Mixing of Basalt and Dacite to Produce Intermediate Compositions at Mutnovsky Volcano, Kamchatka

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Magma mixing is recognized as a ubiquitous process at stratovolcanoes. However, the degree to which mixing occurs, influences bulk compositions, and its importance to the generation of intermediate magmas remains controversial. Here we present new temperature and fO_2 data, determined from the compositions of coexisting iron-titanium oxides, from 13 lavas ranging in composition from basalt to dacite. These data are paired with plagioclase chemistry, textural variations, and crystal size distribution data to elucidate magma mixing processes at Mutnovsky volcano, Kamchatka.

Mutnovsky is an arc front volcano located in southern Kamchatka, and consists of four eruptive centers (Mutnovsky I-IV) that began forming ~80 ka. The three oldest centers, Mutnovsky I-III, erupted predominantly basalt and basaltic andesite, but also minor volumes of andesite and dacite. Mutnovsky IV erupted only basalt and basaltic andesite.

Geochemical modeling results indicate that Mutnvosky basaltic andesite may be the product of fractional crystallization (FC) of basalt combined with assimilation of a dacitic component. Subsequent FC of 60% clinopyroxene, 30% olivine, and 10% magnetite from the basaltic andesite geochemically reproduces the chemistries of erupted andesites. Trace element modeling of erupted dacites is consistent with partial melting of underplated basaltic material (i.e., no FC or AFC of a more mafic magma).

New temperature data for Mutnovsky lavas are as follows: basaltic lavas ~1000°C, basaltic-andesites ~900°C, andesites ~850°C, and dacites ~950°C. Plagioclase compositions (An#) fall into two distinct populations, $An_{80\pm10}$ and $An_{45\pm5}$. The An# for basaltic and dacitic samples each show one population, An_{80} and An_{45}, respectively. Basaltic andesites and andesite samples each contain both populations of plagioclase, with a minor component of $An_{50\text{-}70}$. Sodic plagioclase in the basaltic andesites and andesites shows dissolution/resorption textures, indicating disequilibrium. These new data are consistent with mixing of a basaltic and dacitic component to generate the erupted intermediate lavas at Mutnovsky.