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Making...Moving...Mixing? The Role of Magma Transport in Controlling Observable Geochemical Variation in Mantle Melts

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A fundamental challenge for mantle geochemistry is to infer consistent dynamic processes from a wide-suite of chemical proxies. Standard geochemical models (e.g. batch and fractional melting) provide useful tools for predicting effects of melting on fractionation but only handle mixing of individual melts in an ad-hoc fashion. There is clear evidence for at least limited interaction and mixing of melts from heterogeneous sources and to make use of this information for inferring process, requires models that can place stronger quantitative constraints on the mixing and sampling processes. These processes are controlled, at some level, by the coupled fluid-solid mechanics of mantle flow, melting and melt-transport. This talk reviews the current state of models that calculate the geochemical consequences of physically consistent flows.

The current models stem from a general macroscopic set of conservation equations for mass, momentum and energy for two-phase melt and solid systems. I will briefly review the formulation and demonstrate its behaviour for a new suite of mid-ocean ridge models. These new models calculate time dependent 2- and 3- dimensional solid and melt flow fields together with melt compositions. Current compositional modules include fractionally melted major elements, reactive trace elements and reactive U-series elements. These codes have also been modified to allow for simple reactive/dissolution flow to investigate the chemical consequences and mechanisms of flow localization (channeling). The principal purpose of these models is to understand the range of variations and inter-element correlations in melt and residue compositions that might be caused by dynamic processes. I will compare the output of these models to standard geochemical models and to data from 12ºN on the East Pacific Rise (Spiegelman and Reynolds, 1999) to suggest that dynamics can produce observable effects and can change the inferences drawn from simpler models.

These models, currently, consider the consequences of melt transport for homogeneous sources but are readily extended to examine sampling and mixing of heterogeneous sources. Time permitting, preliminary models for interaction with source heterogeneity will be presented.

Spiegelman, M & Reynolds, J.R., *Nature*, **402**, 282-285, (1999).