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SOURCING MAYOR ISLAND OBSIDIAN

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Introduction

The recent introduction of portable energy-dispersive XRF (PXRF or EDXRF) has provided an opportunity to carry out non-destructive chemical analyses of obsidian and other lithic materials with greater reliability than was achievable in the past. This represents a significant technological advance, and in successfully sourcing a large obsidian assemblage from an early site on Ponui Island near Auckland, Sheppard et al. (2011) have clearly demonstrated the advantages of using PXRF. However, their statement (p.45) in relation to visual sourcing that "although this can be effective in the hands of skilled analysts with appropriate reference collections (Furey 2002, Jones 2002), it is hard to objectively assess the quality of the results provided by different analysts" also casts doubt on the continuing use of physical or visual characteristics in the identification of obsidian sources in New Zealand. It seems appropriate, therefore, to consider some of the current options for sourcing of obsidian, and in particular whether artefact material originating from Mayor Island can be reliably identified on the basis of visual characteristics only, or requires the use of PXRF to be certain. Although my comments relate mainly to Mayor Island obsidian, they are applicable to that from other sources as well.

Sourcing methods

Recent studies have employed three different approaches to the identification of Mayor Island (and other) obsidian:

1. visual examination only (e.g. Walter et al. 2010, 2011)
2. a combination of visual and PXRF analysis (e.g. Cruickshank 2011, Moore 2011, 2012, Mosley and McCoy 2011)
3. PXRF analysis only (e.g. McCoy et al. 2010, Sheppard et al. 2011)

Visual identification

Mayor Island obsidian has been identified on the basis of its distinctive olive green colour in transmitted light since the 1960s, and clearly some archaeologists still consider this to be a sufficiently reliable means of source

attribution (e.g. Walter et al. 2010, 2011). The only other flake quality obsidian with a greenish colour is that from the Pungaere (or Kaeo) source in Northland (Moore 2012, in press). While there can be some difficulty in distinguishing between these, particularly in the absence of reference material, my own observations and studies by others indicate the number of artefacts that cannot be confidently attributed to one or other of these sources is likely to be small (e.g. Furey 2002, Moore 1988). For example, my re-analysis of an assemblage from the Motutoa site at Hokianga suggests that Frederickson's (1990) original assignment of all obsidian to the Pungaere source, based on visual characteristics only, was probably close to if not 100 per cent correct.

To my knowledge no specific study of the results obtained from visual sourcing by different analysts has ever been undertaken in New Zealand. There is one case, however, involving the partial analysis of an assemblage from the early site of Houhora in Northland, where the results obtained by chemical analysis (EDXRF) have been subsequently checked by visual examination by three different archaeologists, enabling a useful comparison to be made (Table 1). The initial EDXRF analysis of 300 randomly selected flakes (from a total of about 3000) indicated that 64 per cent were most likely from Mayor Island and 18 per cent from 'Northland' (presumably Pungaere); 15 per cent were uncertain but apparently from either Mayor or Northland (Seelenfreund and Bollong 1989). Of these, 254 were subsequently examined visually by Martin Jones, who reported slightly higher proportions for Mayor Island and 'Northland' obsidian but considerably fewer unknowns (Furey 2002: 108). My own analysis of the same collection, undertaken in 2011, produced fairly similar results. An entirely separate collection of 873 flakes, visually sorted by Louise Furey, gave proportions of 66 per cent Mayor and 28 per cent Northland, which are more likely to be closer to the true figures for this site, because the flakes were selected from all cultural layers.

In this case the proportions determined from the three visual analyses (and EDXRF) are sufficiently similar to suggest that Mayor Island obsidian can be identified with reasonable confidence by different analysts, even in the presence of significant quantities of Pungaere material. A considerable degree of consistency among the analysts is reflected in the similar level of uncertainty in the results (3-6 per cent).

Visual and PXRF analysis combined

In my opinion this is the best method of sourcing larger obsidian assemblages as the visual examination removes the requirement for chemical analysis of potentially hundreds of samples and provides an independent check on the reliability of the PXRF results. It is also more 'hands-on' than PXRF analysis

alone, creating an opportunity to obtain additional information (e.g. on cortex) that may be of value in determining the original nature of the utilised material and assessing the means of procurement (Moore 2012).

Table 1. Comparison of analyses of 'green' obsidian from Houhora ('grey' obsidian excluded). Data mainly from Furey (2002).

Method of analysis	N	Mayor Island	Pungaere	Uncertain
EDXRF	300	64%	18%	15%
Visual (Jones)	254	68%	21%	< 6%
Visual (Moore)	254	73%	19%	4%
Visual (Furey)	873	66%	28%	3%

The unpublished analysis by Arden Cruickshank (2011) of a very large obsidian assemblage (approximately 6500 pieces) from site R11/859 at Mangere, Auckland, is a good example of this approach. In this case the entire collection was initially divided into six different groups based on a range of visual characteristics. Up to 30 pieces from each group (150 in total) were then selected at random for PXRF analysis. About 30 per cent of the total assemblage (N = 2015) was 'green' in transmitted light, and all 30 pieces subjected to chemical analysis were confirmed as being from Mayor Island. Personally, I would have analysed only those pieces where there was some uncertainty over the source assignment (i.e. mainly the 'grey' obsidian), but otherwise this was an effective way of dealing with such an assemblage.

Another recent study involved a small obsidian assemblage (N = 92) from the Wakanui site L37/8 in Canterbury (Mosley and McCoy 2010). Initial visual examination indicated that 71 flakes (77 per cent) were olive green in transmitted light and thus most likely from Mayor Island. Subsequent EDXRF analysis of the bulk of the collection confirmed that at least 65 (92 per cent) of the 'green' group were from Mayor, but also revealed that two were from Kaeo; four were too small and/or thin for analysis. The fact that two of the 'green' flakes were not from Mayor Island could be seen as a failure of visual sourcing, but of course had they been of unsuitable size this would not have been picked up by EDXRF analysis either. The obvious lesson to be learned from this study is that although most of the 'green' obsidian will be from Mayor Island (except in Northland), there is a possibility that a certain amount may not.

PXRF analysis alone

As I see it, there are several problems with this approach. Firstly, since

it completely ignores the visual characteristics of the obsidian, there is no way of establishing whether the results are consistent with what is known about the physical nature of the source (for example, if the designated source is primarily detrital, do any of the flakes have a water-worn cortex?). Secondly, the sample selected for analysis is likely to be somewhat biased because of the requirement that pieces are generally >10 mm in size (or > 1 g), of suitable thickness and have relatively flat or smooth surfaces (Mosley and McCoy 2010, Sheppard et al. 2011). This means that the number of pieces analysed may represent only a proportion of the total assemblage, and the remainder are not sourced at all. Thirdly, unless the raw analytical data are presented it makes it difficult for others to judge the quality of the results.

In the case study presented by Sheppard et al. (2011), the number selected for PXRF analysis constituted only 60 per cent (N = 565) of the total assemblage. Of the pieces in this sample 68 per cent (N = 382) were attributed to Mayor Island on the basis of their high Zr (zirconium) content. I have no reason to doubt that the source assignment is correct, but it leaves me wondering whether the proportion of Mayor Island obsidian (and that from all nine other sources) would be any different if the remaining 40 per cent of the assemblage had also been analysed. It is also disappointing that Sheppard et al. (2011) make no mention of the data previously reported by Nicholls (1964) from the same site. According to her analysis, by visual examination only, the two lower cultural levels contained 70-71 per cent 'green' obsidian which, based on my own analysis (Moore 2012), was almost certainly all from Mayor Island. These two levels are presumably equivalent to the main cultural layer referred to by Sheppard et al. (2011), although they make no comment on that. Considering there is likely to be a certain degree of spatial variation in the obsidian throughout the site, the two figures (68 per cent and 70-71 per cent) are remarkably similar. In effect, then, the PXRF analysis of 382 pieces of Mayor Island obsidian has done little more than confirm Nicholls' (1964) original data.

A similar study, using the Otago University PXRF (Bruker AXS), has also been carried out on a smaller collection from Mt. Wellington (Maungarei) in Auckland city (Davidson 2011). In this case only 64 per cent (N = 121 pieces) of the total assemblage was analysed because 68 pieces were too thin to obtain reliable X-ray spectra. Again this raises the issue of whether the relative proportions indicated from partial PXRF analysis are entirely reliable. The proportion of Mayor Island obsidian was 12 per cent (N = 15), but if many of the remaining unanalysed pieces were also 'green' this figure may not be correct.

Discussion

It is evident from the various case studies reviewed here that although we

now have access to PXRF, there is no obvious reason to discard visual sourcing completely. Available evidence supports the prevailing view that most obsidian which is green in transmitted light originated from Mayor Island, except in Northland, where there is some potential for confusion with Pungaere material. Yet even in cases where both sources are represented, as at Houhora, the level of uncertainty may be only about 5 per cent. It is probably reasonable to assume, therefore, that sourcing of Mayor Island obsidian on the basis of its colour will generally be >90 per cent correct.

There is no doubt that PXRF is capable of providing reliable data, but I question whether the analysis of hundreds of pieces of Mayor Island obsidian is actually an effective use of resources. Sheppard et al. (2011) do not say how long it took to carry out analysis of the Mayor Island obsidian alone (382 pieces), but the actual running time was 6 minutes per sample. That equates to 38 hours, and therefore the analysis presumably took around five days. In comparison, this number of pieces could be easily identified by visual examination in one day, though not necessarily with 100 per cent reliability; the only equipment required is a suitable light source.

Is there really a need for great accuracy? Since only 60 per cent of the Ponui assemblage was analysed then exact numbers are almost meaningless. What we are trying to establish from sourcing studies, presumably, is where the obsidian has come from and in roughly what quantity, so the data we actually require are reliable source assignments and relative proportions. It probably makes little difference whether the percentage of Mayor Island obsidian from the Ponui site is 68 per cent or 70 per cent because ±2 per cent is likely to be less than the intra-site variation anyway.

In my opinion, the best option would be to initially examine all 'green' obsidian visually and restrict PXRF analysis to those pieces where there was some uncertainty over their source. These tend to be pieces that are too thick, water-worn or sand-blasted to allow good light penetration. This approach is likely to produce better results than the partial analysis of assemblages by PXRF alone, and to be more cost-effective.

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