Petrology and Geochemistry of Mafic Enclaves from Shiveluch Volcano, Kamchatka

ANDREA E. GOLTZ[1], MICHAEL J. KRAWCZYNSKI[1], MAXIM GAVRILENKO[2], NATALIA V. GORBACH[3], PHILIPP RUPRECHT[2]

[1]Department of Earth and Planetary Sciences, Washington University in St. Louis, St. Louis, MO 63130, USA; agoltz@wustl.edu

[2] Department of Geological Sciences and Engineering, University of Nevada, Reno, Reno, NV 89557, USA

[3] Institute of Volcanology and Seismology, Russian Academy of Science, Petropavlovsk-Kamchatsky, Russia

Mixing of mafic and felsic magmas is hypothesized to produce andesitic magma at arcs. Studies of andesites support the magma mixing hypothesis, but fractional crystallization also plays a key role. In this study, we examine the petrology and geochemistry of andesite-hosted mafic enclaves from the eruption of Shiveluch volcano in Kamchatka in order to better understand the evolution of its erupting magmas.

The enclave textures and mineralogies are indicative of their crystallization sequence. In approximate order of crystallization, phenocrysts are oliv + amph + cpx ± plag ± opx. Crenulate margins of the mafic material with the host andesite and vesicularity of the enclaves suggest that this material was mostly liquid upon interaction with the felsic endmember and was likely mixed.

The whole-rock geochemistry of the enclaves has a well-defined trend in major element plots that extends geochemical trends of differentiation indices defined by previous analyses of Shiveluch andesite without a compositional gap to more mafic compositions (Mg# 53.9-69.6; SiO_2 52-56 wt%). Trends in major and trace elements amongst subgroups of enclaves suggest that a mafic magma partially differentiated to form the geochemical diversity of enclaves.

The most primitive samples have olivine with Fo_{92}-Fo_{90} cores and Fo_{82}-Fo_{80} rims. The rim composition is identical to core compositions in less primitive samples. Olivine grains with Fo_{80} cores are often rimmed by a high-Mg amphibole. Amphibole phenocrysts in less primitive samples are often reverse zoned in Fe-Mg, whereas more primitive samples have amphibole phenocrysts with Mg-rich cores. One model that could explain these trends is that chemical stratification of a super-hydrous mafic intrusion allowed crystals of different chemistries to form while thermal and density gradients enabled crystals to move between chemically distinct zones, allowing them to form rims of different compositions.