Finding geochemical fingerprints of melt transport processes

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The mean trace element composition of mantle-derived melts can be modelled remarkably well with Shaw's simple melting equations. This is both a deeply meaningful result and a significant problem. As a positive, it means we can routinely estimate mean degrees and depths of mantle melting using trace element datasets, without recourse to more complex models. However, Shaw-style melting equations provide an essentially zero-dimensional description of mantle melting; they do not incorporate the physical–chemical details of two-phase flow and melt-rock reaction that are involved in the formation and migration of melt out of the mantle. Therefore, the Shaw equations' successful description of basalt trace element contents, despite the limitations of these equations, could imply that patterns of mean trace element concentration contain little information on the details of melt transport.

Here we investigate how the chemical variability of mantle derived melts, rather than their absolute trace element contents, can be used to constrain melt transport. Inverting a variety of global, local, and single-sample (melt inclusion) datasets we find a common structure of deep mixing of melts followed by efficient transport out of the shallow melt region. These results provide a new insight into the characteristics of melt-transport pathways that allows us to now compare properties of melt transport in active melting regions with the predictions from self-consistent physical models of melt migration.