NEW ZEALAND
ARCHAEOLOGICAL ASSOCIATION
NEW ZEALAND JOURNAL OF ARCHAEOLOGY

Petrography of Polynesian Plainware from ‘Ata, Tonga

William R. Dickinson[1]

ABSTRACT

The temper sands in two representative potsherds of Polynesian Plainware collected from the surface on the central plateau of ‘Ata, the southernmost island of Tonga, are poorly to moderately sorted aggregates of angular to subangular volcanic sand apparently derived from pyroclastic strata exposed over wide areas in the interior of ‘Ata. The tempers are unlike any in the several hundred prehistoric sherds that have been examined in thin section from elsewhere in Tonga, and indicate local manufacture of pottery on ‘Ata.

Keywords: PETROGRAPHY, TEMPER SANDS, POLYNESIAN PLAINWARE, ‘ATA, TONGA.

INTRODUCTION

Polynesian Plainware potsherds, associated with adze flakes and preforms, were collected from a surface scatter on the interior plateau of ‘Ata (Burley *et al.* 2004, this volume), the small southernmost island of Tonga formed by the erosional remnant of a stratocone composed of interstratified lavas and pyroclastic deposits. Two representative sherds were examined petrographically in thin section to compare their tempers with the tempers in prehistoric pottery from elsewhere in Tonga as a means of determining whether the ‘Ata earthenware was made locally, or was brought to ‘Ata from some larger Tongan island. The sectioned sherds were selected as the least weathered of a total of 38 sherds from interior ‘Ata in which tempers are megascopically indistinguishable.

‘ATA TEMPERS

The ‘Ata sherds contain manually added tempers that display distinct contrasts in grain size with the coarsest silt particles of the clay pastes, and consist of angular to subangular aggregates of poorly to moderately sorted volcanic sand similar, though not identical, to one another in mineralogical composition. Grain types in the temper sands include the following (frequency percentages in parentheses based on counts of 311 and 479 grains, respectively, in thin sections of the two sherds): plagioclase feldspar (38, 45), particles of volcanic glass (39, 33), clinopyroxene (7, 17), orthopyroxene (1, 2), olivine (1, 1), and microlitic volcanic rock fragments (14, 2), the last being fragments of the groundmasses of lava or breccia blocks in which microscopic plagioclase microlites are imbedded in volcanic glass.

Both sands were probably collected from residual or slopewash colluvium, or possibly from ravine-floor sediment, derived from beds of tuff and associated pyroclastic strata

[1]Department of Geosciences, University of Arizona, Tucson AZ 85721, USA

New Zealand Journal of Archaeology, 2004, Vol. 25 (2003), pp. 107–111.

exposed over wide areas on the interior plateau of ‘Ata (Johnstone 1978; Vallier *et al.* 1985). Grain types and compositional characteristics of the sherd tempers closely match volcanic materials exposed on ‘Ata. The dominance of plagioclase over pyroxene in the temper sands mimics the proportions of phenocrysts in most samples of volcanic rock from ‘Ata (Vallier *et al.* 1985), including selected samples (n=3) from the north coast of ‘Ata examined in thin section for this study. Tiny round vesicles within many of the glassy volcanic rock fragments in the ‘Ata tempers closely resemble counterparts observed in the rock samples from ‘Ata. An abundance of tan to brown volcanic glass particles in the temper sands is characteristic of mafic pyroclastic debris, as widely exposed on ‘Ata. Finally, rare grains (<1%) of cumulus microgabbro, which is plagioclase-pyroxene igneous rock of coarser internal crystal size than volcanic rock, resemble the gabbro xenoliths reported from pyroclastic breccia on ‘Ata (Vallier *et al.* 1985).

The relative proportions of clinopyroxene (cpx), orthopyroxene (opx), and olivine (olv) among the ferromagnesian silicate mineral grains of the temper sands are closely comparable to those in a beach sand collected from the north coast of ‘Ata and clearly derived from volcanic bedrock on ‘Ata. The average cpx/opx/olv percentages for the temper sands (recalculated to 100) are 82/10/8, not statistically distinguishable from the values of 83/11/6 for the beach sand. Although the proportions of ferromagnesian grains in the tempers are thus fully supportive of their inferred derivation from ‘Ata itself, the comparison is not alone diagnostic because other volcanic sources in Tonga contain the same ferromagnesian minerals in broadly similar proportions (Bryan *et al.* 1972; Ewart *et al.* 1973).

OTHER TONGAN TEMPERS

Previous petrographic examination of >250 prehistoric potsherds from other islands of Tonga has documented the nature of indigenous temper sands (Dickinson and Shutler 2000), and none closely resembles the tempers in the ‘Ata sherds. Typical non-calcareous volcanic sand tempers in sherds from islands of central Tonga, including Tongatapu and islets in the Ha‘apai and Vava‘u groups (Fig. 1), are strongly placered beach sands in which pyroxene is much more abundant than plagioclase (Dickinson *et al.* 1996). The volcanic debris was derived from blankets of pyroclastic ash that mantle the limestone bedrock of the islands, but is well sorted and subrounded detritus that was extensively reworked within island beach systems. Among the central Tongan tempers even the least placered variants, in which plagioclase is more abundant than pyroxene (Fig. 1), are much better sorted sands than the ‘Ata tempers, and volcanic rock fragments are not so predominantly glass-rich.

The tempers in sherds from Niuatoputapu and Tafahi in northernmost Tonga include volcanic sands even richer in volcanic glass particles than ‘Ata tempers (Fig. 1), but are better sorted than the ‘Ata tempers, and the volcanic glass particles are characteristically pumiceous (Dye and Dickinson 1996), with vesicles both larger and more abundant than in ‘Ata temper grains. Eruptive sources for pyroclastic debris at the active volcano of Tafahi and on nearby Niuatoputapu were petrologically comparable to those on ‘Ata, but empirical differences in the texture and composition of the volcanic products appear to rule out, on objective petrographic grounds, the geographically unlikely transport of ceramic wares from distant Niuatoputapu to ‘Ata.

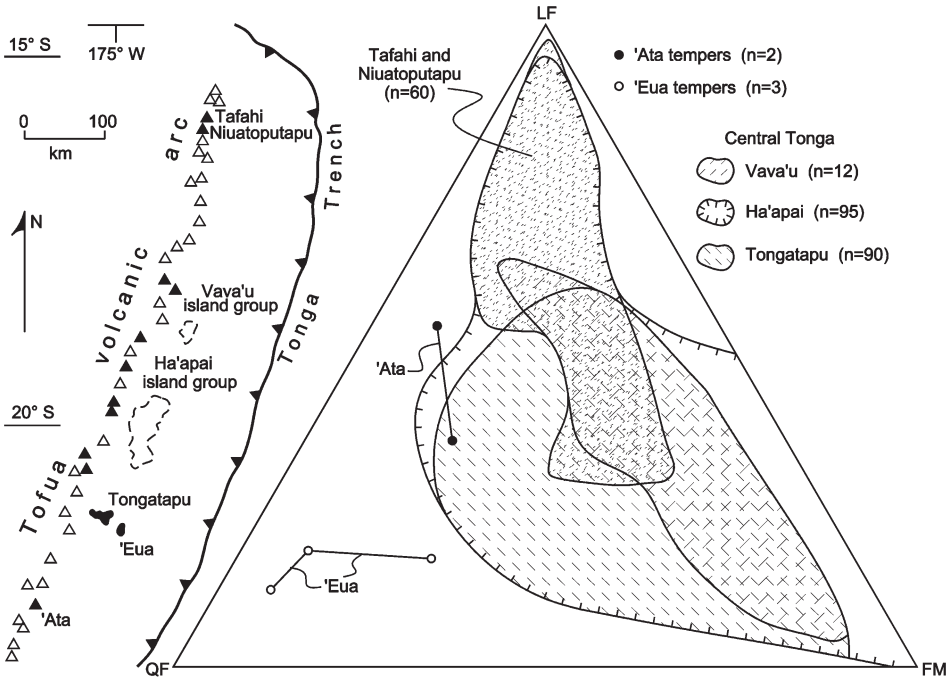

Figure 1: Pottery-yielding islands and island clusters in Tonga (left) and compositions of Tongan temper sands in LF-QF-FM space (Dickinson 1998). On the map, solid triangles are volcanic islands and open triangles are submerged volcanic seamounts of the Tongan island arc lying parallel to the subduction zone at the Tonga Trench. On the triangular plot, LF is lithic fragments (polycrystalline-polyminerallic rock fragments and glass particles), QF is plagioclase feldspar grains, and FM is total ferromagnesian silicate and oxide mineral grains. Lithic fragments are exclusively volcanic rock fragments except in 'Eua tempers. Data from Key (1967), Dickinson (1974, 1988), Dye (1987), Dickinson *et al.* (1996), Dye and Dickinson (1996), and unpublished personal files.

'EUA TEMPERS

Selected Polynesian Plainware sherds (n=3) from 'Eua, an island lying just to the east of Tongatapu (Fig. 1), contain subangular temper sands as poorly sorted as the 'Ata tempers and even richer in plagioclase (Fig. 1). The 'Eua temper sands, however, contain only minor volcanic rock fragments (grain frequency ~10%), most of which are microlitic grains rather than being composed exclusively of volcanic glass. Moreover, the 'Eua tempers consistently contain prominent non-volcanic grains of altered (uralitic) microgabbro (grain frequency ~5%) derived from the Eocene bedrock of 'Eua exposed nowhere else in Tonga (Ewart and Bryan 1972; Cunningham and Anscombe 1985). Grains of uralitic clinopyroxene largely altered deuterically to fibrous amphibole, and probably many of the plagioclase grains as well, were also derived from the local Eocene plutonic bedrock of 'Eua.

In one prehistoric sherd (To6.2257) of the Poulsen collection from the Tuhu Mahina site along the mid-Holocene paleoshoreline of Tongatapu (Burley *et al.* 2001), Key (1967) described anomalous temper that is indistinguishable mineralogically from the temper sands of known ‘Eua sherds. This occurrence documents at least limited ceramic transfer from ‘Eua to nearby Tongatapu in prehistoric times, but the differences between ‘Eua and ‘Ata tempers provide no support for analogous ceramic transfer from ‘Eua to ‘Ata. The only points of commonality between ‘Eua and ‘Ata tempers are abundance of plagioclase in amounts atypical of other Tongan tempers, and rare microgabbro grains in the ‘Ata tempers, but the paucity of volcanic rock fragments in the ‘Eua tempers and the ubiquitous uralitic alteration of the much more abundant gabbroic detritus in the ‘Eua tempers rules out any close relationship to ‘Ata tempers.

SUMMARY

The sand tempers in Polynesian Plainware sherds collected on ‘Ata are fully appropriate in texture and composition for derivation from volcanic sources on ‘Ata, but do not resemble the tempers in any other sherd assemblages known from Tonga. The conclusion that the wares were made locally on ‘Ata by residents of, or visitors to, the island is thus robust on petrographic grounds.

ACKNOWLEDGEMENTS

The sherds, rock samples, and beach sand studied from ‘Ata and ‘Eua were kindly provided by D.W. Steadman with the encouragement and help of D.V. Burley.

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Received 9 April 2003
Accepted 8 July 2003