Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12723

Making silicic magmas: It's igneous but maybe a lot colder than you think

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For 6 decades, silicic magmas have been interpreted to reflect the production of a minimum melt (MMP) in equilibrium with quartz and feldspar followed by extraction. However, alternatives exist with the finding that imposed thermal gradients can lead to production of metaluminous granite at 400°C. Seismology finds no large bodies of melt in the upper crust—yet electrical conductivities in the same magmatic locations can be extremely high. Indeed, the level of disconnect between geophysical observations and a MMP view of silicic magma formation is startling—here we ask the question: Can silicic mush form directly from gabbro through melt rock reactions? The implications range from how continental crust is produced to making silicic magma bodies for supereruptions.

First, we will present experiments equilibrating hydrous alkali silicate melt with quartz and 2 feldspars at 1 kbar; melts vary from rhyolitic melts at 725°C down to very hydrous (37wt% H2O) liquids having ~30wt% alkalis-70wt% SiO2 anhydrous composition. With viscosities $<10^{-5}$ Pas, this liquid should flow up through mush zones porously, reacting to produce rocks with higher quartz and K-spar modes. This flow would likely control heat flow, cooling mafic mushes quickly. Second, we will present case studies from Troodos, Iceland, Duluth and Torres del Paine where gabbro is juxtaposed with granitoid (sometimes granophyre). Textural evidence such as K-spar growing on plagioclase with common crystal orientation are consistent with the view of a feldspar exchange reactions forming K-spar. High Or content K-spars and low Ti in quartz indicate temperatures well below the haplogranite solidus. Third, as the continuous side of Bowen's reaction series, plagioclase exists through the entire reaction process of gabbro to granitoid. We will present 87Sr/86Sr of whole rock (subsamples) along gabbro to granitoid transects as well as microanalyses of plagioclase and K-spar. In multiple cases, granitoids, which have more radiogenic WR 87Sr/86Sr, have unradiogenic plagioclase grains that have the same 87Sr/86Sr as the gabbro. These ratios are demonstrably not reflecting mechanical incorporation of plagioclase into granite magma (based on known ages). Thus, plagioclase 87Sr/86Sr provides the ultimate CSI of a granitoid's earlier life as a gabbro.