Correlations between MORB helium isotope ratios and mantle seismic wave speeds

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Compositional variations observed in mid-ocean ridge basalts (MORBs) reflect complex relationships between the thermal, compositional, and dynamical state of the mantle. Progress in resolving these competing effects requires the construction of global databases [1-2] that then allows one to explore potential correlations between basalt geochemistry, physical properties of ridge segments including ridge topography, spreading rates, mantle composition and potential temperature, and underlying shear-wave speeds [3]. Here we compare ridge-segment-averaged helium isotopic compositions with shear-wave velocities at both the global- and regional-scale to further elucidate thermal, chemical, and dynamical controls on major-trace element and isotopic variability at spreading centers.

An initial dataset of helium isotope measurements from spreading centers worldwide has been constructed. This dataset consists of 327 individual ridge-segment-averaged helium isotope compositions from the three ocean basins. This global dataset displays a strong correlation between helium isotopes and the underlying shear-wave velocities in the upper mantle. Helium isotopes and shear-wave velocities are also highly correlated with Na_{90} values [3]. This global trend is dominated by mid-ocean ridge basalts from the Atlantic Ocean while the Pacific shows no significant correlations. Helium isotope ratios from the mid-Atlantic ridge also display a strong correlation with off-axis shear-wave velocities computed by moving the ridge-segment-averaged helium isotopic compositions in the direction of plate motion. Geodynamic models indicate the off-axis relationship between helium isotope ratios and shear-wave velocities may be related to flow patterns in the (upper) mantle.

[1] Gale A. et al. (2013) *G*^{3}, 14, 489-518. [2] Gale A. et al. (2014) *J. of Petrol.,* 55, 1051-1082. [3] Dalton C. A. et al. (2014) *Science,* 344, 80-83.