What controls extents of MORB differentiation?

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O'Hara [1] emphasized the importance of differentiation in controlling the compositions of erupted basaltic magmas. Indeed, it is now recognized that virtually all erupted magmas are significantly removed from primary mantle melt compositions. The new global compilation of MORB compositions combined with data for the physical parameters of global ridge segments [2] permits investigation of what physical parameters control the extent of fractionation, as indicated by either MgO or Mg#. There is no correlation with spreading rate globally, and large variations in MgO occur at constant spreading rate. Additional parameters must be important. One of them is the overall magmatic budget and extent of melting as indicated by $Na_{8.0}$ or ridge depth. If fractionation systems depend on flux of magma through the crust, that flux depends on both spreading rate and extent of melting. Natural experiments to investigate and calibrate these two effects occur in transects across hot spots where spreading rate is constant and magmatic flux varies. For well sampled ridge segments around the Azores there is a very clear relationship between ridge depth and an ~2% change in the mean MgO content of ridge segments. Similar effects are seen for the Galapagos. These data suggest greater extents of fractionation with higher magma flux, consistent also with the lower MgO content of EPR segments compared to many MAR segments. The Eastern Lau Spreading Center provides another natural experiment where spreading rate and water contents vary regularly along strike. Here lower MgO occurs at slower spreading rates, but shallower ridge depths and higher water contents, consistent with higher flux leading to greater extents of fractionation. Other signals apparent in the data are the effects of large fracture zones and segment length., as well as high pressure fractionation. Taking all of these into account raises the possibility of a general law for extent of fractionation that could be utilized with physical models of magma ascent and cooling.

[1] O'Hara (1965) *Scottish J. Geology* **1** 19-40, [2] Gale et al. (2013) G-cubed doi:10.1029/2012GC004334