Petrogenesis and Tectonic Setting of Ultramafic Rocks in Attappadi Valley, Bhavani Shear Zone, South India

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The Moyar-Bhavani and Palghat–Cauvery shear zones in Southern Granulite terrain (SGT) in South India have been interpreted as major collisional sutures. The present study area, Attappadi valley, is located along the western part of the Bhavani Shear Zone. Bands and layers of ultramafic and mafic rocks were reported from the Attappadi valley. Dismembered Neoarchean suprasubduction zone ophiolites (Agali Ophiolite complex) have also been reported from this region. The mafic-ultramafic rocks exposed in the study area include dunite, pyroxenite, websterite, hornblende clinopyroxenite and gabbro. The olivine grains are extensively fractured and serpentinisation has been developed in dunite. Chromite/chromian spinels occur as subhedral to anhedral disseminated grains in the ground mass of olivine in dunite. The chromitite occurs as thin veins in pyroxenite and as intercumulus grains in dunite. The pyroxenes observed are enstatite, augite and diopside. Minor amounts of carbonate and magnetite are found as secondary minerals formed as products of post-magmatic alteration processes. The magnesite mineralization occurs within peridotites/pyroxenites as veins and veinlets suggestive of metasomatic alteration. PGE and Cu-Ni sulphide mineralization were also observed in these ultramafic rocks. Olivines in the the dunite have narrow range of forsterite content (Fo) ranging from 84.4 to 87.0 with a high FeO (13 wt%), similar to olivines in Alaskan- type ultramafic complexes. The chromian spinels have Cr# ranging from 0.65 to 0.86 and also have wide range of Al_2O_3 and Fe_2O_3 contents. The clinopyroxene and orthopyroxene are Mg-rich, similar to the composition of pyroxenes reported from typical Alaskan-type intrusions. The petrographic and chemical characteristics of various minerals present in the ultramafic rocks from the study area show remarkable similarities with the Archaean Alaskan type complexes. The mineral chemistry of Alaskan-type complexes is characterized by Mg-rich olivine, Ca-rich diopsidic clinopyroxene, high Fe–Cr, and low Al chromite, and calcic hornblend with wide range in composition. The Cr-spinel compositions of dunite and pyroxenite plot in the field of island-arc cumulates. The clinopyroxene data plot in the region of Alaskan-type intrusions. The oxygen fugacity of dunites calculated based on olivine-spinel pairs yielded high $\Delta \log fO_2$ varying from 2.1 to 3.3 similar to that of Alaskan-type intrusions and island-arc basalt ($\Delta \log fO2 = 2.0–3.0$). The Al_2O_3, TiO_2 and FeO/MgO ratio calculated for the parental melts show close connection with the basaltic melts generated in island arc setting. Hornblende is present as a primary interstitial phase in all these rocks. The high TiO_2 content and Mg# of hornblende indicate the magmatic nature. Plagioclase is absent in both rock types. Experimental studies have shown that the crystallization of plagioclase can be suppressed in a hydrous environment and clinopyroxene can crystallize prior to plagioclase from a parental hydrous basaltic magma. All these observations point to the hydrous nature of the parental melts for this ultramafic intrusion. The tectonic evolution of Attappadi rock suites without a doubt shows the signatures of Archean Alaskan type ultramafic rocks. The Alaskan-type complexes have been formed above subduction zones, representing arc magmas or arc-root complexes or at the change from the arc setting to the extensional regime. They also represent uplifted fragments of the deep levels of the island arcs.