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PETROGENESIS OF CHARNOCKITE ASSOCIATED WITH GRANITE NEAR PUDUKKOTTAI IN THE MADURAI BLOCK: CONSTRAINTS FROM THE FIELD-ASSOCIATION, PETROGRAPHY AND PHASE-EQUILIBRIUM MODELING.

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Abstract

Charnockite, in the Pudukkottai region, which is in the north-eastern part of Madurai Block, Southern Granulite Terrain (SGT), occurs in three different associations: 1) patches within the biotite gneisses ranging from cm scale to few meters across, 2) foliation parallel but at places irregularly oriented patches within the garnet bearing pink granites and 3) as few meters across quarry-scale massive, enclave-like charnockites within the gneisses.

The association of pink-granite and charnockite is studied for understanding its origin and evolution using the phase-equilibrium modeling approach. The pink-granite is an A-type ferroan granite. The major minerals in the pink-granite are quartz + K-feldspar + plagioclase+ biotite+ magnetite+ rutile with conspicuous presence of coarse grained garnets which are heterogeneously distributed throughout the granitic body. The associated charnockite has a similar mineralogy but the with presence of characteristic orthopyroxene and ilmenite >> rutile. The garnets are scarce in charnockite, occurring only in very small sized patches. Retrograde alteration of orthopyroxene to biotite is preserved in several samples of the charnockite. On the other hand, the garnet grains in granite commonly show embayed boundary and have inclusions of ribbon-, circular- and irregular- shaped quartz along with zircons indicating that these garnets could have been older crystals entrained in the melt from the residual source.

Phase-equilibrium modeling in the MnO-Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O-TiO_2 (MnNCKFMASHT) chemical system was carried out for the bulk composition similar to a sample of charnockite and biotite-gneiss, each to understand the P-T conditions of charnockite-granite association, probably having originated from a biotite-gneiss source. The P-T pseudosections corresponding to charnockite and biotite-gneiss have similar topology except for the slight shift in phase boundaries, reflecting the fact that there is only a slight difference in the bulk composition of these two rock types. The pseudosections suggest that the orthopyroxene bearing mineral assemblage is a result of biotite dehydration melting at temperatures of more than 750°C and pressures below 8 kbar. The charnockite mineral assemblage finally got stabilized on cooling along the decompression path suggesting an overall clockwise path of evolution starting from granitic source. Because the granitic source does not yield enough volume of melt on dehydration melting, as evidenced by the smaller sizes of granite-charnockite outcrops, it does not get completely segregated from the source, preserving its bulk composition. Further, the patchy occurrence of charnockite indicates the heterogeneous distribution of hydrous minerals and thus melt-production in the source.

The origin of granite-charnockite association, as we propose here, does not require any influx of anhydrous external-fluid to cause stabilization of orthopyroxene and can be tested by the elemental and isotopic studies.

We, further, propose that this dehydration melting of the grantitic protolith would have occurred at middle to lower crustal levels during the ultrahigh temperature metamorphism which is reported from a widespread region of the Madurai Block.

Keywords: Charnockite, P-T pseudosection, Madurai Block, phase-equilibrium modeling, Southern Granulite Terrain.