Investigation of Archean mantle plume components from 2.7 Ga komatiites (Abitibi, Canada)

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Komatiitic flows in Munro Township, Abitibi greenstone belt, are of two types: Al-depleted (ADK), which has low Al/Ti, and Al-undepleted (AUK) komatiites, with chondritic Al/Ti. The different geochemical types reflect source components and melting processes at 2.7 Ga.

We present new data for three thick differenciated lava flows: Fred's Flow and Pyke Hill are AUK with moderate depletion to strong REE depletion $(Ce/Yb)_N$=0.64 and 0.34 respectively. Theo's Flow is an Al-depleted Mg-Fe rich tholeiite with HREE depletion $(Gd/Yb)_N$>1.35) and flat LREE.

REE patterns of these flows reflect their initial geochemical signatures, and indicate differences in sources, and/or depths and degrees of partial melting probably in mantle plumes. To characterize the mantle source components, we modeled their major and trace elements. On the basis of the most primitive cumulus olivine crystals, the minimum eruption temperatures (°C) have been estimated according to calculations of [1]. Forsterite contents of olivine are 89.8% in Fred's Flow, 93.9% in the Pyke Hill flow and 84-86% in Theo's Flow and correspond to 1420±43°C, 1516±45°C and 1325±40°C, respectively. Parental magma compositions (CaO/Al_2O_3≈1) of Fred's Flow and Pyke Hill correspond to partial melts of a fertile mantle peridotite, whereas CaO/Al_2O_3≈1.5 of Theo's Flow suggests a higher pyroxene/garnet ratio in the source, as in pyroxene-rich peridotite [2].

External Pb-Pb isochrons have been obtained for Theo's Flow and Fred's Flow to better understand the evolution of source heterogeneities with time. The ages obtained for Theo's Flow and Fred's Flow are 2686±94My and 2604±102My respectively. Hf and Nd isotopes will be further investigated to propose initial isotopic signatures of the source of komatiites formed in Archean mantle plumes 2.7 Ga ago.

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Compositional gaps and melt segregation in magmatic systems: A multiphase dynamics approach

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Compositional diversity in evolving magmatic systems is driven in large part by the multiphase dynamics of melt-crystal separation. Key to quantitative description of these systems is to accurately calculate the rate and timing of crystal-melt separation. This calculation requires accurately computing three separate, but closely linked, problems: heat transfer, phase equilibria, and multiphase dynamics, all of which can play an important role in determining the compositional and melt fraction histories of magmatic bodies. We have developed a multiphase approach to compute extraction in magmatic systems (Dufek and Bachmann, 2010) combined with an enthalpy closure from a callable library based on MELTS (Ghiorso and Sack, 1995). In this dynamics model separate phases are

We use this model to demonstrate dynamics on several different scales: We use this new model to demonstrate dynamics on several different scales: 1. Melt segregation and crystal-melt dynamics in small and moderate scale magmatic systems (using examples from Cotopaxi and the Fish Canyon Tuff), and 2. Thermal evolution on the crustal scale influenced by tectonic forcing, including shortening and extension. In all cases we explore the rate and location of fractionating phases, and the driving mechanisms for fractionation.

We have particularly applied this model to examine the production of compositional (Daly) gaps in a number of tectonic settings. Compositional gaps are common in volcanic series worldwide. The pervasive generation of compositional gaps influences the mechanical and thermal properties of the crust. We show that gaps are inherent to crystal fractionation for all compositions, as crystal-liquid separation takes place most efficiently within a crystallinity window of ~50–70 vol% crystals. The probability of melt extraction from a crystal residue in a cooling magma chamber is highest in this crystallinity window due to (1) enhanced melt segregation in the absence of chamber-wide convection, (2) buffering by latent heat of crystallization, and (3) diminished chamber-wall thermal gradients. This mechanical control of igneous distillation is likely to have played a dominant role in the formation of the compositionally layered Earth's crust by allowing multiple and overlapping intrusive episodes of relatively discrete or quantized composition that become more silicic upward.

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