

The Nature of Prehistoric Obsidian Importation to Anir and the Development of a 3,000 Year Old Regional Picture of Obsidian Exchange within the Bismarck Archipelago, Papua New Guinea

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ABSTRACT. The results of obsidian sourcing studies from the Anir Island assemblages are presented and compared with other studies to develop a regional picture of obsidian distribution and use over a three and a half thousand year period for the Bismarck Archipelago, Papua New Guinea. Predicted changes in technology and mobility patterns are correlated with regional changes in the frequency and distribution of obsidian from particular sources in the region. Early Lapita assemblages in most parts of the archipelago were dominated by west New Britain obsidian. In the Middle Lapita period changes occurred in the northern and eastern Bismarck Archipelago and assemblages here became dominated by Admiralty Islands obsidian. In later periods, west New Britain obsidian re-gained dominance in some areas. Nevertheless, in the Lapita phases pottery assemblages suggest exchange was between culturally similar, socially related groups.

SUMMERHAYES, GLENN R., 2004. The nature of prehistoric obsidian importation to Anir and the development of a 3,000 year old regional picture of obsidian exchange within the Bismarck Archipelago, Papua New Guinea. In *A Pacific Odyssey: Archaeology and Anthropology in the Western Pacific. Papers in Honour of Jim Specht*, ed. Val Attenbrow and Richard Fullagar, pp. 145–156. *Records of the Australian Museum, Supplement 29*. Sydney: Australian Museum.

Tracing the transport of obsidian in Melanesia's past has played an important role in identifying prehistoric exchange networks and understanding levels of interaction between communities (Ambrose, 1976, 1978; White, 1996). Obsidian has a naturally restricted occurrence. In the Bismarck Archipelago it is found in three regions: the Admiralty Islands, the Willaumez Peninsula and Mopir (Fig. 1). Within both the Admiralty Islands and the Willaumez Peninsula sources, 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.

The earliest evidence for the movement of obsidian in this region comes from Matenbek, a cave in southern New Ireland. Obsidian flakes found in contexts dated to 20,000 B.P. were sourced to outcrops in west New Britain, a distance of 350 km in a straight line (Summerhayes & Allen, 1993). For the next sixteen and a half thousand years obsidian was transported from its source areas to a number of sites in New Britain and

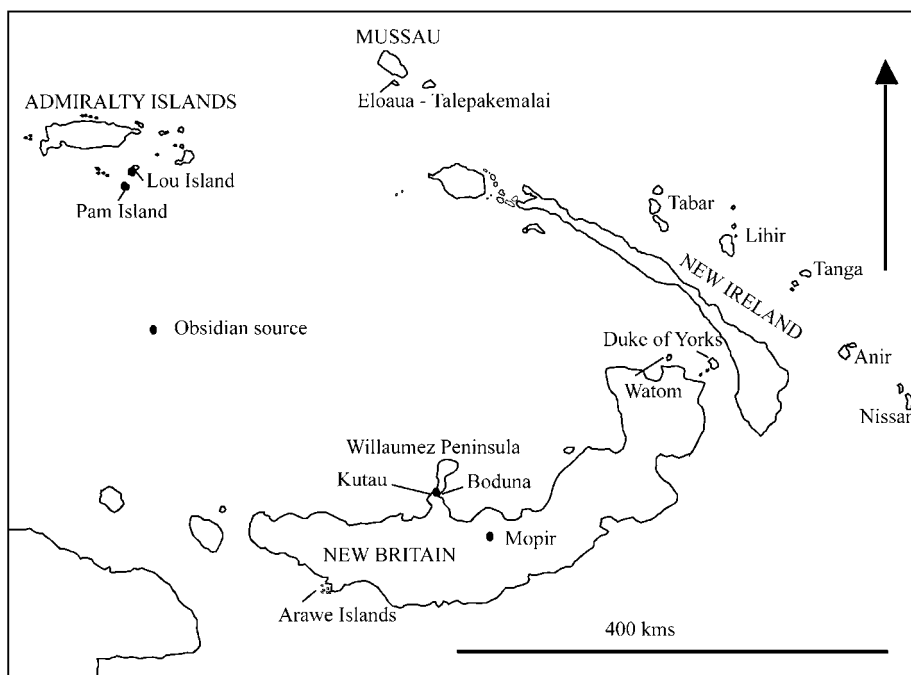


Fig. 1. The Bismarck Archipelago showing obsidian sources and archaeological sites.

New Ireland, within the Bismarck Archipelago. Obsidian was also transported within the Manus Islands from the terminal Pleistocene (Fredericksen, 1997). This restricted distribution of obsidian was to change in the latter part of the fourth millennium B.P. when people left the Bismarck Archipelago and colonized Remote Oceania for the first time.

The archaeological signature for the colonization of the islands east of the main Solomon chain is Lapita pottery, a 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. To the west, obsidian of a similar age has been found in sites in Sabah, Malaysia (Bellwood & Koon, 1989; Bellwood, pers. comm.). This extends the range of obsidian movements to over 6500 km. The identification of Bismarck Archipelago obsidian in Remote Oceanic sites was seen by Kirch (1988a) as an indicator of a formal exchange network that was an adaptive mechanism in the colonization process forming a “lifeline” back to a homeland (see also Green, 1976; 1979: 45; 1987: 246). In this context, exchange is an adaptive strategy for colonists moving east (Kirch, 1987) and a means of maintaining social ties (Green, 1987).

To further explore such models, however, the nature of the regional distribution of obsidian within the Bismarck Archipelago itself needs to be better understood. This paper aims to do this by first describing the way that importing obsidian to the Anir Islands in New Ireland Province changed in nature over time, and second, examining how the trends identified on Anir fit the regional picture of obsidian distribution. Excavation of the archaeological assemblages from Anir and characterization of the obsidian were undertaken by myself. The results of the characterization analysis are presented here. The Anir fieldwork is part of a larger project the aims of which are to assess the significance of exchange and the nature of interaction in the colonization of the western Pacific and its role in maintaining cohesion between far flung communities (Summerhayes, 2000b).

The Anir assemblages

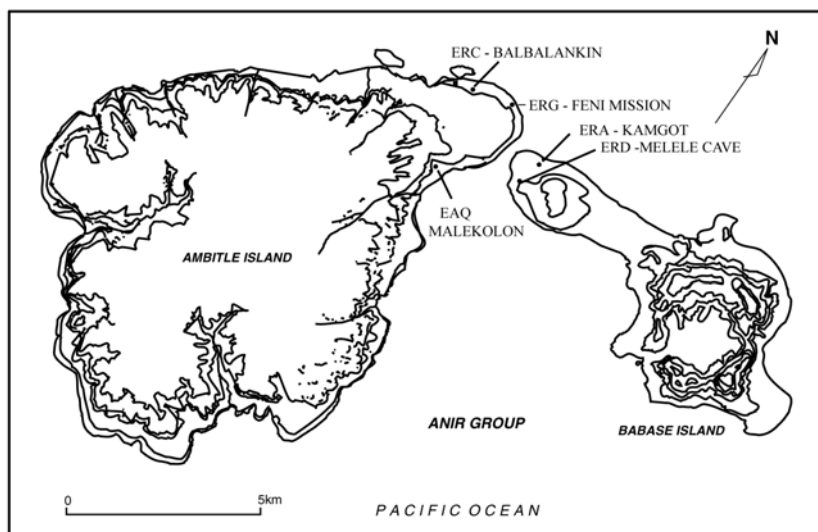
Anir is composed of two islands, Ambitle and Babase, located 60 km off the southeast coast of New Ireland (Figs. 1 and 2). Fieldwork undertaken on Anir since 1995 has identified four Lapita sites where excavation found Lapita pottery in association with obsidian and shell artefacts (see Summerhayes, 2000b for further details of excavations; and Summerhayes, 2001a for a detailed listing of all radiocarbon determinations from Anir given in this paper).

Kamgot—ERA. On Babase Island, a major Lapita site was located near Kamgot village (site code ERA). The site is large, extending over 400 m in an east-west direction, and 60 m in a north-south direction. Twenty test pits were excavated over three field seasons with over 20,000 sherds and 1,000 pieces of obsidian retrieved. Other cultural material included chert and shell artefacts, bone and shell. On the basis of decoration, the pottery assemblage is “Early Lapita” (Summerhayes, 2000b). This fits well with the radiocarbon determinations which place the sequence between 3,300 and 3,000 B.P. (at 2σ range). The two AMS radiocarbon determinations on charcoal are consistent with a calibrated age of 3,360(3,250)3,080 cal. B.P. (WK7561) and 3,380(3,290)3,080 cal. B.P. (WK7563), while the conventional radiocarbon determinations on shell are calibrated at 3,330(3,210)3,070 cal. B.P. (WK7562) and 3,210(3,080)2,950 cal. B.P. (WK7560). Forty-eight obsidian artefacts from Test Pit 1 were selected for characterization analysis. This comprised a 42% sample of the obsidian from that test pit.

On Ambitle Island, three Lapita sites were excavated: Malekolon (EAQ), Balbalankin (ERC) and Feni Mission (ERG).

Malekolon—EAQ. The Malekolon site is located 0.5 km inland in a small valley (Fig. 2), although occupation would originally have been on the beach of an embayment when the Lapita material was discarded. A volcanic eruption on the island 2,300 years ago covered the embayment with ash, which was subsequently infilled by clays excavated from the top of the limestone escarpment (Licence *et al.*,

Fig. 2. The Anir Islands showing the location of excavated sites.



1987: 274). Pottery from the site was previously described by White & Specht (1971) and excavated by Ambrose in the early 1970s. The background to the geomorphological history of the site and a full description of the excavated test pits are published elsewhere (Summerhayes, 2000*b*). Five test pits were excavated along an east-west transect from the beach extending inland, with only one, Test Pit 4, having cultural material. Over 2,500 sherds and 200 pieces of obsidian were excavated from this single test pit. The bulk of the material was in the lower 40 cm of a brown ash sitting on top of black beach sand (25 cm deep) which in turn overlies a yellow and white beach sand. Decoration on the pottery includes dentate, linear incision, shell impressions, striations, and nubbins. Stone artefacts were also recovered. Only three conventional radiocarbon determinations are available from Malekolon. The first is on galip nut and comes from Ambrose's early 1970s excavation: 2,707(1,996)1,528 cal. B.P. (ANU 957) (Ambrose, pers. comm.). The next two are from Summerhayes' excavations and are on charcoal: 3,830 (3,430) 2,960 cal. B.P. (ANU 11193) and 2,750 (2,080) 1,530 cal. B.P. (ANU 11190). The first and last determinations could date the volcanic eruption. All determinations have large ranges exceeding 900 years at two standard deviations (see Spriggs, 1989 for a discussion on chronometric hygiene). A sample, consisting of 89 obsidian artefacts from Test Pit 4 (42% of the population) was selected.

Balbalankin—ERC. The Balbalankin site is located 140 to 200 m inland from the beach, extending towards the edge of the escarpment on an area of raised flat ground (Summerhayes, 2000*b*). Eight test pits were excavated at the site with over 1400 sherds retrieved. Pottery decoration includes dentate, linear incision, nubbins, appliqué and shell impressed ware. Other artefactual material included chert and shell artefacts, and midden material. The material was originally deposited in a low energy water environment, similar to that at the Arawe Islands and Talepakemalai (Kirch, 1988*b*; Gosden & Webb, 1994). On the basis of decoration, the pottery assemblage is "Middle Lapita" (Summerhayes, 2000*b*). This fits well with the single conventional radiocarbon determination on charcoal available from Test Pit 1—2,950(2,750)2,360 cal. B.P. (ANU 11188). Twenty-four obsidian artefacts were selected from Test Pit 1 for analysis; they comprised a 44% sample of that test pit's obsidian population.

Feni Mission—ERG. The Feni Mission site is located at the Catholic Mission on Ambitle (see Summerhayes, 2000*b* for details of excavations). Only one test pit was excavated from which 569 sherds and 113 pieces of obsidian were retrieved. The pottery sherds look eroded and re-deposited. Decoration includes dentate, linear incision, applied bands and flat knobs. From a cursory examination, the dentate decoration is open and loose. On the basis of decoration, the pottery assemblage is Middle to Late Lapita. Only a single conventional radiocarbon estimate (on charcoal) is available from the site: 3,690(3,280)2,850 cal. B.P. (ANU 11191). Again, this determination has a large range of 800 years at two standard deviations. A sample of 25 obsidian artefacts selected for analysis comprised 22% of the obsidian population from that test pit.

In summary, the Kamgot assemblage has four age determinations consistently around the late fourth millennium B.P., while Balbalankin is later in time dating to the early to late third millennium B.P. The other two sites have determinations which have large standard deviations. Summerhayes (2001*a*) gives details on the chronology of these sites. The number of obsidian specimens selected and their percentage of the total population for each test pit are listed in Table 1.

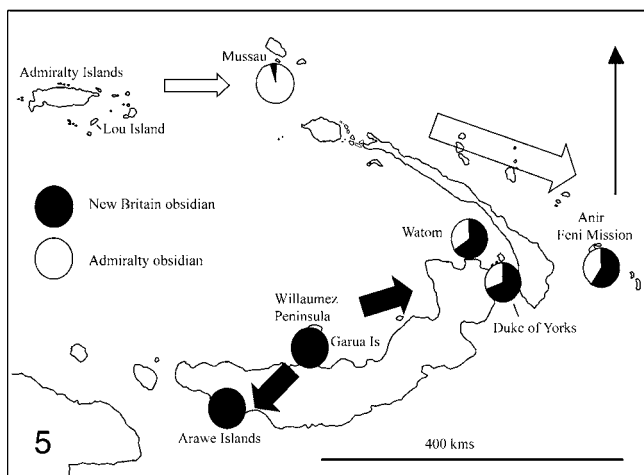
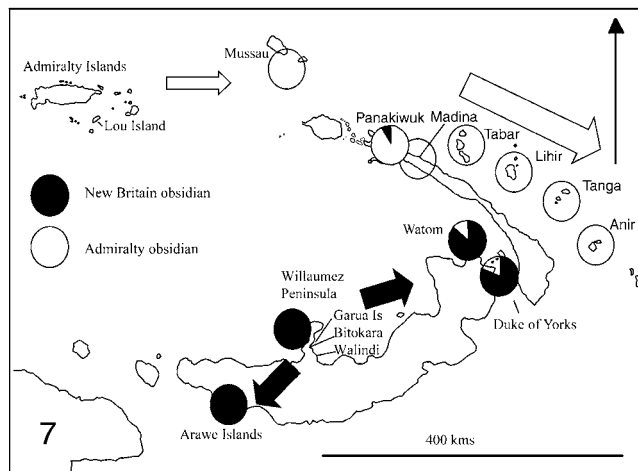
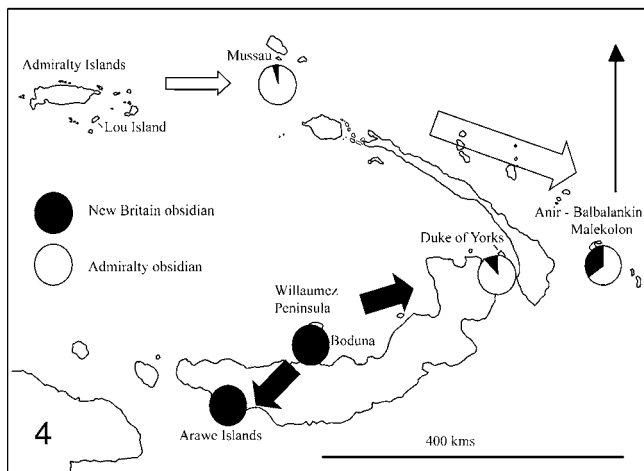
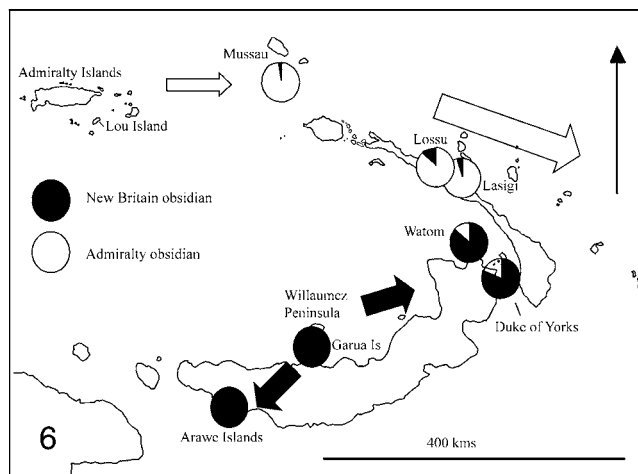
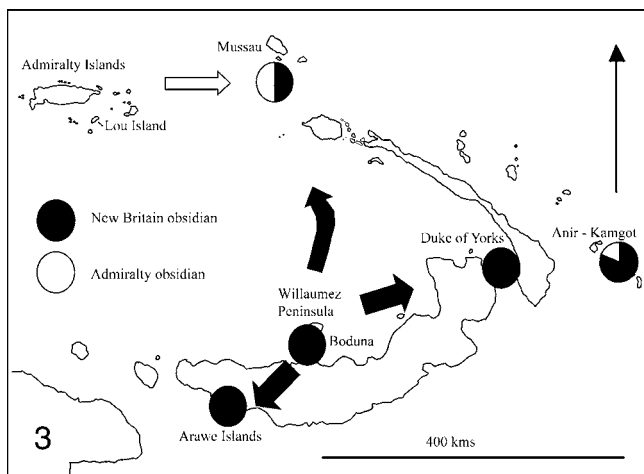
Results

One hundred and eighty-six obsidian artefacts were chemically analysed using the established PIXE-PIGME (proton induced x-ray and proton induced gamma-ray emission) technique at the Australian Nuclear Science and Technology organization, Lucas Heights. A sample was randomly selected from each spit in each site. For a detailed outline of the technique and parameters used see Summerhayes, *et al.* (1998).

The results show that the proportion of obsidian from different sources varies at each site (Table 1). Obsidian from the Kamgot site is predominantly from the Willaumez Peninsula source of Kutau (80%) while the rest comes from the Admiralty sources. Malekolon and Balbalankin, on the other hand, have predominantly Admiralty obsidian at 64% and 67% respectively, with the rest from Kutau. In the Feni Mission assemblage the proportions are somewhere in between with 56% from the Willaumez Peninsula source of Kutau and 44% from the Admiralty Islands. It has been

Table 1. Distribution of obsidian in each Anir site by source area.

site	number of specimens analysed	% of population (%)	Willaumez Peninsula sources (%)	Admiralty Island sources (%)	Admiralty sub-source of Umrei (%)	Admiralty sub-source of Pam
ERA Kamgot—TP 1	48	47	80	20	67	25
EAQ Malekolon—TP 4	89	42	36	64	84	14
ERC Balbalankin—TP 1	24	44	33	67	88	13
ERG Feni Mission	25	22	56	44	55	45



Figs. 3–7. Regional distribution of obsidian from Early to Post Lapita and during the last 1600 years: (3) Early Lapita period; (4) Middle Lapita period; (5) Late Lapita period; (6) Post Lapita period; (7) the last 1600 years.

Table 2. Sites with obsidian assemblages.

time period B.P.	locality	sites	references
Early Lapita 3,500 to 3,000–2,900	Arawe Islands	Paligmete (FNY) Adwe sq. D/E/F (FOH)	Summerhayes <i>et al.</i> , 1998 Gosden & Webb, 1994; Summerhayes, 2000a, 2001a,b
	Willaumez Peninsula	Boduna (FEA)	Summerhayes <i>et al.</i> , 1998; Specht & Summerhayes, in prep.
	Duke of York Islands Mussau Island	Kabakan Island (SEE) Talepakemalai (ECB) Area B Lower levels	White & Harris, 1997 Kirch, 1987, 1988b, 1990 Kirch <i>et al.</i> , 1991; Kirch, 2001
	Anir Islands Arawe Islands	Kamgot (ERA) Apalo (FOJ) Adwe sq. G (FOH) Amalut (FOL)	Summerhayes, 2000b, 2001a Summerhayes <i>et al.</i> , 1998 Gosden & Webb, 1994 Summerhayes, 2000a, 2001a,b
Middle Lapita 2,900 to 2,700–2,600	Willaumez Peninsula Watom Island	Boduna (FEA) Vunavaung (SDI) layer C4	Ambrose & Gosden, 1991 Green & Anson, 1991; Anson, 2000
	Duke of York Islands Mussau Island	SDP layer III Talepakemalai (ECA) Epakapaka shelter (EKQ) lower levels	White & Harris, 1997 Kirch <i>et al.</i> , 1991 Kirch, 2001
	Anir Islands	Malekolon (EAQ), Balbalankin (ERC) Mission (ERG)?	Summerhayes, 2000b, 2001a
	Arawe Islands	Apalo (FOJ) upper units	Summerhayes <i>et al.</i> , 1998; Summerhayes, 2001a
	Willaumez Peninsula	Garua Island (FSZ and FAO)	Summerhayes, 2000a; Torrence & Stevenson, 2000
	Watom Island	Vunavaung (SDI) layer C3 Kainapirina (SAC) layer C2 Maravot (SAD)	Green & Anson, 2000a,b Anson, 2000
Late Lapita 2,700–2,600 to c.2200	Duke of York Islands Mussau Island	SDP layer II Epakapaka shelter (EKQ) middle levels Talepakemalai (ECA) upper levels	White & Harris, 1997 Kirch <i>et al.</i> , 1991
	Anir Islands Arawe Islands	Mission (ERG)? Winguru (FNZ)	Summerhayes, 2000c, 2001a Gosden <i>et al.</i> , 1989; Gosden & Webb, 1994
	Willaumez Peninsula Watom Island	Garua Island (FSZ and FAO) Vunavaung (SDI) layer C2 and C1 Kainapirina (SAC) layer C1	Torrence & Stevenson, 2000 Green & Anson, 2000a Anson, 2000
	Duke of Yorks Mussau Island	SDP layer 1, SEO Epakapaka shelter (EKQ) upper levels	White & Harris, 1997
	New Ireland	Lossu (ECA) Lasigi (ELS and ELT)	White & Downie, 1980 Golson, 1991, 1992
	Lou Island	Sasi (GDY), Esmin (GEB), Pisik (GBC)	Ambrose, 1991
Post Lapita Transition 2,200 to 1,600	Northern New Ireland	Panakiwuk (EAS) Madina	Marshall & Allen, 1991 Ambrose, 1976; Ambrose, 1978
	New Ireland's off-shore islands	Tabar, Lihir, Tanga, Anir	Ambrose, 1976; Ambrose, 1978
	Southern New Ireland west coast	Lambon Island (EPG and EPK) Kamudru (EPQ/EPR)	White, 1997
	east coast	EQA, EQH, EQB, EQD, EQE, EQF, EQZ	White, 1997
	Mussau Island	Sinakasae (EKU) Emussau Is Midden (EKS) Eloaua Cave (EHM) Rockshelter Mussau (EKP) Epakapaka (EKQ)	Kirch <i>et al.</i> , 1991
	Willaumez Peninsula WNB	Garua Island (FSZ and FAO) Walindi (FRI), Bitokara (FRL)	Summerhayes <i>et al.</i> , 1998 Torrence & Stevenson, 2000
	Inland New Britain Arawe Islands	Yombon (FGT), Misisil Cave (FHC) Winkapiplo (FON) Adwe (FOH) surface, Apalo (FOJ) surface	Summerhayes <i>et al.</i> , 1998 Summerhayes <i>et al.</i> , 1998
		Lolmo Cave (FOF) upper levels Murién (FST)	
		Apugi (FFS, FFT), Yimlo (FLE) Alanglongromo (FLF), Alanglong	Summerhayes <i>et al.</i> , 1998

argued elsewhere, on the basis not only of radiocarbon determinations but also regional trends in pottery form, decoration and production, that these changes are chronological (Summerhayes, 2001a). Kamgot is Early Lapita, Balbalankin and Malekolon are Middle Lapita, while Feni Mission is possibly Middle to Late Lapita.

A regional pattern

To identify wider regional trends over the past 3,500 years, obsidian assemblages from Anir and other excavated sites in the Bismarck Archipelago which have been chemically analysed by PIXE-PIGME have been placed into five chronological stages for comparative purposes (Figs. 3–7). Although there are four sources on the Willaumez Peninsula (Kutau, Gulu, Baki and Hamilton), only one was dominant in the export of obsidian—Kutau. Only minor amounts from the other three sources, if any at all, left the area. Where Kutau is known to be the source of the obsidian analysed, it will be referred to as such. However, some of the obsidian artefacts mentioned in this text were analysed before the finer discriminations between these sources could be made using updated PIXE-PIGME techniques (Summerhayes *et al.*, 1998). Thus the generic source name of the Willaumez Peninsula is given when referring to these artefacts.

Where an assemblage's chronology is in doubt, such as those from the Duke of Yorks, it is placed into a temporal sequence according to decoration and dentate stamped motifs¹. Assemblages are referred to here by both their site code (allocated by the Papua New Guinea National Museum and Art Gallery) and place name, if available.

Early Lapita. The regional distribution of obsidian from the Early Lapita period: 3,500–3,000/2,900 B.P. is shown in Fig. 3; Table 2 lists the sites from this period used in the distribution map.

Kutau obsidian dominates the New Britain assemblages whether they be next to the source such as Boduna (FEA) or on nearby archipelagoes such as the Arawe Islands (FOH, FNY) or Duke of York Islands (SEE) (White & Harris, 1997; Summerhayes, *et al.*, 1998). Even assemblages further from New Britain and the Willaumez Peninsula sources have a preponderance of Kutau obsidian. Kutau provided half the obsidian found in the early Mussau Lapita assemblage of Talepakemalai (ECA) (Kirch *et al.*, 1991), while in Kamgot (ERA) it provided 80%.

The above results from Kamgot confirm the earlier conclusions that Kutau obsidian is the dominant source in Early Lapita assemblages throughout the Bismarck Archipelago. They also confirm that Admiralty obsidian was never dominant in these early assemblages, although a higher proportion of it was found in sites furthest away from the New Britain sources. At sites closer to the Willaumez Peninsula sources, few if any pieces of Admiralty obsidian are found. Only two pieces were identified in the Arawe assemblages—one each in Adwe (FOH) and Paligmete (FNY). In Kamgot (ERA), which is almost equidistant to both sources, 20% of obsidian is from the Admiralty Islands. At sites closer to the Admiralty sources, such as Talepakemalai (ECA) about half the assemblage was Admiralty obsidian.

Of interest are those sites which have obsidian from both source areas, e.g., Talepakemalai (ECA) and Kamgot (ERA). Talepakemalai (ECA), for instance is much closer to the Admiralties than it is to the Willaumez Peninsula (Fig. 1). If nearness to the source were the only factor, then the

Talepakemalai (ECA) assemblage would have contained 100% Admiralty obsidian. Yet this is not the case, which suggests that other factors were at play.

Middle Lapita. The earlier obsidian distribution pattern changes during the Middle Lapita period: 2,900–2,800 to 2,700–2,600 B.P. The regional distribution of obsidian in this period is shown in Fig. 4; the sites from this period used in the distribution map are listed in Table 2.

The results from Anir confirm the regional trend that Admiralty obsidian replaced Kutau as the major source in assemblages from sites to the east and north of the Willaumez Peninsula obsidian sources. Admiralty obsidian dramatically increases to 67% at Balbalankin (ERC) and 64% at Malekolon (EAQ). This is a major increase compared to the earlier assemblage at Kamgot (ERA). In contrast, Feni Mission (ERG) has a higher percentage of Kutau obsidian (56%) than Balbalankin and Malekolon with 33% and 36% respectively. This is closer to the Late Lapita phase pattern which is discussed next.

Changes identified at Balbalankin and Malekolon also occur in the Mussau Islands, and the Duke of Yorks off the eastern tip of New Britain. In the Mussau assemblages, which are close to the Admiralty sources, the change is more marked than elsewhere. While the earlier levels of Talepakemalai (ECA) and Epakapaka rockshelter (EKQ) had roughly equal amounts of Willaumez Peninsula and Admiralty obsidian, this changes in the later levels where Admiralty sources dominate (Kirch *et al.*, 1991: 157). A similar trend is seen in the Duke of York assemblages, situated between New Britain and New Ireland, where 89% of the obsidian specimens (or artefacts) from SDP layer III analysed by PIXE-PIGME was from the Admiralties (White & Harris, 1997: 103). Unfortunately, from the sole Watom site of this period, SDI layer C4, only two pieces of obsidian were found: one came from Mopir and the other from the Admiralty source of Umrei (Anson, 2000: 108). Sites closer to the Willaumez Peninsula obsidian sources (Boduna, Arawe Islands) have Kutau obsidian with only one piece of Admiralty (Umrei) obsidian identified in the Apalo (FOJ) site.

Late Lapita. The regional distribution of obsidian in the late Lapita period: 2,700–2,600 to c. 2,200 B.P. is shown in Fig. 5; the sites from this period used in the distribution map are listed in Table 2.

The Feni Mission site, which on the basis of pottery decoration was classified as Middle/Late Lapita, shows an obsidian pattern similar to Late Lapita assemblages from the eastern tip of New Britain and the islands separating New Britain and New Ireland. Here, the distribution of obsidian reverts to a pattern similar to Early Lapita, where west New Britain sources dominate. This is seen in the Duke of Yorks (SDP) and at Watom (SAC, SDI). Unlike the previous Lapita periods, however, Mopir obsidian makes an increased appearance at this time in both the Duke of York and Watom assemblages (only one piece was found in Middle Lapita). Mopir obsidian is not found further east in New Ireland during this period.

In the Duke of York Islands site SDP layer II, 68% of the obsidian analysed by PIXE-PIGME came from west New Britain sources, while the rest came from Admiralty sources (White & Harris, 1997). Of the New Britain sources, 54% came from Mopir, and 46% from Kutau. Using density measurements on 53 artefacts, west New Britain sources

(Willaumez Peninsula and Mopir) account for 38% while the Admiralty sources account for 62%.

A similar pattern is seen in the Watom assemblages. From Kainapirina (SAC) layer C2, west New Britain sources dominate at 60%, of which 78% came from the Willaumez Peninsula and 22% from Mopir (Green & Anson, 2000b: 70). Unfortunately, only five pieces came from another late Lapita site on Watom: Vunavaung (SDI) layer C3. Two were sourced to Mopir, two to Admiralty sources (one each to Umrei and Pam), and one was not allocated (Anson, 2000: 108).

The pattern of obsidian distribution from the sites in western New Britain (Arawe FOJ, Garua Island FSZ, FAO) and Mussau remain mostly unchanged. Kutau obsidian is still found in the Mussau (ECA, EKQ) assemblages, albeit in small numbers (Kirch *et al.*, 1991).

Post-Lapita transition. The regional distribution of obsidian in the post-Lapita transition period from 2,200 to 1,600 B.P. is shown in Fig. 6. These assemblages are at the end of the Lapita period, where dentate stamped pottery sherds are rare, and the few that are found are probably mixed from earlier deposits with pottery where appliqué is found. Incised decoration is found on a restricted range of mostly incurving vessel forms. This is in stark contrast to the vessels of the preceding Lapita period where incurving forms are mostly absent (Summerhayes, 2000c). The sites from this period used in the distribution map are listed in Table 2. No sites from Anir have assemblages of this period. A volcanic eruption on Ambitle Island around 2,300 years ago devastated the island (Licence *et al.*, 1987: 274) and was of such a force that any inhabitants would have perished. The next evidence of human occupation occurs on Ambitle in the following period (see below).

There are three patterns in the obsidian distribution. First, continuity in obsidian exploitation can be seen in assemblages close to their source areas such as the west New Britain sites of FAO and FSZ on Garua Island and Winguru (FNZ) in the Arawe Islands; and those from the Lou Island sites of Sasi (GDY), Emsin (GEB) and Pisik (GBC) which have local obsidian (Ambrose, 1991).

Second, Admiralty Island obsidian dominates the assemblages from the Mussau Islands (EKQ) and North/Central New Ireland (Lossu [EAA] and Lasigi [ELS and ELT]). On Mussau Island (EKQ) a small amount of west New Britain obsidian was still being imported. From Lossu (EEA), 20 artefacts were analysed using PIGME. Eighty-five percent came from Umrei in the Admiralties, and 15% from the Willaumez Peninsula. None were allocated to sub-sources (White & Downie, 1980). From the Dori site (ELS) at Lasigi, 88 artefacts were analysed of which 94% came from the Admiralties, while 6% came from West New Britain (Golson, 1991, 1992).

Third, changes are seen in assemblages at the tip of east New Britain where the proportion of west New Britain (Willaumez Peninsula and Mopir) obsidian continues to increase. This is seen in the Watom (SDI layer C2 and SAC layer C1) and Duke of York (SDP layer 1) assemblages where west New Britain obsidian accounts for over 80% of the obsidian analysed. In the Duke of Yorks site obsidian from Mopir equals that from Kutau, and forms between 18% and 25% in the Watom assemblages. Admiralty obsidian is still reaching this area; in the Duke of Yorks it makes up 20% (White & Harris, 1997: 103), while on Watom it is 16% and 19% from SDI layer C2 and SAC layer C1

respectively (Anson, 2000: 108; Green & Anson, 2000b: 70).

Last 1,600 years. The last 2,000 years are difficult to model due to limited archaeological investigation. The material from this last segment of time is patchy but some headway has been made and gross patterns are emerging (Fig. 7). The sites for this period used in the distribution map are listed in Table 2.

The obsidian pattern evident in the previous period continues. First, Admiralty obsidian dominates the assemblages of Mussau, northern New Ireland and the offshore islands of New Ireland. Rather than having a secondary role, west New Britain obsidian begins to drop out completely in these later assemblages. That is, it is no longer being exchanged into these areas. From Mussau, the assemblage from Sinakasae (EKU), dated to the eighth century B.P. (thirteenth century A.D.) is mostly Lou with a minute amount from the Willaumez Peninsula (Kirch *et al.*, 1991: 157). According to Kirch *et al.* (1991), by the late prehistoric period no Willaumez Peninsula obsidian is found in the assemblages from EKS on Emussau Island, or from EKS, EHM and EKP on Mussau where only Admiralty obsidian has been found.

From the New Ireland cave site of Panakiwuk (EAS) nine of the 10 analysed pieces found in layer A dated to less than 2,000 B.P. Seven (78%) are from the Admiralty Islands (six from Lou, one from Pam Lin), and only two (22%) from the Willaumez Peninsula (Marshall & Allen, 1991: 71). From the offshore islands of New Ireland, isolated obsidian surface finds have been collected by Ambrose (1976, 1978) on Tabar, Lihir, and Tanga, and myself on Tabar, Tanga, and Anir. Those from Anir were found in association with Buka pottery which was traded from the south over the last 800 years. This is the first evidence for re-occupation of the island. Although only a handful of obsidian flakes has been analysed, all are from the Admiralty source of Umrei. Ambrose (1978: 331) records that a scatter of five flakes from Masahet Island, off Lihir, all came from the Willaumez Peninsula, however, the age of this site is unknown and is probably earlier than 1,600 B.P.

Second, the west New Britain obsidian sources are now the sole supplier of obsidian within this island. No Admiralty obsidian is reaching New Britain. This is the case for the many analysed assemblages from the Willaumez Peninsula, Arawe, and Kandrian regions of West New Britain listed above (Summerhayes *et al.*, 1998). The extensive ethnographic literature, which outlines the movement of Willaumez Peninsula obsidian to Watom and other parts of New Britain, also indicates the lack of Admiralty obsidian during this period (see Specht, 1981 for references).

Third, the assemblages in southern New Ireland have mostly west New Britain obsidian and a minor amount of Admiralty (Lou Island) obsidian. Of importance is Peter White's (1997) work in the southern part of New Ireland, where slight differences are seen between the east and west coast assemblages that he collected. Along the west coast (EPE, EPG and EPK on Lambon Island and EPQ/EPR and EPS at Kamudru), west New Britain obsidian dominates with little material from the Admiralty Islands sources present (White, 1997: 144). The east coast sites (EQA, EQH, EQB, EQC, EQD, EQE, EQF and EPZ), on the other hand, have a higher proportion of Admiralty obsidian, which on density analysis could comprise up to 22% of the assemblage (White, 1997: 144). Ambrose also made a surface collection of five flakes at Muliama on the east coast

of New Ireland, with three sourced to the Willaumez Peninsula and two to the Admiralties (Ambrose, 1978: 331).

On the basis of obsidian distribution, New Ireland is thus separated into two regions: the north and east where Admiralty obsidian dominates, and the south where west New Britain sources dominate. There are two major spheres of obsidian distribution, a northern west to east network evident out of the Admiralty Islands across to central New Ireland, yet including all the northeastern offshore islands, and a southern network evident in the whole of New Britain and the southern third of New Ireland.

Discussion

The evidence presented above shows major changes over time in the distribution of obsidian from different sources and reinforces the prediction of Gosden *et al.* (1989) that “these differences may allow the tracking of discrete exchange networks in different parts of the Bismarcks when analyses are available from further sites” (Gosden *et al.*, 1989: 575). There is a major change from the dominance of west New Britain (Kutau) obsidian in all Bismarck Archipelago Lapita assemblages during the Early Lapita phase, to one where Admiralty obsidian dominates in the eastern Bismarck Archipelago assemblages of New Ireland, Mussau and East New Britain during the Middle Lapita phase. Although this pattern continues from Late Lapita onwards for Mussau and northern New Ireland, it changes for the southern New Ireland and east New Britain assemblages in which west New Britain obsidian dominates. West New Britain continues to be dominated by its local sources throughout all the phases. Within the last 1,600 years a regional boundary, based on obsidian, is seen in southern New Ireland. What these changes in the distribution of obsidian can tell us about the past is best addressed by looking first at the nature of Lapita exchange, and second, at the nature of mobility and settlement patterns.

Nature of Lapita exchange. Indications about the nature of exchange can be gained from the limited analysis of obsidian technology undertaken to date where it is proposed that obsidian was not a “prestige good” valued for its scarcity with distance from the source region. This conclusion is based on analyses of both the Arawe Islands (Halsey, 1995) and Reef Islands and Santa Cruz (Sheppard, 1992, 1993) Lapita assemblages, from which it was argued that these assemblages showed an expedient technology and that proximity to the source was not an important factor in the reduction of obsidian. Other assemblages located away from the obsidian source areas which also showed an expedient technology or wasteful reduction of obsidian include the Duke of Yorks (White & Harris, 1997), southern New Ireland (White, 1997), Mussau ECA (Kirch *et al.*, 1991: 157) and Watom (Green & Anson, 2000b: 64–66). Similar characteristics are seen in assemblages right next to the west New Britain sources such as Bitokara Mission (Torrence, 1992), as well as the Garua Island assemblages. Torrence *et al.* (1996) argue that users from Garua obtained obsidian from non-Garua sources to maintain social links with other groups. Whether an expedient use of obsidian lasted through all three Lapita phases in the Bismarck Archipelago is unknown. Further technological analyses of obsidian from the Middle to Late Lapita sites in this region are thus a priority in understanding the mechanisms of exchange.

However, the value of obsidian was argued to be social not utilitarian. Sheppard’s (1992: 152) work is important here as he argues that models of trade and exchange based on formalist economic grounds do not explain the nature of the assemblages as the obsidian was not curated and economized. Of importance is Sheppard’s suggestion that obsidian’s commodity value “is maximized in social terms at points in its history where it may be a concrete symbol of exchange” (1993: 135). He goes on to suggest it is not at these points that the obsidian’s value is seen in utilitarian terms, but “subsequent to these exchange events, consumption of some of the obsidian may then be carried out according to another set of commodity (utilitarian) values” (Sheppard, 1993: 135).

Torrence *et al.* (1996: 220) offer a model to explain the expedient use of obsidian. They argue that obsidian collected would have been the result of embedded procurement in which “materials are collected in the course of carrying out other activities”. As such, “one would not expect the consumption of obsidian procured in this way to reflect distance from the raw material source” (Torrence *et al.*, 1996: 220). Yet, as the authors note, embedded procurement would not explain the non-use of local obsidian on the Garua Island sites (see also Torrence & Summerhayes, 1997). The selection of non-local obsidian would be best explained, they argue, in terms of maintaining social ties with other groups (Torrence *et al.*, 1996: 220), but as they point out, the data available are insufficient to reveal the nature of the social factors involved.

The nature of mobility and settlement patterns. If the value of obsidian was social, then what do changes over time in the obsidian distribution patterns within the Lapita periods suggest? The proportion of obsidian within an assemblage is dependent not only on closeness to the source, but also on what Green (1987) called the “social distance” between those communities within the exchange network. Change in the proportions of obsidian over time was argued to reflect the changing nature of the “social distance” between communities accessing the sources and those who are the recipients as part of an exchange transaction. The appearance of the two obsidian distribution networks where Admiralty obsidian dominates in the Mussau and New Ireland assemblages during the Middle and Late Lapita periods no doubt represents a re-alignment in the movement of obsidian and the changing relationships between those accessing the sources and those who are the recipients as part of an exchange transaction. However, what about the nature of Lapita society as a whole? Relations between Lapita communities are not expected to have remained stationary for half a millennium. So, do the changes in obsidian distribution patterns represent a greater regionalization or social break-up between these Austronesian communities within the Bismarck Archipelago? The pottery assemblages provide an important insight here.

Any regionalization evident from the pottery assemblages occurs at the end of the Lapita sequence, which is much later in time than changes occurring in the distribution of obsidian. There is no regionalization of Lapita pottery over time in the Bismarck Archipelago. Any changes in the decoration or style of Lapita pottery are seen in most Bismarck assemblages at the same time. For instance, for over nearly half a millennium similar changes occurred in the ceramics in three Lapita assemblages on the edges of the Bismarck

Archipelago (Anir Islands, Arawe Islands and Mussau Islands) which suggests a homogeneous society (Summerhayes, 2001*b*, see also Summerhayes, 2000*c*, for a discussion on the function of Lapita pottery). Social distance between these communities does not seem to have been lessened with the changes in obsidian distribution. Thus, changes in the distribution of obsidian did not equate with major divisions within Lapita society in the Bismarck Archipelago.

What does change over time and what may have affected the distribution of obsidian is the nature of settlement mobility. It is argued (Summerhayes, 2000*a*), for instance, that there is a change in settlement patterns from a mobile to more sedentary one. This argument is based on a change in pottery production strategies which occurs at the same time that pottery becomes more standardized in shape and size. Perhaps the changes in obsidian distribution and settlement mobility patterns are associated? A model involving the association of a mobile Lapita society with a dominance of west New Britain obsidian, and a more sedentary settlement strategy with the appearance of two obsidian distribution networks is one that needs to be explored further. Such a model needs to take into account wider regional processes occurring in the western Pacific.

The expanded distribution of west New Britain obsidian in the early Lapita period into areas of the Bismarck Archipelago where it was not previously found is no doubt related to the Austronesian expansion into this region. It co-occurs with the widespread distribution of Lapita pottery and other cultural elements not seen in the region previously (Green, 1997; Spriggs, 1996). The dominance of west New Britain obsidian in Early Lapita assemblages, including sites closer to the Admiralty sources, could be an expression of the direction of initial impetus for Austronesian expansion which on linguistic grounds came from the west New Britain region (Lilley, 1991; Ross, 1988). Unfortunately no sites earlier than the Mussau assemblages have been excavated from west New Britain to date. The dominance of west New Britain obsidian in areas beyond New Ireland such as Nissan (Spriggs, 1991) or in the earliest Remote Oceania sites of the Santa Cruz and Reef Islands (Green, 1987) indicates that the initial colonization of this region occurred during the phase when west New Britain and not Admiralty obsidian dominates.² Although the Santa Cruz and Reef Island assemblages are defined as Middle Lapita, the dominance of west New Britain obsidian indicates that the early movement out of the Bismarck Archipelago and into Remote Oceania occurred in the Early Lapita/Middle Lapita time span. Thus, 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 were the most mobile. Kirch's (1988*a*) model of exchange as a "lifeline" back to a homeland (see also Green, 1976; 1979: 45; 1987: 246) is applicable here.

It is only after Remote Oceania was colonized for the first time by peoples from the Bismarck Archipelago that what has been referred to as the "two major spheres of obsidian networks" developed. As noted earlier this may be no more than a result of a change from a mobile to a more sedentary settlement pattern. Obsidian was initially distributed with the initial impetus of expansion from west New Britain, followed by a more sedentary settlement pattern leading to a distribution pattern where closeness to the source accounts for the majority of obsidian found. Whether obsidian was obtained by direct procurement,

traders or down-the-line exchange is unknown, although either (a) direct procurement or (b) procurement from the source then exchange between few socially related groups, has the advantage of explaining the expedient nature and social value of the obsidian assemblage. The social value of obsidian thus need not have changed over time within these societies. Furthermore, obsidian from the more distant source regions is still found in the later Lapita assemblages, for example, west New Britain obsidian found in Mussau Islands assemblages or Admiralty obsidian in the Arawe assemblages. The presence of a piece of Admiralty obsidian in the Arawe assemblage of Apalo does not demonstrate a specialized exchange network out of the Admiralty Islands. It does indicate that interactions and processes other than economic ones are at play.

Assemblages more distant from the source regions, such as Watom, the Duke of Yorks, and Anir Island, show similar changes in the proportions of Admiralty and New Britain obsidian over time which could indicate either changing exchange links with the source areas (Gosden *et al.*, 1989: 575; Green & Anson, 1991; White & Harris, 1997) or just changes in local exchange links with nearby communities. As noted earlier, more work is needed to refine the transition by technological analyses of Middle and Late Lapita assemblages.

The last 1600 years. In this period there are two major spheres of obsidian distribution: a "northern west-east" distribution out of the Admiralty Islands and across to central New Ireland including all the offshore islands; and a southern distribution including the whole of New Britain and the southern third of New Ireland. An understanding of the nature of these exchange configurations is hindered by a lack of detailed technological analyses of the post-Lapita and recent obsidian assemblages located away from the source areas. Such analyses are needed to identify the role of exchange in this time period in much the same way that Sheppard (1992, 1993) has done for the Lapita assemblages of Santa Cruz and the Reef Islands.

The limited evidence that is available suggests that, unlike the earlier periods, the obsidian in the Bismarck Archipelago was curated and economized. For instance, within the later southern New Ireland assemblages White (1997) argues that flakes from Admiralty obsidian were smaller, i.e. more reduced. He considers that "the more distant material is distinguished by users, perhaps pointing to a down-the-line exchange network" (White, 1997: 145). The small size of the pieces of Admiralty obsidian in these assemblages thus suggests that they passed through more hands, or nodes of exchange, before being used and discarded. If so, a simple down-the-line model for exchange, which was associated with an economical and curated use of obsidian, may be applicable for this late period for many parts of the Bismarck Archipelago.

Further technological analyses of assemblages from the last 1,600 years may thus show a non-expedient economizing behaviour different to that from the previous Lapita phases. Technological analyses could test the model that there was a change from either direct procurement or procurement from the source then exchange between few socially related groups as seen between settlements in the Lapita phases, to down-the-line exchange between socially unrelated groups seen in the ethnohistorical period. If proven, such studies could give time depth to the down-the-line exchange of obsidian seen in the ethnographic present (Chowning, 1978; Specht, 1981; Fullagar *et al.*,

1991; Parkinson, 1999). Until such technological analyses take place, however, interpretations are limited.

The development of the two major spheres of obsidian distribution within the last 1,600 years out of the preceding Lapita phases in association with a change from expedient to non-expedient technology would indicate changing mechanisms of exchange and micro-social configurations. The area where the two exchange networks meet in southern New Ireland coincides with a cultural boundary which was recorded by German observers in the late nineteenth and early twentieth centuries. Parkinson (1999: 117) records that the inhabitants of the southern part of New Ireland "are closely related to the inhabitants of the Duke of York Islands and of the northeastern Gazelle Peninsula". This is also seen in the distribution of men's societies and cultural practices such as the "duk duk" recorded in southern New Ireland, the Duke of Yorks and amongst the Tolai of the Gazelle Peninsula. It is in contrast to the cultural practices of the Mandok, Notsi, Nelik, and other speakers of central and northern New Ireland who participated in Malaggan ceremonies.

A clue to the formation of a cultural divide is provided by Specht, who in 1973 argued that the period from 1,000 to 750 years ago was one of change in the coastal regions. He (1973: 449) noted that "Watom was totally devastated about 1,000 years ago by volcanic eruptions that created the Rabaul caldera, and was reoccupied, perhaps by the antecedents of the present Tolai inhabitants, about 750 B.P.". Could the boundary between the two major spheres of obsidian be reflecting the cultural divide between the antecedents of the Tolai and peoples to the north in New Ireland?

In this context Jim Allen's comments on the relationships between territories are pertinent. Although referring to the Pleistocene, it equally applies to the Holocene post-Lapita phases. When comparing the obsidian distributions between north and south New Ireland, Allen argued that as more Bismarck sites were settled, "relationships between territories: around the archipelago presumably also evolved structurally" (Allen, 1996: 21). He noted that this developmental model "involving considerations like boundary formation and the regularising of across-boundary social relationships through trade, has many analogues in later Melanesian prehistory" (Allen, 1996: 21). Such a development in boundaries separating socially unrelated groups could be what was happening from the post-Lapita transition period onwards. Prior to that, the Lapita settlements would have formed one socially homogeneous group, which began to break up towards the end of the Late Lapita period. During the Lapita period, the non-Austronesian Lapita settlements whose ancestry went back over 35,000 years in the Bismarck Archipelago would have had other social boundaries and relationships which are not covered in this article, due mainly to the lack of excavated non-Lapita archaeological sites from this period.

Conclusion

The allocation of obsidian artefacts from Anir to their sources and their placement within the changing temporal configuration of obsidian distribution has added and further refined patterns identified by Ambrose (1976; 1978), White (1996) and Fredericksen (1997). It is now beyond doubt that west New Britain obsidian dominates the Early Lapita assemblages throughout the Bismarck Archipelago; and that while west New Britain obsidian continues to dominate

assemblages close to those sources, Middle Lapita assemblages in the eastern Bismarck Archipelago region are dominated by Admiralty obsidian. Later assemblages indicate that regional obsidian distribution patterns changed yet again with west New Britain obsidian regaining dominance in east New Britain and southern New Ireland, particularly in the last 1,600 years. Yet, it is argued here that the development of these two obsidian distribution networks (one out of west New Britain and the other out of the Admiralty Islands) does not equate with major divisions within Lapita society in the Bismarck Archipelago. A model incorporating changing mobility strategies towards a more sedentary society after the initial colonization movement out of the Bismarck Archipelago could explain the beginning of these obsidian networks. Based on current limited technological studies it is proposed that the social value of obsidian did not diminish in the Middle and Late Lapita periods and the movement of obsidian took place between socially related groups. In contrast, in many parts of the Bismarck Archipelago, assemblages of the last 1,600 years are expected to indicate a non-expedient technology and that down-the-line exchange took place.

This paper highlights a number of concerns affecting modelling patterns in the distribution of obsidian. The first is the problem of relying solely on obsidian distribution patterns in modelling Lapita society. Only when changes in pottery assemblages from different parts of the Bismarck Archipelago were compared with changes in the obsidian assemblages could insights be made into the significance of the development of two obsidian distribution networks and their relationships to any change in Lapita society. The second is that the paper notes the limited number of technological analyses conducted on Lapita obsidian assemblages within the Bismarck Archipelago. Yet it is from these few technological analyses that the modelling of the social value of obsidian mostly depends. Further technological analyses on Lapita obsidian assemblages must be a priority for the future. Another issue, which was not addressed in this paper, concerns the non-Austronesian inhabitants of the Bismarck Archipelago, their use of obsidian and their changing relationship with the Austronesian settlers of the region over time. This is an area of study that is poorly understood and in urgent need of more research including fieldwork. Only when such fieldwork and technological analyses are undertaken can a more accurate model of obsidian distribution be formulated.

Notes

- ¹ Site SEE, for instance, has dentate pottery with the form and decoration of Early Lapita. Most of this pottery, however, was found within 10 cm of the surface with the rest found spread out in the top three layers (White & Harris, 1997: 100). Although White and Harris entertain possible disturbance due to late nineteenth century European traders, the more likely cause of disturbance, given the island location opposite the volcanoes of northeast New Britain, is a tsunami. The radiocarbon date from SEE is 3,090±60 B.P. (SUA 3082) on shell which calibrates to 3,000(2,847)2,740 cal. B.P. (Summerhayes, 2001a has calibration details) and thus should not be associated with the deposition of this early pottery, in particular when details about the layer from which the sample was taken have not yet been published.

² East of the southeast Solomon sites obsidian is rare with only a handful of pieces found in Lapita contexts in New Caledonia (sourced to west New Britain—Sand & Sheppard, 2000), Malo (sourced to West New Britain, Admiralties and the Banks—Ambrose, 1976), Tikopia (sourced to the Admiralties—Spriggs, 1997) and Naigani in Fiji (sourced to west New Britain—Best, 1987). These few pieces are not part of the exchange system to the west that incorporated the Reef and Santa Cruz Islands sites (see Summerhayes, 2000a: 10–11 for details). Most of the obsidian is found in Middle Lapita assemblages, including Naigani (Summerhayes, 2000a). Tikopia on the other hand is Late Lapita. The presence of Admiralty obsidian in Late Lapita contexts suggests continued infrequent contact with the west.

ACKNOWLEDGMENTS. Thanks to Jim Specht and Chris Gosden for their direction in Melanesian archaeology. Special thanks to the communities on Anir, the New Ireland Provincial Administration, the National Research Institute of Papua New Guinea, and the National Museum and Art Gallery, for approval and support during fieldwork. The field research was made possible by funding from the Australian Research Council (Large Grant) and the Australia & Pacific Science Foundation. Thanks to the Australian Institute of Nuclear Science and Engineering (AINSE) for providing funding to undertake the obsidian characterization analysis and to ANSTO for providing the facilities. Thanks to Dr David Cohen (ANSTO) for his support over the many years. Thanks to the field crew who worked with me over three seasons: Stephanie Garling (Sydney University), Sarah Jane Marshall (Oxford), Vicky Barnecutt (Oxford), Esma Holden (Auckland University), Jennifer Porter (La Trobe University), David Winse (La Trobe University), Michael Therin (Sydney University), Matthew Leavesley (Australian National University), Baiva Ivuyo (National Museum), the late Robert Mondol (National Museum) and Herman Mandui (National Museum). Special thanks to Francis Neantele, Jo Manil, Paul Nebil, Paul Vingilmat, Chris Phauso, Leo Faboksiaro, and Bruno Sianlon from Anir. Wal Ambrose, Geoff Clark, Stephanie Garling, Roger Green, Matthew Spriggs and Peter White kindly provided comments on the paper and I thank them. Lastly, a special acknowledgment to the late Roger Bird for his pioneering work on the sourcing of obsidian, and without whom the obsidian sourcing program would never have started.

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