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Geochemical constraints on the origin of ophiolitic chert from Naga Hills Ophiolite, Northeast India

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ABSTRACT

The uppermost part of the Naga Hills ophiolite (NHO) sequence representing vestiges of the Neo-Tethyan ocean in the Indo-Myanmar ranges, consists of Late Jurassic to Late Cretaceous cherts that carapace the ophiolitic volcanics. This contribution presents petrographic and whole rock geochemical studies to comprehend their origin and paleo-depositional environment. The occurrences of abundant radiolarian microfossils in the studied cherts are observed. Geochemical signatures of these cherts indicate that they are generated at rifted arc basin by pronounced hydrothermal activity along with terrigenous material influx from active continental margin. Redox sensitive trace element proxies U/Th (0.12-0.74), Ni/Co (0.10-0.67) and V/(V+Ni) (0.22-0.47) record oxic paleo-redox conditions of formation. The cherts of NHO are envisaged to have formed in a transitional tectonic environment associated with magmatism and subsequent sedimentation in a rifted arc basin proximal to an active continental margin.

Keywords: Ophiolite, Radiolarian chert, Depositional environment, Paleo-redox conditions, Tethys Ocean.

INTRODUCTION

The north eastern extension of the Yarlung-Tsangpo suture zone, located along the Indo-Myanmar ranges (IMR), hosts a collage of dismembered ophiolitic suite and mélange of Neo-Tethyan origin. This ophiolitic suite comprising plutonic to volcanic lithologies of ultramafic-mafic composition, is overlain by deep sea silicious pelagic sediments with radiolarian fossils. The Naga Hills ophiolite (NHO), the northern most extension of the IMR, hosts a dismembered suite of ophiolitic rocks. Many workers have discussed different tectonic settings for the formation of NHO from mineral chemical and whole rock studies of one or more litho-units belonging to this ophiolitic suite and associated metamorphic complex. Early works suggest basalts to be originated in a back arc basin environment, while some suggest within plate tectonic regime for their origin (Sengupta et al., 1989; Rao et al., 2010). Recent studies suggest dual affinities for the NHO i.e. mid oceanic ridge and arc tectonic setting (Dey et al., 2018; Hussain and Dey, 2022). Singh et al. (2016) and Khogenkumar et al. (2021) suggest both non-subduction (viz. OIB and MORB) and subduction origin. Studies based on the metamorphic complex associated with the NHO, reveal that the basalts were metamorphosed to blueschist and eclogite facies in a subduction zone setting (Chatterjee and Ghose, 2010; Ao and Bhowmik, 2014; Bhowmik et. al, 2022; Bhowmik and Pradhan, 2024). Our previous works based on the spinel chemistry and whole rock Os isotopic studies for mafic-ultramafic plutonic assemblage of NHO, indicates the evolution of the NHO to a supra-subduction zone tectonic setting (Verencar et al., 2021; 2022; 2024a).

The chert beds are largely intercalated with the mafic volcanics of the NHO and these have been least studied as compared to their igneous counterparts in the ophiolitic sequence. The geochemical studies of these siliceous rocks containing radiolarians and sponge spicules, have become an important tool to infer the paleogeography and the tectonic setting of their depositional environment. Certain major oxides like TiO_2, Al_2O_3, Fe_2O_3 and MnO in addition to trace and rare earth elements, have been effectively used to evaluate the process involved in the genesis of cherts (Kato et al., 2002; Huang et al., 2013; Garbán et al., 2017). A few studies including paleontological studies by Agrawal (1985) and Baxter et al. (2011); and geochemical studies by Thong et al. (2022) have been carried out earlier on the cherts from NHO. Here, in this study, we evaluate the geochemical signatures of the cherts associated with ophiolitic volcanic rocks and further discuss their depositional environment in terms of paleo-redox conditions and constrain their tectonic affiliation based on the geochemical characteristics.

REGIONAL GEOLOGY

The Late Mesozoic to Early Cenozoic evolution of the Tethyan Ophiolite Belt is linked to the closure of the Tethyan Ocean and collision of the Indian and Eurasian Plates. These two tectonic events were marked by plate convergence, subduction of oceanic lithosphere, ophiolite obduction, high pressure-low temperature metamorphism and collision-accretion activities that altogether gave rise to Alpine-Himalayan and Burmese-Indonesian arc systems (Robertson, 2002; Acharyya, 2007; Aldanmaz et al., 2008; Saha et al., 2018;2019). In India, Cretaceous ophiolites have been recorded as parts of the Alpine-Himalayan and Indo-Burman orogenic belts. The NHO belt in the IMR represents a segment of Tethyan oceanic crust and upper mantle that was involved in an eastward convergence and collision of the Indian Plate with the Eurasian Plate at the Myanmar continental margin during the Late Cretaceous-Eocene (Ghose and Agarwal, 1989) (Figure 1a