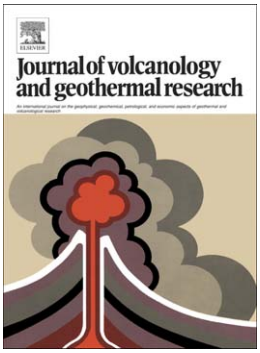

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Staged storage and magma convection at Ambrym volcano, Vanuatu

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ABSTRACT

New mineral-melt thermobarometry and mineral chemistry data are presented for basaltic scoriae erupted from the Mbwelesu crater of Ambrym volcano, Vanuatu, during persistent lava lake activity in 2005 and 2007. These data reveal crystallisation conditions and enable the first detailed attempt at reconstruction of the central magma plumbing system of Ambrym volcano. Pressures and temperatures of magma crystallisation at Ambrym are poorly constrained. This study focuses on characterising the magma conditions underlying the quasi-permanent lava lakes at the basaltic central vents, and examines petrological evidence for magma circulation.

Mineral-melt equilibria for clinopyroxene, olivine and plagioclase allow estimation of pressures and temperatures of crystallisation, and reveal two major regions of crystallisation, at 24–29 km and 11–18 km depth, in agreement with indications from earthquake data of crustal storage levels at c. 25–29 km and 12–21 km depth. Temperature estimates are ~1150–1170 ºC for the deeper region, and ~1110–1140 ºC in the mid-crustal region, with lower temperatures of ~1090–1100 ºC for late-stage crystallisation. More primitive plagioclase antecrysts are thought to sample a slightly more mafic melt at sub-Moho depths.

Resorption textures combined with effectively constant mafic mineral compositions suggest phenocryst convection in a storage region of consistent magma composition. In addition, basalt erupted at Ambrym has predominantly maintained a constant composition throughout the volcanic succession. This, coupled with recurrent periods of elevated central vent activity on the scale of months, suggest frequent magmatic recharge via steady-state melt generation at Ambrym.

Keywords: Ambrym, thermobarometry, petrology, recharge, convection, mafic.

1. Introduction

Ambrym is one of the most active volcanoes in the Vanuatu island arc, SW Pacific. It has been continuously active since first described in 1774, displaying persistent lava lake activity, gas bursting (cf. Harris & Ripepe, 2007), and prodigious outgassing (Bani et al., 2009, 2012), with intermittent explosive or lava flow events.

Ambrym features long-lived lava lakes in two adjacent near-summit intracaldera cones. The volume of historically erupted magma at Ambrym volcano is low, but the presence of quasi-permanent lava lakes and long-lived high gas output require sustained heat and gas fluxes (Harris et al., 1999), and imply magma recycling (Harris et al., 1999), endogenous growth (Francis et al. 1993; Oppenheimer and Francis, 1998), or cryptic