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GEOCHEMICAL CHARACRTERISTICS OF CHARNOCKITE AND HIGH GRADE GNEISSES FROM SOUTHERN PENINSULAR SHIELD AND THEIR SIGNIFICANCE IN CRUSTAL EVOLUTION.:Dr. E.B.SUGAVANAM & K.T.VIDYADHARAN.

All the world over the stable shield areas are of high grade gneiss-granulite rocks occuring in close proximity with low grade granite-greenstone belts. The southern Peninsular shield exposes one of the largest high grade gneiss- charnockite terrains extending between Orissa in the north-east and Cape Comorin in the South. The high grade terrain in the south is in juxtaposition with the prominant granite-greenstone belts of Karnataka craton. The relationship between the low and high grade regions are not well understood. Greater attention has been paid to study the granite-greenstone belts of Karnataka craton compared to the adjoining granulite belts.

These shields are considered to represent ancient continental nucleii composed of the earlier crustal materials. Detailed studies of these terrains in different parts of the world contributed valuable clues to the evolutionary history of different parts of the earth's crust. Extensive work has been carried out on various aspects of petrology, petrochemistry, mineral chemistry, geochemistry and geochronology in major shield areas in other parts of the world. In contrast to these studies, much less information is available on the high grade regions of southern Peninsular shield of India. A limited study has been carried out on the charnockites of Pallavaram, the "type area" near Madras as well as in selected areas of Tamil Nadu and Kerala. Archaean high grade complexes in some parts of the world are regarded as recrystallised sediments (Siderenko[14], Cheney and Stewart[2]) and volcanics (Bowes[1]; Viswanathan[18]; Nagvi et al[9].). The natural corollary of this approach is to regard these high grade complexes as highly metamorphosed greenstone belts. On the other hand Tarney[17], Lambert et al[6], based on chemistry, concluded that the gneissic complexes differ significantly from the granite-greenstone pluton association.

Archaeans of south India are divided as "charnockite province" with deep seated highly metamorphosed rocks and "non-charnockite province" (Fermor[3]). A broad metamorphic zonation between greenschist and granulite facies rocks of southern Karnataka craton is considered as the continuous metamorphic sequence resultant of prograde metamorphism (Pichamuthu[12]). Structural disposition of the granulite terrain as compared to greenstone-granite terrain of Karnataka suggest that Tamil Nadu-Kerala granulite represent the oldest Archaean province (Narayanaswami[10]; Radhakrishna[13]). Granulite terrain of south India is regarded as charnockitic "mobile belt" associated with granite-greenstone belt and the Peninsular Gneissic Complex of Karnataka (Swami Nath et al.[16]). A contemporaneous evolution of granulites and greenstone belts in south India is evidenced by their relatively similar ages (Katz[4,5]).Contrary to the above conclusion of Katz, based on geological and geophysical characteristics of the structural provinces in the south Indian shield, a crustal tilting and north-west continuity of Tamil Nadu-Kerala granulite terrain beneath Archaean Karnataka craton has been suggested (Subrahmanyam[15]).

In the south Indian shield, the quartzofelspathic gneiss, the supracrustal rocks, layered intrusions in the charnockite province have been intensely deformed, obliterating the original nature and fabric of diverse litho units. It is difficult to decipher whether the intercalations of litho units in these areas is due to supracrustal superposition or due to deformation and conformable intrusion.

The paper presents the results of detailed investigations encompassing externsive structural mapping in the charnockite-high grade gneiss terrain of North Arcot district and the "type area"in Pallavaram in Tamil Nadu supported by petrography, mineral chemistry, major, minor and REE distribution patterns in various lithounits. This has helped in understanding the evolutionary history of the southern peninsular shield. A possible tectonic model has also been suggested. The results of these studies have been compared with similar rock types from parts of Andhra Pradesh, Kerala, Sri Lanka, Lapland and Nigeria which has brought about a well defined correlation in geochemical characteristics.

The area investigated has an interbanded sequence of thick pile of charnockite and a supracrustal succession of "shelf type " sediments, layered igneous complex, basic and ultrabasic rocks involved in a complex structural, tectonic, igneous and metamorphic events. Detailed field studies could bring out a tentative chronological succession of the above events.

In Leake's[7] diagrams, using Niggli values, the dominant igneous character of charnockite from different areas is well established while the khondalites distinctly plot close to fields defined for pelitic, semipelitic aluminous clay derived rocks. In Tarney's[17] SiO_2 - TiO_2 plot, charnockite from all the areas, under reference, fall in well defined igneous fields comparable with that of calc-alkaline Archaean plutonic suite of rocks.

In K_2O - CaO, K_2O- Na_2O, MgO - Na_2O binary plots as well as in K_2O - Na_2O - CaO and Ab-An-Or ternary plots the charnockite from North Arcot, Salem in Tamil Nadu, Kollegal and Sargur in Karnataka, parts of Andhra Pradesh, Kerala, Lapland and Nigeria fall in tonalite-granodiorite field while majority from Andhra, Sri Lanka occupy granodiorite-quartz monzonite-granite fields. However, the charnockites from Pallavaram essentially occupy granodiorite-adamellite-alkali granite fields. These studies have established the igneous nature of the pre-charnockitic rocks and their compositional heterogenity, most characteristic of any shield area.

The charnockites and associated high grade gneisses occupy a calc-alkaline trend ranging from tonalite-granodiorite-adamellite[8] to alkali granite in the 'AFM' as well as in Miyashiro's plots of FeO vs FeO/MgO and SiO vs FeO/MgO. The basic granulite and other mafic rocks delineate an iron enriched tholeiitic trend. Thus, the characteristic bimodal igneous nature of high grade terrain is well brought out with a felsic/calc-alkaline unit as dominant over mafic/iron enriched tholeiitic rocks.

In Pearce and Cann[11] diagrams, using TiO_2, Zr and Y, basic granulites are found to be mainly "Ocean Floor Basalts" (OFB) with a few of them falling in "Calc. Alkaline Basalts" (CAB) and "Low Potash Tholeiite" (LKT) indicating "within plate" characteristics.

The trace element geochemistry points out tonalite-granodiorite characteristics of charnockite and tholeiitic characteristics of "Andean type"continental margin for basic granulites. Similarly, REE pattern studies from Pallavaram indicate enrichment of LREE and depletion of HREE in charnockites comparable to the plutons produced at "Andean type" continental margins and do not correspond to andesitic volcanics. REE characteristics of basic granulites compare well with "within plate" Archaean continental tholeiites and not with greernstone basic volcanics.

In a comparataive study of geochemistry of the charnockites from the areas, under reference, with the averages of similar shield terrains in other parts of the world, it is found that in K_2O - Na_2O - CaO plot, the charnockites of North Arcot, Salem, Nigeria and Lapland having tonalitic composition, plot within the area occupied by Canadian granulites, Kaapvaal tonalites and K-poor Amitsoq gneisses of Greenland. On the other hand, the potash rich charnockites from Pallavaram, Andhra Pradesh, Sri Lanka occupy the area defined by igneous-metamorphic rocks of USSR shield as well as the Amitsoq gneisses and younger Kaapvaal intrusives. The basic granulites from Tamil Nadu and Karnataka fall in the area occupied by Canadian and Swaziland greenstone rocks.

Thus the geochemical evidence indicates that the high grade terrains in Southern Peninsular Shield are not simply a pile of recrystallised sediments and volcanics nor they are just metamorphosed greenstone belts. .They form a pile of bimodal meta-igneous rocks, one being felsic/calc-alkaline and the other basic/Fe enriched tholeiitic in composition with felsic being the dominant component. Together they compare well with that of younger calc-alkaline comnplexes of Cordilleran type.

The mineral paragenesis of charnockite and the associated rocks from parts of Tamil Nadu, Karnataka and Andhra Pradesh conform to their formation transitional from upper amphibolite to lower granulite facies conditions. The different methods of geothermometry and geobarometry (Weaver et.al) uswing critical experimental curves and coexisting mineral assemblages clearly confirm to their formation between 700°C and 800°C at 5 to 7 Kb, with 8 Kb pressure and 850° C temperature, being the maximum P-T conditions for these areas. The data agree well with those recorded from other Precambrian granulite terrains.

As the geological setting and geochemical characteristics of greenstone belts of Karnataka craton have been found to simulate fossil "back-arc basin", the spatially juxtaposed granulite-high grade gneisses of south Indian shield can be considered to represent the fossil 'marginal arc'.

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