LA-ICP-MS trace element and Pb-isotope analysis of Mt. St. Helens dome material from 1981-1985 and 2004-2005 eruptive episodes

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Renewed eruptive activity at Mount St Helens, Washington, provides a unique opportunity for petrologic and geochemical studies of an erupting silicic volcano. We report results from ongoing trace element and isotopic studies of lava and ash material from the 1980-1985 and 2004-2005 eruptive episodes. To date the work has focused on the relationship between recently erupted material and that from the 1980-1985 dome growth. Trace element contents in minerals (feldspar, hornblende and pyroxenes), groundmass and glass were determined by laser ablation ICP-MS techniques using a 193 nm ArF Excimer laser and VG PQII ExCell ICP-MS quadrupole mass spectrometer. Pb isotope compositions in feldspar and groundmass were measured using the same laser coupled with a NuPlasma multicollector ICP-MS.

Trace element contents of newly erupted material are largely similar to dome samples from 1980-1985, with some important differences. Feldspars from dome and fragmental material sampled on the 4 November 2004 have markedly elevated Li contents (40-60 ppm), compared to dome samples collected in October 2004 and from 1980-1985. Li enrichment may relate to volatile enrichment, but is significantly larger than that observed in feldspar associated with the May 1980 plinian eruption (Berlo et al., 2004 Science). The samples taken from the new dome flank in October 2004 are probably fragments of uplifted older material in the conduit or crater floor, but a small proportion of feldspars from fragmental samples associated with October steam explosions also have elevated Li. $^{208}Pb/^{206}Pb$ ratios measured in groundmass also differ between October (2.0477±0.0017) and November (2.0425±0.0011) dome samples, arguing against simple closed-system magmatic differentiation as the source of compositional variation between these magmas. Feldspars from both samples also show a more diverse range of Pb isotope compositions than groundmass.

Petrology and geochemistry of Mount St. Helens ash before and during continuous dome extrusion

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Ash samples of the current Mt. St. Helens dome building event have been collected since the initial eruption on October 1, 2004. Analysis of dome material collected periodically, beginning October 20, 2004, establishes a frame of reference for evaluating the time-series of ash samples collected prior to and since the first appearance of new lava in the crater on October 11. The ash deposits are comprised predominantly of feldspar crystals accompanied by amphibole, pyroxene and fragments of crystalline groundmass and glass.

Comparisons of major- and trace-element phase chemistry and groundmass textures in ash deposits reveal a progression of sources from a heterogeneous assemblage dominated by fragments of older crater material, toward a more homogeneous assemblage derived from fragmentation of the new lava dome. Early ash emissions had glass compositions ranging from basaltic andesite to high-silica rhyolite. Distinct clusters of analyses, especially evident in TiO_2 and MgO, clearly indicate mixed populations of glass fragments in early events. Variability in melt inclusion and glass fragment major-element chemistry in ash however is more restricted and better reflects juvenile dome compositions with ongoing dome growth.

LA-ICP-MS analysis of feldspar crystals in freshly extruded dacite show that despite consistent Ba concentrations, Li concentrations are significantly greater than observed in 1980 to 1986 dome lavas as well as dome samples from October 2004. This enriched Li signature is significant in that it may be a useful indicator of juvenile material in ash deposits despite the high variability in major-element glass chemistry. Ash deposits may also provide material from otherwise unsampled components of hotter near-vent and flow-interior facies of dome lava, and may provide the first indication of new magma compositions. Our ongoing ash studies are demonstrating the utility of collection and analysis of tephra for tracking magmatic changes during prolonged dome extrusion.