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– ARTICLE –

Chemical Signatures & Social Interactions: Implications of west Fergusson Island obsidian at Hopo, east of the Vailala River (Gulf of Papua), Papua New Guinea

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ABSTRACT

Eleven artefacts made of west Fergusson Island obsidian were recovered in beach sands inland from today's coastline east of the Vailala River in the Gulf of Papua. These artefacts were found some 900 km by sea southwest of their geological source location. They extend the known western limit for incoming obsidian along the south coast of mainland PNG by 155 km. Here we discuss the chemical signatures of these artefacts towards an interpretation of social relations between peoples living on the south coast of PNG after *c.* 2600 calBP.

HERMAN MANDUI

In 1969, Ron Vanderwal recovered two pieces of obsidian from archaeological excavations measuring 30 m² at the Oposisi site on Yule Island. One piece was from the earliest ceramic horizon (Zone IIC) dating to *c.* 2000 years ago (Allen *et al.* 2011; Vanderwal 1973) and one piece from the more recent but undated Zone IA (Vanderwal 1973: 127, 214). Oposisi was re-excavated in 2007 by Glenn Summerhayes and co-researchers, Herman Mandui being a member of that team (Allen *et al.* 2011). One of the aims of that new excavation was 'To test a previous suggestion (Summerhayes and Allen 2007: 106) that the two pieces of obsidian previously reported from Oposisi underestimated the amount of obsidian imported into the site' (Allen *et al.* 2011: 70). Their excavations showed that small quantities of obsidian were present in all levels of the site (Allen *et al.* 2011: 75), raising doubts about then-current models that envisioned obsidian to have been transported westward during a 'coloniser mode' connected with the initial introduction of ceramics along the south coast of PNG (Irwin 1991: 506). Based on their findings, Allen *et al.* (2011) proposed that people living at Oposisi participated in long-distance maritime interactions, involving exchange, along at least 600 km of coastline (the distance from Yule Island to the eastern tip of PNG by sea) for 500 years or more (*c.* 2000 to 1500 calBP).

In September 2010 Herman Mandui visited one of us (RS) during fieldwork on the Kouri lowlands 5 km east of the Vailala River, as he needed to discuss matters relating to the preservation of cultural relics with residents of nearby Epemeavo village (Figure 1). Herman's visit came a few days after the completion of the excavations referred to in this paper. Herman was very interested when told that we had uncovered two small assemblages of obsidian artefacts, the first such finds west of Yule Island. After a moment's contemplation, likely considering how these new finds would fit in to the cultural history of the south coast of PNG, Herman asked whether we were *absolutely* sure that we had reached the bottom of the archaeological deposit. As an archaeologist and anthropologist, Herman engaged with contemporary community issues and research debates in insightful ways that continue to contribute to the preservation of PNG's cultural heritage.

OBSIDIAN ON THE SOUTH COAST OF PNG

Archaeological investigations during the 1960s and 1970s reported the near-synchronous appearance *c.* 2000 years ago of pottery-using settlements along 400 km of coastline, from Amazon Bay-Mailu in the east, to Yule Island-Hall Sound in the west (Allen 1972; Bulmer 1978; Irwin 1985; Vanderwal 1973) (Figure 2). Early horizons at these sites contained pottery of comparable styles as well as obsidian imported from Fergusson Island in the Massim, north of the eastern tip of mainland PNG (Allen 1972; Bulmer 1978; Irwin 1985; Vanderwal 1973: see also Allen *et al.* 2011). Within an archaeological time-scale, pottery, or ideas about making pots, moved quickly westward

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Figure 1. Herman Mandui (right) discussing *bevaia* canoe hulls with Moisen Iavi (centre) of the Miaro Clan at Epemeavo village (2010).

along the south coast of PNG, reaching the Aird Hills in the western Gulf of Papua by *c.*1900 years ago (David *et al.* 2011; Rhoads 1983). However, unlike at Amazon Bay-Mailu, Port Moresby and Yule Island-Hall Sound to the southeast, obsidian was not found in early ceramic horizons at sites along the Gulf of Papua.

Amazon Bay-Mailu is the closest area west of the eastern tip of mainland PNG with a published archaeological record that connects the south coast of PNG to obsidian source locations on Fergusson Island (*c.*400 km to the northeast by sea). Excavations at the sites of Selai and Mailu 1 in Amazon Bay-Mailu showed that 'obsidian has

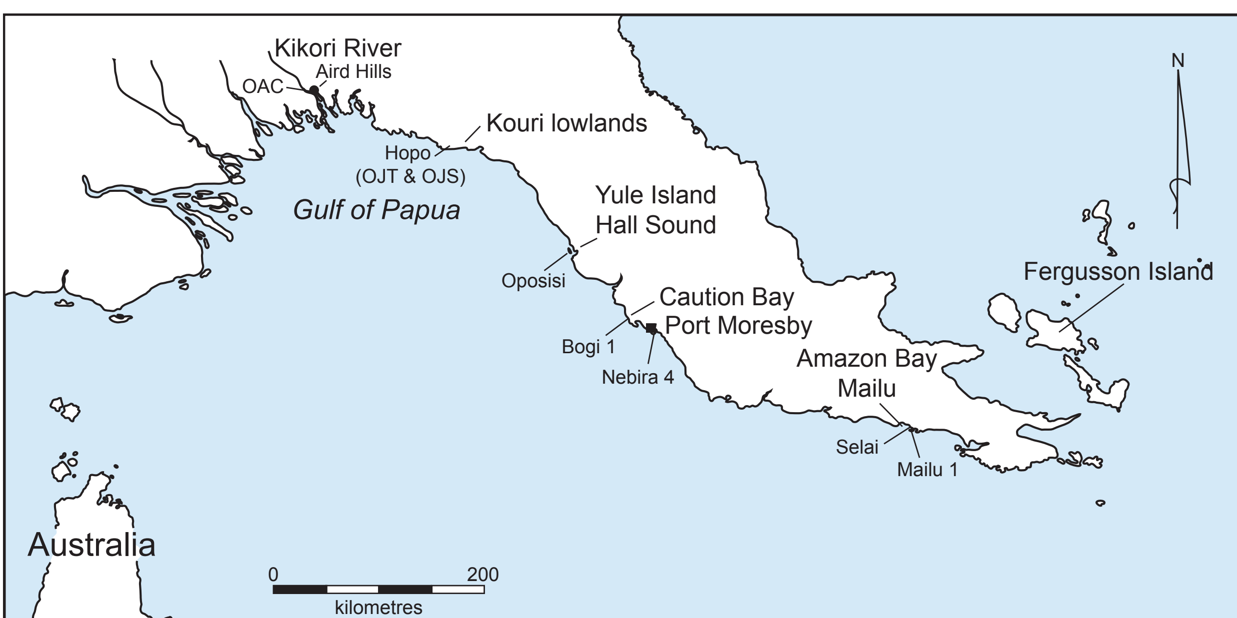

Figure 2. Map of PNG showing places referred to in the text.

been moved at least this distance [from Fergusson Island] throughout the last *c.*2000 years without discernible interruption' (Irwin 1985: 210). The mean weight of obsidian artefacts in the earliest assemblages from Amazon Bay-Mailu is 2.0 g, declining very quickly to 0.5 g above the lowest cultural horizon and remaining largely unchanged thereafter, suggesting that obsidian was more readily available during the initial period of cultural activity within those sites (Irwin 1985: 215; Irwin and Holdaway 1996: 227). It appears that ceramic styles and access to obsidian may at times have been related in some way at Amazon Bay-Mailu, as 'the point at which obsidian achieves its greatest relative proportion coincides with … the point at which the rate of [ceramic] stylistic change is apparently greatest' (Irwin 1985: 214).

A further *c.*300 km northwest of Amazon Bay-Mailu, Nebira 4 near Port Moresby also contains an early ceramic horizon dating to *c.*2000 years ago. There, obsidian artefacts, at least 33 pieces originating from Fergusson Island, were found at all levels of the site (Allen 1972: 109; see also Vanderwal 1973: 214). Allen (1972: 109) describes the obsidian assemblage as containing artefacts that are extremely small in size. Small pieces of obsidian were also found at a number of other sites in the Port Moresby area and these assemblages are likely to be of a similar age to that of Nebira 4 (Allen 1977: 411). Bulmer (1979: 19–20) cites the very small size of obsidian flakes from the Port Moresby sites (Nebira 2, Nebira 4, Eriama, and Taurama) as evidence that obsidian was at no time available in any great quantity in the area.

A programme of excavations at Caution Bay 20 km northwest of Port Moresby commencing in 2009 is today at the centre of debates about the antiquity and implications of pottery use and obsidian availability along the south coast of png (e.g. David *et al.* 2011; Irwin 2012; McNiven *et al.* 2011, 2012b; Specht 2012). Excavations at Caution Bay revealed Lapita pottery and obsidian in contexts dated to *c.*2900–2600 calBP (e.g. McNiven *et al.* 2012a: 18). The discovery of Lapita pottery and obsidian in associated contexts is of critical importance to unravelling the story of obsidian use on the south coast of png, as Lapita pottery and obsidian often go hand-in-hand as material signatures of the 'Lapita Cultural Complex' across much of Island Melanesia (e.g. Kirch 1990; Sheppard 1993; Summerhayes 2003, 2009; White and Harris 1997). Excavations at Edubu 1 in Caution Bay uncovered 12 obsidian artefacts in deposits tentatively dated to between 2350–2650 calBP. As is the situation at other sites in the Port Moresby area (see above), these artefacts are very small, in this case having a mean weight of 0.3 g (McNiven *et al.* 2012a).

Obsidian was also found in Lapita levels of the Bogi 1 site at Caution Bay, although here it appears to be associated with post-Lapita (McNiven *et al.* 2011: 4), which suggests that the intensity or scope of social interactions may have changed following the end of Lapita. The ongoing and possibly increasing availability of obsidian after the Lapita period does not in itself necessarily confirm that social connections between the south coast of png and the Massim were regular or that connections became stronger through time. Irwin (2012) suggests that an apparent post-Lapita increase in access to obsidian at Caution Bay may imply that Lapita settlers became isolated from Lapita communities to the northeast. If contact with the Massim was infrequent, obsidian artefacts may have passed through many hands and been curated to very small sizes as they came to represent a material signature of social interactions between the descendants of Lapita settlers as their social networks became increasingly well-established on the south coast.

Our excavations just east of the Vailala River extend the known western limit of obsidian use on the mainland south coast of png to close to where wide sandy beaches end and the contiguous deltaic swamplands of the Gulf of Papua commence. Despite numerous archaeological investigations in the Kikori-Purari delta region of the Gulf of Papua, there is no evidence that obsidian reached that far west (e.g. David 2008; David *et al.* 2008, 2010; Rhoads 1980, 1983). Skelly and David (in press) point out that obsidian availability, and particular ceramic styles, are limited to sandy coastlines on the south coast of png, which they suggest implies on-going communication between settlements along the south coast of png and parent communities to the east. They see relationships between sandy coastlines and the spread of obsidian to be more than a geographic coincidence. In this paper, we discuss the kinds of social relationships that brought obsidian to the sandy beaches of Kouri lowlands, and how these relationships may have differed to those between beach fronting settlements and settlements in the deltaic regions of the Gulf of Papua.

SITE DESCRIPTIONS

Eleven obsidian artefacts were found at two sites on the Kouri lowlands east of the Vailala River in 2010 (Figure 3). The Kouri lowlands form a crescent-shaped area of freshwater swamps and beach plains seaward of the Kira Hari Hills. The Kouri lowlands stretch along *c.*27 km of coastline east of the Vailala River to a prominent headland known as 'The Bluff'. Kerema, the provincial and administrative capital of the Gulf Province, is a further 13 km along the coast to the east of The Bluff. The two archaeological sites (png National Museum and Art Gallery site codes ojt and ojs) are both located inside the Hopo ancestral village location of oral traditions. The sites are 65 m apart; both were identified from surface deposits with discrete low-density scatters of shell fragments and pottery sherds. ojt and ojs are on an elevated sandy promontory where the Hopo ancestral village once stood. Hopo is today bordered by swamps to the north, south and east and covers just over 1ha, measuring 95 m north-south by 110 m east-west. When sites ojt and ojs were first occupied, they

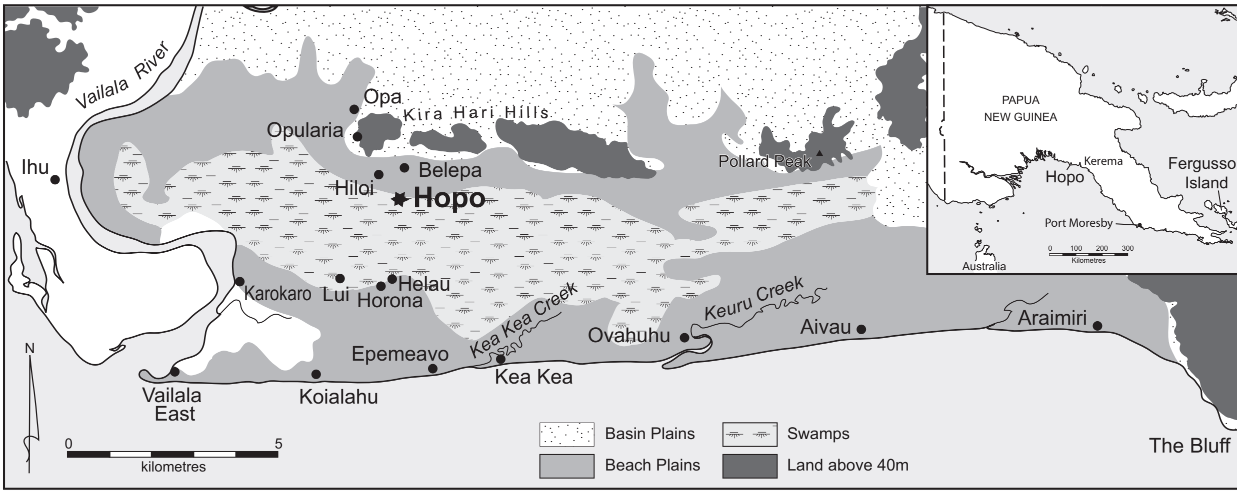

Figure 3. Map of the Kouri lowlands showing the position of the Hopo ancestral village location where archaeological sites OJT and OJS are found (after Ruxton *et al*. 1969: map 2).

were very near the coast, however today these sites are 4.5 km inland as they are in a region where the coastline has rapidly prograded southward (Austen 1934: 20; David *et al*. 2009; Löffler 1977: 113; Rhoads 1994: 53; Ruxton 1969: 10; Williams 1969: 28).

THE EXCAVATIONS

At site OJT, a single 1 × 1 m square was excavated in 47 excavation units (XUs) to a maximum depth of 104.7 cm. Excavations followed the stratigraphy where visible. At site OJS, three 1 × 1 m squares (A, B and C) were excavated. Square A was excavated in 46 XUs to a maximum depth of 95.5 cm. Square B, down-slope, contiguous and to the east of Square A, was excavated in 48 XUs to a maximum depth of 100 cm. Square C, further down-slope, contiguous and to the east of Square B, was excavated in 56 XUs to a maximum depth of 131.8 cm. The three OJS excavation squares share a common stratigraphic sequence varying in specific details. The site slopes down slightly to the east and, accordingly, the depths of interfaces between individual SUs differ slightly from square to square. To maintain systematic and relatively fine-grained chronostratigraphic control, each square was excavated and analysed separately (Figure 4).

Figure 4. OJS Squares A and B excavations completed, Square C excavation in progress. Excavator: Basil Mali.

STRATIGRAPHY

OJT contains five major stratigraphic units (SUs); the uppermost SU1A contains black, loosely-consolidated topsoil. SU2, below SU1A, contains very dark brown well-consolidated silt and little cultural material. It appears to represent a period of infrequent site use or possibly abandonment. SU3, below SU2, contains loosely consolidated very dark brown sand and the oldest ceramic horizon at the site. SU4, below SU3, is increasingly culturally depauperate with depth. The basal SU5 is culturally sterile (Figure 5).

OJS contains six major SUs. The uppermost SU1A has black, loosely-consolidated topsoil. SU2, below SU1A, contains well-consolidated organic-rich sediment with a minor sand fraction. SU3 below SU2 contains very dark greyish-brown, well-consolidated sandy silt and a dense homogeneous ceramic horizon (for details of the SU3 ceramic horizon, see Skelly 2014). SU4 below SU3 contains dark brown, poorly-consolidated lightly compacted sandy sediments and a ceramic horizon chronostratigraphically discrete from the ceramic horizon above it in SU3. The basal SU5 is culturally sterile (Figure 6).

DATING

Five AMS radiocarbon dates were obtained from OJT and 16 from OJS. Here we focus on radiocarbon determinations from SU3 at site OJT (N=3) and SU4 at site OJS (N=10), as these are the SUs that contain the obsidian artefacts (for comprehensive radiocarbon sequences for OJT and OJS, see Skelly 2014). Calibrated ages are cited at 95% probability using Calib 6.0 (Stuiver and Reimer 1993).

Three radiocarbon determinations were obtained for SU3 at site OJT. Together, these three determinations date the formation of SU3 to a time within 1932–2701 calBP (Table 1). However, the correct age of the SU3 deposit may be closer to the more recent end of the calibrated age range, *c.*1932–2308 calBP (Wk-31828, Wk-31830). The younger of the SU3 determinations (Wk-31830) has a ^{13}C value common for grasses or sedges (Fiona Petchey, personal communication 2011). Assuming determination Wk-31830 is based on a short-lived taxon, the older charcoal dates (Wk-31828, Wk-31829) may incorporate an 'old wood' error that would make them decades more recent than their radiocarbon results suggest (see Allen and Wallace

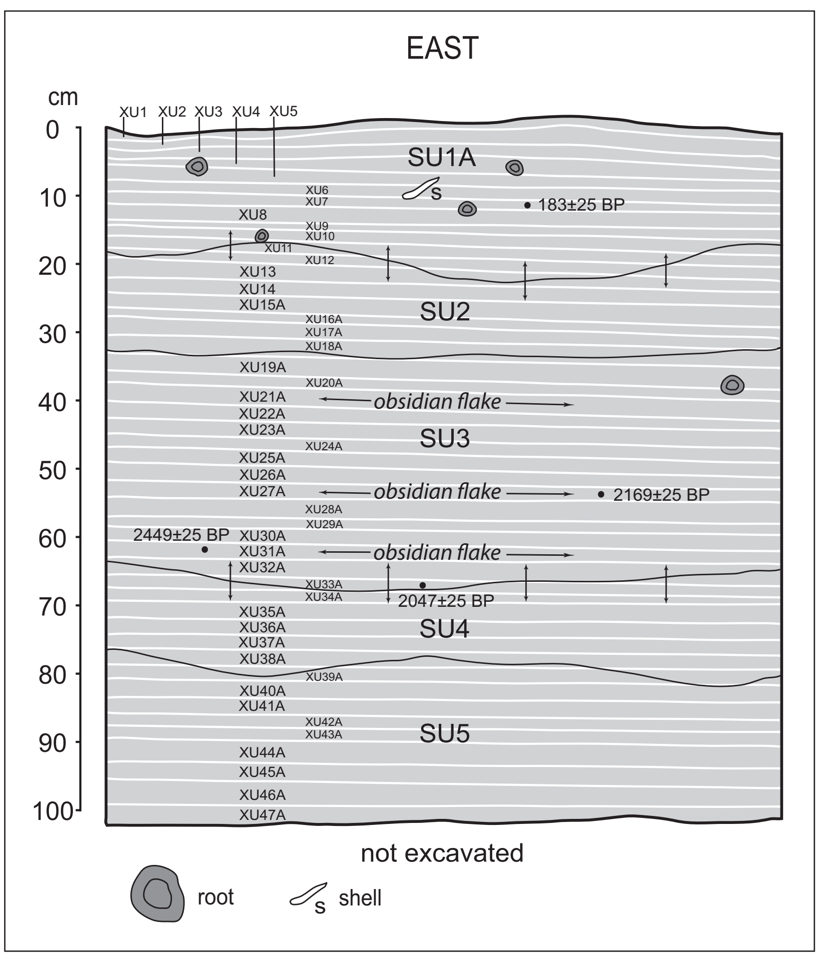

Figure 5. OJT Square A, east section with XUs superimposed. Radiocarbon determinations on samples collected *in situ* are shown as spot-locations (see Table 1 for calibrations). 'Obsidian flake' signifies the individual XUs containing such artefacts.

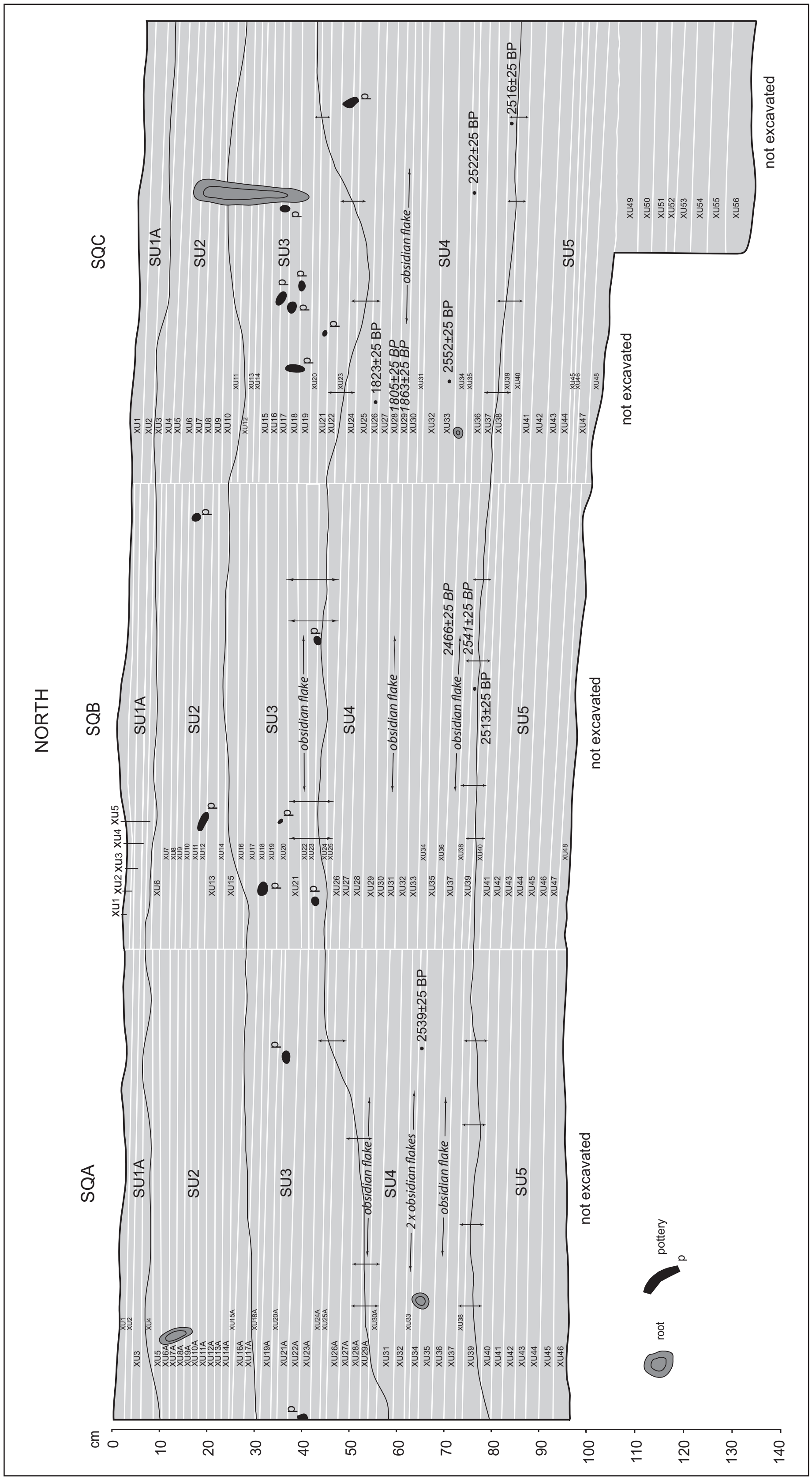

Figure 6. OJS Squares A, B and C, north section with XUs superimposed. Radiocarbon determinations on samples collected *in situ* are shown as spot-locations. Radiocarbon determinations on samples collected from the sieves are italicised (see Table 1 for calibrations). 'Obsidian flake' or 'obsidian core' signify the individual XUs containing such artefacts.

Table 1. *Radiocarbon determinations, OJT and OJS. *samples were retrieved from the wet sieves (all other samples were collected in situ). Calibrations undertaken using Calib 6.0, INTCAL09 (Stuiver and Reimer 1993).*

SU	Depth (cm)	Weight (g)	Wk-Lab. Code	$\delta^{13}C$ ‰	$F^{14}C$ %	^{14}C Age (years BP)	Calibrated Age BP (68.3% probability)	Calibrated Age BP (95.4% probability)
OJT Square A								
3	53.7	0.03	31828	−24.9±0.2	76.3±0.2	2169±25	2126–2158 (0.382) 2174–2175 (0.017) 2251–2299 (0.601)	2069–2079 (0.014) 2111–2209 (0.454) 2225–2308 (0.532)
3	63.0	0.02	31829	−24.4±0.2	73.7±0.2	2449±25	2365–2392 (0.139) 2397–2412 (0.075) 2434–2497 (0.376) 2597–2612 (0.087) 2639–2687 (0.323)	2359–2544 (0.617) 2562–2571 (0.012) 2585–2616 (0.097) 2635–2701 (0.273)
3	69.9	0.03	31830	−10.4±0.2	77.5±0.2	2047±25	1950–1961 (0.132) 1969–1981 (0.129) 1985–2042 (0.739)	1932–2066 (0.919) 2081–2110 (0.081)
OJS Square A								
4	62.9	0.03	30795	−25.0±0.2	72.9±0.2	2539±25	2545–2561 2575–2581 2617–2635 2702–2741	2499–2595 2612–2639 2693–2745
OJS Square B								
4	63–65*	0.02	32235	−24.6±0.2	73.6±0.2	2466±25	2466–2543 2564–2569 2587–2616 2636–2700	2365–2414 2434–2619 2632–2708
4	67–70*	0.10	32236	−26.1±0.2	72.9±0.2	2541±25	2545–2561 2575–2581 2617–2635 2702–2742	2500–2595 2613–2639 2694–2745
4	72.8	0.04	31228	−25.3±0.2	73.1±0.2	2513±25	2509–2528 2539–2593 2615–2637 2697–2719	2489–2644 2672–2737
OJS Square C								
4	49.1	0.02	31230	−9.0±0.2	79.7±0.2	1823±25	1720–1743 1753–1812	1699–1825
4	52–54*	0.05	32237	−9.2±0.2	79.9±0.2	1805±25	1706–1742 1755–1784 1793–1811	1631–1652 1692–1820
4	54–56*	0.04	32238	−10.3±0.2	79.3±0.2	1863±25	1738–1760 1774–1829 1847–1863	1725–1870
4	64.3	0.20	31232	−24.4±0.2	72.8±0.2	2552±25	2618–2634 2705–2745	2505–2530 2538–2593 2614–2638 2697–2749
4	66.4	0.03	29540	−25.2±0.2	73.1±0.2	2522±25	2519–2526 2541–2591 2615–2636 2698–2726	2493–2600 2609–2641 2680–2740
4	76.3	0.07	31233	−25.9±0.2	73.1±0.2	2516±25	2515–2527 2540–2592 2615–2637 2698–2720	2491–2603 2607–2642 2676–2738

2007: 1170; Schiffer 1986; Weisler *et al.* 2009: 955). We note that Wk-31830 represents a stratigraphic inversion in the radiocarbon sequence as the sample comes from the SU3–SU4 below two older determinations in SU3 (Wk-31828, Wk-31829). The radiocarbon inversion may be a consequence of disturbance at the site or the downward intrusion of very small organic samples (see Skelly 2014: 457).

One obsidian flake from OJT is from the SU2-SU3 interface and two flakes are from SU3. The largest obsidian artefact was excavated lying horizontally *in situ*, at 50.1 cm depth just above a radiocarbon determination that calibrates to 2069–2308 calBP.

Based on three radiocarbon determinations, mid-levels of SU4 at site OJS date to a time within 1631–1870 calBP (Wk-31230, Wk-32237, Wk-32238). However, as little charcoal was found in mid-levels of SU4, two of the dated samples were collected from the sieves and we do not consider the mid-levels of SU4 to be well-dated compared to lower levels of SU4. We also note that the ceramic assemblage in mid-levels of SU4 contains pottery sherds with shell-impressed decorations stylistically comparable with shell-impressed pottery from Port Moresby sites, especially the Bogi 1 (Caution Bay) shell impressions securely dated there to 2150–2000 calBP (David *et al.* 2012). We therefore suggest, based on stratigraphic associations, that 1631–1870 calBP is likely to be a minimum age for the mid-levels of SU4. Seven charcoal samples from close to the base of SU4 cover the period 2365–2748 calBP (Table 1). Radiocarbon modelling suggests that together these seven stratigraphically lower determinations date earliest site use at OJS to *c.* 2600 calBP (for details of radiocarbon modelling see Skelly *et al.* 2014).

Of the eight obsidian artefacts from OJS, two are from the SU3-SU4 interface, five are from SU4 and one is from the SU4-SU5 interface (Table 2). The two obsidian artefacts from the SU3-SU4 interface occur at levels clearly below a dense ceramic horizon in SU3 (Skelly 2014). We interpret these as belonging to the upper part of SU4. One obsidian flake is from XU29 of Square C, the same level where an AMS determination covers the period 1725–1870 calBP (Wk-32238) (although these levels may be a little older, see above). Two obsidian flakes from XU33 and one from XU36 of Square A occur above and below a level (XU34) dated to within 2499–2744 calBP (Wk-30795). In addition, one obsidian flake from XU37 of Square B is from between levels dated to 2365–2707 calBP (Wk-32235) and 2500–2745 calBP (Wk-32236). In summary, obsidian from OJS is contemporaneous with the earliest ceramics dated to *c.* 2600 calBP and may have continued reaching the site for a few centuries thereafter.

OBSIDIAN ARTEFACTS

A total of 11 obsidian artefacts were recovered (three obsidian flakes from OJT and eight obsidian artefacts from OJS). As can be seen in Table 2, these obsidian artefacts are small, averaging 0.08 g in weight and 8.5 mm maximum length. The OJT assemblage consists of one broken and two complete flakes. The broken flake from XU26 is extensively worked, exhibiting fine ventral retouching along its distal end as well as abrupt retouching along its proximal end (Figure 7). At OJS, the obsidian assemblage is represented by two complete flakes, a flaked piece, and five broken flakes (one medial, two proximal, and two longitudinally broken flakes). The very small size of these obsidian artefacts is consistent with a highly curated assemblage. The presence of a heavy retouched flake (OJT Square A XU26) and a retouching flake (OJS Square A XU33) suggest *in situ* reworking of a raw material that was difficult to access.

Table 2. *Obsidian stone artefacts, OJS Squares A–C, OJT Square A.*

Square	SU	XU	Depth below surface (cm)	Artefact type	Weight (g)	Max. length (mm)	Max. width (mm)
OJT							
A	2–3	21	38.1–40.6	Complete flake	0.01	5.51	3.86
A	3	26	50.1 (*in situ*)	Longitudinally broken retouched flake	0.16	11.20	8.19
A	3	30	58.9–60.7	Complete flake	0.01	7.42	5.87
OJS							
A	3–4	29	51.5–53.4	Proximal flake	0.05	9.52	5.58
A	4	33	59.8–61.9	Complete retouching flake	0.04	6.17	5.30
A	4	33	59.8–61.9	Proximal flake	0.04	8.57	5.51
A	4	36	67.4 (*in situ*)	Longitudinally broken flake	0.18	9.13	8.52
B	3–4	22	34.9–36.9	Complete flake	0.01	4.26	2.91
B	4	31	53.0–54.8	Flaked piece	0.16	10.31	5.94
B	4–5	37	65.3–67.3	Longitudinally broken flake	0.01	6.42	4.98
C	4	29	54.0 (*in situ*)	Medial flake	0.23	14.57	10.05

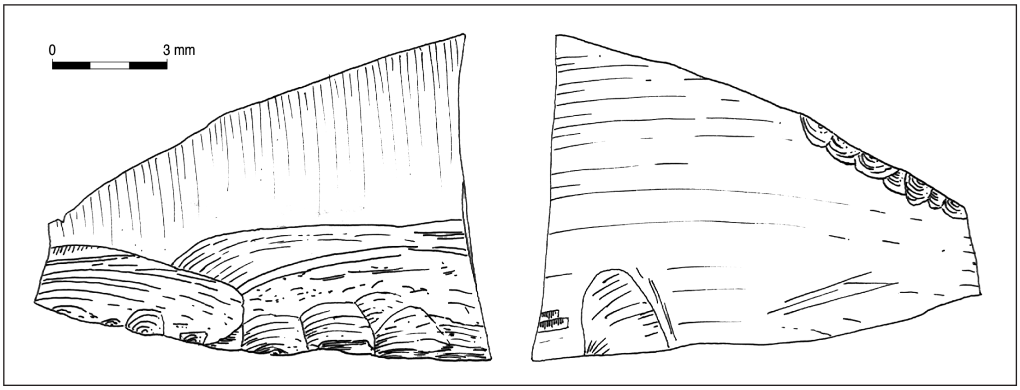

Figure 7. Obsidian flake excavated *in situ* at site OJT, XU26.

CHEMICAL ANALYSES

Papua New Guinea has a strong history in obsidian sourcing studies (Summerhayes 2009). For the current study, portable X-Ray Fluorescence (pXRF) was selected as a non-destructive technique to source the obsidian artefacts, using a Bruker Tracer III-SD pXRF based at the Department of Anthropology and Archaeology, University of Otago. Optimal instrument settings for mid-z trace elements (Rb, Sr, Y, Zr, and Nb) were employed, as these are usually considered to be the most effective elements for distinguishing between potential sources (Shackley 1995). Each artefact was analysed at 40 kV, 30 μA with a filter (12 mil Al + 1 mil Ti + 6 mil Cu), for a 300 second run time. Standard analysis protocol involved placing the flattest surface possible upon the Tracer's analytical window, as surface morphology is often considered to be a potential source of error. All artefacts with visible surface dirt were washed prior to analysis. Prior to analysis, all artefacts were also measured as overall size is considered to impact upon accuracy of results (Davis *et al.* 2011; Golitko *et al.* 2010; Shackley 2011), with artefacts needing to cover the window of analysis, which for a Bruker Tracer III-SD is 4×3 mm. In addition, for the mid-Z elements, artefacts are usually required to have an infinite thickness of 3 mm.

A pelletized USGS basalt standard (BHVO-2) was used as a control and shot before the pXRF run to test accuracy (Table 3). Calibration to parts per million (ppm) was a two-step process: first, the raw data was processed using Bruker's obsidian (OB40) calibration in S1CalProcess (Speakman 2012). These results were then improved by applying a linear regression based on twelve pelletized international standards (AGV-2, BCR-2, BIR-1a, BHVO-2, DNC-1a, GSP-2, QLO-1, SDC-1, SDO-1, SRM 278, SRM 688, W-2a), each shot three times using the same settings as the archaeological samples.

The obsidian artefacts were then compared to source material collected from all currently known obsidian sources in Papua New Guinea. The results indicate that all eleven obsidian artefacts from Hopo originated from the west Fergusson Island source (Figure 8; see Table 4 for the calibrated ppm for all of the Hopo obsidian artefacts). Although all of the Hopo artefacts were under optimal size of 4×3 mm, it is not considered that this altered the geochemistry of the artefacts sufficiently to allow for misidentification of source.

DISCUSSION

The 11 obsidian artefacts from archaeological sites OJT and OJS originated from sources on western Fergusson Island, located 900 km to the southeast of the Kouri lowlands by sea. The artefacts are very small, which is consistent with the general pattern found in obsidian assemblages elsewhere on the south coast of PNG. Obsidian artefacts at OJS were tiny (<0.23 g) suggesting that obsidian was a rare

Table 3. *Error range for pXRF using BHVO-2 as standard.*

	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb
University of Otago pXRF (ppm) (n=1)	1310	84281	82	12.0	351	25	159	16
USGS standard (ppm) median	1290	86300	103	9.8	389	26	172	18
USGS standard (ppm) range	1250–1330	84900–87700	97–109	8.8–10.8	366–412	24–28	161–183	16–20

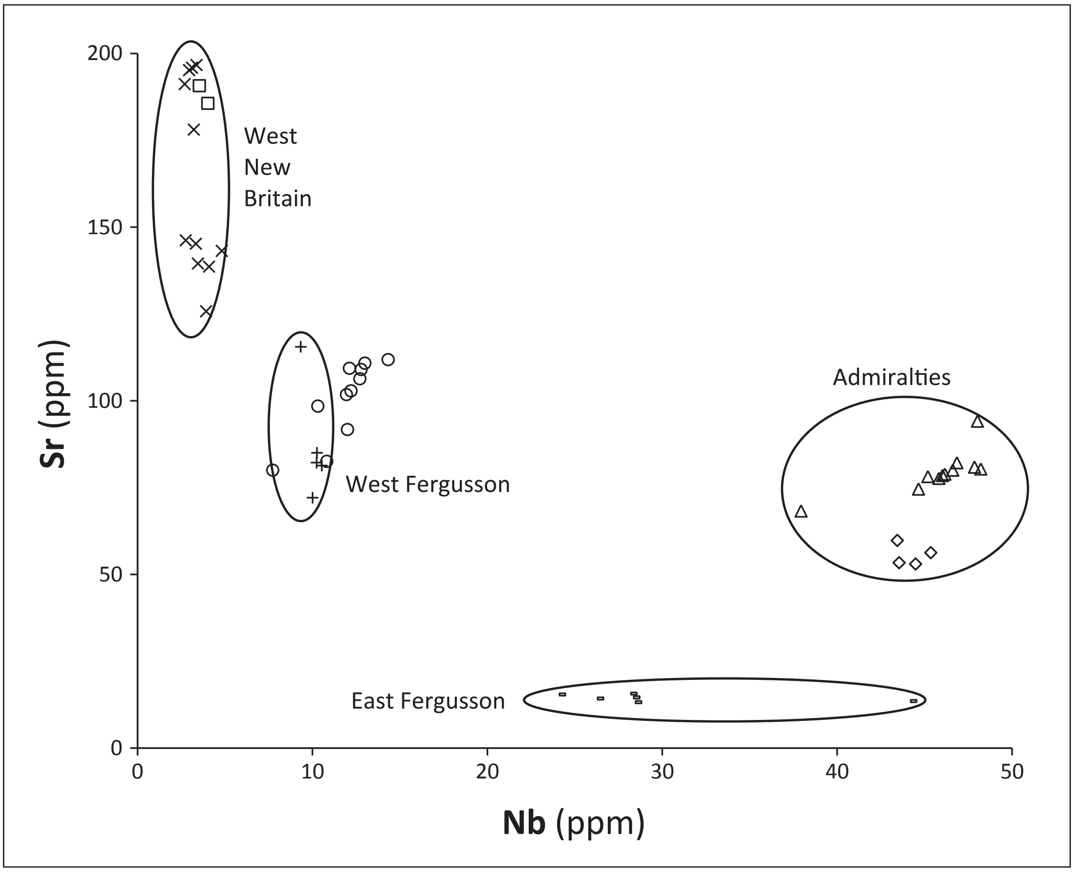

Figure 8. pXRF results comparing obsidian artefacts to source material. Note: small circles equal artefacts.

Table 4. *Calibrated data (in parts per million) for Hopo obsidian artefacts.*

Artefact	Mn	Fe	Zn	Rb	Sr	Y	Zr	Nb
HO-A-21-1	445	10536	158	140	83	26	275	11
HO-A-26-1	381	8662	31	157	103	34	369	12
HO-A-30-1	724	14640	114	178	111	30	378	13
HP-A-29-1	626	13864	100	174	112	34	406	14
HP-A-33-1	938	18489	202	160	98	25	309	10
HP-A-33-2	865	17663	130	178	109	31	369	12
HP-A-36-1	517	9335	34	157	106	32	359	13
HP-B-22-1	593	11691	281	116	80	18	235	8
HP-B-31-1	443	7422	35	133	92	31	337	12
HP-B-37-1	652	11800	138	155	102	28	339	12
HP-C-29-1	459	9784	24	170	109	34	384	13

raw material on the Kouri lowlands.

Two of these artefacts (from OJS Square A XU36 and Square B XU37) are from levels containing Lapita sherds and date to *c.* 2600 calBP (see above). Irwin and Holdaway (1996: 225–226) describe 'structural characteristics' shared by Lapita and 'Early Papuan' sites where similar pottery was used by presumably Austronesian-speaking, marine-orientated horticulturists establishing far-flung villages most often in previously unoccupied coastal locations following rapid dispersals by sea. They also point out that many of the debates about Lapita dispersal also apply to Early Papuan sites along the south coast of PNG. One of the 'structural characteristics' of the Lapita period paralleled along the south coast is that obsidian exchange appears to have been part of social relationships that maintained links between people through time and across space.

Seafaring Lapita explorers and their descendants very likely ventured westward across the Gulf of Papua in order to reach western Torres Strait (McNiven *et al.* 2006). However, the absence of obsidian in western parts of the Gulf of Papua suggests that social connections between Lapita descendant settlements did not continue into the deltaic areas west of the eastern edge of the Purari River delta. Like their ancestors, the descendants of Lapita settlers limited their settlements and social networks to the wide sandy beaches and offshore islands on the south coast of PNG. For these people, exchanging pots or sharing ideas about pottery styles as well as obsidian exchange appear to have been part of a shared cultural heritage.

The social history of obsidian exchange along the south coast of PNG resonates with the maintenance of connections in similar ways to that of the Lapita diaspora. Summerhayes (2007:26) describes Lapita colonizers moving eastward out of the Bismarck Archipelago, with 'a social system that ensured interaction between other communities needed for the survival and success of the colonization process. These Lapita settlements were socially related groups with strong communication ties.' Obsidian is also cited as a material signature of more localised social relationships during the Lapita and post-Lapita periods, whereby 'the extensive spatial distribution of obsidian in the period roughly 3,500 to 1,500 BP is likely to have been the product of the operation of many localised, intra-regional systems, with various degrees of integration or leakage between them' (Torrence and Summerhayes 1997:83).

The small amounts of obsidian available on the south coast of PNG did not move through the same social relationships that resulted in pottery reaching the western Gulf of Papua by *c.*1900 years ago (David *et al.* 2011; Rhoads 1983). We suggest that the social relationships that included obsidian exchange were limited to Lapita people and their descendants who occupied settlements on wide sandy beaches and off-shore islands from the eastern tip of PNG to the eastern edge of the Purari River delta. The western movement of obsidian appears to have been limited to relationships that imbued obsidian with social and cultural values that were not recognised by peoples with different ancestral pasts living further to the west.

Although nine of the 11 pieces of obsidian at OJT and OJS are from post-Lapita levels, the sample size is too small to speculate as to whether obsidian exchange and/or availability increased in the Kouri lowlands during the immediate post-Lapita period, as may have been the case to the east at Caution Bay (McNiven *et al.* 2011). However, we can say that obsidian continued to reach the Kouri lowlands after Lapita decoration on pots ended, which implies that social networks continued to be maintained along the south coast of PNG by descendants of Lapita peoples.

The absence of obsidian from deltaic landscapes suggests that the point where sandy beaches end marked a geographical and socio-cultural junction during the period from *c.*2900 to *c.*2000 calBP, perhaps even more so than during the ethnographic period when Motuan seafarers connected the two regions in *hiri* trade. We suggest that where the wide sandy beaches ended so, too, did social relationships that involved the movement and possibly exchange of obsidian. The social interactions that eventually brought pottery to the deltaic lowlands *c.*1900 calBP likely involved recipient groups without a heritage of obsidian exchange like that amongst Lapita people and their descendants. People living on sandy coastlines east of the Purari River delta shared a heritage involving seafaring, pottery making and access to obsidian from Fergusson Island. For them, the social interactions that included obsidian exchange helped maintain social relationships and may have also played a role in the custodianship of a shared cultural heritage.

Obsidian stopped reaching the Kouri lowlands no later than sometime within the calibrated age range 1631–1870 calBP, and possibly slightly earlier. To the east, obsidian stopped reaching Yule Island-Hall Sound when Oposisi was abandoned after 1382–1554 calBP (Allen *et al.* 2011:72). Access to obsidian continued at Amazon Bay-Mailu until a few hundred years ago, suggesting that feint semblances of past social relationships emplaced by Lapita peoples persisted over many centuries through social interactions among descendant communities, some of these interactions involving the exchange of obsidian originating from Fergusson Island.

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