

Tectonomagmatic evolution of the Panjal Traps (Kashmir) and thoughts on their economic potential

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The Early Permian (290 Ma) Panjal Traps of Kashmir are the largest contiguous outcropping of volcanic rocks within the Himalaya and erupted during the early stages of Gondwana break-up. The Traps consist mostly of basalt but there are volumetrically minor andesitic and silicic volcanic rocks as well. The basalt chemistry displays a range of compositions from continental tholeiite to ocean-floor basalt with many showing evidence of crustal contamination ($\leq 10\%$). The basalts that show limited or no evidence for contamination have Sr-Nd isotopes (i.e. $ISr = 0.7043$ to 0.7073 ; $\epsilon_{Nd}(t) = \pm 1$) similar to a chondritic (i.e. subcontinental lithospheric mantle) source whereas the remaining basaltic rocks have a wide range of Nd (i.e. $\epsilon_{Nd}(t) = -6.1$ to $+4.3$) and Sr (i.e. $ISr = 0.7051$ to 0.7185) isotopic values. The estimated primary melt compositions of the low-Ti Panjal Traps are picritic to high-Mg basalt and have mantle potential temperatures ($T_p = 1370^\circ\text{C}$ to 1420°C) similar to ambient mantle rather than anomalously hot mantle (i.e. mantle-plume). The Panjal Traps erupted within a continental rift setting that developed into a shallow sea or lagoon. Sustained rifting saw the formation of a nascent ocean basin that led the genesis of E-MORB-like basalts and a greater influence from a depleted mantle source. As rifting continued, sea-floor spreading was initiated and microcontinental fragments separated from Gondwana and formed the ribbon-like continent Cimmeria and the Neotethys Ocean. The identification of both columnar jointed basalt and pillow basalt within the Traps implies that there is a possibility for two different styles of mineral deposits associated with the Panjal Traps: 1) orthomagmatic deposits within layered intrusions that developed during the continental rifting stage and 2) volcanogenic massive sulphide deposits that developed during the formation of a shallow lagoon or nascent ocean basin.