Primitive melt inclusions — the missing link between the mantle and MORB

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Mineral crystals in Mid-Ocean Ridge Basalt (MORB lavas commonly contain tiny inclusions of frozen melts. These inclusions are providing new insights into the physical process by which the mantle melts to produce MORB. For many years, it was generally believed that MORB were direct products of batch equilibrium melting of the upper mantle. However, recent geochemical studies of the residues of mantle melting, abyssal peridotites [*Johnson et al.,* 1990; *Johnson and Dick,* 1992], show that the residual mantle is not in direct equilibrium with MORB. Johnson et al. [1990] did show, however, that peridotites and MORB could be related by fractional melting, a process in which small melt fractions are removed from the source as soon as they are formed. It is now widely believed that MORB melts are aggregate mixtures of these small melt fractions, but question arises whether the small melt fractions can be sampled? As demonstrated by geochemical studies of tiny droplets of melt trapped in magmatic minerals contained in MORB [*Sobolev and Shimizu,* 1993; *Johnson et al.,* 1995], the answer to this question is "yes." In a study of melt inclusions trapped in plagioclase feldspar crystals from sheeted dike diabases deep in the magmatic system at Hole 504B, we found that the melt inclusions had compositions far more primitive and depleted than the MORB above them [*Johnson et al.,* 1995]. We also discovered that the inclusions were in equilibrium with many abyssal peridotites (see figure), thereby demonstrating that fractional melts do exist as trapped inclusions that can be studied directly. Thus, these melt inclusions provide the missing observational link between the source peridotites and MORB lavas.

References:

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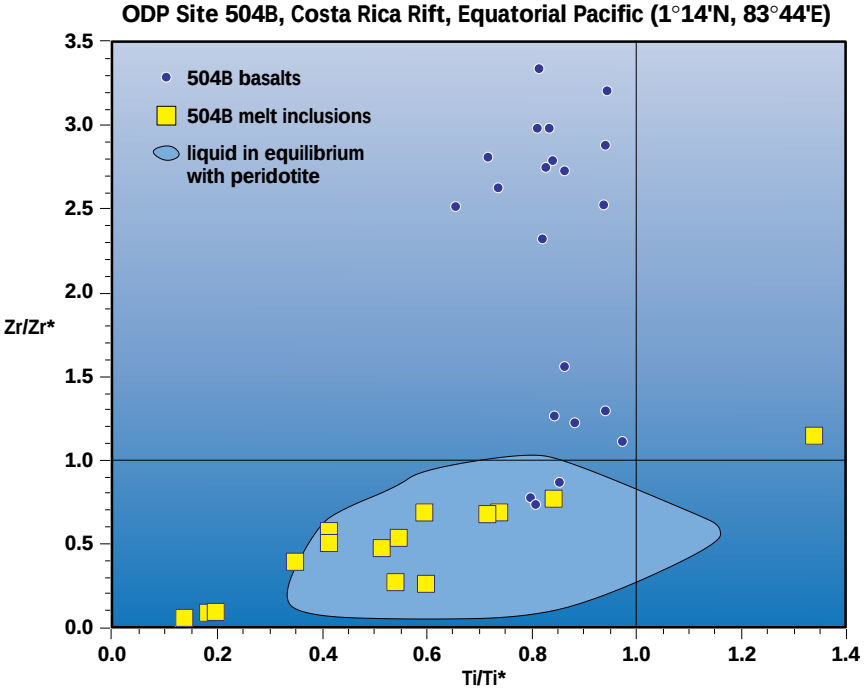

Zr/Zr* and Ti/Ti* are measures of the anomalies of Zr and Ti on extended rare earth element diagrams, with values less than 1 indicating negative anomalies. Shaded field represents hypothetical melts in equilibrium with abyssal peridotite diopsides. The inclusion compositions are consistent with being fractional melts.