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Geochemical characteristics of orthopyroxene-bearing meta-granitoids in the northern Chilka lake area, Eastern Ghats belt, India: Insights into the tectonic setting and petrogenesis of their precursor lithologies

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The northern Chilka Lake area stone quarries expose a high-grade terrane characterized by garnet sillimanite gniesses(khondalites) that are interbanded with orthopyroxene-bearing gneisses and garnet biotite leucogneisses(leptynites) [1].This study presents,for the first time,bulk-rock and mineral chemistry data of orthopyroxene-bearing lithologies in this region and discusses the petrogenetic aspects and tectonic significance of their pre-metamorphic protoliths.Field, petrographic and geochemical studies revealed the existence of three orthopyroxene-bearing rock units:(1)Enderbites, (2)Garnetiferous Charnockites(G-Ch) and (3)Non-Garnetiferous Charnockites(NG-Ch).The textural associations and mineral chemistry data suggest that orthopyroxenes in each unit are distinct and most likely of metamorphic origin.The chondrite normalized diagram for enderbites reveals a flat to slightly enriched LREE pattern[$(La/Sm)_n$=1.30-2.13],with no discernible HREE depletion[$(Gd/Yb)_n$ = 1.40-2.16].The Eu/Eu* vs ΣREE plot demonstrates an appreciable correlation[Eu/Eu*= 0.39-0.65;ΣREE=106.31-259.65],with one isolated sample showing a slightly positive Eu anomaly[1.14] and the lowest ΣREE value[69.53],likely representing a cumulate.However,the REE patterns of G-Ch rocks[$(La/Sm)_n$=2.89-3.65;$(Gd/Yb)_n$=2.29 2.87;Eu/Eu*=0.64-1.08] and NG-Ch rocks[$(La/Sm)_n$=4.90-8.94; $(Gd/Yb)_n$=5.76-11.67;Eu/Eu*=0.85-1.55] diverge from the trend observed in enderbites and also differ markedly from each other,indicating that the three rock units are not co-genetic but rather petrologically and geochemically distinct entities.The Ta vs Yb plot suggests a volcanic arc signature for all three units and the NG-Ch rocks plot on the adakite field in the (La/Yb)n vs Ybn diagram.The preferred petrogenetic model for enderbite precursors is partial melting of mafic source(LCC materials?) with residual plagioclase and no residual garnet.In light of the REE compositional similarity of G-Ch rocks with PAAS and NASC,this study suspects its precursors to be products of partial melting of a pelitic source.HREE+Y depletion in the NG-Ch rocks suggests residual garnet in source region and its precursors could probably be melt products of a garnet-bearing lower-crustal source(older-gneisses?).This study therefore postulates the existence of independent episodes of tonalitic and granitic magmatism,which likely occurred before or during the Grenvillian orogenic event(?),as suggested by the deformation history[1].These episodes are thus construed to be temporally distinct from the magmatic event responsible for generating massif-type anorthosites[2],basaltic magmatism[3] and dehydration melting event of khondalites[4] previously identified in the Chilka Lake area.

[1]Dobmeier&Raith(2000) *Geol.Mag.*137,27-37 [2]Chakrabarti.R et al.,(2011)Topics in Igneous Petrology,Springer 355-382 [3]Bose.S et al.,(2011b) Dyke Swarms:Keys for Geodynamic Interpretation,Springer 241-262 [4]Sen&Bhattacharya(1997),Proc.Indian Acad.Sci.106,277–297

Table 1. Composition ranges of key trace elements and major oxides

Rock type	Enderbite	G-Ch	NG-Ch
Element (ppm)			
Nb	8.60 - 33.23	18.82 - 19.70	6.75 - 10.80
Ta	0.68 - 1.81	1.09 - 1.11	0.20 - 0.37
Zr	11.70 - 220.10	30.48 - 59.89	52.09 - 100.30
Hf	0.62 - 5.45	0.90 - 1.85	1.29 - 2.75
Ti	7853.45 - 14448.00	3776.85 - 4316.40	2098.25 - 2877.60
Y	28.11 - 66.90	42.84 - 43.08	6.60 - 8.16
Oxide (wt%)			
SiO_2	42.70 - 52.48	66.54 - 68.66	67.29 - 68.03
Al_2O_3	15.83 - 19.86	14.69 - 15.20	14.47 - 15.28
CaO	7.87 - 11.67	3.26 - 3.66	2.62 - 2.70
FeO	10.64 - 13.73	3.39 - 3.78	2.95 - 4.39
MgO	2.77 - 6.38	0.57 - 0.69	0.85 - 1.45