Chemical Variations and Melting Systematics along the Western Galápagos Spreading Center, 90.5° - 98°W

John Sinton, Buffy Cushman and Garrett Ito, University of Hawai‘i, Honolulu, Hawai‘i USA

From west to east along the Galápagos Spreading Center (GSC), there are remarkable co-variations in axial depth, axial morphology, crustal thickness and the composition of erupted lavas. West of 95.5°W the GSC has an axial valley, crustal thickness is about 5.5 km and nearly all erupted lavas are N- (normal) MORB. Between 95.5°W and ~93°W the axis shows transitional morphology, crustal thickness increases to ~6.5 km and erupted lavas are transitional (T-) MORB showing modest increases in K/Ti, Nb/Zr and radiogenic isotope ratios. Between ~93°W and the Galápagos transform zone at 90.5°W the axial region is dominated by axial high morphology, crustal thickness up to 8 km and the eruption of enriched (E-) MORB extending to maxima in K/Ti and Nb/Zr. In addition to enrichments in highly incompatible elements and radiogenic isotopes, E-MORB are characterized by high Na_2O and H_2O, and low CaO/Al_2O_3 and SiO_2 at a given MgO, features generally consistent with relatively low extents of partial melting. In an attempt to determine the relative contributions from enriched mantle, active upwelling, and potential temperature in the development of the crustal thickness and chemical gradients along the GSC, we have developed a melting equation that explicitly incorporates a deeper zone of hydrous melting into the decompression melting regime beneath the ridge axis. The model solves for a range of variables that are constrained to match the crustal thickness and concentrations of K, Na_2O, H_2O and Ti in lavas at various locations along axis. Modeled variables include the depths to the anhydrous and hydrous solidi, (sensitive to temperature and source water content, respectively), productivity in the hydrous region, source composition, and the flow rate of material passing through the hydrous zone. The results of this model indicate that incorporation of hydrous melting reduces the required mean extent of melting, even for N-MORB. The production of GSC E-MORB requires an enriched source, but the magnitude of this enrichment correlates inversely with the extent of active upwelling. Chemical heterogeneity including H_2O can account for most of the variation in crustal thickness and composition along the western GSC; the maximum potential temperature anomaly associated with this section of ridge is 34°C. Our preferred explanation for the eastern, shallowest, most chemically enriched portion of the axis is that it is produced by only a slight (11 ± 11°C) temperature anomaly coupled to an enriched source with moderately active upwelling.