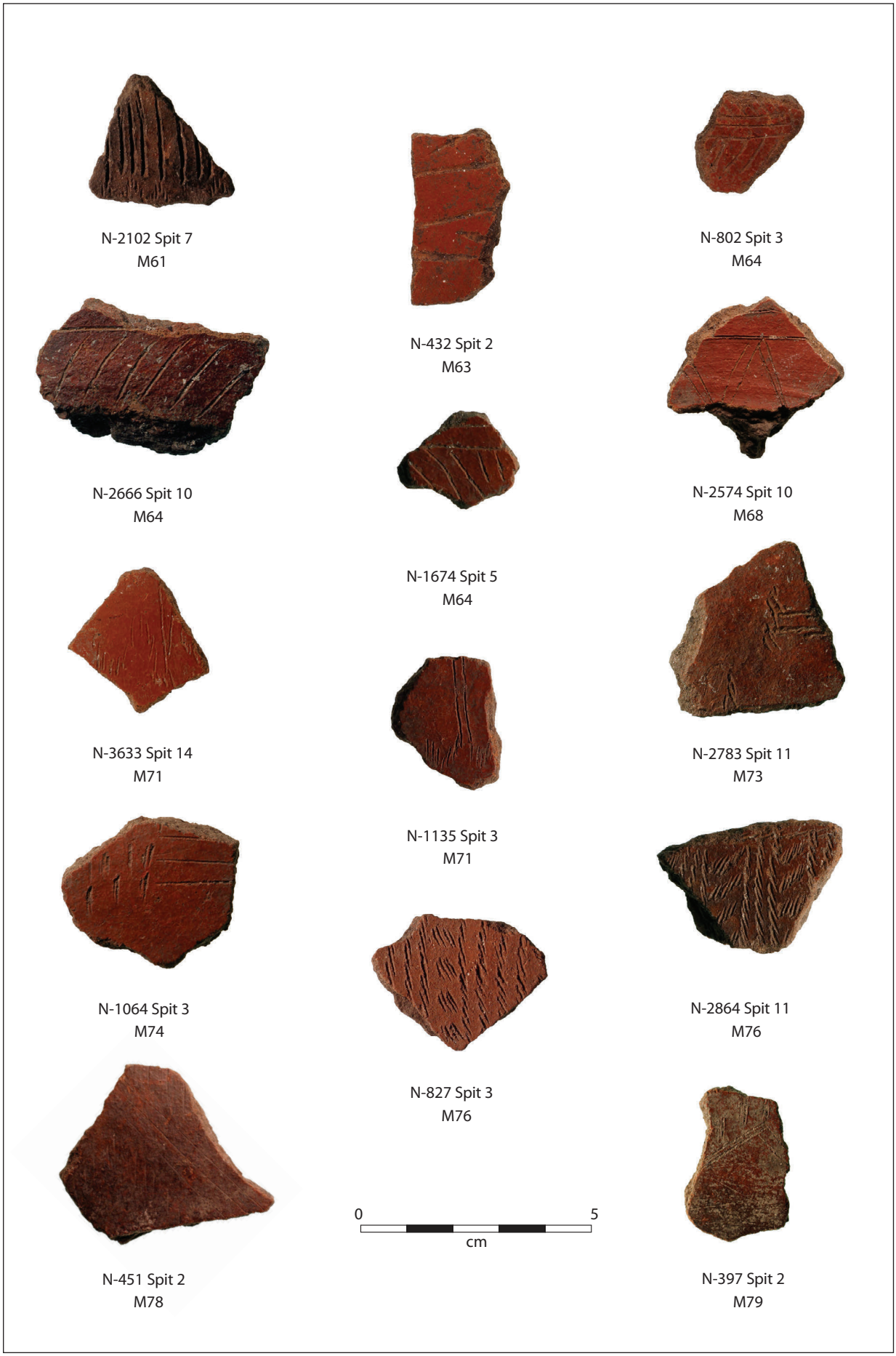


Figure 9.13. Examples of incised decoration on Madang style body sherds at Nunguri (cont.).

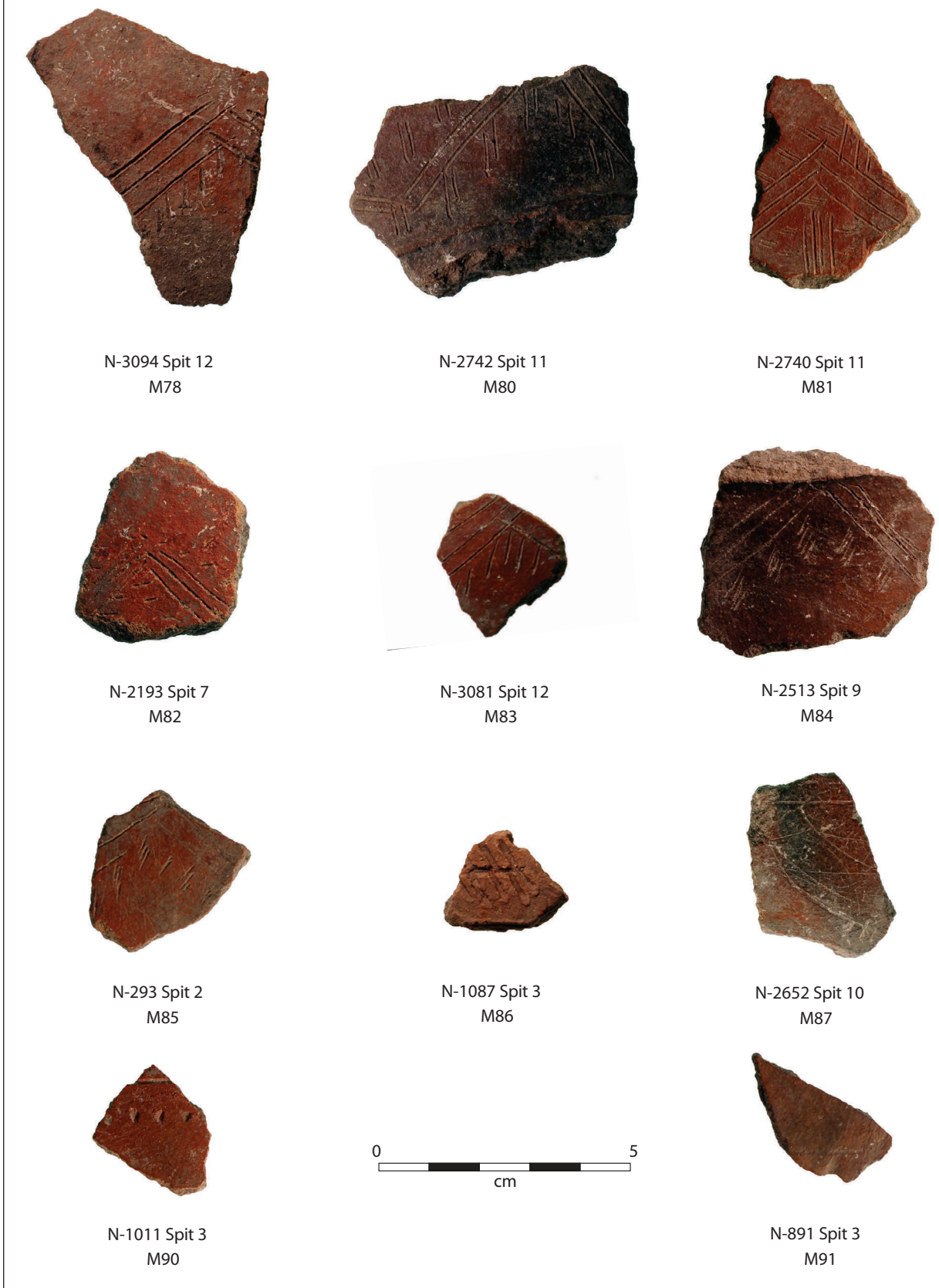


Figure 9.14. Examples of incised decoration on Madang style body sherds at Nunguri (cont.).

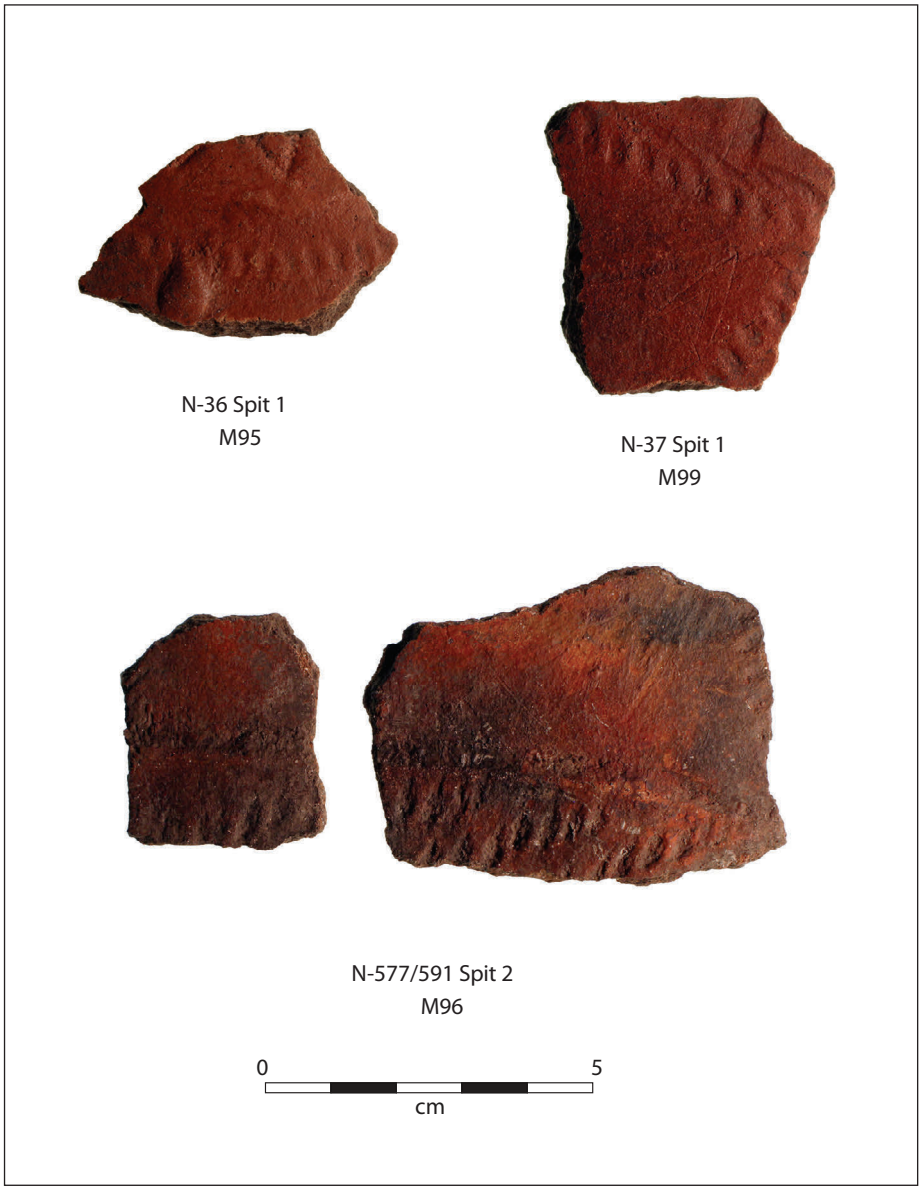


Figure 9.15. Examples of paddle impression on Madang style body sherds at Nunguri.

Nunguri decorated sherds differ significantly by body thickness relative to application method (Table 9.2–9.4). However, the effect size (η^2) of 1.3% suggests that decoration method does not account for much of the variation in body thickness. A post hoc Kruskal-Wallis test (Table 9.3) shows that there are statistically significant differences between almost all of the decorative methods: between the thicknesses of appliqué and incised sherds ($X^2 = 4.430$, $df = 1$, $P = 0.04$), appliqué and impressed sherds ($X^2 = 26.857$, $df = 1$, $P<0.01$), incised and impressed sherds ($X^2 = 34.874$, $df = 1$, $P = 0.01$), incised and paddle impressed sherds ($X^2 = 3.881$, $df = 1$, $P = 0.49$), and between impressed and paddle impressed sherds ($X^2 = 6.485$, $df = 1$, $P<0.01$). The difference between appliqué and paddle impressed sherds is not statistically significant ($X^2 = 1.208$, $df = 1$, $P = 0.27$).

A wide range of decorative configurations is apparent on Madang style sherds from Nunguri (Table 9.5–9.7). Nub-

Table 9.2. *Average body thickness (mm) by application method at Nunguri.*

	Appliqué	Incision	Impression	Paddle impression
Mean	4.82	4.90	4.19	4.61
SD	1.65	1.56	1.40	1.71
CV	34%	32%	34%	37%

Table 9.3. *Kruskal-Wallis test of body thickness (mm) by application method at Nunguri.*

	Appliqué	Incision	Impression	Paddle impression
No. of cases	1992	621	153	73
Mean rank	1424.62	1504.33	1066.68	1316.99

$X^2 = 36.217$, $df = 3$, $\eta^2 = 1.3\%$, $P<0.01$

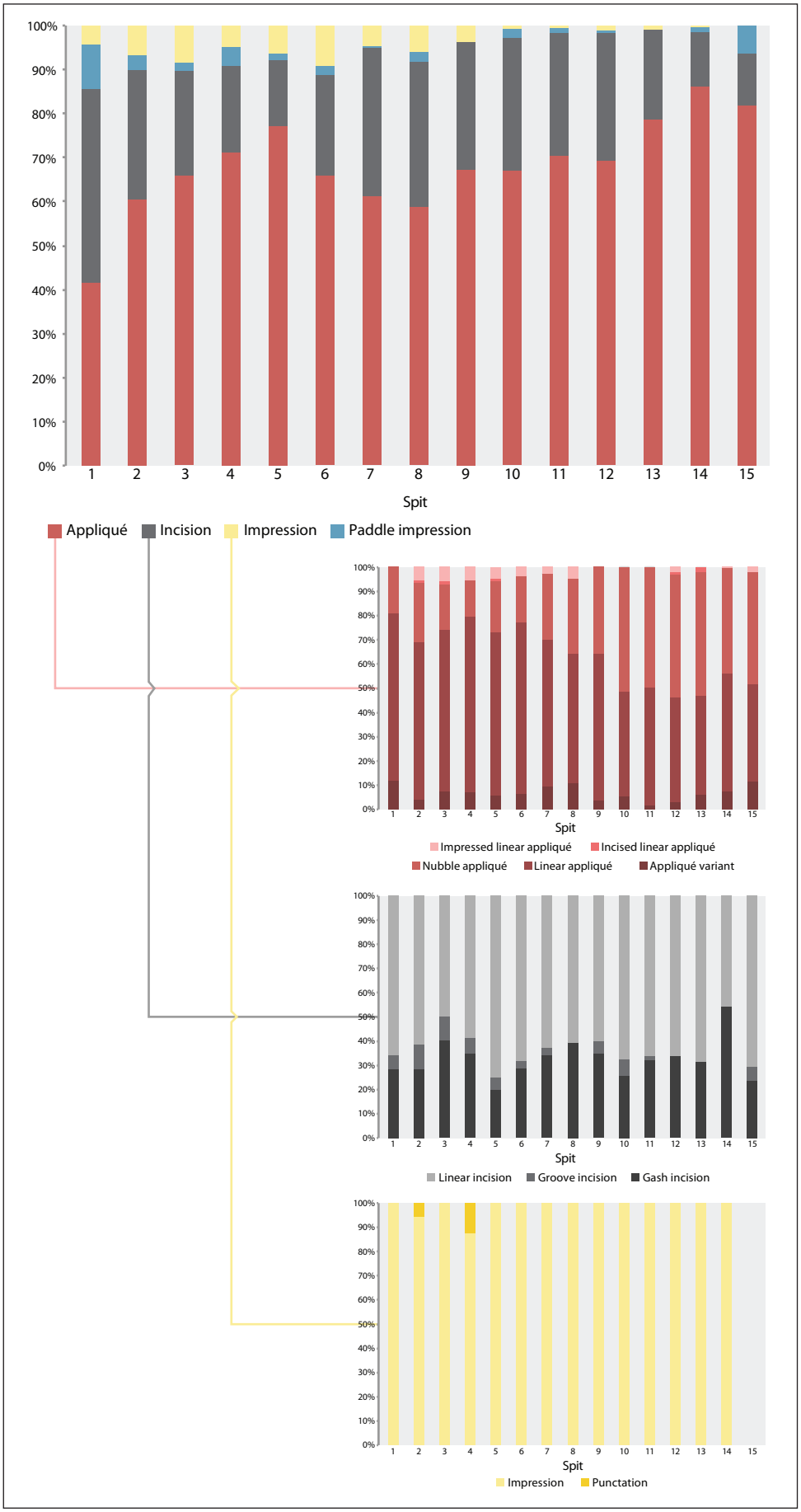


Figure 9.16. Percentage of application methods represented on the external body/shoulder of sherds at Nunguri, Test Pit 1 by excavation spit.

Table 9.4. *Mood's test of body thickness (mm) by application method at Nunguri.*

	Appliqué	Incision	Impression	Paddle impression
Number of cases	1992	621	153	73
Thickness>median	1006	338	43	32
Thickness≤median	986	283	110	41

Median = 4.45, $X^2 = 35.521$, df = 3, $P < 0.01$

ble appliqué was usually applied as single (NA1) or double (NA2) bands, while linear appliqué was usually applied as straight lines (LA1) or diagonal dashes (LA4). Single straight lines of scraped (AV1) and impressed (ImLA1) appliqué were also commonly applied. Linear incision was usually inscribed as freehand lines (LI1), along with a wider variety of small gash arrangements. Paddle impressions usually consist of multiple lines (PI1) or chevrons (PI3). Simple impressions (Im1 and Im3) were sometimes made onto the body/shoulder of the pot but were used frequently to decorate the interior corner point. Punctation (Pu3) was sometimes used to decorate the lip and, rarely, the body/shoulder.

Decoration is almost exclusively limited to the body/shoulder. Lip decoration is only present on 3% of all vessels at Nunguri. Punctation was mainly used to punch holes around the top of the lip, but shallower impressions, and rare gash incisions were also made (Table 9.7). There appears to be a general trend over time towards leaving the lip undecorated as Spit 14 and Spit 15 contain substantially more cases of lip decoration than do Spits 1–13 (Figure 9.17). The outside of the lip was also, very occasionally, decorated with incision, impression/punctation, and appliqué. These decorations are rare and there is no clear trend over time related to this decorative zone. The inside lip was only occasionally decorated on incurving vessels and never on everted/inverted vessels.

Impressions made around the interior corner point of Nunguri pots are common (Table 9.7). These impressions vary slightly in shape and size, reflective of the tool being

Table 9.5. *Appliqué configurations represented at Nunguri, Test Pit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub-rim groove	Sub-rim groove ridge	Interior corner point
NA1	303	–	–	–	–	–	–
NA2	96	–	–	–	–	–	–
NA3	1	–	–	–	–	–	–
NA4	–	–	–	–	–	–	–
NA5	–	–	–	–	–	–	–
NA6	3	–	–	–	–	–	–
LA1	441	–	–	–	–	–	–
LA2	3	–	–	–	–	–	–
LA3	12	–	–	–	–	–	–
LA4	252	–	1	–	–	–	–
LA5	25	–	–	–	–	–	–
LA6	9	–	–	–	–	–	–
LA7	16	–	–	–	–	–	–
LA8	2	–	–	–	–	–	–
LA9	17	–	1	–	–	–	–
LA10	7	–	–	–	–	–	–
LA11	1	–	–	–	–	–	–
LA12	1	–	–	–	–	–	–
LA13	2	–	–	–	–	–	–
LA14	2	–	–	–	–	–	–
AV1	118	–	–	–	–	–	–
AV2	8	–	–	–	–	–	–
InLA1	8	–	–	–	–	–	–
InLA2	1	–	–	–	–	–	–
ImLA1	62	–	–	–	–	–	–
ImLA2	2	–	–	–	–	–	–
ImLA3	1	–	–	–	–	–	–

Table 9.6. *Incised configurations represented at Nunguri, Test Pit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub-rim groove	Sub-rim groove ridge	Interior corner point
LI1	318	–	–	–	–	–	–
LI2	21	–	1	–	1	–	–
LI3	6	–	–	–	–	–	–
LI4	1	–	–	–	–	–	–
LI5	–	–	–	–	–	–	–
LI6	–	–	–	–	1	–	–
LI7	3	–	–	–	–	–	–
LI8	14	–	–	–	–	–	–
LI9	3	–	–	–	–	–	–
LI10	2	–	–	–	–	–	–
LI11	–	–	–	–	1	–	–
LI12	7	–	–	–	–	–	–
LI13	2	–	–	–	–	–	–
LI14	2	–	–	–	–	–	–
LI15	9	–	–	–	–	–	–
LI16	17	–	–	–	–	–	–
LI17	1	–	–	–	–	–	–
GI1	16	–	–	–	–	–	–
GI2	27	–	–	–	–	–	–
GI3	92	2	2	–	1	–	–
GI4	8	–	–	–	–	–	–
GI5	3	–	–	–	–	–	–
GI6	15	–	–	–	–	–	–
GI7	23	–	–	–	–	–	–
GI8	10	–	–	–	–	–	–
GI9	57	–	–	–	–	–	–
GI10	4	–	–	–	–	–	–
GI11	1	–	–	–	–	–	–
GI12	15	–	–	–	–	–	–
GI13	1	–	–	–	–	–	–
GI14	5	–	–	–	–	–	–
GI15	14	–	–	–	–	–	–
GI16	1	–	–	–	–	–	–
GI17	1	–	–	–	–	–	–
GI18	1	–	–	–	–	–	–
GI19	3	–	–	–	–	–	–
GI20	2	–	–	–	–	–	–
GI21	–	–	–	–	–	–	–
GI22	2	–	–	–	–	–	–
GI23	2	–	–	–	–	–	–
GI24	1	–	–	–	–	–	–
GI25	1	–	–	–	–	–	–
GI26	–	–	–	–	–	–	–
GrI1	36	–	–	–	–	–	–
GrI2	2	–	–	–	–	–	–
GrI3	2	–	–	–	–	–	–
GrI4	1	–	–	–	–	–	–

Table 9.7. *Impressed and paddle impressed configurations represented at Nunguri, Test Pit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub-rim groove	Sub-rim groove ridge	Interior corner point
Im1	59	4	1	4	–	–	272
Im2	2	–	–	–	–	–	–
Im3	30	–	–	–	–	–	–
Im4	1	–	–	–	–	–	–
Pu1	–	1	1	–	–	–	–
Pu2	3	–	–	–	–	–	–
Pu3	1	19	1	–	–	–	–
PI1	5	–	–	–	–	–	–
PI2	17	–	–	–	–	–	–
PI3	10	–	–	–	–	–	–
PI4	3	–	–	–	–	–	–
PI5	3	–	–	–	–	–	–
PI6	–	–	–	–	–	–	–
PI7	3	–	–	–	–	–	–
PI8	2	–	–	–	–	–	–
PI9	–	–	–	–	–	–	–
PI10	1	–	–	–	–	–	–

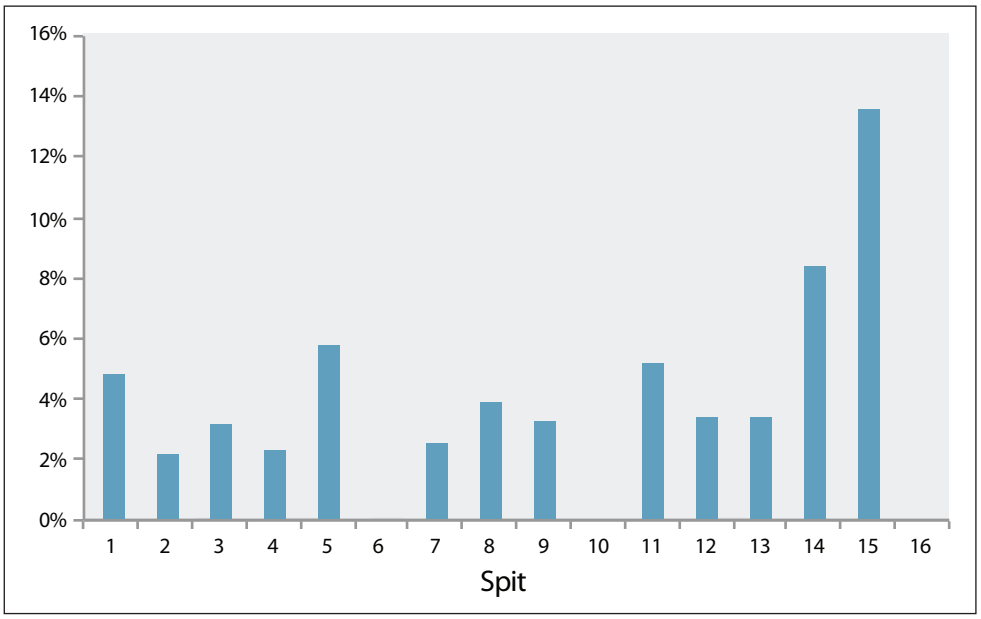


Figure 9.17. Percentage of Nunguri rims with decorated lips by excavation spit.

used and the gestures of the potter, but they are all classified here as Im1, a shallow impression, probably produced using the side of a wooden tool. As described by Egloff (1975), 'inner rim notching' refers to impressions made around the circumference of the interior corner point of everted/inverted rims or on the inner lip of incurving and direct rims. Inner rim notching (combining Im1 on interior corner point of Class 1, 2, 3, and 5 rims, and Im1 on the inner lips of Class 4 rims) was present on just under half of all Nunguri rims (47%, n = 276). There is a significant association between inner rim notching and excavation spit ($X^2 = 46.595$, df = 15, $P<0.01$) and it is possible that inner rim notching became less common over time. However, although Figure 9.18 illustrates a generally negative trend over time, the high variance between each spit means this interpretation is tentative.

Numerous motifs are present in the Nunguri assemblage (Table 9.8). Appliqué motifs account for 57% of the total observed cases, while incision accounts for 41%, and impressed and paddle impressed motifs account for less than 1% each. Combinations of two or more application methods to form motifs are extremely rare and also represent less than 1% of the observed cases. Notably, M11 appliqué motif, with double linear band flanked by short linear diagonals, is the most common motif represented at the site. This is particularly the case in Spits 1–9. In Spits 10–15, M1 appliqué motif, with a single linear band flanked by nub-

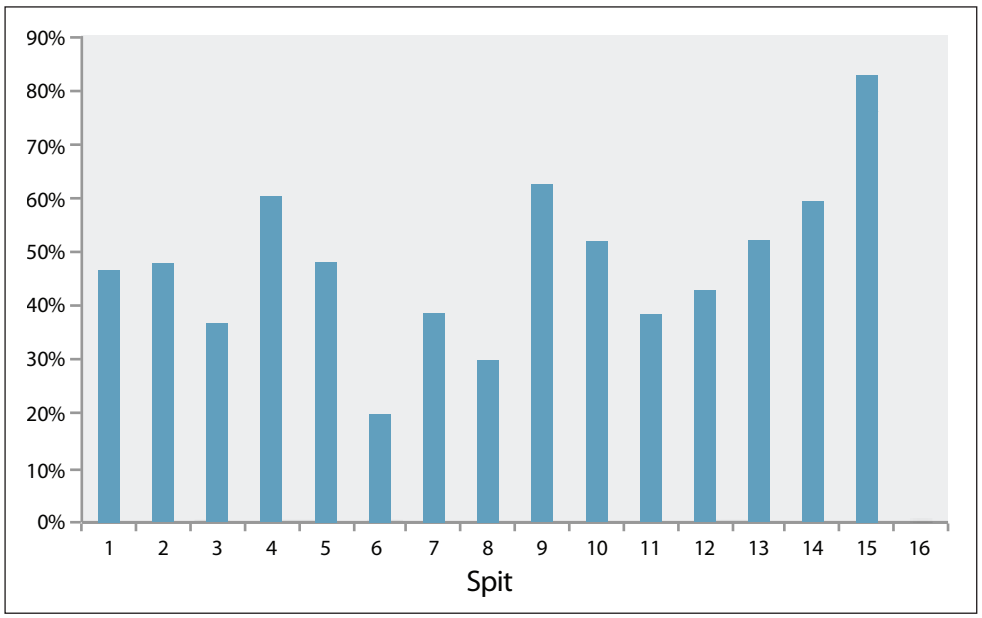


Figure 9.18. Percentage of Nunguri rims with inner rim notching by excavation spit.

Table 9.8. *Motifs represented at Nunguri, Test Pit 1 by excavation spit.*

	Excavation spit															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Appliqué																
M1	3	8	5	3	6	1	1	2	4	3	4	6	7	15	3	**71**
M2	–	–	2	–	1	1	1	2	2	–	–	–	2	3	–	**14**
M3	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M4	–	1	–	–	–	–	1	–	–	1	–	–	–	2	–	**5**
M5	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M6	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	**3**
M7	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M8	–	–	–	1	–	–	–	–	–	–	1	–	–	1	–	**3**
M9	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**1**
M10	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**10**
M11	2	11	24	20	5	21	5	5	8	–	4	3	3	7	6	**124**
M12	–	1	2	–	3	–	1	–	–	–	–	–	–	–	–	**7**
M13	1	2	2	1	–	–	–	–	–	–	–	–	–	–	–	**6**
M14	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M15	–	1	–	1	–	–	1	–	–	–	–	–	–	–	–	**3**
M16	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	**2**
M17	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**
M18	–	2	1	2	–	3	–	–	–	–	–	–	–	–	–	**8**
M21	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M22	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M24	–	1	1	–	–	–	1	–	–	–	–	–	–	–	1	**4**
M25	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M27	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	**4**
M28	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M29	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M30	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**
M31	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	**1**
M32	–	–	–	1	2	–	–	–	–	–	1	–	–	–	1	**5**
M34	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M35	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**1**
M36	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	**1**
Subtotal	**6**	**35**	**42**	**31**	**18**	**28**	**14**	**9**	**14**	**4**	**10**	**12**	**13**	**29**	**11**	**285**

Table 9.8 (*continued). Motifs represented at Nunguri, Test Pit 1 by excavation spit.*

	Excavation spit															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Incision																
M37	–	1	2	–	–	–	–	–	–	1	–	–	–	–	–	**4**
M38	–	1	–	1	–	–	–	–	1	–	–	–	–	–	–	**3**
M41	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	**2**
M42	3	8	7	4	–	3	6	8	1	1	2	5	3	–	1	**52**
M43	–	–	–	–	–	2	4	–	–	–	1	–	4	–	–	**11**
M44	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**1**
M45	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**1**
M46	–	4	5	2	–	5	2	3	2	3	–	1	2	2	1	**32**
M47	–	–	–	2	–	–	–	1	–	–	1	–	–	1	–	**5**
M48	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M49	–	1	1	1	–	1	1	–	1	–	2	2	1	–	–	**11**
M51	–	–	2	–	–	–	–	–	–	1	–	1	–	–	–	**4**
M52	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M53	–	1	3	1	–	–	–	–	–	–	2	–	2	1	1	**11**
M54	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M55	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	**2**
M56	3	3	–	–	–	–	–	–	–	–	–	–	–	–	–	**6**
M57	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	**1**
M58	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	**1**
M59	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**
M60	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**1**
M61	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M63	–	2	1	1	–	–	–	3	–	1	1	–	–	–	–	**9**
M64	2	1	1	–	1	–	1	–	2	2	–	–	1	–	1	**12**
M65	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M66	–	–	–	–	–	1	1	–	–	–	–	–	–	1	–	**3**
M67	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M68	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	**2**
M69	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M71	–	–	1	–	–	–	–	–	–	1	–	1	–	1	–	**4**
M72	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M73	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	**1**
M74	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M76	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	**2**
M77	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M78	–	1	–	–	–	1	–	–	–	–	–	1	–	–	–	**3**
M79	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	**3**
M80	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	**2**
M81	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	**1**
M82	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
M83	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	**1**
M84	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**1**
M85	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M86	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M87	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	**1**
Subtotal	**9**	**29**	**27**	**13**	**2**	**14**	**19**	**18**	**9**	**13**	**14**	**14**	**13**	**9**	**4**	**207**

Table 9.8 (*continued*). *Motifs represented at Nunguri, Test Pit 1 by excavation spit.*

	Excavation spit															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Impression																
M88	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M89	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M90	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**1**
M91	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Subtotal	**1**	**–**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**–**	**4**
Paddle impression																
M95	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
M96	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
M97	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	**1**
M99	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Subtotal	**2**	**2**	**–**	**–**	**–**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**5**
Total	**18**	**66**	**71**	**44**	**20**	**43**	**33**	**27**	**23**	**17**	**24**	**26**	**26**	**39**	**15**	**501**

bins, is generally more common. This suggests that there was a gradual shift away from using linear and nubble appliqué combinations towards motifs exclusively using linear appliqué. Various incised motifs are also common at Nunguri, particularly M42 with linear bands flanked by continuous gash incised bands, and M46 with linear bands flanked by continuous double-gash incised bands. Interestingly, the structural procedures of applying long bands on a pot's external surface, which are then flanked by smaller configurations, is a common characteristic shared by the application methods.

Nunguri slip is usually dark reddish brown (2.5YR 3/6, 5YR 3/6) or reddish brown (2.5YR 4/6) but can also be very dark brown (7.5YR 2/3) and very dark reddish brown (5YR 2/3) owing to varying firing conditions. Slip is often associated with fine striations on the external surface, the largest of which resemble deliberate incisions. These are usually only visible under low-level magnification and more likely resultant from the tool used to apply the slip or contact with the bush material used in firing. Slip is present on the external surface of 98% (n = 2874) of decorated body sherds and 93% (n = 717) of rims. However, this slip is only present internally on 8% (n = 218) of decorated sherds and 75% (n = 573) of rims, suggesting that it was applied around the entire exterior surface but only around the inside of the rim and sometimes the inside the top of the body/shoulder. Those sherds without slip appear to be the result of post-depositional processes, but this remains to be demonstrated.

To delineate technical variation within the broader groupings based on form, mineralogy, and clay chemistry, these decorative attributes will now be cross-compared with technical class, techno-fabric/mineralogical group, and techno-compositional group. This procedure establishes techno-style groupings, which will allow the interplay between production groups and communities of practice to be addressed. Firstly, Figure 9.19 shows the association between decorative method and technical class. Appliqué

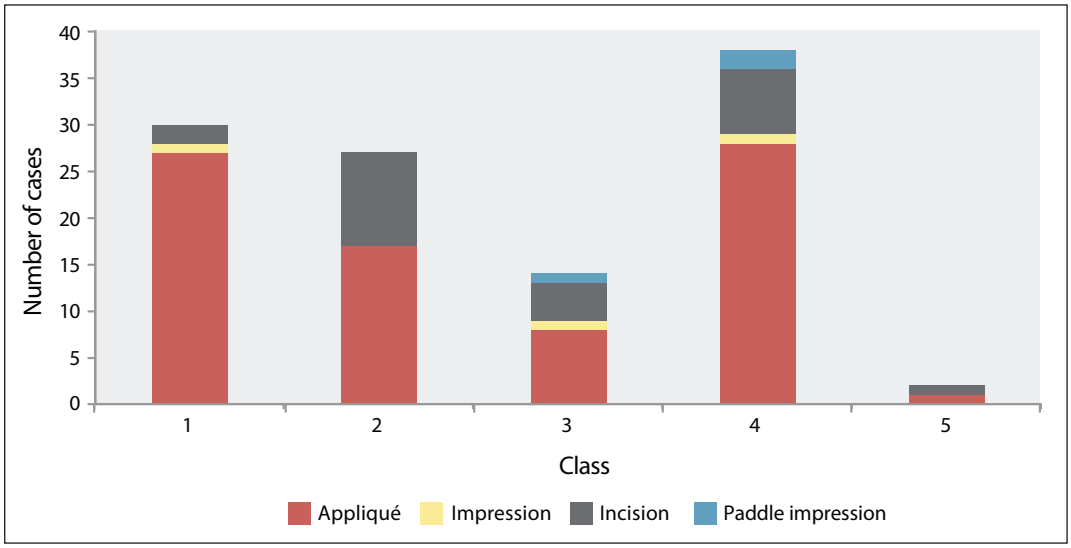


Figure 9.19. Cases of application method on body/shoulder by technical class at Nunguri.

and incision were used to decorate Classes 1–5, paddle impression was used to decorate both Class 3 and 4, and impression was used to decorate Classes 1, 3, and 4. Although the figure below suggests that there are differences between how the vessel classes were decorated, a Pearson's Chi Squared Test (with Monte-Carlo simulation owing to low cell counts) shows that there is no significant association between technical class and decorative method ($X^2 = 14.886$, df = 12, P = 0.23).

There is, however, a statistically significant association between the presence of lip decoration and technical class ($X^2 = 13.017$, df = 4, P = 0.01). Cross-tabulation shows that Class 2 vessels in particular are more likely than expected to display lip decorations (adj. residual = 3.5). Moreover, albeit tentatively, a significant association probably exists between technical class and the presence of slip ($X^2 = 21.199$, df = 8, P = 0.04), as Class 1 vessels display slip substantially less often than expected (adj. residual = –3.7) and Class 3 (adj. residual = 3) and Class 4 (adj. residual = 2.2) display slip substantially more often than expected (note that this could be because Class 3 and 4 rims are more recent and so less affected by observed wave action; see Chapter 6). Lastly, there is also a significant association between vessel class and inner rim notching ($X^2 = 154.419$, df = 4, P < 0.01), as Class 1 (adj. residual = 5.9) and Class 2 (adj. residual = 5.7) display the attribute substantially more than expected, and Class 5 (adj. residual = -2.4) and particularly Class 4 (adj. residual = -11.4) display the attribute less often.

There is no correlation between techno-fabric group and decoration method ($X^2 = 4.062$, df = 9, P = 0.79) (Fig. 9.20). Nor is there a significant association between fabric groups and lip decoration ($X^2 = 4.646$, df = 3, P = 0.20), fabric groups and red slip ($X^2 = 9.794$, df = 6, P = 0.13), or fabric and inner rim notching ($X^2 = 3.515$, df = 3, P = 0.33).

As only one clear clay chemical cluster was delineated among the Nunguri rims, it is not possible to compare and test different techno-compositional groupings against decorative elements. It is possible, however, to code the PCA outputs of the clay chemical data based on decoration, in an attempt to tease apart the single techno-compositional group. Despite this, Figures 9.21–9.23 show that decorative method, the presence of lip decoration, and the presence of inner rim notching do not clearly discriminate subgroupings based on clay chemical data.

To finalise the classification, numerous techno-style groups can be distinguished confidently within the Nunguri assemblage, shown in orange in Table 9.9, while many more, shown in blue, may have existed but were not identified owing to the small sample size of decorated rims within each class and fabric. The 31 techno-style groups are the result of slight variations in the *chaîne opératoire* during the procurement, forming and decorating phases. These results suggest there was a flexible approach to many minor forming and decorating techniques being produced by multiple production groups, thus forming multiple technical classes. Because the Madang assemblages contain large quantities of locally produced material which all fits within the same broad 'style group,' just how these techno-style groups fit into the production groups and community of practice is not straightforward. The implications of this classification will be further examined in the following chapter.

Results: Tilu

In the Tilu assemblage, a similar set of application methods were used to decorate Madang style ceramics. Throughout Layer 1 (Spits 1–10), appliqué (Fig. 9.24–9.25), incision (Fig. 9.26), and paddle impression (Fig. 9.27) are common on

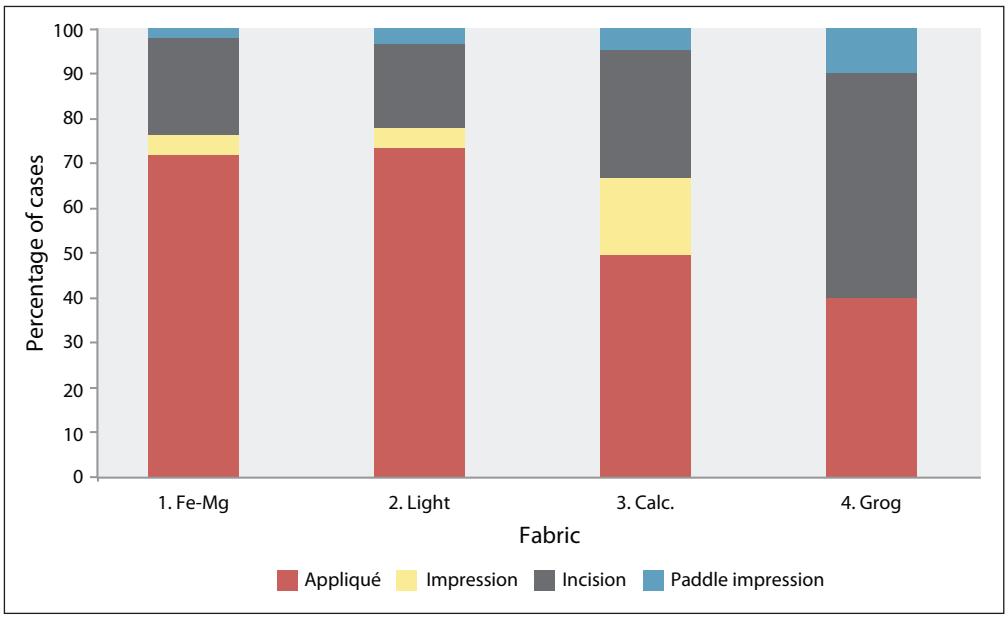


Figure 9.20. Cases of application method on body/shoulder by techno-fabric at Nunguri.

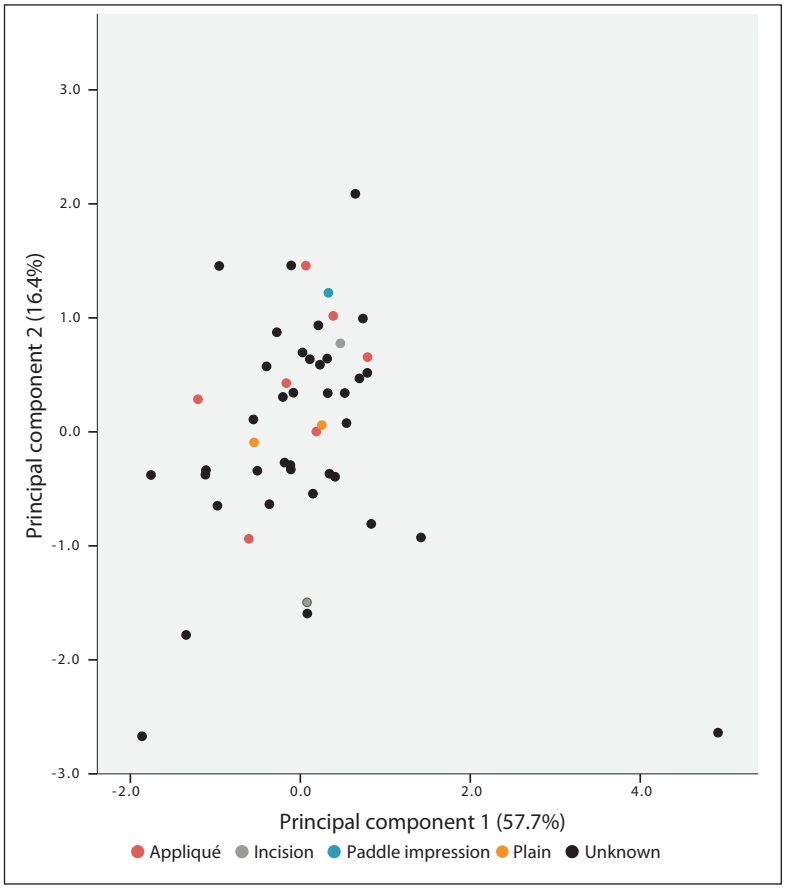


Figure 9.21. PCA showing clay chemical data of Nunguri sherds coded by body/shoulder application method.

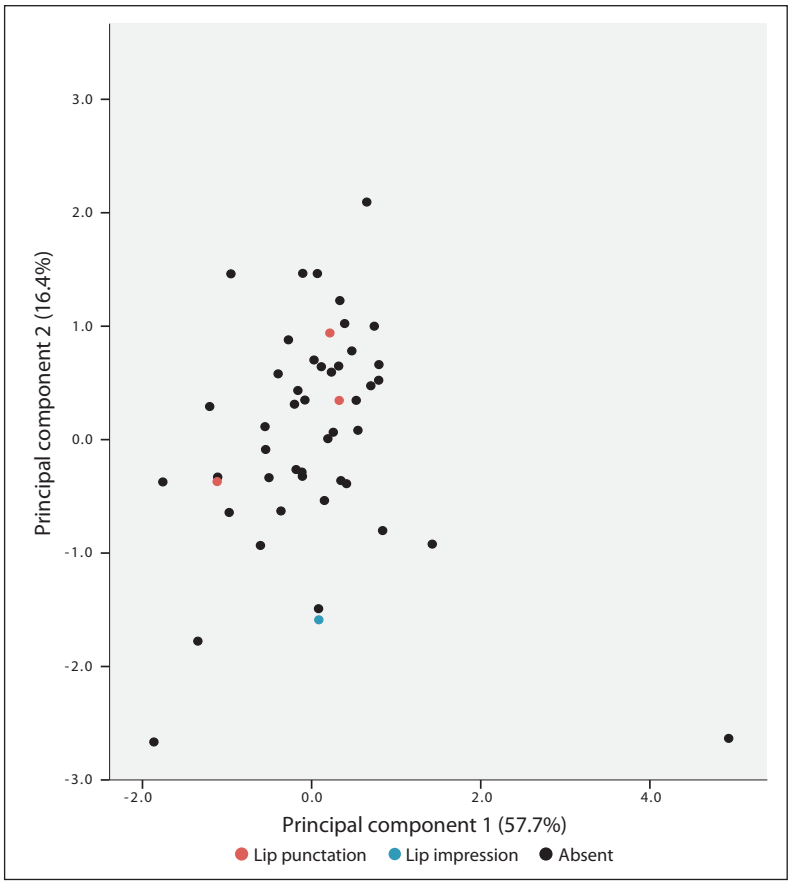


Figure 9.22. PCA showing clay chemical data of Nunguri sherds coded by lip decoration.

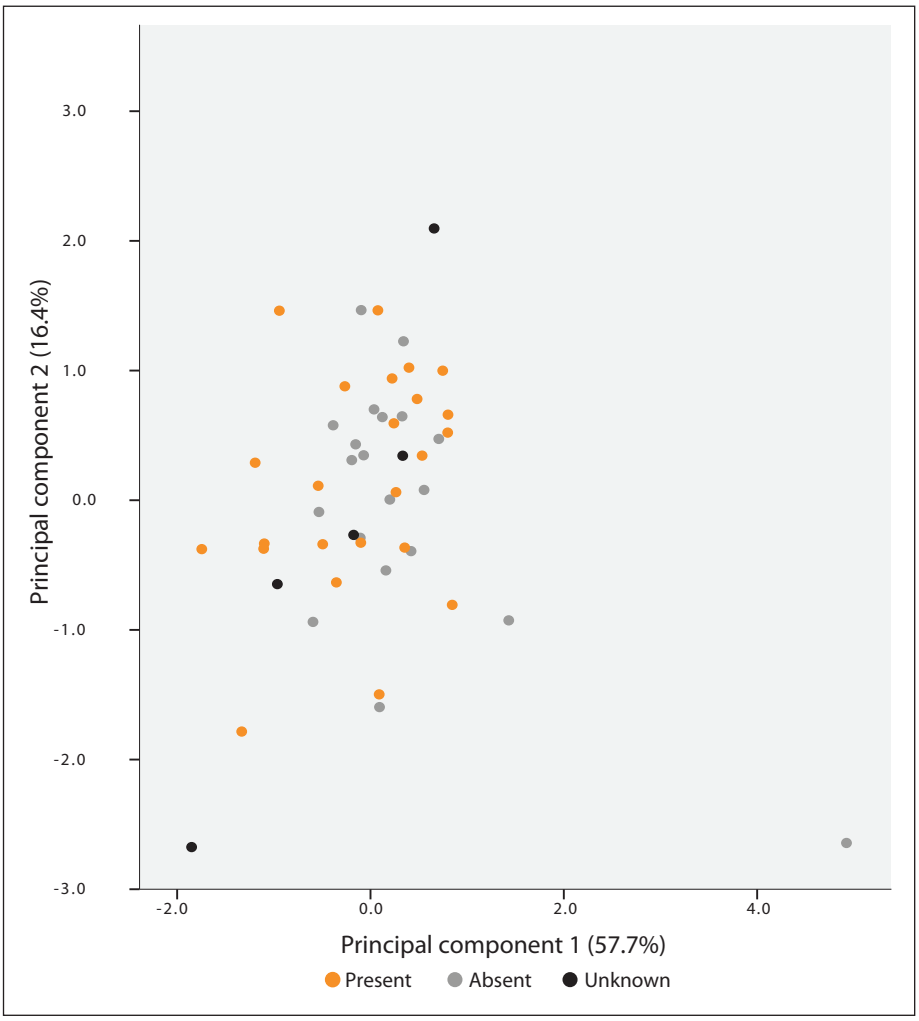


Figure 9.23. PCA showing clay chemical data of Nunguri sherds coded by inner rim notching.

Table 9.9. *Techno-style groups within the Madang style at Nunguri. Orange cells indicate observed correlations, blue cells were not observed.*

	Class				
	1	2	3	4	5
FeMg (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Light (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Calcareous (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Grog (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.

the body, with instances of impression/punctation only occurring on the lip, inner lip, or interior corner point. Sample sizes in Layer 2 (Spits 11–12) restrict interpretations as only five decorated body sherds were recovered, displaying six discrete cases of appliqué decoration (Table 9.10). Within each application method, several sub-methods are observable. Most commonly, appliqué was applied as a line or a nubbin (Fig. 9.28), but, less often, lines of appliqué were subsequently impressed, incised, or scraped. Incision was usually produced as lines or gashes and rarely as grooves. Impressions on the lip are usually punctations which punch deeply into the clay, while those impressions on the interior corner point and inner lip are often shallower impressions. Unlike Nunguri, no impressions were produced on the body/shoulder. Although numerous plain body sherds were recovered (n = 8896), only two rims were complete enough to be assigned as 'plain.'

The relative proportions of each application method change significantly through the excavation spits (Pearson Chi-squared test, $X^2 = 92.405$, df = 33, $P<0.01$). However, this is owed to large amounts of variation in Spit 7 (adj. residual = -5.1). Paddle impression is the reverse, being substantially more common than expected in Spit 7 (adj. residual = 5). Unlike at Nunguri, there is no convincing change in application method over time. Also unlike Nunguri, the relative proportion of sub-methods within each application method does not change significantly through the spits for appliqué ($X^2 = 72.927$, df = 55, $P = 0.106$), incision ($X^2 = 19.023$, df = 16, $P = 0.265$), or impression ($X^2 = 1.224$, df = 6, $P = 1$) (see Fig. 9.16). This suggests that the process of decorating with appliqué, incision, impression and paddle impression remained relatively consistent over time.

Body thickness of Tilu's decorated sherds differs significantly by application method (Table 9.11–9.13). A post hoc Kruskal-Wallis test (Table 9.12) shows there is no statistically significant difference between mean thickness of appliqué and incised sherds ($X^2 = 1.563$, df = 1, $P = 0.217$) but there is between appliqué and paddle impressed ($X^2 = 32.475$, df = 1, $P<0.01$), and incised and paddle impressed ($X^2 = 20.141$, df = 1, $P<0.01$). This may relate to the body being further thinned during the decorative paddling stage.

The decorative configurations, used in isolation or to form motifs, are limited with a smaller range expressed than in the Nunguri assemblage. There is, however, a substantially larger range of configurations represented in any one spit at Tilu than the limited configurations applied to modern *bodi*. In the past, nubble appliqué was applied as single (NA1) or double (NA2) lines, and linear appliqué as single straight bands (LA1), diagonal dashes (LA4), or waves (LA9) (Table 9.14). Several paddle decorations are visible but the most common are simple linear marks (PI2).

Table 9.10. *Decorative application methods represented at Tilu, Unit 1 by excavation spit.**

	Excavation spit												
Application method	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Appliqué													
Nubble appliqué	63	42	41	30	19	23	15	7	25	7	1	1	**247**
Linear appliqué	55	33	54	22	10	12	10	6	16	9	1	1	**41**
Appliqué variant	5	2	6	6	4	2	–	–	2	1	–	–	**28**
Incised linear app.	–	3	–	1	–	1	–	–	–	–	–	–	**5**
Impressed linear app.	–	–	–	–	–	–	1	–	–	–	–	–	**1**
Appliqué (?)	5	11	10	6	1	7	1	1	7	3	–	2	**54**
Subtotal	**128**	**91**	**111**	**65**	**34**	**45**	**27**	**14**	**50**	**20**	**2**	**4**	**376**
Incision													
Linear incision	11	6	2	8	2	4	4	1	3	–	–	–	**41**
Gash incision	5	5	4	1	2	4	3	1	–	–	–	–	**25**
Groove incision	–	–	2	1	–	–	–	–	–	–	–	–	**3**
Subtotal	**16**	**11**	**8**	**10**	**4**	**8**	**7**	**2**	**3**	**–**	**–**	**–**	**69**
Impression													
Impression**	10	12	10	9	2	6	10	3	7	1	–	–	**69**
Punctation***	1	–	–	–	1	1	2	–	5	2	–	–	**12**
Subtotal	**11**	**12**	**10**	**9**	**3**	**7**	**12**	**3**	**12**	**3**	**–**	**–**	**81**
Paddle impression													
Paddle impression	24	19	19	18	10	22	30	6	27	7	–	–	**182**
Total	**179**	**133**	**148**	**102**	**51**	**82**	**76**	**25**	**92**	**30**	**2**	**4**	**924**

* Note, the counts referred to in this table refer to all observable cases of the application method, on both body and formal sherds. Thus, some sherds may preserve evidence of >1 application method.

** Note, most cases of impression were produced on the interior corner point. Only two instances occur on the inner lip and one instance occurs on the lip. No instances occur on the body.

*** Note, all cases of punctation occur on the lip.



Figure 9.24. Examples of appliqué decoration on Madang style body sherds at Tilu.



Figure 9.25. Examples of appliqué decoration on Madang style body sherds at Tilu (cont.).

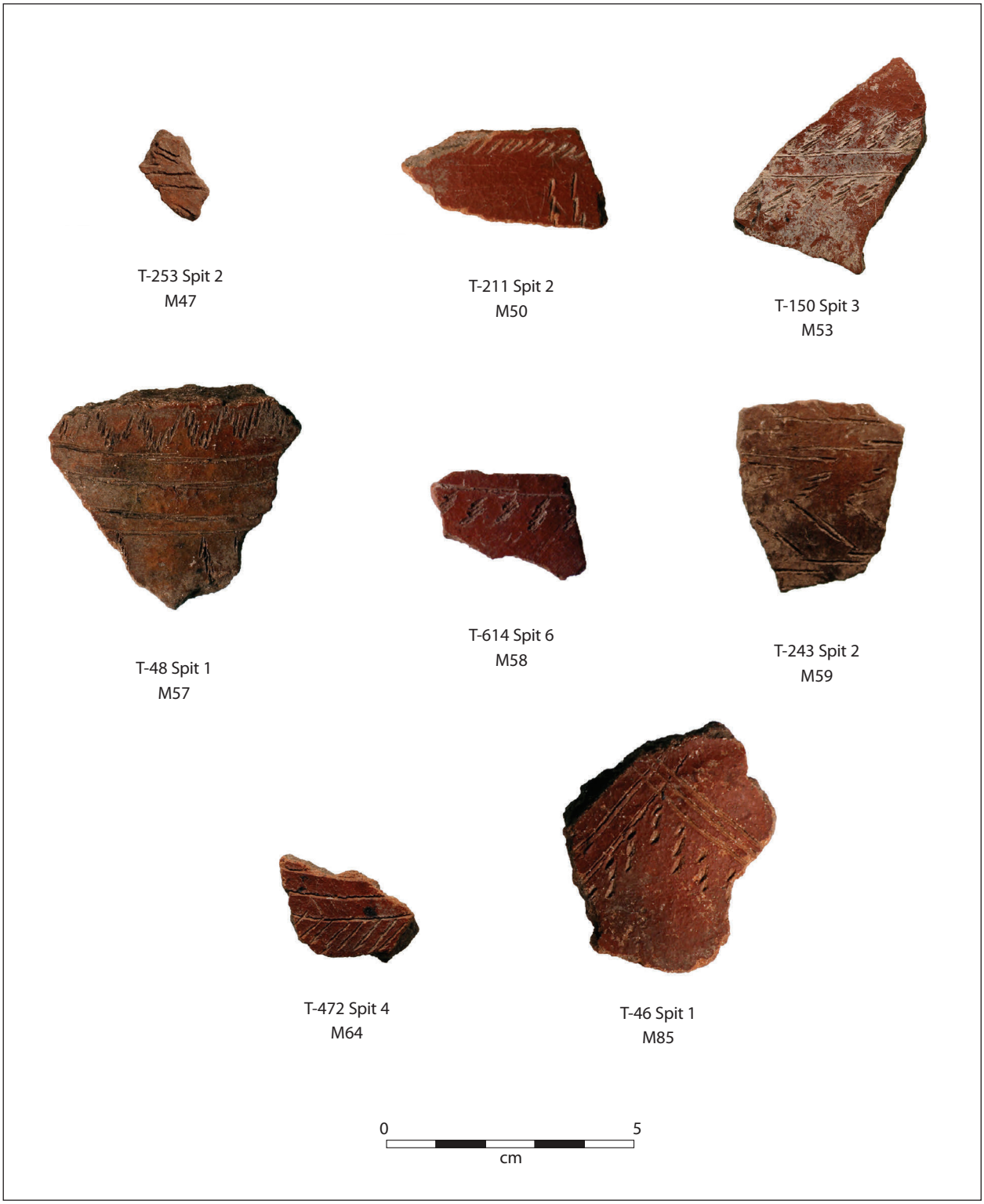


Figure 9.26. Examples of incised decoration on Madang style body sherds at Tilu.

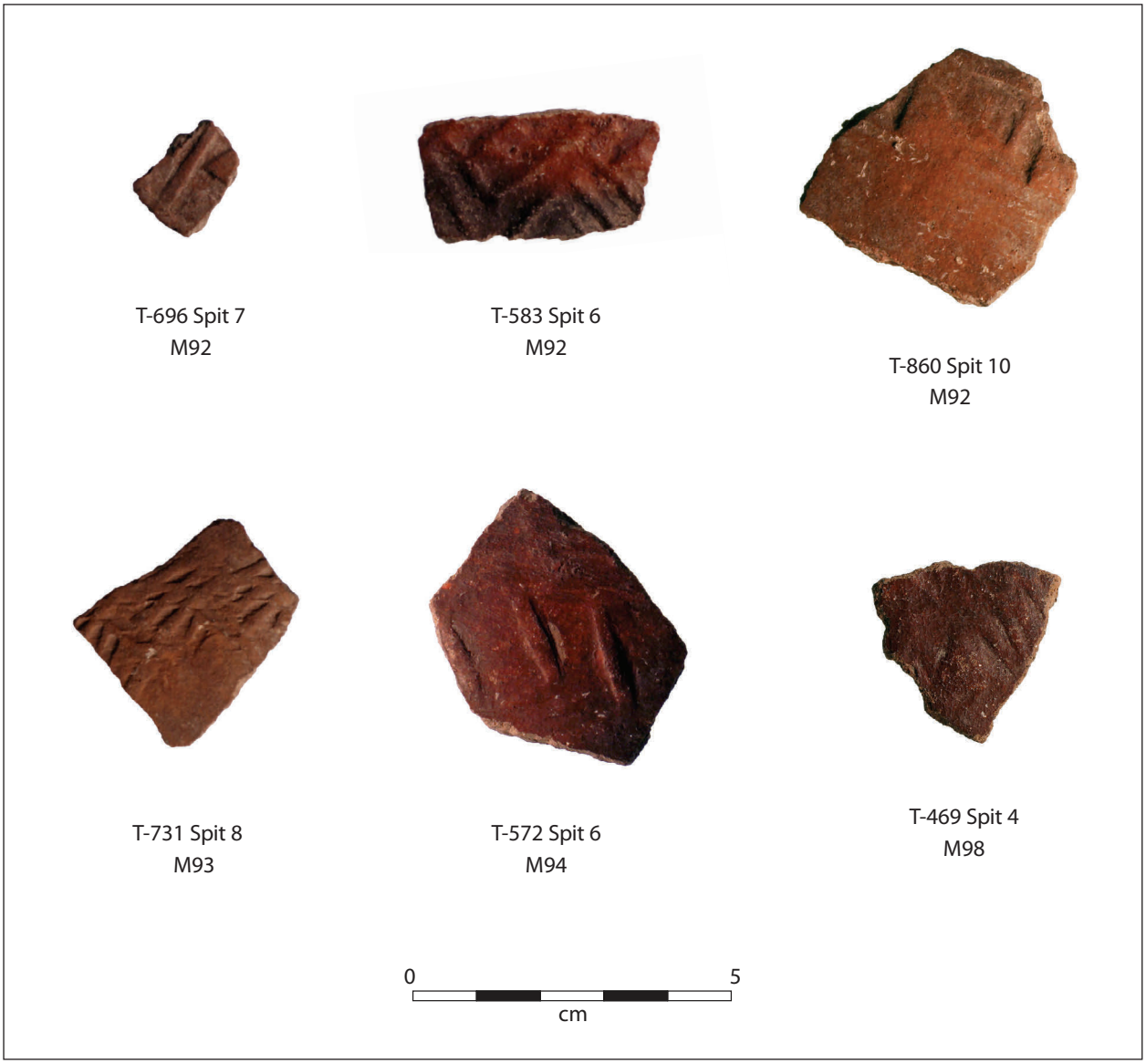


Figure 9.27. Examples of paddle impressed decoration on Madang style body sherds at Tilu.

Table 9.11. *Average body thickness (mm) by application method at Tilu, Unit 1.*

	Appliqué	Incision	Paddle impression
Mean	4.82	5.13	4.14
SD	1.50	1.61	1.47
CV	31%	31%	36%

Table 9.12. *Kruskal-Wallis test of body thickness (mm) by application method at Tilu, Unit 1.*

	Appliqué	Incision	Paddle impression
No. of cases	570	64	173
Mean rank	425.67	464.00	310.40

$X^2 = 37.063$, df = 2, $\eta^2 = 4.6\%$, $P < 0.01$

Table 9.13. *Mood's test of body thickness (mm) by application method at Tilu, Unit 1.*

	Appliqué	Incision	Paddle impression
No. of cases	570	64	173
Thickness>median	312	37	54
Thickness≤median	258	27	119

Median = 4.43, $X^2 = 31.099$, df = 2, $P < 0.01$

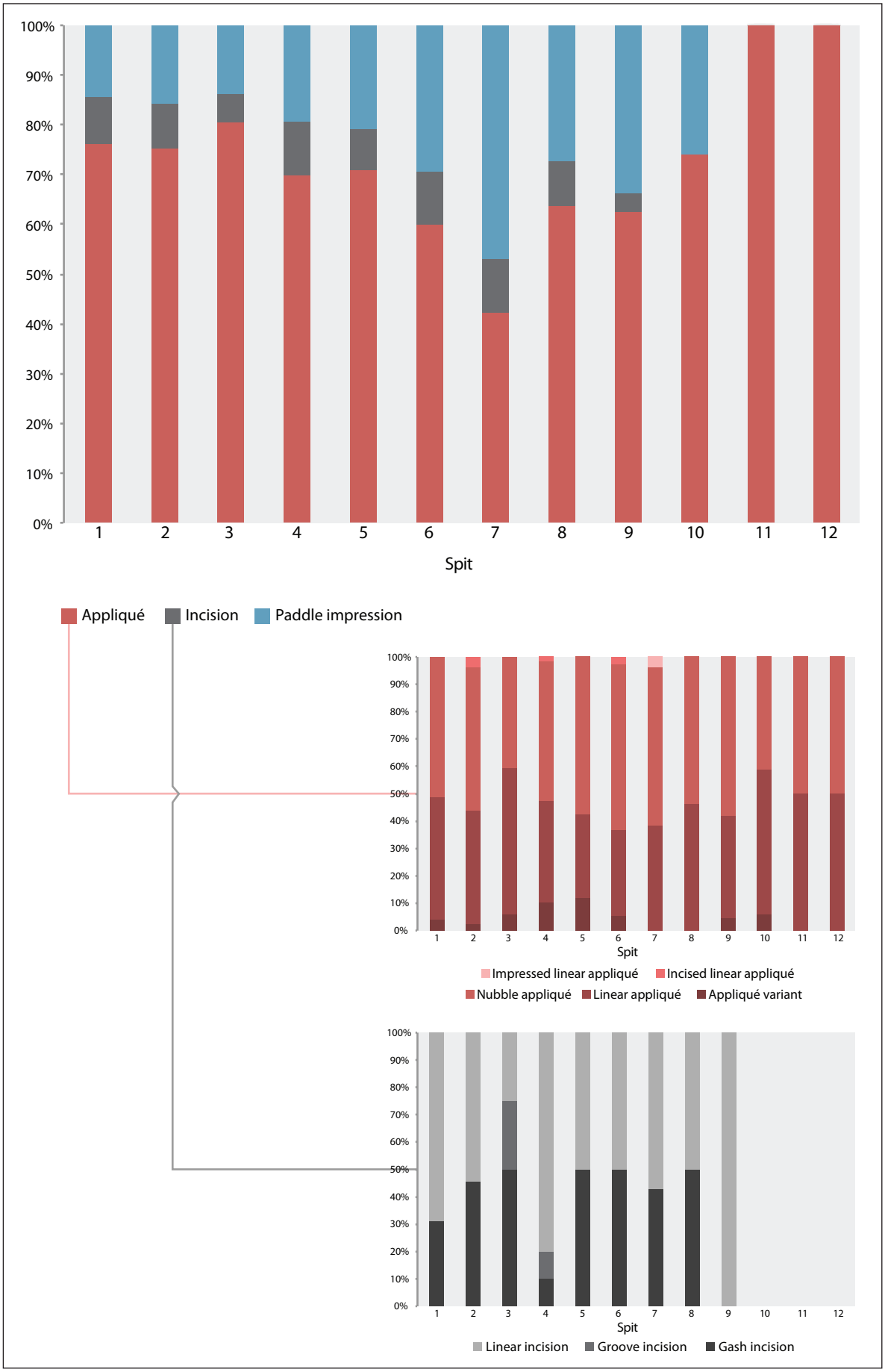


Figure 9.28. Percentage of application methods represented on the external body/shoulder of sherds at Tilu, Unit 1 by excavation spit.

Chevrons (PI3) and 'toothed' linear paddle marks (PI4) are also common (Table 9.16). Typical linear incisions are the single linear band (LI1) and chevrons (LI15), and common gash incisions include a variety of precise repetitive arrangements (GI1-5). Groove incisions are uncommon (Table 9.15).

Most of these decorations were applied to the external body of the pot (see Table 9.14–9.16); however, it is not possible to distinguish if the decorations were restricted to the shoulder as per modern Madang pots owing to the lack of carinations. As above, appliqué, paddle impression, and incision were all exclusively used on the shoulder/body, while punctation and impression were all exclusively used to decorate the lip and interior corner point in a simple and probably quick manner. No instances exist of punctation around the neck as per modern decoration.

Lip decoration at Tilu is more common than at Nunguri. Although configurations on the lip are only represented on 10% of Tilu vessels, it is clear that this technical element was more common during Tilu's early occupation, in the deeper excavation spits. Figure 9.29 illustrates the percentage of rims with punctate or impressed lips relative to the MNV in each spit. There is a statistically significant association between excavation spit and presence of lip decoration ($X^2 = 38.282$, df = 9, $P<0.01$) and this is particularly the case in Spit 9 (adj. residual = 4.8) and 10 (adj. residual = 3.5), in which counts of lip decoration are substantially more than expected. The two examples from Spit 10 are decorated with Pu1; small, deep, circular punctations produced with a needle-like point, dotted regularly around the circumference of the lip. The decorated lips from Spit 1–9 are decorated with Pu3, a much broader punctation using the side of a sharp tool, and Im3, probably produced using the same or similar tool as Pu3 but leaving only a shallow impression around the lip.

Impressions around the interior corner point are common on Tilu rims (Table 9.16). As at Nunguri, these are all classified here as Im1. Inner rim notching was present on most Tilu rims (78%, n = 69) and notably absent on far fewer (22%, n = 20; note some instances could not be observed where the interior corner point was not preserved). This is in contrast to Nunguri, where only half of all rims displayed inner rim notching, suggesting it became less common over time. However, unlike lip decoration, there is no statistically significant association between inner rim notching and excavation spit at Tilu ($X^2 = 17.921$, df = 9, $P = 0.31$).

Table 9.14. *Appliqué configurations represented at Tilu, Unit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub–rim groove	Sub–rim groove ridge	Interior corner point
NA1	137	–	–	–	–	–	–
NA2	51	–	–	–	–	–	–
NA3	–	–	–	–	–	–	–
NA4	1	–	–	–	–	–	–
NA5	2	–	–	–	–	–	–
NA6	3	–	–	–	–	–	–
LA1	133	–	–	–	–	–	–
LA2	–	–	–	–	–	–	–
LA3	8	–	–	–	–	–	–
LA4	26	–	–	–	–	–	–
LA5	2	–	–	–	–	–	–
LA6	8	–	–	–	–	–	–
LA7	1	–	–	–	–	–	–
LA8	–	–	–	–	–	–	–
LA9	18	–	–	–	–	–	–
LA10	–	–	–	–	–	–	–
LA11	–	–	–	–	–	–	–
LA12	–	–	–	–	–	–	–
LA13	–	–	–	–	–	–	–
LA14	–	–	–	–	–	–	–
AV1	24	–	–	–	–	–	–
AV2	2	–	–	–	–	–	–
InLA1	2	–	–	–	–	–	–
InLA2	–	–	–	–	–	–	–
ImLA1	1	–	–	–	–	–	–
ImLA2	–	–	–	–	–	–	–

Table 9.15. *Incised configurations represented at Tilu, Unit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub–rim groove	Sub–rim groove ridge	Interior corner point
LI1	10	–	–	–	–	–	–
LI2	7	–	–	–	–	–	–
LI3	1	–	–	–	–	–	–
LI4	–	–	–	–	–	–	–
LI5	2	–	–	–	–	–	–
LI6	–	–	–	–	–	–	–
LI7	–	–	–	–	–	–	–
LI8	–	–	–	–	–	–	–
LI9	–	–	–	–	–	–	–
LI10	–	–	–	–	–	–	–
LI11	–	–	–	–	–	–	–
LI12	1	–	–	–	–	–	–
LI13	2	–	–	–	–	–	–
LI14	–	–	–	–	–	–	–
LI15	10	–	–	–	–	–	–
LI16	2	–	–	–	–	–	–
LI17	–	–	–	–	–	–	–
GI1	4	–	–	–	–	–	–
GI2	8	–	–	–	–	–	–
GI3	5	–	–	–	–	–	–
GI4	3	–	–	–	–	–	–
GI5	5	–	–	–	–	–	–
GI6	–	–	–	–	–	–	–
GI7	–	–	–	–	–	–	–
GI8	–	–	–	–	–	–	–
GI9	2	–	–	–	–	–	–
GI10	–	–	–	–	–	–	–
GI11	–	–	–	–	–	–	–
GI12	–	–	–	–	–	–	–
GI13	–	–	–	–	–	–	–
GI14	–	–	–	–	–	–	–
GI15	–	–	–	–	–	–	–
GI16	–	–	–	–	–	–	–
GI17	–	–	–	–	–	–	–
GI18	–	–	–	–	–	–	–
GI19	–	–	–	–	–	–	–
GI20	–	–	–	–	–	–	–
GI21	–	–	–	–	–	–	–
GI22	–	–	–	–	–	–	–
GI23	–	–	–	–	–	–	–
GI24	–	–	–	–	–	–	–
GI25	–	–	–	–	–	–	–
GI26	–	–	–	–	–	–	–
GrI1	2	–	–	–	–	–	–
GrI2	–	–	–	–	–	–	–
GrI3	–	–	–	–	–	–	–
GrI4	–	–	–	–	–	–	–

Table 9.16. *Impressed and paddle impressed configurations represented at Tilu, Unit 1 by location.*

	Body	Lip	Outside lip	Inside lip	Sub–rim groove	Sub–rim groove ridge	Interior corner point
Im1	–	–	–	2	–	–	67
Im2	–	–	–	–	–	–	–
Im3	–	1	–	–	–	–	–
Im4	–	–	–	–	–	–	–
Pu1	–	2	–	–	–	–	–
Pu2	–	–	–	–	–	–	–
Pu3	–	9	–	–	–	–	–
PI1	7	–	–	–	–	–	–
PI2	34	–	–	–	–	–	–
PI3	14	–	–	–	–	–	–
PI4	17	–	–	–	–	–	–
PI5	7	–	–	–	–	–	–
PI6	2	–	–	–	–	–	–
PI7	1	–	–	–	–	–	–
PI8	7	–	–	–	–	–	–
PI9	1	–	–	–	–	–	–
PI10	–	–	–	–	–	–	–

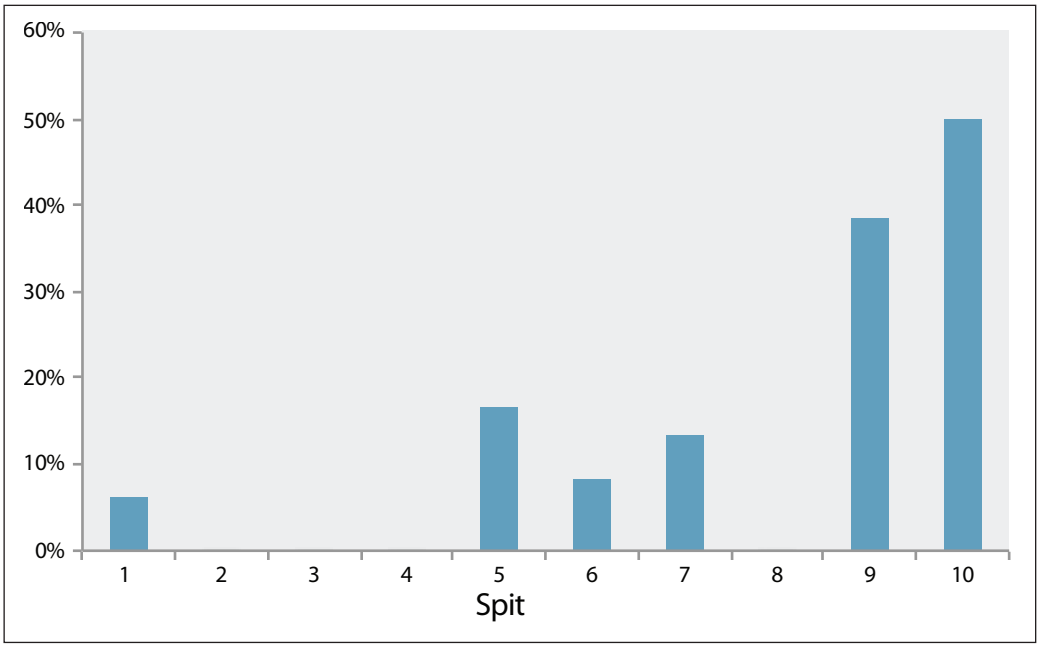


Figure 9.29. Percentage of Tilu rims with decorated lips by excavation spit.

At Tilu, 21 different motifs were recorded; again far fewer than in the Nunguri assemblage. There is, however, still a substantially larger range of motifs represented at Tilu than the single design seen on modern *bodi*. Appliqué motifs comprise 84% of all observed cases, and incision and paddle impression, 8% each. This is notably different from Nunguri, where appliqué motifs account for only 57% and incised motifs account for 41%. No examples of impressed/punctate motifs were observed, nor were any combinations of two or more different decorative methods used to produce motifs. The M1 appliqué motif, a single linear band flanked by nubble bands, constitutes almost half of the total (n = 67, 48.55%) while all other motifs are comparatively minor (Table 9.17). This picture contrasts with Nunguri, where M11 is generally more common than M1, except in lower deposits. This pattern supports the idea that the M1 motif was more common earlier in time, and that the Tilu sequence overlaps with the Nunguri sequence, but also stretches slightly further back in time.

Tilu slip cannot be visually differentiated from Nunguri slip. It is usually dark reddish brown (2.5YR 3/6, 2.5YR 3/4, 5YR 3/6) or reddish brown (2.5YR 4/6) but can also be very dark brown (7.5YR 2/3) owing to varying firing conditions. Slip is externally present on 95% (n = 628) of decorated body sherds and 90% (n = 103) of rims at Tilu. Similar to

Table 9.17. *Motifs represented at Tilu, Unit 1 by excavation spit.*

	Excavation spit												
Application method	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Appliqué													
M1	16	13	17	6	3	2	4	–	4	1	1	–	67
M2	2	1	3	2	1	–	–	–	–	1	–	–	10
M4	–	2	1	1	2	–	–	2	1	1	–	–	10
M8	1	–	–	–	–	1	–	–	–	–	–	–	2
M11	3	3	6	2	1	1	–	1	1	–	–	–	18
M19	–	–	1	–	–	–	–	–	–	–	–	–	1
M20	–	–	–	–	–	–	–	1	–	–	–	–	1
M26	1	–	–	–	–	–	–	–	–	–	–	–	1
M32	3	1	1	–	–	–	–	–	–	–	–	–	5
M33	–	–	1	–	–	–	–	–	–	–	–	–	1
Subtotal	**26**	**20**	**30**	**11**	**7**	**4**	**4**	**4**	**6**	**3**	**1**	**–**	**116**
Incision													
M47	–	1	–	–	–	–	–	–	–	–	–	–	1
M50	–	1	–	–	–	–	–	–	–	–	–	–	1
M53	1	–	–	–	–	1	–	–	–	–	–	–	2
M57	2	–	–	–	–	–	–	–	–	–	–	–	2
M58	–	–	–	–	–	1	–	–	–	–	–	–	1
M59	–	1	–	–	–	–	–	–	–	–	–	–	1
M64	–	–	–	1	–	–	–	–	–	–	–	–	1
M75	–	–	–	–	–	–	1	–	–	–	–	–	1
M85	1	–	–	–	–	–	–	–	–	–	–	–	1
Subtotal	**4**	**3**	**–**	**1**	**–**	**2**	**1**	**–**	**–**	**–**	**–**	**–**	**11**
Paddle impression													
M92	–	–	–	–	–	1	1	–	–	1	–	–	3
M93	–	–	–	–	–	–	–	1	–	–	–	–	1
M94	–	–	–	–	–	1	–	–	–	–	–	–	1
M98	–	–	1	1	1	1	2	–	–	–	–	–	6
Subtotal	**–**	**–**	**1**	**1**	**1**	**3**	**3**	**1**	**–**	**1**	**–**	**–**	**11**
Total	**30**	**23**	**31**	**13**	**8**	**9**	**8**	**5**	**6**	**4**	**1**	**–**	**138**

the Nunguri sherds, slip is only internally present on 7% (n = 48) of decorated body sherds and 79% (n = 90) of rims, indicating that it was applied around the exterior but not far into the interior.

There appears to be no statistically significant association between technical class and application method (Pearson's Chi-Squared test $X^2 = 5.559$, df = 8, P = 0.679). Figure 9.30, which has excluded cases of lip decoration and inner rim notching, shows that Class 1 rims display cases of appliqué, incision, and paddle impression, while Class 2 rims display all but incision. Classes 3, 4, and 5 all display instances of appliqué, the same kind as that applied to Class 1 and 2 vessels. Small sample sizes make further interpretation difficult.

Additionally, unlike Nunguri, there is no statistically significant association between lip decoration and technical class ($X^2 = 2.694$, df = 4, P = 0.383), the presence of inner rim notching and technical class ($X^2 = 6.647$, df = 4, P = 0.161), or between the presence of slip and technical class ($X^2 = 5.868$, df = 4, P = 0.268). There is also no significant association between techno-fabric groups and the decorative method used ($X^2 = 4.679$, df = 9, P = 0.786). This is illustrated in Figure 9.31, which shows appliqué as the dominant decorative method for each fabric, with paddle impression being of secondary importance, and incision being uncommon.

As above, it is difficult to compare the techno-compositional groupings with decorative methods, but the PCA data are here coded by decorative attributes to tease apart the single techno-compositional group. Despite this, Figures 9.32–9.34 show that decorative method, the presence of lip decoration, and the presence of inner rim notching do not clearly discriminate subgroupings based on clay chemical data. This pattern is consistent with Nunguri and suggests that those production groups that were using the Bilbil-area clay sources were using various decorative techniques interchangeably.

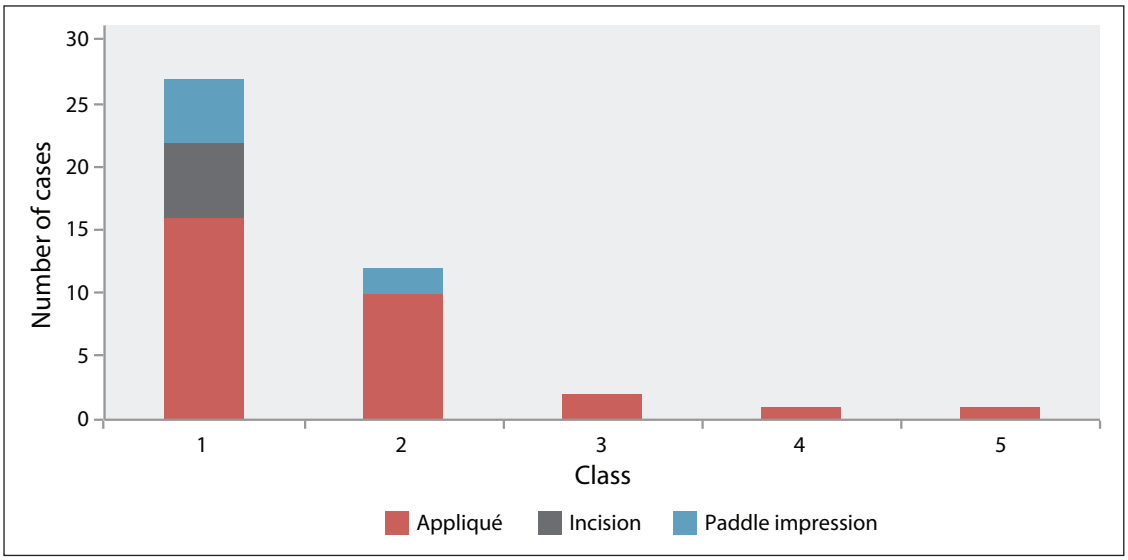


Figure 9.30. Cases of application method on the body/shoulder by technical class at Tilu, Unit 1.

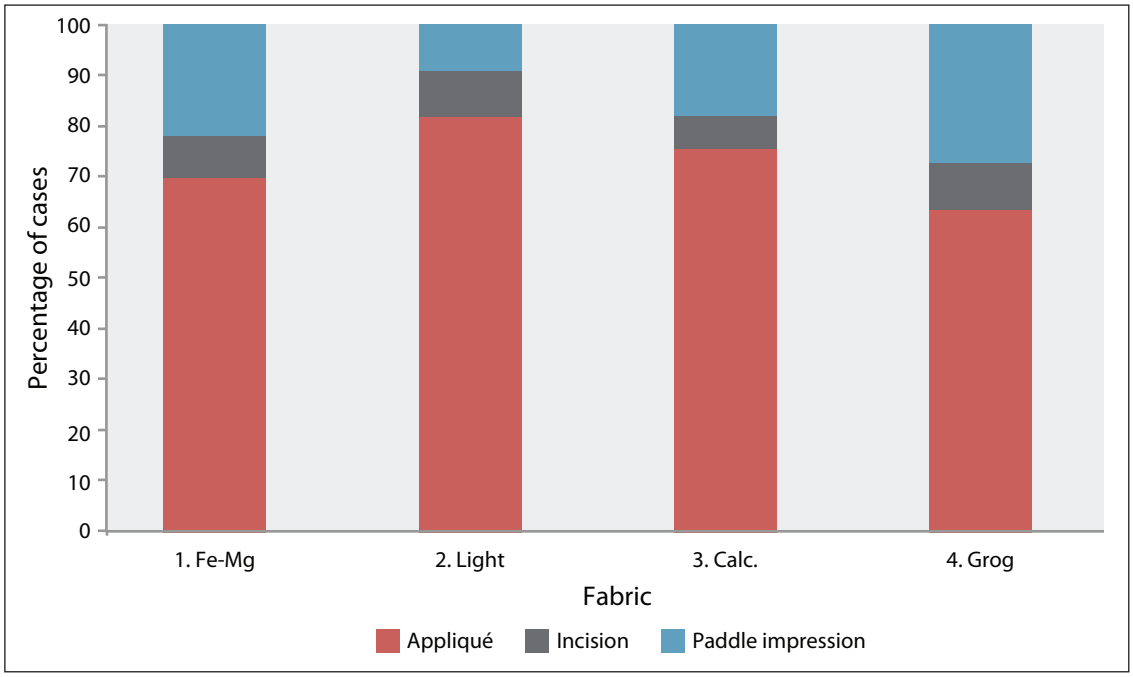


Figure 9.31. Percentage cases of application method on the body/shoulder used by techno-fabric at Tilu, Unit 1.

Table 9.18 summarises the Tilu techno-style groupings, representative of variations in the *chaîne opératoire* during the procurement, forming and decorating phases. Ten variations have been confidently determined but many more are likely to have been produced as is the case at Nunguri with a larger sample size. These techno-style groups arose within different production groups in the local Madang area. This local context makes interpreting the organisation of production groups within the broader community of practice much more difficult than at a regional level. The specific implications of these results in the local Madang setting will therefore be elaborated on in the following chapter.

Results: surface survey

The decorated sherds collected during surface survey are limited (Table 9.19), and the following is an overview rather than an in-depth analysis. The collection includes four decorated rims and three decorated body sherds from Kranket, one decorated rim and one decorated body from Siar, and five decorated rims and one decorated body from Yabob.

Decorative configurations of individual decorative elements are also limited, but within the range of Nunguri and Tilu decorations (Table 9.20). Most of the decorative

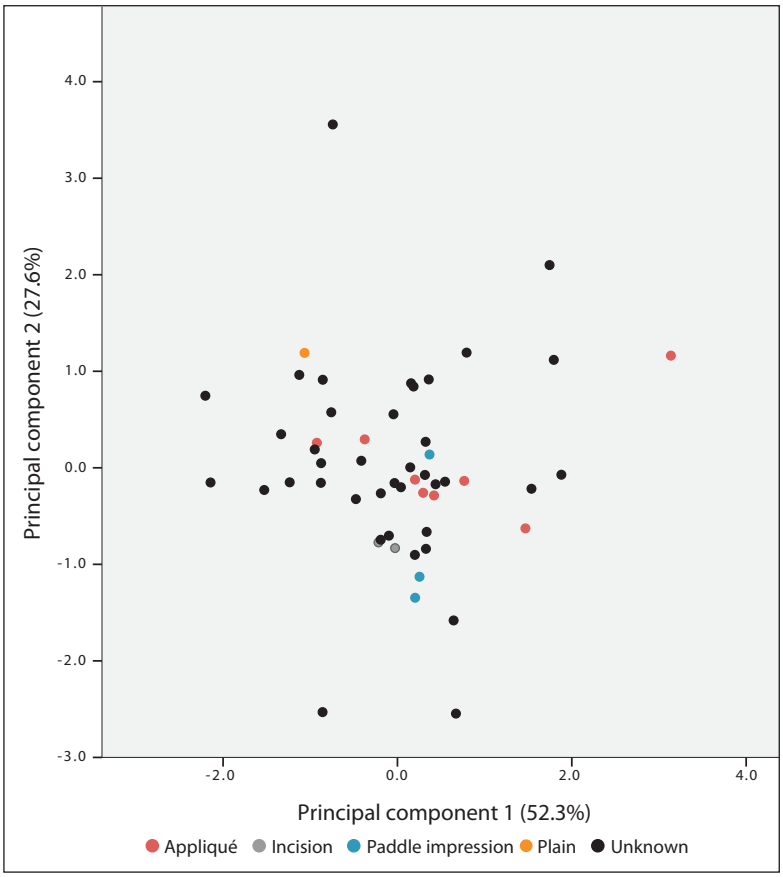


Figure 9.32. PCA showing clay chemical data of Tilu sherds coded by body/shoulder application method.

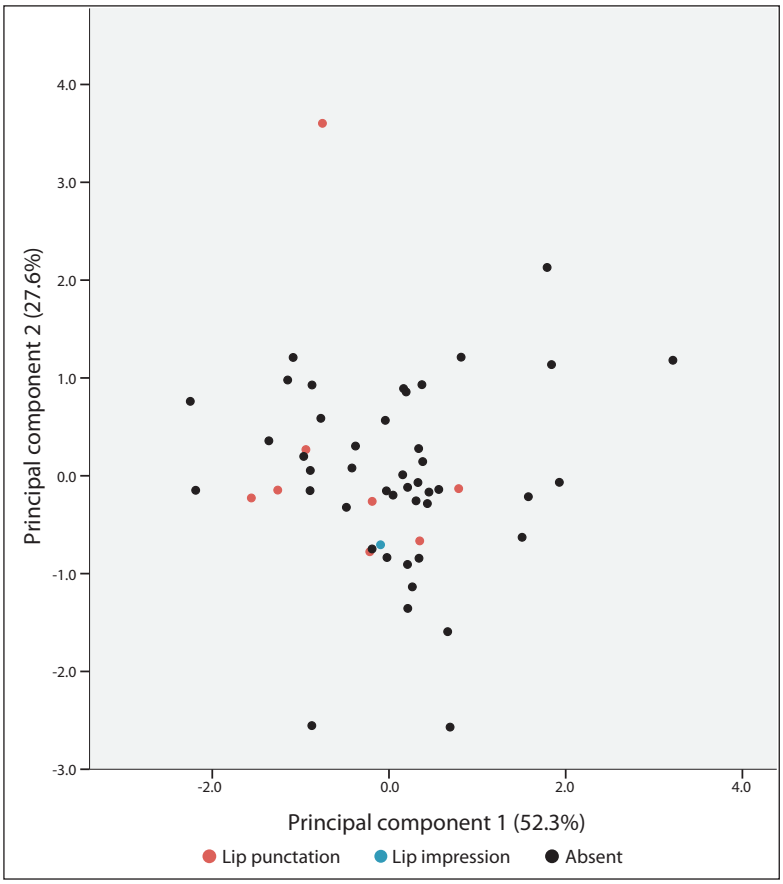


Figure 9.33. PCA showing clay chemical data of Tilu sherds coded by lip decoration.

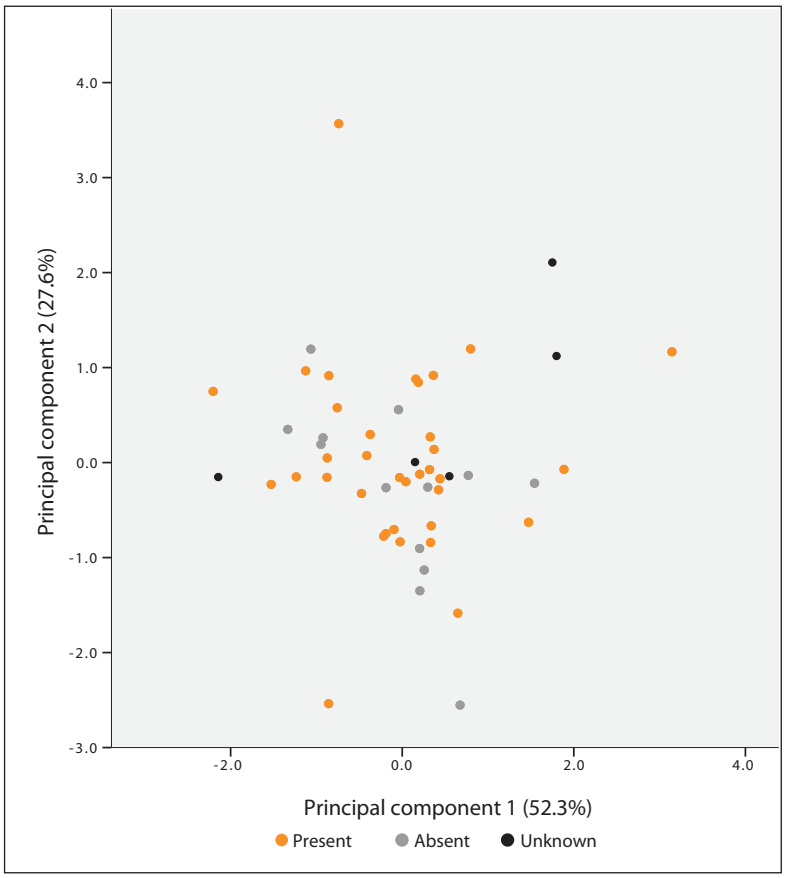


Figure 9.34. PCA showing clay chemical data of Tilu sherds coded by inner rim notching.

Table 9.18. *Techno-style groups within the Madang style at Tilu. Orange cells indicate observed correlations, blue cells were not observed.*

	Class				
	1	2	3	4	5
FeMg (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Light (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Calcareous (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.
Grog (Local clay)	Appliqué	Appliqué	Appliqué	Appliqué	Appliqué
	Incision	Incision	Incision	Incision	Incision
	Impression	Impression	Impression	Impression	Impression
	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.	Paddle imp.

Table 9.19. *Decorative application methods represented from surface collections.**

Application method	Kranket Island	Siar Island	Yabob Island	Total
Appliqué				
Nubble appliqué	–	1	–	1
Linear appliqué	7	–	2	9
Appliqué variant	–	–	2	2
Incised linear app.	–	–	–	–
Impressed linear app.	–	–	–	–
Appliqué (?)	–	–	–	–
Subtotal	**7**	**1**	**4**	**12**
Incision				
Linear incision	2	–	1	3
Gash incision	1	1	–	2
Groove incision	–	–	–	–
Subtotal	**3**	**1**	**1**	**5**
Impression				
Impression	2	1	2	5
Punctation	–	–	1	1
Subtotal	**2**	**1**	**3**	**6**
Paddle impression				
Paddle impression	–	–	–	–
Total	**12**	**3**	**8**	**23**

* Note, the counts in this table refer to all observable cases of the application method, on both body and formal sherds. Thus, some sherds may preserve evidence of >1 application method.

Table 9.20. *Decorative configurations represented in surface collections by location.*

	Body	Lip	Outside lip	Inside lip	Neck	Sub-rim groove	Sub-rim groove ridge	Interior corner point
Kranket Island								
LA1	1	–	–	–	–	–	–	–
LA4	2	–	–	–	–	–	–	–
LA7	2	–	–	–	–	–	–	–
LA10	1	–	–	–	–	–	–	–
LI2	1	–	–	–	–	–	–	–
LI12	1	–	–	–	–	–	–	–
GI11	1	–	–	–	–	–	–	–
Im1	–	–	–	–	–	–	–	2
Siar Island								
NA1	1	–	–	–	–	–	–	–
GI25	1	–	–	–	–	–	–	–
Im1	–	–	–	–	–	–	–	1
Yabob Island								
LA4	2	–	–	–	–	–	–	–
AV1	1	–	1	–	–	–	–	–
LI11	1	–	–	–	–	–	–	–
Pu3	–	–	–	–	1	–	–	–
Im1	–	–	–	–	–	–	–	2

configurations are limited to the body, but one instance of appliqué variant (AV1) is present on the outside lip of a Class 4 incurving rim. Interestingly, this surface collection contains the only instance of a sherd with neck decoration, which is similar to modern Bel pots in being punctation produced around the circumference of the neck. This is present on Y-6, a large Class 1 sherd, which suggests either that the configuration was in use prior to the cessation of Yabob Island potting or that the pot was traded in later. Only two motifs are present in the surface collection (M11 and M70), both from Kranket Island. Inner rim notching on the interior corner point is present on five sherds (31%).

The sample sizes of decorated surface collections are too small to effectively delineate groupings when compared to vessel class and fabric. However, as above, the PCA plots showing techno-compositional data can be coded by different decorative elements. Below, the techno-compositional grouping is coded first by decorative method and then by presence of inner rim notching. These figures (9.35–9.36) show similar results to Nunguri and Tilu with no clear association between clay and decoration.

Results: exotics

Of the 12 'exotic' sherds excavated and collected around Madang, 11 retain decorative elements. At Tilu Unit 1, seven body sherds with decoration atypical of the Madang style are present (Fig. 9.37). This includes: T-230, a thick (8.82 mm), deeply grooved and impressed sherd from Spit 2; T-520, a thinner (6.29 mm), deeply incised sherd from Spit 5, and five thick, deeply incised and punctate impressed sherds from Spit 6 which likely derive from the same vessel. One of the exotic rims from Tilu Unit 1 (T-188) is also decorated with punctation, while the ring-base (T-913) from Tilu Shovel Pit 1 is decorated with impressions around the circumference of the base and on the body of the vessel. The single exotic sherd from Nunguri (N-3712) is a rim decorated with bands of gash incision on the body and punctation along the lip. The possible exotic from Yabob (Y-5) is decorated with punctations along the outside lip (see Chapter 7). The decorations produced on these 'exotic' sherds are similar in form to Madang style decorations: straight freehand incisions bordered by diagonals, lines of gash incisions, rows of punctations. However, the gestures and tools used, along with the placement on the vessels are clearly different.

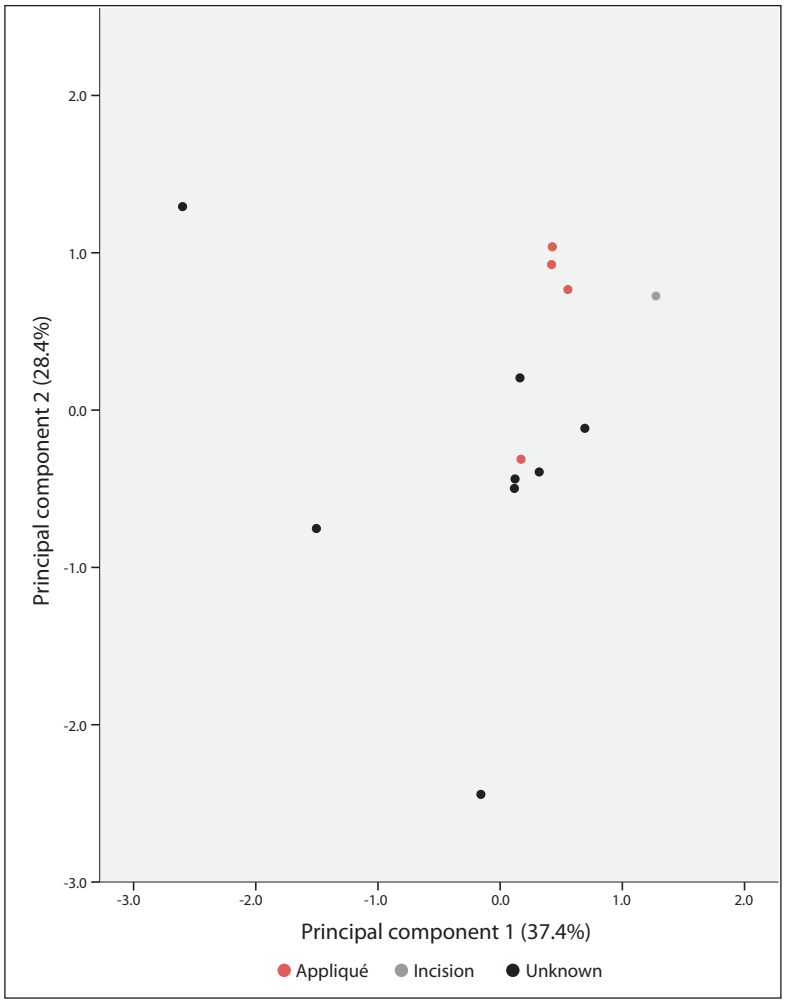


Figure 9.35. PCA showing clay chemical data of survey sherds coded by body/shoulder application method.

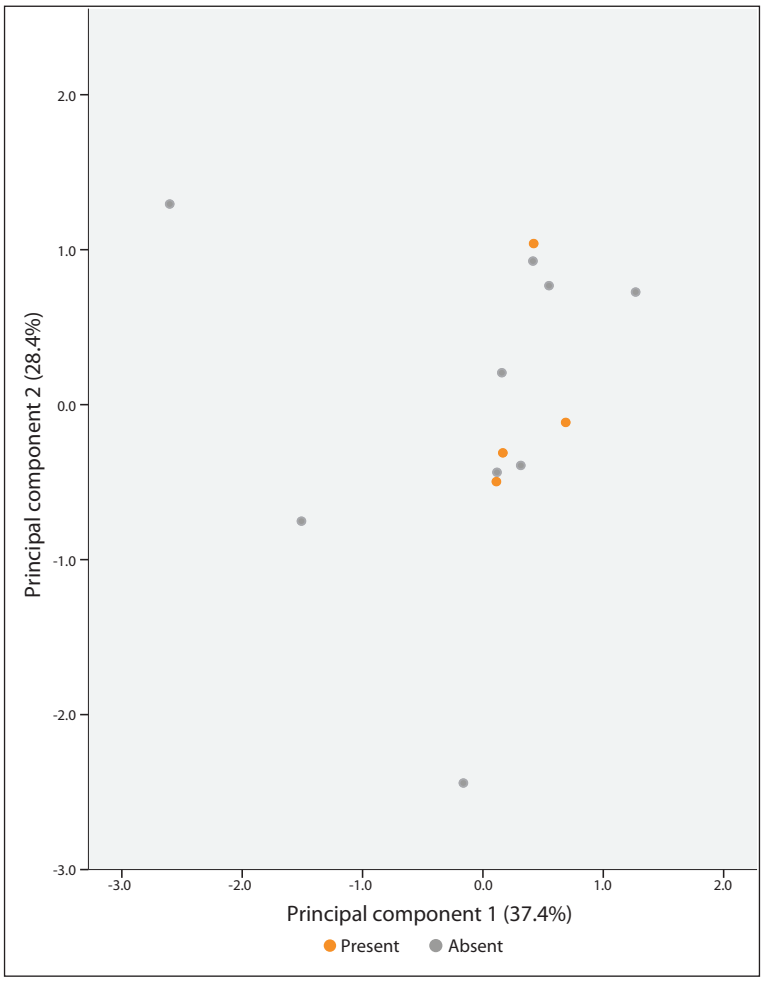


Figure 9.36. PCA showing clay chemical data of survey sherds coded by inner rim notching.

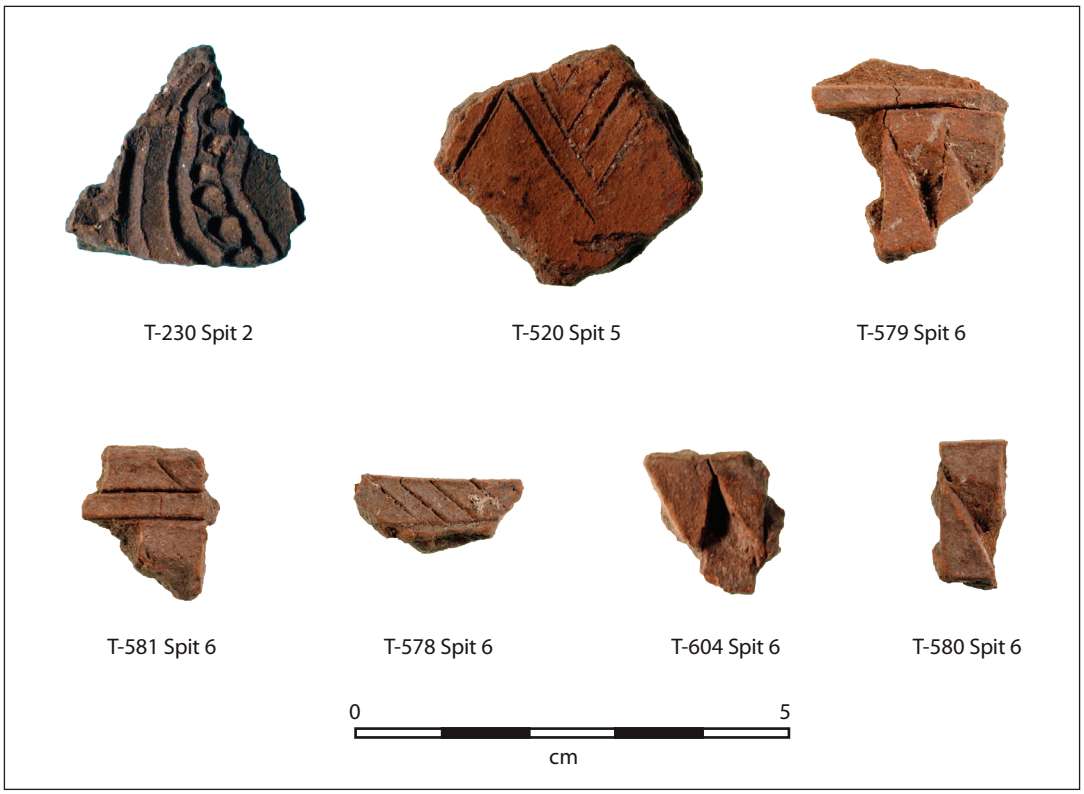


Figure 9.37. Exotic decorated body sherds from Tilu, Unit 1.

Summary

The results of the decorative analysis examining minor technical elements suggests that the range of Madang style Technical Classes 1–5 were decorated with various decorations, as opposed to particular classes or fabrics being decorated with specific techniques, which might indicate specific production groups making specific technical classes but using similar raw materials. Rather, the results suggest that there is no reason to assign a single *chaîne opératoire* to different production groups. This supports the results of the fabric analysis in Chapter 8. More likely, around Madang in the past, like today, one or more production groups were producing a wide range of vessel classes. However, unlike today, these vessels were decorated with a range of different decorative forms using a range of decorative techniques.

With regard to using technical elements as useful chronostratigraphic indicators, the presence of lip decoration (impression and particularly punctation) is related to earlier iterations of the local Madang style. It is expected that this technical element will be present on many of the ceramics from pre-650 BP deposits further east. Paddle impression is also more likely to be associated with earlier pots, being much more common at Tilu, while manual impression using a point or blunt end on the body/shoulder is more likely to be late. Punctation applied around the neck and small gash incisions arranged as per modern Bel designs are not present on any of the pre-colonial pots excavated from Nunguri and Tilu. However, an instance of neck punctation is present from a surface find at Yabob and on the *you-bodi* collected by Miklouho-Maclay (see Chapter 3).

This chapter has completed the ceramic technological analysis undertaken to create a hierarchical classification system to delineate techno-style groups. These techno-style groups represent variations to the *chaîne opératoire* within various production groups, which may be able to be discriminated based on techno-fabric/mineralogical groupings. Various production groups seem to have been producing a series of technical classes and continued interaction, imitation, and knowledge exchange between these groups constitute a broader community of practice: a set of social and technological processes which left behind broadly groupable ceramics: the Madang style. The next chapter is a discussion of these results and will explore production and exchange in the local Madang context, and the nature of changing technological processes leading up to ethnographic times.

Chapter 10. Materialising Ancestral Madang

Every sufficiently advanced technology is indistinguishable from magic.
— Arthur C. Clarke (1973)[1]

To materialise Madang's ancestral potters, this chapter ties together the analytical lines running throughout the book. By doing so the chapter addresses one of the major research objectives: to examine the changing processes of production and exchange leading up to the ethnographically observed Madang exchange networks. This is done in two progressive stages. First, a discussion of the pre-colonial pottery making process is necessary to describe the nature of past production groups and communities of practice around Madang. This will integrate procurement, forming, and decorating processes into a holistic examination of the *chaîne opératoire*. These observations, based on the ceramic classification presented in Chapters 7–9, are tied to embodied knowledge as a process by which materials, people, and techniques change and interact over time. Second, this chapter will examine aspects of pre-colonial exchange around Madang and the northeast coast. This process begins with meso-networks on the local level, integrating information from the ceramic analyses, and later expands to discuss macro-networks operating at the regional level (see Chapter 1), through comparisons with pottery assemblages along the Madang coast, in Sepik, the Bismarck Archipelago, and the New Guinea Highlands. This approach will further explore embodiment, and the sharing of knowledge across space and time by building the current study into a regional network of object exchange.

Vai: aspects of pre-colonial production

This section will explore the nature of pottery production around Madang in the pre-colonial past. It will first summarise the various *chaînes opératoires* (or *vai* in the Bilbil language) observed in the ceramic analyses, and how these differ across time and space. Using this information, production groups working within broader communities of practice will be systematically distinguished.

1 Clarke's Third Law, in: 'Profiles of the future: an inquiry into the limits of the possible.'

Procurement

The investigation of the procurement phase aimed to establish the timing of local production and subsequent adjustments to technological organisation in terms of changing resource procurement. The results presented in Chapter 8 indicate that the procurement of raw materials for potting in the pre-colonial past probably followed a similar set of processes to today. Clay, sand temper, slip, firing fuel, and water were all required to make a pot. Women would have visited the mainland to collect clays, deriving particularly from the Holocene alluvium of the Astrolabe Land System, which characterises the area around modern Bilbil village. There, organic topsoil overlies thick and easily accessible clay deposits, formed by the colluvial aprons of the Gum and Gogol rivers, which flow out to the Bismarck Sea to the north and south of Bilbil, respectively. These clay sources may have been located under and beside garden plots or near streams where the deposits are conspicuously exposed. The specific techniques behind selection, extraction, and transport are all unknown, but it is plausible that wooden digging sticks were used to extract the material and string bags were employed in a similar manner to today, to carry balls of clay back to the households.

The geochemical results demonstrate that the clays used to produce Madang style pots in the past were more similar to modern Bilbil potting clays than to the modern Yabob clays. Based on the PCA and HCA results, one sherd (N-2713 from Spit 11) possibly clusters closer to modern Yabob clay sources than the Bilbil sources. Another Nunguri sherd (N-188 from Spit 2) and two Kranket Island sherds (K-2 and K-7) group away from both the Bilbil and Yabob sources, and might represent a third procurement zone, such as Mindiri to the south (Fig. 10.1). The ethnographic clay sources used at Mindiri could not be obtained in the course of this study but would contribute greatly to interpretations about procurement and exchange along the northeast coast. Importantly, even the oldest rims in the sample, from Tilu Unit 1, Spit 10, cluster with the modern Bilbil clay sources and show that the very earliest Madang style pottery found in the area so far, dating to 550–650 cal. BP, was probably locally produced and not imported.

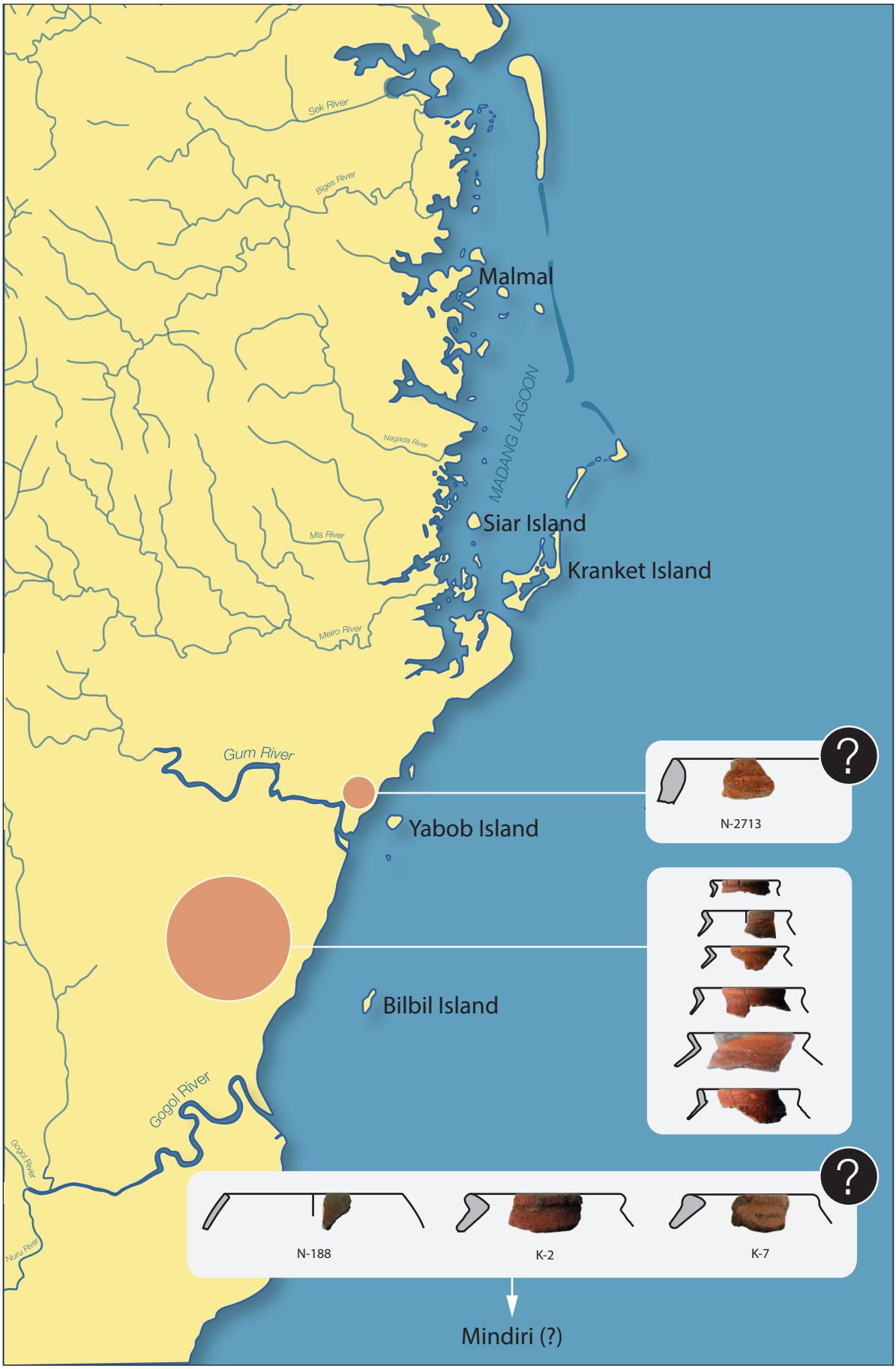


Figure 10.1. Clay procurement zones around Madang including the major procurement hub around Bilbil and possible minor sources at Yabob and Mindiri.

The sherds marked as 'exotic,' based on the initial stage of intuitive sorting, overlap with Madang style ceramics in their clay chemical composition but differ in their tempers (see below). As mentioned in Chapter 8, this is perhaps because these 'exotic' pots derive from production groups using clays from the same Astrolabe Land System, near Bilbil. This is possible given distinct coil-made pots are today produced from similar clays in the Gogol River Valley on the same land system. An alternative explanation is that the data quality obtained using the SEM-EDS was not sufficient to separate minor variations in local or sub-regional clay sources.[2] An alternative approach such as LA-ICP-MS might provide a useful and complementary dataset to discriminate sources based on trace elements.

A variety of sand types were used to temper the extracted clay, including black beach sand, white ('light') beach sand, coral beach sand, and possible grog. Black sands, dominated by clinopyroxenes, feldspars, Fe/Ti oxides, quartz, and volcanolithic fragments seem to have been preferred by the potters and resulted in harder vessels.[3] White beach sands comprised of primarily feldspathic and quartz grains, along with minor pyroxenes and other dark minerals, were also used, but much less often. Calcareous coral sand, deriving from uplifted offshore islands, was used with similar infrequence. Lastly, a temper type identified as grog is also present, albeit very rarely. This is similar to that identified in previous petrographic analyses of Madang style pottery (Specht *et al.* 2006) in containing substantial clay grains or broken sherds. However, because no sherds were exclusively tempered with grog, also containing substantial locally available white and black beach sands, it is not clear whether grog was used deliberately as a tempering agent like Type X ceramics or if 'grog' represents accidental inclusions from the reuse of workshop/house floors.

The diversity of tempers used to produce Madang style pots may indicate multiple production groups in operation, each using different tempers. For instance, there could have been one group using black beach sand from a river mouth south of Madang Lagoon, one group using white sand from a mainland beach around the Lagoon, one group using calcareous sand from an offshore island, and one using grog. However, because the clays are all chemically similar, it is possible that a single or small number of production groups were using different tempers. This would echo the statements of modern Bel potters, who do not distinguish between sand types. For instance, perhaps the favoured black sand was collected during trips to the mainland to procure clay, and then taken back to offshore islands. When the supplies of black sand ran out, potters could have collected sand from the immediate coral beach rather than paddling back to the mainland to get more black sand. This would especially be the case if only a small batch of pots were being made, during the off-season in August–January.

The fabric analysis at Nunguri suggests a tendency to temper with coral beach sand more frequently through time, indicating an increased reliance on offshore materials (e.g. Bilbil Island, Yabob Island, Yomba Island, Urembu Island, or the Madang Lagoon islands). Importantly, all of the tempers identified in Madang style ceramics are consistent with locally available grains and do not resemble those from further east towards the Vitiaz Strait (Gaffney *et al.* 2019), north towards the Sepik (Summerhayes pers. comm.), or inland, towards the Madang Highlands (Gaffney *et al.* 2015). Moreover, the local procurement of materials around Madang does not appear to have become more standardised over time as in other areas of New Guinea (Chynoweth 2015; Hogg 2007; Summerhayes 2000; Sutton *et al.* 2016; Vilgalys & Summerhayes 2016). Rather, from the outset, Madang's pottery-makers were accustomed to using relatively standardised clay sources (i.e. a number of clay pits within a small geographic range) but were flexible in their use of tempering agents.

'Exotic' sherds are more easily distinguished by their tempers (Fig. 10.2). Many lack the clinopyroxene augite (e.g. T-913 ring base), which is characteristic of Madang style pots produced around the Madang archipelago. Many others appear not to be tempered at all and the only inclusions present are probably natural fragments from the clay deposit (e.g. T-188, T-230, T-410, T-604). Although the clay sources may have been similar compared with most Madang style pots, the choice of tempers, and the choice of whether to temper at all, distinguish different production groups.

The ethnographic data in Chapter 4 demonstrate that the number of clay sources in use does not seem to correlate to the residential mobility of the potters but is linked to political, social, and technological concerns. Six distinct clay sources were used at the modern Yabob potting village, while at Bilbil only two sources were targeted, despite both groups being equally sedentary and with similar land tenure patterns. Rather, the number of clay sources may represent the standardisation and regularity of procurement processes (see Arnold 2000). Bilbil potters continue to practice pottery making relatively frequently and in a standardised manner, while at the time of this research Yabob potters produced ceramics very infrequently and with far fewer practitioners. The standardised selection of potting clay near Bilbil over *c.* 600 years does suggest there may have been social regulation of these clay deposits determining who could access the clay to produce pots. It may also reflect which land parcels were accessible to the Bel and their alliances with different groups on the mainland.

The continuity of raw material collecting, broadly unbroken and maintained over the course of about 600 years attests to the durability of the Bel potters' procurement

2 Note, Lilley's (1986: 230) sourcing clustered Bilbil clay with Tuvaltae clay. Tuvaltae/Korak is a small potting tradition just north of Sarong on the mainland, immediately west of Karkar.

3 Based on optical observations, although more thorough technological analyses would be required to demonstrate this assertion.

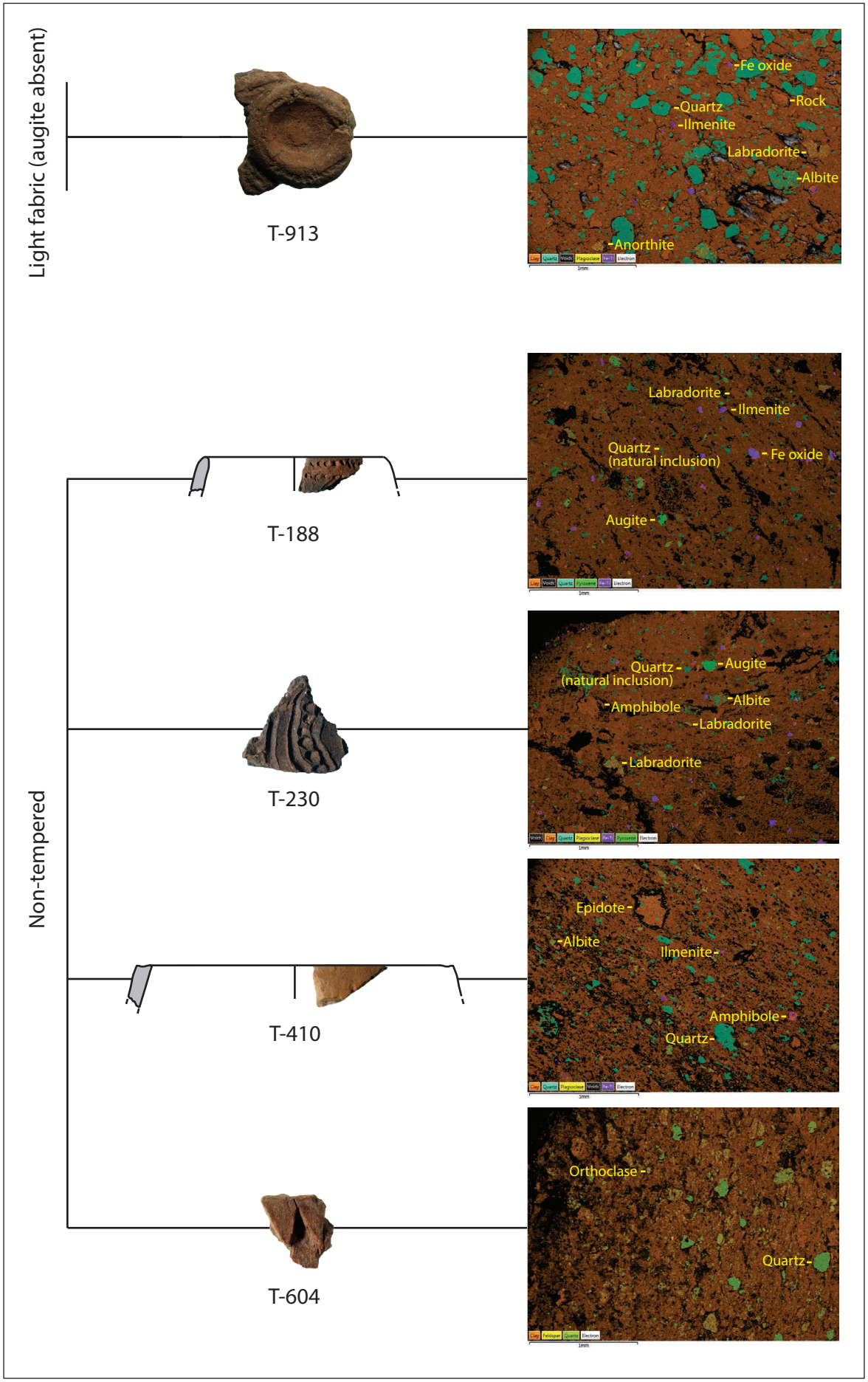


Figure 10.2. Different procurement choices represented by 'exotic' sherd tempers.

phase. Raw materials are essential to making things work. Because the Bel pottery production process hinged on making the raw material work and because production was essential to exchange and the procurement of subsistence crops and valuables, tampering with procurement strategies would have been risky and unnecessary.

Forming

The study of the Madang style forming phase aimed to describe the range of pre-colonial pottery production technologies around Madang and to describe the minor adjustments to these technologies over time. The results presented in Chapter 7 show that the forming stages of pottery manufacture in the pre-colonial past were immediately ancestral to the processes used around Madang today. Despite this, there are several important technical modifications that have taken place within these technological processes, over the past *c.* 600 years. Pre-colonial Madang style pots were all produced using the paddle and anvil method and were made using five broadly discernible technical sequences (Madang style Classes 1–5). These sequences represent distinct repetitions in *chaînes opératoires*, which may have been distinguished by the pre-colonial potters themselves (i.e. emic types), or several sequences may have been described as the same 'type' based on primary function or size. Four of these sequences (Classes 1, 2, 3, and 5) appear to have been made using a rim preform, given the abrupt reduction in body thickness just below the neck. Class 4 pots are different: incurving with no neck. If they were produced in a similar fashion to modern *magob*, which are also incurving, then they were made with a rim preform, but an anvil rather than the potter's thumb would have been used to open the orifice.

Through time, specific *chaînes opératoires* were engaged more often and indicate gradual trends towards making things differently (Fig. 10.3–10.4). Importantly, each forming sequence was enacted with similar clays and a variety of tempers, suggesting that each production group employed multiple forming methods, as they do today. The changes to the way people were making pots in the past are consistent with the stratigraphic sequences at Nunguri and Tilu and associated radiometric dates (see Chapter 6). For instance, Class 3 pots, representing an additional set of techniques for smoothing the interior of the lip to produce thick and relatively flat rims, become more frequent over time, beginning around 500–600 years ago (Nunguri Spit 12 and Tilu Spit 2) but becoming increasingly frequent within the last 300 years (Nunguri Spits 1–7). Interestingly, the early Class 3 rims at Nunguri are identical to the sole Class 3 rim found in the upper deposits at Tilu. Today all of the observed *bodi* pots are made using this technique. This demonstrates a gradual inclination towards producing *bodi* in this manner, as opposed to producing them with thinner rims (Class 1), or rims that are smoothed and paddled on the exterior of the lip (Class 2).

The innovation of Class 3 pots with flatter rims may be tangled up with consumption and reuse patterns. As the women potters were most likely also the cooks, they would have used *su* (recycled *bodi* employed as cooking stands) in everyday routine. These rims, made to be thicker and flatter, would have formed sturdier supports for cooking when turned upside down compared to high-angled, thin-rimmed Class 1 vessels. By extension, the practice of using *su* may be around 500–600 years old.

Additionally, in both the Nunguri and Tilu assemblages, there is a lack of Class 5 rims, which seems to mimic the rarity of *you-bodi* water pots in modern Madang groups. However, these become more common over time. On the other hand, Class 4 rims become less frequent in the assemblages and are not represented in the suite of ethnographically observed pots today or those in museum collections.[4] These Class 4 pots are morphologically more similar to Pila pots produced today along the northeast coast of New Guinea, *c.* 12 km northwest of Madang, than they are to modern *magob* pots. *Magob* are distinct from other Madang pots in the method of producing the rim preform, using a stone to pound open the orifice. This technique is also used to produce pottery at several Pila villages. It is possible then that the *magob*, and by extension Class 4 pre-colonial pots, were introduced by the ancestors of Pila potters, who married in to Bel potting groups and that Class 4 rims represent an earlier iteration of the modern *magob*. Vice versa, it is also possible that Pila pots stem from an offshoot of Bel potting traditions around Madang, or that the two traditions have emerged from a common ancestoral tradition.

The seriation of pot classes at Nunguri and Tilu are illustrated in Figures 10.3 and 10.4. When overlain, based on known radiocarbon dates from excavated contexts at both sites, the trends are consistent, supporting the radiocarbon determinations that indicate Tilu was occupied slightly earlier than Nunguri, and the later deposits at Tilu probably equate to early deposits at Nunguri (Fig. 10.5). Such a chronological sequence is not the end goal of this monograph, but it provides the chronometric resolution needed to then address the tempo with which technological processes changed and morphed over time.

The substantial variability of each pot's *chaîne opératoire* within these broader technological classes suggests there was a high degree of creative freedom in the production phase. For instance, Class 1 pots ranged in orifice diameter from 5–20 cm, with no real suggestion that these can be easily subdivided into different sub-groups although the size may have guided the eventual use in cooking or storage. Class 1 rims also followed a variety of profiles and courses, with a similar variety of lip profiles and extra lip features. There is little indication that minor technical

4 I examined ethnographic Madang pots from several key museums in Australasia, including the extensive Tuckson collections in the Australian Museum, and two early examples from the Macleay Museum, University of Sydney. It is possible that such forms exist in museums in America or Europe, for instance in Berlin or Budapest.

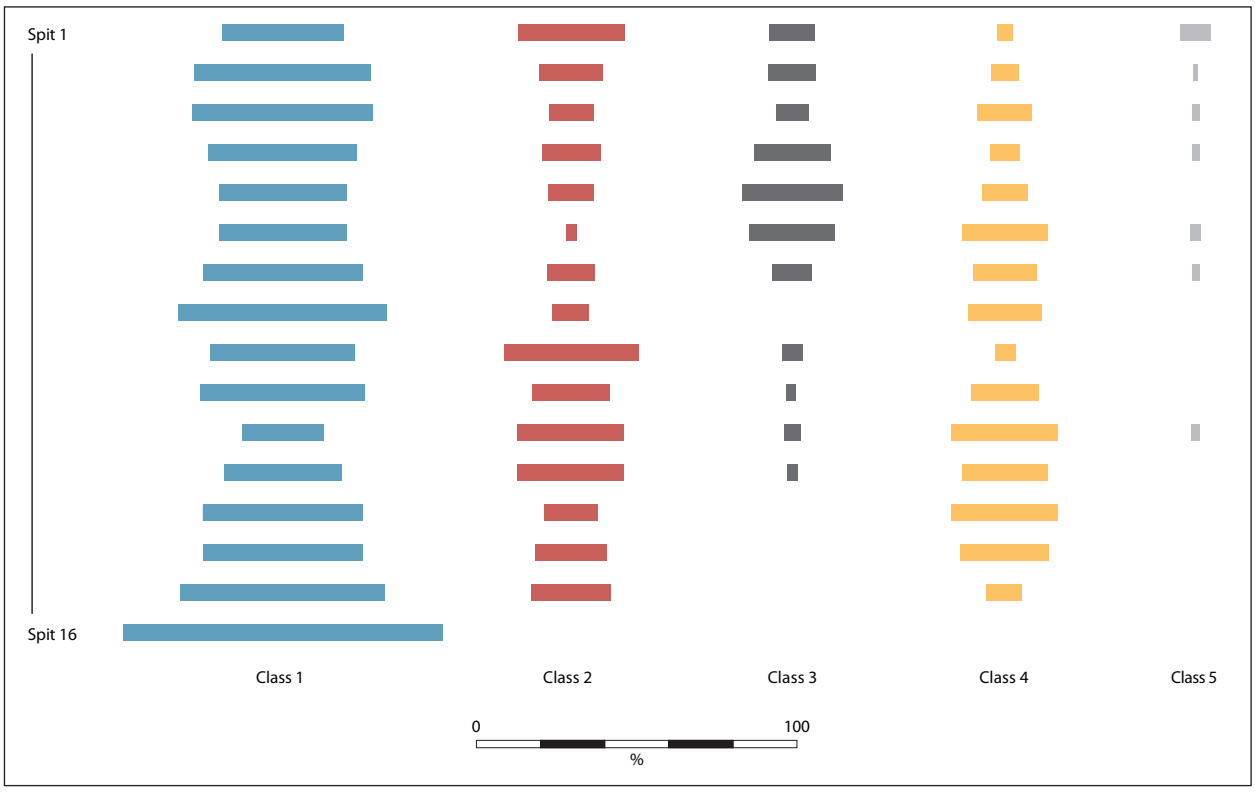


Figure 10.3. Seriation of Madang style technical classes at Nunguri, Test Pit 1.

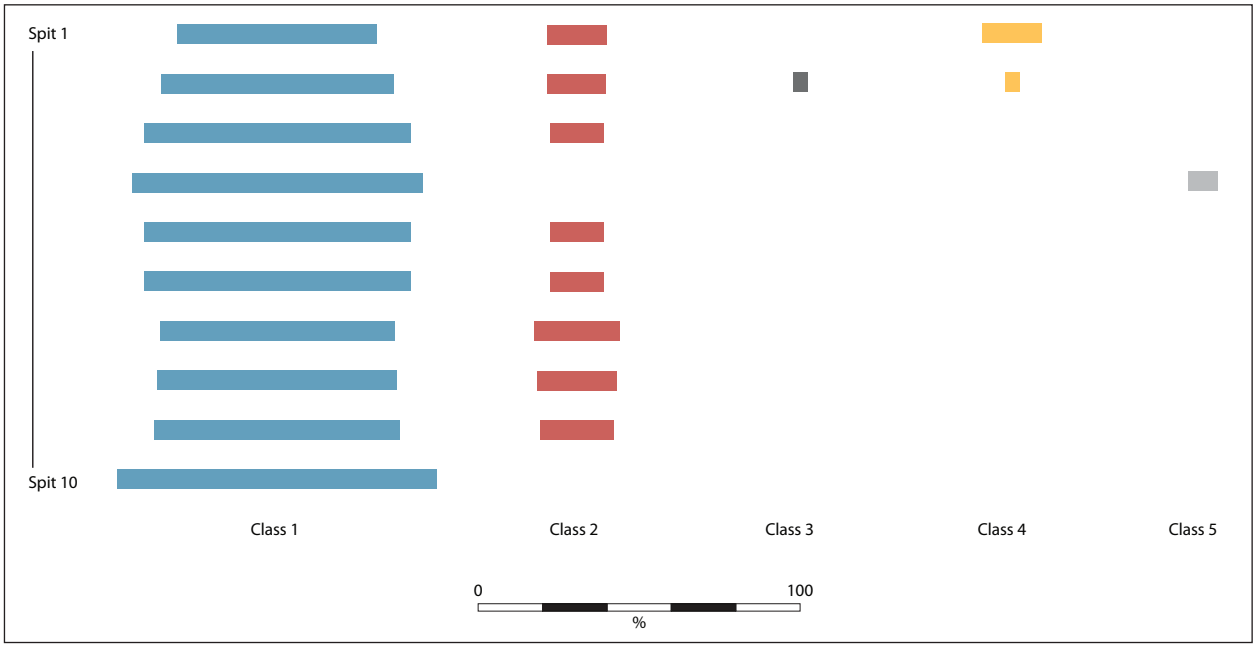


Figure 10.4. Seriation of Madang style technical classes at Tilu, Unit 1

variants tracked a pattern of gradual change. Rather, most technical elements continually fluctuated, suggesting that although the broad technical sequences (Classes 1–5) were socially regulated, experimentation and flexibility within these sequences was relatively ubiquitous.

Decorating

The analysis of the decorating phase presented in Chapter 9 was designed to clarify the groupings identified through the procurement and forming stages. This aimed to confirm the number of production groups working within various communities of practice. Moreover, because minor technical elements more readily lend themselves to investigating small-scale changes to technology (Mayor

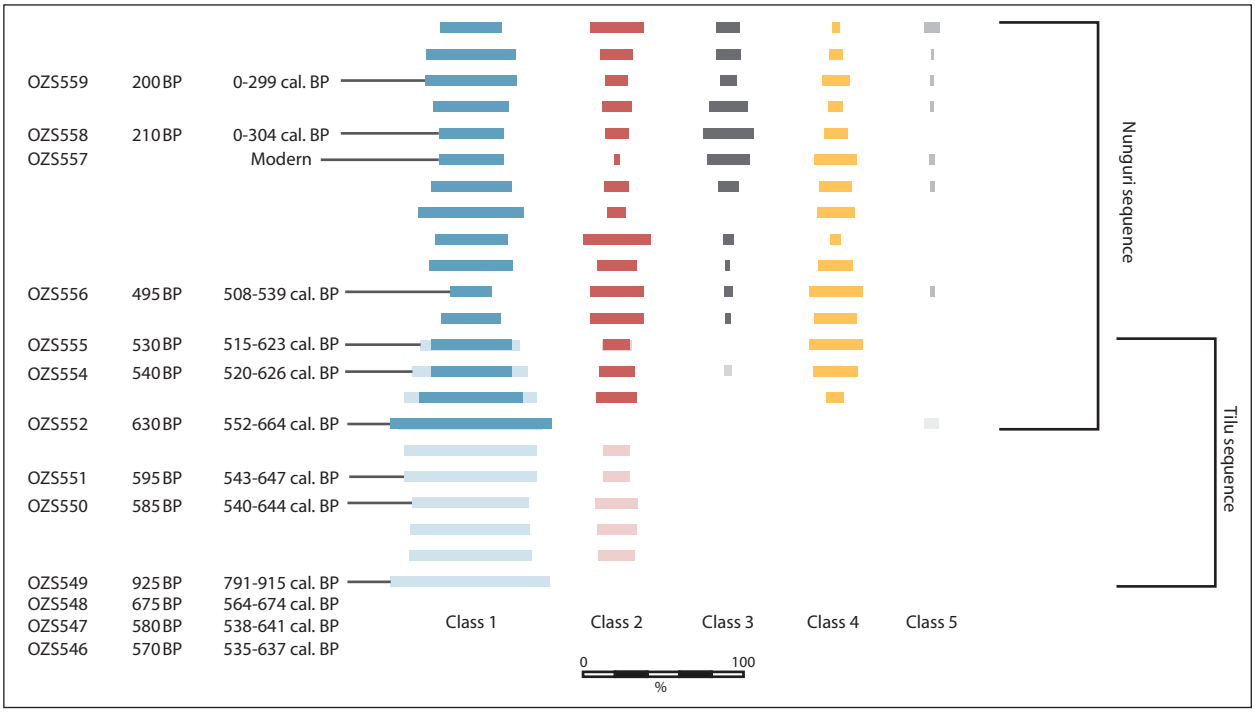


Figure 10.5. Comparison of Nunguri and Tilu seriations with associated absolute dates. Note the approximate overlap between the sequences.

2005), this analysis aimed to distinguish how technological change and knowledge acquisition took place locally over the past *c.* 600 years.

The results revealed that there was a series of established conventions which seem to have been cognitively constructed and shaped the nature of decorations. First, potters almost never combined multiple application methods. Only four instances of combination motifs were observed at Nunguri and no instances were seen at Tilu. Secondly, the potters tended to apply long lines flanked by smaller elements. These lines would demark specific locations on the pot and structure the finer decorative methods. Most decoration was made on the body/shoulder and this was usually applied as appliqué or incision. This is different to minor decorations around the rim, neck, and lip of the pot. For instance, decoration on the interior corner point was always impressed. Decoration on the lip was always punctation/impression. These rules were almost always conformed to, so we can infer that when the potter did not follow the rules it was for a specific reason. Perhaps such instances represent women from other villages that were newly learning the rules of potting, unaware of specific conventions; perhaps they were masters of the craft who held authority and the *vou*[5] to openly experiment with complex designs (see Roux 1990; Roux *et al.* 1995). These decorative regulations are in stark contrast to vessel forming, within which minor technical elements were fluid and flexible.

There are indications that there was gradual change to how pots were decorated over the past six centuries. Appliqué on the body/shoulder was more common earlier in time, and less common later in time, although these decorative methods are certainly not diagnostic of early and late periods of pottery manufacture. Rim decoration, on the other hand, was particularly common early in time and does appear to be diagnostic of early Madang style pottery (*c.* 650–550 cal. BP).

It is clear that specific decorations did not map directly to specific production groups as different decorative methods and motifs were used interchangeably across different raw materials and different technical classes. It is likely that decorative techniques, owing to their short and uncomplicated technical syntaxes, were observed and learned horizontally across production groups, along with being taught vertically through generations. This process may account for similarities in decoration across the technical groupings. This assertion contrasts with Egloff (1975), who suggests that decorative methods are akin to 'types' and are the most useful indicator of different production groups. He also stated that specific rim morphologies are correlated with decorative methods (Egloff 1975: 6), though without statistical demonstration. The contexts of each rim count at Egloff's sites are also not clear, nor whether any kind of refitting or MNV calculation was done, which would affect the frequency of decorated rims where sample sizes are low.

A Pearson's chi-squared test with Monte Carlo simulation owing to low cell counts confirms that, based on

5 A form of socially regulated intellectual property; see Chapter 3.

Egloff's data (in Egloff 1975: Table 1), there are significant correlations between rim forms and decorative methods ($X^2 = 349.998$, df = 100, $P < 0.01$), even when unknowns and undecorated sherds are removed ($X^2 = 241.189$, df = 54, $P < 0.01$). To elaborate, Table 10.1 shows a cross tabulation of Egloff's rim forms with decorative method, with ad-

Table 10.1. *Cross-tabulation of chi-squared results showing correspondence of decorative method to Egloff's (1975) rim type. Blue indicates adjusted residuals greater than two. Red indicates adjusted residuals less than minus two.*

	Appliqué	Incision	Paddle	Punctation
 1	−1.8	2.1	2.5	−3.0
 2	−1.1	−0.5	1.9	1.1
 3	0.9	−1.4	0.7	−0.1
 4	0.3	0.2	−0.5	−0.5
 5	0.7	−1.9	2.8	−1.1
 6	2.5	−1.2	−1.5	−1.4
 7	−0.2	0.7	−0.4	−0.4
 8	1.2	−0.9	−0.4	−0.4
 9	3.6	−1.5	−2.2	−2.0
 10	–	–	–	–
 11	1.7	−0.7	−1.0	−0.9
 12	−1.6	−0.9	4.8	−0.4
 13	–	–	–	–
 14	−3.3	4.6	−0.8	−0.8
 15	3.4	−2.5	−1.2	−1.1
 16	–	–	–	–
 17	−1.2	1.6	−0.3	−0.3
 18	0.1	0.6	−0.7	−0.6
 19	−1.5	2.6	−0.9	−0.8
 20	−1.2	1.6	−0.3	−0.3
 21	−0.3	−0.1	−0.6	1.4
 22	−4.9	0.1	−1.6	11.1

justed residual values of greater than two, indicating substantially more counts than expected, marked blue while those with less than negative two, indicating substantially fewer counts than expected, are red. The results indicate that many rim forms were more or less frequently decorated with appliqué, incision, paddle impression, or punctation. For instance, Rim Form 22 is frequently decorated with punctation, and much less often with appliqué. This form is consistent with modern Madang style rims (Class 3), which are decorated with punctation around the neck.

This pattern is counter to the data presented in this volume, which suggest no significant differences between the technical classes ($X^2 = 13.680$, df = 12, P = 0.315), despite similar sample sizes (Egloff = 291, Gaffney = 213, both with unknowns and plain sherds removed). Table 10.2 compares the decorative data produced in this volume (compiling Tilu, Nunguri, and surface collections) with Egloff's (1975) data, again using a cross-tabulation of chi-squared results and adjusted residuals. This time, Egloff's rim forms have been condensed into Madang style Classes 1–5. The table shows that there are many notable correlations between form and decoration in Egloff's assemblage, whereas in the 2014 assemblage there is only one correlation, with Class 4 rims less frequently displaying impression/punctation. It is unclear why Egloff's assemblage produces notable associations and the 2014 assemblage does not, but it may relate to Egloff's assemblage representing a greater geographic and temporal range. It does appear that Egloff's Rim Form 22, which is well represented (n = 70), is a modern iteration of a Class 3 vessel that is not represented in the 2014 assemblage except for one surface find (Y-6). This would support the assertion that decoration can, to some degree, be used as a relative temporal signature, just as forming techniques gradually shifted from Class 1 to Class 3 being dominant.

Table 10.2. *Cross-tabulation of chi-squared results showing correspondence of decorative method to Class 1–5 rims. Egloff's assemblage above, Gaffney's assemblage below. Blue indicates adjusted residuals greater than two. red indicates adjusted residuals less than minus two.*

		Appliqué	Incision	Paddle	Punctation
Egloff (1975)	1	2.0	–1.2	2.8	–4.8
	2	2.3	–0.8	–1.5	–1.4
	3	–3.2	0.6	–1.6	7.0
	4	0.1	0.6	–0.7	–0.6
	5	–1.5	2.6	–0.9	–0.8
		Appliqué	**Incision**	**Paddle**	**Imp/Punct**
Gaffney	1	–0.2	–1.9	0.8	1.9
	2	–1.3	1.0	–0.5	1.0
	3	–0.5	1.3	0.1	–0.8
	4	1.9	0.2	–0.3	–2.5
	5	0.3	0.6	–0.4	–0.8

We can integrate the Madang style decorating techniques into broader learning schemes within the production groups. For instance, the introduction of impression as a decorating method at Nunguri, to supplement appliqué, incision, and paddle impression, probably resulted from vertical learning, perhaps with potters marrying in from another potting tradition, who then continued that method and taught it to their daughters. This is because the use of tools to impress rather than incise or apply would have required subtly different gestures to those learned by potters accustomed to using paddling, appliqué, or incision. Alternatively, independent innovation by one or more potters within the production group may have occurred and later been increasingly adopted by others observing that potter or her pots.

In pre-colonial Madang the symbolic meaning of decorations is not apparent. As outlined in Chapter 4, amongst modern Bel potters there are three stages of decoration with varying importance. First, the zone of decoration is delimited to the shoulder and neck of the pots (this rule is usually only ignored if producing a pot for the tourist trade). Second, small incisions are usually made around the shoulder. Finally, the potter makes deep impressions around the neck. However, these aspects of decoration are considered by the Bel to be arbitrary matters of personal preference and without discursive meaning. This is similar to other examples of pottery production internationally (e.g. Stanislawski 1977 studying the *Hopi,* or Gosselain 1992 studying the *Bafia*), where production technique is considered important but decorations are seemingly arbitrary. This is not to say that specific decorative forms did not have specific meanings in the past (although these are not known by the modern Bel). For instance, in the early 20th century, Hanneman (1969) collected numerous designs from Bel artefacts, particularly wooden ones. For many of these geometric designs the makers or users could ascribe the meaning and symbolism behind the decoration. These decorative elements were often personal to the designer and represented important events or chance observations. Small incisions might indicate cassowary tracks if produced by one person, or mouse tracks if produced by another; one design might indicate coconut fronds, while another similar one might indicate fish spines. It is particularly striking that many of the incised designs executed on pre-colonial pots are remarkably similar in form to those produced on the colonial period wooden implements described by Hanneman (1969).

Given the hints towards an intertwined ritual and bodily significance of pottery production (see Chapters 3–4), we could expand ideas about these rules surrounding decoration further. Oral traditions suggest pots in Madang must be slipped prior to firing, and it is through firing that pots become 'as a man'; red like the red paint worn by initiated

Bel males. This is reinforced in the Bel language, referring to the slip as the pot's skin (Yeyeg, quoted in Christensen 1975:86). This stage is an integral and invariant procedure in the production process and without it the pots could not fulfil their function. Just as the red slip represents the red pigment and paint used in initiation ceremonies, perhaps we can tentatively speculate that incisions and appliqué marks on the surface of pots were also symbolic. Perhaps incision marked the incision of young men and the appliqué the scarification. It is worth stating that many scarification designs amongst Sepik groups are identical to those produced on historical pottery and wooden bowls (see designs in Schechter 2011; Terrell 2011), while the correlations between pottery decoration and tattooing have long been cited (Kirch 1997:131).

The magic of the *chaîne opératoire*

We can expand this discussion about ritual and assert that magic was another significant and essential tool in the production sequence. Such intangible and archaeologically invisible materials are often overlooked. However, as presented in Chapter 3, magic was a pervasive undercurrent of life for the pre-colonial Bel, until the Lutheran Church instigated the destruction of magical items and the dilution of magical knowledge systems (Mennis 2006a:138). Although no magic was discussed during the 2014/2015 interviews with Bel potters, previous researchers have noted the importance of magic in the production both of pots and of the canoes used to transport these pots (Aufinger 1942; Hannemann 1944; May & Tuckson 2000; Mennis 2006a, 2011, 2014; Tuckson 1966) and oral histories frequently indicate production technologies were restricted and required magic (Mennis 1980b, 1981a, 1981b). The Bilbil and Yabob held the *vou* – technological expertise (also referred to as magic) – to produce and distribute pottery, giving these groups an elevated status on the northeast coast.[6]

During the forming stage, potters would use anvils with magical properties to pound malignant *tibud*[7] out of the clay (Tuckson 1966). In a similar way, men would recite magical words to appease these spirits when chopping down trees to make canoe hulls or while pulling these logs through the forest (Mennis 1980b:24). It follows that it was the raw material that contained malignant *tibud,* which needed to be appeased or driven out to safely carry on with daily routine. It is not unreasonable to suggest that in digging for clay and slip, and collecting temper sands, firing material, and fresh water, Bel woman would have negotiated locally abundant *tibud* through the use of magical words or materials. Perhaps then, magic played a central role in activating the *chaîne opératoire* and materialising ancestral Madang pots.

Production groups and communities of practice

From the foregoing discussion of pottery procurement, forming, and decorating, we can build pre-colonial pottery manufacture into a tentative series of *chaînes opératoires* (Fig. 10.6). Although many processes remain archaeological enigmas, simply because they do not leave lasting traces on potsherds or do not survive in the archaeological record, this description of pottery manufacture forms the backbone of interpretation and allows for comparison with other pottery manufacturing groups, extant or defunct. The systematic technological classification presented in Chapters 7–9, and summarised above indicates that in the pre-colonial past one or more production groups were in operation around Madang, collecting similar local raw materials and producing the same variety of potteries with standard techniques. Each production group made pots, following five distinct forming sequences, but there was a large degree of freedom in how the individual pots took form. Decorations were also interchangeable within each raw material and forming sequence, and between production groups, despite following set rules. I posit that these production group/s were operating within a closely related community of practice (see Lave & Wenger 1991; Wenger 1998). Within this community of practice, there was considerable mobility, movements of potters, and transfer of ideas, horizontally and vertically, which maintained technical variability within the community but prevented divergent threads clearly emerging in different production groups.

Communities of practice are here seen as overlapping networks of production groups, which share technical traditions (Eckert *et al.* 2015) – ways of doing and making. These technical traditions are reshaped through learning and sharing across generations (Stark 1998b) and can be identified by examining technical processes and the repetition of technical elements in the *chaîne opératoire* (Eckert 2008). As introduced in Chapter 1 and expanded in Chapters 7–9, learning and knowledge acquisition are processes whereby motor skills and abstract thinking are intertwined at every stage of making: learning the properties of raw materials; the use of tools; the craft lexicon; the symbolism behind specific shapes, functions, and decorations; and the envisaged vessel forms. Within the production group, practitioners first participate through peripheral learning such as the collection of clays or the preparation of paste, but progressively graduate into more complex tasks and more demanding bodily requirements. Although considerable time is spent learning the movements and materials, production entails broader enmeshment with the social world and further time is spent becoming part of the group, developing *savoir-faire* (know how), and making a real *Bel* potter. In some modern studies of apprenticeship, the 'technical' component of the production process is negligible compared to emotional and social labour involved in becoming part of a group (Wallaert 2013). Thus,

6 Note that on the south Papuan coast, pots were also imbued with magic (May & Tuckson 2000:60).

7 Spirits, souls of the dead, ancestors, or sprites who inhabited the living world. Everything which could not be explained was attributed to *tibud*, which could cause sickness, natural disasters, and accidents (summarised from Mager 1952; see Chapter 3, pg. 53).

learning within this community of practice resulted in the specialised knowledge of raw material locations, forming techniques and firing temperatures, but also a range of implicit social values such as what to wear, how to act, and when to perform specific tasks (Wendrich 2013).

Through technical traditions shared by the community of practice, different modes of identity and personhood were created (Dobres 2000) and social boundaries were formed (Stark 1998b; Wallaert 2013). Those who produced pots within the group were, through their habitual engagement with the process of production, seen as different from those who distributed the pots or those who gardened. Moreover, on the community level those groups who produced and distributed pots were regarded with distinct elements of difference, compared with those who primarily produced food for consumption or those who made wooden bowls. In the case of the Bel groups, this fact can be observed in oral accounts of Bel's unique place as pottery makers and traders in the broader northeast coast's social landscape (see Mennis 1980b, 1981a, 1981b). To paraphrase Childe (1936), in Madang woman makes herself, and her social group's place in the broader social environment.

Among the modern Bel potters, the women who learnt to pot as young girls are often the most proficient manufacturers, likely because the pottery learning process has become intertwined with other core cognitive processes (see Piaget 1972; Sternberg 1983, 1999). Although vessel forming is usually a conservative practice, this is especially the case in household production where manufacture takes place behind closed doors (Arnold 1998). For the Bel, who often pot communally, we might expect less conservatism but more standardisation in form as there is more communication, discursive and non-discursive, about how others are producing pots. However, the archaeological pottery suggests otherwise, that there was substantial variation within broadly conservative but gradually changing technological processes.

Two processes operating within the community of practice, which perhaps explains the interplay between conservatism and change, may be a dialectic between 1) marriage, and 2) the *vou*. If marriage along the Madang archipelago was primarily exogamous, as it is today, then it would have encouraged substantial residential mobility over the lifetime of the potter, with Bel potters learning to pot in one clan group but teaching their daughters in another. Simultaneously, Bel woman from non-potting clans or non-Bel woman would have married into production groups and learned to pot as adults in these marital groups. The movement of inexperienced women into potting groups as well as the movement of experienced potters within these groups would have been a major source of innovation and variation within the technical tradition. The high degree of interaction within the community of practice over the generational timespan would account for consistent gestures and tools being used, following specific and vertically taught *chaînes opératoires*, but would also account for occasional sources of innovation and the diverse technical variation within each, owing to differing skill levels, different desires to learn, and different lengths of time spent as a member of the community of practice.

This leads on to the second process. Females learning to pot can be compared to the male initiation ceremony. Although gradual and without lavish rituals, the learning process produces knowledge that is controlled and regulated through the *vou*; a magic protocol that keeps technical knowledge secret within the community of practice. The similarities in clay chemistry, indicating that the area around Bilbil was the locus of clay procurement, suggest that the production groups producing Madang style pots were not geographically disparate, unless raw clay was being traded long distances. Although Mindiri can be included within the community of practice, around Madang itself production and consumption of pots was almost exclusively local and it seems there were geographic and social limitations in the past, as there are today, concerning which groups could pot. So, although we could expand the boundaries of the community of practice to include the canoe builders, those who transported the pots, and so forth, those groups specifically engaging with pottery manufacture were tightly regulated. Based on the relatively restricted clay sources used and the general conformity to an overall Madang style aesthetic, it is likely that the process of *vou*, preventing females who married into other clans along the coast then producing their own pots, has a long history.

Dadeng: aspects of pre-colonial exchange

In addition to following processes of making, we can also examine how objects become bound up in the life histories and social interactions of the people who transported, exchanged, used, and valued them (Ingold 2011). It is through these lines of entanglement that lives are lived. Despite this, we should also recognise that entanglements have their boundaries. Fluidity has its limits, stoppages, asymmetries, and consolidations and these are important to describing the local and historical contingencies of exchange in the area (Knappett 2011; Strathern 1996; Thomas 2019).

The community of practice – a network of groups along the coast, and to some extent extending inland, with shared ways of doing and making things – was essential to the maintenance and reconfiguration of these exchange processes. This section will describe aspects of pre-colonial exchange around Madang and examine how, and perhaps why, changes to pottery distribution occurred over last 500–600 years. This will compare the results of the present volume with the wider archaeological literature regarding the northeast coast at 1) the local level, and 2) the regional level.

Local distribution

The community of practice operated within local and regional networks, but had locational nodes, at the clay de-

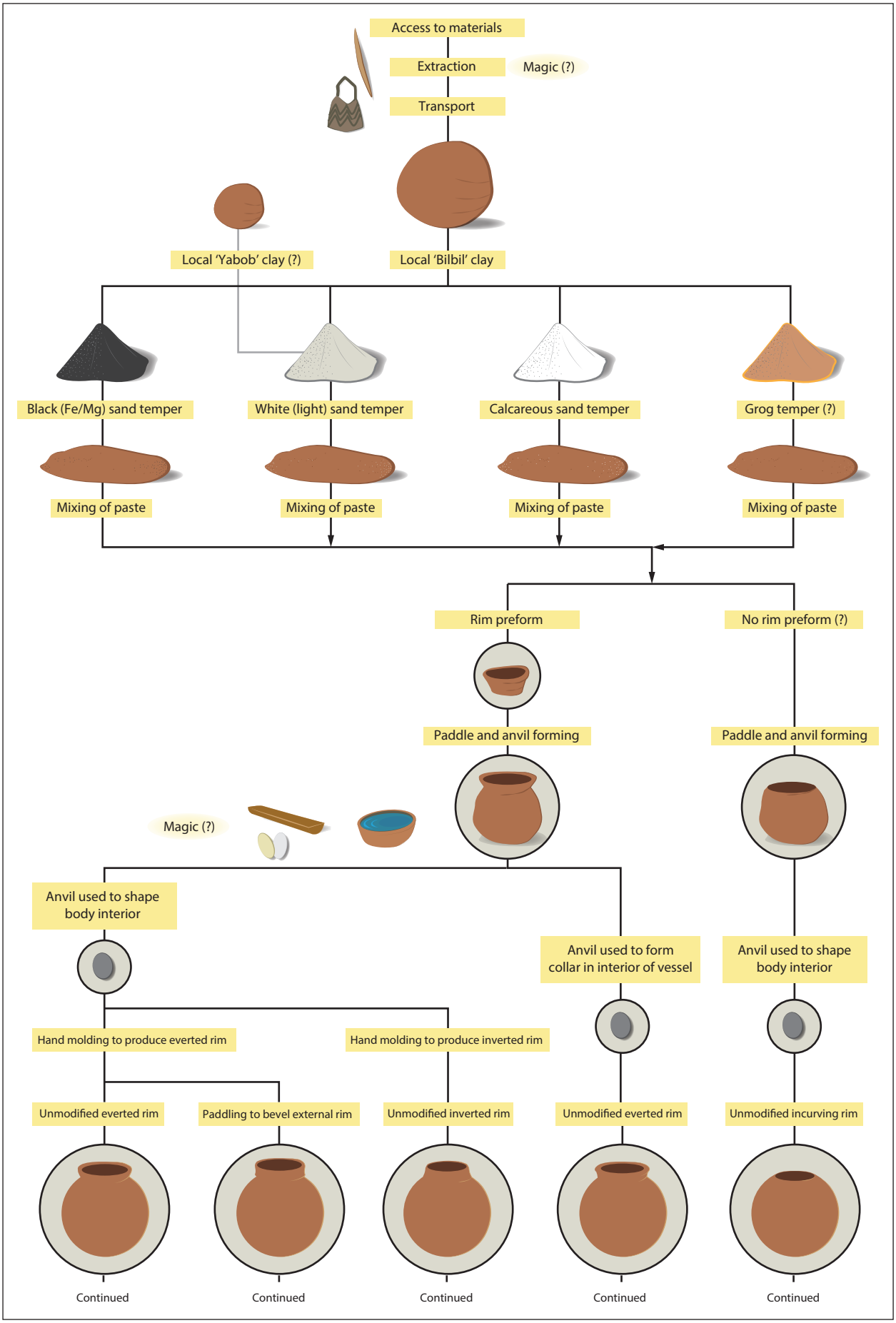


Figure 10.6. *Chaînes opératoires* of pre-colonial Madang style potteries.

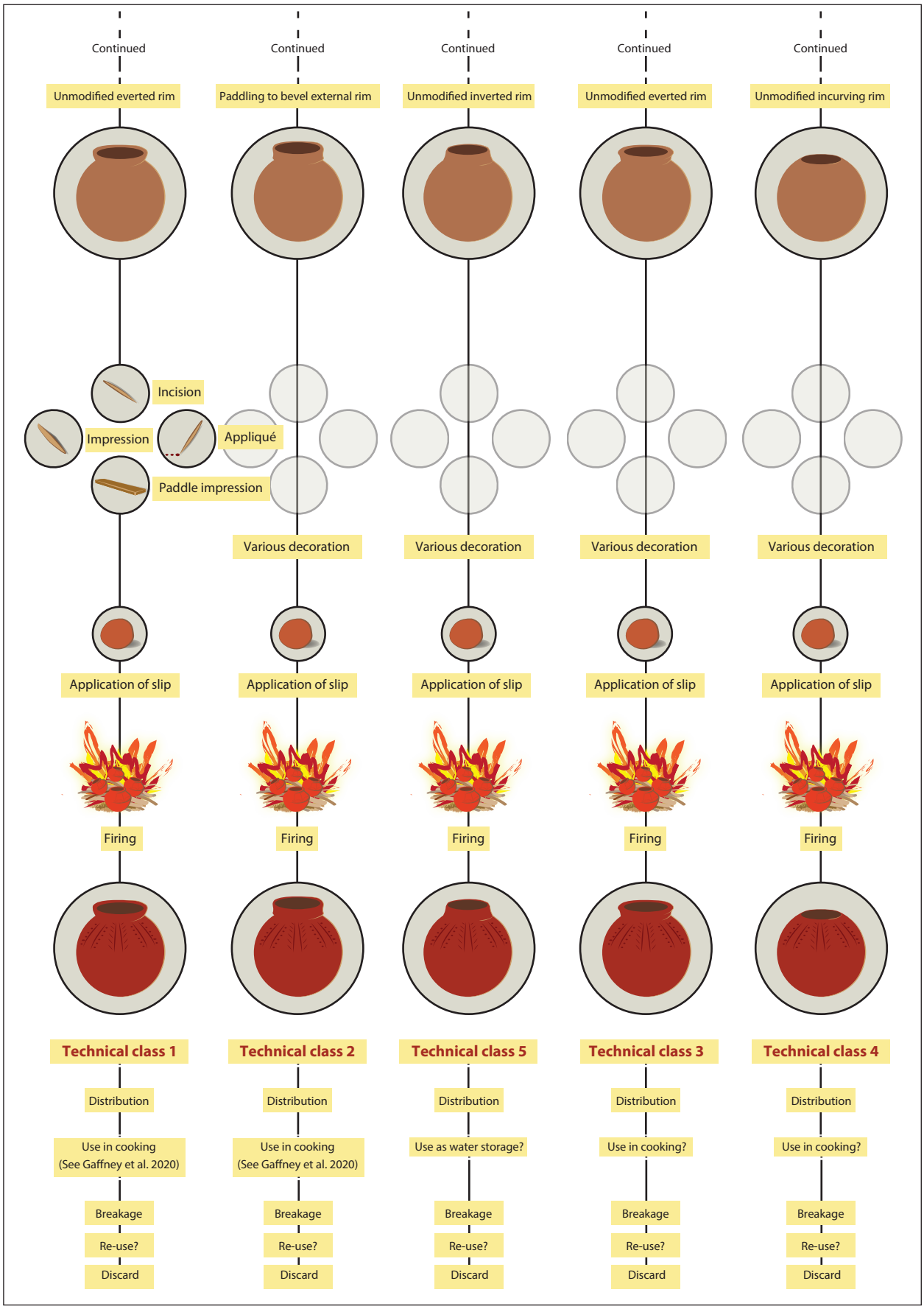


Figure 10.6 *continued*. *Chaînes opératoires* of pre-colonial Madang style potteries.

posit, the household, the workshop, the canoe, and across the landscape (Ingold 2010). On the local scale, oral traditions and ethnographic observations suggest exchange took place, often informally, within Bel settlements, along the island chain between Bel groups, and on the mainland between Bel and inland clans (see Lawrence 1964: 27; Mennis 1980b, 1981a, 1981b; Sentinella 1975). At ethnographic contact, Bel groups were primarily living on offshore islands and in coastal localities around Madang Lagoon (Kranket, Siar, Riwo, Malmal, and Sek) or on the four small islands extending southwards down Astrolabe Bay (Bilbil, and three islands used by the Yabob). To establish where Bel groups were living deeper in the pre-colonial past, how they were interacting, and with whom they were exchanging, it is useful to synthesise the available local archaeological evidence.

As presented in Chapter 5, previous archaeological work was completed by Jim Allen (1971) and Brian Egloff (1973, 1975) around Madang. However, the excavations were limited in extent and the subsequent analysis of ceramic material was cursory. Nonetheless, these assemblages provide comparative datasets from a variety of locations around coastal Madang. The range of pot forms and decorations presented by Allen and Egloff are consistent with those described from excavated contexts at Nunguri and Tilu, along with surface collections from Kranket, Yabob, and Siar. Allen's description of sherds from the JAE site fits within the present Madang style classification (Classes 1–5) and suggests a very recent pre-colonial occupation on the mainland by non-Bel groups, trading with Bel potters for food, bush material, tools, as bride prices, gifts, compensation, and so on.[8]

Although Allen used a different classification system, the JAE rims were grouped by morphology and forming technology, making the results broadly comparable to the present Madang style Classes 1–5. Following my classification system, 54% of Allen's sherds are attributable to Class 1, 7% to Class 2, 40% to Class 3, and 0% to Classes 4 and 5. The nearest approximation of this distribution is from the upper deposits at Nunguri, especially Spit 5, which contains 40% Class 1, 14% Class 2, 31% Class 3, 14% Class 4, and 0% Class 5. This deposit is associated with a date of 210 ± 25 BP (OZS558; see Chapter 6), calibrated to either modern (15–0 cal. BP), or very recent in the pre-colonial past (304–267 cal. BP and 215–145 cal. BP) at two standard deviations. The high number of Class 3 rims at JAE suggests recent pre-colonial occupation (*c.* 300–150 years ago), while the lack of shoulder carinations, along with the presence of appliqué, indicates the deposit is not modern. The absence of Class 4 and 5 rims may result from a small sample size (n = 85). It may also represent cultural differences in the mainlanders' practices of storage and food preparation. Perhaps other items such as wooden bowls or bamboo fulfilled the functions of Class 4 and 5 vessels, which were possibly intended as water storage and boiling pots, just as modern Highlands populations do not often use clay pots owing to different cooking methods (Hughes 1977).

As above, Egloff's excavations in 1973–1974 were geographically extensive, working locally from Sek Island in the north to Bilbil Island in the south. Each of the 17 sites Egloff recorded bore distinct red-slipped Madang style potsherds, suggesting that Bel potting groups were exchanging objects around the Lagoon and onto the mainland in the pre-colonial past. These sites include Sek Island, Migajpanad Island, Yabob Island, Bilbil Island, Nagada, Vidar, St Fieldis (near Alexishafen), Tabad Island, Riwo Island, Malmal village, Malmal Udou, and Malmal Island. To refine the chronology of exchange, Egloff obtained three radiocarbon determinations from Malmal village (Tilu) indicating occupation by *c.* 550 BP, calibrated to *c.* 300–700 years ago at two sigma (see Chapter 5). Egloff's dates were primarily derived from combined samples of charcoal from different depths, using conventional dating techniques that produced a substantial error range of 400 years. The 2014 excavations and subsequent AMS radiocarbon dating of single wood-charcoal samples from both Nunguri and Tilu have refined this initial date of ceramic occupation around Madang. Although the 2014 dates broadly confirm the original interpretations of Egloff (1975), who suggested Madang style pottery production and exchange along the local coastline was very recent, the earliest known evidence for occupation can now more precisely be situated around 550–650 cal. BP.

It is notable that Tilu in the north contains subtly older deposits than at Bilbil Island, despite Bilbil featuring as a locus of pre-colonial pottery production in oral accounts. Deposits from other mounds on Bilbil Island might yet yield slightly older dates, in line with Tilu. Alternatively, pottery production at Bilbil Island may indeed be slightly younger than the initial production and exchange around Madang, with the first potters living on Yabob Island, as the Honpain story states (see Chapter 3 and 6), and later dispersing to Bilbil, closer to the favoured clay sources.

It is not certain from either the 1973–4 or 2014 excavations at Tilu, whether the initial ceramic occupation at 550–650 cal. BP represents the exchange between Bel potters near Bilbil/Yabob and other Bel groups living at Malmal (Tilu), or if those living at Malmal (Tilu) were non-Bel speakers and less closely related, both culturally and genealogically, to the pottery makers. As Tilu was plausibly an island at initial occupation it may be more suggestive of a Bel settlement pattern, as the Bel identify as 'people of the coast/sea,' and occupy many of the offshore islands. The sequence suggests no disjuncture in material culture, implying that Tilu has been occupied by a lineage of people with similar exchange, consumption and discard practices throughout the past few hundred years. The working interpretation is therefore that the early deposits at Tilu represent part of the initial Bel settlement in the Madang area.

8 This is following oral traditions that suggest Bel groups did not live near the JAE site or on the mainland around modern Bilbil village until the German administration in the late 19th century (see Chapter 3 and 4, also Mennis 1980b, 1981a, 1981b).

Neither Egloff nor Allen describe any non-Madang sherds in their local assemblages.[9] Fabric and clay composition were not examined by either scholar, so it is impossible to state unequivocally that exotic or non-Madang style pots were absent from the assemblages. It is readily apparent though that Madang style pots dominated local exchange and consumption. This is consistent with the 2014 investigations, which only recovered 12 'exotic' sherds, equating to under 0.0003% of the total.

Local exchange patterns are often difficult to tease apart where resource procurement zones overlap (Arnold 1980). However, the comparison between the material described above with summary collections from the 1970s suggests local exchange of pots (known as *Dadeng* in Bilbil) between Bel groups was probably occurring from *c.* 650–550 years ago, while exchange with mainland groups was almost certainly occurring by *c.* 300–150 years ago, prior to European contact.

Regional distribution

The discussion will now turn to regional exchange networks. Like the island of Tumleo off the Sepik, or Yule Island, Motupore, and Mailu off the south Papuan coast, which could not produce enough food to support their populations (see Irwin 1991; Summerhayes & Allen 2007; Terrell *et al.* 2011), the Madang offshore islanders had to turn their gaze outwards to maintain subsistence (Mennis 2014). At ethnographic contact, the Madang exchange network extended several hundred kilometres along the northeast coast, overlapping with the Siassi network, the Sio, the Arop, the Tami and so on, to obtain crops and domestic animals, along with desired material culture (Harding 1967). To investigate the extent of this network in the pre-colonial past, the analytical lens is now cast more broadly onto the northeast New Guinea region. Comparisons will be drawn between the local Madang pottery assemblages and those described elsewhere in the archaeological literature, in an attempt to establish how pots were exchanged through the region. The distribution of Madang style pots outside of Madang itself suggests that local and regional exchange was subtly different.

To the north, Madang style pots were transported at least as far as Karkar Island, probably to the Takia-speaking Bel, who today occupy the southern half of the landform. Egloff (1975) excavated six sites on the island (JBL–JBQ), all of which contained red-slipped Madang style sherds, consistent with those described in this monograph. Many of them were decorated with linear appliqué, suggesting that this exchange occurred prior to the colonial period. Recent excavations and dating on Karkar confirm the pre-colonial presence of the Madang style in the last half-millennium before present (Gaffney *et al.* 2018). At Sarong (JBK), on the adjacent mainland, no Madang style sherds were recovered, and may indicate a social boundary in the direct exchange of pots north towards Hansa Bay. As yet, there is no evidence that Madang style pots were exchanged as far as Aitape on the Sepik coast, or vice versa, but the superficial similarities between the Madang style and the Aitape sequence are striking, as pointed out by Lilley (2002: 88).

Madang style ceramics were certainly traded further east, where it appears the majority of pre-colonial and colonial period exchange was directed. Madang style sherds have been found along the Rai Coast, at Sio and Gitua on the Huon Peninsula, in the Vitiaz Strait, the Huon Gulf, and into New Britain (Abramson 1969; Egloff & Specht 1982; Gaffney *et al.* 2019; Gosden & Webb 1994; Lilley 1986, 1991; Lilley & Specht 2007; Summerhayes 2001a). Lilley (1986) provides the only substantial description of a Madang style assemblage outside of Madang itself and he describes sherds from dated deposits at Sio (KBQ) and on Malai Island (KLJ) in the Siassi group.

Of the 129 classifiable Madang style rims identified in the Vitiaz Strait sites, Lilley discriminates three classes, from which this volume's classification is ultimately derived. Class 1 rims, everted with round lips, represent 61% of the assemblages; Class 2 rims, with pointed lips, represent 31%; Class 3 rims, with flat lips, represent only 8% (Lilley 1986: 195). Interestingly, Class 4 and 5 vessels are not present, perhaps suggesting consumer choice in the exchange of pots with different functions, as at JAE on the Madang mainland (see above). There may not have been any demand, as wooden bowls were produced along the Rai Coast and in the Siassi and Tami islands.

The full range of Madang style decorative methods is represented in the Vitiaz Strait assemblages: appliqué (72%), incision and punctation (21.5%), paddle impression (0.3%), and incised/impressed appliqué (6.1%) (Lilley 1986: 206). Overall, appliqué was common on Class 1 (33%) and 2 vessels (37%), but incision was more common on Class 3 vessels (60%) (Lilley 1986: 209), which mirrors the results from the 2014 sample, along with Egloff's (1975) Rim Form 22. A cross tabulation of chi-squared results (Lilley 1986: Table 6.3), however, indicates that based on the sample size no statistically-meaningful association between decorative method and rim form is necessarily present ($X^2 = 7.607$, $df = 4$, $P = 0.109$, using Monte Carlo simulation), further supporting the 2014 results (contra Egloff 1975). Lilley's results have been converted to display adjusted residuals in Table 10.3 and can be compared to Table 10.2 above.

As per the 2014 sample, Lilley noted only one carinated shoulder, in contrast to modern Madang vessels, further demonstrating that almost all pre-colonial Madang style pots were more spherical in shape (e.g. Fig. 3.8, especially pot D705). Inner rim notching was present on 66% of Lilley's Class 1 rims, 72% of Class 2 rims, and 80% of Class 3 rims, which is more akin to the Tilu assemblage (78%) than Nunguri (47%), supporting a generally earlier date for much of this exchange.

9 Egloff (1975: Figure 1) describes Sarong-style sherds, which are deeply incised, but these appear to only be present further north at Sarong and on Karkar.

Table 10.3. *Cross-tabulation of chi-squared results showing correspondence of decorative method and rim class (based on Lilley 1986: Table 6.3). Blue indicates adjusted residuals greater than two.*

	Appliqué	Incision	Plain
1	0.0	1.0	–1.6
2	–1.3	–0.1	2.5
3	1.2	–0.9	–0.7

Lilley (1986) also provides the only other examination of Madang style fabric and composition, using thin-section petrography, supplemented by emission spectrography and XRD. His analysis of non-plastic inclusions was, in some ways, more thorough than mine, describing also the relative abundance of different minerals along with mineral texture. Nonetheless, the results are broadly comparable, and demonstrate pottery exchange between Madang and further east. Supporting the results presented in Chapter 8, Lilley (1986: 229) notes a high diversity of pastes in use by Madang style potters (Table 10.4), some even overlapping with the Sio style. Madang style pastes can be grouped into half of the nineteen paste groups that Lilley identified. Most sherds fall into the range of fabrics described around Madang and comprise various proportions of Fe-Mg (primarily pyroxene), light (plagioclase and quartz), and calcareous (probably coral rather than shell) inclusions. This is testament to the flexibility of the procurement stage. Of particular interest, however, are three anomalous sherds. Table 10.4 shows Lilley's Paste Groups 1 and 18 do not fit with the range of fabrics observed around Madang, as they distinctively lack pyroxene. Lilley had difficulty in 'sourcing' these pastes to the nearest ethnographic clay because while most of his Madang style sherds grouped with the Bilbil clay sources, so too did many Lapita and Sio sherds (Lilley 1986: 244–245). It is possible that some Madang style sherds would not group with the Bilbil sources in clay or fabric, especially if they date to before initial Bel occupation around Madang, perhaps suggesting potting initially occurred somewhere else in the region.

On the site level, at Malai (KLJ) in the Siassi Islands, Madang sherds are present alongside Type X and Sio styles and formed a substantial part of the assemblage (30%). The site dates to very recently, mostly within the last 200 years and definitely within the last 550 years, making it a good comparison to Nunguri. Throughout the sequence, across two excavation pits, Madang sherds become more common, especially by Layer 2/3, which likely dates to very recently in the pre-colonial past (Lilley 1986: 297). Class 1 and 2 rims are present throughout the sequence, contributing 53% and 30% of the Madang rims respectively.[10] Curiously, Class 3 rims are absent, which on the basis of the analyses in the previous chapters, strongly suggests the deposit is older than *c.* 200 BP (*c.* 0–300 cal. BP), despite Lilley's numerous modern dates on wood-charcoal in Layer 2 (see Chapter 5). No trend over time was observed in the number of different rims being deposited, but appliqué

10 Note, 17% of Madang style rims could not be assigned to a class.

Table 10.4. *Comparison of Gaffney's fabric and Lilley's paste group designation.**

Gaffney fabric	Description	Lilley paste group	Sherd type	Classification
Calcareous	Calcareous dominant with minor Fe-Mg (Px)/light (Pl+Qtz) inclusions	2	Rim	Class 3
		2	Decorated body	Appliqué
		2	Decorated body	Appliqué
		2	Decorated body	Appliqué
		2	Plain body	Slipped
Light	Light dominant (Qtz+Pl) with minor Fe-Mg (Px)/calc. inclusions	16	Rim	Class 1
		16	Decorated body	Incision
		16	Decorated body	Paddle impressed
		16	Plain body	Slipped
	Light dominant (Qtz and/or Pl) with minor Fe-Mg (Px) inclusions	19	Decorated body	Appliqué
		19	Plain body	Slipped
		15	Decorated body	Incised linear appliqué
		12	Decorated body	Incision
Fe-Mg	Fe-Mg (Px) dominant with minor light (Pl and/or Qtz) and calc. inclusions	8	Plain body	Slipped
		11	Rim	Class 1
Anomalous	Calc. dominant with minor light (Pl or Qtz) inclusions. Fe-Mg (Px) absent	18	Decorated body	Incision
		1	Decorated body	Incision
		1	Decorated body	Incised linear appliqué

* Numbers and designations extrapolated from Lilley (1986: Fig. 7.6–7.7.)

became less common through the layers, which is consistent with the trend at Nunguri. The petrology of Lilley's Madang style material was considered too heterogenous to delineate any meaningful trends through time.

At Sio (KBQ), Madang is again found alongside Type X and Sio style, but the Madang style only makes up 13% of the total sherd count (Lilley 1986:307). It is interesting that although the Sio assemblage has a large Madang component, no Sio pots were observed in the Madang assemblages I analysed. This could be owed to lack of interest in recieving pots on the part of the Bel traders, who desired food and exotic material culture.

Two test pits were excavated at Sio (KBQ), but there are inconsistencies in the ceramic sequences, with Pit I suggesting Class 3 was present early in time, at least *c.* 900 years ago, and Pit II suggesting Class 3 was more recent, *c.* 550 years ago at the earliest (Lilley 1986:336).[11] Lilley (1986:334) formulates two hypotheses to reconcile these discrepancies: 1) his radiocarbon dates do not accurately describe the age of associated pottery, implying disturbance, mixing, redeposition, or vertical movement through the deposits, or 2), there is spatial variation in the deposition of pottery between the pits. Based on the Madang style seriation proposed above (Fig. 10.5), hypothesis 2) is plausible if both of the deposits containing the Madang style Class 3 rims date solely to around 0–600 years ago. There is likely to be some bias in the Pit I assemblage meaning Class 3 rims are not present in upper deposits. Lilley (1986:333) suggests this could be caused by the redeposition of older beach sands mixed with sherds onto Layer 1. Any Class 3 rims present in deeper deposits and in association with older dates can be thus regarded with skepticism. This is only problematic for Pit I, where a small number of Class 3 rims is present.[12] The Pit II sequence is most consistent with the Madang chronologies and may provide the best support for a pre-700 year old ancestral Madang style. Madang sherds in Lilley's Pit II Layer 4 (older than 900 cal. BP) are all Class 1, similar to the earliest deposits at Tilu.

From these analyses, Lilley (1986:340; 1988) was the first to formulate a phase-based model for pre-colonial exchange along New Guinea's northeast coast. His (1986:341) Phase 1 denotes Lapita exchange in the Vitiaz Strait *c.* 2500–2800 BP and will not be discussed further. In Lilley's illustration of Phase 2, sometime before c. 550–600 BP and possibly up to 1600 BP, Ancestral Madang pottery characterised by incision is shown arriving in Sio from the Madang coast. However, the 2014 excavations around Madang suggest the earliest evidence for pottery making along that coast is only *c.* 650 years old. Although any interpretations should remain tentative, given the possibility that future research could uncover earlier evidence for ceramic manufacture in the area, if Madang style pots were traded in to Sio at this early time, then they may have been coming from somewhere else.

Lilley Phase 3 is dated from c. 550–600 BP to c. 300–350 BP and sees increasing numbers of Madang style pots being imported, used and deposited in the Huon/Vitiaz Strait. This occurs just after initial occupation and pottery manufacture around Madang and is simultaneous with the burst of local pottery exchange between Bel groups around Madang. Phase 4, from *c.* 300–350 BP to less than 200 BP is subdivided into two sub-phases. The first sub-phase sees Madang sherds continuing to play a minor part in regional assemblages. During the next sub-phase, leading up to European contact, greater numbers of both Madang and Sio pots were being traded around the Huon/Vitiaz Strait area. Phase 4 is contemporaneous with an increase in the number of sherds being deposited locally at the Madang sites, and the first suggested evidence of exchange with non-Bel groups around Madang.

Having discussed local and regional exchange, Figure 10.7 illustrates tentative chronologies for Madang style ceramic exchange along the northeast coast, adapting Lilley's four phase sequence on the basis of new evidence. This new model incorporates the results of the present volume with the wider archaeological literature. The chronological timeframes are only indicative and are simply designed to show changes to the network over time. The first period, before *c.* 700 years ago indicates the possible exchange of pots to Arop/Long Island and Sio, but from somewhere other than the Madang Coast – perhaps 'Yomba Island,' which will be discussed in the next section. Then, with a shift of potters to the Madang Coast just after 700 years ago, there was an expansion of the Madang exchange network, delivering to Sio and Arop, but also feeding into local exchange networks. Through Sio, down-the-line exchange probably accounts for the Madang style in the Arawes in southwest New Britain and possibly in the Tami Islands. It is around this time that Madang pots also make it to Aibura Cave in the New Guinea Highlands, through

11 Pit I consists of six layers, containing 28 Madang rims and 795 decorated sherds (Lilley 1986:327). Class 1 (53%) is present in Layers 1–4, Class 2 (25%) present only in Layers 2–3, and Class 3 (11%) present in Layers 2/3 (mixed) and Layer 4. Pit I Layer 2 is dated to 670 ± 60 BP (ANU-4332), calibrated to 539–699 cal. BP. However, there appears to be very minor inversion in Layer 3, dated to 1) 340 ± 90 BP (ANU-4330), 267–535 cal. BP (92.3%); 2) 300 ± 100 BP (ANU-4329), 250–521 cal. BP (77.5%); 3) and 510 ± 60 BP (ANU-4606), 467–653 cal. BP (100%). Layer 4 is dated to 1500 ± 70 BP on shell (ANU-4607), calibrated to 913–1216 cal. BP (100%), but containing very low densities of Madang style sherds (see Lilley and Specht 2007). Pit II consists of four layers containing 21 Madang rims and 34 decorated sherds. Class 1 (43%) is present from Layer 1–3, Class 2 (10%) is only present in Layer 2, and Class 3 (33%) is present only in Layers 1–2. Pit II Layer 1 is modern. Layer 2 is dated to 400 ± 90 BP (ANU-4334), 284–558 cal. BP (97.7%). Layer 3 is dated to 950±BP (ANU-4336), 723–979 cal. BP (99.4%) at the latest and 1290 ± 100 BP (ANU-4337), 978–1362 cal BP (100%) at the earliest.

12 It is not clear from Lilley (1986) how many Madang Class 3 vessels are present in Pit I Layer 4, but the number must be fewer than four (the total number of Class 3 rims in the pit).

inland down-the-line exchange perhaps using river valleys. Then, between around 550–200 years ago there was a further reconfiguration of the network, with pots making their way in to the Siassi group, and then further on to Kove in New Britain. Lastly, in the period just before European contact, the export of pots to Sio and the Siassi group dramatically increased and oral traditions tell us that pots were certainly being moved up into Karkar to the north. With this basic framework in mind, we now return to the concepts of embodied knowledge and communities of practice.

Exchange, embodied knowledge, and communities of practice

Approaches to exchange and trade voyaging must diverge from simply tracking the lines connecting A to B and instead tease apart how people forged and experienced these links (Scheldman 2011). In this way we can begin to locate creativity, learning, and embodiment, not only on the micro-scale, within the production group, but also across the social landscape between trade friends. To integrate the foregoing discussion of ceramic exchange more thoroughly with embodied knowledge, it is important to note that, like production, exchange must operate within the logic of local and regional communities of practice.

As we have seen from the distribution of Madang pottery-bearing sites, the pre-colonial communities of practice around northeast New Guinea extended between groups living along the coast, on offshore islands, and in the foothills. These groups shared ways of coming together, hosting guests, and exchanging objects (see Thomas 2009). The community of practice that facilitated Bel object exchange was not necessarily the same as the community of practice formed and experienced by the Bel women who were making the pots (see above). On these overseas trade voyages, men were making their own communities of practice, subtly different from those formed around Madang itself, by reinforcing existing relationships and creating new threads in their social networks.

Through processes of routine action – learning the art of sailing – often beginning from a young age (Mennis 1980b:17), men would have generated and reshaped their bodily knowledge. Pushing the *balangut* out to sea, tethering the sails, and understanding the winds and the stars, were all part of this technological process (Mennis 2011), making knowledge and know-how at the interface of bodies, techniques, and materials (Lemmonier 1992). This process also involved learning the magic to negotiate local *tibud* at different points of land and in the water around them (see above). While on trade voyages in the recent pre-colonial period, men would recite secret words to evade the water *tibud* and would throw heated potsherds into the waves to quell them (Mennis 1980b:44). It was at this point that two material lines – pottery and canoes – were woven together integrally.

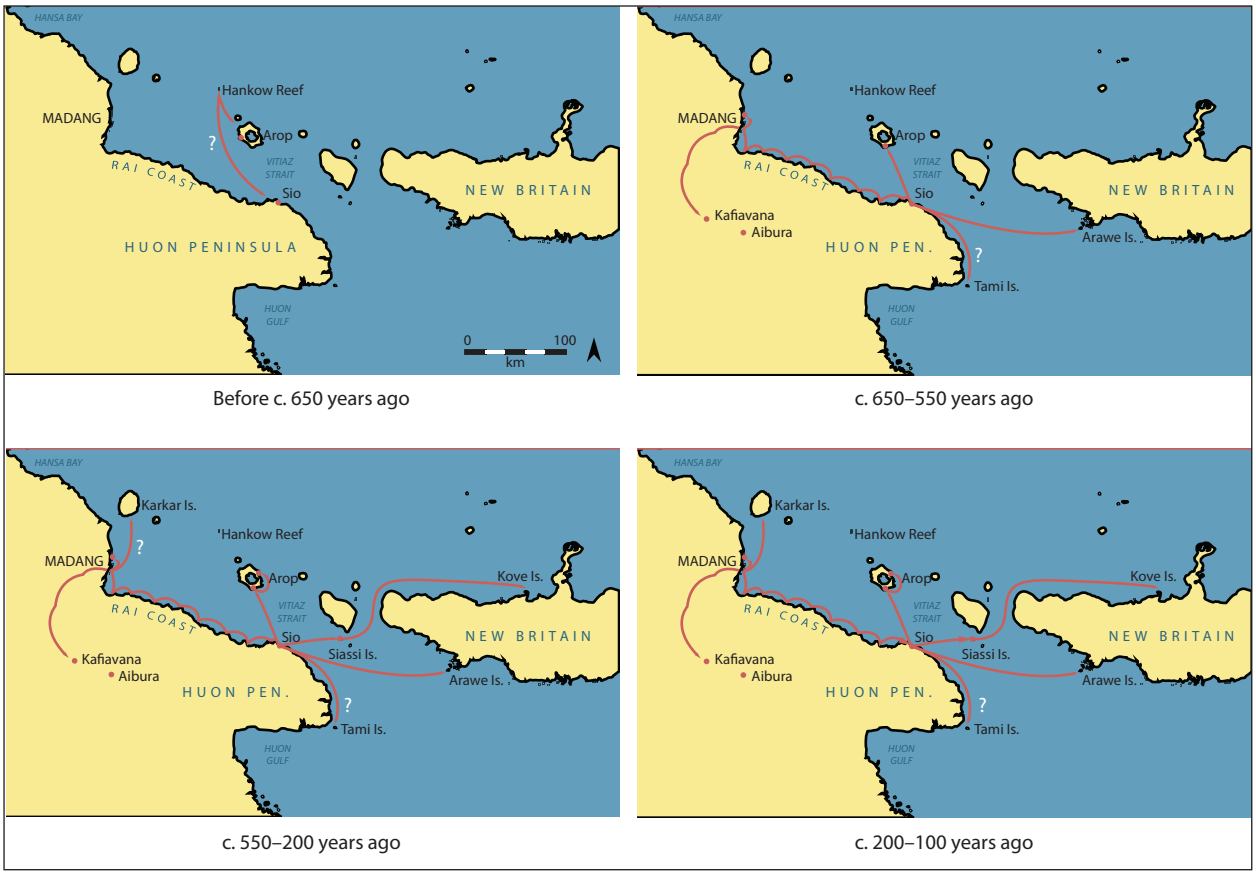


Figure 10.7. Diagrammatic model showing pre-colonial exchange of Madang style pots around the northeast coast.

The community of practice also required the interaction of different people for social relationships to be made and remade. Although learning the correct number of pots to exchange for the correct number of taro or wooden bowls was an important set of skills, embodying the finer points of the *Dadeng* involved a broader set of social regulations: knowing when to arrive at different settlements, who to speak with, how to dress, who to offer betelnut to, and so on. This was particularly the case as traders attended to obligations including expectations of gifting, delayed returns, and debt (*dinau*) between trade friends. Learning the *Dadeng* would have been further complicated by the mutability of things, which can require different modes of exchange for the self-same object, depending on specific social contexts (Robbins & Akin 1999; Thomas 1991:100; Walter & Green 2011:19). The potsherds described in this monograph probably represent the discard of similar pots acquired through various modes of exchange: for example, direct, mass exchange for food or other material culture, small-scale down-the-line trade and commodity exchange involving middlemen, and gifting during ceremonies or rituals, bride prices, compensations, and reconciliatory acts.

Summary

To conclude this chapter on pre-colonial production and exchange, we have seen that on present evidence, locally produced Madang style ceramics started to be made suddenly at around 600–500 years ago, representing one or more production groups operating within a broader community of practice. Within this community of practice there seems to have been substantial interaction and knowledge exchange, but bound by tight regulations governing the procurement and production of pots. These pots fed into local exchange networks, along with larger regional systems, which seem to have become more extensive and intensive over time, leading up to the ethnographically observed situation in the late 19th century.

By following the materials, learning the movements, and drawing the lines (Ingold 2011), we see that they are all inexorably woven together. However, all of this interaction – the binding up of bodies, minds, gestures, pots, canoes, food, magic, spirits, people, communities, and landscapes – can become bewildering. It is rather in the asymmetries of these interactions, and at the limits of the community of practice, that social boundaries are made, delimiting and expanding people's place within their social world. We have begun to chart these asymmetries by describing the production groups who made the Madang style ceramics and illustrating the transformative exchange networks proposed above (Fig. 10.7). The next chapter will outline possible explanations for these asymmetries from a culture history perspective, with the aim of reconciling some discrepancies in linguistics, oral tradition, landscape, and material culture.

Chapter 11. Bel Culture History

> *The Melanesians were strong people, the Papuans moved back and the Melanesians took their place… The Melanesians came to all the islands from Bilbil to Sek*
> — Pall of Tagari of Bilbil (1976)[1]

One of the key objectives of this monograph has been to describe the history of the Bel potters and the sequence of events leading up to the ethnographically documented societies around New Guinea's northeast coast, and Madang in particular. The previous chapters have focused on how technological changes occurred through time and the evolving processes of production and exchange along the marginal coastal strip and offshore islands. This final chapter will try to identify which events caused these changes. Some core culture history concerns put forward in Chapter 1 regarding Bel origins, migrations, and interrelatedness, will be teased apart. This brings language, oral tradition, landscape, and material culture back together in an attempt to derive a rudimentary narrative for change through time. The volume will conclude by considering the implications of this narrative for Pacific anthropology and archaeology and will describe future prospects for research to further fill gaps in our understanding of Melanesian production and exchange.

Debates in language, landscape, history, archaeology

Austronesian-speaking migrants (east or west)?

In 1988, Malcolm Ross suggested that the North New Guinea cluster of Austronesian languages had resulted from east–west migrations of communities from West New Britain (see Fig. 1.9). However, Terrell and Welsch (1997) argued that the post-Lapita ceramics around Aitape along the Sepik coast of New Guinea, in particular the Sumalo ware, were more consistent with the movement of potting traditions from further west, in Island Southeast Asia. These ceramics were seen to have more in common with Metal Age pottery from the Moluccas than post-Lapita ceramics of the Vitiaz Strait and the northeast coast of New Guinea. Later interpretations by Terrell and colleagues (2011), however, imply the precursors of the Aitape ceramic sequence are less clear. Conversely, Lilley (1999) suggested that culturally related groups, such as those of the Sepik and Vitiaz Strait, are just as likely to produce dissimilar pottery as they are similar pottery and saw the archaeological evidence and Ross' (1988) linguistic model as coalescent. I would build upon this and state that culturally related groups are capable of producing pots which on the surface appear distinct but are closely related in terms of their *chaînes opératoires*. As introduced in the previous chapters, this is because the extended technical syntaxes required to form pots are generated by long periods of learning and enskilment and eventually become durable strands of the technological process, even when there is variability in surface features that result from innovations to minor technical elements and short syntaxes. Equally though, non-related groups are capable of producing pots that closely resemble one another, but do not share deep technological commonalities, potentially owing to ongoing maritime interaction and interrelated shifts in aesthetics leading to similarities in surface technical elements along the coast. This all raises important questions about the Madang style, which, on the surface, closely resembles the later sequence of Sepik ceramics, but is dissimilar to both the early Sepik and Vitiaz Strait ceramics despite the Bel languages deriving from the Proto Ngero/Vitiaz Linkage along with the Austronesian languages of the northeast coast and the Vitiaz Strait. From which direction did the Madang potting traditions arrive, and were they coupled in a simple manner with the movement of the Bel languages?

This volume has thoroughly described the pre-colonial ceramic material culture of coastal Madang District, reporting on the objects themselves, along with the broader technological processes of production and exchange. It is clear that various technical elements allow Madang style sherds to be grouped apart from Lapita, Type Y, Type X, and Sio sherds, which represent distinct technological traditions active at various times around the northeast coast. Surficially, these styles would be expected to be related to Madang if there was an east–west movement of potting groups, unless of course these groups chose to deliberately differentiate their products. Even if this was the case, how-

1 Quoted in Mennis (1981b: 33).

ever, the technological processes underlying production are expected to be derivative and closely related. In support of this, strands of the Lapita technological process such as incision, red-slipping, and paddling (see Kirch & Yen 1982:192–193) have clearly been reiterated or reinvented at various times, surviving through to the Madang potters, some 2500 years later. Other traditions such as Type X and Sio preserve different technical elements, but owing to overlapping chronologies and distinct production signatures, cannot be antecedent or derivative of the Madang style. The working interpretation is that, along with Type X and Sio style, the Madang style is distantly derivative of Lapita and post-Lapita potting traditions around northeast New Guinea.

Further northwest, along the Sepik coast, various ceramic wares have been described (Dickinson 2011; Golitko 2011; Golitko & Terrell 2012; Schechter 2011; Terrell 2010; Terrell & Schechter 2007, 2011; Terrell & Welsch 1997). This work provides a dated sequence of four distinct ceramic traditions present around Aitape: Nyapin ware (2000–1500 BP), Sumalo ware (lasting somewhere between five and 270 years, starting 1200 or 1400 BP), Aiser ware (1000–500 BP), and Wain ware (more recent than Aiser ware but without absolute dates) (Jones 2011; see Fig. 11.1). Like the Madang style, Terrell sees these traditions as ultimately deriving from Lapita, which had its formative period in the Bismarck Archipelago (Terrell & Schechter 2007; Terrell *et al.* 2011). It seems that Lapita potters later moved onto the north coast as there is evidence for dentate pottery production in the form of two poorly-provenienced surface finds around Aitape (Swadling 1981:66, 1988:19; Terrell & Welsch 1997:558). Provisional conclusions made by Golitko (2011; Golitko & Terrell 2012) suggest that with few exceptions these four ceramic wares, along with the north coast Lapita, were made locally.

The four Sepik wares share certain technical similarities with plainware Lapita, and with the Madang style. The Nyapin, Sumalo, and Aiser wares were almost always red-slipped, but in terms of vessel forms, the Nyapin ware and the Sumalo ware do not closely resemble the more recent Madang style. Nyapin ware consists of some carinated vessels decorated with incised lines or wavy bands, stick punctations, and shell-edge impressions. Sumalo ware consists of carinated bowls with everted and concave rims, and shallow platters (Terrell & Schechter 2011b). Such vessel forms, along with these minor technical elements, are not common in the Madang style. There are greater affinities to the Aiser ware, however. This ware consists of thin walled, round bottomed pots with simple, everted, unnotched rims, and incurving bowls. Like the Madang style, there are no shallow bowls or platters in the Aiser tradition. The Aiser production process is difficult to establish based on the available data; it is unclear whether the Aiser pots were produced using a paddle and anvil, hand moulding, coil, or slab construction. However, based on the thickness of the body sherds (~0.3–0.6 cm), it is likely that they were constructed using a paddle and anvil technique, similar to Madang style pots.

It is notable that many of the vessel forms in the Aiser tradition mimic Madang style Class 4 vessels, the precursor to the modern Bel *magob*. As suggested in Chapter 10, it is hypothesised that these are linked to Pila pottery producers around Hansa Bay, but the nuances of these interrelations are not known with certainty. May and Tuckson (2000:175, 302, 310) state that the technique of opening out the orifice of the clay roughout with a stone anvil, as used for *magob,* is the same amongst Pila potters, as well as Korak speaking potters at Tuvaltae (adjacent to Karkar Island), Kaiep potters near Wewak, and Tumleo Island potters near Aitape itself. A more remotely similar technique involving a stone anvil opening out the orifice of the roughout after a long clay preparation sequence is evident amongst Sio potters[2] (May and Tuckson 2000:150). In addition to these similarities, the technique of preforming the rim of restricted vessels such as the Madang style Class 1, 2, 3, and 5 pots, as well as modern Korak and Tumleo Island varieties (Pétrequin and Pétrequin 2006:340), is suggestive of historical connections and imply these technological processes may be closely related. It is quite plausible that the Aiser ware followed a similar sequence involving a stone anvil to open the roughout, with a distinct stage of rim preforming prior to vessel manufacture using paddle and anvil.

Decorations on Aiser sherds comprise diagonal incisions and punctations, appliqué nubbins and bands, and punctate-appliqué bands, which are not represented in the earlier wares. These incisions and appliqués are arranged into similar motifs to the Madang style, with long double bands being flanked by smaller decorative elements. Common forms include configurations similar to LI12, LI15, NA1, NA3, and motifs M28 and M63 (compare this volume Chapter 9, with Terrell & Schechter 2011b: Fig. 7.9–10). However, the zonation of decorations is different, with Aiser rims commonly being decorated on the lip and inner lip, while Madang decorations tend to be restricted to the body/shoulder. Moreover, Aiser decorations display combinations of incised, applied, and impressed appliqué decorations, whereas Madang sherds rarely combine decorative methods.

It is interesting that appliqué appears in the Aitape sequence broadly contemporaneously with, or just before, appliqué occurs around Madang. The chemical analyses from Aitape and Madang suggest that Aiser and Madang represent distinct, locally made styles, but the technical similarities speak of common decent, with divergent traditions emerging vertically through generations of geographic separation. As the Pétrequins (1999) point out in their examination of modern production sequences, the method of manufacture on Tumleo Island near Aitape is

2 Sio pots are produced with an elaborate clay preparation stage which involves forming the paste into a cup and leaving it to dry overnight before then collapsing that clay into an upside-down cone from which the vessel is then shaped. The Korak and Sio-Gitua pottery production sequences share distinct similarities (May and Tuckson 2000:150).

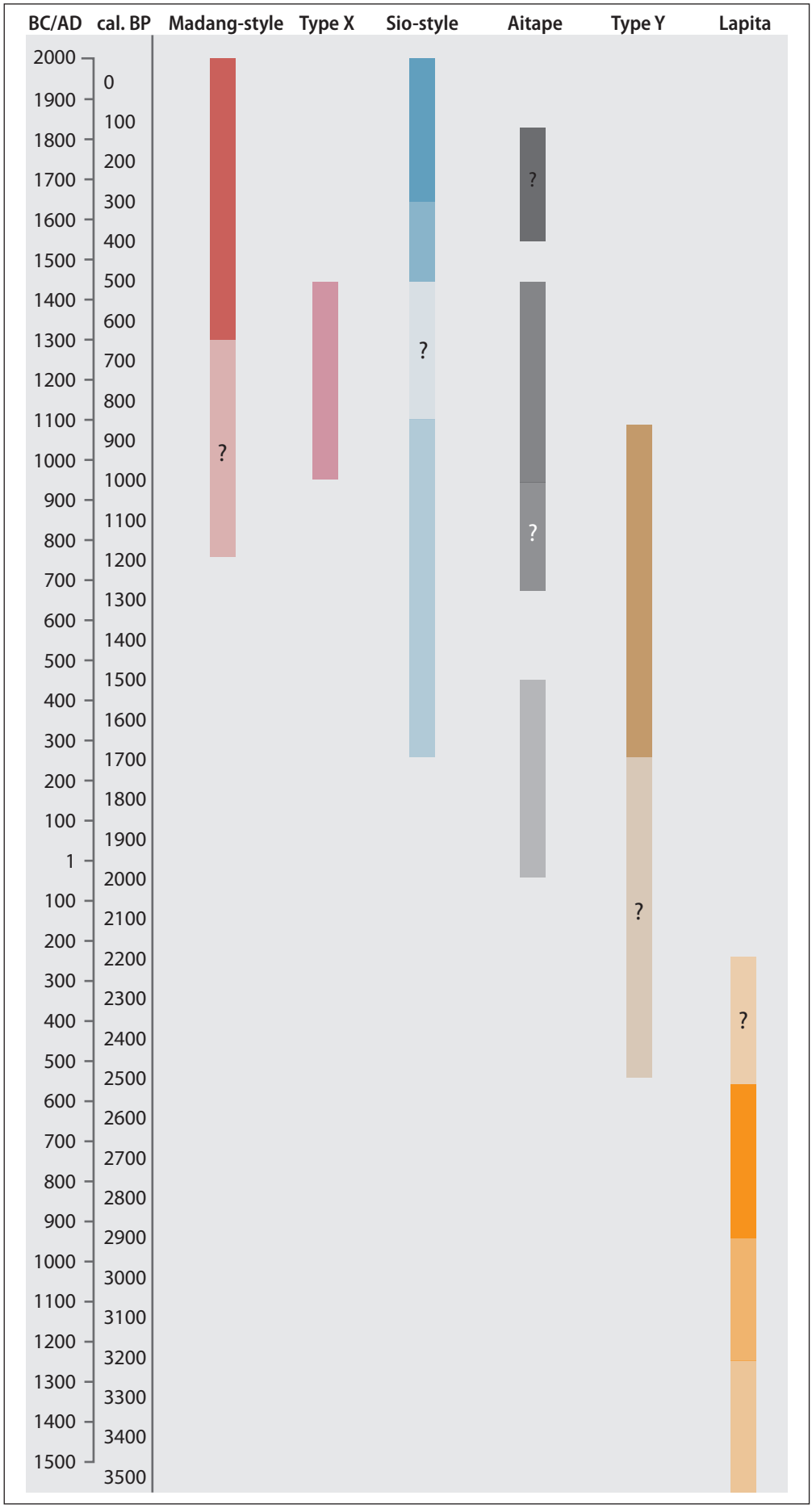


Figure 11.1. Duration of major ceramic traditions around the northeast coast of New Guinea.

remarkably similar to that at Bilbil/Yabob, probably deriving from common descent, although they suggest this is owed to an eastward spread of potters from the Moluccas. If, as Terrell and colleagues (2011) suggest, the Aitape sequence represents an unbroken series of traditions leading from Lapita to the present day, it could imply that the Madang style does derive proximally from further west as an offshoot of the Aiser tradition. Alternatively, if the forming sequence of Aiser pots is shown to be dissimilar to the Madang style, it would imply that the commonalities in decoration, slip, and vessel form, are surficial and might represent the horizontal communication and mimicry of designs across a north/northeast coast community of practice and exchange. However, if Aiser and Madang styles were produced using similar *chaînes opératoires,* dissimilar to the Sumalo ware, it would support a second push from the east onto the north coast by a separate Austronesian-speaking potting group. The superficial decorative and formal similarities, although tantalising, are at present unable to reconcile these different scenarios.

Despite these limitations, the distribution of similar technical syntaxes involved in rim preforming suggests that this stage of production characterised Late Lapita and post-Lapita ceramic manufacture in the Bismarck Archipelago, before potting groups moved westwards onto New Guinea and its outlying islands, in association with North New Guinea cluster speech communities, as well as southwards to the Massim and south coast of Papua, where Yule Island and Boera pottery is made in a similar fashion, in association with Papuan Tip cluster speech communities (Pétrequin and Pétrequin 2006: 341). However, it is unclear whether these syntaxes are related to similar rim preforming in the Aru Islands and other parts of Island Southeast Asia, where the potters speak non-Oceanic Austronesian languages. The similarities between technical elements and short syntaxes along the stretch of northeast New Guinea between Aitape and Sio also imply that the series of staged population movements by North New Guinea cluster language speakers onto the Sepik coast and later into the Vitiaz Strait and eventually Madang, were characterised by ongoing social networks that facilitated interaction and knowledge exchange.

Yomba Island

Following western migration from West New Britain, or perhaps, an eastern movement from north New Guinea, some oral narratives suggest Bel speakers based themselves on an ancestral homeland, often referred to as Yomba Island (Mennis 1980b, 1981a, 1981b). At 'Yomba' – whether a now-submerged island in the Bismarck Sea, a series of clan areas, or something much more historically complex – the inhabitants probably spoke Proto-Bel (see Ross 2009) and produced pottery and canoes, trading with Arop/Long Island and Sio. The most common Bel origin story tells of Yomba then sinking into the sea and its inhabitants fleeing to the Madang coast and other places in northeast New Guinea (Mennis 1978). Mary Mennis has long argued that this island was real and once located at Hankow Reef in the Bismarck Sea. The dredging of a submarine volcano just west of Hankow Reef revealed a base of rhyolites and dacites. Usable clays for pottery manufacture are likely to have existed there and, we can infer, also on Hankow (Mennis 2006b). The disappearance of this island was probably not caused by a volcanic eruption as some oral histories attest (Johnson 2013), but, tentatively, could have resulted from a tsunami caused by tectonic activity (Mennis 2006b).

Although one approach would be to distil the various oral histories into a unifying narrative, in which the Bel-speakers arrived in a single migration event with strong environmental push forces, this might ignore much of the historical complexity that characterised Bel migration. It is perhaps more plausible to view these oral traditions as descriptions of processes lasting several generations or more. For instance, it is possible that people hailing from 'Yomba' had populated areas of the Madang coast prior to the island's destruction. Alternatively, if Yomba was located elsewhere, it may be a collective concept to denote common origins, which would have been important to maintaining social unity and identity throughout intergenerational movements to the Madang coast. In this way, these events can be seen as diasporic processes (see Lilley 2004b), whereby migration flows would have linked the new occupants to their ancestral homeland. Additionally, many of the Bel villages report that they did not derive from Yomba but from other vanished islands. For example, the Siar say their ancestors were already in Madang when Yomba sank, but when Siasawan Point broke, the people living there relocated to Siar Island. As such the oral testimonies may preserve communal memories of various tsunami, seismic, and uplift/subsidence events, which typified the area in the Late Holocene (see Chapter 2) and indeed still do today. Within the Madang Lagoon area and along the coast, there would have been migration flows and interactions of cultures prior to any such Yomba disaster. The new Bel arrivals from 'Yomba' may have tapped into an already dynamic and changing social landscape.

We can investigate these ideas further using the archaeological data presented in this volume. Returning to the four scenarios introduced in Figure 1.8 of Chapter 1, if there had been a single sudden migration of Bel speakers from Yomba we would expect to see an abrupt start to locally-made pottery production in Madang, perhaps alongside a handful of exotic pots salvaged from Yomba, lining up chronologically with geological evidence and some oral histories. This would then be followed by a gradual change to ceramic manufacture over the centuries. If there was trade between Yomba and Madang prior to any such Bel migration, we would expect exotically made Madang style pots, with an abrupt change to local production at Yomba's disappearance. Alternatively, if there was a gradual diaspora to Madang, we would expect to see locally produced Madang style vessels prior to Yomba's disappearance. If this diaspora was characterised by high levels of ceramic

transfer between the two potting centres, we would expect both locally and exotically produced Madang style pots around Madang, prior to Yomba's disappearance.

The current chrono-stratigraphic and ceramic results indicate there was an abrupt start to the Madang style along the coast, involving local production from about 600 BP, calibrated to 550–650 years ago. This corresponds very closely with geological evidence presented in Chapter 2, which suggests the last major tectonic uplift in the area occurred at 550 BP and could have caused a tsunami, along with the destruction of offshore islands. However, for now, this association must be regarded with caution, as the geological dating used marine-derived radiocarbon, and the local ΔR correction is completely unknown (Simon Day pers. comm. 2015), meaning that the geological and archaeological evidence may not line up very closely at all.

Genealogies collected by Mennis (2006a) suggest that the first Bel arrived at Madang around eight to ten generations ago, which conventionally (based on average generational cycles of 25 years; see Kirch 2018) would date to about 250 years ago. Taken at face value, this is about 300 years later than initial ceramic occupation and would support a gradual diaspora to Madang prior to Yomba's disappearance. However, there are a number of ways in which genealogies can be remembered, forgotten, revised, and transformed as they are passed down (Linnekin 1997:13; Thompson 2017:204). For instance, it is possible that a process of elision may have occurred in the genealogies, whereby the middle portion of the sequence is poorly remembered, and identical names are conflated (see Mercer 1979:140). Similarly, when some members of the sequence are forgotten, the rest of the ancestors are recalled as being more recent than they were, in an effect known as 'telescoping' due to memory error (Sypher *et al.* 1994). The same process has been observed on Arop/Long, where genealogies suggest the previously discussed eruption happened *c.*1850 AD, which is about 200 years too late according to geological dating (Mennis 2006b, quoting Tom Harding and Eldon Ball). Additionally, if the purpose of the genealogy is to reaffirm the claims of different clans, explain the political landscape, or legitimise alliances, then the specific length of that sequence may be secondary to the names that it recites (Linnekin 1997:14).

Another overlooked factor is the assumed generational length; some authors suggest the conventional span of 20 to 30 years may not hold in this area of New Guinea. In one instance, Mennis (1980b:17) recorded that Bek from Riwo was born in about 1900, but his father saw Miklouho-Maclay in 1871, so even if Bek's father was only ten years old when he observed the Russian, he would have been about 40 when he fathered Bek. In another more tentative instance on Ritter Island, Simon Day interviewed a man whose father claimed to have witnessed the 1888 lateral collapse. The father supposedly watched the event when he was about twenty years old and fathered his son when he was about 70 (Simon Day pers. comm. 2015). To make such an explanation correspond with the archaeological and geological evidence, however, it would then require us to presuppose an unbroken sequence of ten generations, during which reproduction occurred only later in life (between the ages of 40–60). This would align the beginning of the genealogies with around *c.* AD 1400–1600, a time prior to Arop/Long Island's major eruption. However, there is an element of post hoc speculation here – making the genealogical, geological, and archaeological narratives line up.

At present we cannot establish precisely which events unfolded leading up to the end of 'Yomba,' and what led the Bel to choose Madang as their new home. Most parsimoniously, however, the genealogies have likely been elided or telescoped and the broad picture that the archaeological, oral historical, and geological evidence paints is one of a single relocation of Bel potters to the coast over a short time span. It is unclear whether or not the Bel homeland continued to exist for a time after the settlement of Madang, but there is little to no archaeological evidence for ongoing exchange with an ancestral Yomba. Another possibility is that the Bel who lived at Yomba procured their clay from the Bilbil area, travelling by canoe over one hundred kilometres, like the Amphlett Islanders do in the Massim (Lauer 1970b). This is a less common, but not impossible, situation and would be archaeologically invisible.

Adaptations to the coast

The Bel who left Yomba to the Madang coast, whether all at once or over several generations, seem to have preferentially settled in uninhabited areas or those marginal zones with less resistance to intrusion. One potential scenario would see any uplift and associated tsunami that may have destroyed 'Yomba' then displacing existing populations on islands near Madang too, making the Yomba Islanders' relocation easier. Oral traditions say some people escaped the island on canoes or makeshift rafts and bunches of coconuts, others who were visiting the mainland or other islands returned to find their home no more (Mennis 2006b). The stony ground on the offshore islands around Madang was not productive for horticulture compared to the mainland. Some tried to live on several other islands before finally deciding on new offshore settlements. Mennis (2006b) argues that others lost the art of potting as there was no clay on their islands and they could not access sources on the mainland. Furthermore, particular clans may have quickly placed embargoes on clay sources to regulate production. Those in Madang Lagoon instead specialised in canoe hull production for trade. The archaeological evidence attests to this social regulation of raw material sources and, perhaps, limitations on the clans who were permitted to pot. Certainly, the new geographic distribution of the Bel speakers, from a single homeland to a mosaic spread across a coastal archipelago, would have required new approaches to resource acquisition, local trade and exchange, craft specialisation, and collaboration.

Towards a Bel culture history

The local sequence

Having outlined aspects of Bel culture history, integrating the current archaeological evidence, it is now possible to build a general narrative of long-term cultural change around coastal Madang District. The following sequence is designed as an interpretive framework to be tested with future research. Figure 11.2 illustrates this sequence alongside major external events in the Bel social memory such as the end of Yomba, the eruption of Arop/Long Island, the arrival of Europeans, and the Pacific War. These later historic time periods are derived from Mennis (2006a) and Sinclair (2005).

Yomba Period (pre AD 1300), defined by Bel ceramic production on Yomba Island (or other ancestral homelands).

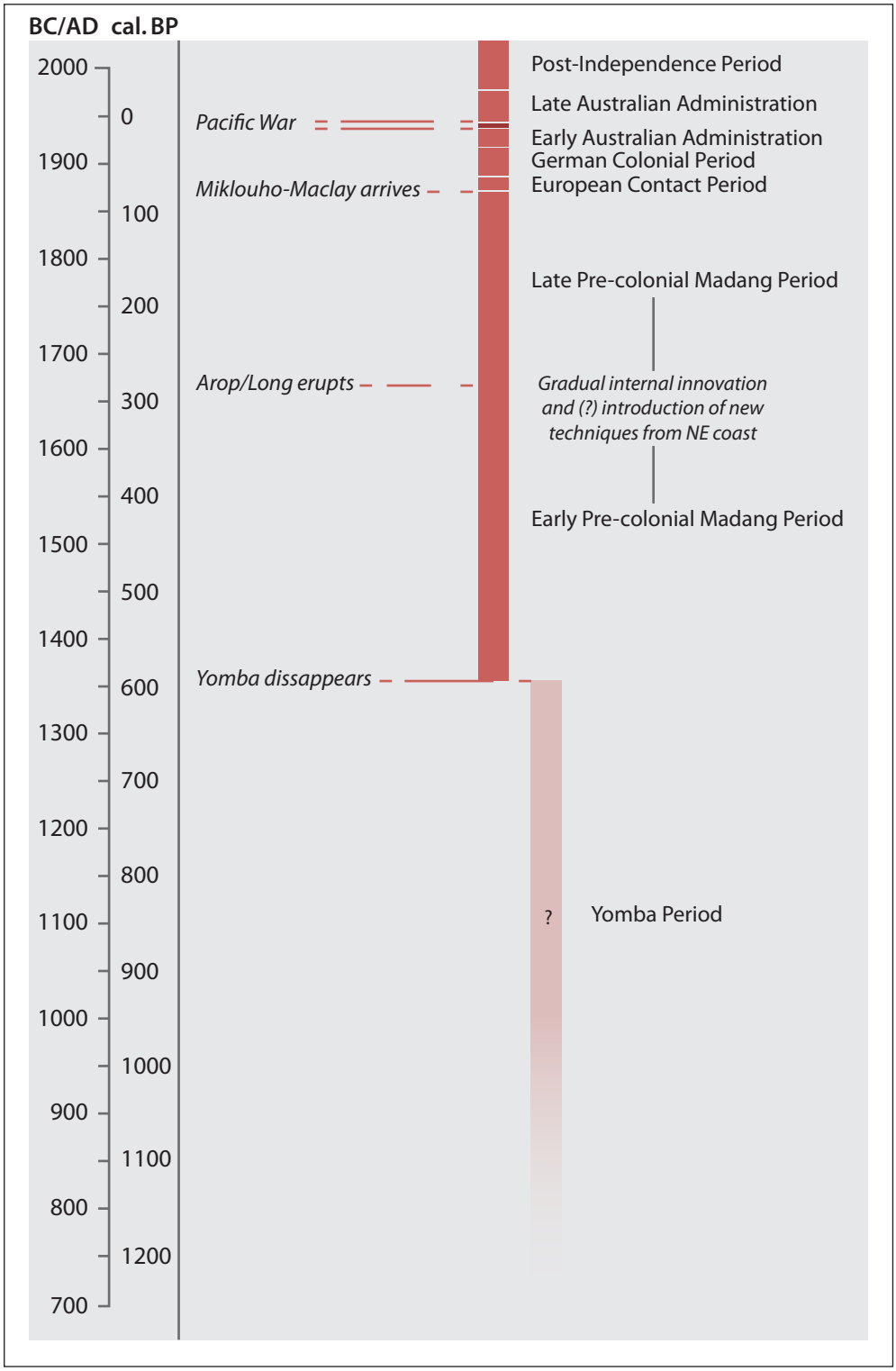


Figure 11.2. Diagrammatic representation of proposed Bel culture history sequence around Madang.

Possible ceramic evidence present at Sio and Arop/Long Island. Madang style: red-slipped, applied/incised, paddle and anvil ware.

Early Pre-Colonial Madang Period (*c.* AD 1300–1700(?)), defined by Bel ceramic production around Madang. Possible specialisation of craft production associated with dispersal of groups along mainland coast. Gradual increases in production and exchange intensity. Madang style: red-slipped, applied/incised, paddle and anvil ware. Class 1 and 2 common but scarcity/absence of Class 3 vessels.

Late Pre-Colonial Madang Period (*c.* AD 1700(?)–1871), defined by Bel ceramic production around Madang. Notable increases in production and exchange intensity both locally and onto Rai Coast/Huon Peninsula. Madang style: red-slipped, incised/applied, paddle and anvil ware. Class 1, 2, 3, and 4 vessels common.

European Contact Period (AD 1871–1884), defined by Bel ceramic production around Madang. The Bel, and particularly Bilbil, people's material affluence noted by early European explorers. Madang style: red-slipped, incised/applied, paddle and anvil ware, Class 3 vessels common.

German Colonial Period (AD 1884–1914), defined by continuing Bel ceramic production around Madang. Colonial process causes disruptions to settlements and pre-colonial technologies. Bilbil and Yabob forcibly moved to mainland. Changes to trade and exchange with introduction of the money economy. Madang style: red-slipped, incised, paddle and anvil ware, Class 3 vessels common.

Early Australian Administration (AD 1914–1941), defined by continuing Bel production around Madang but exchange diminishes and halts during wartime. Madang style: red-slipped, incised, paddle and anvil ware, Class 3 vessels common.

Late Australian Administration (AD 1945–1975), defined by continuing Bel production around Madang but exchange has been completely reconfigured owing to war. Attempts at disruptions to conventional pottery production in 1970s, introducing kilns and wheel throwing. Increases in tourist trade. Madang style: red-slipped, incised, paddle and anvil/wheel thrown/hand moulded wares, bases and stands introduced, flowerpots introduced, dominance of Class 3 vessels.

Post-independence Period (AD 1975–current), defined by continuing Bel production around Madang, particularly at Bilbil, with Yabob and Mindiri becoming defunct. Exchange to Rai coast is now almost completely absent, with a focus on local tourist trade. Wheel throwing rejected in favour of paddle and anvil technique. Red-slipped, incised and perforated, paddle and anvil/hand moulded ware, bases and stands, flowerpots, handwritten incision/signatures, dominance of Class 3 vessels.

Conclusions

As introduced in Chapter 1, longstanding models describing transformations of production and exchange in Melanesia attest to increasing specialisation and diversification after the gradual breakdown of larger regional networks in the Lapita period (Allen 1985). Ethnographic accounts (e.g. Strathern 1988) suggest that, over time, social groups and individuals would have fostered elements of difference in their material culture, ways of making things, and ways of doing things. The local Madang model for change proposed above fits well with this trend of increasing intensity in processes of production and exchange leading up to, and continuing through, ethnographic contact. As presented in Chapter 10, this is also consistent with Lilley's (1988, 2017) observations for the Siassi link in the Vitiaz super-system, where low-intensity production and exchange of Lapita ceramics was followed by a ceramic downturn. It should be noted, however, that based on the distinct similarities in forming and slipping of Ancestral Madang and plainware Lapita, it is unlikely that ceramic manufacture ceased altogether in the area. Later, fragmented pottery production and exchange networks then re-emerged along the northeast coast with increased specialisation and intensity. The fact that this trend seems to have occurred in various places in Island Melanesia at a similar time implies that these networks were not closed systems but part of a wider regional complex of interaction.

The Madang results also mirror Irwin's (1985), Bickler's (1997) and Sutton's (2016) studies of the Papuan south coast, where, upon arrival of new settlers, there was an archaeologically-instantaneous adaptation to local resources and materials such as clay and temper sands. Immediately, local pottery production boomed. Evidence from elsewhere along the northeast coast (Lilley 1986) and the Vitiaz Strait (Egloff & Specht 1982) suggests that the distribution of Madang pots continued and even increased in amplitude after the Bel speakers moved to the coast. An outstanding question remains: was there a common incentive for insular potting groups around New Guinea to move closer to the coast and coastal resources? Despite being historically contingent, similarities can certainly be drawn between the experiences of small potting groups who migrated to the coast, often inhabiting coastal islands without much arable land, but specialising in, and intensifying, ceramic manufacture and exchange.

The pre-colonial Bel production and exchange may also challenge conventional interpretations that 'segmentary' economies were organised according to stasis and equilibrium, lacking flux, and without strong internal processes driving material capital and profit. Around coastal Madang, specific groups, genders, clans, and individuals worked towards differing specialisations. Clans could control certain magic and intellectual property, essential to production and exchange: some clans and genders controlled canoe-hull production, others controlled pottery manufacture, and others still controlled pottery distribution. Did the Bilbil begin to capitalise on a privileged position as the

pot makers and distributors around Madang and the northeast coast, which allowed them unequal access to exotic resources? This certainly seems to have been the case in Harding's (1967: 139; see also Sahlins 1972: 382–383) description of the Siassi traders who made material gains by controlling the movement of objects and managing expectations of value. Both Nikolai Miklouho-Maclay and Otto Finsch noticed the Bilbil people's disproportionate access to exotic materials when they arrived in the late 1800s. Seen through a Western capitalist lens, the Bilbil and other subsistence traders like the Siassi were understood as thrifty and calculating, leading to Sahlins' (1963) classic distinction between Melanesian free-enterprising capitalists and Polynesian feudalists. These coastal groups lacked the landesque capital which provided mainland populations with the potential to generate, transform, and control both food and interpersonal alliances. Amongst the Bilbil, however, these potentialities for both growing produce and making social relationships moved to the clay pit, the potter's hands, and the red-slipped vessels that were then mobilised around the coast on trade voyages. This volume suggests that embargos on this way of life and trends towards increasing monopolisation of production and exchange can be traced back to the Early Pre-Colonial Madang Period, just after the Bel relocated to Madang.

From a methodological and theoretical perspective, this volume has attempted a new approach to Pacific ceramic analysis. It provides an alternative approach to style, re-centring technological process rather than morphological typology. This allows for a systematic delineation of past production groups, working within broader communities of practice. Untangling how the processes of pottery production and distribution operated will aid archaeological interpretations that suggest forming technology is non-conservative and easily transmitted across large geographic distances, between non-related groups.

The Madang results have also shown that individual technical elements or very short syntaxes, such as decorations, are prone to change and disappearance over short periods, perhaps only a few hundred years. Minor technical forming elements, such as inner-rim paddling on Class 3 vessels can also arise in similar time frames, whether through internal innovations by skilled potters or introductions from other potting groups. It has been important to approach the ceramic assemblages from a technological perspective, as on the surface the Madang style appears similar to many of the globular pots that populate the New Guinea coast, as Otto Finsch observed over 100 years ago (Finsch 1888, translated in Mennis 1996: 29).

Based on the first systematic archaeological investigations around Madang, dealing thoroughly with two ceramic sequences from the coastal area, the monograph has also presented archaeological narratives that describe recent Bel culture history, and the development of their pottery production and trade. To further test the narratives produced from these assemblages, the study would need to be expanded, to analyse Madang style sherds excavated from contexts older than *c.* 550–650 years old. This would demonstrate, based on forming techniques, whether or not they are consistent with the Pre-Colonial Madang Period ceramics, and would assess the chemical composition of the pots relative to the current study. If the chemical composition is similar or the same it might imply that Bel potters travelled to Madang to procure clay, or that Madang potting traditions are in fact older than *c.* 550–650 years on the coast and that earliest sites have not yet been located. If the chemical signatures were different, it would be the first strong evidence for local manufacture on Yomba (or an equivalent, geographically distinct, ancestral homeland).

The main inhibitor for refining these narratives is a lack of fieldwork. To form a more secure local sequence, excavations could be undertaken on Siar Island, Yabob Island, Yomba Island, Bilia, Riwo, and Sek, along with the Madang coastal strip. To look for earlier ceramic deposits along the Madang coast, one would need to excavate inland, on the hills and former beachlines behind modern Bilbil village, away from the recent coral uplifts, which date predominantly to within the last 500 years, and seemingly no more than 3000 years at the most (Morgan *et al.* 2005). Research on Arop/Long Island, Crown, and Bagabag Islands would fill in another piece of the puzzle, investigating linkages between Madang and the Vitiaz Strait. Because these islands lie closest to Hankow Reef, the possible location of Yomba Island, they would be the best places to investigate Yomba Period Madang style ceramics. Further, coverage of Mindiri and the Rai Coast would investigate a crucial link between Madang, Sio and the Vitiaz network.

The Tilu assemblage is basically identical to the Nunguri assemblage in material terms, containing domesticated animal bones, shellfish, pottery, obsidian and sedimentary stone tools, and shell adzes and ornaments, which might be described as a quintessentially 'Austronesian-style' assemblage. However, this observation gets to the very heart of whether material remains map to 'culture' effectively, so that archaeologists can assign ethno-linguistic groups to sites and assemblages. Without investigating sites in the area known to be occupied by non-Bel speakers we cannot test these assumptions. With regard to anthropological concerns about learning, language, and communities of practice, these theoretical and methodological assumptions need to be further explored to refine our understanding of the human past in New Guinea, especially in the time leading up to ethnographic contact, but certainly with implications for Lapita and post-Lapita settlements around the Pacific generally.

Endnote

As presented at the start of this book, following Tim Ingold's (2011) advocation, we must follow the materials, learn the movements, and draw the lines. That is, in the study of material culture we must examine the process of making, rather than exclusively the made objects. These lines of technological process were not severed at European contact. They continue today.

In modern Bel culture, many aspects of the 'traditional' are re-enactments of pre-colonial life as opposed to unbroken continuations of these technological processes: from dance and music, to settlement patterns and canoe making. In recent years there has been a deliberate attempt to re-establish collective Bel identity following German colonial disruptions and WWII and, later, fuelled by Papua New Guinea's independence (Suwa 2005). It is not simply the finished objects that create collective identity but these vital technological processes, created at the interface of minds, bodies, and materials, which unify producers, distributors, and consumers in modern communities of practice.

Pottery making alone has continued broadly unbroken and has been resistant to many concurrent social changes. Yeyeg of Yabob-up-top was considered a master of the craft and potted for most of her life. Her long-established practice of paddle and anvil techniques outlasted modern introductions of the potter's wheel that have come and gone during her lifetime, and she continued to occasionally produce *bodi* well into her nineties. But pottery making has changed over the past century. Far from being a transgression on 'traditional' technological processes, recent Madang style tourist pottery reflects local, creative responses to new opportunities (Fig. 11.3). These pots carry the message across the globe that the community exists, that it is different, and can proudly and uniquely produce objects that not only reflect the vibrancy of contemporary *kastom*,[3] but also of ancestral traditions, making brilliant red, globular clay pots as the *tumbuna*[4] did in the past. Today, only Bilbil village remains to continue the legacy of the Madang style into the future; maintaining potting processes, which have been reimagined and recreated over the past 650 years or more.

3 *Kastom* (Tok Pisin) can roughly be translated as tradition and practice, but there are subtle differences between this term and the English 'custom,' as shown by Keesing (1982, 1993) and Lindstrom (2008).

4 *Tumbuna* (Tok Pisin) are the ancestors.



Figure 11.3. Modern Bilbil pot designed for tourists. Inscribed: Bilbil village, Madang Province, Papua New Guinea (Personal collection, gifted to research team; photograph: Les O'Neill 2016).

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