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ISLA DE PASCUA OBSIDIAN

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ABSTRACT: A survey of obsidian source sites at Isla de Pascua shows that there are four separate sources. Measurements of composition by the PIXE-PIGME technique show that two of the four sources can be distinguished on the basis of composition and that all Isla de Pascua obsidian can be distinguished from other known sources in the South Pacific. Density and appearance are also useful for characterising the four Isla de Pascua sources.

INTRODUCTION

Isla de Pascua (Easter Island) is volcanic in origin and has a number of obsidian deposits while artefacts and other small pieces are found throughout the island. It has been generally accepted (e.g. Evans, 1965; 'Stevenson et al., 1984) that there are three obsidian sources at Maunga Orito, Rano Kau and Motu Iti. Baker (1974) described three occurrences at Maunga Orito, Te Manavai and Motu Iti. Two areas marked "afloramiento obsidiana" are shown in an archaeological map prepared by a group from the University of Chile; these are at the northwest lip of the Rano Kau caldera and at Te Manavai on the northeast slope of Rano Kau. An obsidian quarry ("Hatu Mataa") is marked on the slopes of Maunga Orito. Prehistoric exploitation of this field has been studied by Stevenson et al. (1984). Obsidian at all these locations is clearly visible from neighbouring roads and the offshore islet Motu Iti is another well known source of obsidian. There are therefore four sources rather than three. It seems that in most cases, material which has previously been described as from Rano Kau is likely to be that which is here named Te Manavai whereas the Rano Kau NW material has usually not been considered. A reference set of obsidian source samples, was collected during a visit to Isla de Pascua in January 1986 by members of the Australian Museum Society.

OBSIDIAN SOURCES

The geology and geochemistry of Isla de Pascua have been described by Baker (1974). Three major areas of volcanic activity account for the triangular shape of the island (Figure 1). Poike, the first centre of activity, forms the peninsula at the east and Rano Kau occupies the peninsula at the southwest. The more extensive basaltic flows from M. Terevaka (506 m) form the main part of the island linking the two earlier areas. Many small hills, craters and

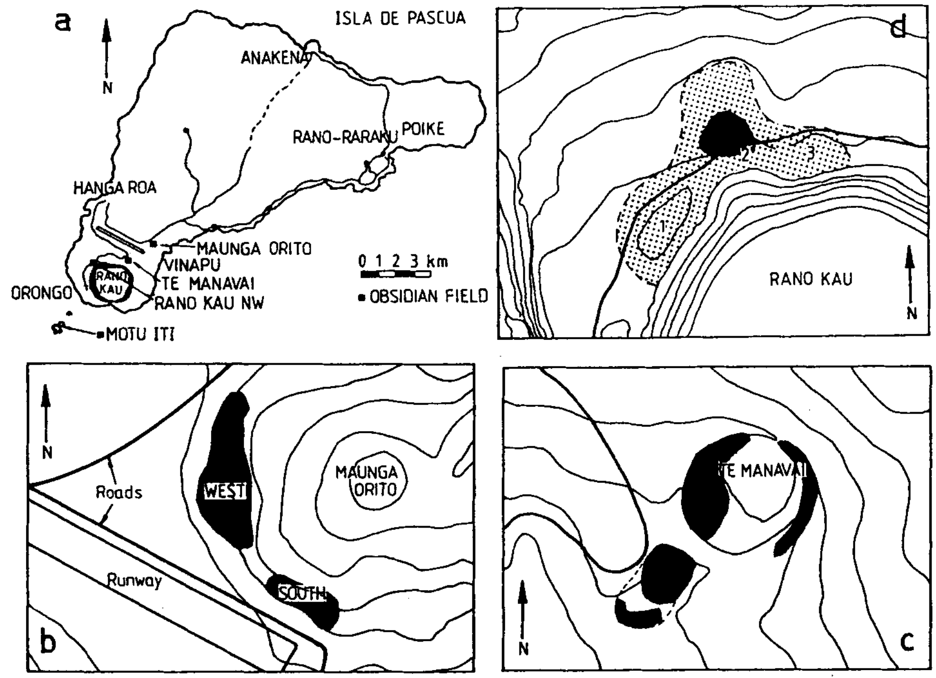

Figure 1. Location of Isla de Pascua obsidian fields: a. general map; b. Maunga Orito field; c. Te Manavai field; d. Ranokau Northwest field.

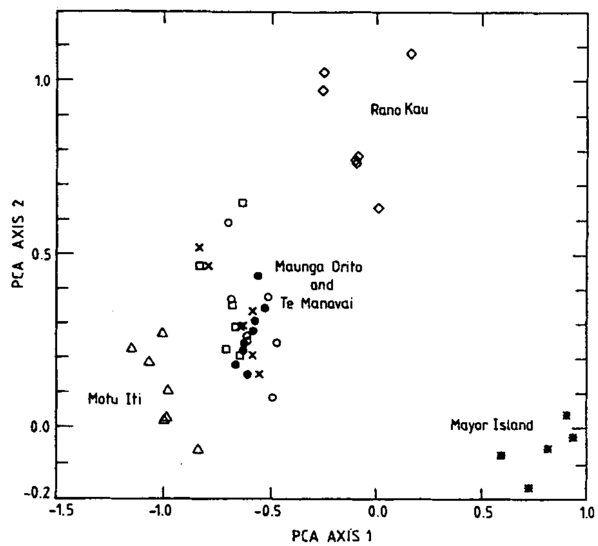

Figure 2. Principal components analysis based on nine element ratios showing separate clusters for Motu Iti and Ranokau Northwest obsidian and the clear separation of Mayor Island obsidian.

flows have been formed by activity subsidiary to these three main centres. Acidic rocks (rhyolites and obsidian) are found only in the southwest and the islets offshore and the obsidian sites occur close to a NE/SW line. They are attributed to fissure activity during a single phase in the evolution of Rano Kau. However, it was found in this work that each obsidian occurrence has characteristic features and it may be concluded that they were not part of a single uniform flow. The location of the four obsidian fields is shown in Figure 1a and in more detail as shaded areas in Figures 1b to 1d.

Except for Motu Iti, the obsidian fields consist mostly of fractured material exposed by surface erosion and human activity. Original material is embedded in soft rock, clay or soil. There are occasional visible veins which have near vertical dip and are sometimes deformed. These veins contain thin parallel plates or thicker slabs separated by trachyte or rhyolite. They are generally at right angles to the line of the proposed fissure.

Maunga Orito: Maunga Orito is a steep hillock rising to 220 m at the northeast of Rano Kau but separated from this by the valley containing the airport runway. Obsidian occurs on the steeper areas of the south and west flanks between approximately 100 and 125 m (Figure 1b). An area of low density on the southwest side divides the field into two portions - south and west. On the shallower slope, perhaps 50 to 100 m above the west end of the south field, an area of slumping and erosion has exposed veins of obsidian. The veins are 1 to 3 cm thick and are oriented approximately east-west. They are deformed and tilted close to the vertical and interbedded with soft white trachyte. Similar veins are exposed occasionally elsewhere and there is some occurrence of obsidian elsewhere around M. Orito.

Te Manavai: Manavai (or Mamavai) is a term used to describe shelters erected to surround garden areas. The Te Manavai obsidian field occurs around a natural feature which could serve the same purpose. It is a small subsidiary crater (approximately 450 m diameter) at 150 to 200m elevation on the northeast flank of Rano Kau across the valley (and runway) from M. Orito. Obsidian occurs around the rim and on some parts of the inside and outside slopes of the crater (Figure 1c). It is mostly rather thinly dispersed but occasional dense patches occur. The most obvious of these is beside the road on a small plateau which is the southwestern expression of the subsidiary crater on the uphill slope of Rano Kau. Thin veins of obsidian are found in the centre of the plateau and a small area separated from the southwestern end. They are tilted close to the vertical and interbedded with soft rock, possibly trachyte. A small pit at the centre of the plateau shows small obsidian pieces embedded in rock, clay or soil to a depth of 50 cm.

Rano Kau NW: The Rano Kau northwest field covers three crests on the northwest rim of the Rano Kau caldera and extends into a shallow hollow below the road to Orongo (Figure 1d). Two of the crests are to the east of the point where the road comes closest to the rim and the third and larger crest lies to the southwest of this point. The obsidian density is relatively low except on the central crest just above and below the road (approximately between the 260 and 280 m contours). Drainage pits on the uphill side of the road show obsidian pieces embedded in soil and clay to a depth of 50 to 150 cm.

Motu Iti: The islet of Motu Iti lies approximately 1.5 km offshore from Orongo at the southwestern end of Isla de Pascua. It consists of thick slabs of obsidian interbedded with light and dark banded rhyolite. The beds are essentially vertical and lie in an approximate east-west direction.

COMPOSITION ANALYSIS

Measurements have been made of the composition of 50 samples from the reference set using the PIXE/PIGME technique (Duerden et al. 1980). This was done as part of a project for analysis of Lapita obsidian artefacts for which material from Wekwok (Admiralty Islands - AD 2000) and Mayor Island (New Zealand - ZS) as well as NBS standard obsidian (No.278) were used for reference. Results for 13 elements are given in Table 1. They confirm the trends presented for a smaller number of samples having no details of provenance by Duerden et al. (1987) and provide a firmer basis for comparison of obsidian from Isla de Pascau with that from other South Pacific sources - the most similar being the Mayor Island source. This can be done in many ways and the results are illustrated in Figure 2 by an example of cluster analysis using the principal components method. Ten element ratios were used as input data and the two axes are derived from those values which contribute most to the variance of interpoint distances in multiparameter space.

Five measurements on Mayor Island obsidian fall at the bottom right in Figure 2 with a very clear separation from the remaining results which are all for Isla de Pascua obsidian. The Rano Kau NW results also cluster separately while Motu Iti clusters at the lower left. The separation of the Motu Iti cluster is maintained in all the tests supplied. However, obsidian from Maunga Orito and Te Manavai cannot be distinguished on the basis of the concentrations of elements measured in this work.

DENSITY AND APPEARANCE

Measurements of density (Figure 3) show significant differences for samples from Maunga Orito, Rano Kau NW and Motu Iti. However Te Manavai obsidian shows a greater variability with densities which overlap the range for both Maunga Orito and Rano Kau NW. The variability can be attributed to the presence of 1-3 mm diameter spherulitic inclusions in much of the Te Manavai obsidian. In fact there are a number of differences in appearance which can be used to aid the characterisation of Isla de Pascua obsidian, viz:

i. Samples from Maunga Orito have a dull appearance and the majority are grey/green when inspected in sunlight - this colour only occurring for this group;

ii. A majority of samples from Te Manavai are glossy black with varying size and density of white spherulitic inclusions. This feature only occurring for this group; however some samples are duller black with few or no inclusions;

iii. Samples from Rano Kau NW are a very glossy black with irregular-shaped translucent inclusions which deflect the plane of fracture sufficiently to give a steaky appearance; and

iv. Motu Iti obsidian is a uniform black with a smooth conchoidal fracture and cannot be easily distinguished from black material from the first two groups.

These distinctions were tested by inspection of several artefact collections independently by several observers. It proved to be possible to identify material from M. Orito (matt grey/green) which accounted for one-third of the artefacts. Te Manavai material (spherulitic inclusions) accounted for 5-10% of the samples. The remainder of the samples were black and could not be further distinguished by inspection.

CONCLUSIONS

Contrary to the usual statement in previous publications, there are four rather than three sources of obsidian - at Maunga Orito, Te Manavai, Rano Kau Northwest and Motu Iti. Material previously described as from Rano Kau is most likely to have come from Te Manavai - a subsidiary crater on the flank of Rano Kau. Elemental composition, density and appearance are all useful for identifying material used in artefacts but none of these methods can alone distinguish all four groups. Elemental composition provides a clear distinction from Mayor Island and other South Pacific obsidian sources.

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TABLE 1
Element Concentrations for Isla de Pascua Obsidian ($\mu g.g^{-1}$)

Group	F	Na %	Al %	Si %	K %
Maunga Orito South	1730-1920	3.43-3.86	5.79-6.55	31-36	3.47-3.64
" " West	1910-1810	3.39-3.88	5.73-6.83	28-35	3.00-3.86
Te Manavai Plateau	1750-1790	3.41-3.84	6.01-6.47	32-39	3.38-4.13
" " Crater	1700-1880	3.71-3.90	6.26-6.41	22-44	3.58-4.11
Rano Kau Northwest	1920-2150	3.23-3.65	5.64-6.28	32-38	3.58-4.11
Motu Iti	1580-1720	3.46-3.91	6.03-6.69	22-36	2.39-3.84

Group	Ca %	Ti	Mn	Fe %	Zn
Maunga Orito South	0.45-0.56	1240-1360	600-650	2.49.2.64	220-240
" " West	0.47-0.53	1090-1550	580-690	2.33-2.86	210-240
Te Manavai Plateau	0.47-0.58	1150-1460	580-710	2.25-2.80	200-250
" " Crater	0.26-0.36	920-1390	520-690	2.17-2.74	210-240
Rano Kau Northwest	0.26-0.36	920-1110	420-510	1.90-2.33	200-250
Motu Iti	0.48-0.69	990-1450	530-750	2.03-2.92	170-230

Group	Rb	Sr	Y	Zr	Nb
Maunga Orito South	89-102	25-34	146-164	850-910	120-140
" " West	77-100	25-34	137-158	770-890	110-130
Te Manavai Plateau	89-103	25-32	126-184	700-900	110-140
" " Crater	89-105	27-32	129-157	790-880	120-140
Rano Kau Northwest	78-114	7-13	126-176	740-990	100-140
Motu Iti	72- 96	39-56	115-152	650-820	100-130

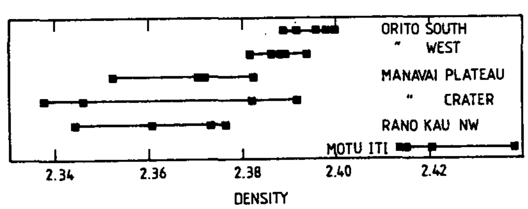

Figure 3. Results of density measurements on Isla de Pascua obsidian.