ABSTRACT

Geological mapping of 1250 km^2 area in and around Salur in the Eastern Ghats Belt of India reveals a crescent-shaped body of blastoporphyritic garnetiferous granitoid gneiss (BGG) in a milieu of granulite facies metasedimentary gneisses which also occur as enclaves within BGG. The metasedimentary gneisses are affected by three phases of deformation. The first phase of deformation produced isoclinal folds (F_1) and generated pervasive gneissose foliation (S_1). Superposition of southeasterly dipping reclined F_2 folds on F_1 resulted in mesoscopic hook-shaped interference patterns. The folds generated due to third phase of deformation are north-south trending open upright in nature.

Texturally, mineralogically and chemically BGG is a heterogeneous suite comprising three petrographic varieties which share intrusive relationship in the field. They are orthopyroxene-bearing gneiss (OPGn), two pyroxene-bearing gneiss (TPGn) and pyroxene-absent, biotite-rich gneiss (PAGn). OPGn is characterised by a prominent gneissic layering defined by strongly drawn-out K-feldspar augens, quartz lenticles and prismatic pyroxene grains torn asunder; the platy fabric is partly obliterated by polygonal granoblastic texture. The rocks are granodiorite to mostly tonalite in composition and characterised by anhydrous mineral assemblages. PAGn is massive to weakly deformed and often show relic mesoscopic glomeroporphyritic and cumulate textures defined by weakly deformed, nearly idiomorphic and poorly recrystallised K-feldspar megacrysts; the weak alignment of K-feldspar megacrysts in the rocks is reminiscent of magmatic flow, although a crude gneissic fabric is discernible in the finer grained matrix. The rocks are granitic in composition and characterised by high modal proportion of biotite. TPGn is physically and chemically intermediate to OPGn and PAGn varieties. Field setting and analyses of structural elements indicate pre- to syn-F_1 (OPGn) to late syn-F_1 (PAGn) solidification of BGG within the supracrustal milieu.

Major and trace element geochemistry of BGG together with petrographic characteristics and experimental results on incongruent melting of natural metasedimentary rocks strongly suggest that (i) the rock suite was derived by high degrees of partial melting of metasedimentary source rocks and (ii) chemical diversity in the rock suite was

caused by incomplete separation between restitic mineral phases (garnet, plagioclase, zircon ± orthopyroxene ± quartz ± biotite ± ilmenite) and melts (represented by liquidus phases K-feldspar, biotite ± quartz ± plagioclase ± ilmenite). Results of theoretical modelling involving rare earth and responsive trace elements support the view that anhydrous OPGn, broadly tonalite to granodiorite in composition, formed due to the accumulation of higher proportion of restitic phases, whereas volatile-rich PAGn of granitic composition is characterised by higher proportion of liquidus phases from restite-melt mush generated by high degrees of melting of metagreywacke source rock. However, occasional presence of zoned plagioclase and zircon with multiple growth rings suggests that magmatic differentiation through crystal fractionation was also possibly operative, albeit in smaller scale within localised domains.

Petrogenetic grid considerations, results of thermobarometry and microtextural relations in metasedimentary and granitoid gneisses are consistent with a counter clockwise P-T path for the rocks. The low P – high T prograde sector is documented by pre-F_1 cordierite-bearing leucosome formation in metapelites (metatexites). Heating and loading of the rocks (syn-F_1) resulted in the formation of garnet ± orthopyroxene-bearing diatexites and decomposition of cordierite to orthopyroxene + sillimanite + biotite + quartz symplectites in metapelites, and stabilisation of scapolite + wollastonite + clinopyroxene assemblage in calc-silicate gneisses. Near-peak temperature, 850°C at 7.5 kbar, was attained during late syn to post-F_1 stage. The post-peak stage was marked by cooling (with loading) during and after F_2; this resulted in widespread annealing recrystallisation in all rocks, and stabilisation of grossular corona at matrix wollastonite – scapolite interfaces and decomposition of scapolite to anorthite + calcite symplectites in the calc-silicate gneisses. During cooling, cation exchange between ferromagnesian minerals was reset at 700 – 750°C. The cooling event was truncated at the above temperatures by near-isothermal decompression manifested by decomposition of garnet porphyroblasts in BGG to plagioclase + orthopyroxene / ilmenite / biotite double-layered corona and restabilisation of cordierite at the expense of garnet + sillimanite + quartz in metepelites. Low-pressure, near-isobaric cooling followed thereafter leading to overprinting of high-T granulite facies mineral assemblages by low-T muscovite + calcite assemblages, and further resetting of cation exchange thermometer to low temperatures (≈ 600°C).

The reconstructed P-T path together with the restite retention model for BGG has been argued to be consistent with profuse siliceous magma production by high degrees of crustal anatexis triggered by asthenospheric upwelling as in extensional regime. The buoyant sialic crust comprising restites of melting, liquidus phases, melt and vapour was subsequently filter pressed in to the cover rocks as lit-par-lit injections or diapirs during a phase of collisional tectonics (F_1). Heat supplied by the cooling plutons led to the onset of low P - high T metamorphism in the supracrustal rocks. The thermal maximum was soon reached due to a sharp decline in the energy throughput from intrusive near-cooled magma bodies; however, loading continued till the phase of reclined folding (F_2) but with cooling of the rocks in the post peak-T stage. Subsequently, gravitational instability in the thick accretionary prism led to near-isothermal decompression through tectonic / erosional denudation. Finally, the uplifted crustal section underwent thermal relaxation which caused overprinting of high-T mineral assemblages by low temperature ones. This magmato-tectonic model is deemed to represent stages in the evolutionary history of the Salur granitoid complex in particular, and the Eastern Ghats Mobile Belt in general.