Mafic Magmatism in the Western Himalaya and Trans-Himalaya: Geochemical-isotopic Characterization and Tectonic Setting

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Mafic magmatic rocks in the western Himalaya are preserved in the form of volcanosedimentary sequences, dykes and gabbroic bodies. Proterozoic magmatism is recorded from the Lesser Himalayan sequences of Mandi-Darla-Rampur - Himachal, through the Garhwal volcanic and dyke sequences of the Garhwal Himalaya to the Bhowali-Bhimtal volcanic sequences of the Kumaun Himalaya. The sequences were considered to be ~2.5 Ga old (W.R. Sm-Nd age) but later studies have shown these to be about 1.8 Ga old (single zircon age). These rocks have enriched large ion lithophile elements (LILE) and light rare earth elements (LREE) and depleted high field strength elements (HFSE) – Nb, Ti and P. Epsilon Nd (t) values of ~+5 indicate their derivation from isotopically depleted mantle source(s).

Ordovician magmatism is recorded from Thanna Mandi - Bafliaz section where a diverse sequence of magmatic rocks ranging from tholeiitic and alkaline volcanic and dykes on to extremely alkaline sequences of spilite-Keratophyre dykes. These volcanic rocks show highly enriched trace element characteristics and depleted epsilon Nd(t) of \sim +8. Keratophyre dyke sequences are rare in the Himalayas and these are very important to understand the mantle sources and tectonic scenario during their emplacement.

The Middle Permian volcanic sequence of the Panjal traps and its equivalent -Baralacha La dykes and Phe volcanics from NW Spiti region. These rocks have a sequence of tholeiitic and alkaline volcanics and dykes. These rocks are characterized by enriched LILE-LREE and depleted HFSE as observed for the Precambrian volcanic sequences. Limited Nd-isotopic data on the Phe volcanics gives an epsilon Nd (t=0) of ~-2.7 to -7.8 indicating their derivation from enriched source(s) as opposed to the isotopically depleted sources for the Precambrian volcanics and dykes. All the mafic magmatic rocks from the Precambrian to Middle Permian Panjal and its equivalents in the western Himalaya probably represent rift tectonic setting as indicated by the associated sediments and their trace element characteristics.

Cretaceous magmatism is represented by Ophiolitic rocks of the Indus and Shyok suture zones. The rocks of the Indus suture zone are considered to represent remnants of the Neo-Tethyan ocean. The Zildat ophiolitic mélange in the eastern Ladakh comprises a minor unit of N-MORB with epsilon Nd(t) of \sim +8 and a

dominant unit of the Oceanic Island Basalt (OIB-type) with epsilon Nd(t) of ~+4, tectonically intermixed with deep sea sediments. The epsilon Nd values for the Zildat rocks indicate their derivation from depleted but unrelated mantle source regions. Similar lithological packages are reported from the Shergol ophiolitic mélange in western Ladakh. Recent trace element and isotopic data indicate presence of intraoceanic island arc system being represented by the Nidar Ophiolitic Complex, these are equivalent to the Dras arc of the western Ladakh. Recent data from the Shyok suture zone indicate Andean type island arc system in the Nubra and Shyok valleys and it has a component of back arc system further to the NW in Pakistan. The epsilon Nd(t) for the mafic magmatic rocks of the Nidar ophiolitic complex is aout +8, indicating their derivation from depleted mantle source(s).