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Experimental investigation of the storage depth and temperature of the Earthquake Flat Pyroclastics magma body (Okataina Volcanic Center, New Zealand)

ELIZABETH R. G. GRANT[1], DAWNIKA L. BLATTER[2], THOMAS W. SISSON[2] AND KARI M. COOPER[1]

[1]University of California, Davis

[2]U.S. Geological Survey California Volcano Observatory

Presenting Author: ergrant@ucdavis.edu

The Earthquake Flat Pyroclastics [1], hereafter Earthquake Flat tuff, (Okataina Volcanic Center, New Zealand) is ~10 km^3 of highly porphyritic (40 vol%), orthopyroxene<oxide<hornblende<biotite<quartz<plagioclase phenocrystic rhyolite (~74 wt.% SiO_2), that erupted explosively at ~50 ka following the caldera-forming Rotoiti eruption [2]. The Rotoiti eruption released ~100 km^3 of cummingtonite-bearing, moderately porphyritic (15–25 vol%) rhyolite (~75 wt% SiO_2; [3]). Prior experimental work on the Rotoiti rhyolite estimated its pre-eruptive temperature and pressure by cummingtonite stability to ≤750 °C and ≤300 MPa if H_2O-saturated [4]. Although the two eruptions vented only ~20 km apart, connections between the two magma bodies are unknown [1]. We present results of H_2O-saturated phase equilibrium experiments buffered at NNO on a glass concentrate from the Earthquake Flat tuff to estimate the pre-eruptive temperature and pressure (depth) of its source magma body. Based on co-saturation of the melt concentrate with quartz and plagioclase, our experiments show that the Earthquake Flat magma was most likely stored at crystal-rich conditions between 75-200 MPa, and 710-760 °C, saturated with H_2O-rich magmatic vapor. Despite similar shallow, low-temperature storage conditions of the Earthquake Flat and Rotoiti magma bodies, the higher K_2O concentration of the former accounts for the presence of biotite versus cummingtonite (+/- orthopyroxene and hornblende) in the latter. The high crystallinity of the Earthquake Flat tuff, combined with abundant poly- and mono-mineralic clusters, suggests that its source magma body was a shallow, mushy proto-pluton prior to mobilization and eruption. Alkali feldspar appears experimentally about 20°C cooler than the appearance of quartz but is absent in the erupted tuff. The absence of alkali feldspar in the tuff either indicates that eruptible portions of the pluton were poised slightly too hot for that mineral to be stable, or that alkali feldspar broke down pervasively during remobilization of the magma body. Further, it is likely that excessive crystallinity probably accounts for the absence of K-feldspar in the erupted materials.

[1] Nairn (2002), IGNS (NZ) **25**. [2] Molloy *et al.* (2008), JGSL **165**, 435-477. [3] Schmitz and Smith (2004) JPET **45**, 2045-2066. [4] Nicholls *et al.* (1992), GCA **56**, 955-962.