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GNEISS-CHARNOCKITE TRANSFORMATION AT KOTTAVATTAM, SOUTHERN KERALA (INDIA)

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At Kottavattam, leucocratic granitic garnet-biotite gneisses (age < 2 Ga) have been partially transformed to coarse-grained charnockite along a system of conjugate fractures (N70E and N20W) and the foliation planes (N60-80W; dip 80-90 SW) about 550 m.y. ago. (1). To examine and quantify changes in fabric, mineralogy, pore fluids and chemical composition, associated with this process, large rock specimens showing gneiss-charnockite transition were studied in detail.

The gneisses exhibit a streaky foliation defined by biotite, which is partly obliterated by a diffuse network of garnet-bearing leucosomes. This typical migmatic texture is completely extinguished in the charnockitized zones due to thorough recrystallization and considerable coarsening. Except of the partial breakdown of biotite and the neoblastesis of hypersthene, only minor changes in mineralogy and modal composition are observed (gneiss: kfsp 26-30, qtz 28-30, plag 22-27, gar 6-10, bio 6-10; charnockite: kfsp 27-30, qtz 24-28, plag 26-29, gar 6-10, bio 2-4, opx c.5). Ilmenite, pyrrhotite, graphite + rutile and magnetite occur in both the gneiss and charnockite, thus indicating a comparable internal buffering of pore fluids to low fugacities of water and oxygen, but to high fugacities of carbon dioxide. A comparable, though complex evolution of the pore fluids in gneiss and charnockite is also documented by their similar fluid inclusion characteristics (2): relic briny inclusions (+salt)--- medium- to low-density carbonic inclusions (0.70-0.86 g/cm^3; 4-10 mol% N_2, < 1 mol% hydrocarbons)---nitrogen inclusions (up to 14 mol% CO_2, < 1 mol% hydrocarbons) --- medium-density watery inclusions (0.89-0.94 g/cm^3) and mixed CO_2-H_2O inclusions forming clathrate ices.

The chemical data show that 'in-situ' charnockitization at Kottavattam was essentially an isochemical process:

	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5
gn:	68.1	13.6	5.6	0.08	1.1	2.4	2.5	4.4	0.90	0.38
ch:	67.9	14.0	4.7	0.04	0.9	2.3	2.7	5.3	0.87	0.36

	Rb	Sr	Ba	Zr	V	Zn	La_N	Yb_N	Eu_N/Eu_N^*	$\delta^{18}O$
gn:	220	130	1055	344	105	65	132	32	0.2	10.3‰
ch:	216	141	1032	349	70	63	132	20	0.3	10.3

The compositions of mineral phases in the gneiss and charnockite assemblages are almost identical: garnets (alm 75-76, pyr 13-15, gro 7-9, spe 2), biotites (X_{Mg} 0,47-0.53; Ti 0.55-0.64 atoms p.f.u.), plagioclases (An 32-36, or 1-2), K-feldspars (Or 78-84, Ab 15-20, An 1-2), ilmenites (>98 $FeTiO_3$); orthopyroxenes could not be analysed due to complete alteration.

P-T estimates obtained from up-dated calibrations of garnet-biotite thermometry and garnet-plagioclase-quartz-ilmenite-rutile barometry indicate that equilibration of the gneiss and charnockite assemblages occurred at isothermal-isobaric conditions, i.e. 750 + 10 °C and 5.6 + 0.2 kb lithostatic pressure.

The results of the present study corroborate the concept that charnockite formation at Kottavattam is an internally-generated phenomenon (1) and was not triggered by the influx of carbonic fluids from a deep-seated source (3,4). We suggest that charnockitization was caused by the following mechanism:
(i) Near-isothermal decompression during uplift of the gneiss complex led to an increase of the pore fluid pressure ($P_{fluid} > P_{lith}$) which - in a regime of anisotropic stress - triggered or at least promoted the development of conjugate fractures.
(ii) The simultaneous release of pore fluids from bursting fluid inclusions and their escape into the developing fracture system resulted in a drop of fluid pressure ($P_{fluid} < P_{lith}$) which ultimately initated the dehydration reaction (i.e. the breakdown of biotite and neoblastesis of hypersthene).
(iii) The internal generation and buffering of the fluids and their probably limited migration in an entirely granitic rock system explains the absence of any significant metasomatic mass transfer, as oposed to the externally controlled Kabbaldurga-type charnockitization (4,5).

(1) Srikantappa, C., Raith, M. and Spiering, B. (1985) J. Geol. Soc. India **26**, 849-872
(2) Klatt, E. and Raith, M. (1987) European Current Research on Fluid Inclusions, 9th Symposium, University of Porto, Portugal, Abstracts.
(3) Ravindra Kumar, G.R., Srikantappa, C. and Hansen, E. (1985) Nature **313**, 207-209
(4) Hansen, E., Janardhan, A.S., Newton, R.C., Prame, W.K.B.N. and Ravindra Kumar, G.R. (1987) Contrib. Miner. Petrol. **96**, 225-244
(5) Stähle, H.J., Raith, M., Hoernes, S. and Delfs, A. (1987) J. Petrol. **28**, 5, in press