Geochemical Heterogeneity of Indian Ocean MOR Mantle – Abhishek Saha, CSIR-National Institute of Oceanography, Dona Paula, Goa - 403 004, India. (E-mail: asaha@nio.org, asaha.nio2015@gmail.com)

The tectonic and magmatic processes contributing to the heterogeneous nature of the upper mantle posit important constraints on the composition and differentiation of the Earth at various scales. Mid-oceanic ridges of intermediate, slow and very-slow spreading rates across the world's oceans are characterized by different crustal configurations portraying the compositional diversity of the upper mantle. The two viable processes that attribute to chemical and isotopic heterogeneity of the mantle include (i) multiple episodes of melt replenishment and melt-rock interaction in open magma systems and (ii) recycling of oceanic and continental crustal materials and components of sub-continental lithospheric mantle. Oceanic crust and mantle sections exposed at intermediate, slow and ultra-slow spreading centres provide maximum proximal observations of ambient conditions at crust-mantle interfaces and melt generation-migration-differentiation processes that can be translated towards understanding of the mantle heterogeneity. Geochemical data for Carlsberg Ridge Basalts (CRB) and Central Indian Ridge Basalts (CIRB) yield crucial insights into their petrogenetic aspects in the context of the geochemical and tectonic evolution of the Indian Ocean mantle. The CRB and CIRB samples exhibit tholeiitic to transitional composition of precursor melts derived by high degree, shallow level partial melting of a spinel peridotite mantle source. They show E-MORB affinity with selective enrichment in incompatible trace elements. Higher values of Zr/Hf and Zr/Sm in conjunction with lower Nb/Ta ratio corroborate their origin from an enriched mantle source. Negative Nb anomalies with lower Nb/Y and Zr/Y for majority of the samples conform to a non-plume origin of these basalts. Higher Zr/Nb and Th/Nb compared to OIB substantiate contributions from recycled subduction-processed components in the source mantle. Lower Nb/U values with higher Ba/Nb, and Ba/Th, Zr/Nb and Th/Nb compared to OIB and N-MORB attest to role of a metasomatized oceanic lithosphere that recycled into the depleted upper mantle attributing to the source heterogeneity. Sr-Nd isotopic signatures ($^{87}\text{Sr}/^{86}\text{Sr}$: 0.702668 to 0.702841 and $^{143}\text{Nd}/^{144}\text{Nd}$: 0.512972 to 0.513068) of CRB suggest a HIMU source component preserved in

the northwest Indian Ocean Mid Oceanic Ridge mantle. In conjunction with this, geochemical and zircon U-Pb geochronology data for the lower oceanic crust gabbros from Central Indian Ridge (CIR) suggest episodic recycling of ancient metasomatized continental lithosphere of Madagascan and Gondwana origin towards the Indian Ocean MOR mantle heterogeneity. The geochemical attributes of CIR gabbros depict a marked deviation from typical depleted N-MORB compositions and conform to an E-MORB affinity. This E-MORB affinity for the CIR gabbros is ascribed to enriched lithospheric input into the depleted asthenospheric mantle. HFSE and REE compositions can be translated in terms of melt extraction by shallow level melting of a chemically heterogeneous upper mantle carrying depleted asthenospheric and recycled lithospheric components. The compositional diversity of the Indian Ocean MOR mantle can be translated in terms of periodic refertilization of depleted N-MORB type mantle through delamination and recycling of oceanic (HIMU component) and continental lithosphere (EM I component) concurrent with Neoproterozoic-Palaeozoic amalgamation and Jurassic dispersal of Gondwana Supercontinent respectively. This complies with the derivation of CRB from a geochemically heterogeneous Indian Ocean mantle that experienced a protracted residence beneath the Gondwana Supercontinent prior to the opening of Indian Ocean and trapped recycled metasomatized oceanic lithosphere genetically linked with multiple stages of paleo-ocean closure and continental convergence during Gondwana assembly. The preservation of 3.0 Ga-250 Ga zircon grains of continental origin within oceanic gabbros of CIR can be correlated with (i) subduction-driven delamination, convective downwelling and recycling of older continental margin lithosphere into the mantle during the Mozambique ocean closure and Gondwana amalgamation at around 750 Ma, and (ii) delamination, convective removal and incorporation of older continental fragments into the upwelling mantle asthenosphere in response to the dispersal of Gondwanaland at ~167 Ma ensued by opening of the Indian Ocean.

(Abstract of Lecture delivered at the Virtual Monthly Meeting of the Society on 10.02.2021)

DOI: 10.1007/s12594-021-1702-6