Heterogeneity in Mid-ocean Ridge Sources

P. D. ASIMOW[1]

[1] Division of Geological and Planetary Sciences 170-25, California Institute of Technology, Pasadena CA 91125 USA; asimow@gps.caltech.edu

Understanding of decompression melting of homogeneous peridotite sources beneath mid-ocean ridges has reached a reasonably mature state. One can construct apparently adequate models that relate source composition, including volatile contents, and potential temperature to major and trace element chemistry of the aggregate primary liquid and to correlations with physical variables like melt flux and axial depth. Such models are the basis of the consensus view of the average thermal and compositional state of the upper mantle and the range of their variability.

In my view, one major remaining frontier for petrologists working on mid-ocean ridges is the handling of source heterogeneity within a particular melting regime. A variety of data (e.g. melt inclusion diversity within samples) and lines of reasoning (e.g. the need for recycling to maintain fertility of the source) require that such heterogeneity exists. There is some small scale of heterogeneity below which the source melts as if it were effectively homogeneous and some large scale above which the source components can be treated as chemically and thermally independent and their melts simply mixed; these scales may be different for different elements and lithologies. The challenge is to develop tools that predict behavior at intermediate scales where incomplete thermal and/or chemical interaction occur and hence standard mixing theory is confounded by complex feedbacks between composition and melting behavior and between melting and equilibration. Additional challenges center on the kinetics of interactions during melt migration through heterogeneous media.

I will review some of the reasons these problem defeat the current generation of melting models, the efforts that have been published by various authors, the theoretical progress that is needed, and the prospects for success.