Geophysical Research Abstracts, Vol. 7, 06335, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06335

Variation with spreading rate of melt production rates under mid-Ocean ridges

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The rate of melt production under mid-ocean ridges is controlled primarily by the temperature of the underlying mantle and by the rate of seafloor spreading. Geophysical measurements of the igneous crustal thickness (from wide-angle seismics and gravity) provide information on the amount of melt that reaches the crust. Geochemical inferences from rare earth element (REE), major and trace element concentrations of mid-ocean ridge basalts provide complementary information on the total amount of melt generated in the mantle. Both geophysical and geochemical methods give consistent results for the amount of melt generated from the mantle and frozen to form oceanic crust, suggesting that even at ultra-slow spreading ridges the extraction of melt to the crust is efficient, and large amounts of melt do not remain in the mantle.

This correlation between geophysical and geochemical determinations of melting holds across all spreading rates and also for variations in average melt thickness between adjacent ridge segments. It suggests that $<$15% of the melt generated is frozen in the mantle before it reaches the crust. The REE concentrations of basalts from ultra slow-spreading ridges are higher than those from normal oceanic ridges, which is directly indicative of reduced mantle melting, and they show characteristic light REE enrichment, interpreted as caused by a deep tail of small percentage wet melting. An abrupt decrease of melt thickness occurs at full spreading rates below $\sim$20 mm/a, pointing to the importance of conductive cooling inhibiting melting of the upwelling mantle at ultra slow-spreading centres.

Thin oceanic crust is common adjacent to rifted continental margins away from mantle plumes. It can be explained by a similar mechanism to that inferred beneath ultra slow-spreading ridges of mantle cooling by conductive heat loss from mantle upwelling slowly beneath the rifting continent prior to breakup. However, to date rather little geochemical information is available from continental margins to complement the geophysical measurements.