– ARTICLE –

Obsidian from the Jacquinot Bay area, East New Britain Province, Papua New Guinea

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ABSTRACT:

The paper describes the analysis by portable XRF (pXRF) of 44 pieces of obsidian from six archaeological sites around Jacquinot Bay in the Pomio District of East New Britain, Papua New Guinea. One piece is possibly from a middle Lapita pottery context, but the remainder are undated but almost certainly post-Lapita in age. The pXRF analysis attributes all pieces to New Britain sources: 41 from Mopir and three from Kutau/Bao. The dominance of the Mopir source supports a relatively late date for the obsidian's arrival in the Jacquinot Bay area. When considered in relation to a stemmed obsidian tool from Pakia village inland to the north of Jacquinot Bay, the results suggest that future work in this region area may feed into wider discussions on the control of resources and the social function of obsidian in the Papua New Guinea island provinces.

Keywords: Papua New Guinea, New Britain, obsidian, pXRF analysis, social connections

INTRODUCTION

The transport of raw materials has a long history in the islands of Papua New Guinea, stretching back about 24,000 years with the presence of New Britain obsidian in caves on the east coast of New Ireland (Summerhayes & Allen 1993; Leavesley & Read 2011). In more recent millennia New Britain obsidian has been transported widely throughout the south-western Pacific islands and westwards into island southeast Asia, particularly within the last 3000 or so years (Summerhayes 2009; Torrence & Swadling 2008; Reepmeyer *et al*. 2011). Detailed chemical characterisation of the various New Britain source areas clearly separates those on Willaumez Peninsula from the Mopir source some 60 km to the southeast and discriminates as well between individual Willaumez Peninsula source areas (Bird *et al*. 1997). These previous sourcing studies also revealed intriguing patterns of obsidian source selection and material transport within and beyond New Britain. In part, this apparent selectivity could reflect the age of specific obsidian flows and the impact of major volcanic events on accessibility to sources (e.g., Machida *et al*. 1996; Torrence, Bonetti *et al*. 2004; Torrence, Neale *et al*. 2004; Torrence & Doelman 2007). In the case of complex stemmed tools that were produced at New Britain sources during the middle Holocene and were widely transported throughout the islands and mainland of Papua New Guinea, explanation for selectivity may lie within the social realm. According to geochemical analyses, most of these tools derived from the Kutau/Bai source area of New Britain. Such near-exclusivity of source has been interpreted as reflecting social relationships and the role of the tools as prestige goods or status symbols (Torrence and Summerhayes 1997; Specht 2005; Torrence *et al*. 2013).

The present paper is intended to further these discussions through a preliminary study of the transport of obsidian to the Jacquinot Bay area of the Pomio District on the south coast of East New Britain Province of Papua New Guinea (Fig. 1). Hitherto, archaeological interest in this province has focused on Lapita pottery sites on Watom Island and the Duke of York Islands (Anson *et al*. 2005; White 2007), and the mainland has remained archaeologically largely unknown. Two notable exceptions are an obsidian stemmed tool from Pakia (Specht 2005) and a Lapita pottery site in the Liton River (Leavesley & Sarar 2013), both situated on the northern side of Jacquinot Bay, though neither find was recovered from a controlled archaeological context. Here we extend this limited archaeological information through geochemical analyses of obsidian surface finds from sites around Jacquinot Bay. Although these samples are small and undated, their chemical characterisation provides a counterpoint to the prevailing picture of the dominance of Willaumez Peninsula obsidian across New Britain.

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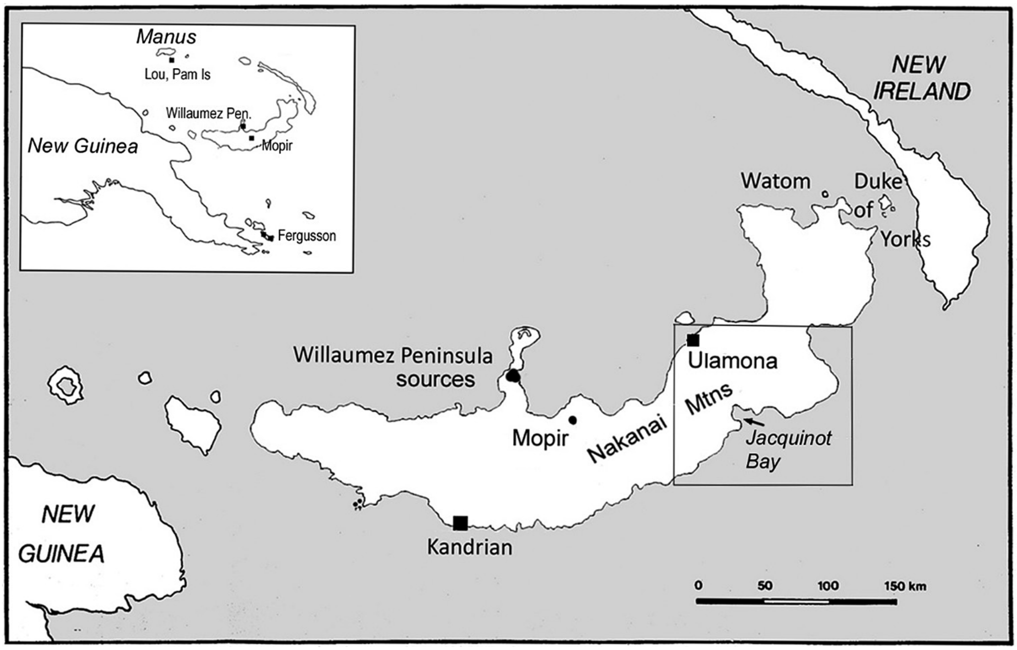

Figure 1. Map showing the location of obsidian source areas on New Britain and in Manus Province, and the location of Jacquinot Bay in southeast New Britain, Papua New Guinea.

MATERIALS AND METHODS

Jacquinot Bay is a large (*ca.* 14 by 12 km) indentation on the southeast coast of New Britain (Fig. 2). The main population around the Bay speaks Austronesian languages of the Mengen family (Ross 1988: 406). The area is dominated geologically by sedimentary limestones of Miocene age, which form the Nakanai Mountain range, with coastal fringes of younger, uplifted reef limestones locally present (Ryburn 1974; Riker-Coleman *et al.* 2006). In the past, this limestone dominance meant that lithic raw materials of igneous/volcanic origin had to be imported from the north side of New Britain (cf. Panoff 1969: 6). The area has a high mean annual rainfall of over six metres (McAlpine *et al.* 1983: 177), with extensive underground river systems that feed several major surface rivers and occasional coastal resurgences of the underground water courses (cf. Sounier 2014).

Archaeological study of the area consists of four short survey visits without excavations, beginning in 1984 with

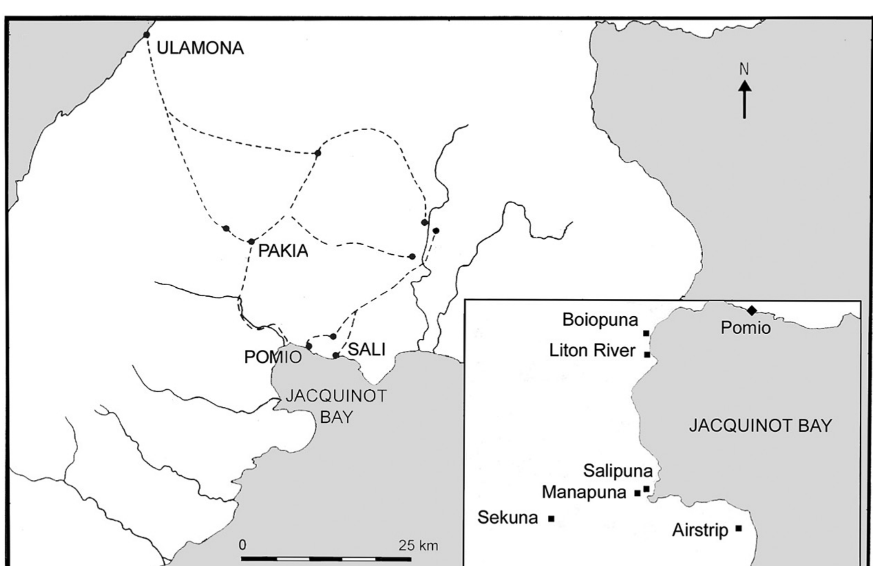

Figure 2. Location of archaeological sites with obsidian finds in the Jacquinot Bay area, southeast New Britain, Papua New Guinea.

the Lapita Homeland Project reconnaissance (Allen *et al*. 1984), and continuing in 2015 and 2017 as part of an assessment of the cultural values of the Nakanai Mountains' region (cf. Gabriel *et al*. 2017). Surface collections of obsidian totalling 44 pieces were made at five locations in 1984 and 2015 (Fig. 2); Table 1 shows the find-spot locations and the number of pieces recovered. Most (34) came from the Sekuna ancestral village site (PNG site code SFM - field code site 6), a former ridge-top settlement that figures prominently in local oral histories. Its deposits have been exposed and partially destroyed by road-building and traffic associated with the development and operation of an oil-palm plantation. Salipuna (SFN - site 9) is a currently-occupied ridge-top settlement near the mouth of the Walunge Toto River. Manapuna (SCQ - site 8) is another ancestral location well-known in oral history that is situated on a ridge-top near Salipuna. 'The Rock from Sali' at Boiopuna (SFK - site 3) is a massive limestone boulder detached from an uplifted limestone formation, though a local story attributes its origin to the area known as Sali on the north-eastern side of Jacquinot Bay. A single obsidian flake was found on the path leading to the rock. A further collection location was around the windsock at the north-eastern end of the Palmalmal airstrip (SFO - site 10), an area that was extensively disturbed by construction of an Allied airstrip and military base. The final sample is a single obsidian flake recovered by Kariwiga in 2015 at about 2 m depth on the sandy bed of the Liton River mouth at Baien village (SFI - LIT).

There is no direct dating evidence for any of the samples, though local oral testimony records Sekuna (SFM) as an ancestral site where the location of a men's house is still remembered. This could indicate a late date for the site's final occupation but does not clarify the time depth represented by the site, though some point within the last few hundred years is likely. The cultural deposit was exposed by the oil palm plantation activities and it is not possible to determine the depth of the cultural layer below ground surface before this disturbance. Depth below ground surface, however, is not necessarily a good guide to the site's antiquity or the duration of its occupation as it is situated on a ridge in limestone country with a low sedimentation rate that is only occasionally augmented by airfall tephra from north coast volcanoes. A fragment of a stone pestle found on the road surface at Sekuna in 2015 does not assist in assigning a date to the deposit (this item remains in the possession of one of the customary landowners). Elsewhere in Papua New Guinea similar stone pestles have been assigned a middle Holocene age (Swadling 2004; Swadling *et al*. 2008), but in the Jacquinot Bay area such pestles, known locally as 'taro stones', have been used in garden fertility practices during the 20th century (Panoff 1972: fig. 21). Local information regarding the occupation of Manapuna (SCQ) likewise does not assist in assigning a date to the obsidian from this site. Oral history indicates that a settlement was established there many generations ago and subsequently the site was abandoned and re-occupied several times. The last re-occupation was after the Pacific War in 1945. Where within this history the small sample of obsidian belongs is not known.

Table 1. *Distribution and frequency of obsidian collections from the Jacquinot Bay area, East New Britain, Papua New Guinea used in this study.*

PNG National Museum site code	Field code	Local name	No. of pieces
SFK	3	Boiopuna	1
SFM	6	Sekuna	34
SCQ	8	Manapuna	3
SFN	9	Salipuna	2
SFO	10	Airstrip	3
SFI	LIT	Liton River	1
Total			**44**

The bed of the Liton River (SFI) where Kariwiga found an obsidian flake also yielded Lapita pottery that Leavesley and Sarar (2013: 172) suggest could be from a middle to late stage in the development of Lapita style pottery, implying a date in the order of 2900–750 cal BP. The nature of the relationship between the obsidian and the pottery is not known, and in the absence of cultural material assignable to a date earlier or later than the pottery, the possibility that they were contemporary can be neither dismissed nor confirmed.

The 44 obsidian artefacts do not constitute meaningful technological assemblages in terms of sample sizes and association; only Sekuna (SFM) is represented by more than three pieces and, as noted above, all samples are surface finds or from disturbed contexts of unknown age and duration. The following discussion, therefore, is restricted to a few basic observations. The technology is generally informal. Flakes predominate in all sites, but cores and retouched flakes are also present in small numbers in the SFM sample. No formal tools are present, and most of the assemblage is small, under 20 mm in length, except for the piece from Liton River (SFI) which is 65 mm long.

The 44 pieces were all washed in the field in river or rain water and were subsequently re-washed at Otago University prior to geochemical analysis. The analyses were carried out using a Bruker Tracer III-SD portable X-ray fluorescence spectrometer (pXRF) at the Department of Anthropology and Archaeology, University of Otago, Dunedin. Samples were shot for 300 seconds live-time on optimal settings for mid-Z elements Mn, Fe, Rb, Sr, Y, Zr, and Nb, which have been shown to be effective for differentiating between obsidian sources within New Britain. Settings were 40kv and 30μA and included the use of a green filter (12 mil Al + 1 mil Ti + 6 mil Cu). All samples were calibrated to parts per million (ppm) using Bruker's factory OB40 calibration.

Prior to each run of artefacts, a pelletized USGS geo-

Table 2. *Results of BHVO-2 tests in parts per million (ppm), comparing the University of Otago pXRF machine against the United States Geological Survey standards. SD = standard deviation; RSD = relative standard deviation.*

	Mn	Fe	Rb	Sr	Y	Zr	Nb
University of Otago average (n=4)	1083.00	79930.00	14.80	337.50	23.28	153.63	16.43
USGS values	1290.00	86300.00	9.80	389.00	26.00	172.00	18.00
SD	31.00	324.00	0.38	2.82	0.61	1.23	0.36
RSD (%)	2.86	0.41	2.57	0.84	2.63	0.80	2.20

logical standard (BHVO-2) was shot to test for machine accuracy. The results of this testing are presented in Table 2, which shows a high level of accuracy for all elements utilised in the analyses.

The archaeological specimens were compared with 50 geological samples from all but two of the obsidian sources thus far known in Papua New Guinea (Admiralty Islands: Lou Island (11), and the Pam Islands (4); New Britain: Mopir (4), and the Willaumez Peninsula sources Kutau/Bao (7), Gulu (4) and Baki (9); and West (6) and East (5) Fergusson Island). Not included were two sources in western Manus Island (Kennedy *et al.* 1991; Summerhayes *et al.* 2014) as samples from these were not available at the time of the pXRF analyses and they have yet to be reported at off-island locations. The geological samples were all shot at the University of Otago on the same settings as the archaeological material.

RESULTS AND DISCUSSION

All 44 artefacts are attributed to New Britain source areas (Fig. 3). Forty-one pieces cluster with the Mopir geological samples, and the remaining three pieces, all from Sekuna (SFM), cluster with the Kutau/Bao geological samples (Fig. 4). The detailed results for the artefacts and geological source samples are provided in Table 3.

The dominance of obsidian from Mopir is not surprising, as this is about 60 km closer to Jacquinot Bay than the sources on Willaumez Peninsula. Both areas are located on the northern side of the island at about 150 km (Mopir) and 210–220 km (Willaumez Peninsula) respectively from Jacquinot Bay. Direct access to the Mopir and Willaumez Peninsula sources by people from the Jacquinot Bay area is unlikely. Transport of the obsidian to Jacquinot Bay was probably overland along the north coast of New Britain

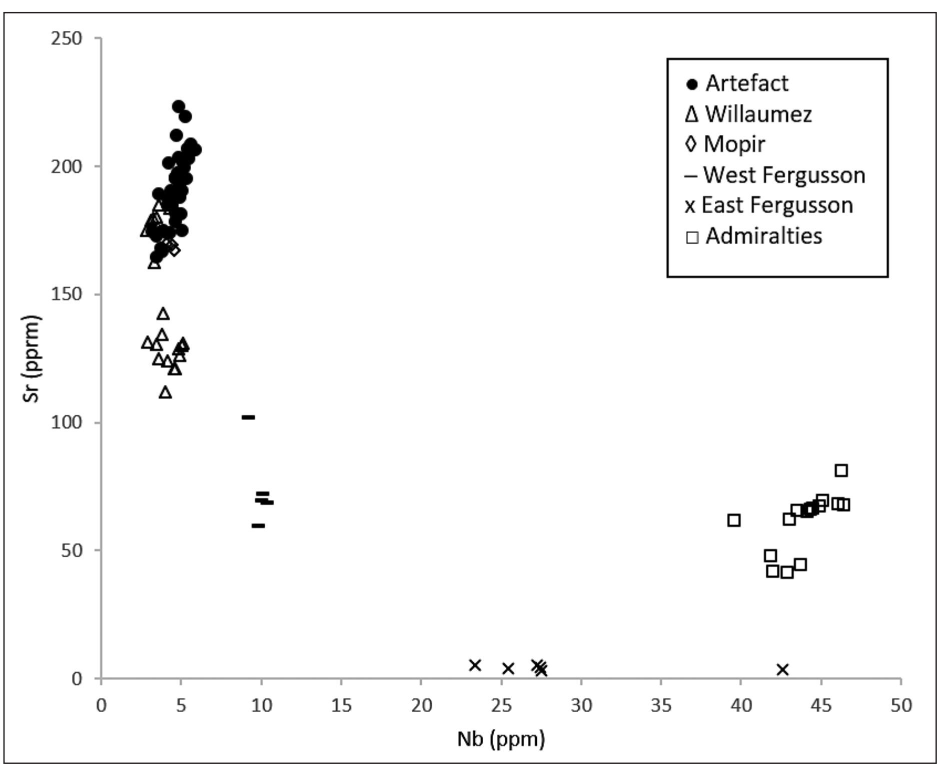

Figure 3. Bivariate plot of the results of the analyses of archaeological obsidian finds from the Jacquinot Bay area plotted against the main obsidian source areas of Papua New Guinea.

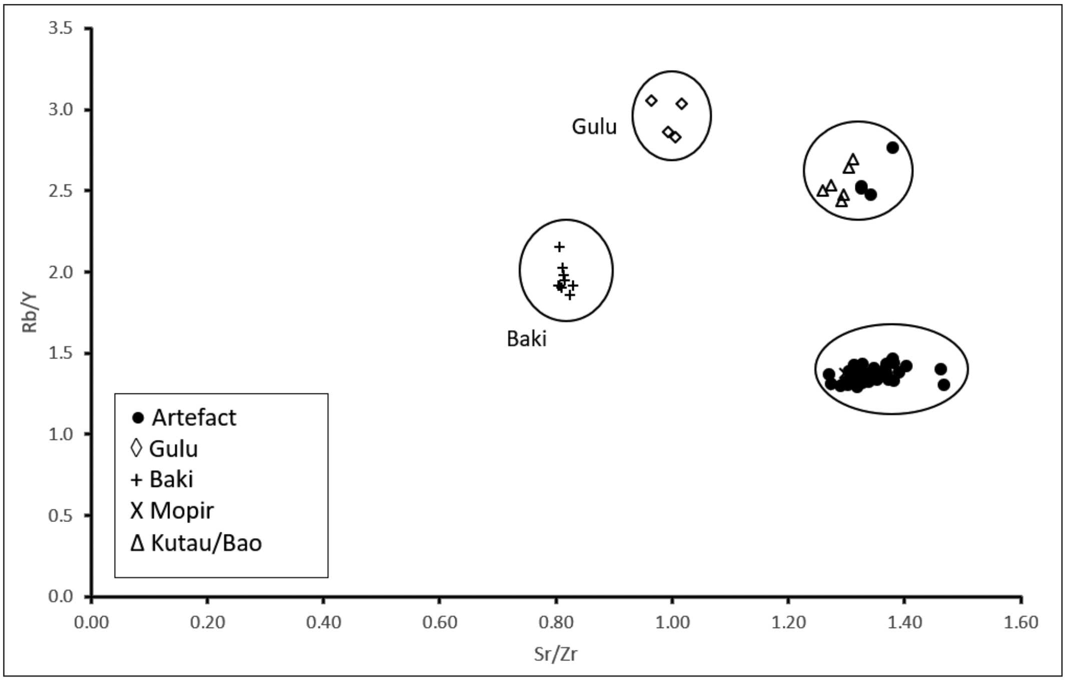

Figure 4. Comparison between West New Britain geological source areas and the archaeological samples of obsidian artefacts from the Jacquinot Bay area.

Table 3. *Results of pXRF analyses in parts per million for all archaeological and geological samples.*

Sample code	Source	Mn	Fe	Rb	Sr	Y	Zr	Nb
SFI LIT_1	Mopir	539	8401	35.7	158	25	122	4
SFO 10_1	Mopir	605	9471	41.7	187	29	137	4
SFO 10_2	Mopir	659	10980	40.3	193	30	145	5
SFO 10_3	Mopir	752	12627	48.2	223	34	153	5
SFK 3_1	Mopir	581	9334	39.0	187	29	140	4
SFM 6_1	Mopir	574	9426	37.3	168	27	129	4
SFM 6_2	Mopir	559	8877	37.9	174	28	133	3
SFM 6_3	Mopir	554	8565	36.5	166	28	129	4
SFM 6_4	Kutau/Bao	441	11180	58.7	201	23	152	4
SFM 6_5	Mopir	623	10791	46.0	196	32	148	5
SFM 6_6	Mopir	631	10628	40.4	188	30	142	5
SFM 6_7	Mopir	585	8963	36.8	173	28	133	4
SFM 6_8	Mopir	584	10008	41.5	193	30	144	5
SFM 6_9	Mopir	729	10612	42.4	203	31	149	5
SFM 6_10	Kutau/Bao	493	9933	61.7	212	22	154	5
SFM 6_11	Mopir	726	11794	45.6	209	31	152	6
SFM 6_12	Kutau/Bao	478	9353	55.5	189	22	143	4
SFM 6_13	Mopir	663	10896	43.3	196	31	148	5
SFM 6_14	Mopir	637	10499	42.0	195	30	143	5
SFM 6_15	Mopir	634	10883	43.6	199	30	145	5
SFM 6_16	Mopir	617	9967	41.0	185	30	140	4
SFM 6_17	Mopir	571	9677	40.7	186	30	141	4
SFM 6_18	Mopir	736	10106	42.1	195	31	145	5
SFM 6_19	Mopir	613	9832	39.5	181	29	139	5
SFM 6_20	Mopir	553	9450	37.0	174	27	131	4

Table 3. *continued*

Sample code	Source	Mn	Fe	Rb	Sr	Y	Zr	Nb
SFM 6_21	Mopir	630	11338	46.0	206	31	150	6
SFM 6_22	Mopir	648	11253	42.4	203	31	147	6
SFM 6_23	Mopir	664	11202	44.4	203	32	149	5
SFM 6_24	Mopir	584	9329	37.2	174	28	137	4
SFM 6_25	Mopir	566	9997	39.4	178	28	133	5
SFM 6_26	Mopir	578	10255	41.2	190	30	142	5
SFM 6_27	Mopir	608	10729	42.7	197	31	146	5
SFM 6_28	Mopir	695	11189	45.3	207	32	148	5
SFM 6_29	Mopir	626	11052	44.6	206	32	148	6
SFM 6_30	Mopir	578	9811	40.4	190	29	142	5
SFM 6_31	Mopir	594	10043	38.7	185	29	138	4
SFM 6_32	Mopir	639	10403	42.4	197	31	144	5
SFM 6_33	Mopir	596	9452	38.9	182	27	139	5
SFM 6_34	Mopir	787	12725	45.2	219	34	150	5
SCQ 8_1	Mopir	592	9246	37.3	175	29	133	4
SCQ 8_2	Mopir	602	10644	40.7	190	30	143	4
SCQ 8_3	Mopir	666	10599	41.8	197	31	146	5
SFN 9_1	Mopir	582	9430	37.6	175	28	135	5
SFN 9_2	Mopir	663	10859	42.7	201	31	149	5
Obsidian source area								
ANU1131	Lou Island (Admiralties)	563	18184	146.1	68	42	387	46
ANU1855	Lou Island (Admiralties)	525	17911	144.3	69	41	383	45
ANU1856	Lou Island (Admiralties)	574	17737	140.8	68	41	382	46
ANU1857	Lou Island (Admiralties)	482	17582	140.6	67	40	374	45
ANU1859	Lou Island (Admiralties)	478	16768	136.3	65	40	364	44
ANU1874	Kutau/Bao (Willaumez)	419	7366	47.4	162	19	127	3
ANU1875	Kutau/Bao (Willaumez)	460	8068	52.8	175	21	139	3
ANU1879	Gulu (Willaumez)	306	7651	53.6	130	19	130	3
ANU1880	Gulu (Willaumez)	348	7712	56.8	131	19	136	3
ANU1882	Kutau/Bao (Willaumez)	467	8355	53.0	185	21	138	4
ANU1883	Kutau/Bao (Willaumez)	472	8202	55.3	179	21	136	3
ANU1899	West Fergusson	373	9700	125.5	69	25	282	10
ANU1943	Kutau/Bao (Willaumez)	456	8538	52.8	179	21	138	3
ANU1951	Kutau/Bao (Willaumez)	540	8593	55.0	183	21	140	4
ANU2000	Lou Island (Admiralties)	478	13554	138.0	61	38	296	40
ANU2024	Pam Lin (Admiralties)	471	13364	148.6	41	40	264	43
ANU2027	Pam Lin (Admiralties)	477	13920	155.9	44	42	275	44
ANU2030	Pam Mandian (Admiralties)	536	14919	152.0	48	39	273	42
ANU2362	Mopir	567	8631	37.3	169	27	127	4
ANU2365	Baki (Willaumez)	438	9526	55.6	125	29	154	4
ANU2366	Baki (Willaumez)	446	9552	55.6	124	29	154	4
ANU2367	Baki (Willaumez)	441	10020	56.5	128	28	158	5
ANU2372	Mopir	597	8978	37.7	174	28	131	4
ANU277	Lou Island (Admiralties)	597	19922	121.1	81	43	404	46
ANU280	Lou Island (Admiralties)	569	17068	138.0	66	39	369	44
ANU283	Pam Lin I (Admiralties)	447	13741	153.5	42	40	267	42
ANU287	Kutau/Bao (Willaumez)	433	8525	52.6	180	22	139	4
ANU301	West Fergusson	683	21128	113.4	5	74	882	27
ANU302	West Fergusson	359	9505	125.3	72	26	298	10

Table 3. *continued*

Sample code	Source	Mn	Fe	Rb	Sr	Y	Zr	Nb
ANU303	West Fergusson	322	9243	130.3	60	27	274	10
ANU304	West Fergusson	383	9475	124.2	69	24	284	10
ANU305	West Fergusson	430	8111	127.7	102	22	194	9
ANU306	East Fergusson	759	22213	117.9	4	77	918	27
ANU307	East Fergusson	802	26902	156.7	3	115	1465	43
ANU308	East Fergusson	738	21876	114.4	3	73	896	28
ANU309	East Fergusson	939	25172	128.6	4	63	605	25
ANU310	East Fergusson	944	27961	132.6	5	65	620	23
ANU380	Baki (Willaumez)	404	8945	58.0	112	27	138	4
ANU3885	Lou Island (Admiralties)	451	16797	136.4	66	38	362	44
ANU4919	Lou Island (Admiralties)	491	16516	136.8	62	39	360	43
ANU5272	Lou Island (Admiralties)	514	16902	137.0	66	40	372	44
Baki G001_10	Baki (Willaumez)	457	9811	53.2	121	28	150	5
Baki G001_11	Baki (Willaumez)	453	10497	59.4	130	30	160	5
Baki G002_28	Baki (Willaumez)	445	10328	56.0	131	29	158	5
Baki G017_4	Baki (Willaumez)	449	10013	54.1	126	29	153	5
Baki Garala_1	Baki (Willaumez)	432	9663	53.4	121	27	148	5
Gulu 04/08_1	Gulu (Willaumez)	311	8110	58.1	134	20	135	4
Gulu 04/08_6_1	Gulu (Willaumez)	313	9230	63.5	142	21	140	4
Mopir East	Mopir	607	8982	38.2	167	28	129	5
Mopir Ulip Stream East_1	Mopir	593	9226	37.1	169	28	132	4

and then across the Nakanai Mountains, rather than by sea around the eastern end of New Britain, a journey of at least 500 km. In the 1960s, anthropologist Michel Panoff (1969: 15) recorded a trans-island trade route linking the Jacquinot Bay area to the north coast of New Britain, and showed the route as terminating in the Ulamona area on the north coast. Obsidian from both source areas was probably transported down-the-line to Ulamona, and then carried across southwards to Jacquinot Bay, though other trans-island routes to the east and west of Jacquinot Bay could also have been used.

The presence of obsidian from the Kutau/Bao sources at Sekuna (SFM) but not at other sites is arguably a function of sample bias. The Kutau/Bao specimens constitute only about 9% of obsidian in the Sekuna sample of 34 pieces; it is, therefore, not surprising that Kutau/Bao is not represented in the very small samples from the other five sites.

Panoff (1969: 6) attributed the origin of obsidian in the Jacquinot Bay area as being 'Talasea' without clarifying whether this referred to the area immediately around the government station at Talasea where most of the Willaumez Peninsula sources are situated, or to the entire administrative atrea known as the Talasea District. The Mopir source area was within the Talasea District, but at the time of his fieldwork Panoff is unlikely to have been aware of its existence, since the source was not on record in either the archaeological or geological literature.

Of particular interest is the attribution of the Liton River obsidian to the Mopir source. Mopir obsidian is absent from the earliest Lapita pottery levels as a result of devastation of the source area by the W-K2 volcanic eruption (e.g., Summerhayes *et al.* 1998), but re-appears in later Lapita levels onwards. Its presence in the Liton River bed, possibly deriving from the Lapita pottery deposit, would thus be consistent with Leavesley and Sarar's attribution of the pottery to a middle or late Lapita stage, though as discussed above, the relationship between the obsidian and the pottery is unknown.

CONCLUSIONS

The analysis of the small sample of obsidian so far recovered from the Jacquinot Bay area shows its origin as exclusively from New Britain sources, with a strong preference for the Mopir source area, consistent with Mopir being nearer to Jacquinot Bay than those on Willaumez Peninsula, though the latter source area is represented by three pieces. Presumably, by the time obsidian reached the Jacquinot Bay area, people around Jacquinot Bay were less interested in where the obsidian came from than in its utility, especially as there is no simple way of distinguishing between the sources through in-hand specimens. On the other hand, the near-exclusiveness of the Mopir source could reflect the nature of the social links through which the obsidian passed to reach Jacquinot Bay, such as established trade friendships between the Mopir and Jacquinot Bay areas that guaranteed consistent supply from the Mopir source.

These obsidian pieces are not the only obsidian known from the Jacquinot Bay area. In or about 1965, a stemmed obsidian artefact was found about 60–90 cm below ground surface at Pakia village, inland from the northern head of Jacquinot Bay (Specht 2005: 379). The Pakia find has been attributed to the Kutau/Bao source (Torrence *et al.* 2013:table 1, item 26), which was the primary production source for New Britain stemmed obsidian tools. Such tools are dated to the middle Holocene around Willaumez Peninsula and have been found widely distributed across the New Guinea islands and on the mainland (e.g., Torrence *et al.* 2013:fig. 1). The finest of these were made from Kutau/Bao obsidian, and their widespread distribution probably reflects a strong desire to acquire them, perhaps reflecting some kind of control over their production and distribution by the inhabitants of Willaumez Peninsula (Torrence & Summerhayes 1997; Torrence *et al.* 2013), to the exclusion of products from the Mopir source. Of more than 40 stemmed tools listed for the New Guinea region, only one from the Kandrian area in southwest New Britain is attributed to the Mopir source (Torrence *et al.* 2013:item 16 on table 1, and fig. 11 right). This restricted distribution is intriguing as stemmed tools were made at Mopir (Fullagar *et al.* 1991: 111) and an unprovenanced example in B.P. Bishop Museum, Honolulu has also been assigned by pXRF to that source (Mulrooney *et al.* 2016). Torrence *et al.* (2013: 300–301) note that similar exclusivity of production is also suggested by evidence from Manus Province, several hundred kilometres to the north of New Britain, where only obsidian from the Umleang-Umrei source area was used for the production of stemmed tools. Torrence *et al.* (2013) explore possible explanations for such exclusivity in the social transactional realms for both Manus and New Britain, extending earlier proposals regarding mid-Holocene social networks in this region (cf. Torrence and Swadling 2008). The emerging picture of obsidian acquisition in the Jacquinot Bay region with a preponderance of items sourced to Mopir may reflect shifts through time in these networks and relationships that further work in this area may illuminate and provide additional comparative perspectives on these issues.

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