Collaborative Research: The role of oxygen fugacity in calc-alkaline differentiation and the creation of continental crust at the Aleutian arc

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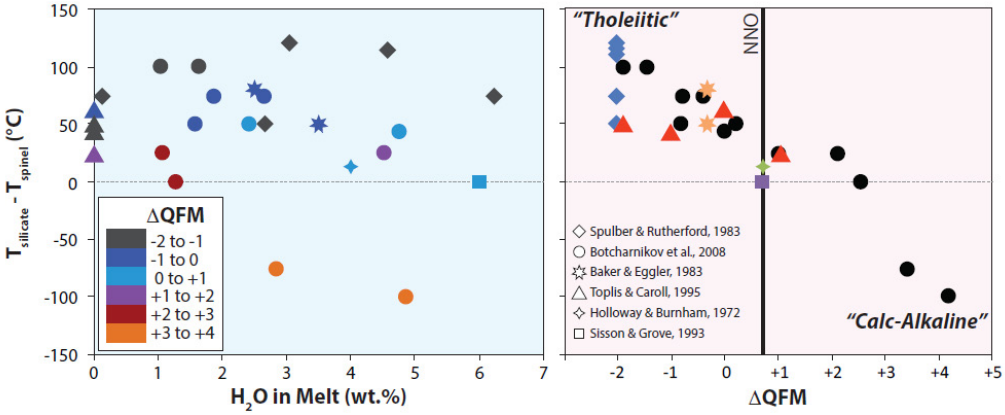
Among the key characteristics shared by bulk continental crust and some subduction zone magmas is calc-alkaline affinity, a rapid draw-down in Fe concentration early in a magma's cooling history. Resolving the key roles that H_2O, fO_2, and magmatic bulk composition play in controlling calc-alkaline trends will have important implications for models of how Earth's continents initially formed and have grown through time. This project combines study of volatile contents, radiogenic isotopes, and oxidation conditions of melt inclusions from natural Aleutian arc magmas, which is paired with an experimental study of the independent controls of H_2O and fO_2 on phase equilibria of Aleutian magmas. Our first major results focus on quantifying the effects of H2O and fO_2 on magmatic phase appearance, and assessing the relationship between H_2O, fO_2, and calc-alkaline affinity of natural Aleutian magmas. In fall 2015, we will venture into the field through the NSF-sponsored shared platform for Aleutians research to collect new samples of the most strongly cal-alkaline Aleutians magmas.

Correlations both among global magmas and within the Aleutians suggest fO_2, H_2O, and Fe-depletion (i.e., calc-alkaline affinity) are linked at arcs • Phase equilibria experiments suggest that fO_2 is the main control on oxide vs. silicate crystallization, and early oxide saturation is linked to Fe-depletion in magmas.



Compilation of experimental data showing how the suppression or enhancement of magnetite relative to silicates varies as a function of H_2O and oxygen fugacity. No trend is apparent with magmatic H_2O content, but there is a strong correlation with oxygen fugacity. Moreover, experimental liquids follow a tholeeitic trend in cases where silicates crystallize early relative to magnetite, whereas liquids follow a calc-alkaline trend when magnetite appears early. Redox conditions more oxidized than the Ni-NiO (NNO) solid oxygen buffer are apparently required to generate a true Fe-depletion trend in experimental liquids

Published Abstracts

Kelley, K. A., E. Cottrell, M. N. Brounce, and Z. Gentes (2014), Roles of magmatic oxygen fugacity and water content in generating signatures of continental crust in the Alaska-Aleutian arc, EOS Transactions AGU, presented at 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec., T11A-4531.