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LETTER

Implications of equilibrium and disequilibrium among crystal phases in the Bishop Tuff

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ABSTRACT

Eruption of the Bishop Tuff magma preserved equilibrium of exchange components and element concentrations among magnetite, ilmenite, biotite, apatite, zircon, and liquid. Orthopyroxene and clinopyroxene were not in exchange equilibrium with the other MgFe-bearing phases, but they appear to have been in equilibrium among themselves. Internally consistent temperatures recorded by the FeTi-oxide, Ti-in-quartz, and $\Delta^{18}O$ quartz-magnetite thermometers, coupled with evidence for magmatic corrosion of quartz and sanidine, indicate that an initially low-T (≈700 °C), near-H_2O-saturated, high-SiO_2 rhyolite magma was heated up to ≥800 °C and its crystal cargo partially melted by recharge of hotter melt from below. Oxygen fugacity and compositions of biotite, ilmenite, magnetite, and silicate liquid initially adjusted by internal rearrangement of components and conservation of oxygen. Partial melting of feldspars liberated Sr and Ba back into the melt. Mixing during recharge eventually re-introduced compatible elements (e.g., Mg, Ba, Sr) as well as foreign crystals of euhedral ortho- and clinopyroxene, which evidently never totally re-equilibrated with the rhyolite liquid. Introduction of CO_2 and accompanying reduction in the aH_2O during recharge raised crystallization temperatures of quartz and sanidine in the rhyolite sufficient to allow marginal regrowth of these phases with enhanced contents Ti, Ba, and Sr.

Keywords: Bishop Tuff, Supervolcanoes, silicic magma, petrogenetic processes, disequilibrium