Major and trace element constraints on petrogenesis of Northern Central Indian Ridge basalts

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The northern Central Indian Ridge (NCIR ~18-22 mm/yr half spreading rate), one of the poorly defined mid-ocean ridge system, has important implications on the dynamics of slow seafloor spreading.

In order to address the magmatic evolutionary processes and to formulate the pressure estimation for NCIR MORB, we report a set of new major and trace element data for a suite of dredged basalts from the NCIR (~5-10^{0}S). Basalts are mostly aphyric to moderately phyric with plagioclase and olivine as the dominant phenocryst phases, respectively. Melt inclusions (spherical and irregular shaped) are mostly common within the plagioclase phenocrysts. Their characteristic composition (Al_2O_3, MgO and FeO_t ranges between 5.4-6.8; 13-14 and 13.3-13.8 wt%, respectively) suggests that they have been affected by post-entrapment crystallization.

Bulk rock and quench glass samples vary primitive (Mg#0.73) to moderately evolved (Mg#0.57), with a comparable range in incompatible (Zr=63-141 ppm, Nb=0.88-6.60 ppm) and highly compatible trace element (Ni=86-205 ppm, Cr=220-375 ppm) concentrations. Incompatible trace element ratios like K/Ti and $(La/Sm)_N$ of our samples range from typical N-MORB (K/Ti ~0.02, La/Sm ~0.42) to T-MORB (K/Ti ~0.18, $(La/Sm)_N$ ~1.23). T-MORB has low Zr/Nb and Y/Nb ratios (~ 13.4, 3.5) compared to N-MORB (high Zr/Nb and Y/Nb ratios~ up to 72 and 25 respectively). In addition, the T-MORB also contains high Ba and Th and moderate Rb, with overall depletion in U. The depleted mantle source shows depletion in incompatible elements, e.g. Nb, Ta and TiO_2 among the minor oxide. Low HREE ratios [$(Gd/Yb)_N$ <1.2] possibly negate the role of garnet in mantle sources.

Major and trace element variations, particularly decreasing Mg# suggest crystallization of mainly olivine and plagioclase in most of these basalts prior to their eruption. The pressure and temperature of formation of primitive NCIR MORB basalts (Mg#>0.68), using Di-Ol-Si ternary diagram, are estimated to be around 10 kbar and ~1250^{0}C respectively. The relation of incompatible versus compatible elements and ratios of highly incompatible element pairs suggest that the magma was subsequently modified by crystal fractionation and spinel was the first mineral to crystallise out followed by relatively Fe-rich olivine at reducing pressure. Higher density regional coverage and detailed isotopic ratios together with their trace and REE contents would help to explain meaningfully the mixing model and composition of mixing end members and this in turn would lead to better understand the nature of the mantle characteristics beneath the NCIR.