

Petrogenesis of Girnar volcano-plutonic complex in Deccan Traps, India

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The Girnar Hill Complex within the Deccan Traps, India is a volcano-plutonic complex consisting of various mafic to silicic rocks. Diorite is the main rock type, forming a central hill (~1100 m), which is surrounded by gabbro, and low-lying basaltic flows; syenite veins occur within diorite. Silicic rocks occur as semi-circular hills at the outer margin and enclose the entire complex. Diopside and augite are the dominant phases in gabbro and diorite, whereas (shattered) pigeonite is present in the coarse-grained silicic rocks. A prominent silica gap is observed between silicic rocks (70–75 wt% SiO₂) and mafic rocks (<55 wt% SiO₂). Chondrite-normalized rare earth elements (REEs) patterns for the basalt and gabbro show moderate relative LREE enrichments (La/Sm_N ~0.9–1.8), and a distinct positive Eu anomaly indicating accumulation of plagioclase. Diorite displays a flat HREE pattern (Gd/Lu_N ~2) similar to basalt and gabbro but more LREE enrichment (La/Sm_N ~5.6). Silicic rocks have highly enriched REE patterns (La/Sm_N ~3), a prominent negative Eu anomaly, suggesting fractional crystallization of plagioclase or partial melting in the plagioclase stability field. Sr-Nd-Hf isotopic composition of the mafic rocks (⁸⁷Sr/⁸⁶Sr = 0.704–0.707, ¹⁴³Nd/¹⁴⁴Nd = 0.512587–0.512733, ¹⁷⁶Hf/¹⁷⁷Hf = 0.282912–0.282962) indicate mantle origin with variable, but moderate crustal input. In contrast, silicic rocks (⁸⁷Sr/⁸⁶Sr = 0.724–0.732, ¹⁴³Nd/¹⁴⁴Nd = 0.512237–0.512280, ¹⁷⁶Hf/¹⁷⁷Hf = 0.282569–0.282599) are highly contaminated by incorporating different types of the local continental crust. Geochemical variations, particularly trace elements and isotopic ratios of rocks from the Girnar volcano-plutonic complex of Deccan Traps indicate an important role of continental crust in the generation of silicic rocks that are associated with Continental Flood Basalts.