Whole-Rock Geochemistry, Geothermometry, and Computer-Based Modal Analysis of the 1956-Present Eruptive Products of Bezymianny Volcano, Kamchatka, Russia

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Complementary data sets from major element whole-rock geochemical analyses, geothermometry, and mineral modal analyses are used to characterize the evolution of magma in the Bezymianny system. Bezymianny Volcano is an ideal laboratory for studies into magmatic evolution at volcanoes which have experienced edifice collapse. A comprehensive sample repository representing over 50 years of volcanic activity provides the unique ability to investigate the factors which sustain its ongoing eruptive activity.

Whole-rock geochemical analyses show a progressive trend toward more mafic compositions with 61.0 wt. % SiO_2 in 1956 to 56.6 wt. % SiO_2 in 2010. Major element trends are consistent with linear two-component magma mixing. Co-existing Fe-Ti oxides and two-pyroxene geothermometry calibrations show crystallization temperatures for the 1956 eruption range between 900^{o}C and 950^{o}C (accuracy of ±30^{o}C). >From 1956 to 2007, a general warming trend is observed with an increase to 1050^{o}C ± 30^{o}C.

We developed a computer-based modal analysis technique for the rapid quantification of large data sets. We use image processing, ENVI®, software to analyze high resolution petrographic thin section imagery acquired in both plane and cross polar light. Steps required include: 1) color training of desired mineral phases; 2) supervised classification based on a maximum likelihood algorithm; and 3) post-classification output of modal abundance. This technique demonstrates a low residual error when compared with manual point count analyses and the product can be used for feature extraction and crystal size distribution analysis. The modal analysis results are summarized in Figure 1.

Bezymianny's correlated chemical and temperature trend can be interpreted as reflecting mafic recharge subsequent to the initial collapse-blast-plinian sequence. Furthermore, (1) an increase in crystallization temperatures; (2) temporal changes in modal abundances; and (3) a transition in the character of effusive eruptions from dome growth to summit lava flow morphology all suggest a mafic source entering the system is responsible for fueling its highly regular and ongoing activity.