



Mineralogy and geochemistry of alkaline basic dykes from the northern Indian plate: signs of more than one episode of rifting and associated magmatism

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Rift related magmatism during Permian time in the northern margin of Indian plate, north-west Pakistan is shown by the occurrence of roughly linear array of alkaline rocks in the region. The constituent rocks include alkali granites, granodiorites, nepheline syenites, carbonatites and dykes of basic composition. The field relations, mineralogy and whole rock geochemistry of these basic dykes has been investigated. Significant textural and mineralogical distinctions have divided the basic dykes into a) dolerite and b) epidote amphibolites, cross cutting other alkaline rocks and pre-Permian rocks in the region.

Clinopyroxene having augitic composition is a major mineral in dolerite, however, it is completely absent in epidote amphibolites. Amphiboles in dolerites are brown coloured having pargasitic composition while it is green to light green in colour having the composition of magnesio-hornblende in epidote amphibolites. Compositionally different types of olivine are present in dolerites while it is absent in epidote amphibolites. Intra-plate tectonic settings for both the rock types has been interpreted by Hf-Ta-Th and FeO-MgO-Al₂O₃ discrimination plots. Lower Zr/Nb ratio (<10) and K/Ba ratio (amid 20-40) for both the rock types further show their affinity to within-plate magmatism. Dolerites show depletion in REEs and other incompatible elements as compared to epidote amphibolites. The equilibrium partial melting models from primitive mantle using Dy/Yb, La/Yb, Sm/Yb, La/Sm and Nb/Y ratios show that both of these dykes originate from spinel lherzolite mantle. However, the degrees of partial melting from mantle is different i.e. epidote amphibolite show smaller degree (<5%) of partial melting of mantle than the dolerites (<10%).

The contrasting geochemistry suggests that both of these dykes originated from heterogeneous mantle in two pulses with different degrees partial melting followed by fractional crystallization. Compositional zoning in plagioclase and clinopyroxene and variation in olivine composition indicates the role of fractional crystallization in dolerites. Lower Nb/La ratio of dolerite than epidote amphibolites show the involvement of crustal rocks in dolerite during its ascent. Similar interpretation of more than one episodes of magmatism associated with rifting has also been made by geochemical studies of carbonatites in the region.