GABBROIC ANORTHOSITES FROM KOTAGIRI, NILGIRI HILLS, TAMIL NADU

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ABSTRACT

Field, petrographic and geochemical characters of new occurrence of gabbroic anorthosites around Kotagiri indicate that they are of Archaean age and define ancient lineament. The rocks have suffered granulite facies metamorphism (820°C/7 kb) at 2.6 Ga.

INTRODUCTION

Hitherto, the Nilgiri Hill ranges in Tamil Nadu were thought to be composed of massive charnockites and the migmatites derived from these rocks. Recent field investigation has revealed the presence of numerous enclaves of ultramafic and gabbroic anorthosites within the massive charnockites in Nilgiri Hills. The occurrence of gabbroic anorthosites near Kotagiri is significant since such bodies have not been reported earlier but noticed only in the adjacent Moyar and Bhavani shear zones[1,2]. This note records for the first time the occurrence of gabbroic anorthosite bodies spatially associated with ultramafic rocks, around Kotagiri (Lat. 11° 25′ and Long. 76° 55′) in SE part of Nilgiri Hills. Petrography, whole rock and mineral chemistry of these rocks have been presented.

GEOLOGICAL SETTING

The Nilgiri Hill ranges in South India are predominantly composed of charnockites (garnet, orthopyroxene, clinopyroxene, hornblende bearing granulites) and thin but mappable bands of various metasedimentary units like ferruginous quartzites, kyanite quartzites and garnet-sillimanite biotite gneiss (khondalites). Numerous small bodies of ultramafic rocks varying in composition from dunite-peridotite to pyroxenites and mafic to gabbroic anorthosites were noticed around Ooty, Wellington and Kotagiri areas.

Regional geothermobarometric studies in Nilgiri Hills has shown that the rocks have suffered granulite facies metamorphism[3,4] ($T = 840 \pm 70°C$; $P = 6.7 \pm 0.7$ kbar).

FIELD OCCURRENCE AND PETROGRAPHY

Dull white to greyish, medium-grained gabbroic anorthosites are well exposed about 7 km south of Kotagiri on the Kotagiri–Mettupalyam road. They have a maximum width of 0.2 km and show sharp contact with charnockites. The rocks can be distinguished from the greasy charnockite by their typical gabbroic texture and crude mineralogical banding. In field one can notice gradation from gabbroic anorthosite to anorthositic gabbros. Numerous small, lenticular bodies of gabbroic anorthosites varying in width from 4 to 8 metres extending to a length of about 10 to 15 metres were noticed in a nullah cutting about 20 km from Mettupalyam on the Mettupalyam–Ooty road. Reddish garnet-rich layers are conspicuous in these bodies.

In thin section, gabbroic anorthosites consist predominantly of plagioclase, clinopyroxene, orthopyroxene and brownish hornblende. They exhibit granoblastic texture. Crude banding is rarely seen in thin sections defined by clusters of fine to medium grained mafic minerals alternating with plagioclase-rich bands. Plagioclase grains are often twinned and at times show triple point junction. Anorthite content of plagioclase varies from An_{40} to An_{60}. Quite often plagioclase grains show bent lamellae and are often zoned indicating that the rocks are deformed. Intensive granulation of plagioclase, noticed all along the grain boundaries indicates high-grade metamorphic effects. Granular scapolite (Me 75%, table 1) coexists with plagioclase. Presence of considerable amounts of K-feldspar (table 1) indicates that it has been introduced during migmatization.

Greenish clinopyroxene ($2V_\gamma = 70°$) is the next common mineral to occur in gabbroic anorthosites. Exsolution of opaque phase is noticed all along cleavage planes and grain boundaries.

Yellow to pale pink hypersthene is common in gabbroic anorthosites. Granular, reddish garnet is characteristic in samples collected from 20 km to Mettupalyam. Almandine-rich garnets (table 2) develop at the expense of clinopyroxene and plagioclase as they occur as rim bordering these minerals (figure 1).

Table 1 *Chemical analyses of gabbroic anorthosites*

	N 172/2	N 172/5	N 187/2	N 191/1
SiO_2	44.34	48.11	43.27	42.31
Al_2O_3	21.04	16.44	22.01	21.86
FeO*	6.86	7.05	3.49	4.91
MnO	0.16	0.14	0.02	0.05
MgO	5.46	7.23	4.89	6.58
CaO	14.72	10.11	12.69	13.81
Na_2O	3.15	5.20	8.78	4.79
K_2O	2.12	3.91	3.16	4.21
TiO_2	1.15	0.92	0.54	0.31
P_2O_5	0.03	0.65	0.42	0.41
H_2O	0.47	Nd	Nd	Nd
Total	99.50	99.76	99.27	99.24
Trace elements in ppm.				
Ni	30	43	17	34
Co	28	38	21	12
Sr	385	668	926	246

* denotes total iron.
Nd – Not determined.
N 172/2 – anorthositic gabbro; opx 7%, hbl 29%, plg 53%, K-feldspar 2%, opa 7%, 7 km from Kotagiri.
N 172/5 – gabbroic anorthosite; opx 6%, cpx 20%, hbl 28%, plg 36%, K-feldspar 32%, opa 6%, 7 km from Kotagiri.
N 187/2 – gabbroic anorthosite; opx 12%, plg 48%, K-feldspar 12%, per 15%, car 15%, 20 km from Mettupalyam.
N 191/1 – gabbroic anorthosite; opx 5%, cpx 4%, plg 50%, K-feldspar 35%, opa 5%, Tenkapatti.

Presence of quartz is noticed in some sections and it may be secondary in origin.

GEOCHEMISTRY

Chemical analyses of four gabbroic anorthosites along with modal analysis are presented in table 2. They show variable CaO and Al_2O_3 contents due to variable amounts of modal plagioclase and clinopyroxene. Some of the samples show considerably higher concentration of K_2O content indicating subsequent migmatization.

Chemical analyses of gabbroic anorthosites when plotted on Niggli mg vs c and c vs al-alk show igneous character (figures not given). This is also supported by the general increase in Ni with increasing MgO content. The Sr content varies from 246 to 926 ppm. When plotted on AFM diagram, the gabbroic anorthosites follow a calc-alkaline trend and display lack of iron enrichment. These trends are similar to the trends shown by gabbroic anorthosites of Sittampundi complex[5] and Sargur schist belt[6] of Archaean age.

Table 2 *Mineral chemistry (N 172/4)*

	Gar	Cpx	Sca	Plg
SiO_2	39.30	50.31	46.23	54.09
Al_2O_3	21.38	4.58	26.50	28.64
FeO	23.55	11.15	0.10	0.07
MnO	2.21	0.52	0.03	–
MgO	5.31	10.55	0.03	–
CaO	8.06	21.52	17.99	11.54
Na_2O	–	0.93	3.31	4.92
K_2O	–	0.03	0.14	0.23
TiO_2	0.04	0.37	0.03	0.01
Total	99.85	99.96	94.36	99.50
No. of oxygen atoms	(24)	(6)	(12)	(32)
Si	6.102	1.902	7.153	9.825
Al^{iv}	–	0.098	4.799	6.132
Al^{vi}	3.913	0.106	–	–
Fe^{2+}	3.058	0.352	0.011	0.011
Mn	0.290	0.017	0.005	–
Mg	1.228	0.594	0.006	–
Ca	1.341	0.871	2.967	2.246
Na	–	0.068	0.994	1.731
K	–	0.001	0.024	0.028
Ti	0.004	0.0	–	0.001
X_{Mg}	0.286	0.628	–	–

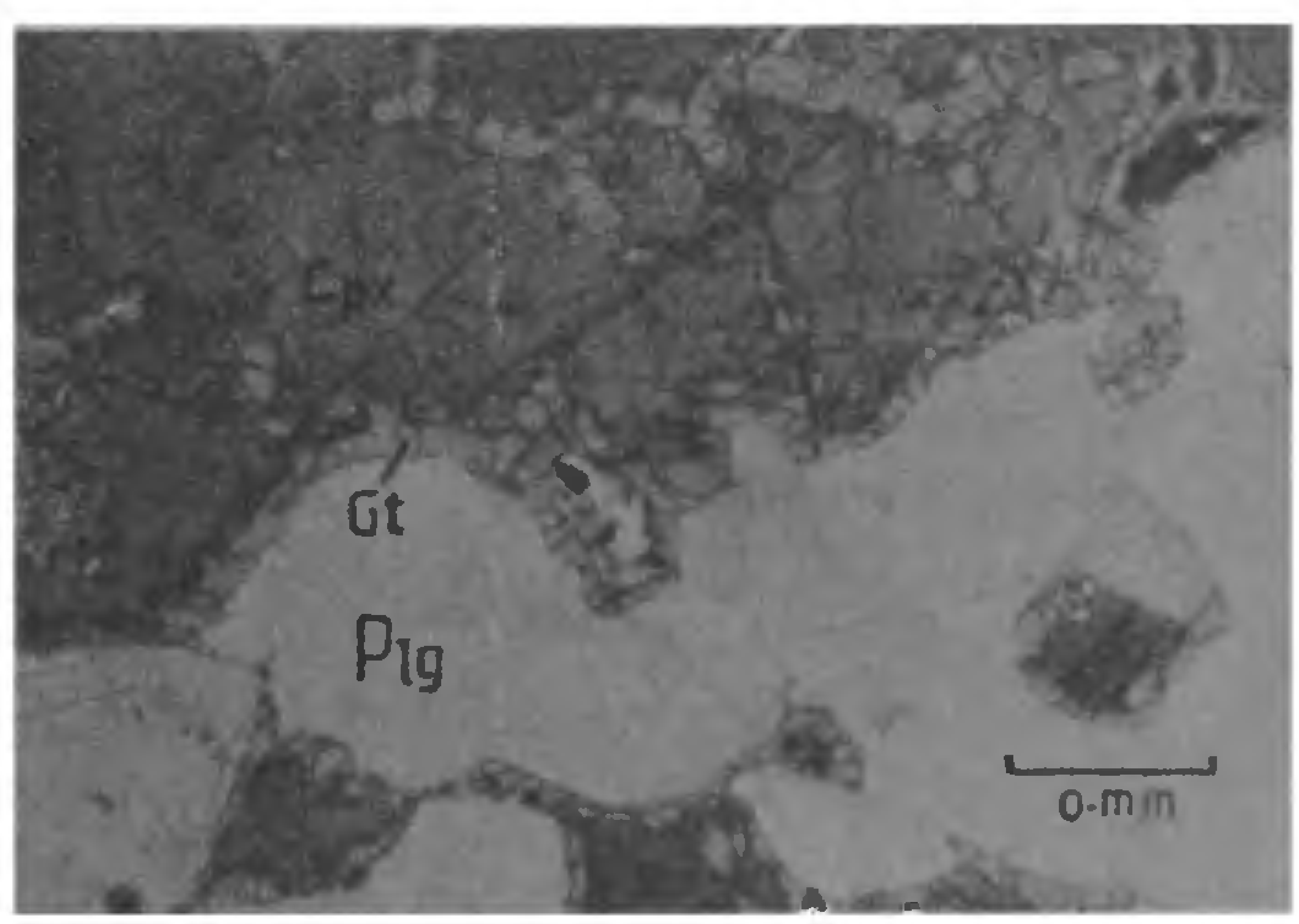

Figure 1. Development of garnet at the expense of clinopyroxene and plagioclase.

METAMORPHISM

Based on the coexistence of garnet-clinopyroxene and garnet-clinopyroxene-plagioclase-quartz assemblages, a metamorphic temperature[7] of $820 \pm 50°C$ and pressure[8] of 7.09 ± 1 kbar is estimated. This value is in conformity with the regional metamorphic temperatures of $840 \pm 70°C$ obtained for charnockites from Nilgiri Hills[3,4].

DISCUSSION

The metamorphic pressure (7·0 Kb) and temperature ($820 + 50°C$) of the gabbroic anorthosites clearly demonstrates that they have suffered the dominant granulite facies (charnockite forming) metamorphism of 2·6 Ga. The gabbroic anorthosite emplacement must be older than 2.6 Ga and hence pre chornockitic. Thus, they may represent dismembered extensions of the layered ultramafic-gabbro-anorthosite complexes exposed around Bhavani[2] which are older than 3.0 Ga. Further, their occurrence along the N 60°E trending lineament is significant. This lineament of Archaean age has been reactivated in later times. Recognition of rock types like this and the associated supracrustals in the Nilgiri Hills, particularly along lineaments, will enable one to understand the tectonic uplift history of the Nilgiris.

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NEWS

RARE METALS FROM WASTES

The Ust-Kamenogorsk lead and zinc works in Kazakhstan produces indium, selenium, thallium, tellurium and other rare metals out of dust (industrial waste).

Scientists have developed the world's first method of recovering rare elements with organic liquid solvents not reacting to a water solution. The process takes couple of minutes. It needs practically no electricity or fuel. The process also improves the environment. Discharges of gases and dust into the atmosphere have decreased tens of times and purified industrial water is recycled.

"The new method boosts production of rare metals", says Akhat Kulenov, works' manager. "We have trebled production of indium, selenium and tellurium and increased 60 per cent the output of thallium. Their quality has improved, thanks to the new method. The process is non-stop and automatically controlled. (*Soviet Features*, Vol. XXV, No. 93, p. 6; The Information Dept., USSR Embassy in India, P.B. 241, 25 Barakhamba Road, New Delhi 110 001).