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Geochemistry and Sources of Stone Tools in South-west New Britain, Papua New Guinea

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Abstract. The capacity to trace the movement of region-specific materials across landscapes is a key archaeological theme in investigations of community interaction and exchange. In this study I investigate the scale of raw material and artefact procurement and exchange of a range of stone tools from southwest West New Britain Province, Papua New Guinea using a non-destructive geochemical technique—portable x-ray fluorescence (pXRF) spectrometry. The complex geochemistry of the Bismarck Archipelago and previous ethnographic and archaeological studies provide data that allow opportunities to explore the role of stone tools made from igneous rocks by flaking, hammer-dressing and grinding, particularly axe and adze blades, within intra- and inter-island exchange networks. The results indicate that groups residing on the southwest coast of New Britain obtained their stone tools from source regions on the north side of West New Britain, the Gazelle Pen. of East New Britain, and probably even from islands in the Vitiaz Strait and off the north coast of New Guinea. Inclusion of these south coast tools in models of past regional exchange networks, such as down-the-line exchange, greatly expands our knowledge of the role of stone tools in social interactions in the Bismarck Archipelago from the Lapita pottery period onwards.

Introduction

Throughout the Pacific Islands the growth of compositional provenance studies of lithic artefacts continues to refine our understanding of patterns of inter-island and intra-archipelago exchange networks, social interaction, and potentially craft specialisation, especially for artefacts made of basalt, andesite and obsidian (e.g., Weisler and Kirch, 1996; Summerhayes *et al*., 1998; Summerhayes, 2009; Mills *et al.,* 2011; Kirch *et al.,* 2012; Kahn *et al.,* 2013; Clark *et al.,* 2014; Weisler *et al.,* 2016). The relatively recent adoption of non-destructive portable XRF has enabled a new phase of sourcing studies for a wider range of samples within both the Pacific Islands and Australia (Sheppard *et al*., 2010; Attenbrow *et al.,* 2017; Richards, 2019). Within Near Oceania, the region encompassing New Guinea, the Bismarck Archipelago and Solomon Islands, pottery and volcanic glass (obsidian) have been the primary subjects of sourcing studies using various techniques. In the case of obsidian this has been particularly effective (Bird *et al*., 1997; Torrence and Summerhayes, 1997; Summerhayes, 2009; Shaw *et al*., 2020). For Near Oceania, pXRF has been used exclusively for obsidian sourcing (e.g., Torrence *et al.,* 2013; Specht *et al*., 2018), though my analyses of archaeological and ethnographic assemblages of stone axes and adzes on the Willaumez Pen. on the north coast of West New Britain Province, Papua New Guinea has extended the range of applications of pXRF (Pengilley *et al*., 2019). By taking advantage of legacy geochemical data from that region, many of these tools have been successfully grouped into potential source regions and integrated into existing models of regional trade.

The present paper builds on that work to expand our knowledge of the likely geological origins of stone tools in New Britain during the Lapita pottery and post-Lapita periods. It again takes advantage of the legacy data from geological fieldwork undertaken on New Britain by Dr. R. W. Johnson and others at the Bureau of Mineral Resources, Canberra (now Geoscience Australia) in the 1960s and 1970s. Similar to other regions, New Britain stone axes and adzes are comprised almost exclusively of igneous rocks. Whilst there is currently no field evidence of axe and adze

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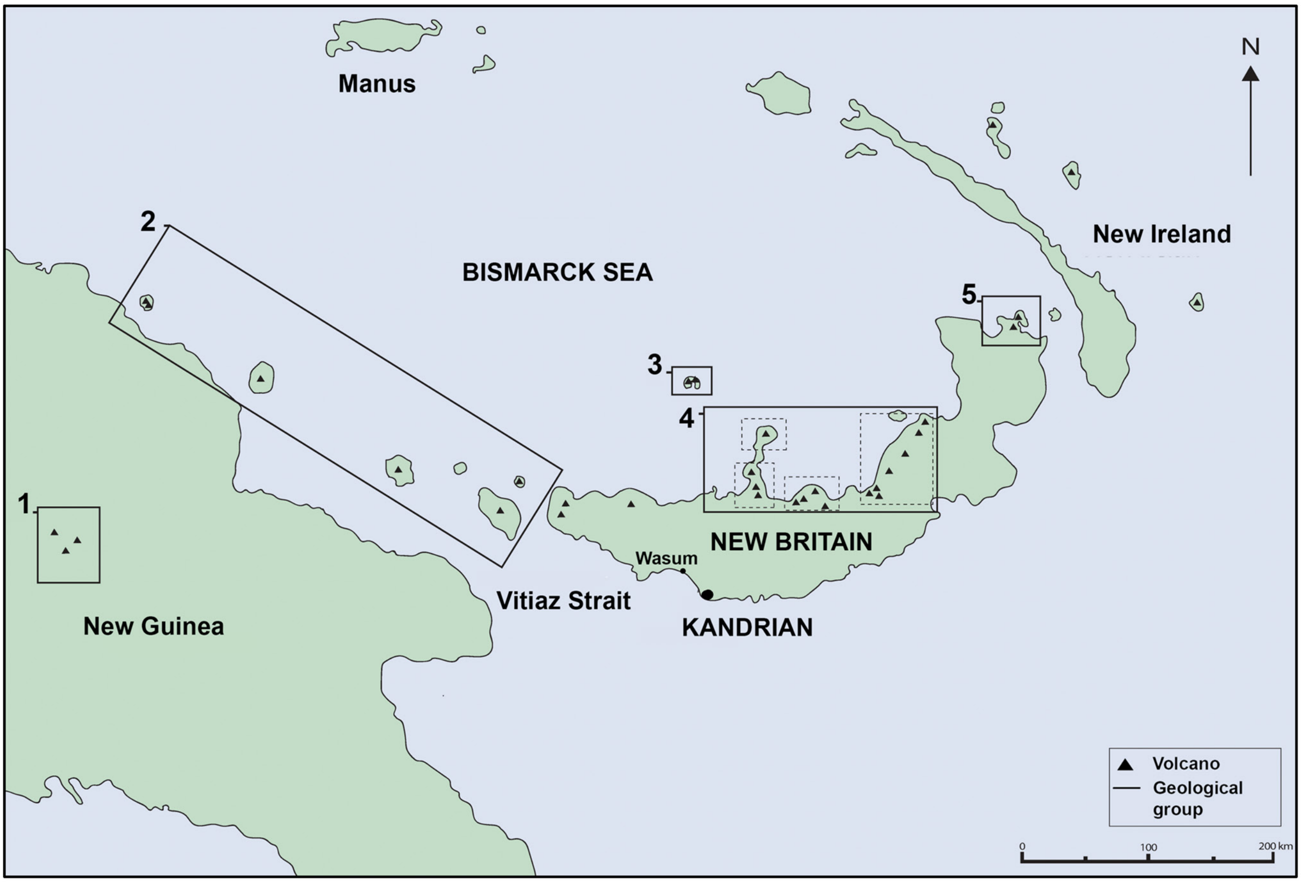

Figure 1. Location of major geological source regions used in this study. 1—New Guinea, 2—Vitiaz Strait, 3—Bali-Witu, 4—West New Britain sources (WPN, WPS, Hoskins, Eastern), 5—Rabaul.

manufacture on New Britain, such as grinding grooves or quarry sites, it is highly likely that raw material was sourced from areas with both abundant outcrops of igneous rock and the requisite production expertise.

In contrast to the extensive volcanic outcrops on the north side of New Britain, the southern half of New Britain is primarily comprised of Miocene sedimentary limestones in the interior and raised Pleistocene coral reef limestone along the coast. To evaluate the scale and scope of Lapita and post-Lapita networks and interaction spheres in this region this paper tests a hypothesis that most igneous stone tools in southern New Britain were imported from the north, focussing on artefacts recovered in the Kandrian and Passismanua regions of southwest New Britain.

Background

Regional interaction

The island of New Britain is located east of mainland New Guinea and is the largest island in the Bismarck Archipelago, a region containing the island provinces of Papua New Guinea (Fig. 1). As elsewhere in the Archipelago, in recent times communities in New Britain were linked through a series of interaction spheres that enabled the movement of region-specific products. Todd (1934a,b) and Chowning (1978) produced detailed ethnographic accounts on exchange networks between New Britain communities within these interaction spheres.

There is only minimal mention of stone tools in these ethnographic accounts as stone tool use had long ceased in New Britain by the time they were written (Chowning, 1978: 300). However, where they are mentioned, stone axe and adze blades appear to have been traded into regions where suitable raw material was not available. Chowning (1978) discusses accounts of exchange between the Kove language groups on the coast to the west of Willaumez Pen., Lakalai speakers on the volcanic Hoskins Pen., and Sengseng speakers in the Passismanua area, inland from Kandrian on the Yalam Limestone. These trade routes are consistent with the stone tools found in archaeological contexts in this region, particularly movement between Hoskins Pen., the base of the Willaumez Pen. and the Passismanua region (Pengilley *et al.,* 2019). Exchange between the Sengseng and other groups was largely dominated by the Sengseng's desire for goods that were only available on or near the coast. These included a variety of shells, coconuts, lizard skins, salt and obsidian imported from the north side of the island, which the Sengseng received in exchange for shields, minerals, betelnut, bark-cloth and chert raw material and artefacts produced from sources in the Yalam limestone of the Passismanua region (Chowning, 1978: 297).

Todd's (1934a,b) accounts of exchange along the south coast of New Britain provide a discussion of the goods involved. These included food bowls, pottery, canoes and round cane baskets that were brought from the Siassi Islands (Vitiaz Strait) and the western end of New Britain along the south coast, as well as shell money from people of the Rabaul area at the eastern end of New Britain. Trans-Vitiaz Strait trade was a prominent network linking New Britain with communities on the New Guinea mainland and the adjacent islands. Harding (1967, 1994) and Lilley (1986, 2004) have detailed a wide range of raw materials, craft goods, valuables and consumables that were passed between trading societies in the region. The Mandok (Siassi) were responsible for a large portion of this trade. Raw materials were a major component and included items such blocks of obsidian from the north coast of New Britain, red earth pigment from Tarawe volcanic centre on Umboi and black earth pigment from Malalamai on the Rai coast of New Guinea (Harding, 1967: 29–60). There is some indication that stone blades were also involved in these trans-Vitiaz exchanges and likely entered the Siassi system from several different sources. Despite the lack of existing archaeological evidence, it also seems likely that stone blades entered New Britain trade networks from sources in the Vitiaz Strait.

In comparison to the expedient nature of obsidian and chert flakes that dominate the New Britain archaeological assemblages (with the exception of mid-Holocene stemmed tools), stone axe and adze blades and their hafts would have required a significant amount of energy and skills to produce finished objects (Torrence, 2011). Taking into account the lack of evidence for the exchange of unmodified raw material or blanks intended for working into axes and adzes, finished stone blades are likely to have played a specific role in exchange networks. For example, a cache of stone axe heads that were found near the provincial town of Kimbe on the north side of New Britain might indicate that these artefacts were of value and deliberately buried at the site (Specht, 2005). Much like stone blades in the highlands of New Guinea, it is likely that New Britain artefacts not only held utilitarian value but also held ceremonial and prestige value and were exchanged, for example, as bride price items. If, as suggested here, axe and adze blades held a significant position in trade networks between different communities they were also probably curated and passed down inter-generationally.

Geological background

Many volcanic regions across the Bismarck Archipelago have produced raw material suitable for the production of stone tools, although due to the geological complexity of the raw material and a lack of field data, it is currently impossible to identify specific sources. However, the geological structure of the region enables geochemical distinctions between different volcanic regions.

New Britain is located in the eastern sector of the 'Bismarck Volcanic Arc', a volcanic chain that extends from the Schouten Islands off the north coast of New Guinea in the far west to Rabaul in the far northeast of East New Britain. This region formed as a result of the subduction of the Solomon Sea plate beneath the South Bismarck plate in the north (Johnson and Molnar, 1972; Neall *et al.,* 2008). New Britain is distinguished by two geologically different landscapes, the Wadati-Benioff zone of volcanic rocks in the north (Bali-Witu Islands, the Willaumez Pen. and the north coast) and the Miocene limestone karst of the central Whiteman mountain range southwards towards the south coast. On south coast, late Cainozic uplift has produced raised terraces of coralline limestone and marine sediment platforms along the mainland coast and formed islands such as Apugi near Kandrian (Ryburn, 1976).

The volcanic ranges of the Willaumez Pen. and adjacent regions in northern New Britain consist of andesitic and basaltic outcrops suitable for the production of stone tools. Non-destructive pXRF geochemical characterisation of stone blades from the Willaumez Pen. points to the Hoskins region as a likely major source of stone artefacts (Pengilley *et al.,* 2019). Similarly, volcanic outcrops in the Bali-Witu Islands and the North region of the Willaumez Pen. appear to have been the origin area for some blades that reached sites on Garua Island and the centre of the Pen.. These results gave rise to a model of exchange networks through which stone blades moved to communities distant from the source areas (Pengilley *et al*., 2019: 9–10). This model will be applied to the south coast assemblage in order to examine whether these same source regions were exploited, or tools were brought into the region from elsewhere.

Materials and methods

Geochemical study

To identify potential geological sources, I accessed a legacy reference geochemical dataset (major and trace elements) for 314 geological samples representing the likely major geological source regions (Fig. 1, Appendix 1). This dataset comprises 203 samples from the Willaumez Pen. and adjacent volcanic ranges and 26 samples from the Bali-Witu Islands; these were analysed at the Department of Geology, Australian National University, Canberra using a Philips PW1220 wave length dispersive XRF spectrometer (Johnson and Chappell, 1979; Woodhead and Johnson, 1993). The sample also includes XRF results for 54 samples from the Rabaul area of New Britain drawn from the GEOROC online database (Heming, 1979; Wood *et al*., 1995; McKee *et al.*, 2011; Patia *et al*., 2017), 15 samples from islands located in Vitiaz Strait and along the north coast of New Guinea (Woodhead *et al*., 2010), and 16 samples from Mounts Hagen, Giluwe, Murray and Bosavi on the New Guinea mainland (Mackenzie, 1976).

This paper compares the legacy compositional dataset to the results of non-destructive geochemical analyses of an archaeological sample from southern New Britain generated with a Bruker Tracer 5i pXRF spectrometer. To allow comparison between the two datasets, the new pXRF data was transformed into quantitative values using an empirical basalt calibration protocol designed for this instrument (Pengilley *et al.,* 2019, Supplementary Data 4 for the calibration routine). This step ensures that the data from different instruments is comparable and allows it to be amalgamated with legacy datasets. Measurements were made over 150 seconds using settings determined by the pre-loaded basalt calibration. Two standards, UHH.MK05.14E.57 and NIST688, were routinely analysed during analysis to estimate precision and accuracy of results (Appendix 2). Data provided from the pXRF analyses of the standards enabled assessment of the machine's capabilities to ensure compatibility between the datasets. Measurements were taken from three different locations on the least weathered surfaces of each artefact to minimise potential contamination, and these were then averaged to reduce the potential effect of sample heterogeneity. Measured elements included nine majors (MgO, K_2O, SiO_2, Al_2O_3, P_2O_5, CaO, TiO_2, MnO, Fe_2O_3) and nine traces (V, Ni, Cu, Zn, Rb, Sr, Y, Zr, Nb). To facilitate comparison with the legacy dataset, major elements (Na to Fe) are reported as weight percent (wt.%) oxides and trace elements (Co to Nb) as parts per million (ppm) (Appendix 3). Under the pre-loaded basalt calibration, improvements in correlation (R^2) were seen in a majority of elements. Because some variance occurred in the recovery data from these standards, MgO, K_2O, SiO_2, V, Ni, Cu and Nb were excluded from further analysis as these elements were either under or over recovered. (see Appendix 2).

The second stage of the geochemical study involved the combined analysis of legacy and pXRF data using Discriminate Function Analysis (DFA) with JMP 14.0

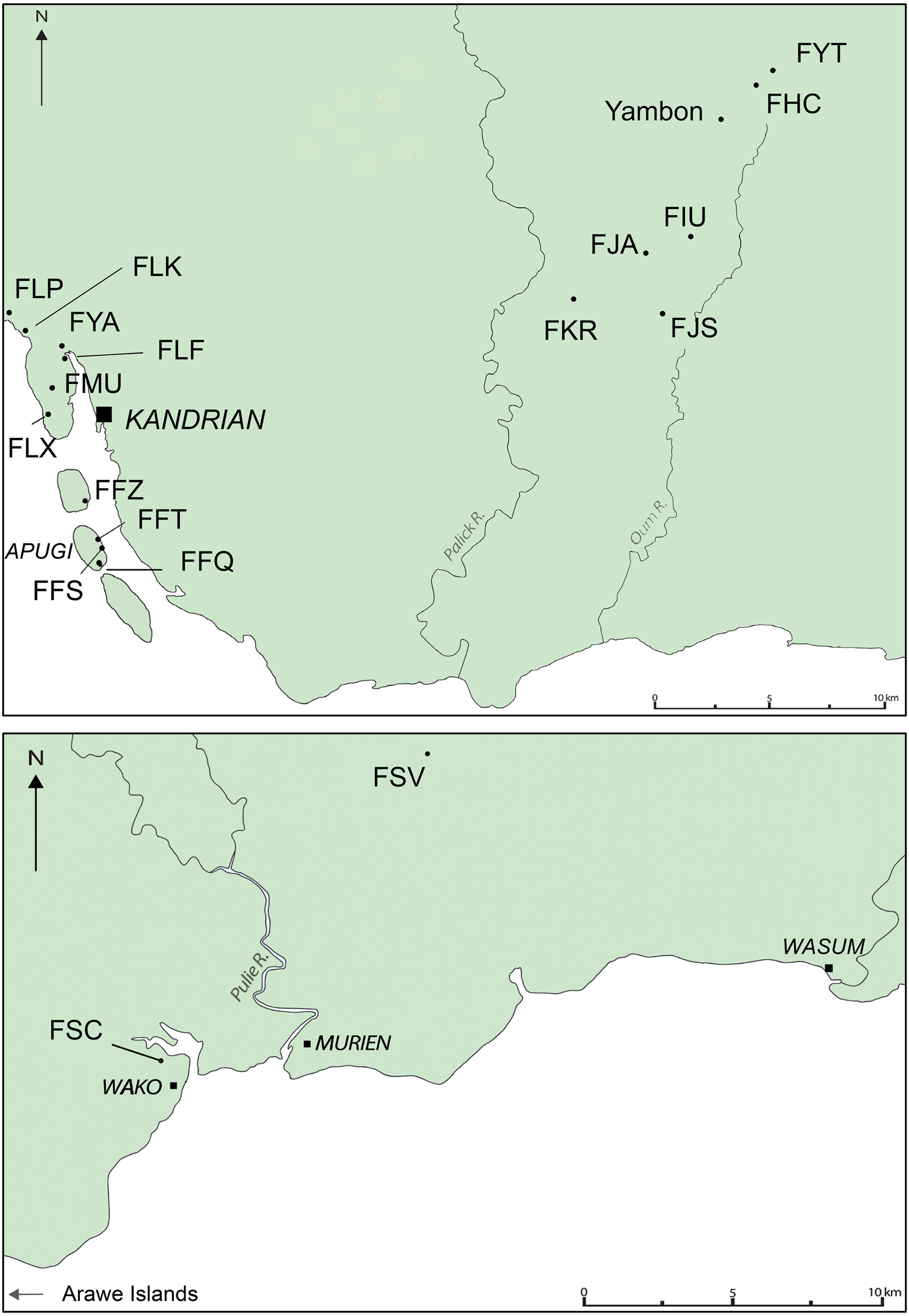

Figure 2. Location of sites where the stone tools were collected or excavated.

software (2018; © SAS Institute Inc.). By combining input variables into composite functions, DFA is able to classify the archaeological samples into source groups based on the training data provided by the geological source data. A degree of probability is provided to each outcome to show the likelihood of each match, and in this study only those items with a predicated posterior probability degree of 0.7 or higher were included. DFA can be used to assign 'unknowns' to a geological source region and has previously been used successfully for this purpose in the Marquesas Islands (McAlister and Allen, 2017), Papua New Guinea (Pengilley *et al.,* 2019) and Tonga and Samoa (Clark *et al.,* 2014). Geochemical regions and social regions were used during analysis to help classify artefacts into potential source groups, a method that was previously employed successfully to classify stone axes and adzes from the north coast of New Britain (Pengilley *et al.,* 2019).

The archaeological sample

This study is based on 67 stone tools from 18 archaeological sites in southwest New Britain, most of which were from surface collections (51) or finds by local people (4), and the rest (12) were from five excavated sites (Fig. 2; Appendix 3). This sample provides an opportunity to analyse the spatial distribution of stone artefacts over a large region. The size of the sample may seem small but is large for New Britain, where stone artefacts are rarely recovered from archaeological excavations. The tools were made by various techniques: flaking, grinding and hammer-dressing, sometimes combining two techniques. The sample includes a pestle (n = 1), possible bark cloth beaters (n = 2), nut-cracking anvils (n = 2), a discoid (n = 1), unidentified flaked pieces (n = 3), a split pebble (n = 1), and axe and adze blades (n = 57). The blades are largely comparable in form and size to those found elsewhere on New Britain, New Guinea and elsewhere in Near Oceania and include waisted and stemmed forms (e.g., Crosby, 1973; Specht, 2005; Pengilley *et al*., 2019: fig. 2). A selection of these tools is presented in Fig. 3. Part of the sample (n = 26) consists of artefacts from surface collections and excavated contexts associated with Lapita style pottery (approx. 3250–2750 BP), providing evidence for possible inclusion of some blades in Lapita exchange networks. The remaining items from surface collections are likely to belong to more recent periods (Torrence, 2011: 30). Only one tool is dated: adze blade FHC/I/95 from Misisil cave (site FHC) came from a dated context ca 1500–750 cal. BP (Lentfer *et al*., 2010: fig. 3), and one blade fragment at site FFT was associated with Lapita pottery.

Results

Discriminating between sources

To establish how well the geological source regions differentiated, a total of nine geochemical groups were employed in this study, each representing a different potential source area for which raw material could be exploited. Four of these groups are situated on the Willaumez Pen. (GN, GS) or in the volcanic ranges located to the east (E, F). These groups are geochemically distinct from each other due to the north-south direction of the underlying Wadati-Benioff zone, and once DFA was applied, good discrimination between the groups was possible (Fig. 4). There was some overlap between groups E and F, discussed further below. The other geological groups include samples from Rabaul, Bali-Witu Islands, Vitiaz Strait and New Guinea highlands. DFA of these samples shows clear separation between these geological regions (Fig. 4).

To address a potential lack of fit between the distribution of cultural groups across the New Britain landscape and the geochemical regions overlying the Wadati-Benioff zone, the concept of 'social regions' was employed in relation to exchange patterns. This potential lack of fit only relates to samples from the north coast of West New Britain. Samples from regions E and F were grouped with those in the Hoskins Pen. and the eastern group. GN and GS samples were mostly unaffected and are renamed as social groups WPN and WPS. When DFA was re-applied to test these new categories, good discrimination was achieved between regions (Fig. 5).

Once source groups were established, DFA was applied to the entire sample to assign artefacts into potential source groups. Artefacts were only grouped if they showed a predicated posterior probability degree of 0.7 or higher and their geological region classification aligned with their social region classification. This approach assigned 39 tools to two source groups (Fig. 6). Four of these tools were from Lapita-associated contexts with matches made to sources both within New Britain and beyond. In Fig. 6, artefacts grouped with a specific source are colour coded; unassigned artefacts are identified as black triangles.

Interpreting possible exchange patterns

Geochemical (Table 1) and social (Table 2) groups were employed to determine potential source regions. The relationship between artefact findspot and origin of raw material is represented in Fig. 6. While the remaining artefacts could not be securely classified, the data suggests these artefacts were of raw materials likely derived from even more distant locations. The wide range of stone sources present on sites south of the central Whiteman Range provides support for the hypothesis that stone artefacts, particularly axe and adze blades, were frequently moved around and were probably well-integrated into exchange relationships.

It is clear that the volcanic region east of the Willaumez Pen. was a major producer of axe and adze blades, a result consistent with the findings of Pengilley *et al*. (2019). Of the total sourced artefacts, 15 (33.3%) were assigned to either E or F geochemical region, and all of these artefacts were assigned to the Hoskins social region, thus excluding the eastern social region (Tables 1, 2). Within the Willaumez Pen., 9 tools (23.1%) could be assigned to the northern part of the Pen. (WPN/GN).

The absence of tools originating from the source region at the base and lower parts of Willaumez Pen. (GS, WPS) is notable as this supports the lack of field evidence for stone tool manufacture in this region. Previous geochemical sourcing of stone blades from sites in this region also produced no matches to volcanic outcrops in the WPS and GS regions (Pengilley *et al.,* 2019: 9). These results suggest that groups which controlled access to the obsidian sources most likely obtained valuables such as stone tools through exchange from nearby regions. Additionally, whereas sites located on the Willaumez Pen. which had artefacts from the Bali-Witu source region, none of the artefacts from the southern sites of New Britain were assigned to the Bali-Witu source region. Thus, the Bali-Witu networks were apparently only linked to communities on the north side of the island and lacked connections to networks to the south of the Whiteman Range.

Thirty eight percent of the matched tools were assigned to source regions beyond the central area of New Britain.

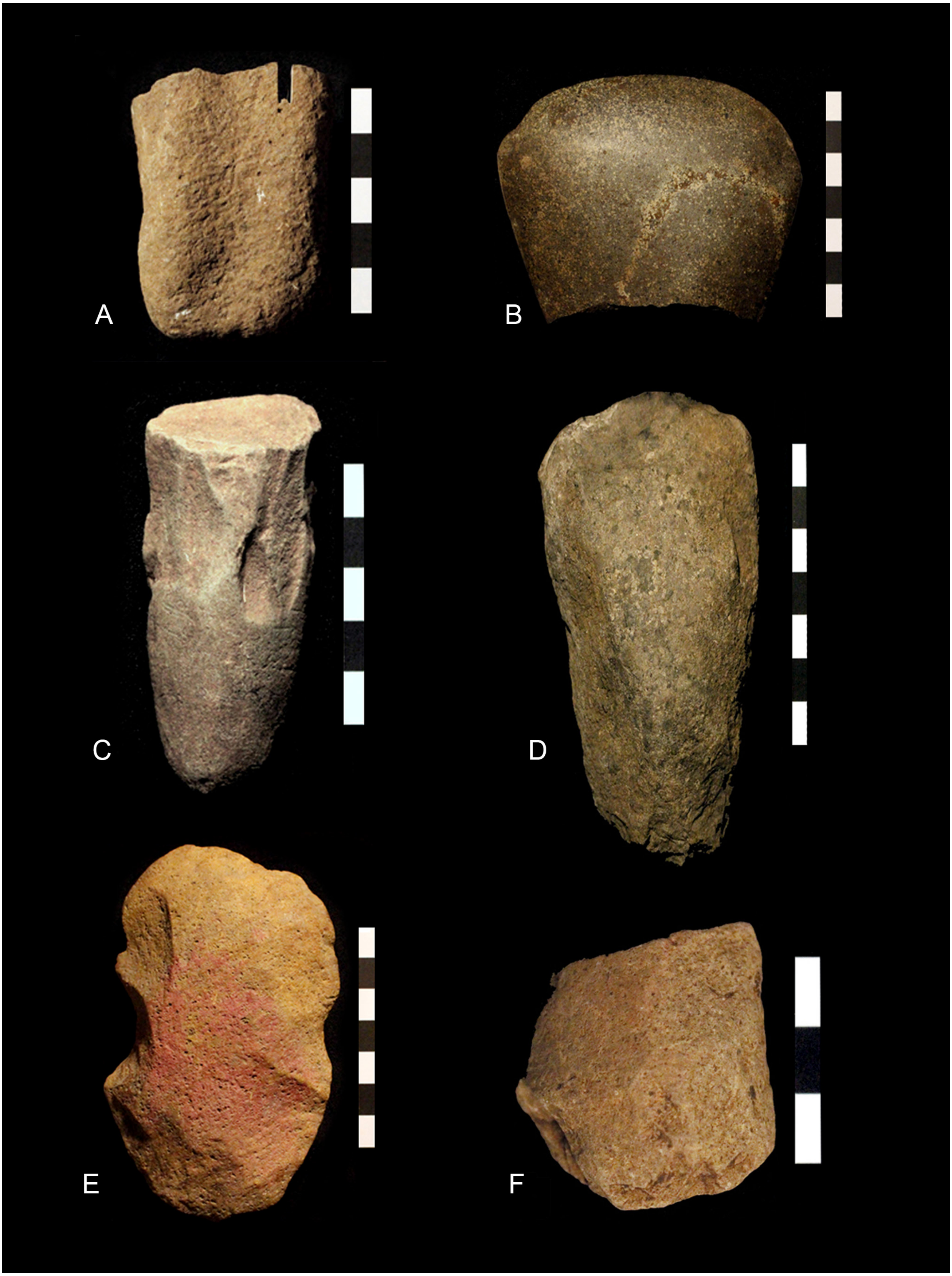

Figure 3. Selection of stone items analysed in this study with their Geochemical/social region. (*A*) File or nut-cracking anvil, surface find at site FLP, Analo village, Kandrian (E/Hoskins). (*B*) Cutting-edge of axe, surface find from site FSV, Giring (Gegering) village, Lamogai, central New Britain (Vitiaz/Vitiaz). Reproduced by courtesy of C. Gosden and R. Fullagar. (*C*) Possible bark-cloth beater, surface find from site FSC, Monkereme near Wako village, south coast New Britain (GN/WPN). Reproduced by courtesy of C. Gosden and R. Fullagar. (*D*) Adze blade, surface find from square 20N/35E at Lapita pottery site FFS, Auraruo, Apugi Island, Kandrian (F/Hoskins). (*E*) Flaked waisted axe or adze made on a pebble, surface find at site FYT, Hauwauyang cave, near site FHC, Misisil cave, Passismanua (GN/WPN). (*F*) Adze or axe butt, excavated from trench III, spit 3 at Lapita pottery site FFT, Rapie area, Iangpun village, Apugi Island, Kandrian (Vitiaz/Vitiaz).

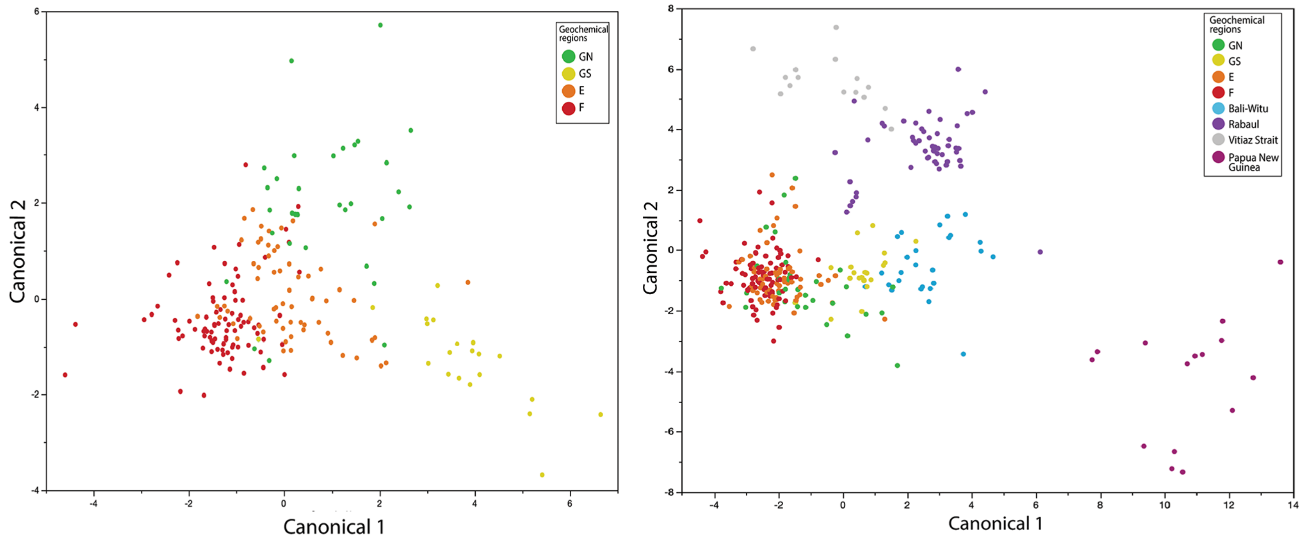

Figure 4. Discriminant Function Analysis of Willaumez Pen. geological regions (left) and all geological regions included in this study (right).

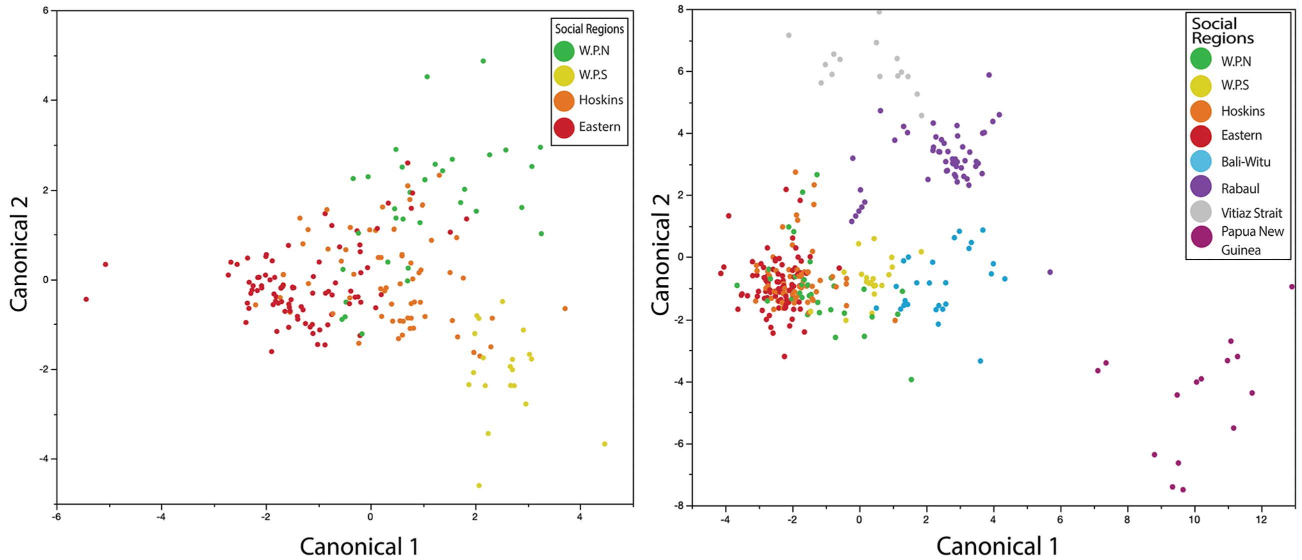

Figure 5. Discriminant Function Analysis of Willaumez Pen. social regions (left) and all social regions included in this study (right).

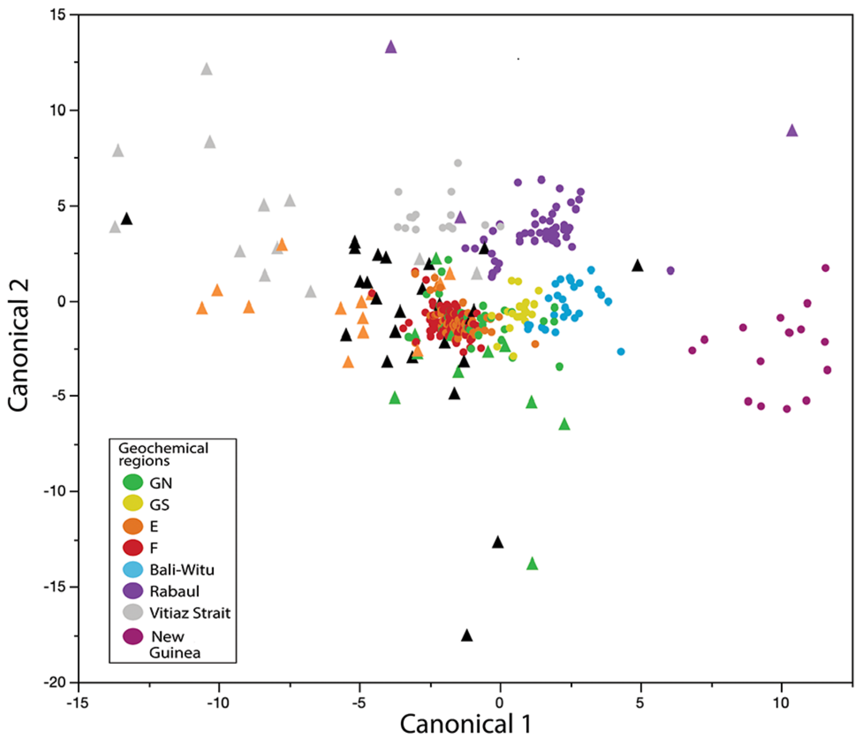

Figure 6. Results of geochemical characterisation. Artefacts classified to a source region are coloured the same as the source to which they have been assigned, and unassigned tools are depicted by black triangles.

Table 1. Items successfully assigned to each geochemical source region. *Kandrian coast group includes one Lamogai/Wasum item in each of the GN and Vitiaz regions.

archaeological area	geochemical source region								
	E	F	GN	GS	H	Rabaul	Vitiaz	New Guinea	totals
Passismanua	0	1	1	0	0	0	3	0	5
Kandrian coast*	4	0	2*	0	0	3	5*	0	14
Apugi Island	4	5	6	0	0	0	4	0	19
Ganglo Island	1	0	0	0	0	0	0	0	1
totals	9	6	9	0	0	3	12	0	39
totals as %	23.1	15.4	23.1	0	0	7.7	30.8	0	100%

No samples matched sources on the New Guinea mainland. Roughly 8% of the sample were assigned to the Rabaul geochemical region at the most easterly part of New Britain. To the west, 30.8% of the tools were assigned to sources located in the Vitiaz Strait and islands along the New Guinea north coast confirming the inclusion of stone tools in long distance trade networks across water along with pigments, pots and other artefacts (Harding, 1994). While the involvement of these stone tools in the networks was suspected, this new data securely links them to the inter-island trade, though specific material sources are not identified.

Change over time

The geochemical analysis of stone tools from sites on the southern side of New Britain also provides an opportunity to study possible change of sources over time. Intensification of exchange networks enabling the movement of larger volumes of region-specific products would be one expected effect of increasing settlement across the region. The results of this study allow us to understand the role stone blades had in these changing interaction spheres. Surface and excavated artefacts from four Lapita sites have successfully been matched to a social region, with 61.5% assigned to Hoskins or WPN (Table 3). Notably, however, 27% were assigned to the Vitiaz Strait social region and 11% to Rabaul.

While only 26 out of 45 artefacts at the Lapita pottery sites could be successfully assigned to a source and the exact date of each artefact is not known, the results provide some indication of the movement of a diverse range of stone tools through the region in early times. While most items in the sample were the product of surface collections and can be assumed to belong to the most recent millennium, our small sample of excavated artefacts includes an axe or adze butt at site FFT on Apugi Island that was clearly associated with Lapita pottery assigned to the Vitiaz social region (Fig. 3F; WNB/S/25 in Appendix 3). This indicates that the connection between the Kandrian and Vitiaz Strait communities was in existence during Lapita times, though the connection might have begun prior to that time, and continued for the next three millennia. At the mainland Lapita site of FLX three of the nine items assigned to a geochemical source are assigned to the Rabaul region, but none of the 36 items analysed from Apugi Island (FFQ, FFS, FFT) can be confidently attributed to the Rabaul region. This marked contrast might be explained in several ways, including the development of links with the Rabaul region after the Lapita pottery period. Testing this possibility will require larger and better contextualised samples.

Discussion and conclusions

The majority of stone tools in this study were made from stone sources in the Hoskins Pen., with smaller numbers coming from northern Willaumez Pen., the Rabaul region, and various islands in the Vitiaz Strait region. These results indicate that while most exchange activity occurred across New Britain from north to south, a substantial number of items also came to the Kandrian-Passismanua areas along the south coast from both the east and the west. These results support the social networks proposed between communities in New Britain and the wider Bismarck Archipelago (Torrence *et al*., 2013).

In recent time exchanges between the north coast and the south coast of New Britain involved the well-known trade of obsidian and pigments moving south in exchange for other products (Chowning, 1978: 297–298). We can now confidently add to these accounts that stone axe and adze blades and other tools also moved from these areas into the south (Fig. 7). Two main source regions have become apparent: the areas inhabited today by the Bulu (North Willaumez Pen.) and Lakalai (Hoskins) communities. It is not possible to trace the exact route or routes by which these

Table 2. Items successfully assigned to each social region. *Kandrian coast group includes one Lamogai/Wasum item in each of the WPN and Vitiaz regions.

Archaeological area	Social region								
	Eastern	Hoskins	WPS	WPN	Bali/Witu	Rabaul	Vitiaz	New Guinea	totals
Passismanua	0	1	0	1	0	0	3	0	5
Kandrian coast*	0	4	0	2*	0	3	5*	0	14
Apugi Island	0	9	0	6	0	0	4	0	19
Ganglo Island	0	1	0	0	0	0	0	0	1
totals	0	15	0	9	0	3	12	0	39
totals as %	0	38.5	0	23.1	0	7.7	30.8	0	100.1%

Table 3. All surface and excavated finds from Kandrian area Lapita pottery sites assigned to social regions.

site	number analysed	WPN	Hoskins	Vitiaz	Rabaul	total assigned (%)
FFS	24	3	9	1	0	13 (54%)
FFT	11	2	0	3	0	5 (45%)
FLX	9	0	1	3	3	7 (78%)
FYA	1	0	1	0	0	1 (n/a)
totals	45	5	11	7	3	26 (57.8%)
totals %		19.2%	42.3%	26.9%	11.5%	99.9%

artefacts reached the southern communities, although based on ethnographic data, it is likely that they travelled through the centre of the island via one of several paths. According to local informants on the south coast, one route led from the Kove area on the north coast via the Lamogai plateau to the south coast, and another ran from the Hoskins region across the island to Gasmata and then westwards along the coast to Kandrian (J. Specht, unpublished 1979 field notes).

In comparison to the ethnographic literature, exchange routes utilised in earlier periods appear to have been similar to those used in recent times. It remains to be seen, however, whether there were any changes in the networks of exchange links over time with a shift to movements of artefacts between communities in the same geographic region.

The characterisation of stone tools to sources outside West New Britain indicates that they were part of trade networks that spanned a much larger area. We can see the movement of tools along a network that linked Rabaul with the Kandrian coast. Stone tools produced in the east were probably traded for specific material such as obsidian that was unique to the Willaumez Pen. or chert from Yalam limestone geological formations in the Passismanua region.

While there is no mention of the involvement of stone tools in ethnographic accounts of trade between New Britain and the islands to the west, the geochemical results indicate there was such trade in pre-contact times. Numerous trading points along the coast would have facilitated movement of goods between communities and it is likely that stone tools produced on the islands of Vitiaz Strait were involved in down-the-line exchanges similar to those described in the ethnographies until they reached communities in Arawe Islands and Kandrian areas, and eventually the inland Passismanua area. When this movement of stone tools into southern New Britain began is unclear at present. The identification of tools of likely origin in the Vitiaz geochemical region at Lapita pottery sites on Apugi Island and the adjacent mainland of New Britain most likely indicate that these west to east connections began during Lapita pottery times. It is noteworthy that Lapita pottery occurs on Tuam Island in Vitiaz Strait (Lilley, 2002), raising the possibility that the Tuam site was a link in a network through which the stone tools passed.

Geochemical characterisation using a combination of pXRF and conventional legacy data has thus significantly increased our understanding of the role stone tools in exchange networks through New Britain and more widely in the Bismarck Archipelago. Further fieldwork focused on the primary source regions that have been isolated in this study might lead to the identification of specific areas of raw material procurement or signs of tool manufacture, such as grinding grooves. Irrespective of whether the transported stone tools were needed for ritual or utilitarian purposes, the pXRF studies allow us to trace their movement to the Kandrian and Passismanua regions from other regions, whereas previously we could previously only speculate about their origins.

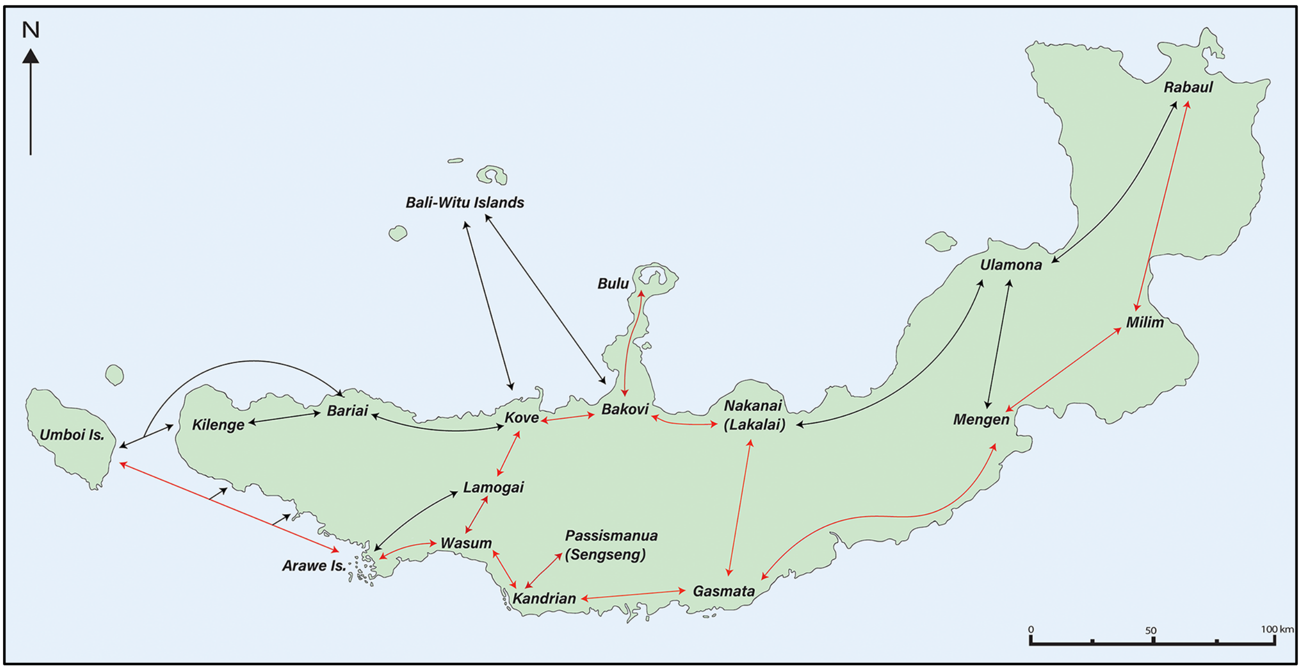

Figure 7. Summary of exchange networks throughout New Britain. Black lines indicate previously established routes of trade and the red lines indicate the possible paths that the stone tools on the south coast could have followed from their original source region.

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References

Attenbrow, V., T. Corkill, R. Pogson, L. Sutherland, and P. Grave. 2017. Non-destructive provenancing of ground-edged mafic artefacts: a Holocene study from the Sydney Basin, Australia. *Journal of Field Archaeology* 42(3): 173–186.
https://doi.org/10.1080/00934690.2017.1324354

Bird, R., R. Torrence, G. R. Summerhayes, and G. Bailey. 1997. New Britain obsidian sources. *Archaeology in Oceania* 32(1): 61–67.
https://doi.org/10.1002/j.1834-4453.1997.tb00371.x

Chowning, A. 1978. Changes in West New Britain trading systems in the twentieth century. *Mankind* 11(3): 296–307.
https://doi.org/10.1111/j.1835-9310.1978.tb00660

Clark, G. R., C. Reepmeyer, N. Melekiola, J. Woodhead, W. R. Dickinson, and H. Martinsson-Wallin. 2014. Stone tools from the ancient Tongan state reveal prehistoric interaction centers in the Central Pacific. *Proceedings of the National Academy of Sciences of the USA* 111(29): 10491–10496.
https://doi.org/10.1073/pnas.1406165111

Crosby, E. 1973. A Comparative Study of Melanesian Hafted Edge-Tools and Other Percussive Cutting Implements. Unpublished PhD thesis, Australian National University, Canberra.
http://hdl.handle.net/1885/109367/

GeoReM. 2019.
http://georem.mpch-mainz.gwdg.de/

Harding, T. G. 1967. *Voyagers of the Vitiaz Strait. A Study of a New Guinea Trade System.* Seattle: University of Washington Press.

Harding, T. G. 1994. Precolonial New Guinea trade. *Ethnology* 33(2): 101–125.
https://doi.org/10.2307/3773892

Heming, R. F. 1979. Undersaturated lavas from Ambittle Island [sic], Papua New Guinea. *Lithos* 12(5): 172–186.
https://doi.org/10.1016/0024-4937(79)90002-1

JMP 14.0. 2018. SAS Institute, Inc.
https://www.jmp.com/en_au/software.html

Johnson, R. W., and B. W. Chappell. 1979. Chemical analyses of rocks from the Late Cainozoic volcanoes of north-central New Britain and the Witu Islands, Papua New Guinea. In *Report. Australia. Bureau of Mineral Resources, Geology and Geophysics 209,* ed. R. W. Johnson and B. W. Chappell, pp. 1–47. Canberra: Australian Government Publishing Service.
https://d28rz98at9flks.cloudfront.net/15120/Rep_209.pdf

Johnson, T., and P. Molnar. 1972. Focal mechanisms and plate tectonics of the southwest Pacific. *Journal of Geophysical Research* 77(26): 5000–5032.
https://doi.org/10.1029/JB077i026p05000

Kahn, J. G., J. Sinton, P. R. Mills, and S. P. Lundblad. 2013. X-ray fluorescence analysis and intra-island exchange in the Society Island archipelago (Central Eastern Polynesia). *Journal of Archaeological Science* 40: 1194–1202.
https://doi.org/10.1016/j.jas.2012.10.003

Kirch, P. V., P. R. Mills, S. P. Lundblad, J. Sinton, and J. G. Kahn. 2012. Interpolity exchange of basalt tools facilitated via elite control in Hawaiian archaic states. *Proceedings of the National Academy of Sciences of the USA* 109(4): 1056–1061.
https://doi.org/10.1073/pnas.1119009109

Lentfer, C., C. Pavlides, and J. Specht. 2010. Natural and human impacts in a 35 000-year vegetation history in central New Britain, Papua New Guinea. *Quaternary Science Reviews* 29(27–28): 3750–3567.
https://doi.org/10.1016/j.quascirev.2010.08.009

Lilley, I. 1986. Prehistoric exchange in the Vitiaz Strait, Papua New Guinea. Unpublished PhD thesis, Australian National University, Canberra.

Lilley, I. 2002. Lapita and Type Y in the KLK site, Siassi, Papua New Guinea. In *Fifty Years in the Field. Essays in honour of Richard Shutler Jr's archaeological career*, ed. S. Bedford, C. Sand, and D. Burley, pp. 79–90. New Zealand Archaeological Association Monograph 25. Auckland: New Zealand Archaeological Association.

Lilley, I. 2004. Trade and culture history across the Vitiaz Strait, Papua New Guinea: the emerging Post-Lapita coastal sequence. *Records of the Australian Museum, Supplement* 29: 89–96.
https://doi.org/10.3853/j.0812-7387.29.2004.1405

Mackenzie, D. E. 1976. Nature amid origin of late Cainozoic volcanoes in western Papua New Guinea. In *Volcanism in Australasia*, ed. R. W. Johnson, pp. 221–238. Elsevier: Amsterdam.

McAlister, A., and M. S. Allen. 2017. Basalt geochemistry reveals high frequency of prehistoric tool exchange in low hierarchy Marquesas Islands (Polynesia). PLoS ONE 12(12): 1–28.
https://doi.org/10.1371/journal.pone.0188207

McKee, C. O., V. E. Neall, and R. Torrence. 2011. Remarkable pulse of large-scale volcanism on New Britain Island, Papua New Guinea. *Bulletin of Volcanology* 73(1): 27–37.
https://doi.org/10.1007/s00445-010-0401-8

Mills, P. R., and S. P. Lundblad. 2006. Preliminary Field Report: The Geochemistry of the Ko`oko`olau Complex, Mauna Kea Adze Quarry (50-10-23-4136) TMK:4-4-15:10. Report prepared for the Hawaii Natural Area Reserves System (NARS) Commission. Hilo: University of Hawaii.
https://hilo.hawaii.edu/faculty/millsp/documents/NARreport.pdf

Mills, P. R., S. P. Lundblad, K. Hon, J. J. Moniz-Nakamura, L. K. Kahahane, A. Drake-Raue, T. M. Souza, and T. Wei. 2011. Reappraising craft specialization and exchange in pre-contact Hawai'i through non-destructive sourcing of basalt adze debitage. *Journal of Pacific Archaeology* 2(2): 79–92.
https://pacificarchaeology.org/index.php/journal/article/view/34

Neall, V. E., R. C. Wallace, and R. Torrence. 2008. The volcanic environment for 40,000 years of human occupation on the Willaumez Isthmus, West New Britain, Papua New Guinea. *Journal of Volcanology and Geothermal Research* 176(3): 330–343.
https://doi.org/10.1016/j.jvolgeores.2008.01.037

Patia, H., S. M. Eggins, R. J. Arculus, C. O. Mckee, R. W. Johnson, and A. Bradney. 2017. The 1994–2001 eruptive period at Rabaul, Papua New Guinea: Petrological and geochemical evidence for basalt injections into a shallow dacite magma reservoir, and significant SO2 flux. *Journal of Volcanology and Geothermal Research* 345: 200–217.
https://doi.org/10.1016/j.jvolgeores.2017.08.011

Pengilley, A., C. Brand, J. F. Flexner, J. Specht, and R. Torrence. 2019. Detecting exchange networks in New Britain, Papua New Guinea: geochemical comparisons between axe and adze blades and in situ volcanic rock sources. *Archaeology in Oceania* 54(3): 200–213.
https://doi.org/10.1002/arco.5188

Richards, M. J. 2019. Duff's adze typology versus Polynesian adze exchanges. *Archaeology in Oceania* 54(3): 173–183.
https://doi.org/10.1002/arco.5194

Ryburn, R. J. 1976. *Cape Raoult-Arawe, Papua New Guinea, 1:250 000 Geological Series—Explanatory Notes: SB/55-8, SB/55-12*. Canberra: Australian Government Publishing Service.

Shaw, B., S. Coxe, V. Kewibu, J. Haro, E. Hull, and S. Hawkins. 2020. 2500-year cultural sequence in the Massim region of eastern Papua New Guinea reflects adaptive strategies to small islands and changing climate regimes since Lapita settlement. *The Holocene*: 1–16.
https://doi.org/10.1177/0959683620908641

Sheppard, P., B. Trichereau, and C. Milicich. 2010. Pacific obsidian sourcing by portable XRF. *Archaeology in Oceania* 45(1): 21–30.
https://doi.org/10.1002/j.1834-4453.2010.tb00074.x

Specht, J. 2005. Stone axe blades and valuables in New Britain, Papua New Guinea. In *A Polymath Anthropologist: Essays in Honour of Ann Chowning*, ed. C. Gross, H. D. Lyons, and D. A. Counts, pp. 15–22. Research in Anthropology and Linguistics Monograph Number 6. Auckland: Department of Anthropology, University of Auckland.

Specht, J., A. Ford, and J. Kariwiga. 2018. Obsidian from the Jacquinot Bay area, East New Britain, Papua New Guinea. *Journal of Pacific Archaeology* 9(2): 35–43.
https://www.pacificarchaeology.org/index.php/journal/article/view/254

Summerhayes, G. R. 2009. Obsidian network patterns in Melanesia—sources, characterisation and distribution. *Bulletin of the Indo-Pacific Prehistory Association* 29: 110–124.
https://doi.org/10.7152/bippa.v29i0.9484

Summerhayes, G. R., J. R. Bird, R. Fullagar, C. Gosden, J. Specht, and R. Torrence. 1998. Application of PIXE-PIGME to archaeological analysis of changing patterns of obsidian use in West New Britain, Papua New Guinea. In *Archaeological Obsidian Studies*, ed. S. Shackley, pp. 129–158. Plenum: New York.
https://doi.org/10.1007/978-1-4757-9276-8_6

Todd, J. A. 1934a. Report on research work in South-west New Britain, Territory of New Guinea. *Oceania* 5(1): 80–101.
https://doi.org/10.1002/j.1834-4461.1934.tb00132.x

Todd, J. A. 1934b. Report on research work in South-west New Britain, Territory of New Guinea. *Oceania* 5(2): 193–213.
https://doi.org/10.1002/j.1834-4461.1934.tb00140.x

Torrence, R. 2011. Finding the right question: Learning from stone tools on the Willaumez Peninsula, Papua New Guinea. *Archaeology in Oceania* 46(2): 29–41.
https://doi.org/10.1002/j.1834-4453.2011.tb00097.x

Torrence, R., S. Kelloway, and P. White. 2013. Stemmed tools, social interaction, and voyaging in early-mid Holocene Papua New Guinea. *Journal of Island and Coastal Archaeology* 8(2): 287–310.
https://doi.org/10.1080/15564894.2012.761300

Torrence, R., and G. R. Summerhayes. 1997. Sociality and the short distance trader: Intra-regional obsidian exchange in the Willaumez region. *Archaeology in Oceania* 32(1): 74–84.
https://doi.org/10.1002/j.1834-4453.1997.tb00373.x

Weisler, M. I., and P. V. Kirch. 1996. Interisland and inter-archipelago transfer of stone tools on prehistoric Polynesia. *Proceedings of the National Academy of Sciences of the USA* 93(4): 1381–1385.
https://doi.org/10.1073/pnas.93.4.1381

Weisler, M. I., R. Bolhar, J. Ma, E. St Pierre, P. Sheppard, R. K. Walter, Y. Feng, J.-x. Zhao, and P. V. Kirch. 2016. Cook Island artifact geochemistry demonstrates spatial and temporal extent of pre-European interarchipelago voyaging in East Polynesia. *Proceedings of the National Academy of Sciences of the USA* 111(29): 8150–8155.
https://doi.org/10.1073/pnas.1608130113

Wood, C. P., I. A. Nairn, C. O. McKee, and B. Talai. 1995. Petrology of the Rabaul Caldera area, Papua New Guinea. *Journal of Volcanology and Geothermal Research* 69(3): 285–302.
https://doi.org/10.1016/0377-0273(95)00034-8

Woodhead, J. D., J. Hergt, M. Sandiford, and W. Johnson. 2010. The Big Crunch: physical and chemical expressions of Arc/Continent collision in the Western Bismarck Arc. *Journal of Volcanology and Geothermal Research* 190(1): 11–24.
https://doi.org/10.1016/j.jvolgeores.2009.03.003

Woodhead, J. D., and R. W. Johnson. 1993. Isotopic and trace element profiles across the New Britain island arc, Papua New Guinea. *Contributions to Mineralogy and Petrology* 113(4): 479–491.
https://doi.org/10.1007/BF00698317

Appendix 1. Geochemical data for geological reference collections used in this study. Abbreviations: *Geo.* Geochemial Region; *N.G.* New Guinea; *Pen.* Peninsula; *Social* Social Region.

name	location	Geo.	Social	material	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO2	V	MnO	FeO2O3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
E1:68490025	Mt. Witori area	E	Hoskins	Andesite	2.81	17.58	57.33	0.16	0.51	8.41	0.61	240	0.16	3.27	10	75	86	6.1	420	19	34	0
E1:68490031	Mt. Witori area	E	Hoskins	Dacite	1.47	15	66.28	0.16	0.88	5.15	0.48	97	0.14	1.91	0.2	17	76	12	330	20	50	0
E1:68490033	Mt. Witori area	E	Hoskins	Dacite	1.36	15.13	66.43	0.14	0.9	5.24	0.47	94	0.14	2.74	0.2	15	86	13	370	21	58	0
E1:68490030	Mt. Witori area	E	Hoskins	Dacite	1.1	14.74	69.44	0.16	1.03	4.38	0.4	43	0.12	1.73	0.2	9	67	14	310	16	58	0
E1:75710021	Mt. Witori area	E	Hoskins		1.57	14.63	65.8	0.15	0.88	5.31	0.48	80	0.15	1.71	0.1	9	84	13	355	15	59	0.1
E1:WP01001	Mt. Witori area	E	Hoskins	Basalt	2.595	18.739	49.382	0.253	0.974	0	0.88	191	0.175	0	16	0	99	16	404.7	36	96	1.4
E1:W00013	Mt. Witori area	E	Hoskins	Basalt	2.263	17.893	48.718	0.202	0.935	0	0.82	171	0.174	0	14	0	104	16	398	34	95	2
E1:WP01003	Mt. Witori area	E	Hoskins	Andesite	1.956	16.348	58.886	0.258	1.573	0	0.825	120	0.142	0	16	0	91	19.4	301.1	37.2	120	1.7
E1:WP01002	Mt. Witori area	E	Hoskins	Andesite	1.793	15.987	58.919	0.279	1.629	0	0.825	118	0.144	0	16	0	88	20.6	293.3	38.4	125	1.8
E2:51NG3028	Sulu Range	E	Eastern		2.8	18.6	55.8	0.06	0.35	9.4	0.64	253	0.17	2.4	4	202	82	5.2	251	11	26	0.1
E2:51NG3035	Sulu Range	E	Eastern		4.95	16.5	56.8	0.05	0.59	8.95	0.45	189	0.15	4.4	24	97	69	8	217	11	37	0.1
E2:51NG3039B	Sulu Range	E	Eastern		7.05	15.7	55	0.06	0.36	10	0.38	197	0.16	1.94	43	114	68	5.8	224	10	31	0.1
E3:51NG0113	Mt. Galloseulo, Hargy	E	Eastern		1.69	14.3	65.1	0.12	0.67	5.7	0.66	181	0.14	1.5	2	90	85	17.4	255	16	62	0.1
E3:51NG0199	Mt. Galloseulo, Hargy	E	Eastern		3.4	17.2	57.8	0.06	0.57	8.65	0.46	211	0.16	2.3	11	62	74	6.8	268	10	31	0.1
E3:51NG0202	Mt. Galloseulo, Hargy	E	Eastern		5.1	17.3	55.9	0.05	0.4	9	0.35	209	0.16	3	19	60	72	6.8	256	9	22	0.1
E3:51NG0205	Mt. Galloseulo, Hargy	E	Eastern		7.45	15.1	55.6	0.05	0.22	9.7	0.39	226	0.17	2.25	56	79	69	6	221	8	25	0.1
E3:51NG0208	Mt. Galloseulo, Hargy	E	Eastern		2.2	18.3	58.3	0.06	0.7	8.74	0.49	219	0.11	1.75	6	96	66	9.8	285	11	36	0.1
E3:51NG0209	Mt. Galloseulo, Hargy	E	Eastern		2.15	18.1	58.7	0.07	0.64	9	0.5	223	0.11	2.2	7	101	64	9.8	298	11	36	0.1
E3:51NG0213	Mt. Galloseulo, Hargy	E	Eastern		2.75	16.2	59.5	0.08	0.81	8.4	0.53	258	0.12	1.85	12	85	77	11.4	271	12	41	0.1
E4:51NG0166	Mt. Bamus	E	Eastern		3.35	18.7	56.8	0.12	0.44	8.55	0.75	159	0.15	2.5	6	37	65	6.8	277	14	54	0.1
E4:51NG0171	Mt. Bamus	E	Eastern		1.86	19.5	58.3	0.09	0.53	9.35	0.72	144	0.12	1.7	4	64	55	8.2	276	15	47	0.1
E4:51NG0193	Mt. Bamus	E	Eastern		3.9	18.5	54.3	0.09	0.33	8.8	0.62	243	0.14	4.2	20	75	80	1	260	18	46	0.1
E4:51NG0195M	Mt. Bamus	E	Eastern		2.9	18.1	57.3	0.09	0.34	8.8	0.58	259	0.15	2.55	15	100	78	3.6	257	15	51	0.1
E4:51NG0195X	Mt. Bamus	E	Eastern		2.4	19.8	57	0.09	0.45	8.9	0.62	161	0.13	1.78	4	100	59	7.4	239	15	50	0.1
E4:51NG2604	Mt. Bamus	E	Eastern		4.3	18.4	55.2	0.06	0.37	8.95	0.9	213	0.15	2.85	8	102	84	4	252	20	45	0.1
E4:51NG3006	Mt. Bamus	E	Eastern		10.1	13.8	53.9	0.09	0.46	8.8	0.41	222	0.15	2.8	170	64	74	4.6	176	10	33	0.1
E4:51NG3020	Mt. Bamus	E	Eastern		4.3	17.9	55.7	0.09	0.46	8.8	0.61	204	0.15	2.8	9	64	72	6.4	224	16	52	0.1
E4:75710019	Mt. Bamus	E	Eastern		4.74	17.93	55.44	0.05	0.37	8.21	0.76	203	0.21	3.27	7	39	73	5.6	220	12	42	0.1
E4:75710020	Mt. Bamus	E	Eastern		3.38	17.93	58.4	0.12	0.47	8.03	0.63	118	0.17	2.62	4	24	63	8.2	262	14	58	0.1
E5:51NG0065B	Mt. Ulawun	E	Eastern		4.69	18.66	52.32	0.08	0.32	10.6	0.76	290	0.17	3.22	21	81	81	4.6	297	13	21	0.1
E5:51NG0066	Mt. Ulawun	E	Eastern		4.79	18.8	52.5	0.1	0.35	10.67	0.76	301	0.16	3.29	18	81	78	4.6	290	12	22	0.1
E5:51NG0079	Mt. Ulawun	E	Eastern		4.9	19.16	52.47	0.09	0.32	10.76	0.75	294	0.17	3.4	22	80	82	4.2	301	13	21	0.1
E5:51NG0091	Mt. Ulawun	E	Eastern		5.54	17.71	52.33	0.07	0.32	10.43	0.73	319	0.2	4.05	21	53	87	4	321	12	18	0.1
E5:51NG0094	Mt. Ulawun	E	Eastern		4.75	17.85	55.48	0.06	0.39	10	0.52	282	0.14	3.3	41	99	67	5.6	333	11	27	0.1
E5:51NG0150	Mt. Ulawun	E	Eastern		5.47	17.05	54.95	0.05	0.34	9.82	0.49	261	0.18	3.17	21	104	78	5	289	10	21	0.1
E5:51NG0156	Mt. Ulawun	E	Eastern		5.17	17.8	52.43	0.08	0.36	10.61	0.77	322	0.18	3.32	20	69	85	5	309	13	22	0.1
E5:51NG0158	Mt. Ulawun	E	Eastern		6.32	17.13	51.84	0.08	0.33	10.77	0.77	312	0.2	2.92	25	73	87	4.6	314	12	19	0.1
E5:51NG0822	Mt. Ulawun	E	Eastern		3.87	20.37	51.98	0.1	0.37	11.17	0.72	250	0.15	2.16	14	79	70	4.8	336	13	22	0.1
E5:74710020	Mt. Ulawun	E	Eastern		4.55	18.6	52.7	0.1	0.4	10.6	0.85	320	0.16	3.35	18	85	85	6.8	294	16	31	0.1
E5:74710021	Mt. Ulawun	E	Eastern		4.5	18.3	52.5	0.1	0.4	10.7	0.9	317	0.17	3.7	19	102	84	5.6	288	16	29	0.1
E5:74710022	Mt. Ulawun	E	Eastern		4.6	18.4	52.4	0.09	0.38	10.6	0.89	309	0.17	4.2	19	95	84	6	296	16	28	0.1
E5:74710023	Mt. Ulawun	E	Eastern		4.6	18.6	52.3	0.09	0.38	10.6	0.94	312	0.17	3.35	20	93	82	5.8	287	16	28	0.1
E5:51NG0098	Mt. Ulawun	E	Eastern		5.85	18.06	51.79	0.09	0.32	10.98	0.74	295	0.17	2.51	15	94	89	0	0	0	0	0
E6:53NG0850A	Mt. Likurunga	E	Eastern		4.25	17.9	55.3	0.07	0.46	9.3	0.5	230	0.15	3.35	19	111	68	4.6	372	12	26	0.1
E6:53NG0850B	Mt. Likurunga	E	Eastern		3.85	18.7	53.8	0.07	0.44	10.1	0.67	264	0.15	3.1	14	146	71	5.6	358	11	24	0.1
E6:53NG0857A	Mt. Likurunga	E	Eastern		1.95	15.7	64.7	0.07	0.93	5.2	0.48	103	0.13	3.65	4	52	49	13.2	308	15	55	0.1
E6:53NG0857B	Mt. Likurunga	E	Eastern		4.25	16.2	55.2	0.06	0.55	7.25	0.59	187	0.17	6.05	9	172	52	7.2	259	15	28	0.1
E6:53NG1014	Mt. Likurunga	E	Eastern		5.05	17.3	54.6	0.06	0.24	9.55	0.61	252	0.17	3.4	14	46	87	2.2	329	18	28	0.1
E6:53NG2517	Mt. Likurunga	E	Eastern		5.65	16.8	54.1	0.06	0.19	9.55	0.69	278	0.18	3.4	26	49	77	1	302	12	21	0.1
E2:51NG0217F	Sulu Range	E	Eastern		9.2	14.7	53.1	0.03	0.28	10.9	0.3	188	0.16	1.91	88	97	68	2.6	167	6	14	0.1
E2:51NG2649	Sulu Range	E	Eastern		3	18.9	54.8	0.05	0.28	9.7	0.61	275	0.16	2.25	10	128	80	5	256	11	25	0.1
E2:51NG3032A	Sulu Range	E	Eastern		0.81	13.4	72.4	0.03	1.64	2.75	0.31	30	0.07	0.88	0.1	8	35	23	200	14	84	0.1
E2:51NG0217B	Sulu Range	E	Eastern		8.35	15.7	43.2	0.04	0.2	10.7	0.33	187	0.17	1.95	87	100	66	1.8	177	7	15	0.1
E2:51NG3032C	Sulu Range	E	Eastern		0.86	13.8	71.2	0.03	1.64	3.2	0.31	34	0.08	1.04	0.1	12	35	24.5	208	14	86	0.1
E2:51NG3038B	Sulu Range	E	Eastern		0.73	12.5	68.6	0.04	1.06	3.4	0.22	30	0.07	0.64	1	8	29	19.4	204	12	78	0.1
E2:51NG3038G	Sulu Range	E	Eastern		5.15	17.2	55.1	0.05	0.46	9.85	0.43	205	0.16	2.2	19	129	69	6.4	224	11	32	0.1
E3:51NG0111	Mt. Galloseulo, Hargy	E	Eastern		1.68	13.9	65.2	0.12	1.11	5.3	0.67	166	0.12	2.3	1	67	79	16.8	256	17	63	0.1
E3:51NG0115	Mt. Galloseulo, Hargy	E	Eastern		3.57	17.5	55.78	0.1	0.59	9.19	0.6	275	0.14	3.63	17	105	83	7	296	12	36	0.1
E3:51NG0116	Mt. Galloseulo, Hargy	E	Eastern		1.76	14	64.8	0.11	1.16	5.7	0.67	182	0.13	1.78	3	104	83	17.2	256	16	61	0.1
E3:51NG0117	Mt. Galloseulo, Hargy	E	Eastern		2.51	19.27	57.97	0.08	0.6	9.35	0.4	178	0.11	1.99	10	98	61	8.8	293	10	31	0.1
E3:51NG0122	Mt. Galloseulo, Hargy	E	Eastern		4.7	16.4	56.8	0.07	0.53	9.35	0.51	236	0.16	3	22	74	76	7.4	249	11	33	0.1
E3:51NG0123	Mt. Galloseulo, Hargy	E	Eastern		2.3	16	60.4	0.06	0.77	7.9	0.56	246	0.14	1.96	7	118	71	12.4	284	12	45	0.1
E3:51NG0201	Mt. Galloseulo, Hargy	E	Eastern		2.8	18.6	57.5	0.06	0.67	8.95	0.42	185	0.12	2.3	9	58	63	8.8	284	11	32	0.1
E4:51NG0174A	Mt. Bamus	E	Eastern		4.5	17.9	56.7	0.09	0.44	8.7	0.63	167	0.15	2.2	17	44	61	7	258	13	46	0.1
E4:51NG0191A	Mt. Bamus	E	Eastern		2.45	19.9	56.8	0.09	0.45	8.8	0.64	165	0.14	1.91	5	75	60	7.4	241	16	52	0.1

name	location	Geo.	Social	material	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO2	V	MnO	FeO2O3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
E5:51NG0059	Mt. Ulawun	E	Eastern		5.64	17.17	51.31	0.09	0.33	10.7	0.94	326	0.19	3.16	19	73	89	4.8	266	16	24	0.1
E5:51NG0077	Mt. Ulawun	E	Eastern		6.56	16.37	51.92	0.08	0.34	10.66	0.78	333	0.19	3.77	38	91	93	4.6	284	14	21	0.1
E5:70400504	Mt. Ulawun	E	Eastern		5.3	17.51	52.51	0.1	0.38	10.5	0.94	338	0.18	3.1	24	91	91	5.6	270	16	29	0.1
E5:51NG0095	Mt. Ulawun	E	Eastern		4.9	16.67	53.47	0.1	0.44	9.78	0.86	289	0.19	2.17	15	94	88	6.4	288	16	28	0.1
E5:70400505	Mt. Ulawun	E	Eastern		5.74	17.44	51.41	0.09	0.32	11	0.98	329	0.19	3.3	20	81	86	5.2	267	15	24	0.1
E5:75710027	Mt. Ulawun	E	Eastern		5.54	17.01	51.63	0.1	0.32	10.85	0.88	316	0.2	3.3	19	77	84	4.8	258	14	24	0.1
E5:51NG0089	Mt. Ulawun	E	Eastern		6.52	16.78	52.1	0.09	0.32	10.84	0.75	319	0.19	3.07	38	84	89	0	0	0	0	0
E6:53NG0852A	Cape Reilnitz	E	Hoskins		3.9	18.5	53.9	0.07	0.36	9.7	0.67	261	0.15	2.95	13	99	67	5.8	351	21	23	0.1
E6:53NG0871D	Cape Reilnitz	E	Hoskins		6.3	16.9	53.1	0.05	0.27	10.6	0.5	270	0.18	3.1	28	104	70	4.4	348	10	19	0.1
E6:53NG0871E	Cape Reilnitz	E	Hoskins		9.95	15.7	51.2	0.04	0.21	11.2	0.48	234	0.17	2.5	100	88	63	2.8	245	8	12	0.1
E6:53NG1010B	Cape Reilnitz	E	Hoskins		2.55	16.9	63.1	0.08	0.63	6.05	0.47	92	0.14	3.75	7	33	58	5.4	298	14	60	0.1
E6:53NG1015	Cape Reilnitz	E	Hoskins		2.4	16.7	64.3	0.08	0.71	5.8	0.46	116	0.13	2.3	5	27	52	7.8	319	12	60	0.1
E6:53NG2514A	Cape Reilnitz	E	Hoskins		4.95	18.4	54.5	0.06	0.27	9.4	0.48	282	0.15	3.75	30	157	73	2.6	354	9	18	0.1
E6:53NG1037	Cape Reilnitz	E	Hoskins		4.05	15.6	58.9	0.1	0.71	8.05	0.57	340	0.14	2.9	23	163	80	11	384	12	34	0.1
E6:53NG2514C	Cape Reilnitz	E	Hoskins		4.25	18.2	54.6	0.06	0.34	9.65	0.44	231	0.15	3.15	14	180	69	4.6	378	10	19	0.1
RU1	Ru River	E	Hoskins		2.87	17.36	50.04	0.13	0.09	7.79	1.06	123.67	0.17	10.52	15.00	100.67	61.33	1.33	306.33	18.33	53.00	5.33
RU2	Ru River	E	Hoskins		2.81	17.54	55.62	0.09	0.41	8.01	0.75	87.00	0.20	8.11	2.67	19.00	69.00	4.33	332.33	9.67	42.00	2.67
RU3	Ru River	E	Hoskins		3.54	14.99	36.79	0.08	0.14	6.80	1.12	137.00	0.15	12.69	33.67	36.67	74.67	1.67	266.00	17.33	37.33	4.67
RU4	Ru River	E	Hoskins		6.17	13.03	42.91	0.09	0.39	11.11	1.32	217.33	0.19	14.38	42.00	24.00	87.67	4.00	197.00	29.00	49.33	9.33
RU5	Ru River	E	Hoskins		4.04	11.10	39.03	0.06	0.18	5.81	1.06	171.33	0.20	14.23	46.33	219.00	122.67	5.00	196.67	26.67	48.00	7.33
RU6	Ru River	E	Hoskins		3.44	14.73	58.56	0.06	0.09	6.85	1.14	159.67	0.20	9.90	11.67	106.33	85.67	1.67	181.00	17.67	56.00	7.00
F1:51NG0269	Mt. Krummel Area	F	W.P.S		6.2	16.6	53	0.1	0.43	9.3	0.5	245	0.21	4.2	24	107	83	5.2	335	13	35	0.1
F1:51NG0274	Mt. Krummel Area	F	W.P.S		4.9	17.6	54.8	0.07	0.41	9.2	0.43	256	0.16	3.85	25	97	81	5	369	14	25	0.1
F1:51NG0277	Mt. Krummel Area	F	W.P.S		6.65	17	53.7	0.07	0.23	10.4	0.38	231	0.15	4	48	89	71	2.4	361	9	21	0.1
F1:51NG0283	Mt. Krummel Area	F	W.P.S		4.6	18.3	55.2	0.07	0.34	9.45	0.44	210	0.15	2.6	24	96	70	4	350	12	25	0.1
F2:51NG2682	Mt. Du Faure	F	Hoskins		1.81	17.7	62.6	0.13	1.1	5.9	0.5	113	0.08	3.3	7	86	59	17.2	499	14	71	2
F4:68490003	Cape Hoskins	F	Hoskins		5.12	17.79	54.56	0.12	0.3	9.94	0.49	240	0.15	2.91	35	89	71	2.1	400	15	27	0
F4:68490013	Cape Hoskins	F	Hoskins	Andesite	2.97	17.92	57.13	0.15	0.56	8.4	0.58	250	0.15	2.66	12	115	76	6.2	435	18	35	0
F4:68490047	Cape Hoskins	F	Hoskins	Andesite	4.31	17.48	55.48	0.14	0.47	8.87	0.52	275	0.15	2.84	27	115	74	4.9	400	19	27	0
F4:68490102	Cape Hoskins	F	Hoskins	Andesite	5.42	17.26	55	0.17	0.46	9.41	0.52	225	0.16	3.37	34	88	76	5.2	380	16	28	0
F4:68490108	Cape Hoskins	F	Hoskins	Andesite	2.28	16.99	61.24	0.24	0.88	6.19	0.52	135	0.14	3.37	3	56	67	9.2	430	23	50	0
F4:68490151	Cape Hoskins	F	Hoskins	Basalt	5.69	17.76	52.78	0.17	0.24	10.33	0.48	285	0.18	3.34	21	105	77	1.1	380	18	21	0
F4:68490152B	Cape Hoskins	F	Hoskins	Andesite	4.34	17.59	54.93	0.17	0.49	8.9	0.5	230	0.17	4.68	15	130	80	5.7	410	14	27	0
F4:68490153	Cape Hoskins	F	Hoskins		1.41	15.36	66.99	0.18	1.05	4.83	0.41	79	0.13	2.61	0.2	20	57	11	375	25	63	0
F4:68490154	Cape Hoskins	F	Hoskins		1.88	16	64.5	0.18	1.12	5.62	0.47	120	0.13	2.64	3	53	68	16	385	23	72	0
F4:68490162	Cape Hoskins	F	Hoskins		4.28	16.2	59.96	0.12	0.86	7.77	0.44	190	0.14	3.06	25	165	68	12	305	16	53	0
F4:68490164	Cape Hoskins	F	Hoskins	Dacite	1.43	15.2	68.16	0.15	1.41	4.05	0.4	76	0.1	2.99	2	25	44	18	330	19	83	0
F4:68490171B	Cape Hoskins	F	Hoskins	Andesite	3.75	17.26	54.74	0.15	0.5	8.68	0.51	185	0.12	5.26	13	93	74	6.5	420	13	37	0
F4:68490174	Cape Hoskins	F	Hoskins		3.85	16.37	57.26	0.17	0.83	8.33	0.54	190	0.14	3.83	13	100	72	13	390	19	58	0
F5:51NG0225	Wulai Island	F	Hoskins		4.35	17.8	56.4	0.09	0.49	8.25	0.5	205	0.14	3.19	14	85	69	5.8	413	15	38	0.1
F5:51NG0233	Wulai Island	F	Hoskins		3.05	18.8	56.7	0.1	0.63	7.9	0.53	177	0.14	3.4	9	31	62	6	433	13	40	0.1
F5:51NG0236	Wulai Island	F	Hoskins		5	18.4	55.1	0.09	0.43	8.65	0.56	253	0.15	3.25	24	43	71	5.8	413	12	35	0.1
F5:51NG0239	Wulai Island	F	Hoskins		5.6	17.9	52.5	0.08	0.48	10.2	0.49	266	0.16	4.05	30	159	70	4.2	403	10	24	0.1
F6:51NG0220A	Cape Reilnitz	F	Hoskins		0.5	14.3	71.4	0.12	1.72	2.75	0.46	24	0.08	2.55	0.1	8	56	28.5	276	26	100	0.1
F7:53NG0814B	Lolobau, Banban Is.	F	Eastern		5.2	16.8	54.7	0.09	0.4	9.8	0.57	279	0.17	6.15	18	96	77	6	302	14	32	0.1
F7:53NG0832	Lolobau, Banban Is.	F	Eastern		3.7	19	54.4	0.1	0.41	9.8	0.6	265	0.16	2.7	14	101	76	6.2	325	15	32	0.1
F7:53NG1058A	Lolobau, Banban Is.	F	Eastern		1.14	15.8	68.8	0.09	1.05	4.35	0.41	48	0.11	2.5	0.1	19	47	12.2	320	16	59	0.1
F1:51NG0270B	Mt. Krummel Area	F	W.P.S		5.45	17.1	53.5	0.11	0.44	10.4	0.62	269	0.15	4.05	25	103	81	6.6	439	14	33	0.1
F1:51NG0276	Mt. Krummel Area	F	W.P.S		4.95	18	54.5	0.08	0.42	9.55	0.36	243	0.15	3.15	31	98	76	4.4	424	11	22	0.1
F1:51NG0279	Mt. Krummel Area	F	W.P.S		4.85	18.5	54.5	0.09	0.41	9.55	0.45	253	0.15	3.85	29	61	73	4.4	452	11	25	0.1
F2:51NG2683A	Mt. Du Faure	F	Hoskins		2.4	16.3	63.4	0.1	1.15	6	0.37	136	0.1	3.8	7	42	57	17.6	480	9	57	0.1
F2:51NG2683C	Mt. Du Faure	F	Hoskins		2.8	16.3	62.8	0.1	1.24	5.9	0.38	155	0.1	2.65	7	42	52	17.6	484	8	54	0.1
F2:51NG2683D	Mt. Du Faure	F	Hoskins		3.1	19.9	59	0.1	0.8	7.2	0.45	180	0.12	1.42	13	57	62	11.8	560	9	50	0.1
F2:51NG2683E	Mt. Du Faure	F	Hoskins		3.75	17.9	57.2	0.1	0.66	7.45	0.57	203	0.14	3.9	7	77	64	9.2	477	23	43	0.1
F2:51NG2685A	Mt. Du Faure	F	Hoskins		4.8	15.7	58	0.18	1.11	8.75	0.53	190	0.12	3.1	23	83	63	12.8	625	13	59	2
F2:51NG2685B	Mt. Du Faure	F	Hoskins		4.7	15.9	58.3	0.13	0.88	8.15	0.46	177	0.13	3.65	19	71	65	11.8	441	13	49	0.1
F2:51NG2699	Mt. Du Faure	F	Hoskins		5.25	15.4	57.5	0.09	0.84	8.4	0.46	184	0.14	3.2	24	76	74	11.2	429	50	45	0.1
F3:51NG3062A	Mt. Wago	F	Hoskins		5.7	16.9	53.5	0.1	0.35	9.75	0.66	265	0.15	4	35	107	79	2.2	390	73	41	0.1
F3:51NG2686	Mt. Wago	F	Hoskins		3.9	16.3	57.2	0.16	0.9	8.15	0.65	289	0.13	4.05	30	165	75	13.8	442	41	67	0.1
F4:68490077	Cape Hoskins	F	Hoskins	Andesite	4.82	17.3	53.85	0.12	0.56	9.45	0.52	230	0.15	3.68	22	71	74	8.3	410	16	38	0
F4:68490092B	Cape Hoskins	F	Hoskins		1.34	16.44	65.28	0.21	1.35	5.05	0.42	76	0.13	2.81	0.2	13	64	14	355	23	66	0
F4:68490159A	Cape Hoskins	F	Hoskins		3.66	15.41	63.31	0.13	1.05	6.75	0.4	140	0.12	2.08	19	46	54	13	330	15	60	0
F4:174	KO	F	Hoskins	Andesite	3.85	16.37	57.26	0.17	0.83	0	0.54	190	0.14	0	13	0	72	13	390	19	58	0
F4:162	Mululus	F	Hoskins	Andesite	4.28	16.2	59.96	0.12	0.86	0	0.44	190	0.14	0	25	0	68	12	305	16	53	0
F4:159A	Mululus	F	Hoskins	Dacite	3.66	15.41	63.31	0.13	1.05	0	0.4	140	0.12	0	19	0	54	13	330	15	60	0
F4:108	Mt. Lolo	F	Hoskins	Andesite	2.28	16.99	61.24	0.24	0.88	0	0.52	135	0.14	0	3	0	67	9.2	430	23	50	0
F4:154	Mt. Oto	F	Hoskins	Dacite	1.88	16	64.5	0.18	1.12	0	0.47	120	0.13	0	3	0	68	16	385	23	72	0
F4:92B	Mululus	F	Hoskins	Dacite	1.34	16.44	65.28	0.21	1.35	0	0.42	76	0.13	0	0	0	64	14	355	23	66	0

name	location	Geo.	Social	material	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO2	V	MnO	FeO2O3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
F4:164	Mululus	F	Hoskins	Dacite	1.43	15.2	68.16	0.15	1.41	0	0.4	76	0.1	0	2	0	44	18	330	19	83	0
F5:51NG0241	Wulai Island	F	Hoskins		5.55	18.6	52.2	0.08	0.26	9.85	0.49	260	0.17	4.1	28	102	71	3.4	409	11	23	0.1
F6:51NG0218B	Cape Reilnitz	F	Hoskins		4.85	15.7	55.6	0.06	0.52	9.1	0.56	285	0.16	2.55	16	81	83	7.2	263	21	30	0.1
F6:51NG3052B	Cape Reilnitz	F	Hoskins		5.35	16.5	56.5	0.1	0.62	8.5	0.47	211	0.15	2.4	37	94	72	7.6	358	11	31	0.1
F7:53NG0814C	Lolobau, Banban Is.	F	Eastern		0.96	13.9	68.5	0.2	1.6	3.1	0.7	21	0.13	1.43	0.1	4	95	22.5	246	34	118	2
F7:53NG0839A	Lolobau, Banban Is.	F	Eastern		5.5	17.6	50.9	0.05	0.19	10.8	0.58	347	0.2	2.8	16	146	82	1.8	250	10	15	0.1
F7:53NG1047C	Lolobau, Banban Is.	F	Eastern		2.65	15.1	60.7	0.16	0.83	6.7	0.84	301	0.16	7.4	7	186	88	12.6	296	24	71	0.1
F7:53NG1051	Lolobau, Banban Is.	F	Eastern		1.1	13.7	69.2	0.24	1.28	3.8	0.74	38	0.14	0.99	0.1	9	83	21	255	33	111	1
F7:53NG2523C	Lolobau, Banban Is.	F	Eastern		6.7	15.9	53.6	0.09	0.39	10.6	0.61	282	0.17	3.5	37	55	73	4.6	296	15	30	0.1
F7:53NG2526A	Lolobau, Banban Is.	F	Eastern		1.13	14.3	69.4	0.22	1.2	3.75	0.69	19	0.15	1.18	0.1	5	95	20.5	267	33	110	2
F7:53NG0819B	Lolobau, Banban Is.	F	Eastern		1.53	15.5	65.9	0.18	1.05	4.55	0.67	82	0.14	1.96	0.1	21	75	16	279	27	88	0.1
F7:53NG0827A	Lolobau, Banban Is.	F	Eastern		5.75	17.1	53.5	0.06	0.37	10.6	0.59	256	0.17	2.7	25	114	68	4.8	259	12	25	0.1
F7:53NG0835G	Lolobau, Banban Is.	F	Eastern		3.2	18.2	55.9	0.09	0.56	9.25	0.68	255	0.15	2.75	14	90	72	8	303	16	39	0.1
F7:53NG1049	Lolobau, Banban Is.	F	Eastern		1.95	14.5	63.9	0.18	0.99	5.7	0.8	193	0.15	1.81	4	106	82	16.2	278	26	85	1
F7:53NG1054	Lolobau, Banban Is.	F	Eastern		2.2	14.5	62.2	0.24	0.97	5.85	0.91	92	0.16	2.2	1	4	102	15.2	300	28	82	0.1
F7:53NG0846	Lolobau, Banban Is.	F	Eastern		2.5	14.5	59.9	0.15	0.84	6.25	0.83	257	0.16	3.2	6	143	93	14.4	292	26	72	0.1
Gn1:114	North Willaumez Pen.	GN	W.P.N	Pyroxene Andesite	3.22	15.38	58.6	0.25	1.46	7.02	0.89	235	0.18	2.22	70	155	100	15	395	20	75	5
Gn1:263	North Willaumez Pen.	GN	W.P.N	Basalt	6.42	16.87	51.4	0.24	0.7	10.88	0.75	305	0.14	6.35	75	140	75	5	540	10	30	0.5
Gn1:296B	North Willaumez Pen.	GN	W.P.N	Basalt	7.42	14.91	52.42	0.17	0.8	10.84	0.73	340	0.18	2.3	105	155	75	15	300	20	40	0.5
Gn1:306	North Willaumez Pen.	GN	W.P.N	Dacite	1.48	14.63	66.34	0.21	2.14	4.04	0.71	40	0.14	1.63	75	70	90	25	270	25	115	0.5
Gn1:308	North Willaumez Pen.	GN	W.P.N	Dacite	2.22	15.15	63.39	0.21	1.89	5.33	0.74	125	0.14	2.12	50	90	75	20	285	20	90	0.5
Gn1:311	North Willaumez Pen.	GN	W.P.N	Basalt	6.73	15.91	51.57	0.11	0.44	11.74	0.8	275	0.17	2.74	100	175	80	5	355	5	30	0.5
Gn1:319	North Willaumez Pen.	GN	W.P.N	Dacite	1.29	14.5	66.91	0.11	2.22	3.76	0.53	65	0.14	1.04	45	35	90	25	275	30	130	0.5
Gn1:339	North Willaumez Pen.	GN	W.P.N	Basaltic Andesite	4.36	15.42	53.83	0.21	0.92	8.83	1.01	300	0.2	5	55	235	115	15	480	25	55	5
Gn1:51NG0256	North Willaumez Pen.	GN	W.P.N		1.31	14.4	67.2	0.24	2.15	3.75	0.68	49	0.13	1.45	2	26	87	28	280	36	127	2
Gn1:51NG0257	North Willaumez Pen.	GN	W.P.N		3.15	15.6	58.8	0.25	1.26	6.9	0.86	233	0.18	2.35	8	130	97	15.4	409	28	75	1
Gn1:75710018	North Willaumez Pen.	GN	W.P.N		3.1	15.09	58.56	0.25	1.33	6.95	0.87	227	0.19	2.16	10	130	99	16	412	28	78	0.1
Gn1:WP01010	Dakataua	GN	W.P.N	Basaltic Andesite	4.037	16.317	54.581	0.215	1.017	0	0.764	311	0.176	0	27	0	84	13.9	444.9	24.8	44	0.7
Gn1:WP01007	Dakataua	GN	W.P.N	Basaltic Andesite	3.464	15.482	55.382	0.218	1.075	0	0.719	267	0.153	0	24	0	82	14.8	384.2	25.6	52	0.8
Gn1:G02051	Dakataua	GN	W.P.N	Basaltic Andesite	2.632	17.65	53.065	0.262	1.053	0	0.728	241	0.177	0	20	0	0	18.1	404.9	36.5	109	1.6
Gn1:G02055	Dakataua	GN	W.P.N	Basaltic Andesite	3.081	17.092	54.302	0.145	0.901	0	0.745	274	0.155	0	23	0	0	16.8	423.4	26.6	89	1.3
Gn1:G02050	Dakataua	GN	W.P.N	Basaltic Andesite	1.751	14.126	53.549	0.189	1.337	0	0.566	167	0.139	0	10	0	0	22.4	330.9	37.3	111	1.7
Gn1:WP01006	Dakataua	GN	W.P.N	Andesite	1.76	16.689	60.276	0.252	1.659	0	0.816	104	0.154	0	10	0	95	20.6	304.1	39.1	121	1.8
Gn1:WP01012	Dakataua	GN	W.P.N	Andesite	1.867	15.079	62.731	0.265	1.816	0	0.747	115	0.143	0	11	0	86	22.3	289.8	37.8	106	1.6
Gn1:DR10706	Dakataua	GN	W.P.N		3.34	9.92	26.34	0.25	0.32	7.78	0.52	77.33	0.18	13.06	47.67	88.33	98.00	7.00	464.00	12.00	37.00	2.00
Gn1:DR10707	Dakataua	GN	W.P.N		2.50	12.84	40.87	0.15	0.62	7.68	0.74	148.33	0.16	11.11	40.33	138.67	90.00	6.67	385.67	21.67	53.00	5.33
Gn1:DR16286	Dakataua	GN	W.P.N		1.18	7.95	52.21	0.05	2.07	1.01	0.19	21.33	0.03	1.64	8.67	13.00	20.00	37.33	134.67	16.67	96.33	1.00
Gn1:DR10694	Dakataua	GN	W.P.N		5.31	10.15	36.92	0.34	0.50	8.11	2.77	301.33	0.32	16.26	80.33	111.00	149.33	17.33	194.00	45.67	214.33	25.00
Gn1:DR10720	Dakataua	GN	W.P.N		2.28	9.49	29.15	0.08	0.59	6.15	0.56	83.67	0.14	12.21	60.00	265.33	79.00	10.00	490.00	17.33	46.33	3.67
Gn1:DR10731	Dakataua	GN	W.P.N		1.36	10.81	50.32	0.12	1.59	3.00	0.59	33.00	0.12	5.48	20.00	28.00	68.67	23.00	219.00	37.33	107.33	11.33
Gn1:DR10730	Dakataua	GN	W.P.N		1.59	13.43	60.93	0.17	1.94	3.55	0.73	59.00	0.15	5.69	2.00	20.00	77.67	23.00	233.00	34.00	107.67	13.00
Gn1:51NG0258A	North Willaumez Pen.	GN	W.P.N		1.46	14.6	66.7	0.25	2	3.75	0.73	52	0.14	1.98	0.1	21	87	28	279	35	123	1
Gn1:75710026	North Willaumez Pen.	GN	W.P.N		3.12	15.64	58.22	0.25	1.35	7.05	0.94	222	0.19	2.15	9	122	96	15.2	414	29	76	1
Gn1:341	North Willaumez Pen.	GN	W.P.N	Pyroxene Andesite	2.92	16.87	58.93	0.2	1.63	6.87	0.62	200	0.16	2.71	30	80	75	20	525	15	70	5
Gn2:51NG0242	Kimbe Island	GN	W.P.N		4.5	18.6	52.6	0.09	0.4	9.85	0.76	258	0.15	3.6	17	102	70	3.8	400	14	30	0.1
Gn2:51NG0246	Kimbe Island	GN	W.P.N		10.1	15.3	49.2	0.06	0.19	13	0.52	258	0.18	2.55	119	127	65	1.2	228	13	21	0.1
Gn2:51NG0248	Kimbe Island	GN	W.P.N		5.75	18.5	51.1	0.07	0.43	10.6	0.67	284	0.16	3.8	30	66	74	4	382	11	20	0.1
Gn2:51NG0245A	Kimbe Island	GN	W.P.N		1.79	15.1	66.1	0.12	1.03	4.75	0.51	93	0.11	3.35	12	27	86	10	286	31	102	1
Gn2:51NG0250A	Kimbe Island	GN	W.P.N		5.05	18.5	51.1	0.07	0.42	10.5	0.69	277	0.16	3.6	21	87	73	3.4	385	12	23	0.1
Gs1:51NG3063	Mt. Garbuna, Welcker	GS	W.P.S		4.5	18.6	52.6	0.09	0.4	9.85	0.76	258	0.15	3.6	17	102	70	3.8	400	14	30	0.1
Gs1:51NG3064	Mt. Garbuna, Welcker	GS	W.P.S		1.27	14.6	68.5	0.16	2.8	3.6	0.54	60	0.09	1.8	0.1	24	56	41	406	20	117	1
Gs1:51NG3065	Mt. Garbuna, Welcker	GS	W.P.S		3.2	15.3	62.7	0.11	1.9	6.2	0.49	149	0.12	2.75	11	74	59	28	393	18	84	1
Gs1:75710022	Mt. Garbuna, Welcker	GS	W.P.S		3.75	16.52	57.25	0.13	1.4	7.78	0.6	186	0.18	4.36	9	70	60	15	565	14	45	0.1
Gs1:75710023	Mt. Garbuna, Welcker	GS	W.P.S		1.62	14.09	68.62	0.1	2.68	3.75	0.4	61	0.09	1.34	6	26	40	36	335	18	108	1
Gs:G02002	Garbuna	GS	W.P.S	Andesite	3.42	14.80	61.45	0.08	1.91	0.00	0.35	180.00	0.11	0.00	28.00	0.00	0.00	26.20	277.70	16.20	115.00	1.90
Gs:G02003	Garbuna	GS	W.P.S	Dacite	3.35	14.21	63.81	0.07	2.00	0.00	0.31	160.00	0.10	0.00	27.00	0.00	0.00	27.20	293.50	16.60	97.00	1.60
Gs2:51NG2707A	Mt. Bangum	GS	W.P.S		6.9	15.6	50.9	0.11	0.62	11.7	0.52	269	0.1	5.2	34	68	67	8.6	560	13	31	0.1
Gs2:51NG2707B	Mt. Bangum	GS	W.P.S		2.95	15.1	62	0.13	2.1	6.15	0.51	137	0.11	2.05	6	45	53	26	431	16	83	2
Gs2:51NG2708	Mt. Bangum	GS	W.P.S		3.4	16.9	59	0.14	1.34	6.7	0.51	129	0.13	3.15	8	71	53	8.8	488	18	83	1
Gs2:51NG2709	Mt. Bangum	GS	W.P.S		3.23	15.7	60.6	0.15	1.9	6.8	0.59	168	0.13	3.35	13	28	60	25.5	500	15	73	2
Gs3:279B	Garua Harbour	GS	W.P.S		0.58	12.62	72.19	0.02	3.7	2.07	0.33	30	0.05	3.14	30	25	35	60	245	20	160	10
Gs3:343	Garua Harbour	GS	W.P.S		0.24	12.58	75.33	0.02	3.82	1.25	0.27	35	0.07	1.58	40	20	40	55	200	20	150	0.5
Gs3:51NG0255	Garua Harbour	GS	W.P.S		7.35	13.2	57.1	0.11	1.26	9.05	0.5	185	0.14	3.5	83	74	63	17.4	394	16	54	0.1
Gs3:51NG0271	Garua Harbour	GS	W.P.S		0.26	12.8	75.6	0.03	3.85	1.22	0.27	6	0.07	0.33	0.1	3	38	55	206	21	150	2
Gs1:51NG0145B	Mt. Garbuna, Welcker	GS	W.P.S		3.3	15.7	61.6	0.13	1.85	6.55	0.5	168	0.13	3.15	13	66	60	25	447	16	77	2
Gs1:51NG0262	Mt. Garbuna, Welcker	GS	W.P.S		1.08	14.9	67	0.16	2.75	4	0.55	92	0.09	2.9	4	65	61	37	430	22	106	2
Gs1:51NG4004C	Mt. Garbuna, Welcker	GS	W.P.S		4.15	15.3	59.6	0.1	1.62	7.4	0.44	175	0.13	2.95	16	80	64	21.5	412	20	67	0.1
Gs2:51NG2713A	Mt. Bangum	GS	W.P.S		3.4	15.1	61.8	0.14	2.05	6.55	0.5	166	0.12	3.1	13	79	61	25.5	466	17	78	0.1

name	location	Geo.	Social	material	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO2	V	MnO	FeO2O3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
Gs2:51NG2713C	Mt. Bangum	GS	W.P.S		3.4	15.3	61.7	0.13	1.77	6.8	0.51	162	0.13	2.95	11	75	58	25	465	16	77	1
Gs2:51NG2714C	Mt. Bangum	GS	W.P.S		2.85	15.4	62.4	0.13	2.05	6.1	0.52	153	0.11	3.05	7	48	58	28	453	18	86	1
H1:48NG0013	Unea Island	H	Bali-Witu	Basalt	4.8	16.1	53.7	0.23	0.93	9.2	1.07	316	0.18	5.3	25	354	93	41.8	385	27	88	3
H1:48NG0020	Unea Island	H	Bali-Witu	Basalt	2.4	15.6	57.5	0.4	1.78	5.75	1.14	247	0.13	5.15	4	86	108	68	446	42	130	4
H1:48NG0500	Unea Island	H	Bali-Witu	Basalt	6.95	15.3	53.7	0.17	1.12	10.2	0.58	198	0.15	2.35	57	76	61	36.6	425	19	76	2
H1:48NG0505	Unea Island	H	Bali-Witu	Basalt	4	16.6	58	0.23	1.72	7.35	0.53	161	0.18	3.05	19	108	61	53.5	488	23	113	3
H1:48NG0520	Unea Island	H	Bali-Witu	Basalt	2.8	15.4	59.5	0.28	2.3	5.65	0.8	147	0.17	3.7	9	58	74	74.5	365	40	163	5
H1:48NG0523	Unea Island	H	Bali-Witu	Basalt	3.15	16.4	60.1	0.25	1.91	6.25	0.36	128	0.14	3.15	13	75	56	59.5	493	25	126	4
H2:48NG0028	Garove Island	H	Bali-Witu	Dacite	1.51	14.3	64.9	0.34	1.21	4.05	1.25	42	0.2	1.4	0.1	6	104	86.2	244	67	286	11
H2:48NG0033	Garove Island	H	Bali-Witu	Basalt	5.5	15.7	52.6	0.16	0.41	10.5	1.42	301	0.2	2.1	27	56	90	36	238	30	97	3
H2:48NG0034	Garove Island	H	Bali-Witu	Dacite	1.69	14.3	63.9	0.39	1.21	4.5	1.28	52	0.19	1.25	0.1	9	106	89	239	69	298	11
H2:48NG0036	Garove Island	H	Bali-Witu	Basalt	5.3	16.3	52.6	0.16	0.41	9.8	1.43	294	0.2	1.8	24	50	89	36.2	243	30	98	4
H2:48NG0526	Garove Island	H	Bali-Witu	Dacite	1.85	14.6	64.6	0.27	1.25	4.1	1.2	66	0.19	1.6	5	17	86	80.5	223	60	273	10
H2:48NG0532	Garove Island	H	Bali-Witu	Rhyolite	0.73	13.4	70.3	0.14	1.68	2.6	0.66	11	0.15	0.9	0.1	4	83	88	191	62	307	12
H2:48NG0556	Garove Island	H	Bali-Witu	Basaltic Andesite	3.8	15	54.9	0.25	0.51	7.35	1.75	325	0.23	4.9	5	20	114	48.4	287	42	120	5
H3:48NG0044	Wambu Island	H	Bali-Witu	Basalt	10.3	15.9	49.6	0.12	0.24	10.8	1.11	228	0.18	2.3	170	88	67	23	218	20	67	3
H3:48NG0048A	Narage Island	H	Bali-Witu	Basalt	5.8	18.4	47.5	0.37	0.72	12.6	0.95	276	0.19	6.2	31	116	68	24.6	748	18	64	1
H3:48NG0582	Munda Island	H	Bali-Witu	Basalt	11.3	15	49.2	0.11	0.25	10.8	1.14	234	0.18	3.45	227	81	70	24.6	195	21	68	3
H3:48NG0592	Munda Island	H	Bali-Witu	Olivine Tholeiite	9.15	16.6	49.9	0.1	0.21	11.1	1.01	225	0.17	2.3	152	73	68	24	210	21	58	1
H3:48NG0601	Wingoru, Witu Is	H	Bali-Witu	Basalt	5.95	17.2	51.8	0.19	0.83	10.6	1.03	247	0.18	2.95	38	116	69	35.2	396	21	72	3
H3:48NG0605	Mundua, Witu Is	H	Bali-Witu	Quartz Tholeiite	6.45	16.9	51.7	0.18	0.75	10.9	0.99	246	0.18	2.95	50	128	66	33.6	367	21	71	3
H1:48NG0006	Unea Island	H	Bali-Witu	Basalt	8.55	15.4	50.5	0.09	0.41	12	0.68	252	0.17	3.6	75	82	64	20.8	335	16	40	1
H1:48NG0022	Unea Island	H	Bali-Witu	Basalt	4.45	19.5	50.4	0.15	0.59	11.2	0.8	241	0.16	2.7	18	77	70	26.6	538	18	48	2
H1:48NG0509	Unea Island	H	Bali-Witu	Basalt	3.4	16.6	56.1	0.28	1.64	7.35	0.9	235	0.16	4.15	9	106	86	49.8	448	32	113	4
H2:48NG0559	Garove Island	H	Bali-Witu	Basaltic Andesite	4.35	16.4	55.4	0.17	0.53	8.1	1.38	194	0.2	3	18	25	87	44.6	247	37	130	4
H2:48NG0572	Garove Island	H	Bali-Witu	Basalt	7.95	16.5	49.7	0.08	0.2	12.9	0.85	261	0.18	1.55	61	60	67	20	228	17	42	2
H2:48NG0538	Garove Island	H	Bali-Witu	Basaltic Andesite	3.45	15.6	55.2	0.22	0.88	7.3	1.55	306	0.21	2.95	4	51	109	48	298	41	120	5
H3:48NG0038A	Undaka, Witu Is	H	Bali-Witu	Quartz Tholeiite	10.8	14.4	49.2	0.11	0.19	11.4	1.15	230	0.18	1.4	196	86	71	23.4	208	21	69	3
samp. 8014	Rabaul	Rabaul	Rabaul	Basalt	5.64	18.99	48.19	0.13	0.5	0	0.81	294	0.16	0	34	0	73	26	551	13	35	7
samp. 7084	Rabaul	Rabaul	Rabaul	Basalt	4.64	18.89	50.11	0.19	0.94	0	0.95	353	0.18	0	24	0	87	56	643	35	42	7
samp. 8080	Rabaul	Rabaul	Rabaul	Basalt	4.4	18.5	51	0.26	1.39	0	0.96	262	0.28	0	29	0	73	41	691	13	70	0
samp. 7007	Rabaul	Rabaul	Rabaul	Basalt	4.42	17.45	52.44	0.19	0.97	0	0.99	313	0.19	0	27	0	89	32	464	13	51	6
samp. 6985	Rabaul	Rabaul	Rabaul	Basaltic Andesite	3.79	16.7	54.71	0.2	1.21	0	1.07	291	0.35	0	13	0	94	32	457	13	64	0
samp. 7066	Rabaul	Rabaul	Rabaul	Basaltic Andesite	3.8	17.4	55.27	0.23	1.53	0	0.86	275	0.15	0	27	0	71	65	593	39	77	0
samp. 8015	Rabaul	Rabaul	Rabaul	Andesite	2.3	16.1	60.27	0.28	2.22	0	0.9	122	0.28	0	16	0	86	64	394	23	118	5
samp. 8087	Rabaul	Rabaul	Rabaul	Andesite	2.42	15.4	61.56	0.37	2.44	0	0.96	131	0.16	0	94	0	102	64	365	23	124	0
samp. 8016	Rabaul	Rabaul	Rabaul	Andesite	2.04	15.43	62.26	0.34	2.57	0	0.88	113	0.16	0	8	0	90	70	388	35	118	0
samp. 8042	Rabaul	Rabaul	Rabaul	Dacite	1.51	15.52	64.54	0.27	2.81	0	0.91	66	0.18	0	77	0	94	70	359	23	165	10
samp. 8047	Rabaul	Rabaul	Rabaul	Dacite	1.51	15.41	64.66	0.32	2.79	0	0.86	70	0.16	0	69	0	90	76	370	29	153	10
samp. 8058	Rabaul	Rabaul	Rabaul	Dacite	1.42	15.25	64.95	0.3	2.89	0	0.84	61	0.24	0	8	0	98	70	353	23	171	10
samp. RAB53	Rabaul	Rabaul	Rabaul	Basalt	5.44	20.27	48.85	0.12	0.45	0	0.72	316	0.14	0	24	0	64	18	556	13	29	0
samp. RAB97B	Rabaul	Rabaul	Rabaul	Basalt	6.08	17.7	50.05	0.13	0.81	0	0.82	322	0.15	0	30	0	77	26	498	17	46	0
samp. RAB182E	Rabaul	Rabaul	Rabaul	Basaltic Andesite	3.25	16.3	54.81	0.42	1.82	0	1.18	249	0.19	0	6	0	113	57	490	31	89	0
samp. RAB11A	Rabaul	Rabaul	Rabaul	Andesite	2.07	15.34	59.55	0.39	2.83	0	1.11	146	0.18	0	0	0	111	85	371	36	160	0
samp. RAB184D	Rabaul	Rabaul	Rabaul	Andesite	1.98	15.45	61.94	0.34	2.59	0	0.87	108	0.16	0	7	0	86	75	376	36	147	0
samp. RABB20G	Rabaul	Rabaul	Rabaul	Dacite	1.36	15.36	63.99	0.32	2.4	0	0.86	50	0.17	0	0	0	107	74	391	37	142	0
samp. RAB401	Rabaul	Rabaul	Rabaul	Dacite	1.63	15.57	63.42	0.36	2.69	0	0.87	89	0.15	0	0	0	82	74	375	38	149	0
samp. RAB105A	Rabaul	Rabaul	Rabaul	Dacite	1.56	15.21	63.32	0.19	3.05	0	0.74	89	0.12	0	0	0	61	78	289	35	186	0
samp. RAB125	Rabaul	Rabaul	Rabaul	Dacite	1.26	15.03	64.73	0.27	2.83	0	0.8	72	0.16	0	3	0	90	85	348	46	157	0
samp. RAB167	Rabaul	Rabaul	Rabaul	Dacite	0.99	14.78	64.82	0.22	3.77	0	0.77	10	0.15	0	7	0	95	101	331	37	192	0
samp. RAB182A	Rabaul	Rabaul	Rabaul	Rhyolite	0.47	13.03	73.28	0.05	1.66	0	0.31	13	0.08	0	0	0	42	53	206	32	139	0
samp. RP98413	Rabaul	Rabaul	Rabaul	Dacite	3.34	14.79	62.31	0.07	0.98	0	0.46	128	0.13	0	12	0	59	36	281	24	78	1
samp. RP98410	Rabaul	Rabaul	Rabaul	Rhyolite	0.8	13.19	70.91	0.07	1.66	0	0.31	26	0.1	0	0	0	52	54	253	34	127	1
samp. RAB59	Rabaul	Rabaul	Rabaul	Rhyolite	1.18	13.04	73.11	0.06	1.58	0	0.31	23	0.08	0	0	0	43	50	203	29	135	0
samp. RAB159	Rabaul	Rabaul	Rabaul	Rhyolite	0.85	12.87	72.25	0.06	1.65	0	0.31	19	0.07	0	7	0	42	49	204	29	131	0
samp. RP98411	Rabaul	Rabaul	Rabaul	Rhyolite	0.46	13.16	74.17	0.06	1.58	0	0.34	12	0.08	0	0	0	51	56	238	36	138	2
samp. RP98415	Rabaul	Rabaul	Rabaul	Rhyolite	0.57	12.63	72.19	0.05	1.83	0	0.3	18	0.08	0	0	0	44	55	211	32	135	1
samp. TAVQ-817	Rabaul	Rabaul	Rabaul	Andesite	2.81	15.88	59.46	0.29	2.1	0	0.88	146	0.155	0	10	0	96	57.5	425	30	117	2
samp. TAVT820	Rabaul	Rabaul	Rabaul	Andesite	2.48	15.91	61.57	0.33	2.36	0	0.89	104	0.164	0	6	0	90	64.5	409	33	131	2
samp. TAVW-823	Rabaul	Rabaul	Rabaul	Andesite	2.18	15.81	62.58	0.329	2.48	0	0.904	103	0.16	0	4	0	92	66.5	401	34	136	2
samp. VULA-801	Rabaul	Rabaul	Rabaul	Andesite	1.92	15.79	63.21	0.363	2.55	0	0.912	102	0.16	0	0	0	95	68.5	399	35	141	2
samp. VULM-813	Rabaul	Rabaul	Rabaul	Andesite	1.97	15.82	63.37	0.363	2.53	0	0.912	99	0.16	0	0	0	93	68	400	34	141	2
samp. VULP-816	Rabaul	Rabaul	Rabaul	Andesite	1.84	15.64	61.66	0.352	2.57	0	0.895	89	0.16	0	0	0	95	69	397	35	144	2
samp. VULN-814	Rabaul	Rabaul	Rabaul	Andesite	1.86	15.81	63.48	0.363	2.58	0	0.912	89	0.16	0	0	0	92	69.5	406	35	144	2
samp. VULG-807	Rabaul	Rabaul	Rabaul	Andesite	1.8	15.79	63.4	0.352	2.63	0	0.904	92	0.16	0	0	0	94	71	392	36	146	2
samp. VULH-808B	Rabaul	Rabaul	Rabaul	Andesite	1.79	15.75	63.19	0.36	2.62	0	0.91	91	0.162	0	0	0	96	70	393	35	144	2
samp. VULK811	Rabaul	Rabaul	Rabaul	Andesite	1.89	15.88	62.77	0.36	2.54	0	0.907	100	0.161	0	0	0	97	69	404	35	140	2
samp. SER40	Rabaul	Rabaul	Rabaul	Andesite	2.26	15.8	62.22	0.33	2.48	0	0.91	106	0.165	0	4	0	86	62	380	31	129	2

name	location	Geo.	Social	material	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO2	V	MnO	FeO2O3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
samp. RP98020	Rabaul	Rabaul	Rabaul	Andesite	2.81	15.72	61.43	0.32	2.32	0	0.88	114	0.162	0	2	0	86	67.2	400.5	34.5	131.8	3.1
samp. RP96-030	Rabaul	Rabaul	Rabaul	Andesite	1.83	15.74	63	0.35	2.6	0	0.91	98	0.164	0	0	0	90	66	380	33	137	2
samp. RP96-049	Rabaul	Rabaul	Rabaul	Andesite	3.25	15.65	60.44	0.31	2.24	0	0.89	138	0.169	0	14	0	90	58	378	29	115	2
samp. RP96080	Rabaul	Rabaul	Rabaul	Andesite	1.9	15.43	61.51	0.358	2.54	0	0.907	89	0.162	0	0	0	85	65	389	33	140	3
samp. RP96100	Rabaul	Rabaul	Rabaul	Andesite	3.7	15.58	59.9	0.29	2.11	0	0.88	139	0.166	0	19	0	94	54.5	385	28	115	2
samp. RP97001	Rabaul	Rabaul	Rabaul	Andesite	3.55	15.53	60.17	0.312	2.16	0	0.873	127	0.166	0	19	0	85	56	384	29	118	2
samp. RP97030	Rabaul	Rabaul	Rabaul	Andesite	1.92	15.8	63.17	0.357	2.54	0	0.91	93	0.166	0	0	0	88	65.5	385	33	140	3
samp. RP97212	Rabaul	Rabaul	Rabaul	Andesite	4.48	15.84	58.03	0.274	1.85	0	0.825	144	0.167	0	29	0	82	49	389	26	103	2
samp. RP97222	Rabaul	Rabaul	Rabaul	Andesite	1.9	15.8	63.14	0.358	2.53	0	0.914	93	0.165	0	0	0	87	65.5	385	33	140	3
samp. RP98048	Rabaul	Rabaul	Rabaul	Andesite	2.61	15.86	61.47	0.334	2.35	0	0.906	112	0.165	0	8	0	81	68.4	407.4	35.4	129.7	2.6
samp. RP98051	Rabaul	Rabaul	Rabaul	Andesite	2.13	15.76	62.19	0.347	2.47	0	0.907	100	0.163	0	2	0	82	71	402.1	36.1	136.6	2.4
samp. RP99007	Rabaul	Rabaul	Rabaul	Andesite	1.99	15.74	62.46	0.357	2.54	0	0.921	96	0.164	0	0	0	84	73.7	392.5	37.5	139.2	2.6
samp. RP99011	Rabaul	Rabaul	Rabaul	Andesite	2.5	15.72	59.9	0.321	2.19	0	0.877	132	0.158	0	8	0	96	66.1	398.1	34.1	120.7	1.9
samp. RP0015P17	Rabaul	Rabaul	Rabaul	Andesite	1.95	15.79	62.85	0.356	2.54	0	0.928	133	0.168	0	0	0	0	69.5	363.1	37.1	145.7	3.05
samp. 18NG-1010	Bam Island	Vitiaz	Vitiaz	Basaltic Andesite	5.41	16.5	54.9	0.19	1.36	0	0	269	0.16	0	14	0	63	29.6	731	11	30	0.5
samp. 18NG-1023	Bam Island	Vitiaz	Vitiaz	Andesite	3.4	17.1	58.8	0.23	1.27	0	0	217	0.14	0	5	0	66	36	792	12	39	0.67
samp. 19NG-0953	Boisa (Aris)	Vitiaz	Vitiaz	Basaltic Andesite	8.2	14.5	53	0.14	0.55	0	0	266	0.17	0	45	0	67	20.6	615	10	20	0.34
samp. 7471-0030	Manam Island	Vitiaz	Vitiaz	Basaltic Andesite	6.4	16.6	53.5	0.2	1.03	0	0	320	0.16	0	48	0	78	30.5	585	15	43	0.75
samp. 7471-0001	Karkar Island	Vitiaz	Vitiaz	Basaltic Andesite	3.15	19.6	53.8	0.16	0.88	0	0	263	0.16	0	10	0	77	31.6	490	15	34	0.8
samp. 7571-0015	Karkar Island	Vitiaz	Vitiaz	Basaltic Andesite	4.15	15.3	54.69	0.2	1.04	0	0	393	0.22	0	11	0	106	37.8	407	18	45	0.95
samp. 26NG-0788	Bagabag Island	Vitiaz	Vitiaz	Basalt	6.5	16.4	51.2	0.18	0.57	0	0	310	0.18	0	44	0	82	28.4	354	16	45	1.71
samp. 26NG-0787	Bagabag Island	Vitiaz	Vitiaz	Basalt	5.5	17.2	52.1	0.19	0.7	0	0	246	0.18	0	19	0	77	30	369	18	48	2.16
samp. 32NG-0754	Long Island	Vitiaz	Vitiaz	Basalt	6.85	17.9	48.1	0.15	0.72	0	0	338	0.2	0	28	0	77	19.4	787	12	24	0.44
samp. 32NG-0143A	Long Island	Vitiaz	Vitiaz	Basalt	4.4	17.4	51.4	0.25	1.33	0	0	318	0.22	0	7	0	99	38.5	706	16	45	0.89
samp. 32NG-0124	Long Island	Vitiaz	Vitiaz	Basaltic Andesite	3.1	15.1	56.7	0.39	2.25	0	0	255	0.25	0	4	0	133	61.5	665	25	74	1.47
samp. 32NG-0726	Tolokiwa Island	Vitiaz	Vitiaz	Basalt	7.5	16.7	48.9	0.22	0.88	0	0	273	0.19	0	61	0	69	27.2	588	18	35	0.68
samp. 32NG-0679	Umboi Island	Vitiaz	Vitiaz	Basalt	5.55	18.7	49.5	0.16	0.66	0	0	353	0.2	0	19	0	83	20.2	633	13	23	0.45
samp. 32NG-0111	Umboi Island	Vitiaz	Vitiaz	Basalt	14.9	12	49.9	0.11	0.56	0	0	259	0.18	0	388	0	73	19.8	372	10	24	0.38
samp. 32NG-0682	Umboi Island	Vitiaz	Vitiaz	Basalt	7.05	15.8	50	0.14	0.53	0	0	334	0.21	0	26	0	79	18.4	499	12	20	0.33
s_1 [5432]	Mount Hagen	N.G.	N.G.	Shoshonite [5432]	12.4	13.5	50.5	0.58	2.35	7.85	0.92	210	0.14	1.53	340	75	0	74	560	20	83	3.1
s_2 [5432]	Mount Hagen	N.G.	N.G.	Shoshonite [5432]	8.2	15.1	52.2	0.59	2.35	8.8	1.01	230	0.15	1.45	115	105	0	69	615	21	92	2.1
s_3 [5432]	Mount Hagen	N.G.	N.G.	Andesite, Olivine-Hornblende-Augite-Hypersthene [5432]	6.6	15.3	54.4	0.45	2.32	7.65	1	205	0.14	2.65	75	129	0	65	980	24.5	155	3.7
s_4 [5432]	Mount Hagen	N.G.	N.G.	Andesite, Olivine-Hornblende-Augite-Hypersthene [5432]	5.15	17.2	56.8	0.23	1.85	5.6	0.81	150	0.12	2.65	75	59	0	41.5	705	18	155	5
s_5 [5432]	Mount Hagen	N.G.	N.G.	Andesite, Hornblende-2 Pyroxene [5432]	3.45	18	58.4	0.29	1.7	5.75	0.72	125	0.12	2.5	25	53	0	48.5	755	17.5	145	6.3
s_6 [5432]	Mount Hagen	N.G.	N.G.	Andesite, Tridymite-2 Pyroxene-Hornblende [5432]	2.1	18.2	60.8	0.31	2.3	5.45	0.5	69	0.11	2.25	11	20	0	64	935	18	180	4.8
s_7 [5432]	Mount Giluwe	N.G.	N.G.	Shoshonite [5432]	6.5	17.3	51.2	0.58	2.35	8.75	0.99	260	0.14	2.8	81	122	0	65.5	770	21	84	2.4
s_8 [5432]	Mount Giluwe	N.G.	N.G.	Andesite, Olivine-2 Pyroxene [5432]	5.55	16.7	54.9	0.55	2.3	7.5	0.85	185	0.12	2.15	70	85	0	82.5	815	21.5	98	2.1
s_9 [5432]	Mount Giluwe	N.G.	N.G.	Andesite, 2-Pyroxene [5432]	6.45	15.8	56.1	0.47	2.9	6.35	0.78	145	0.12	2.2	130	78	0	108	710	22	145	5.8
s_10 [5432]	Mount Giluwe	N.G.	N.G.	Andesite, Hornblende-2 Pyroxene [5432]	2.85	18.8	56.8	0.79	2.4	6.4	0.62	69.3	0.13	4.78	10	30	0	82	945	21.5	125	4.4
s_11 [5432]	Mount Murray	N.G.	N.G.	Basalt, Olivine [5432]	8.55	14.7	49.9	0.69	1.75	9.6	1.34	285	0.17	1.85	95	135	0	38	635	21.4	115	6.3
s_12 [5432]	Mount Murray	N.G.	N.G.	Basalt, Olivine [5432]	5.2	16.8	52.3	0.7	2.05	7.95	1.48	280	0.16	2.45	33	100	0	43	765	24.5	135	9
s_13 [5432]	Mount Murray	N.G.	N.G.	Andesite, Hornblende-2 Pyroxene [5432]	2.25	17.1	58.5	0.5	2.7	6.4	1.01	130	0.16	3.55	8	22	0	81	785	23.5	285	12
s_18 [5432]	Mount Bosavi	N.G.	N.G.	Basalt, Alkaline, Olivine [5432]	11.7	14.1	47.1	0.42	0.95	9.9	1.28	280	0.18	3.45	222	68	0	29	675	20.5	146	8.9
s_19 [5432]	Mount Bosavi	N.G.	N.G.	Basalt, Olivine [5432]	6.75	16.2	52.5	0.5	1.8	8.2	1.01	195	0.18	2.95	97	52	0	39.5	690	22	187	13.5
s_20 [5432]	Mount Bosavi	N.G.	N.G.	Andesite, Hornblende-2 Pyroxene [5432]	2.1	17.3	60.2	0.34	2.5	6	0.68	120	0.12	2.95	10	42	0	71	765	21.5	256	14

Appendix 2

Precision and accuracy of the pXRF instrument as determined by comparison with basalt standards UHH MK.05.14E.57 and NIST688. Figure A2.1 courtesy of P. Grave, University of New England.

Analysis of the PXRF data from the two basalt standards UHH MK.05.14E.57 and NIST688 show that there is variation among the elemental concentrations. Overall, majority of elements were recovered well and remain close to 100% recovery, however some elements were not sufficiently recovered and were excluded from analysis (Mgo, K_2O, SiO_2, V, Ni, Cu, and Nb). Recovery % for elements taken from both standards is shown in Fig. A2.1 and the mean differences for elements analysed is shown in Fig. A2.2.

Table A2.1. Comparison of PXRF calibration and EDXRF Calibration. *Upper part of table*: UHH MK.05.14E.57 Basalt standard; *lower part of table*: NIST688 Basalt standard.

	UHH MK.05.14E.57 Basalt on Bruker Instrument 900F4708			UHH MK.05.14E.57 Basalt on QuanX EDXRF (Mills and Lundblad, 2006)	
element	mean	sd	rsd %	mean	sd
MgO (%)	6.693	0.341	5.1	3.497	0.099
Al_2O_3 (%)	13.451	0.574	4.3	13.365	0.031
SiO_2 (%)	47.667	2.016	4.2	52.360	0.035
K_2O (%)	1.181	0.075	6.4	0.8570	0.0078
CaO (%)	9.720	0.423	4.4	7.719	0.036
TiO_2 (%)	4.223	0.192	4.5	3.564	0.016
V (ppm)	386.6	20.403	5.3	444	17
MnO (ppm)	1949	0.005	2.5	1510	24
Fe2O3T (%)	12.963	0.387	3.0	11.350	0.010
Ni (ppm)	57.8	9.121	15.8	30.7	1.6
Cu (ppm)	53	5.244	9.9	79.8	7.7
Zn (ppm)	126.8	12.357	9.7	148.4	4.5
Rb (ppm)	22	5.612	25.5	31.6	1.1
Sr (ppm)	502.6	17.111	3.4	568.1	2.5
Y (ppm)	33	1.871	5.7	41.4	1.2
Zr (ppm)	267.4	9.503	3.6	351.5	2.4
Nb (ppm)	25.6	1.517	5.9	34.3	1.5
	NIST688 Basalt on Bruker Instrument 900F4708			NIST688 Basalt[a]	
element	mean	sd	rsd %	mean	sd
MgO (%)	5.654	0.270	4.8	8.46	0.14
Al_2O_3 (%)	14.912	0.212	1.4	17.35	0.13
SiO_2 (%)	41.980	0.994	2.4	48.35	0.997
K_2O (%)	0.280	0.012	4.2	0.187	0.009
CaO (%)	11.553	0.093	0.8	12.17	0.115
TiO_2 (%)	1.157	0.011	0.9	1.168	0.030
V (ppm)	119.25	15.650	13.1	250	13.890
MnO (%)	0.166	0.003	1.8	0.167	0.008
Fe2O3T (%)	11.403	0.201	1.8	10.34	0.007
Ni (ppm)	114	11.045	9.7	150	17.739
Cu (ppm)	74.25	6.4	8.6	96	4.439
Zn (ppm)	82.75	5.058	6.1	58	8.571
Rb (ppm)	1.75	0.5	28.6	1.19	1.253
Sr (ppm)	141.25	1.708	1.2	169.2	27.574
Y (ppm)	22.75	0.957	4.2	19	5.065
Zr (ppm)	48	1.414	2.9	59	60.243
Nb (ppm)	8.25	0.957	11.6	5.7	1.276

[a] Major elements: National Bureau of Standards, Standard Reference Material 688. Trace elements: GeoReM, 2019.

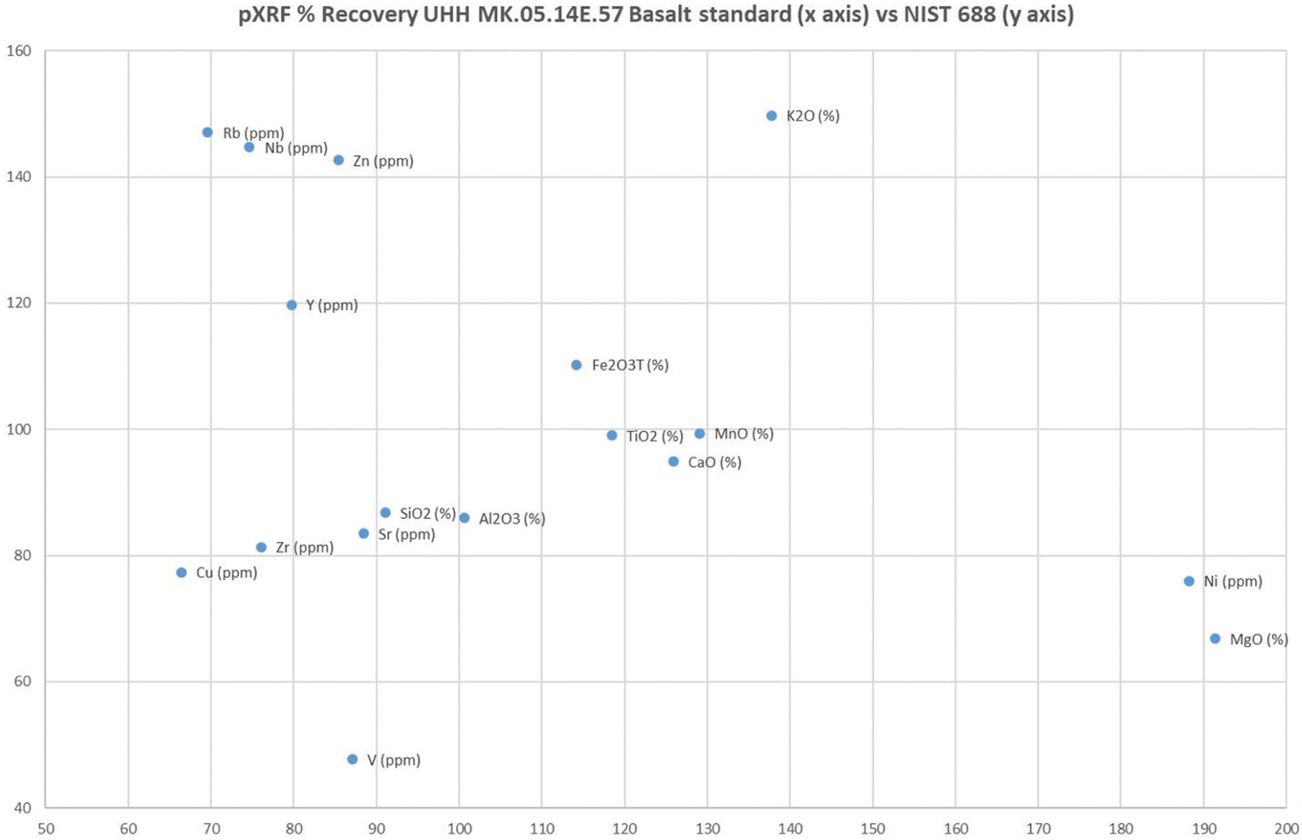

Figure A2.1. Recovery % for PXRF results against UHH MK.05.14E.57 Basalt standard and NIST688 Basalt standard (courtesy of Peter Grave).

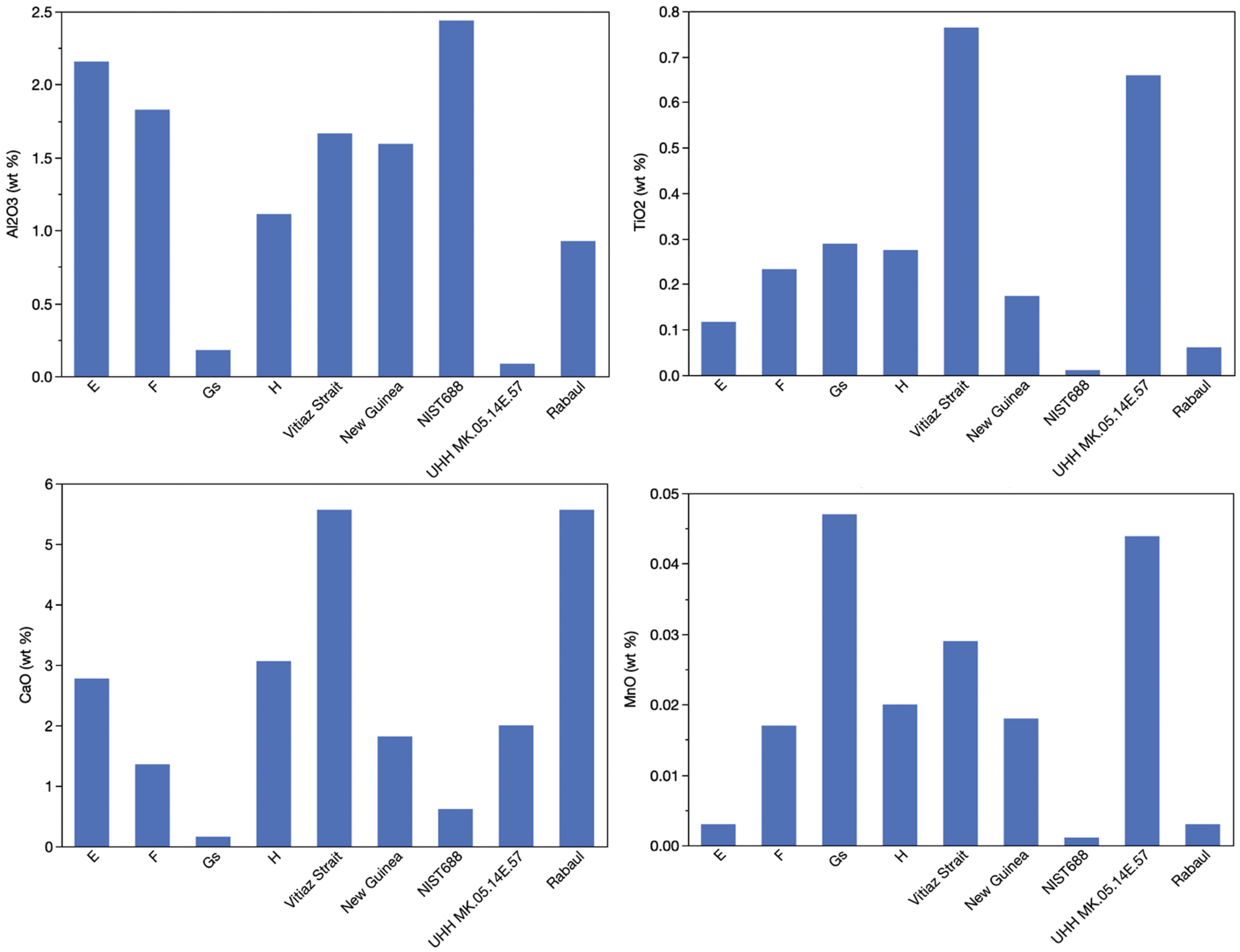

Figure A2.2. Mean differences for elements included in analysis between the Northern Willaumez Pen. geological region and all other geological regions used in this study, and the mean difference between the certified and experimental data for both standards. [*Fig. A2.2 continued on next page*].

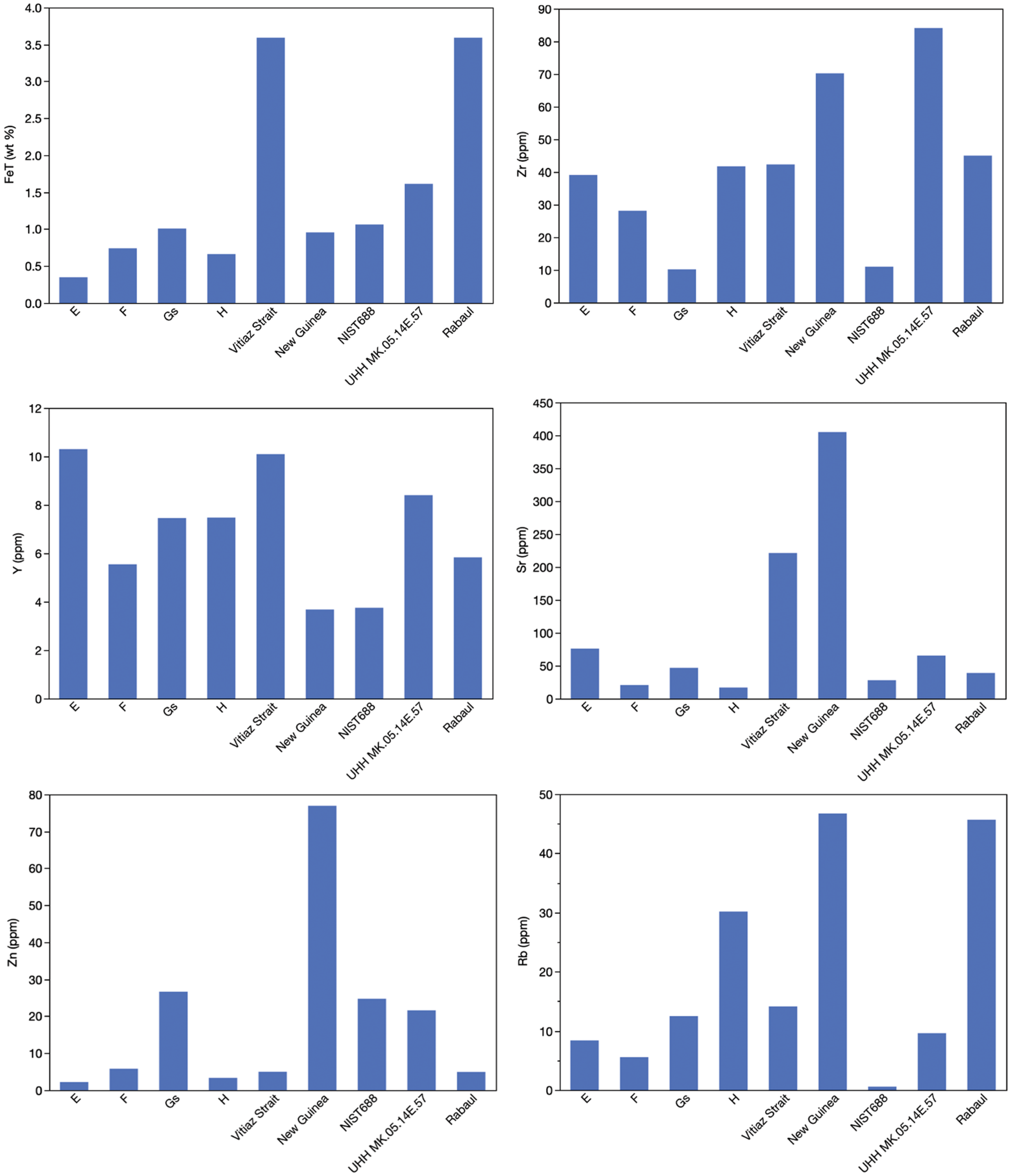

Figure A2.2 [*Continued from previous page*]. Mean differences for elements included in analysis between the Northern Willaumez Pen. geological region and all other geological regions used in this study, and the mean difference between the certified and experimental data for both standards.

Appendix 3. pXRF data for the archaeological sample, with assignments to geochemical and social regions. Artefacts with a DFA probability degree of 0.7 or higher are highlighted. Abbreviations of column-headings in this table: *pXRF*—pXRF sample code; *site*—Papua New Guinea site code; *Geo.*—Geochemical Region; *Social*—Social Region.

pXRF	site	location	context	item	Geo.	Social	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V	MnO	FeO_2O_3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
WNB/S/5	FSV	Lamogai	Surface	axe cutting edge (CE) fragment	Vitiaz (0.9948)	Vitiaz (0.9984)	4.9	15.19	43.07	0.44	0.19	7.25	0.75	152.67	0.31	13.72	52	21.67	194.67	2	117.33	12.67	26.67	2.67
WNB/S/4	FSE	Konomwate	Surface	axe, complete	F (0.6468)	Hoskins (0.9168)	2.71	15.83	46.24	0.27	1.08	8.98	0.65	196.33	0.23	12.82	33.33	137.33	110.67	13.33	464.67	10	42.33	1.33
WNB/S/3	FSE	Konomwate	Surface	?adze or chisel fragment	n/a	n/a	2.83	12.2	33.28	9.03	3.96	10.67	0.86	77	0.22	10.84	15	54.67	235	78.33	983.33	21.67	116.33	0
WNB/S/1	FSC	Monkereme	Surface	?adze or chisel fragment	Gn (0.9885)	WPN (0.9738)	5.43	12.26	36.85	0.75	1.39	8.02	1.75	163	0.25	16.52	84.33	91	206	25	440.33	29	107.33	7
WNB/S/50	FLX	Iumielo	Surface	axe CE fragment	Rabaul (0.9942)	Rabaul (0.9946)	1.03	12.85	57.68	0.09	3.76	1.97	0.33	13	0.16	5.06	8.67	26.33	96.67	69.33	229.67	35	139.67	9
WNB/S/51	FLX	Iumielo	Surface	axe/adze CR or butt fragment	E (0.7183)	Hoskins (0.7322)	4.05	11.48	46.52	0.31	0.95	3.23	1.61	150	0.24	15.18	24.33	33	236	17.67	215.33	46.33	75	14.33
WNB/S/55	FLX	Iumielo	Surface	?flaked axe fragment	GN (0.7479)	WPN (0.6153)	1.76	14.63	52.09	0.47	0.97	4.36	1.17	66.67	0.16	9.39	6	15	103	23	244.67	40.33	145.33	10.67
WNB/S/60	FLX	Iumielo	Surface	axe CE chip	Vitiaz (1.0000)	Vitiaz (1.0000)	5.04	13.05	38.44	0.34	1.61	9.18	0.76	172	0.35	14.63	67.33	39.33	125.67	14.67	627.33	15	49.67	1.33
WNB/S/57	FLX	Iumielo	Surface	waisted axe fragment	Rabaul (1.0000)	Rabaul (1.0000)	2.66	14.37	56.2	0.16	1.38	1.17	1.15	84.33	0.2	11.63	5	30.67	239	111.67	261.67	21.33	48.67	0.67
WNB/S/58	FLX	Iumielo	Surface	axe CE chip	Rabaul (0.9788)	Rabaul (1.0000)	2.45	13.77	56.25	0.25	1.43	3.58	1.16	101.33	0.12	8.75	20.67	20.33	140.33	113.33	1676.33	14.33	106.33	0
WNB/S/56	FLX	Iumielo	Surface	axe/adze fragment	E (0.9492)	Hoskins (0.5033)	3.79	14.52	37.41	0.25	0.39	4.42	2.02	177.33	0.27	16.45	38.33	16.67	226.67	13.33	367.67	20	68	3.33
WNB/S/53	FLX	Iumielo	Surface	axe/adze butt fragment	Vitiaz (0.9079)	Vitiaz (0.8828)	3.95	15.53	47.44	0.43	0.27	7.79	1.13	136.33	0.28	10.91	15.67	20.33	273	11.33	303	29.67	54.67	7.33
WNB/S/59	FLX	Iumielo	Surface	?adze fragment	Vitiaz (1.0000)	Vitiaz (1.0000)	3.68	14.74	45.46	0.2	0.24	5.39	1.92	269.67	0.48	14.16	25	13.33	318.67	12.33	171.33	28.67	58.67	8
WNB/S/48	FLF	Iumielo	III layer 1 spit 1	axe fragment	GN (0.8484)	WPN (0.7192)	3.9	12.32	37.76	0.21	1.29	10.21	0.71	64.67	0.14	11.31	76.33	69	88.33	7.67	497	10.33	40.33	0.67
WNB/S/30	FFS	Apugi Island	Surface	?bark-cloth beater fragment	F (0.7432)	Hoskins (0.9693)	2.63	16.33	48.03	0.71	0.89	6.51	1.63	94.33	0.24	13.98	29.33	19.33	301	7	387.67	34	98.33	9
WNB/S/31	FFS	Apugi Island	Surface	?adze fragment	H (0.7051)	Rabaul (0.5746)	3.49	15.57	48.63	0.31	1.26	6.44	1.47	166.67	0.2	10.9	17	36.33	117	53.67	919.67	23.33	121.67	2.67
WNB/S/32	FFS	Apugi Island	Surface	axe/adze CE fragment	E (0.9742)	Eastern (0.4013)	4.3	13.55	50.89	0.37	0.35	7.96	1.61	323	0.27	13.08	28	32	209.67	26.67	203.67	24	51	7
WNB/S/33	FFS	Apugi Island	Surface	axe/adze CE fragment	E (0.9877)	Eastern (0.5269)	4.95	14.43	45.25	0.63	0.27	8.58	1.94	397	0.3	14.69	22.33	26.33	415.67	12	213.67	20.33	38	5.67
WNB/S/35	FFS	Apugi Island	Surface	flaked piece	GN (0.4068)	Hoskins (0.5454)	3.53	15	49.58	0.36	0.27	6.67	1.14	117.33	0.29	10.89	18.33	12.67	161.67	5.33	316.67	28.33	79.67	8.33
WNB/S/36	FFS	Apugi Island	Surface	axe CE fragment	E (0.8212)	WPN (0.7771)	4.46	13.18	45.16	0.38	0.31	6.49	1.73	420	0.34	15.24	23.33	27	184.67	12.67	196	25	43.67	8
WNB/S/37	FFS	Apugi Island	Surface	?adze butt fragment	GN (0.9434)	WPN (0.9390)	2.69	12.15	49.21	0.44	1.55	5.6	1.36	100	0.27	10.81	13.33	15.67	174.33	37	305.67	36.33	90.33	9
WNB/S/38	FFS	Apugi Island	Surface	?adze or wedge	E (0.9602)	Hoskins (0.5722)	3.29	14.11	50.2	0.32	0.31	7.38	1.3	170.67	0.23	11.32	18.67	27.67	181	17	179.33	26	51	8.33
WNB/S/40	FFS	Apugi Island	Surface	?tool fragment	E (0.7239)	Hoskins (0.5741)	1.88	14.17	53.03	0.33	1.01	3.55	0.97	28	0.14	7.72	7.67	20	161	61.33	248	40.33	160.67	9.33
WNB/S/41	FFS	Apugi Island	20N/30E surface	?axe stem	F (0.9218)	Hoskins (0.8804)	2.8	15.46	37.81	1.04	0.34	8.37	1.18	103	0.19	12.85	29.33	16	180.33	6.33	304.33	20	52.33	4.33
WNB/S/42	FFS	Apugi Island	20N/30E surface	?axe stem	Vitiaz (1.0000)	Vitiaz (1.0000)	4.89	12.28	55.7	0.48	0.2	5.68	1.8	189.67	0.44	11.68	11	19.33	291	5	228.67	33.67	49	13.33
WNB/S/43	FFS	Apugi Island	20N/30E surface	adze butt	F (0.9259)	Hoskins (0.9730)	3.74	15.76	38.06	0.76	1.02	9.88	0.69	178	0.23	14.22	63.33	111.67	139	13.33	345.67	10	30	1.33
WNB/S/45	FFS	Apugi Island	25N/30E spit 3	flaked piece	F (0.9577)	WPN (0.7840)	2.08	20.1	33.48	3.18	0.78	3.7	1.88	151	0.07	16.3	71.33	334	343.67	17.33	1428	100.33	235.33	21
WNB/S/46	FFS	Apugi Island	35N/40E spit 2	?axe butt or stem	GN (0.9948)	WPN (0.9965)	4.08	13.04	48.9	0.48	0.3	10.87	1.22	131.67	0.15	9.65	37.33	21.33	98	3.33	630.33	19	119.33	4.67
WNB/S/7	FFT	Apugi Island	Surface	?axe CE fragment	Vitiaz (1.0000)	Vitiaz (1.0000)	2.05	17.82	41.08	0.53	0.62	6.34	0.94	76.67	0.32	13.92	10.67	18.33	227.67	19.33	299.67	28	62.33	6.33
WNB/S/11	FFT	Apugi Island	Surface	?axe/adze fragment	GN (0.8678)	WPN (0.8494)	3.62	16.58	50.54	0.47	1.29	8.54	1.51	169	0.26	11.32	17	26.67	106.33	10.67	351	26.67	76.33	7
WNB/S/12	FFT	Apugi Island	Surface	?axe/adze fragment	GN (0.8348)	WPN (0.9133)	3.52	14.21	53.79	0.76	0.57	9.8	1.5	250	0.24	10.07	14.67	16	152	10.33	196	24.33	58.67	8.67
WNB/S/14	FFT	Apugi Island	Surface	axe/adze chip	GN (0.6259)	WPN (0.6077)	4.21	14.71	44.89	0.76	0.31	6.85	1.74	293.33	0.3	15.07	19.33	25	184	6.33	227.67	32.33	57.33	10
WNB/S/16	FFT	Apugi Island	Surface	axe/adze fragment	GN (0.7556)	WPN (0.5580)	3.38	17.61	36.21	0.92	0.21	7.32	2.19	201.67	0.27	17.65	31.67	39	255.33	5.33	568.33	38.33	122.33	8
WNB/S/19	FFT	Apugi Island	III spit 1	discoid, flaked	Vitiaz (0.9823)	Vitiaz (0.9770)	2.23	16.08	41.42	0.49	2.51	4.66	0.89	230.33	0.23	15.71	38.33	249.67	157.33	33.33	572	20.33	59.67	2.33
WNB/S/22	FFT	Apugi Island	III spit 2	axe fragment	E (0.9990)	Eastern (0.6031)	2.54	17.72	47.88	0.23	0.5	7.05	1.25	155.67	0.13	12.94	26	41.67	164	26.33	223.67	18	40.33	4.33
WNB/S/24	FFT	Apugi Island	III spit 3	adze fragment	E (0.7005)	WPN (0.5736)	6.01	13.92	39.93	0.17	0.5	7.94	1.5	171.67	0.18	14.54	57.33	32.33	116.33	20.67	283.33	25	81	6.67
WNB/S/25	FFT	Apugi Island	III spit 3	?adze butt fragment	Vitiaz (0.8671)	Vitiaz (0.9951)	5.42	14.76	54.52	0.23	0.43	6.7	1.95	340	0.27	13.16	23	78.33	421.33	21.33	347.33	25	43.67	8.33
WNB/S/26	FFT	Apugi Island	III spit 3	?adze butt fragment	GN (0.8951)	Vitiaz (0.5164)	6.62	14.43	50.35	0.66	1.54	6.3	2.04	249.33	0.35	14.01	32	42.33	268.33	16	1127.33	18.33	86	1
WNB/S/29	FFT	Apugi Island	IV spit 2	?bark-cloth beater fragment	n/a	n/a	2.42	14.9	42.78	0.4	0.82	2.55	1.38	66	0.36	16.65	34.33	56.67	777.67	36.67	339.67	32	81.67	7
WNB/S/64	FJS	Awat	30–40 cm deep	pestle, complete	F (0.9268)	Hoskins (0.9086)	1.23	15.15	37.72	0.51	3.06	13.69	0.34	50	0.19	10.63	19.33	107	211	31.33	474.67	14	42.33	1.67
WNB/S/63	FYA	Iumielo	I layer 1 spit 8	axe/adze CE fragment	E (0.7391)	Hoskins (0.8938)	4.45	15.55	40.07	0.45	0.63	10.01	1.1	143.33	0.23	14.09	45.33	18	121.67	7.67	200.33	25	49	6.33
AKIULI1	n/a	Akiuli	Surface	axe, complete	E (0.6813)	WPN (0.5711)	4.88	15.09	53.8	0.22	0.18	9.99	1.41	343.33	0.21	10.58	18.67	32.67	120	1.33	248	22.33	51.67	8.67
YAMBON1	n/a	Yambon	Surface	axe, complete	F (0.6108)	Hoskins (0.8839)	6.3	14.34	48.43	0.41	0.37	9.48	0.71	160	0.18	11.26	50.33	23	106.67	2.67	238	13	28.67	4
YAMBON2	n/a	Yambon	Surface	axe, complete	Vitiaz (0.9589)	Vitiaz (0.8986)	2.81	11.84	50.8	0.6	0.21	4.36	0.91	199.33	0.28	14.18	8	21.33	180.67	2.33	192.67	16.33	27.67	5.33
YAMBON3	n/a	Yambon	Surface	axe, complete	F (0.5502)	WPN (0.9476)	5.51	10	33.62	1.85	0.41	12.79	0.73	116.33	0.18	14.64	59.33	37.33	129	2.33	200	15.33	28.67	4
FHC/1/95	FHC	Misisil	I layers ⅔ interface	adze, flaked, ground, complete	GN (0.9899)	WPN (1.0000)	2.81	4.77	21.08	0.97	0.58	27.1	0.76	65	0.11	10.67	34.67	30	168.33	15	194.67	39	118	8.33
FYT/1	FYT	Hauwauyang	Surface	waisted axe, flaked, complete	Vitiaz (1.0000)	Vitiaz (1.0000)	2.96	10.34	44.43	0.62	0.55	4.87	1.87	143	0.42	15.17	19.33	58.33	416.67	8.67	176.33	39.67	170	8.67
FLK/25	FLK	Aringilo	Surface	axe fragment	E (0.9548)	Hoskins (0.9589)	4.51	15.71	36.64	0.25	0.19	7.36	1.15	132	0.22	14.59	57.33	83.67	135	3.67	192.67	27	55.33	7.67
FKR/4	FKR	Mihak	Surface	adze fragment	n/a	n/a	2.27	18.39	31.67	1.04	1.44	6.91	1.34	128.67	0.37	17.21	35.33	65.67	583	23	213	29.33	49.33	7
FIU/6	FIU	Akiuli	Surface	pebble, broken	Vitiaz (1.0000)	Vitiaz (1.0000)	3.46	14.93	37.43	0.39	0.91	4.24	1.47	131.33	0.44	17.05	20	37.33	398	49.33	722.33	30.67	74	2.67
FJA/8	FJA	Womilo	Surface	stemmed axe fragment	E (0.6342)	WPN (0.8062)	4.49	16.33	43.77	0.53	0.19	3.96	2.35	195.67	0.47	16.87	26	28	225.33	6	223	48.67	108.33	14.33
FLP/1	FLP	Analo	Surface	axe fragment	F (0.5747)	Hoskins (0.4617)	5.62	13.73	47.69	0.42	0.47	13.66	0.72	143	0.17	10.23	51.67	26	95.33	2.67	191.33	12	27.33	4

pXRF	site	location	context	item	Geo.	Social	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	V	MnO	FeO_2O_3	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb
FLP/2	FLP	Analo	Surface	axe fragment	Vitiaz (1.0000)	Vitiaz (1.0000)	2.98	17.75	40.4	0.42	0.38	5.98	1.31	155.67	0.38	15.43	46	29.67	256.67	34.67	279.33	29.33	102.33	5.67
FLP/3	FLP	Analo	Surface	?nut-cracking anvil	E (0.9607)	Hoskins (0.8487)	2.12	15.41	36.3	0.3	0.45	5.44	1.08	88.33	0.21	11.64	17.67	39.33	101.67	36.33	182.33	35	59.33	7.33
FFZ/23	FFZ	Ganglo Island	Surface	?nut-cracking anvil	E (0.9760)	Hoskins (0.9330)	3.82	15.6	39.72	0.32	0.19	7.75	1.13	128.33	0.22	14.22	40.33	29	157.33	4	177.33	19.67	32.33	6.33
FFQ/1	FFQ	Apugi Island	Surface	adze fragment	GN (0.8178)	WPN (0.9240)	4.03	14.66	51.4	0.21	0.22	9.32	1.58	290.33	0.29	11.39	25	13.67	153.33	1.67	248.33	39	124.33	14.33
FMU/147 (P/T/S/3)	FMU	Iumielo	Surface	adze fragment	E (0.7932)	WPN (0.4961)	6.35	12.53	42.33	0.26	0.18	9.77	1.11	181	0.26	13.87	51.33	18	132.67	3	179.67	15.33	23.33	4.67
FFS/AURARUO/1	FFS	Apugi Island	Surface	axe CE fragment	GN (0.8348)	WPN (0.8926)	3.15	15.68	55.3	0.33	0.38	9.89	1.35	134.67	0.21	8.96	20.33	16.33	47	4	143.33	33.33	100.33	12
FFS/AURARUO/2	FFS	Apugi Island	Surface	waisted tool—?net-sinker	E (0.8572)	Hoskins (0.9864)	3.22	15.01	35.28	0.53	0.23	5.46	1.46	109.67	0.16	14	31.67	21.33	287.67	4.33	220	30.33	81	6
FFS/AURARUO/3	FFS	Apugi Island	Surface	axe/adze fragment	F (0.8922)	Hoskins (0.9891)	1.02	18.13	47.46	0.73	2.92	2.68	0.5	13.33	0.18	6.73	2.33	23.67	128.33	69	230.33	50	154.33	9
FFS/1	FFS	Apugi Island	30N/25E surface	?axe/adze stem or butt fragment	E (0.8573)	Hoskins (0.9352)	4.14	16.01	41.04	0.59	0.23	9.23	1.15	160.33	0.25	13.7	48.33	27.33	167.67	8.33	168.33	21.67	39.67	5.67
FFS/2	FFS	Apugi Island	45N/30E surface	?adze butt fragment	E (0.5260)	WPN (0.6617)	2.91	14.45	49.97	0.51	0.45	6.93	1.48	180.33	0.25	11.17	19.33	16.33	178.67	24.33	287.33	23.67	65.67	6.67
FFS/3	FFS	Apugi Island	20N/35E surface	adze, complete	E (0.8485)	Hoskins (0.7384)	4.04	12.9	43.74	0.43	0.36	5.91	1.26	190.67	0.25	13.7	32.33	27.33	154.33	12.33	136	26.67	40	8
FFS/4	FFS	Apugi Island	20N/35E surface	flaked piece	F (0.8882)	Hoskins (0.8886)	3.46	10.17	42.93	0.62	0.13	6.5	0.44	44.33	0.18	13.22	80.33	31.33	127	5.33	105	21	46.33	6.67
FFS/6	FFS	Apugi Island	25N/35E surface	?adze fragment	F (0.6977)	Hoskins (0.8319)	3.24	15.91	47.02	0.82	0.37	6.99	1.56	158	0.29	13.81	19.33	31	210.33	6.33	247	40.33	70.67	12.67
FFS/7	FFS	Apugi Island	15N/45E surface	adze fragment	E (0.9560)	Hoskins (0.9917)	5.29	15.13	48.79	0.53	0.52	3	1.84	188.33	0.18	15.39	16.33	40.33	275	5	187	43	71.33	14.67
FFS/8	FFS	Apugi Island	30N/65E surface	?axe/adze butt	GN (0.5501)	WPN (0.8635)	3.15	13.71	56.03	0.27	0.2	7.15	1.77	148.33	0.23	10.25	15.33	15.67	124.67	14.33	177.67	26.33	63.67	9.67

Notes

The *pXRF sample code* column = West New Britain/South coast/sample number.

The WNB/S/- samples were run in 2020; the remaining samples were run in 2018 (Pengilley *et al*. 2019).

Yambon/1, -/2, -/3, AKIULI/1 were handed in by local people, findspots unknown.

In the *item* column, CE = cutting-edge.

In the columns for *geochemical and social regions*, matching allocations are highlighted; ‘n/a’ = not assigned.