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Trace elemental and ^{226}Ra-^{230}Th-^{238}U disequilibria data in 41-45° N Mid-Atlantic ridge basalts: Constraints on melting dynamics and implications for source heterogeneity

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New ^{226}Ra-^{230}Th-^{238}U disequilibria data by TIMS and ICPMS trace element data are reported for 28 MORB glasses from north of the Kurchatov Fracture Zone in the central North Atlantic region. The study area includes the 43˚N anomaly that is part of the short wavelength geochemical anomalies observed in the MAR region adjacent to the Azores hotspot and that have been variably attributed to plume-ridge interaction, mantle metasomatism and shallow recycling. A recent geophysical survey in the area indicates that the 43˚N is marked by remarkably thin crust and low heat flow, disfavoring a model of mantle plume with high magma input. We use U-series isotopes to address these issues, because they are unique and sensitive tracers of the melting dynamics. The lavas display a large range in incompatible trace element ratios and in radiogenic isotopes (e.g. ^{143}Nd/^{144}Nd = 0.51288-0.51307), indicating widespread source heterogeneity. Fresh and virtually zero-aged lavas from distinct latitude intervals form two distinct sub-horizontal pseudo-isochrons (mixing lines) on a U-Th equiline diagram, with lavas from around 43˚N MAR having relatively low (^{230}Th/^{238}U) excesses for their degree of enrichment. For normal dry mantle melting conditions, the U-Th systematics would suggest contrasting upwelling rates in the area of up to a factor ten for neighboring ridge sections (fastest beneath the enriched 43˚N section). Furthermore, the greatest garnet signature, and presumably also the deepest melting column, occurs at 43˚N, where the crust is thinnest. Water is inferred to play an important role in the melt source region around the Azores region and we propose a similar important

influence in the 43˚N MAR source region. We propose that the 43˚N MAR anomaly represents the melting of relatively cold and wet mantle material that is passively fed to the ridge as a single blob from the Azores plume, or as an isolated enriched ‘plum’ sitting in the upper mantle. As our EMORB samples resemble very much those from 14˚N on the same ridge as described in Hémond et al. (2006), we believe that such material can also be recycled alkali basalt into the upper mantle.

References

Hémond, C., A. W. Hofmann, I. Vlastélic, and F. Nauret (2006), Origin of MORB enrichment and relative trace element compatibilities along the Mid-Atlantic Ridge between 10˚ and 24˚N, Geochem. Geophys. Geosyst., 7, Q12010, doi:10.1029/2006GC001317.