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Fergusson Island Obsidian from the D'Entrecasteaux Group in a Lapita Site of the Reef Santa Cruz Group

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ABSTRACT

The use of a number of the known Pacific island obsidian sources by people assigned to the Lapita cultural complex is well established. Until now, however, such use of known sources in the D'Entrecasteaux Island Group off the northeastern Papua New Guinea coast has not been documented. This paper seeks to show that obsidian from one of the more accessible sources on Fergusson Island, Kukuia, may occasionally appear in sites of the Lapita cultural complex. It sets out the reasons for believing that one flake from a Lapita site in the Reef Islands of the Santa Cruz Group is from this source and explores some of the implications.

Keywords: OBSIDIAN, SOURCING, LAPITA, WEST FERGUSSON.

Much additional information about the distribution and initial age of exploitation of obsidian from sources on the Willaumez Peninsula of New Britain (Talasea), the Admiralty Islands (Lou, Pam) and the Banks Islands (Vanua Lava, Gaua) has appeared in the decade since Ambrose's (1976) first summary of the topic. In contrast, less has been learned about sources on or near Fergusson Island in the D'Entrecasteaux Group. This has a great deal to do with increased archaeological activity and expanding knowledge of prehistoric sites with obsidian in the Admiralty Group, Bismarck Archipelago, Buka-Bougainville, and Eastern Island Melanesia compared with limited investigations in the Massim area. But it also has to do with the apparent lack of obsidian from the Fergusson Island sources in the assemblages of the last 12,000 years recovered from the Bismarck Archipelago or in later sites in islands further east. The one possible exception is a single flake tentatively assigned to the Kukuia source on Fergusson Island, recovered in an 1100 B.C. site of the Lapita cultural complex on one of the Main Reef Islands in the Santa Cruz Group (Green 1987). Determination of the source of that flake is the subject of this article.

Villages in certain localities within the D'Entrecasteaux Group were part of the *kula*, the valuables part of the main trading network within the Massim today and in the recent past. The obsidians of the Fergusson Island area are the only known sources of this raw material within the Massim's compass (Macintyre and Young 1982: 210). One might therefore expect such a readily exchangeable item to feature strongly in ethnographic reports from the region. Yet it does not. Some accounts do state that obsidian from Fergusson Island was extensively traded within the D'Entrecasteaux Group (Tueting 1935: 11–12; Firth *et al.* 1945: 283), and from Kukuia on Fergusson Island to Vakuta in the Trobriands (Tueting 1935: 12) or from Dobu Island to the Trobriands (Tueting 1935: 13) or from Kukuia via Goodenough to Wanigela in Collingwood Bay (Tueting 1935: 24). But in most ethnographies of trade and exchange in the Massim, including the *kula*, other traditional items are emphasised. Twelve of the usual valuables or related items in the *kula*, but *not* Fergusson Island obsidian, are summarised in flow chart form by Brookfield with Hart (1971: Figure 13.4) drawing on the main ethnographic sources for that network. In contrast, they include New Britain obsidian in a similar analysis of the Vitiaz Strait trading system, and note that within this network obsidian was the item which reached everywhere and travelled farthest (Brookfield and Hart 1971: 328 and Figure 13.5). Similarly Macintyre (1983: Maps 5–11), in her detailed mapping of trade routes centering on Tubetube did not include obsidian among items for which sufficient information existed to attempt a reconstruction, mentioning it only in passing as one of the numerous raw materials in the list of *pali* goods (Macintyre 1983: Table 2). Later she explains

> Obsidian came from the Kukuya area of western Fergusson via Dobu, East Cape and Milne Bay villages, and was traded east by Tubetube people. Older people recalled its use as a cutting blade but oral evidence indicates that by the turn of the century it had been superseded by glass and metal acquired from traders. Bottles and glass fragments were valued in a similar way until as late as 1930, and descriptions of exchanges involving glass suggest that obsidian had formerly constituted a *kune* [*kula*] item, being used as *pasa* [subsidiary decorative item] for shell valuables and high-ranked axe blades. (Macintyre 1983: 212)

Thus it falls largely to archaeology to provide evidence about the distribution of obsidian from Fergusson Island sources in the recent past, both within the Massim and *kula*, and outside that region. Archaeological evidence alone will document the earlier distribution of obsidian from these sources and show when each source was first exploited.

Archaeology has so far not contributed much to our knowledge of the distribution of Fergusson obsidian within the Massim region. But it has shown that obsidian from Fergusson sources was exchanged outside that region westward to Collingwood Bay on the north coast of New Guinea, and as far as Yule Island along the South Papuan coast over the last 1000 to 2000 years (see below). In that context, the identification of a piece of West Fergusson Island obsidian in a Lapita site dating to about 1100 B.C. in the Reef/Santa Cruz Group of the outer eastern islands of the Solomons would have certain important implications. As was remarked when reporting a density measurement on an initial PIGME-PIXE analysis of the flakes:

> it would be the first time a West Fergusson artefact has been found in any site more than a couple of thousand years old, the first time any has been found in a Lapita site, and the first time any West Fergusson obsidian has been found so far to the east (Green 1987: 245).

It was therefore recommended that these claims should be treated with great caution until the flake could be subjected to further examination. This has now been done, and we present here the results which give greater certainty to the assignment of this flake to a West Fergusson source.

FERGUSSON OBSIDIAN SOURCES

Fergusson obsidian sources may be divided into two geographic groups, those from the south-western portion of Fergusson Island, and those from the eastern end of that island and the adjacent islets of Sanaroa and Dobu (Fig. 1). The two groups are usually designated respectively as the West and East Fergusson sets of sources. Three sources within the West Fergusson set may be distinguished on the basis of elemental composition (Ambrose 1976: 369–371; Bird *et al.* 1981a: 7–8, 26 and Table 3; Duerden *et al.* 1987: Table I). One is known from a number of primary and detrital localities situated around Kukuia Peninsula in a relatively old and fairly stable volcanic region. The second is in a geologically recent and very active thermal zone to the north of the peninsula around the locality of Fagalulu. The third, while geochemically most like Fagalulu, differs from it in density and lower sodium and fluorine content. It is known as source XX (West Fergusson?) because although it is attested to by extensive artefact data its precise geologic locale has yet to be pinpointed. The proximity of the artefacts to Fergusson Island and the fact that their composition is nearest to that of the known West Fergusson obsidian sources make this the most likely location of source XX.

The potential and actual locations of obsidian among the East Fergusson set of sources are more complex, and difficult to summarise. Some of these physically distinct sources, moreover, are probably of fairly recent origin, as all occur in a still active volcanic zone. One main source in North Numanuma Bay derives from somewhat older volcanic activity, and in the literature is referred to as Numanuma, or North Numanuma (old) or EF5. A second "main source" in fact consists of a cluster of elementally similar obsidians which come from three physically separate localities. One location is on the south side of Numanuma Bay at Aiasuna village on the east flank of Mount Oiua where lava has flowed in the last 100 to 200 years. It is sometimes referred to as Aiasuna (Young) or EF2. Another in the same general locale is referred to as Aiasuna (Old) or EF4 (Bird *et al.* 1981b: Table 3.2). The second location in the cluster is on the small adjacent island of Dobu to the south where recent flows of lava are again recorded. A third locality belonging to this geochemical group is on the northeast coast, north of Numanuma on the eastern flank of Lamonai Crater. These three locations are usually referred to as Aiasuna or Aiasuna-Dobu. Another major source in the set of East Fergusson obsidians has been identified from samples from Sanaroa Island, a small islet lying off the east coast of Fergusson Island. It is usually described as Sanaroa or EF1. The geologically ancient landform of the island suggests these obsidians "may have been permanently accessible for at least the last 2000 years" (Bird *et al.* 1981a: 8).

While some Sanaroa obsidian occurs as small bomb scattered obsidian boulders of high flake quality glass, other known East Fergusson sources are generally of much poorer flake quality and are usually younger (Bird *et al.* 1981a: 54). The older Numanuma source is described as "inferior crystalline partly perlitised material" (Ambrose 1976: 369) of poor flake quality that produces an irregular surface (Bird *et al.* 1981a: 54). To our knowledge it has not yet been identified in any archaeological site. A similar statement has been made that "none of the Sanaroa obsidian has so far been identified in archaeological deposits" (Bird *et al.* 1981a: 8), although in the same publication one artefact from Collingwood Bay, Mound B is attributed to this source (Bird *et al.* 1981a: 66). Because it is better quality glass and has some antiquity, it is more likely to have been used archaeologically. However, of the three major East Fergusson sources, only artefacts from the Aiasuna-Dobu source cluster have so far been identified from several archaeological contexts.

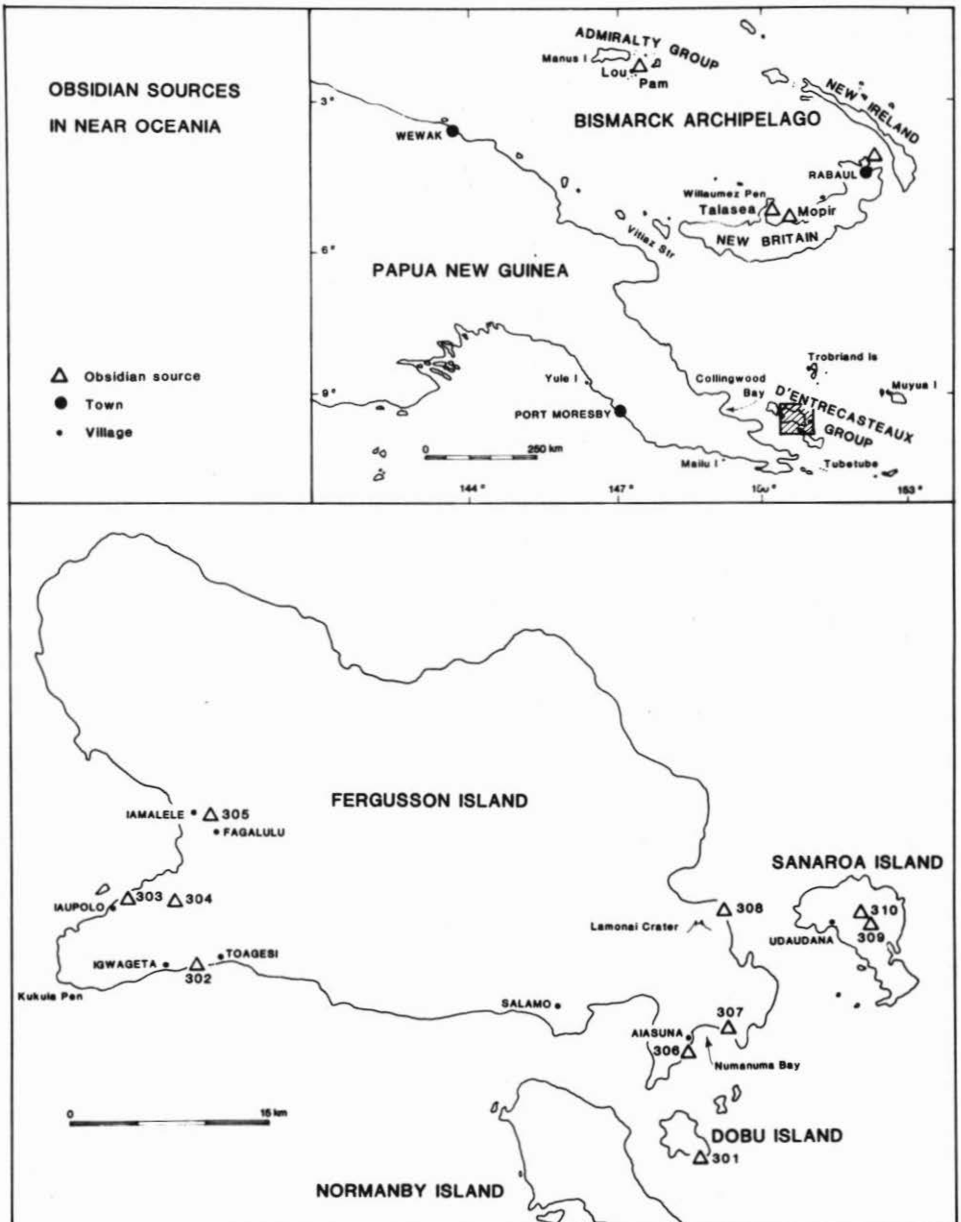

Figure 1: The location of obsidian sources in Near Oceania and especially the Fergusson Island sources in relation to places mentioned in the text.

DISTRIBUTION AND AGE OF FERGUSSON OBSIDIAN EXPLOITATION

Use of West Fergusson sources for artefact manufacture is currently much better documented than that of East Fergusson sources. Although obsidian was an important trade item in the past in the Massim (see above), the only archaeological evidence of its use in the area, based on six surface collected specimens, is that obsidian from the Kukuia West Fergusson source as well as from the Aiasuna-Dobu cluster of East Fergusson reached a site on Muyua (Murua or Woodlark) Island some 220 km away to the east (Ambrose 1976: 370; Smith *et al.* 1977: 195; Bird *et al.* 1981a:67). In the Wanigela site in Collingwood Bay on the north coast of Papua New Guinea 150 km west of Fergusson Island, obsidian from both the Kukuia and Fagalulu West Fergusson sources was extensively used in the last 1000 years, on the evidence of many excavated samples from Mounds B, C and D. The presumed West Fergusson source XX obsidian also occurred in reasonable abundance in Mounds B and D. In contrast, use of East Fergusson sources was rare. Two specimens in Mound C are from either the Sanaroa or Aiasuna-Dobu sources (Ambrose 1976: 370–371), while, as noted above, one item in Mound B is thought to be from Sanaroa and another is assigned to Aiasuna-Dobu (Bird *et al.* 1981a: 66–67). These date the use of those source localities back as much as 800 or 900 years.

Most of the obsidian so far found on the South Papuan coast has proved to be from the West Fergusson source of Kukuia. A coastal sea trip of about 650 km is required to reach the Yule Island area, the point farthest away from West Fergusson, where 3 pieces of obsidian have been found. A trip of some 570 km is necessary to reach the sites of Nebira 4 and Motupore (33 items) near Port Moresby. All of these specimens are assigned to the Kukuia source on PIGME analysis (Bird *et al.* 1981a: 69–70). All appear to be of first millennium A.D. age, the odd exceptions in later contexts probably being derived pieces (G. Irwin pers. comm. 1988). In the sites of Mailu Island, some 350 km from the Fergusson sources, the Kukuia source again dominates the 88 specimens sourced by PIGME, with 11 pieces from source XX, and one likely and one possible specimen from Fagalulu. In contrast, one specimen is almost certainly and two are possibly from an East Fergusson source, in this case the Aiasuna-Dobu cluster (Bird *et al.* 1981a: 67–69). Obsidian was still reaching Mailu up to the time of contact (Irwin 1985: 214).

These South Papuan coast data extend the age of exploitation of the West Fergusson sources of Kukuia, and probably XX, back to 2000 years ago, but add little new information about East Fergusson sources. The distribution of West Fergusson obsidian appears to coincide with the spread of ceramics along the south coast. Moreover, the regular occurrence of obsidian from the West Fergusson Kukuia source in sites is consistent with the geologically older origin of that material, its availability in beach boulder banks and stream cobbles and its presence within an old and now fairly stable volcanic area. It is probable that Kukuia has been the one good source constantly open to easy human exploitation for most of the period of human use of obsidian in the region (Bird *et al.* 1981a: 8). In sum, on the basis of existing evidence about availability, distribution, and length of exploitation of Fergusson Island obsidians, one would expect that if any Fergusson Island obsidian were to be found in a Lapita site, it would probably be an item from the obsidian source on the Kukuia Peninsula[1].

KUKUIA OBSIDIAN IN A LAPITA SITE

The above review provides the context for the attribution to Kukuia of a small flake of obsidian, ANU 511, from the SE-RF-2 site in the Main Reef Islands of the Santa Cruz Group and explains the caution with which this unexpected finding was treated. The site is dated to about 1100 B.C. It is some 1700 km from Fergusson Island in a straight line across open sea. It is at least 2300 km and may actually have been much more by a less direct but more likely island-hopping route. The first water gap on this indirect route, from Fergusson Island north to the Bismarcks, is 360 km. However, one could as easily go along the north Papua New Guinea coast to the Huon Peninsula and then through the Siassi Islands to the southwest coast of New Britain. Lapita sites are known at both these places. Obsidians from the Lou and Talasea sources have been found in the Reef and Santa Cruz Lapita sites (Green 1987), and the Fergusson Island sources are within the demonstrated range for items imported into those sites. A flake from the Kukuia source could not be discounted on grounds of improbable voyaging ability, or because it was outside the kinds of exchange now evident for the Lapita site network. Rather, doubts arose because no obsidian from any Fergusson Island source had so far been identified among the many pieces examined for source in any sites of the Lapita Cultural Complex, whether in the Bismarck Archipelago or farther east, and because such an identification would add another 1000 years to the known time of initial exploitation of the Kukuia source.

This flake was found among the 646 specimens from the SE-RF-2 site by stratifying the sample collection according to density[2]. Specimens with densities greater than 2.3870 were divided off from specimens with densities less than 2.3566. A number of pieces in this collection close to but just above the 2.3566 cutting point turned out, on elemental analysis,

TABLE 1: COMPARISON OF REEF/SANTA CRUZ ARTEFACT ANU 511 AND MAJOR OBSIDIAN SOURCES.

ELEMENT		SOURCE A	SOURCE B	SOURCE C	SOURCE D	ANU 511
F	μg/g	535	833	655	568	545
Na	%	2.69	3.79	3.10	3.53	3.35
Al	%	6.47	8.42	7.22	7.45	7.01
Si	%	33.9	25.7	30.3	33.3	30.7
K	%	3.05	5.06	4.22	3.96	3.47
Ca	%	.86	.97	.85	.53	.54
Mn	μg/g	610	1180	1080	440	440
Fe	%	1.15	2.90	2.77	1.24	1.24
Rb	μg/g	54	131	112	150	143
Sr	μg/g	210	186	109	80	74
Y	μg/g	18	19	35	17	16
Zr	μg/g	140	210	295	285	284

Source A - (Talasea) mean values for 7 samples: NB 201,211,231,243,246,252,261
Source B - (Gaua) mean values for 9 samples: NH 204,206,207,209–212,302,310
Source C - (Vanua Lava) mean values for 9 samples: NH 101–109
Source D - (Kukuia) mean values for 9 samples: WF 103,104,111,114,116,118,121,122,123
ANU 511 - (Archaeological artefact) mean values for 10 runs (see Table 2)

to come from Talasea, as did all those below it. Thus a few flakes in the collection shown to be from Talasea on elemental analysis had specific gravities as high as 2.3596, but none were over 2.3600. One flake, however, had a specific gravity of 2.3633 ± 0005 and clearly fell in the gap between the two cutting points. It is precisely this gap in density measurements between Talasea and Lou source and artefact specimens which is covered by some West Fergusson obsidian sources, although they also overlap with the Talasea density range on one end and the Lou range on the other end (Ambrose n.d.). The density of the ANU 511 flake was later checked and this time the result was 2.3631 ± 0005. Because of its unusual density, the specimen was selected for non-destructive elemental analysis by the PIGME and PIXE procedures of the Australian Nuclear Science and Technology Organisation (formerly the Australian Atomic Energy Commission) at the Lucas Heights Research Laboratories facility (Bird *et al.* 1978; Duerden *et al.* 1979; Duerden *et al.* 1980). These analyses demonstrated that the flake was from a different source to all others in the Reef/Santa Cruz collection, namely West Fergusson. However, the result was based on only one run on this specimen amongst a whole suite of other specimens from this and other sites analysed at the same time.

A further and more rigorous check on specimen ANU 511 has now been performed. Source samples from Talasea, Kukuia, Vanua Lava and Gaua were each run a number of times and ten separate measurements were made on specimen ANU 511 using a number of positions. The mean values for 12 elements are displayed in Tables 1 and 2. The element concentrations observed for ANU 511 are very similar to those for Kukuia obsidian but are slightly lower for most elements. This can be attributed to surface changes which take place after exposure of a fresh obsidian surface to the environment. The other three sources studied show much greater differences in composition when compared with ANU 511, the ratios of observed differences to the standard deviations of the measurements being 4 to 6 times greater on average.

The ratios of element concentrations are little affected by surface hydration and have been used for three different statistical clustering tests (principal components analysis, correspondence analysis and non-linear mapping; Clayton 1982). In all cases, the data for ANU 511 and Kukuia samples form a single cluster which is clearly separate from those formed by the data for the other three source types. This is shown in Figure 2 which is a plot of two parameters calculated from the measured data by principal components analysis.

TABLE 2: RESULTS FROM TEN SEPARATE ELEMENTAL ANALYSES OF ARTEFACT ANU 511.

ELEMENT		Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	MEAN
F	µg/g	546	541	526	551	552	520	548	570	560	565	545
Na	%	3.40	3.43	3.33	3.43	3.19	3.24	3.26	3.33	3.41	3.48	3.35
Al	%	7.00	6.99	6.87	7.06	6.79	6.92	6.98	7.20	7.03	7.29	7.01
Si	%	26.1	29.7	29.4	29.0	29.7	31.2	31.3	33.9	33.0	33.6	30.7
K	%	2.76	3.21	3.00	3.08	3.48	3.56	3.63	4.02	4.01	3.91	3.47
Ca	%	.43	.45	.51	.50	.53	.55	.54	.66	.72	.50	.54
Mn	µg/g	500	470	410	380	440	470	490	410	420	410	440
Fe	%	1.26	1.15	1.24	1.26	1.25	1.32	1.32	1.18	1.16	1.21	1.24
Rb	µg/g	137	135	153	152	133	127	132	153	157	146	143
Sr	µg/g	74	68	67	81	80	80	83	65	66	78	74
Y	µg/g	9	21	15	18	14	20	15	17	16	17	16
Zr	µg/g	270	270	290	320	260	280	290	280	270	310	284

The data points numbered from 50 to 59 inclusive represent the ten measurements on ANU 511 which cluster with Kukuia points (19–27). We may conclude, therefore, that all the evidence is consistent with ANU 511 and Kukuia source obsidian having the same composition, although there has been a slight change at the surface of ANU 511 as a result of long term burial.

Element concentrations measured by the PIXE-PIGME technique in other Pacific obsidians are given by Duerden *et al.* (1987: Table I) and Bird *et al.* (1988). On the basis of this information, elements which would exclude an attribution of ANU 511 to each known source are listed in Table 3. Of the 13 elements examined, only the Ti values for Kukuia (1700–2200 μg/g) lie significantly outside the mean value (1470 μg/g) for ANU 511. Because individual runs on ANU 511 showed that Ti is particularly variable, these results have not been given as Ti has proved much less useful than other elements for obsidian characterisation. After considering the other 12 elements, however, it is difficult to escape the conclusion that known sources other than Kukuia are positively eliminated and Kukuia is strongly indicated for ANU 511.

The density results, of course, are less convincing. On currently calibrated density values for the sources considered here (Ambrose n.d.), the density of ANU 511 lies at the upper margin of the one standard deviation range for Talasea obsidians, and well within the one standard deviation for source XX and Fagalulu obsidians from West Fergusson. Thus on general density measurements, all of these sources are possible. The one standard deviation range for 126 specimens from the Kukuia source is 2.385 ± .015, putting the ANU 511 value of 2.3631 ± .0005 at .0066 less than the lower end of that one standard deviation

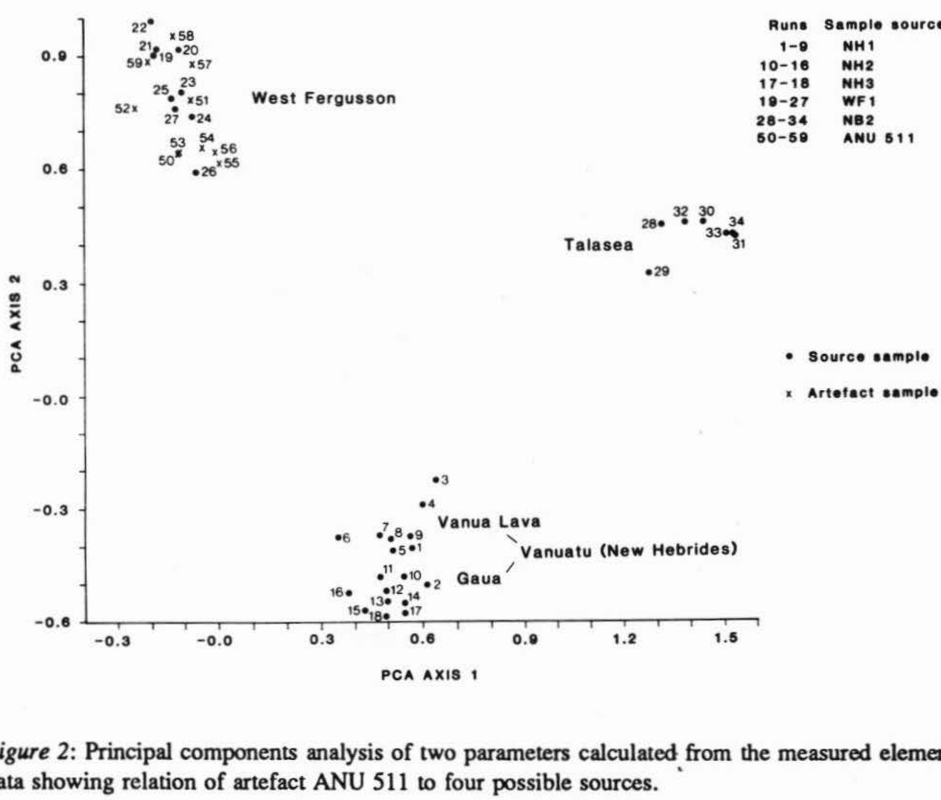

Figure 2: Principal components analysis of two parameters calculated from the measured elemental data showing relation of artefact ANU 511 to four possible sources.

value range. This, however, cannot be seen as a serious reason to reject its attribution to the Kukuia source. What it does indicate is that in individual collections density may help to stratify the sample and pick out the odd flake in the gap between Talasea and Lou sources, but will not by itself accurately source a specimen.

TABLE 3: ELEMENTS WHICH EXCLUDE ATTRIBUTION OF ARTEFACT ANU 511 TO A SOURCE.

SOURCE (S)	ELEMENTS
Admiralty Lou	F, Ca, Mn, Fe, Y
New Britain Talasea	Na, A1, Ca, Mn, Rb, Sr, Zr
New Britain Mopir	K, Ca, Mn, Rb, Sr, Zr
Fagalulu	F, K, Fe, Sr, Zr
East Fergusson	F, Na, Ca, Mn, Fe, Sr, Y, Zr
Banks	F, Ca, Mn, Fe
Artefact Group XX	F, Na, A1, K, Mn, Fe, Zr
" " ZZ	Na, A1, K, Ca, Rb, Sr, Y, Zr
" " KK	F, Na, A1, Ca, Mn, Fe, Sr, Y, Zr

There can be no absolute certainty in allocating an artefact specimen to its source (cf., Ward 1977; Leach and Manly 1982; Leach *et al.* 1986). However, in this case many of the potential sources of variation in PIXE-PIGME data (changes in the equipment used, the use of different standards for calibration, the effects of roughness, hydration and leaching, natural inhomogeneities within an obsidian flow) have been controlled by further tests and multiple runs on both the artefact sample and the sources. A Kukuia West Fergusson source for ANU 511 is now well supported and the tentative nature of its previous assignment to this source can be withdrawn.

CONCLUSION

Long distance, and probably down-the-line exchange of obsidian over some 2000 km and more by ocean voyaging between islands is now a well attested phenomenon of the exchange system that characterises the earlier Lapita Cultural Complex, but not the later trading networks of Melanesia, even though obsidian often travelled farthest within them. Several obsidian sources are usually involved in Lapita sites, although one may be dominant. In SE-RF-2, the use of three sources — Talasea, Lou and Vanua Lava — is well documented and a fourth can now be added. Three of these sources lie well to the west and more than 2000 km away. Thus a very occasional use of obsidian from a West Fergusson source fits comfortably within what was already known, even if it pushes exploitation of this apparently readily available Kukuia source back to 1100 B.C. and extends its potential range of early and widespread occurrence much further east than was previously anticipated. Because the discovery of this obsidian flake from a rarely represented source depended on a stratified sampling approach, it is possible that the other 862 obsidian artefacts from the three Reef/Santa Cruz Lapita sites which have densities of less than 2.3870 (or even 2.3566) and which have not been subjected to elemental analysis may include other non-Talasea needles in what is predominantly a Talasea obsidian haystack. Still, the procedure has helped in ways that other sampling procedures have not to find one of these very low occurrence sources within a large sample by exploiting the gap between typical Talasea densities in a collection and those of the Lou and Banks Island sources.

A further implication relates to an earlier and quite independent argument that a few pieces of muscovite garnet schist in the same Reef/Santa Cruz Lapita sites were likely to derive from the high grade metamorphic rocks on other islands of the D'Entrecasteaux Group (Green 1978). On geological and mineralogical criteria possible localities from New Caledonia to the Bismarcks all seemed able to be excluded, while potential localities further afield (the interior mountains on the main island of Papua New Guinea, locales in Indonesia, and Australia) seemed ever less probable as the distances increased and the possibilities of cultural connections grew more tenuous. The obsidian result provides unexpected support for the earlier claim that a non-obsidian import might have come from the D'Entrecasteaux Group.

Some additional observations may be made. For example, it should be noted that no Lapita sites have yet been documented within the Massim area, despite recent extensive survey work on some of the many islands in the region (G. Irwin pers. comm. 1987). It may be that the area was in fact well outside the ambit of that extensive island arc in Melanesia and West Polynesian where typical Lapita settlements are found, though within the zone from which they drew a few of their imports. Could it be that what we are seeing for the first time with this obsidian flake and the garnet schist is exchange with some non-Lapita communities? Certainly with the very much longer settlement of coastal Papua New Guinea (Groube *et al.* 1986) and the Bismarck Archipelago (Allen *et al.* 1988) that consideration is now an ever present possibility both within the Bismarck Archipelago and beyond it. To suggest that in this D'Entrecasteaux situation as well as in the Bismarcks, some of these communities might also be non-Austronesian speaking ones in contact with Austronesian speaking Lapita communities would, on the present meagre evidence, clearly be pushing the available data too far. But the prospect of developing arguments along such lines no longer seems as difficult as it once did.

NOTES

1. Two obsidian flakes (ANU 372/4 and 372/5) from a small test excavation made on the Crater Rim on Watom for the collection of a radiocarbon date, ANU 247 (Polach *et al.* 1978: 370), are indicated as deriving from the West Fergusson source on the basis of PIGME analysis (Bird *et al.* 1981a: 77). On the Al/Na and F/Na ratios used the two sources Waisisi (NB4) and Kukuia (WF1) overlap in part (Bird *et al.* 1981a: Fig. 14) leaving the certain allocation of some of the artefacts in this zone ambiguous (Bird *et al.* 1981a: Fig. 17), although in general Waisisi artefacts could be "distinguished from Kukuia obsidian by having lower concentrations of the three elements" (Bird *et al.* 1981a: 23). Subsequent work on the Watom site obsidian collection suggests a Mopir (equals Waisisi artefacts) source (Specht and Hollis 1982) as a likely alternative allocation for these two samples. Thus they should not be used as indicating West Fergusson artefact attributions until their present allocation is further examined using data from PIXE as well as PIGME elemental analysis.

2. A referee of this paper commented that this density procedure seems a lot of trouble when the PIXE/PIGME system at Lucas Heights is capable of a throughput of up to 1000 samples per week with a measurement running time of 5 to 10 minutes (Duerden *et al.* 1980). This, however, is a statement of the system's perceived potential, not the actual practice that is followed, as in reality continuous access to the facility for archaeological analysis was, in the past, very limited and had to be balanced against numerous other demands, and because the costs of the facility's use in time,

labour, and running expenses are considerable (currently $A35 per sample for a full analysis, although simpler procedures are also available). Thus archaeologists have seldom been able to have more than a few hundred samples from any one site run gratis and frequently the number is smaller. In the Reef/Santa Cruz case we could not afford the $34,020 it would take to run *all* the samples by this means just to find the statistically rare outlier. As Green (1987: 241) in discussing this point observes, even if sophisticated elemental analysis seems theoretically and procedurally possible, sampling techniques such as density separations need to be developed by *archaeologists* if progress in this field is to be made.

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Over the nine years in which the 972 obsidian samples from the three Lapita sites in the Reef/Santa Cruz islands have been subjected to various kinds of analysis to determine their sources, a number of people have been extremely helpful. In this case we would especially like to thank the following for their direct contributions and useful commentary: W.R. Ambrose, S.B. Best, P. Duerden, G.J. Irwin and an anonymous referee.

REFERENCES

Allen, J., Gosden C., Jones, R. and White, J. P. 1988. Pleistocene dates for the human occupation of New Ireland, northern Melanesia. *Nature* 331: 707–709.

Ambrose, W. R. 1976. Obsidian and its prehistoric distribution in Melanesia. *In* N. Barnard (ed.), *Ancient Chinese Bronzes and Southeast Asian Metal and Other Archaeological Artifacts*, pp. 351–78. Melbourne, National Gallery of Victoria.

Ambrose, W. R. n.d. A note on obsidian density measurements for separating Melanesian obsidian sources. Canberra. Department of Prehistory, Research School of Pacific Studies, Australian National University, 1986.

Brookfield, H. C. with Hart, D. 1971. *Melanesia, a geographical interpretation of an island world.* Methuen, London.

Bird, J. R., Russell, L. H., Scott, M. D. and Ambrose, W. R. 1978. Obsidian characterisation with elemental analysis by proton induced gamma-ray emission. *Analytical Chemistry* 50 (14): 2082–2084.

Bird, J. R., Ambrose, W. R., Russell, L. H. and Scott, M. D. 1981a. *The Characterisation of Melanesian Obsidian Sources and Artefacts Using the Proton Induced a Gamma-ray Emission (PIGME) Technique*. AAEC/E510. Lucas Heights, Australian Atomic Energy Commission.

Bird, J. R., Duerden, P., Ambrose, W. R. and Leach, B. F. 1981b. Pacific obsidian catalogue. *In* B. F. Leach and J. M. Davidson (eds), *Archaeological Studies of Pacific Stone Resources*. BAR International Series 104: 31–43.

Bird, J. R., Ambrose, W., Shahgoli, N. and Kannemeyer, C. 1988. Melanesian Obsidian. Paper presented at the 3rd Australian Archaeometry Conference, Adelaide, August 1988.

Clayton, E. 1982. Some statistical techniques for provenancing artefact material: a user's view. *In* W. Ambrose and P. Duerden (eds), *Archaeometry: an Australasian Perspective*, pp. 90–100. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Duerden, P., Cohen, D. D., Clayton, E., Bird, J. R., Ambrose, W. R. and Leach, B. F. 1979. Elemental analysis of thick obsidian samples by proton induced X-ray emission spectometry. *Analytical Chemistry* 51 (14): 2350–54.

Duerden, P., Bird, J. R., Scott, M. D., Clayton, E., Russell, L. H. and Cohen, D. D. 1980. PIXE-PIGME Studies of Artefacts. *Nuclear Instruments and Methods* 168: 447–52.

Duerden, P., Clayton, E., Bird, J. R., Ambrose, W. R. and Leach, B. F. 1987. Obsidian composition catalogue. *In* W. R. Ambrose and J. M. J. Mummery (eds), *Archaeometry: Further Australasian Studies*, pp. 232–38. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Firth, R., Davidson, J. W. and Davies, M. 1945. The South-eastern Groups. *Pacific Islands: Western Pacific (New Guinea and Islands Northward)*. Great Britain, Geographical Handbook Series, B.R.519C (Restricted), Naval Intelligence Division, Vol.IV: 283–304.

Green, R. C. 1978. Notes on adze flakes, oven stones, pumice, muscovite-garnet-schist and metamorphosed sandstone specimens from the Main Reef/Santa Cruz Lapita sites, Southeast Solomons. *Oceanic Prehistory Records* 7: 29–35.

Green, R. C. 1987. Obsidian results from Lapita sites of the Reef/Santa Cruz Islands. *In* W. R. Ambrose and J. M. J. Mummery (eds), *Archaeometry: Further Australasian Studies*, pp. 239–49. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Groube, L., Chappell, H., Muke, J. and Price, D. 1986. A 40,000 year-old human occupation site at Huon Peninsula, Papua New Guinea. *Nature* 324: 453–55.

Irwin, G. J. 1985. The emergence of Mailu: as a central place in coastal Papuan prehistory. *Terra Australis* 10. Department of Prehistory, Research School of Pacific Studies. Australian National University, Canberra.

Leach, B. F. and Manly, B. 1982. Minimum Mahalanobis Distance Functions and Lithic Source Characterisation by Multi-element Analysis. *New Zealand Journal of Archaeology* 4: 77–109.

Leach, B. F., Anderson, A., Sutton, D. G., Bird, J. R., Duerden, P. and Clayton, E. 1986. The origin of prehistoric obsidian artefacts from the Chatham and Kermadec Islands. *New Zealand Journal of Archaeology* 8: 143–70.

Macintryre, M. and Young, M. 1982. The persistence of traditional trade and ceremonial exchange in the Massim. *In* R. J. May and H. Nelson (eds), *Melanesia: Beyond Diversity*, Volume I, pp. 207–22. Research School of Pacific Studies, Australian National University, Canberra.

Macintyre, M. 1983. Changing paths: an historical ethnology of the traders of Tubetube. PhD thesis, Department of Anthropology, Research School of Pacific Studies, Australian National University.

Polach, H. A., Head, M. J. and Gower, J. D. 1978. ANU Radiocarbon Date List VI. *Radiocarbon* 20 (3): 360–85.

Smith, I. E. M., Ward, G. K., Ambrose, W. R. 1977. Geographic distribution and characterization of volcanic glasses in Oceania. *Archaeology and Physical Anthropology in Oceania* 12 (3): 173–201.

Specht, J. R. and Hollis, J. D. 1982. A new obsidian source in West New Britain, Papua New Guinea. *Mankind* 13 (5): 424–26.

Tueting, L. T. 1935. Native Trade in Southeast New Guinea. *Occasional Papers of the Bernice P. Bishop Museum* XI (15): 1–44.

Ward, G. K. 1977. On the ease of 'sourcing' artefacts and the 'difficulty' of 'knowing' prehistory. *New Zealand Archaeological Association Newsletter* 20 (3): 188–94.

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