Petrological Constraints on Potential Temperature

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The existence of an active volcanic center or "hot spot" has commonly been taken as evidence of a hot diapir or "plume" ascending from the core-mantle boundary. Because many of these centers are located near or on volcanically active ridges, the origin of both types of volcanism must be considered together.

Determination of the potential temperature (Tp) is fundamental to correct modeling of the magma generation process, and would also address the issue of whether or not enhanced volcanic activity at a ridge (Iceland) or remote from a ridge (Hawaii) is driven by a hot diapir originating at the core-mantle boundary, with consequent implications for mantle dynamics. Large disagreements about Tp at Hawaii and along spreading ridges have persisted for decades. In Hawaii, olivine-controlled fractionation is well-documented and various authors have suggested that the parental magmas for this fractionation lie either toward the olivine-rich (high Tp) or olivine-poor (low Tp) end of this trend. Picritic glass shards on the ocean floor from the Puna Ridge of Kilauea (Clague *et al.*, 1995) are compositionally between the two extremes and require a minimum Tp of about 1420˚C (Gudfinnsson and Presnall, 2003). No comparable picritic glass compositions have been found at Iceland or anywhere else along a spreading ridge. See Gudfinnsson *et al.* (this conference) for a discussion of the origin of the most magnesian volcanic glasses from Hawaii and Iceland.

The Tp along spreading ridges, which includes Iceland and close proximity to a number of hot spots, has been controversial since the beginning of experimental studies of MORBs. From 1967 to 1988, petrologists were about evenly divided between those favoring low-pressure (0.7-1.1 GPa, low Tp) and those favoring high pressure (1.5-3.0 GPa, high Tp) magma-generation models. Beginning with the papers of Klein and Langmuir (1987, 1989) and McKenzie and Bickle (1988) and extending to the present time, the earlier controversy has been forgotten and fractional polybaric melting over a wide range of Tp (about 1240-1510˚C in the model of Klein and Langmuir) has been widely accepted. However, Kelemen *et al.* (1997) found that the trace element data for abyssal peridotites are consistent not only with near-fractional melting, but also with a range of batch plus fractional melting scenarios. Both Asimow *et al.* (1999) and Walter (in press) concluded that a model involving a combination of fractional and batch melting best fits the data. In addition, Walter (in press) concluded that the pressure range could be small and centered at about 1 GPa (Tp of about 1240˚C). Green *et al.* (2000) have argued that both hot spot and MORB magmas are generated at a Tp of about 1430˚C. Presnall *et al.* (2002) have recently presented a model that includes melting over a wide range of pressures from 0.9 to 7 GPa, but emphasizes the dominant role of low pressures (0.9-1.5 GPa, Tp of 1240-1260˚C) and mantle heterogeneity in producing the major-element systematics of MORBs. The evolution over the last 36 years from a low *vs* high Tp controversy to widespread acceptance of a large range of Tp, and now to revival of the original debate over high *vs* low Tp is remarkable. An extension of this debate will be presented that integrates experimental phase equilibrium data with global seismic tomography and provides strong support for a low and relatively uniform Tp in most parts of the ocean basins. This requires mantle heterogeneity and dominance of athermal processes in the formation of ridges and "hot spots" near or on ridges, and is consistent with the plate tectonic model of Anderson (2002).

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