The Source of Prehistoric Obsidian Artefacts from the Polynesian Outlier of Taumako in the Solomon Islands

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ABSTRACT

Six obsidian artefacts from the Polynesian outlier of Taumako in the Solomon Islands dating to between 500 and 1000 B.C. were analysed for trace elements by the PIXE-PIGME method. Four are shown to derive from Vanuatu, but the remaining two artefacts do not match any of the known 66 sources in the Pacific region. Continuing difficulties with the methodology of Pacific obsidian sourcing are discussed.
Keywords: OBSIDIAN, PIXE, PIGME, SOURCING, POLYNESIAN OUTLIER, TAUMAKO, SOLOMON ISLANDS, VANUATU, LAPITA.

INTRODUCTION

Excavations were carried out on several archaeological sites in the Taumako group in 1977-78 by Leach and Davidson (n.d.). Obsidian was found at only one location—at a site known as Te Ana Tavatava on the small northern island of Lakao. This site produced abundant evidence of pottery use, although many of the sherds recovered were not *in situ*, but in secondary deposition on the surface. Six pieces of obsidian were found with these pot sherds on the surface of the site, and are also believed to be in secondary deposition. This site has archaeological debris to a depth of 2 m, the bulk of which represents artificial coral gravel house floor build-up during occupation of a small village at the front of a cave. More than 84 cubic metres of this site was excavated and carefully sieved. Not one pot sherd or piece of obsidian was found in the village build-up layers, which are well dated to later than 370 B.C., and which form a continuous occupation sequence up to A.D. 1550. This is strong, but not certain, indirect evidence that the pottery and the obsidian are culturally and temporally associated. The only pottery recovered which was definitely *in situ* is from the earliest horizon which dates before the village occupation began. This horizon has two radiocarbon dates associated as follows:

Sample Number	NZ 4638	NZ 4641
Delta C13	-27.5	-24.3
T = 5568 uncorrected	2420 BP±50	2600 BP±70
T = 5730 uncorrected	2500 BP±60	2680 BP±70
T = 5730 corrected	2540 BP±60	2790 BP±0
Calendrical estimate	590 BC±60	840 BC±90

The reason for the secondary derivation of the pottery and obsidian at this site is not understood with certainty. However, there are two deep prehistoric wells which were dug late in the site's history, and which cut through the pottery bearing level. These were later filled in, and some pottery was present in these fill layers. The preferred interpretation is that pottery was manufactured in this group of islands, and a small quantity of obsidian was in circulation at the same period. Judging from the two radiocarbon dates, cited above, this is estimated to be about 1000 to 500 B.C. In passing, it might be noted that although the pottery is primarily a plain ware, some decorated sherds were recovered which belong to bowl forms typical of Lapita. Moreover, some of the decoration is dentate stamping. There are, however, few points of similarity between this pottery and that from nearby Santa Cruz and the Reef islands at the same period (Green 1976).

One important additional cultural marker is the presence of two specimens of *Tridacna* shell breast pendant in this earliest horizon of Te Ana Tavatava. These are a striking ornament form in the ethnographic period of Santa Cruz, frequently being decorated with a fretwork tortoise shell overlay (Koch 1971:114-115). At Te Ana Tavatava, these artefacts date well back into the first millennium B.C., and numerous examples were also recovered from other excavations on Taumako dating to later periods. No archaeological specimens or fragments have yet been recovered from the Santa Cruz region, and they are not known either archaeologically or ethnographically from Vanuatu. There are, however, points of similarity between Taumako and Vanuatu at later periods, especially in funebrial behaviour (Leach and Davidson n.d.).

The source or sources of obsidian artefacts found in archaeological sites in the Solomons area is of considerable importance in trying to unravel the threads of contact between these regions of the western Pacific in the first and second millennia B.C. Ambrose and Green (1972) and Green (1985) have shown that obsidian artefacts from the Reef islands and Santa Cruz in this period derive from the Admiralty Islands (Lou Island), New Britain (Talasea), D'Entrecasteaux Islands, and Vanuatu (Vanua Lava). Green argues that from 1400 to 700 B.C. obsidian from each of these regions was arriving in the South-East Solomons area, a distance of over 2000 km; but by 0 B.C., the links had shrunk to about 400 km. The distant source of Talasea clearly dominates in the earliest period. Kirch and Yen argue (1982:257-2860) that volcanic glasses from Tikopia derive from Talasea in New Britain (largely in the early period of about 900 B.C.), and the Banks Islands in Vanuatu (dominant from the late 15th century A.D. onwards), though this needs to be confirmed by more certain methods of identification. The identification of the origin of the few obsidian pieces from Taumako should be a useful additional piece in this jigsaw.

METHOD OF ANALYSIS

The six artefacts were sent to Dr R. Bird at the Atomic Energy Research Establishment at Lucas Heights in Australia for analysis by proton induced X-ray and gamma ray emission analysis (PIXE-PIGME). This technique has been described by Deurden *et al.* (1979, 1980). The analysis of these artefacts forms part of a larger project of work examining the character of obsidian sources in the Pacific region and artefacts deriving from archaeological sites (Bird *et al.* (1981). The proton beam from the accelerator excites the surface of the specimen causing characteristic X-rays to be emitted, and in addition, nuclear reactions take place which cause characteristic gamma rays to be emitted. These emissions are collected with suitable detectors, and after reference to rock standards, absolute element concentrations are determined for the artefacts. By comparing the elemental composition of the artefact with information from known geological deposits of obsidian, the source of an artefact can be established. It is important to realise that this identification process is not perfect. There are a number of important areas of uncertainty. One of these arises from the fact that one can ever be sure that all sources available to prehistoric people have been sampled and analysed (see Ambrose *et al.* 1981; Ambrose and Duerden 1982). Another serious problem is that even after numerous elements have been reliably quantified, there is still significant multivariate overlapping in the composition of some obsidian sources. This overlapping can be so complex that novel statistical methods are needed to assess the reliability of any identifications (Leach and Manly 1982; Clayton 1982).

RESULTS

The first results relating to these artefacts were obtained in 1978 using PIGME analysis. At this time, simple methods of statistical matching to sources were employed by the staff at Lucas Heights. Based on the results for Na, Al, F, and the ratios of Al/Na and F/Na, the artefacts were matched to sources as follows (Bird, 3 October, 1978: pers.comm.):

# 78.319	Kukuia (West Fergusson)
# 78.320	Vanua Lava (Vanuatu)
# 78.321	Kukuia (West Fergusson)
# 78.322	Vanua Lava (Vanuatu)
# 78.323	Vanua Lava (Vanuatu)
# 78.621	Vanua Lava (Vanuatu)

Later in the same year, PIXE-PIGME analysis was carried out on the same specimens and the artefacts at first matched to West Fergusson then appeared to belong to a source as yet unsampled. The new results confirmed the Vanuatu source of the remaining four artefacts.

Artefact # 78.319 produced gamma information close to the Kukuia source, although Na and F appeared somewhat lower; but the X-ray results for Zr/Fe and Zr/Sr were only about half the Kukuia values.

Artefact # 78.321 gave gamma information close but not identical to the Fagalulu source in the West Fergusson area, and the X-ray results for Zr/Fe and Zr/Sr differed from both Fagalulu and Kukuia.

The allocations of these two troublesome artefacts to sources were then modified to "similar to West Fergusson sources" (Bird, 16 November and 7 December 1978 pers.comm.). It should be noted that these allocations were made on the basis of raw "window data" for each element. The absolute concentrations for each artefact were subsequently worked out and are given in Table 1.

It should not be thought that this change of identification and general uncertainty surrounding allocation of artefacts to sources is a poor reflection on the method of analysis. On the contrary, the technique has a good reputation, although there are some difficulties in handling prehistoric artefacts. For one thing, it is not always easy to present a plain flat surface to the proton beam; for another, obsidian artefacts which have been buried for long periods of time are known to have a surface chemistry which is different to the interior, and this forms the basis of a well-known dating technique. Since PIXE-PIGME analysis is essentially a surface analysis method, we should expect some differences between the composition of the surface of an artefact and the chemical character of the source to which it genuinely belongs. There is little experimental information which documents just how serious this latter problem is in practice; but it is not believed to be critical (Duerden *et al.* 1980:450).

TABLE 1

Absolute element concentrations for the Taumako obsidian artefacts. Na, Al, Si-Al, K, Ca, and Fe are in %, the remainder are ppm. The Si peak has interference from Al, and is therefore given as Si-Al.

	Artefact #					
	78.319	78.320	78.321	78.322	78.323	78.621
Element						
Na	3.5	3.0	3.5	3.0	3.0	3.1
Al	6.9	7.3	7.1	7.2	7.4	7.5
F	374.2	465.1	272.2	580.3	719.9	639.7
Si-Al	23.9	33.0	38.5	21.1	33.5	37.0
K	4.5	5.1	5.3	4.0	5.1	5.0
Ca	1.0	.9	1.1	1.1	1.3	3.6
Ti	1609.0	1748.4	1651.3	1765.8	1913.9	1658.5
Mn	968.5	1014.5	1012.0	1032.6	1020.0	973.8
Fe	2.5	2.7	2.7	2.7	2.7	2.5
Zn	123.8	102.8	113.8	307.1	109.2	108.9
Ga	18.2	19.5	17.8	17.7	22.1	20.8
As	12.2	9.0	11.5	16.0	14.5	9.3
Pb	14.1	17.5	7.0	17.8	16.9	8.1
Rb	151.3	107.7	139.2	109.7	121.4	102.7
Sr	114.7	102.6	137.7	150.4	130.4	290.9
Y	28.9	38.7	14.4	36.5	31.8	23.3
Zr	287.1	283.2	272.7	254.6	287.5	251.8
Nb	.0	.0	.0	.0	3.2	52.5

If the technique of analysis is not to blame for the general uncertainty surrounding artefact allocation, what is? The complex character of the information we are dealing with should be kept in mind. It is not really surprising that there are difficulties when one considers this. In the case of these PIXE-PIGME analyses, one is dealing with information unevenly distributed through a hyperspace of 18 dimensions. Fortunately, there have been improvements in statistically evaluating where artefacts might fit in this maze of complexity. One of these, a suite of computer programs called POPPER'S RAZOR (Leach and Manly 1982), has been designed to reject incorrect sources for artefacts ruthlessly. In treating the problem as a complex one, the results must be presented in a somewhat more complex manner as well. That is, it is no longer possible to say simply this or that artefact belongs to this or that source without any qualifications. This more fairly represents the genuine situation. In the case of the Taumako artefacts, the results of POPPER'S RAZOR are presented in Table 2. These results derived from information on 18 elements for 66 known sources of obsidian in the Pacific region. This Table can be summarised as follows:

	POPPER'S RAZOR	Earlier Evaluation
# 78.319	Vanuatu definite	? Kukuia (West Fergusson)
# 78.320	Vanuatu definite	Vanua Lava (Vanuatu)
# 78.321	No source known	? Kukuia (West Fergusson)
# 78.322	Vanuatu definite	Vanua Lava (Vanuatu)
# 78.323	Vanuatu definite	Vanua Lava (Vanuatu)
# 78.621	No source known	Vanua Lava (Vanuatu)

There appears to be little difference between the results for absolute concentrations and those of element ratios. It has often been thought that taking ratios leads to greater reliability, because it tends to remove machine dependant conditions. The close similarity of the results here probably indicates smooth running conditions throughout the analyses. It will be noted, however, that the earlier evaluations made on the basis of simple statistical techniques and/or eyeball matching of artefacts to sources have not been uniformly confirmed by POPPER'S RAZOR. Two artefacts still appear to be difficult to match to any known source, but they are not the same pair as earlier thought! It may also be noted that one of these artefacts, # 78.621, is apparently closest to some obsidian from Tikopia. This is a single piece of obsidian from Tikopia which is not believed to derive from a geological deposit on the island (Kirch 1979: pers.comm.), although the elemental character of this piece is quite unlike any known source in the Pacific region.

TABLE 2

Source allocations for Taumako artefacts using POPPER'S RAZOR. For each artefact, the closest three sources are given. In column A, the standardised multivariate distances to the source centroid are given. On average, pieces of obsidian will be about 1.0 units of distance from their correct source. In column B, the significance of these distances are given. NS ($p>.05$), PS ($p<.05$ $>.01$), S ($p<.01$ $>.001$), HS ($p<.001$).

	Based on absolute concentrations			Based on Element ratios		
Artefact	A	B	Source	A	B	Source
# 78.319	2.0	PS	Vanua Lava, Vanuatu	2.5	PS	Vanua Lava, Vanuatu
	2.6	NS	Losa Bay, Vanuatu	2.7	NS	Losa Bay, Vanuatu
	3.8	HS	Fagalulu, West Fergusson	5.0	HS	Purangi, New Zealand
# 78.320	1.4	NS	Vanua Lava, Vanuatu	1.1	NS	Vanua Lava, Vanuatu
	1.4	NS	Losa Bay, Vanuatu	1.1	NS	Losa Bay, Vanuatu
	3.9	HS	Igwageta, West Fergusson	3.9	HS	Gaua, Vanuatu
# 78.321	4.3	HS	Taupo, New Zealand	5.7	HS	Purangi, New Zealand
	4.7	HS	Tairua, New Zealand	5.8	HS	Cooks Bay, New Zealand
	4.8	HS	Fagalulu, West Fergusson	6.0	HS	Vanua Lava, Vanuatu
# 78.322	1.5	NS	Vanua Lava, Vanuatu	1.1	NS	Vanua Lava, Vanuatu
	2.4	NS	Losa Bay, Vanuatu	1.7	NS	Losa Bay, Vanuatu
	3.6	HS	Gaua, Vanuatu	2.5	PS	Gaua, Vanuatu
# 78.323	0.5	NS	Vanua Lava, Vanuatu	0.4	NS	Vanua Lava, Vanuatu
	0.7	NS	Losa Bay, Vanuatu	0.6	NS	Losa Bay, Vanuatu
	2.7	S	Gaua, Vanuatu	2.4	PS	Gaua, Vanuatu
# 78.621	5.7	HS	Talasea, New Britain	5.0	S	Tikopia, Solomons
	6.1	HS	Garua, New Britain	5.9	HS	Gaua, Vanuatu
	6.4	HS	Vanua Lava, Vanuatu	6.1	HS	Vanua Lava, Vanuatu

DISCUSSION

The people in the Taumako group in the first millennium B.C. obtained obsidian from the Vanuatu area, and from some other source in the Pacific as yet unknown. Just how they obtained this obsidian is an open question. Taumako is about 450 km from Vanua Lava in Vanuatu, 320 km from Tikopia, and 107 km from the Reef islands. The obsidian artefacts in the Reef Islands in this era largely derive from Talasea, although Vanua Lava material is also reasonably well represented. It is therefore possible that whatever contact there was which resulted in obsidian getting to Taumako was between the Reef islands and Taumako. The fact that Talasea obsidian has not been shown to have been present on Taumako does not rule this out—it is after all only a very small sample. What prehistorians wish to know from sourcing obsidian artefacts is the nature of human social contact in the past. Basic to this enquiry is the identification of who the participants of this contact were. In this present example it is known that one group of participants were people who lived on Taumako; but who were the others? This cannot be decided from the obsidian evidence. It can only be inferred after complex argument concerning cultural parallels at the relevant period of time, relative distances between islands, and perhaps the strength and direction of ocean currents in the region, and so on. Resolving these arguments is beyond the scope of this paper (see Leach and Davidson n.d.).

This attempt to find the sources of six prehistoric obsidian artefacts from the Taumako group of islands is instructive from a number of points of view. While there may be considerable confidence amongst the scientific community in these sophisticated methods of elemental and statistical analysis, a prehistorian would be forgiven if he viewed the "final" identifications of individual artefacts with hesitation. Although confidence could be placed in the proportions of items deriving from the main sources of supply, it would be wise not to make bold interpretations on the basis of a single unusual result. Prehistorians are frequently interested in the sources of individual obsidian artefacts. The most disquieting feature of the present analysis of these six artefacts is that the sources of only three are confirmed by all evaluations. The view is presented here that existing sourcing technology is not yet sufficiently well developed to be able to rely on individual results. An excellent example of this type of problem was recently illustrated when obsidian artefacts ascribed to different sources were later shown to be fragments of the same individual pieces by joining them together (Brassey and Seelenfreund, 1984:40). In using statistical criteria to sort items into categories, it is inevitable that such errors will be made from time to time. Individual items in the two tails of overlapping distributions which have been further spread by the vagaries of surface chemical degradation and instrumental drift will sometimes fall into the wrong category. However, although the result for an individual artefact may not be fully trustworthy, on average, the relative proportions in the two categories should remain correct.

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