Experimental Investigation of Deep Crustal Origins of Evolved Arc Magmas: Mount St. Helens Yn

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Dacites and rhyodacites (63-71 wt% SiO_2) dominate explosive volcanism in the Cascades, including historic eruptions at Mt. St. Helens (1980) and Lassen Peak (1915). Pre-eruptive conditions of several such magmas have been determined experimentally, quantifying pressures, temperatures, H_2O concentrations, and fO_2s of upper crustal storage [1, 2, 3]. However, growing evidence from zircon geochronology points to prolonged incubation periods for some evolved arc magmas [4], consistent with their generation in the mid– to lower crust where high ambient temperatures and mafic replenishment can keep intrusive complexes hovering near the solidus. Such evolved arc magmas may aggregate to sufficient volumes that they can temporarily overwhelm and dominate the ordinarily andesitic feeder systems, leading to atypically explosive silicic eruptions. Recent experiments on arc basalt [5] confirm that dacitic liquids can be generated by crystallization of typical arc basalt at mid– to deep crustal pressures.

In ongoing experiments using a pumice from the plinian Mt. St. Helens Yn tephra of ~4000 ybp (SiO_2 = 65.2 wt% normalized anhydrous), we are mapping the near-liquidus saturation surface at various H_2O concentrations (3, 6, 9 wt%) and pressures (400, 700, 900 MPa), buffered at Re–ReO_2. We characterized the starting material with XRF and ICPMS analyses of single pumices and found little compositional diversity within the unit. We measured dissolved H_2O in plagioclase-hosted melt inclusions using ATR–FTIR [6], yielding 5 to 6.5 wt% H_2O, similar to published values [2], and determined fO_2 as just below Re–ReO_2 through analyses of magnetite–ilmenite pairs and application of the Ghiorso and Evans [7] oxybarometer. Regions of near-liquidus multiple saturation with plagioclase, oxides, and one or more mafic silicates would be candidate T–P–H_2O conditions for the generation of the Yn and similar magmas.

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