Tectonic controls on MORB melting from correlated peridotite-basalt compositions

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Mid-ocean ridge basalt and abyssal peridotites are generated by decompression melting of the depleted oceanic upper mantle, but the dominant control on the extent of melting is debated. Variations in mantle temperature [1], mantle composition [2] and plate spreading rate [3] have been invoked to explain the global variations in crustal thickness and in the major element composition of mid-ocean ridge basalts (MORB).

Most previous studies have either used the geochemistry of MORB [1] or the mineralogy and geochemistry of abyssal peridotites [4] to understand the melting process. We have compiled a global database of abyssal peridotite compositions, allowing us to study the melting process from the perspective of both melts and melting residues from the same ridge segments. We find that on a global scale, basalt and peridotite major and trace element compositions are correlated, substantiating a melt-residue relationship. Na8 in MORB correlates negatively with Cr# in spinels from abyssal peridotites from the same ridge segments.

However, whereas MORB major element compositions correlate with ridge depth, melting indicators in abyssal peridotites rather suggest a spreading rate control. This results from the fact that most abyssal peridotites are from ridge segments far from mantle plumes, where crustal thickness is low. We calculated the distance of each ridge segment to the nearest hotspots, and find that the effects of near ridge hotspots on MORB major element composition, ridge depth and crustal thickness are more extensive than commonly assumed. When hotspot-influenced segments are removed, the major and trace element composition of both MORB and abyssal peridotites, as well as the mean segment depth are correlated with spreading rate. Slow-spreading ridges are deeper and have higher Na8, lower Fe8 and low Cr# spinel. Spreading rate has an important influence on the melting process, and variations in upper mantle temperature away from hotspots are much smaller than previously thought.

[1] E..M. Klein, C.H. Langmuir. *J. Geophys. Res.* **92** (1987) 8089-8115. [2] Y. Niu, M.J. O´Hara. *J. Petrol.* **49** (2008) 633-664 [3] Y. Niu, R. Hekinian. *Nature* **385** (1997) 326-329 [4] H.J.B. Dick et al. *EPSL* **69** (1984) 88-106