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The temperature of primary melts and mantle sources of komatiites, OIBs, MORBs and LIPs

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There is general agreement that the convecting mantle, although mostly peridotitic in composition, is compositionally and thermally heterogeneous on different spatial scales. The amount, sizes, temperatures and compositions of these heterogeneities significantly affect mantle dynamics because they may diverge greatly from dominant peridotites in their density and fusibility. Differences in potential temperature and composition of mantle domains affect magma production and cannot be easily distinguished from each other. This has led to radically different interpretations of the melting anomalies that produce ocean-island basalts, large igneous provinces and komatiites: most scientists believe that they originate as hot, deep-sourced mantle plumes; but a small though influential group (e.g. Anderson 2005, Foulger, 2010) propose that they derive from high proportions of easily fusible recycled or delaminated crust, or in the case of komatiites contain large amount of H_2O (e.g. Grove & Parman, 2004). The way to resolve this ambiguity is an independent estimation of temperature and composition of mantle sources of various types of magma.

In this paper I report application of newly developed olivine-spinel-melt geothermometers based on partition of Al, Cr, Sc and Y for different primitive lavas from mid-ocean ridges, ocean-island basalts, large igneous provinces and komatiites. The results suggest significant variations of crystallization temperature for the same Fo of high magnesium olivines of different types of mantle-derived magmas: from the lowest (down to 1220 degree C) for MORB to the highest (up to over 1500 degree C) for komatiites and Siberian meimechites. These results match predictions from Fe-Mg olivine-melt equilibrium and confirm the relatively low temperature of the mantle source of MORB and higher temperatures in the mantle plumes that produce the OIB of Iceland, Hawaii, Gorgona, Archean komatiites and several LIPs (e.g Siberian and NAMP).

The established liquidus temperatures and compositions of primary melts allow estimating potential temperatures and compositions of their mantle sources. The results strongly confirm mantle plume theory and presence of variable amounts of recycled crustal material in the mantle sources.

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