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Pyroxene chemistry of gabbroic rocks from ODP Hole 1105A, Leg 179, Southwest Indian Ridge

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ODP Hole 1105A was drilled during Leg 179 on a gabbroic massif exposed along the AtlantisII Fracture zone on Southwest Indian Ridge. Hole 1105A penetrated to a depth of 158 meters on the Atlantis Bank. 118.43 meters of gabbroic rocks were recovered which is almost 82.8% of the cored section [1]. The core was divided into four broader groups based on the presence or absence of oxides. Plagioclase, clinopyroxene, olivine, magnetite and illmentie form the basic cumulus minerals in the gabbroic rocks. Plagioclase and clinopyroxene is present in all the rocks (148 samples) used in this study. Olivine is present in 89 samples and opaque minerals are found in 59 samples used in this study. Very few samples have orthopyroxene and inverted pigeonites and they are mostly associated with oxide rich rocks suggesting that these rocks are products of highly fractionated melt.

Clinopyroxenes from this study are largely augite and forms a broad band when plotted on the pyroxene quadrilateral [2]. A systematic variation is observed in the quadrilateral plot with the high Ca high Mg pyroxenes found in the primitive olivine gabbros, and the low Ca low Mg pyroxenes found in more differentiated oxide gabbros. A large variation is observed in the Mg number of clinopyroxene which ranges from 53.62-86.91. Downhole plots of Mg number of clinopyroxene documents cryptic chemical behaviour in the core. An interesting observation is the behaviour of trace elements like TiO_2 in clinopyroxene. A peak in the plot between clinopyroxene Mg number and TiO_2 is achieved at Mg number 75. The peak also acts as a lithology divider between oxide free and oxide bearing or oxide gabbros. Established trends between tetravalent Al in cpx and D_{Ti} [3] when used to predict clinopyroxene composition in equilibrium with melts show a simillar break at Mg number 75. This suggests that the Fe-Ti oxide minerals present in the gabbroic rocks are products of fractionation and not intrusions in early crystallized rocks.

References

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Variations in mantle composition along the Central Indian Ridge

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More than 50 new ICP-MS analyses of basalt glasses along the Central Indian (CIR) and Carlsberg Ridges combined with new Sr, Nd and Pb isotopic data permit a clearer delineation of the chemical characteristics and geographical distribution of mantle compositions in the mantle beneath the Indian Ocean. While the influence of the Reunion hot spot is clearly evident in CIR compositions, trace element enriched and depleted compositions are found along the entire length of the CIR. The new isotopic data correspond with those previously published with all data have higher $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ and higher $^{87}Sr/^{86}Sr$ compared to N. Atlantic and Pacific samples. Trace elements show subtle distinctions that are clearly resolved with the new high precision data. The enriched component along the CIR is marked by high Ba, Rb and Th relative to the REE, but no Nb depletion. This rules out a sediment origin for this component. The depleted end member is depleted in high field strength elements, including Nb, Ta, Zr and Ti, and shows fractionated ratios of Nb/Ta and Zr/Hf that are consistent with prior melt depletion. In these data, the Nb depletion is carried by the depleted mantle component, rather than the enriched component. The combination of these two effects then leads to complex trace element relationships with a general regional enrichment in Ba and regional depletion in Nb. However, those two signals come from different causes.

While the sampling is not dense enough to clearly define regional gradients, there are statistically significant offsets between the southern and northern CIR, with the distinctive depleted mantle composition diminishing in importance to the north. The few Carlsberg Ridge stations are the least “Indian Ocean like” and would be very difficult to distinguish from an array of East Pacific Rise basalts. Therefore it appears likely that there is a regional gradient in the Indian Ocean, with the maximum effect along portions of the Southwest Indian Ridge, and a progressive diminishment towards the north. Higher density regional coverage of other ridges should lead to much higher definition of mantle domain boundaries and place further constraints on the timing and cause of their formation.