The obsidian sources and distribution systems emanating from Gaua and Vanua Lava in the Banks Islands of Vanuatu

Chief Investigator Dr Stuart Bedford
Research School of Pacific and Asian Studies, Australian National University

Students Mr. Christian Reepmeyer
ANSTO Investigators Mihail Ionescu

Modelling exchange systems in prehistory has always been a major focus of archaeological research in the past, mainly for its value for explaining the relationship between the distribution of material culture and the interdependent social structures.

Due to its strategic location for the region of the Western Pacific, northern Vanuatu has acted as a crossroad between other archipelagos from the time of initial human colonisation onwards.

Research undertaken on adjacent Islands groups such as the southern Solomon Islands as well as the central Islands of Vanuatu show the widespread use of Banks Islands obsidian. However, since the early 70s of the last century no further research has been undertaken to distinctively identify obsidian sources on the Banks Islands.

Several scientific questions on Banks Islands obsidian arose in the last two decades which made it necessary to re-assess previous research and to focus on attaining the same high standard of source characterization as already developed for the Admiralty Islands and West New Britain in the Bismarck Archipelago of PNG.

The necessity to use PIXE-PIGME to re-assess previous data is twofold. PIXE-PIGME is so far the only analytical method in which whole artefacts can be non-destructively analysed. This became especially important as part of the re-analysed material is hosted in the Bishop Museum collection (Hawaii), which made it impossible to extract sample material from the artefacts.

The second objective was to analyse source samples which were systematically collected in the field in 2006. The focus was to assess intra-source variation and find evidence if more than the two previously found obsidian sources in Vanuatu existed and were utilised in the past (Ambrose 1976; Bird et al. 1981; Duerden et al. 1987). Additionally, comparison studies between PIXE-PIGME and LA-ICP-MS were conducted to incorporate previous extensive research on Pacific obsidian sources (Bird 1996; Summerhayes 2004; Torrence et al. 1992) with the new data collected in 2006/2007.

Twenty-nine source samples from the two detected obsidian sources of northern Vanuatu were examined. Furthermore 29 samples from archaeological sites on Tikopia, Southern Solomon Islands, were analysed to expand the preliminary research which has been done on these sites in the early 80s (Green 1987; Kirch & Yen 1982; Kirch 1991). These samples were selected after macroscopic examinations could not clearly identify an obsidian allocation. Additionally five samples from the important early Lapita site on Reef/Santa Cruz SZ-23 were included. Chemical elements were selected for measurement based on previous work which has shown that they produce excellent discrimination (Bird et al. 1997; Summerhayes et al. 1998): F, Na and Al measured on PIGME and Si, K, Ca, Ti, Mn, Fe, Cu, Co, Zn, Sr, Y, Zr, Br and Ga measured with PIXE.
For multivariate statistical analysis (PCA; Figure 1) ten variables were included. Absolute measurements of Fluorine and Potassium and in addition the ratios of F/Na, Al/Na, Mn/Fe, Zr/Fe, K/Fe, Ca/Fe, Sr/Fe and Y/Fe were used. Fluorine and Potassium counts were log transformed, as covariance matrices were employed.

The PCA is heavily influenced by K/Fe on the first axis and Ca/Fe, Al/Na and F on the second axis. The first two components explain a variance of approx. 94%. The five included source areas (West New Britain (▲), Lou (■), Manus new (□), D’Entrecasteaux (x) and the two Vanuatu sources (Vanua Lava = ●; Gaua = ○) plot unambiguously.

The pattern of the PCA results on the Tikopia artefacts is not unambiguous. The artefacts (▼) plot in four clusters: one cluster is centred on the Vanuatu sources, but with extensive overlapping to the Lou sources. A second cluster can be assigned to the West New Britain sources, but with no detailed allocation to one of the sub-sources. Two samples are possible to source to the Admiralty Islands: one plots close to the newfound source in Western Manus (Torrence, pers. comm.) and one sample plot unambiguously into the Lou cluster.

Focussing on several diagnostic elements (K, F, Ca, Fe, Zr and Y; Figure 2-4) the provenance of the artefacts becomes clearer. Several authors (Ambrose 1976; Bird 1996; Duerden et al. 1987) already mentioned the high K and Na content of the Vanuatu obsidian sources, which matches the high alkaline content of the northern New Hebrides Arc. A medium amount of 750ppm F for Vanua Lava and/or 950ppm F for the Gaua source makes it possible to easily distinguish these sources from the Lou sources which have on average >1200ppm F. The new obsidian source from West Manus, however, show similar amounts as the Vanua Lava source, but with clearly lower K rates. The pattern is repeated in the Ca-Fe and Zr-Y diagrams.

This distribution resulted in the source allocation of the analysed artefacts to three different obsidian sources (table below).

<table>
<thead>
<tr>
<th>Source</th>
<th>Sub-source</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanuatu</td>
<td>Vanua Lava</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Gaua</td>
<td>1</td>
</tr>
<tr>
<td>Admiralty Islands</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>West New Britain</td>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>

Three artefacts had low counts in the PIXE analysis, but showed good results with PIGME, so that a preliminary provenance allocation is possible. Fluorine contents of 570, 780 and 920 ppm supports a sourcing to respectively West New Britain, Vanua Lava (or Manus) and Gaua.

Recently Spriggs et al. (in prep.) challenged the assumption of an import of West New Britain obsidian in the early Kiki phase into Tikopia sites. Re-examination of the density-measurements from Kirch and Yen (1982) showed an overwhelming use of Vanua Lava obsidian with a missing import from the Gaua source. Re-analysed pieces from TK36 which were previously sourced to West New Britain showed an unambiguous Admiralty Islands elemental composition. This data was recently supported by LA-ICP-MS analyses (Reepmeyer, in prep.).

Through macroscopic analysis of every artefact from site TK36 one further artefact was detected which showed promising attributes for a West New Britain source allocation. This artefact (TK36-A4-12) was included in the analysis. Unfortunately the artefact showed low totals in the PIXE analyses. PIGME, however, gave a F count of 570ppm which is determining for the West New Britain sources (Bird et al. 1997). Supporting the hypothesis of an import of West New Britain obsidians into Tikopia during Lapita times, which is analogous with the current hypothesis of a widespread use of West New Britain obsidians in many Lapita sites throughout the Western Pacific (Summerhayes 2004).

The second objective of this project, determining inter-method variability, proves to be more complex. Several authors already mentioned the variability in comparing different analytical methods (Bellot-Gurlet et al. 2005; Bugoi et al. 2004). A variability of up to 20% can be expected (Bailey, pers. comm.). These results are supported by this new research. In comparison to the ICPMS results, which are consistent in the quoted elements (and in the further elements identified), an increasing inconsistency especially in the trace element identification of the PIXE analysis can be detected (Figure 5).

However, in the comparison of element means these inconsistencies are equalized (Figure 6). This research is progressing with more data incorporated from the LA-ICP-MS analysis.

**Benefits for the Australian community**

Supporting research programs with smaller Pacific Island neighbours fosters Australia’s relationship with those countries generally. This research will enhance understanding of the region’s deep human past and the way it
articulates historically with the rest of the world. It will advance Australia’s understanding of its nearest neighbours as well as provide those neighbours with information that goes towards strengthening national identity. This is beneficial for sustained relationships that enhance political stability and regional security of Australia and its wider region.

References


Figure 1: Principle Component Analysis.
Figure 2: Absolute counts of Fluorine and Potassium.

Figure 3: Absolute counts Calcium and Iron.
Figure 4: Absolute counts of Yttrium and Zirconium (Axes in logarithmic scaling).

Figure 5: Ratio of LA-ICP-MS and PIXE-PIGME data. Selected samples only.
Figure 6: Ratio of LA-ICP-MS and PIXE-PIGME data. Mean of source samples.

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PhD STUDENTS

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