

OBSIDIAN NETWORK PATTERNS IN MELANESIA – SOURCES, CHARACTERISATION AND DISTRIBUTION.

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INTRODUCTION

This paper provides an overview of the analysis of obsidian use and distribution within Melanesia by firstly, reviewing the source areas including the history of obsidian chemical characterisation, and secondly, by looking at 20,000 years of obsidian use and its distribution.

OBSIDIAN SOURCES

Within Melanesia obsidian has a naturally restricted occurrence to Papua New Guinea and Vanuatu (Figure 1). In the Bismarck Archipelago it is found in two regions: the Admiralty Islands, and West New Britain at the Willaumez Peninsula and Mopir. The third regional source is centred on Fergusson Island. Within all three provinces chemically distinct sub-groups are identified. Because of their restricted natural distribution and distinct chemistry, obsidian found in archaeological sites can be matched (or traced) to their geological sources, thus providing archaeologists with important distribution information. By identifying the sources of obsidian from distant sites over select periods of time, the changing nature of distributions can be mapped and social and economic models to account for those changes can be developed and tested.

Sourcing of Melanesian obsidian began over 35 years ago initiated by Key (1968, 1969). Using emission spectroscopy he separated obsidian collected from Lou Island, the Willaumez Peninsula and East Fergusson. These sourcing results were used on archaeological samples from Watom, Collingwood Bay, Ambitle Island and also Reef Island and Santa Cruz assemblages. Samples from south coast Papuan sites of Nebira, Oposisi and Apere Venuna were also sourced back to Fergusson sources (Vanderwal 1973:214). Later characterisation analyses used XRF (Smith 1974, Smith et al. 1977) on Fergusson Island obsidian, and Lowder and Carmichael (1970) on a single sample from the Willaumez Peninsula. Ambrose using the same technique, sourced obsidian from both Ambitle Island and the Reef-Santa Cruz Group, to the Willaumez Peninsula (Ambrose and Green 1972).

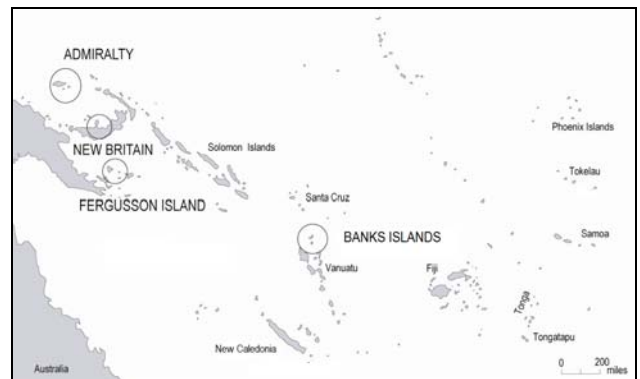


Figure 1. Obsidian source regions in Melanesia.

The next technique to be applied was Neutron Activation Analysis (NAA) (Wall 1976) on samples from Lou Island, the Willaumez Peninsula, West and East Fergusson, and the Banks Islands, along with archaeological samples from a number of sites (Ambrose 1976). Yet, as outlined in Summerhayes et al. (1998), NAA was not used as extensively as another technique, Proton Induced Gamma Emission (PIGME) (Bird and Russell 1976; Bird et al. 1981a), and later Proton Induced X-ray Emission (PIXE), developed together to provide PIXE-PIGME (Ambrose and Duerden 1982; Bird et al. 1983; Duerden et al. 1979; Duerden et al. 1980; Duerden et al. 1986).

PIGME, although measuring only three elements (F, Al and Na) proved useful in separating out Willaumez Peninsula, Admiralty and Fergusson sources, but had overlap between the Willaumez and the Banks Island, Vanuatu, sources. Over 700 archaeological samples were analysed and compared back to the source samples (Bird et al. 1981a; 1981b). PIGME also isolated an unknown source from New Britain, which was later identified as the Mopir source (Specht and Hollis 1982; Fullagar et al. 1991; Summerhayes et al. 1993).

Despite these achievements, three elements were not enough to provide clear distinctions between the source areas. To overcome these limitations Proton Induced X-ray Emission was used and developed by the late Roger Bird alongside PIGME at the Australian Atomic Energy Commission. Thus PIXE-PIGME allowed simultaneous

measurements of gamma and X-ray spectra providing over 20 elements to be measured, 12 of which were isolated by Bird and Ambrose as being useful for source identification (Bird et al. 1988; Duerden et al. 1986; 1987). From 1990 onwards, changes were made to the machine conditions of PIXE-PIGME making it more sophisticated and allowing a better resolution between sources and sub-sources (Summerhayes and Hotchkis 1992, Summerhayes et al. 1993, Summerhayes et al. 1998).

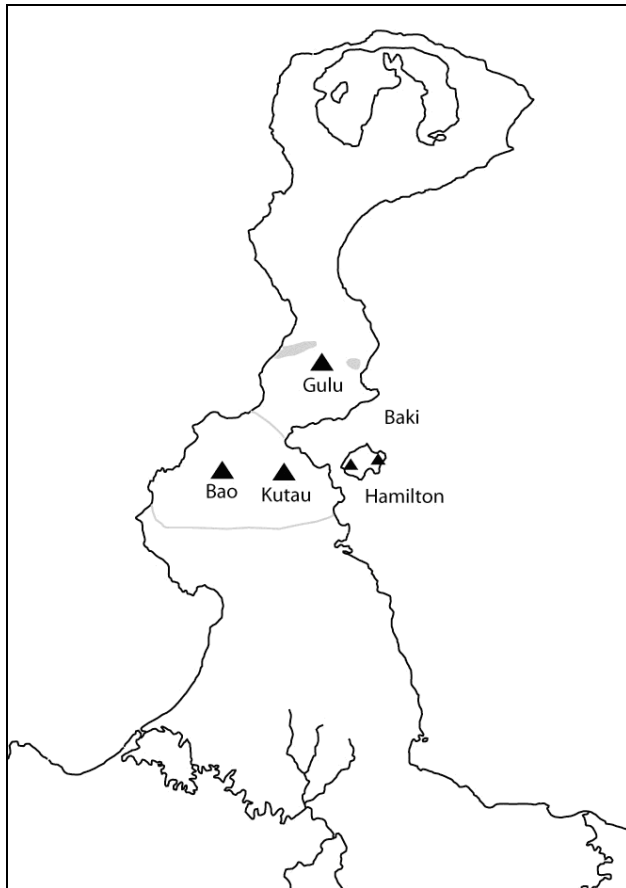


Figure 2. Willaumez Peninsula.

Apart from PIXE-PIGME and the techniques mentioned above, only five other chemical techniques have been used in the recent analysis of obsidian from Melanesia. First is an Energy Dispersive X-ray Fluorescence (EDXRF) analysis of obsidian from Mussau assemblages by Weisler (Weisler and Clague 1998). The second was by Ambrose using a JEOL scanning electron microscope with an EDAX attachment (Fredericksen 1997a) which allowed the subdivision of the major source areas. Thirdly, Raman spectroscopy has recently been used to distinguish major Pacific source areas (Manus, New Britain and Banks) and to allocate a museum obsidian piece from the Pitt Rivers Museum to a source in New Britain which is not surprising given that it was collected along the south coast of New Britain (Carter et al. 2009). Fourthly, using a portable XRF spectrometer Peter

Sheppard has successfully analysed and separated out the source regions from the western Pacific, and has characterised and allocated sources for over 950 archaeological samples from the Reef/Santa Cruz Lapita sites (Sheppard et al. in press). Similar machines have recently been purchased in a number of Australian institutions and also at Otago University, making this technique one of the desirable methods for the future. Lastly, is the use of laser ablation ICP-MS (see Summerhayes 2008 for a description of the technique) on source and archaeological samples by Wal Ambrose and Christian Reepmeyer of the ANU. The technique has successfully used to chemically distinguish western Pacific source areas, and to allocate to general source regions archaeological samples from Pacific and southeast Asian contexts (see Ambrose et al. 2009; Reepmeyer 2008; Reepmeyer et al. in press; Reepmeyer and Clark in press).

Density analysis has also been used as a preliminary screening process to separate major source areas, but with less success (Ambrose 1976; Ward 1979: appendix 8; Allen in press; Torrence and Victor 1995; White and Harris 1997). Overlaps in the density range exist between most sources areas, leading to problems in source attribution (Allen in press).

PAPUA NEW GUINEA

1. New Britain – Willaumez Peninsula and Mopir sources (Figures 2 and 3).

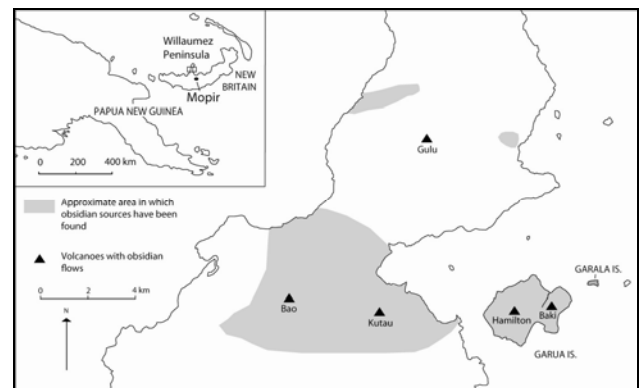


Figure 3. West New Britain sources.

The north coast of New Britain has rhyolitic obsidian bearing deposits within the Bismarck Arc volcanic belt (Johnson et al. 1973) where the Solomon Sea and South Bismarck Plate converge (Johnson 1976:108). This volcanic belt shows changes across the arc running parallel to the east-west axis of New Britain and the Willaumez Peninsula and “concomitant with the changing depths to the underlying Benioff zone” (Johnson 1976:108). That is, within the Willaumez peninsula, there is an increase northwards of potassium and sodium, with changes also in titanium and sulphur. Thus the obsidian flows overlie a Benioff Zone, which dips northwards along the Peninsula, with differences in the chemistry of outcrops expected in the flows along this zone (Johnson

1976:108; Johnson et al. 1973: 529; Lowder and Carmichael 1970:27). As noted in Summerhayes (et al. 1998), “obsidian outcropping in different areas should have slightly different chemical make-ups, despite their geographical proximity”.

In the 1970s samples collected by Ambrose and Specht were ample to allow an initial separation of Willaumez Peninsula sources from those outside the region (Specht 1981, Specht and Hollis 1982; Bird et al. 1981a, 1981b, 1988; Duerden et al. 1987). In the late 1980s Specht was joined by Robin Torrence and Richard Fullagar who resumed the extensive mapping of obsidian exposures on the Willaumez Peninsula and Garua Island, collecting many obsidian samples from different points along their transects (Torrence et al 1992; Torrence et al. 1996, Summerhayes et al. 1998). They recorded whether the obsidian was in primary flows or secondary contexts, and also noted the quality of obsidian. In 1990 Fullagar, Summerhayes and Ivuyo, also successfully mapped the obsidian outcrops of the remote Mopir source, inland from Hoskins, New Britain (Fullagar et al. 1991). A number of flows were recorded, and samples taken for analysis.

In 1990, a total of 125 source samples from over 60 source localities from within the Talasea region, and 21 for the Mopir area (Fullagar et al 1991) were analysed using PIXE-PIGME. The machine conditions were refined with increased time for counting and an increased beam current of 300 nA, resulting in better results allowing five source groupings (see Summerhayes et al. 1993; Summerhayes et al. 1998). Table 1 outlines the source grid co-ordinates.

Table 1. Grid co-ordinates of obsidian sources.

OBSIDIAN SOURCE	LONGITUDE	LATITUDE
<i>WEST NEW BRITAIN</i>		
Kutau/Bao	149° 58' 54" E	5° 17' 24" S
Garua Is. Baki & Hamilton	150° 05' 15" E	5° 16' 10" S
Gulu	150° 02' 09" E	5° 13' 02" S
Mopir	150° 27' 29" E	5° 42' 09" S
<i>ADMIRALTIES</i>		
Lou Island	147° 22' 05" E	2° 23' 05" S
<i>D'ENTRECASTEAUX ISLANDS</i>		
Fergusson Island	150° 32' 0" E	9° 31' 0" S
<i>VANUATU</i>		
Gaua Island	167° 31' 32" E	14° 12' 32" S
Vanua Lava	167° 30' 56" E	13° 44' 22" S

2. Admiralty Sources

Obsidian occurs naturally at four major areas within the Admiralty Islands (Figure 4). As it will be argued that access to sources provides the key to obsidian selection in the Admiralties, some detail on each of the sources is provided here.

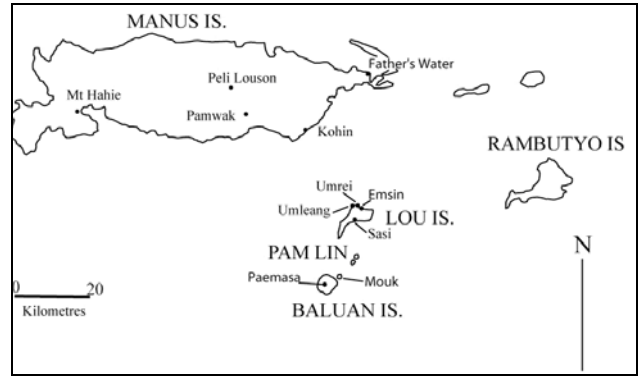


Figure 4. Admiralty sources.

1. Mt Hahie (Kennedy 1997; Bird et al. 1988). Obsidian from this source is not found outside the Southwest Bay area on Manus Island
2. Lou Island. Located 25 km south of Manus Island, Lou is about 12 km long and up to 6 km wide. It is of volcanic origin, with twelve volcanoes, five of which were formed in the last two thousand years (Ambrose and Duerden 1982:85; Ambrose et al. 1981). Three major volcanic events at 2100, 1960 and 1600 years ago obliterated human settlements and covered obsidian sources (Ambrose 1988; Ambrose and Duerden 1982:85; Ambrose et al. 1981). Several obsidian sources have been located on Lou, including Umrei and Wekwok where shafts to extract obsidian are found. At Umleang, Ambrose located 25 shafts, some up to 17 m deep (Ambrose et al. 1981:7). Use of these quarried shafts was probably limited to the last 400 years (Ambrose 1998; Ambrose et al. 1981:13; Fullagar and Torrence 1991). Permanent habitation was probably not possible on Lou prior to the introduction of agriculture.
3. Tuluman Island. Lying just south of Lou, this island was formed in 1954 and is not relevant here.
4. Pam Lin and Pam Mandian Islands. These two small islands are located just over 6 km south of Lou Island. On Pam Lin, which is just 500 m wide, obsidian occurs 2 m above sea level and is thus easily accessible. Ambrose et al. (1981) noted that obsidian from Pam Mandian was of poor quality.

Through extensive sampling and chemical analysis using PIXE/PIGME, Ambrose and his colleagues (Ambrose et al. 1981; Ambrose and Duerden 1982) identified the chemical signatures of the Admiralty Islands' sources. Collection from both source areas and archaeological deposits was made by Ambrose over many years. Ambrose submitted over 300 samples for chemical analysis in his bid to characterise the sources (Ambrose et al. 1981:7). The late Roger Bird, who pioneered the sourcing program with Ambrose, provided the original source data, and this has been refined by using improved machine conditions for the PIXE/PIGME analyses (Summerhayes et al. 1998). Obsidian from Umrei and Wekwok on Lou Island can be clearly separated from each other and from the nearby Pam Lin obsidian.

3. Fergusson Island

The third major obsidian source region in Papua New Guinea is found on and near Fergusson Island, which is part of the D'Entrecasteaux group (Figures 5 and 6). There are a number of outcrops of obsidian on Fergusson Island and the close offshore islands of Sanaroa and Dobu. Samples for earlier analyses were collected in the 1960s by Ian Smith, however, the PIXE-PIGME, density and ICP analyses were performed on samples collected and mapped by Ambrose in the 1970s.

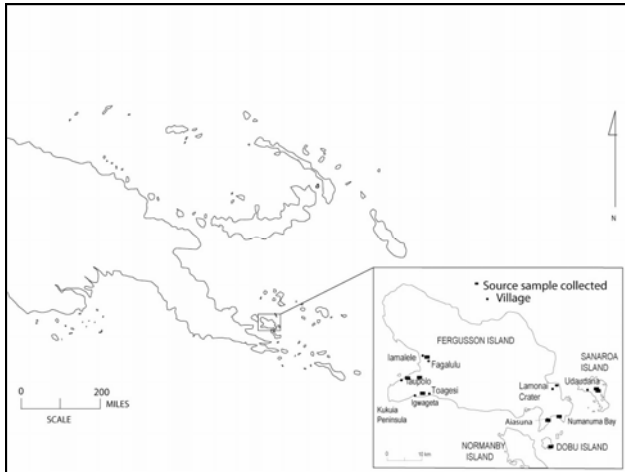


Figure 5. Fergusson Island sources.

The Fergusson obsidian exposures can be divided into Western and Eastern sources:

1. West Fergusson

Within West Fergusson obsidian sources were mapped and collected from two areas:

- The Kukuia Peninsula. Samples were collected from Igwageta, Iaupolo, and east of Iaupolo.
- The Fagalulu active thermal spring area produced cobble-sized obsidian.

2. East Fergusson

Within East Fergusson, samples were collected round three areas:

- Sanaroa Island, east of East Fergusson. Small obsidian clumps present on the surface as scattered ejecta from an explosive volcanic event (Ambrose et al. 1981:4). Obsidian from Sanaroa has not been found in archaeological collections.
- Aiasuna, (south side of Numanuma Bay). Samples were also collected on the other side of Numanuma bay.
- Lomonai. Samples were taken from coastal deposits at the foot of Mount Lomonai.

Samples were also collected from Dobu Island just to the south of East Fergusson. Dobu also contains obsidian flows, one of which was formed within the last 200 years (Smith 1973:11). Obsidian from Dobu has not been found in archaeological deposits.

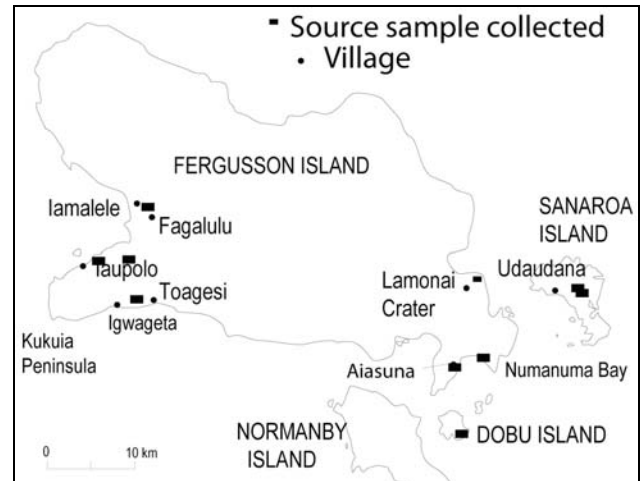


Figure 6. Close up of Fergusson Island sources.

As noted above, Fergusson Island obsidian has been characterised by a number of techniques including emission spectroscopy (Key 1968), XRF (Smith 1974, Smith et al. 1977; NAA (Wall 1976), and PIXE-PIGME (Duerden et al 1979; Bird n.d.). It is chemically distinct from other Melanesian obsidians. Within the Fergusson Island area, West Fergusson obsidian separates out from the East Fergusson sources and offshore islands with low fluorine counts. Within East Fergusson, there is variability within source locations, with Roger Bird noting widely varying compositions (Bird nd: 13). Bird distinguished a third chemical grouping of obsidian found in artefact collections with their closest affinity to the West Fergusson sources which he labelled XX. Table 1 outlines the grid co-ordinates for Fergusson Island.

VANUATU

4. Banks Islands

Obsidian occurs naturally on two islands of northern Vanuatu, Gaua and Vanua Lava. Up until recently we relied in samples collect for analysis by G. Ward (1979) as part of his PhD research into the archaeology of this region in 1973-5 (Figure 7).

- Gaua Island. Obsidian was found on the northeast of Gaua Island close to the rim of the volcanic crater, and also in 'detrital' form at Losalava Bay, next to the mouth of the river (Ward 1979:8-14). Ward collected samples from upper and mid slopes of the islands northeast (Bird et al. 1981a:55).
- Vanua Lava. Obsidian is located northwest of Losa Bay at a beach level flow, and from a nearby stream. Ward collected samples from these locations. Ward also noted that according to local informants, other obsidian sources were located on the island, but he did not have time to record them (Ward 1979:8-14).

Other forms of volcanic glass that sporadically occur in Vanuatu, however, are not present in the archaeological record and are of no use to us here. As noted above, sourcing was undertaken on Banks Islands obsidian using

XRF (Smith et al. 1977), NAA (Wall 1976), density (Ambrose 1976) and PIXE-PIGME (Bird et al. 1988; Duerden et al. 1986; 1987). The obsidian is easily distinguished from other obsidian sources by its colour and in some instances vesicles. Ambrose et al (1981) has described these glasses as pitchstones, which could produce small flakes. Smith et al. (1977:184) describe the Vanua Lava glass as being vesicular, while the Gaua glass is higher quality. Table 1 outlines the grid co-ordinates for these sources.

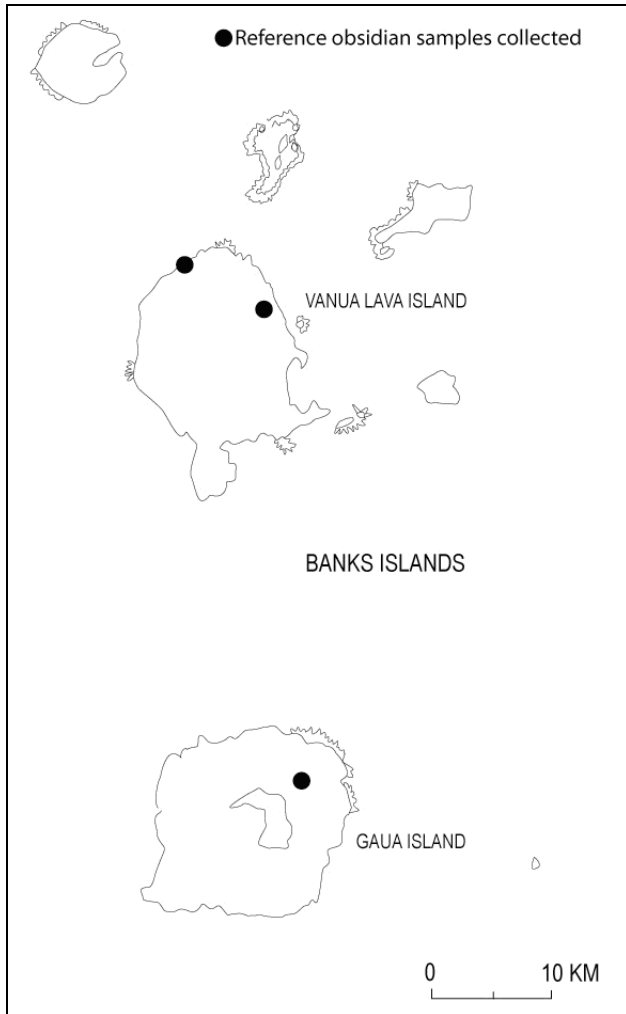


Figure 7. Banks Islands sources.

Work on the Banks sources has dramatically shifted gear with the recent research of Christian Reepmeyer, who as part of his PhD research has examined the Banks sources and chemically re-characterised them using ICP-MS and EDXA-SEM. Sampling from roughly the same areas as Ward, Reepmeyer analysed 29 samples from the source areas and confirmed the chemical separation between the two source areas with a high intrasource homogeneity for both (Reepmeyer 2008:125).

OBSIDIAN DISTRIBUTIONS

Pleistocene – 20,000 years (Figure 8)

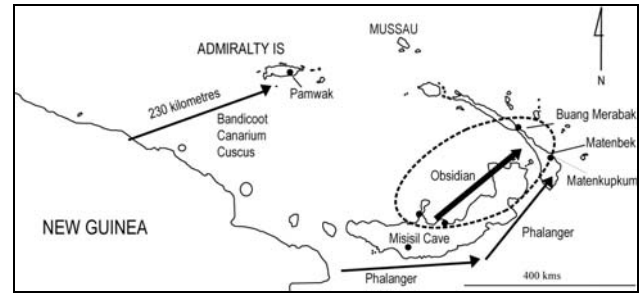


Figure 8. Distribution of obsidian – late Pleistocene.

The first evidence for the extraction and distribution of obsidian is found in the late Pleistocene site of Matenbek, New Ireland (Summerhayes and Allen 1993). In the bottom units dated to between 20,000 to 18,000 years ago, nearly eighty-percent of obsidian came from the Mopir source and the rest from Talasea sources. Matenbek lies over 350 kilometres from the nearest Mopir obsidian source, and just over 400 kilometres from the Talasea sources. The persistent deposition of obsidian over 2,000 years suggests repeated crossings of the St George straight separating New Britain and New Ireland. The distribution of obsidian is best explained by the “extraction of obsidian from the closest available source, and subsequent down the line exchange between semi-sedentary populations” (Summerhayes and Allen 1993:147). This would account for the small appearance of Talasea obsidian and the dominance of Mopir in this assemblage. Obsidian from the late Pleistocene assemblage of Matenkupkum, also from New Ireland, dating from c.16,000-10,000 BP also displays the same proportion of obsidian from the Mopir and Talasea sources. This behaviour continues up till 3,300 BP when Lapita ceramics appear on the scene (see below). Another assemblage from New Ireland, Buang Merabak, has obsidian from 20,000 years ago, however, the results of recent sourcing are still not available (Leavesley and Allen 1998:72), but will be published soon by Leavesley (pers. comm).

Evidence of obsidian use in late Pleistocene sites from New Britain is found from two sites. From Misil Cave, located in the centre of the island, both Mopir and Kutau/Bao obsidian is found (Summerhayes et al. 1998). Given its closeness to both sources, the equal representation of these sources at Misil is expected. A similar situation where distance to the source determines the amount of obsidian seen within a site is seen at Kupona na dari, site code FABM, located at the base of the Wilaumez Peninsula. The site is located on a small hill just 500 metres from the coast and could be older than 20,000 years and perhaps more like 35,000 BP according to its excavator (Torrence et al. 2004). The oldest radiocarbon (AMS) dates were only Holocene in age. Luminescence

dating provided age estimates of 38-39,000 years ago (Torrence et al. 2004:116). Fission Track dating was also undertaken on obsidian. The first occupants exploited obsidian sources near to hand, and the amount of obsidian was related to the sources distance from the site. At its earliest levels both Mopir and Gulu obsidian were found, with Kutau/Bao making an appearance towards the terminal Pleistocene/early Holocene Boundary (Torrence 2004:119). This suggests an older date for the assemblage as Kutau/Bao was only formed just prior to 20,000 years and is the more recent flow according to fission track dating (Bonetti et al. 1998).

The first appearance of obsidian in New Ireland at 20,000 years ago occurs at the same time as other translocations such as cuscus (*Phalanger orientalis*) being transported from mainland New Guinea to New Ireland via New Britain. It is argued that the movements of obsidian and animals across New Britain into New Ireland is the result of an increase in population levels among low density mobile hunter-gatherers, the development of territories and group boundaries leading to a threshold being crossed in the nature of societal interactions and the movement of goods (Summerhayes 2007).

The late Pleistocene also witnessed the first exploitation of Admiralty obsidian and use on Manus at the end of the Pleistocene (Fredericksen 1997a, 1997b, 2000). Obsidian from the unknown source from Lou Island, called source X, first appeared at Pamwak in terminal Pleistocene contexts at c.13,000 BP contexts. Again, this is testimony to use of sea craft with this obsidian extracted from the small nearby island sources and transported some twenty-five kilometres to mainland Manus (Ambrose 1997:532; Summerhayes 2003a). The appearance of obsidian here also occurs with the movement of animals from mainland New Guinea at 12,000 years ago, such as the bandicoot and another species of cuscus (*Spilosocus kraemeri*), and the introduction of canarium nut trees (Spriggs 1997:54).

Early to mid-Holocene (Figure 9)

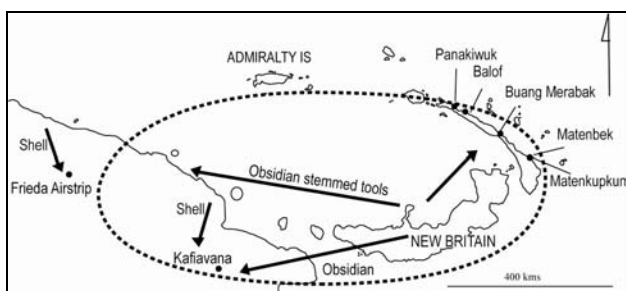


Figure 9. Distribution of obsidian – early to mid Holocene.

The early to mid Holocene sites from New Ireland such as Matenbek continue with a dominance of Mopir obsidian (Summerhayes and Allen 1993:147). Other assemblages, such as Panakiwuk and Balof have obsidian from Talasea, albeit in a very small quantity. A number of sites from this time-span are found from West New Britain, around

the Willaumez Peninsula and Kandrian, and a single site from the Arawe Islands, Lolmo Cave (Summerhayes et al. 1998; Gosden et al. 1994). Those sites on the Willaumez Peninsula have a dominance of West New Britain obsidian, as would be expected being located close to the source outcrops. Those from Kandrian and Lolmo Cave from the Arawes have an equal proportion of Mopir and Talasea obsidian that is expected as the sites are equidistant to both source regions.

During this time period, beginning about 6000 years ago, formal obsidian tool types appeared in assemblages from the north coast of New Britain, being made from a number of sources including Kutau/Bao, Gulu, Baki and Mopir. These “stemmed tools” (Araho et al. 2002) are further evidence of the mobile nature of groups of people using and extracting obsidian from the source closest to hand (Torrence and Summerhayes 1997). Their territories ranged from the major source areas of Willaumez Peninsula to Mopir sixty kilometres away (see Figure 3). Sourcing of stemmed tools found from the Mopir region demonstrate they were made using Mopir obsidian, while identical tools found near the Willaumez Peninsula were made using Kutau/Bao, Baki or Gulu sources. Of interest are the stemmed tools from the interior of New Britain and the south coast that were also made from the available local rocks, not obsidian but chert. Excavations from Yombon have shown that like the obsidian stemmed tools from the north coast, stemmed chert tools appear about 6,000 years ago, although chert had been exploited for stone tool use (as expedient flakes), since the site was first occupied from 35,000 years ago (Pavlidis 1993; Pavlidis and Gosden 1994).

What were these stemmed tools used for? Torrence et al. (2000:235-237) and Fullagar (1993) argue that they were used for plant processing and had to be prepared in advanced and carried round until groups visited the source again. A recent study has however argued that some forms of stemmed tools, similar to those found on the north coast of New Guinea, may have had ceremonial functions as well (Araho et al. 2002). Whatever their function, stemmed tools disappeared under a blanket of ash produced by the eruption of Mount Witori located adjacent to the Mopir obsidian source. The impact of the eruption devastated populations in this entire region with Yombon resettled 800 years after this eruption, and the Willaumez Peninsula 250 years later (Torrence et al. 2000).

Identical ‘stemmed tools’ are also found in a couple of contexts from the north coast of New Guinea. Swadling reports the finding of three stemmed obsidian tools from the Sepik-Ramu all sourced to the Kutau/Bao source in West New Britain (Swadling and Hide 2006; Swadling 1990). Obsidian from New Britain is also making its way across the Vitiav Strait to the mainland and then into the highland region of New Guinea. Obsidian was found at Kafiavana in the eastern highlands in contexts dated to 4500 B.P. (White 1972). One stemmed tool has been supposedly found from surface contexts in a cave site from Biak Island, and is in private hands in an American

collection (Torrence and Swadling 2008). It was sourced using PIXE-PIGME and ICP-MS to Umleang, Lou Island, leading Torrence to note that obsidian from Lou Island could have made its way to New Britain to be hammer dressed and shaped into stemmed tool (Torrence and Swadling 2008: 612). Torrence and Swadling argue that it is “reasonable to assume that the distribution of obsidian stemmed tools signals social interaction between widely spaced Lou and Garua islands and possibly also across the entire distribution of obsidian stemmed tools” (2008: 612). Stemmed tools from secure archaeological contexts along the north coast of New Guinea are needed to confirm these surface collections findings.

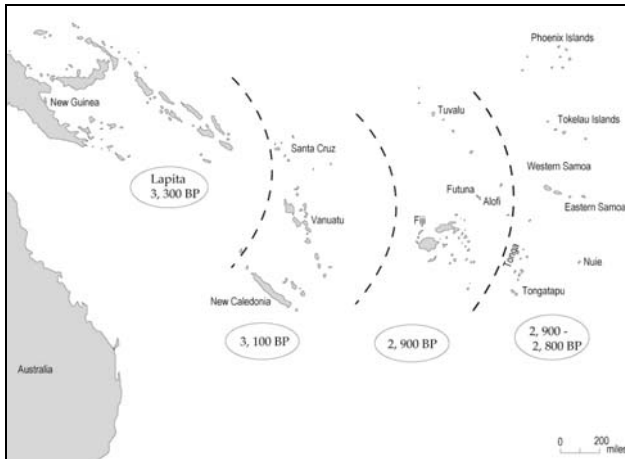


Figure 10. Distribution of the Lapita advance across Melanesia.

The early Holocene period in the Admiralties witnessed the first exploitation of Pam Lin sources. In the middle Holocene, Pam Lin eventually replaced an unknown Lou Island source ('source X') as the main supplier of obsidian to Pamwak (Fredericksen 1997a:72). This source X first appeared at Pamwak in terminal Pleistocene contexts. Two dates for the transition from source X to Pam are 6280+250 (ANU 7122) and 7940+90 BP (ANU 8239) (Fredericksen 1997a:72). This transition occurred at the time when obsidian from Wekwok first appears at Pamwak. The transition also underlies a midden layer with a dense concentration of obsidian that suggests a change in economic strategies, with a much greater use of obsidian from Pam Lin (Fredericksen 1997a:71). Lou Island obsidian occasionally occurs in early Holocene contexts, but the first significant amounts appear only in the top levels. These levels, unfortunately, cannot be dated accurately, with Fredericksen (1997a:71-72) narrowing the increase in Lou only to the period after the introduction of Pam and before the use of pottery of a post-2000 BP style.

Lapita – 3300-2200 B.P.

This period of time witnessed the widest distribution of obsidian the world has ever seen and was associated with the colonisation of Remote Oceania by Austronesian speaking peoples. The archaeological signature for the

colonisation of the islands east of the main Solomon chain is Lapita pottery, a component of which is made up of highly ornate decorated ware with intricate dentate stamp impressed designs. Obsidian from sources in the Bismarck Archipelago is also found in these earliest settlements to the east, being found in the Reef/Santa Cruz islands, Vanuatu, New Caledonia and Fiji, 3000 kilometres to the east. Figure 10 shows the progression of settlement in the Bismarck Archipelago at 3300 BP, the Solomon Islands New Caledonia and Vanuatu by 3100-3000 BP, Fiji by 3000 BP and Tonga and Samoa by 2900 BP. Although the bulk of obsidian leaving the Bismarck Archipelago was from Kutau/Bao, the area witnessed the first export of Admiralty Islands obsidian, and also the first use of Banks Islands obsidian, which had a restricted local use (see below).

Bismarck Archipelago obsidian is also found to the west in the site of Bukit Tengkorak in south-eastern Sabah, Malaysia, in contexts dated to 3300-2800 BP (Bellwood pers.comm.). Although previously published as by Bellwood (1989:129) as between 2300 to 2700 bp, this has been revised by Bellwood. Five pieces have been sourced to Kutau/Bao using PIXE-PIGME (Bellwood and Koon 1989). Kutau/Bao is located 3,500 kilometres distant. A subsequent electron microprobe analysis of re-excavated obsidian from the same site also found Kutau/Bao obsidian in association with obsidian from the Admiralty source of Umrei (Tykot and Chia 1997), (Figure 11). This extends the range of Bismarck Archipelago obsidian to over 6,500 kilometres!

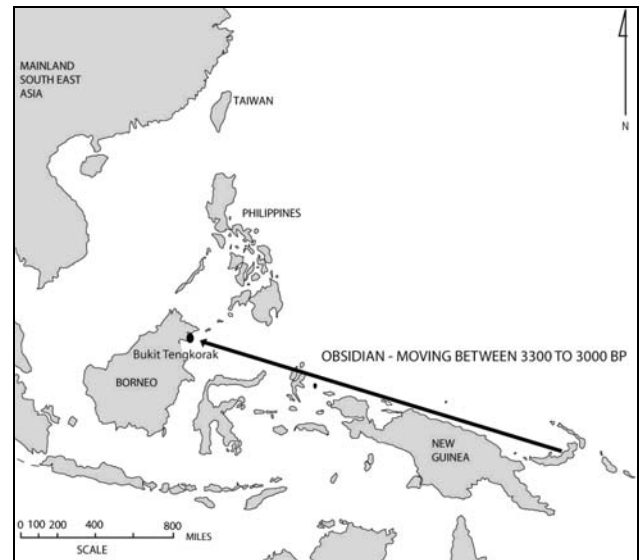


Figure 11. Distribution of obsidian to Sabah, East Malaysia.

Temporal differences in source selection and distribution

Within this wide distribution there were chronological differences in the selection and distribution of obsidian from source areas. This is best illustrated in the Bismarck Archipelago where the development of two spheres of obsidian distribution occur over time, with the southern network evident out of west New Britain preceding a

northern west to east network evident out of the Admiralties. While west New Britain obsidian has a 20,000 year history of movement outside its immediate natural source area (Summerhayes and Allen 1993), the Lapita period marks the first occurrence of Admiralty Island obsidian outside the Admiralties. In the Early Lapita phase (3300-3000 BP), west New Britain obsidian dominated in all Bismarck Archipelago assemblages (Figure 12). This pattern changes in the Middle Lapita phase (3000-2800 BP) when Admiralty obsidian dominated in the eastern Bismarck Archipelago assemblages of Mussau, New Ireland and the tip of east New Britain, plus the Lapita sites from Buka (Figure 13). On Buka, North Solomons, Lapita's presence is later in time, with occupied sites starting from 2760 BP (Wickler 2001:178-179). Wickler had over 300 obsidian pieces from his reef sites and twenty-one pieces from excavated sites sourced at the ANU by Wal Ambrose using density measurements. With the exception of a handful, close to 90% were allocated to Admiralty sources.

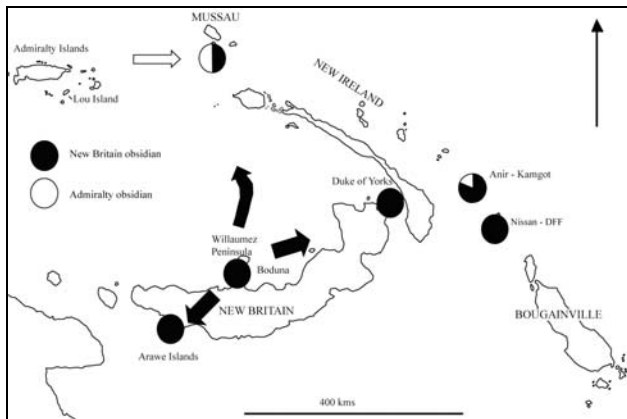


Figure 12. Distribution of obsidian in the Bismarck Archipelago: Early Lapita.

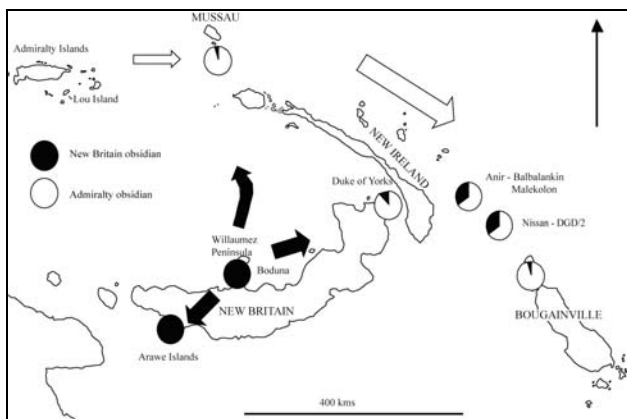


Figure 13. Distribution of obsidian in the Bismarck Archipelago: Middle Lapita.

West New Britain obsidian still dominated in most of the west New Britain assemblages. This pattern continues for Mussau and northern New Ireland but changes for the east New Britain assemblages where west New Britain

sources dominated again from the Late Lapita phase onwards (2700-c.2200 BP) (Figures 14 and 15; Summerhayes 2003b; 2004). A model to account for these changes will be presented after the discussion on obsidian distribution into Remote Oceania.

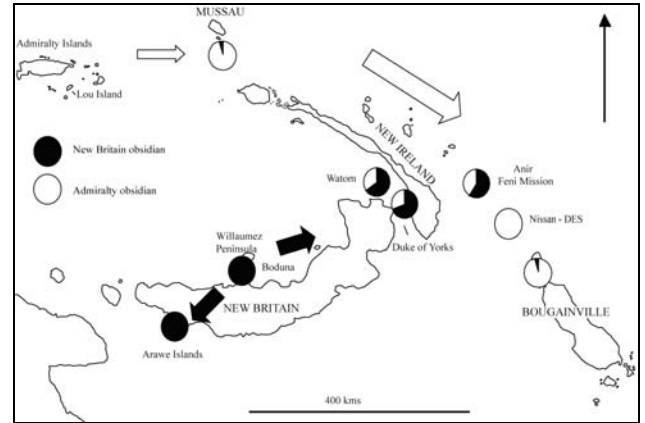


Figure 14. Distribution of obsidian in the Bismarck Archipelago: Late Lapita.

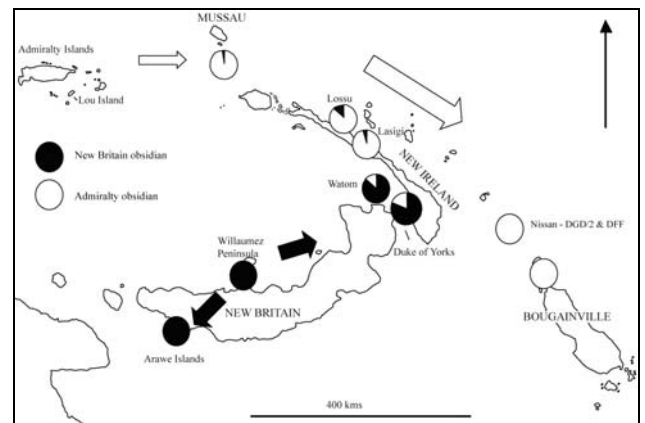


Figure 15. Distribution of obsidian in the Bismarck Archipelago: Post Lapita.

Intra-source selection

Also of importance is the selection of sources within the respective source regions. Within west New Britain it is obsidian from one source, Kutau/Bao, that was selected for export out of this region during the Lapita periods. Even at archaeological sites such as FSZ or FAO that are located close to or on top of other natural obsidian sources such Baki on Garua Island, it is the Kutau/Bao obsidian that dominated. Obsidian from, Mopir, some 60 kilometres east from the Kutau/Bao source, was not generally associated with Lapita assemblages however it made an appearance in the later Watom Lapita assemblages. Although Mopir obsidian has a history of use going back to 20,000 years ago (Summerhayes and Allen 1993), its production ceased temporarily at c.3480(3350)3150 cal BP (Petrie and Torrence 2008) when the nearby volcano, Witori, erupted covering the site and causing devastation hundreds of kilometres away (Torrence et al. 2000,

Torrence 2002; Summerhayes and Hotchkis 1992). It is argued elsewhere that the selection and distribution of Kutau/Bao obsidian when other sources would have been available such as Gulu and Baki, was based on social factors and not ease of access or quality of obsidian (Torrence and Summerhayes 1997). That is the obsidian exports were controlled from the source region, suggesting the exchange of specialised goods, thus lending weight to Sheppard's (1993) notion of the social value of obsidian in exchange. This is different to what went before and after the Lapita period where distance to the source was the major factor determining source selection (Summerhayes et al. 1998: 147-150). Thus the selection of obsidian from the source area was a social one, as was the distribution of obsidian out of the source area to different parts of the western Pacific.

Within the Manus sources, there is no major change in obsidian extractive behaviour for consumption within the Admiralties with Pam obsidian dominating. The only changes are with the selection of Umrei obsidian for distribution eastwards outside the Admiralty Islands in the Early Lapita period at 3300 BP, and the selection and westwards movement of Umrei and Pam obsidian in equal proportions, to northern New Guinea by 1300 BP (Summerhayes 2004).

Distribution of obsidian to Remote Oceania (Figure 16)

The Remote Oceanic Lapita sites from the Reef Islands and Santa Cruz, located in the southeast Solomons, contained mostly Kutau/Bao obsidian (97%), with a handful of obsidian from Umrei and the Banks source of Vanua Lava (Green 1987). One piece from Kukuia, west Fergusson was also found in the Reef Santa Cruz site of RF-2, located over 2,000 kilometres away (Green and Bird 1989). Sheppard (et al. in press) has chemically reanalysed this assemblage using a portable XRF and has confirmed the earlier results which demonstrated a dominance of Kutau/Bao obsidian.

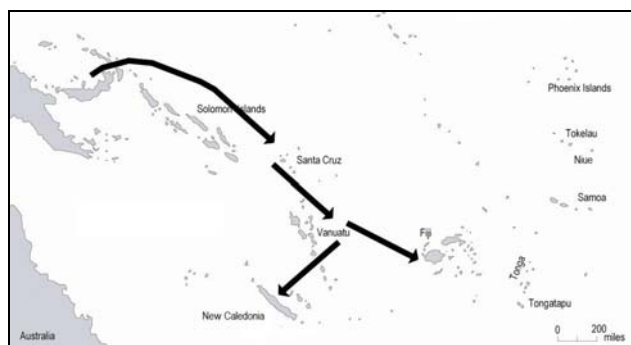


Figure 16. Distribution of obsidian – Remote Oceania Lapita.

East of the southeast Solomon sites it was thought that obsidian was not common. For instance from New Caledonia only a handful of pieces have been found in Lapita contexts from New Caledonia and the Ile de Pins (sourced to Kutau/Bao, West New Britain - Sand and Sheppard

2000). Yet exciting new research at two sites in Vanuatu is changing all this.

The first site is the Makué, on Aore Island, adjacent to Malo Island. Previously less than a dozen obsidian pieces were found on Malo Island (sourced to West New Britain, Admiralties and the Banks - Ambrose 1976), however work by Galipaud at the Makué site has uncovered 87 pieces from excavations, which were analysed using relative density methods by Swete-Kelly and determined to originate from mostly sources from the Willaumez Peninsula, west New Britain, with a minor component (n=22) to either the Banks Islands or Admiralty sources (Galipaud and Swete-Kelly 2007a and b). A chemical analysis on this obsidian will resolve the issue of Banks Islands or Admiralty sources. Galipaud argues that the site was occupied by at least 3200 BP, however after reviewing the published ages (Galipaud and Swete-Kelly 2007b: Table 1) an initial occupation age of 3100-3000 BP is more satisfactory.

The second site from Vanuatu that is rewriting the history books is Teouma on the south coast of Efate (Bedford et al. 2006). Like the Makué, the first occupation of Teouma probably took place by 3100-3000 BP. Also, like the Makué site, and the Lapita sites from the Reef/Santa Cruz Islands, the majority of obsidian is from Kutau/Bao (Reepmeyer et al. in press). Fifty-six pieces of obsidian were recovered from Teouma, and the majority were sourced to Kutau/Bao using LA-ICP-MS. Only six were sourced to the Banks Islands, and one was identified from Mopir (Reepmeyer et al. in press).

A site later in time than Makué, Teouma and the earliest assemblages from the Reef/Santa Cruz islands is Tikopia. Obsidian from Tikopia although first reported from Talasea sources (N=4) and Bank Islands (n=9) (Kirch and Yen 1982) have been re-analysed using PIXE-PIGME and are now known to originate predominantly from Banks Island sources (Vanua Lava and Gaua) with three pieces from Manus (from Umrei on Lou Island and Pam Lin) (Spriggs 1997; and Spriggs et al. in press).

The last obsidian to be described is from Fiji. Two pieces of obsidian from Naigani and a single piece from Bourewa were sourced to Kutau/Bao, west New Britain (Best 1987; Nunn 2007). It is argued that the dominance of west New Britain obsidian in these Remote Oceanic assemblages is a result of the initial colonisation phase out of the Bismarck Archipelago. Once this colonisation phase petered out, continued contact with the Bismarck Archipelago occurred later as evident by the dominance of Admiralty obsidian on Tikopia. The presence of Admiralty obsidian in Late Lapita contexts suggests continued infrequent contact with the west.

Volcanic glass is being imported into Fiji from non-Melanesian sources. Best reports only twenty flakes from Lakeba. Five flakes from early deposits are from Tafahi Island (Tonga), while those from later contexts were argued to have been from the Banks Islands, Vanuatu (1987:31). A re-analysis of these obsidian pieces using LA ICP-MS, however, has shown they probably came

from local unknown sources and not the Banks (Reepmeyer and Clark in press).

Modelling changes in obsidian distribution patterns

Why was there a change in the temporal distribution of obsidian from west New Britain and the Admiralties sources during the Middle Lapita phase? The answer lies in the populating of the Pacific and changes in settlement mobility. The association of west New Britain obsidian with the initial spread of Lapita communities into and out of the Bismarck Archipelago occurred when these societies or individuals within it were the most mobile, during what Irwin (1991) calls a “colonisation” phase. The dominance of west New Britain obsidian in these early assemblages could be an expression of the direction of initial impetus for Austronesian expansion which on linguistic grounds came from the west New Britain region (see Lilley 1990, Ross 1988). The distribution of this west New Britain obsidian could have been a result of either direct procurement or the movement of obsidian through a smaller number of hands (see below a description of technological changes). The subsequent movement of obsidian into Remote Oceanic sites was argued as an indicator of a formal exchange network that was an adaptive mechanism in the colonisation process forming a ‘lifeline’ back to a homeland (Kirch 1988). In this context exchange is an adaptive strategy for colonists moving east and a means of maintaining social ties (Green 1987). When this lifeline is no longer needed then exchange with homeland areas would cease.

Yet was the demise of ‘exchange’ the prime mover for changes in the distribution of some items of material culture? It could be argued that exchange - the movement of items - is epiphenomenal to the movement of people who were needed in the successful colonisation movement during the Early Lapita phase. Once the western Melanesian area was occupied during the Middle Lapita phase, there is a lessening of people movement back in the Bismarck Archipelago homeland communities, reflected in changes in the production of pottery and the distribution of obsidian (see Summerhayes 2003b). The appearance of two obsidian distribution networks with Admiralty Island obsidian making a major appearance could be explained as a product of down the line exchange – i.e. closeness to the source determined the amount of obsidian within a site arising out of a change in the mobility of these Lapita peoples. A model involving the association of a mobile Lapita society with a dominance of west New Britain obsidian, and a less mobile (stable) society with the appearance of two obsidian distribution networks is one that needs more attention. Note that changes in mobility do not equate to a cessation of interaction between these communities in the Bismarck Archipelago and those further east in the western Pacific. Similarities in changes to material culture such as the pottery are argued to be the product of information exchange that necessitates the movement of people and ideas (Summerhayes 2000). Communication between these far-flung communities still existed after the coloni-

sation phase in western Melanesia was over.

Technological studies on Lapita obsidian assemblages have helped shed light on changes to distribution mechanisms. A change to down the line exchange can be seen in the few technological studies of obsidian assemblages. Earlier Lapita assemblages show an expedient technology not seen in the earlier pre-Lapita or later assemblages away from the source regions (see Summerhayes 2004). Hanslip’s (2001) work is important here. Hanslip (2001:196) argues that the earliest assemblages from the Reef Islands and Santa Cruz, RF-2 and SZ-8, which are also part of the colonising phase, not only had the largest pieces of obsidian and lacked bipolar flaking, but also showed no signs of on-site production. That is, the material was imported as is, not as blocks. Such an expedient technology is not expected from a down the line exchange network. Furthermore, Specht (2002:42) shows that the earlier Lapita assemblages had heavier pieces of obsidian (mean weights) and from the one site where data is available (Adwe) there is a decline in this mean weight over time in the Middle Lapita period. Taken together the reduction in the size and weight of obsidian could be indicative of an “economising” behaviour associated with later down the line exchange.

The Early Lapita phase is, however, more complicated as the recent results by Swete-Kelly (2001) show. Swete-Kelly’s analysis on obsidian from Anir shows that although obsidian from the Middle Lapita assemblage of Balbalankin was heavily reduced, indicative of an economising behaviour, the Early Lapita assemblage of Kamgot also showed a heavy reduction, unlike the Arawe Islands and Reef Islands and Santa Cruz material. Obsidian from Malekolon, on Anir, was also said to be heavily reduced (Ambrose 1976, 1978). This suggests a more complicated picture where different distribution mechanisms of obsidian, such as direct procurement and down the line exchange, were occurring during the Early Lapita phase in the Bismarck Archipelago. Modelling the behaviour behind these differing distribution and use patterns needs more technological analyses on Lapita obsidian assemblages. Results from the Early Lapita assembles from Mussau are eagerly awaited.

4. Last 2200 years.

There are a number of major changes to the procurement and distribution of patterns of obsidian during the last two millennia.

After about 2,200 years ago, the archaeological evidence from assemblages in Melanesian Remote Oceania suggests the beginning of regionalisation. This is reflected in the cessation of obsidian transfer from the Bismarck Archipelago into this region. Local Banks Island obsidian is still in use for local consumption, but nothing is moving further south into Vanuatu in association with later Mangaasi ware.

Obsidian from the Admiralties continues to be exchanged to New Ireland, and obsidian from New Britain continues to be distributed to other parts of New Britain and southern New Ireland (Figure 17). Small amounts

also reach northern New Ireland, however, these diminish over time (Summerhayes 2004). The obsidian is mostly from the Kutau/Bao source, however, the other sources, including Mopir are moving again in similar proportions that existed before Lapita suggesting a return to down the line exchange (Summerhayes et al. 1998).

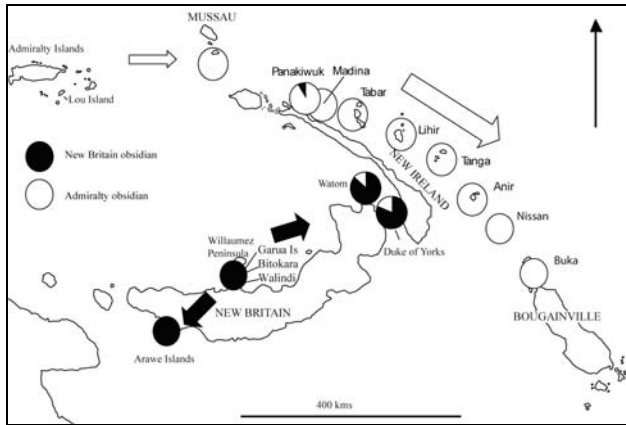


Figure 17. Distribution of obsidian in the Bismarck Archipelago: last 2000 years.

There is an increase in the number of mainland New Guinea sites containing west New Britain obsidian (see White 1996; Watson 1986). Within the recent past obsidian was exchanged by the Siassi traders from New Britain to mainland New Guinea, and from there to various exchange networks along the coast and into the highlands. Obsidian from Kutau/Bao (sources using PIXE-PIGME by Summerhayes) is also found along the north coast of New Guinea such as the Aitape and Wewak regions, including offshore islands (Terrell and Welsch 1997).

There is also an increase in Admiralty Island obsidian reaching the north coast of New Guinea (Summerhayes 2003a). Admiralty obsidian is found in contexts dated to 1600 BP from Tumleo, where Pam Lin (42%) and Umrei (50%) make up the majority of obsidian, and Wekwok found in minor amounts (Summerhayes 2003a). Admiralty obsidian is also found as far as Biak in Irian Jaya (Ambrose pers.com; Torrence and Swadling 2008), and in surface collections from the north coast of New Guinea (Terrell and Welsch 1997; Ambrose 1978).

Finally, Fergusson Island obsidian makes a major appearance on the scene. It should be noted obsidian from Kukuia and Fagalulu, west Fergusson, were the dominant sources used in obsidian distribution. Apart from one obsidian flake found from a southeast Solomons Lapita site (Green and Bird 1989), Fergusson obsidian is not found in archaeological assemblages before 2,000 years ago. It is first found in the Papuan Gulf sites of Oposisi and Ape Venua (Vanderwal 1973:214), Nebira 4 and Mailu in contexts between 2,000 to 1,600 years ago. This marks the colonisation of the south Papuan Coast by Austronesian speakers and descendants of the early Lapita populations (Bird et al. 1981a and b; Green and Bird 1989; Ambrose 1976, Irwin and Holdaway 1996).

Changes in the nature of obsidian reaching Mailu informs us about the nature of interaction among these communities. The obsidian found in these early sites is technologically different from later assemblages indicating different distribution processes. Technological studies on the obsidian assemblages from the eastern Gulf of Papua showed that the earlier 'colonising phase' in Mailu had heavier obsidian than later periods, which is "incidental to the high frequency of communication among related communities undergoing a phase of expansion" (Irwin and Holdaway 1996:228). This is different to obsidian reaching Mailu in what Irwin called a later "trader mode" (Irwin 1991:506).

Fergusson Island obsidian is also found in the closer mainland sites of Wanigela which is dated to the last 1,000 years and also in ethnographic accounts (Egloff 1971; 1979).

FUTURE DIRECTIONS

Major changes are needed for the study of obsidian from the western Pacific. Firstly, there is a need to diversify and use other analytical techniques to characterise the obsidian. PIXE-PIGME which is the primary technique used today, is only available at one research establishment, the Australian Nuclear Science and Technology Organisation (ANSTO). There is a need to use techniques that are readily available at a number of universities around the world, such as ICP analysis. This would ensure that obsidian sourcing is more widely available and also as insurance against closure of the technique at ANSTO. Progress has already been made with establishing chemical signatures of Melanesian obsidian sources using Laser Ablation ICP analysis (Ambrose et al 2009; Reepmeyer 2008), and portable XRF (Sheppard et al. in press). The recent purchasing of hand held XRF machines at a number of Australasian institutions is promising.

Secondly, the development of new machine conditions should go hand in hand with an increase in archaeological research directed to fill in those chronological and spatial black holes in our knowledge of the region. In particular we need more obsidian assemblages from mainland Papua New Guinea covering all time periods, and assemblages from the last 2,000 years from all regions. In short, the direction of obsidian sourcing programs should be directed towards solving archaeological problems.

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