Chemical Variations along the EPR Identify Melt Flow and Influence Segmentation

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Introduction

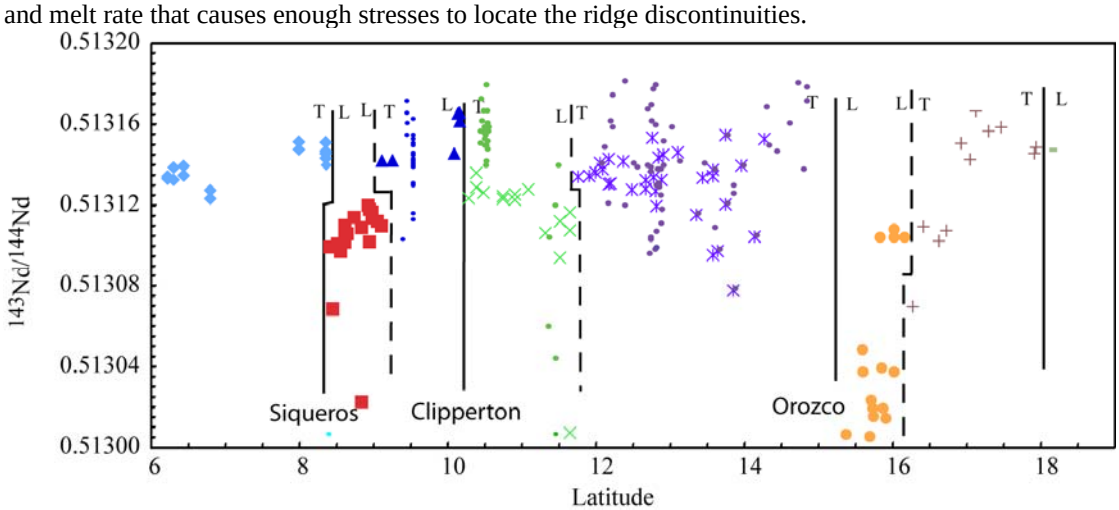
We have analyzed at high "density" samples from the EPR between 8-18N for trace elements and isotopes. At the EPR we observe a systematic variation in the chemical composition of the basalts related to ridge discontinuities, both fracture zones and overlapping spreading centers. At migrating ridges such as the EPR leading (LE) and trailing edges (TE) of ridge segments have been identified. LEs have thicker crust suggesting a larger accumulation of melt. The low degree melts generated of-axis on the TE of the ridge segment can find a shorter route to the ridge by crossing the transform fault plane. The LE therefore has additional low-degree melts which are missing at the TE. The area on the EPR we covered contains four fracture zones (Siqueros, Clipperton, Orozco and 18N) as well as three overlapping spreading centers.

Results and Discussion

We observe discontinuities in the chemical composition of the basalts at all seven ridge discontinuities (see figure) . The changes in the trace element ratios like Ce/Yb, Ba/La, Sm/Nd at six of the seven discontinuities are consistent with the LE receiving a larger amount of low degree melt, as predicted by the geophysical model. The Clipperton Fracture zone is the only discontinuity that has chemical variations that are the reverse of what is expected based on the model.

A second aspect of the chemistry is the consistent offset in Hf and Nd isotopic composition at ridge discontinuities. These variations can be explained if the sources of the EPR basalts has two lithologies with different solidi, whereby the lithology with the lower solidus also has a less radiogenic Nd and Hf isotopic composition. This material will melt earlier and will be concentrated in the low degree melts. Crossing the transform fault plane of these low degree melts could explain the observed isotopic variations. This supports the Carbotte et al. model for the explanation of the crustal thickness variations. And again the only exception is the variation across the Clipperton Fracture Zone.

Lastly and perhaps most importantly, the chemical variations within the individual ridge segments are distinct from each other. The coincidence of chemical discontinuities with ridge discontinuities is consistent for all eight ridge segments and indicates that the segmentation is influenced by the mantle composition. It is hypothesized that changes in mantle source composition, like variations in the amount veining present, can potentially result in changes in the melting regime like depth of melting and melt rate that causes enough stresses to locate the ridge discontinuities.



T and L indicate the trailing and leading edge of a ridge segment. Solid black lines are transform faults, dashed lines are overlapping spreading centers.

Acknowledgements

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