Distribution of magnesium and iron between metamorphic pyroxenes from Saltora, West Bengal, India

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[Read 13 January 1966]

Summary. Four orthopyroxene : calcic-pyroxene pairs from pyroxene-hornblende- and pyroxene-granulites from the Precambrians around Saltora, eastern India, have been chemically analysed. The distribution coefficients with respect to Mg-Fe (K_D) are found to be 0·56, 0·57, 0·60, and 0·61, a set of values well within the limits characteristic of metamorphic parentage.

PYROXENE-GRANULITES, amphibole-pyroxene-granulites, amphibolites and anorthosite-granulites occur within a Precambrian granite gneiss-migmatite terrain around Saltora (86° 56′, 23° 31′) in eastern India. Discontinuous bands and lenses up to 7 Km in length and 3 Km in breadth are relatively well exposed. Besides the basic metamorphic rocks, khondalites (sillimanite-garnet-potash-feldspar gneiss) and calc-gneisses with diopside, calcite, garnet, and calcic plagioclase also occur as bands or more irregular patches. The alignments of the bands are generally parallel to the foliation in the granite-gneisses, and gneissosity, when developed, runs parallel to the foliation outside. The common feature of all these 'inclusions' is their high metamorphic grade, which corresponds to the granulite facies. However, amphibolites, which occur to a lesser extent in the immediate environs of Saltora, register metamorphism corresponding to the amphibolite facies.

The major varieties of the metamorphic rocks are identical in their megascopic aspect to the basic charnockites (pyroxene-granulites, norites). The most common variety is a two-pyroxene-hornblende-granulite. Three pyroxene pairs from such assemblages and one pair from a two-pyroxene granulite were chemically studied with special reference to the distribution of iron and magnesium between orthopyroxene and calcic pyroxene. In view of the current interest in the subject of Fe-Mg distribution between coexisting pyroxenes, it was felt desirable to communicate the results, despite the small number of

TABLE I. Modal analyses of the selected rocks (volumes %)

Rock number	3C	124	10	213
Plagioclase	47·3	27·2	39·2	12·3
Hornblende	—	20·8	22·6	20·1
Diopside (Calcic pyroxene)	22·5	34·9	14·3	42·7
Hypersthene (Orthopyroxene)	17·8	12·3	16·5	15·4
Quartz	tr.	tr.	tr.	4·4
Biotite	6·2	—	—	—
Fe–Ti oxides	6·1	4·8	7·4	5·0
Apatite	—	—	tr.	—
Anorthite percentage of plagioclase*	55	54	45	40

* Determined by symmetrical extinction method.

TABLE II. Chemical analyses of coexisting pyroxenes

	Orthopyroxenes				Calcic pyroxenes			
	3C	124	10	213	3C	124	10	213
SiO_2	50·23	50·12	50·20	51·63	48·89	50·61	50·39	52·60
TiO_2	0·20	0·40	0·25	0·20	0·50	0·45	0·40	0·45
Al_2O_3	3·12	1·25	2·25	1·63	4·64	1·74	2·80	2·93
Fe_2O_3	2·89	2·35	1·52	0·94	2·60	1·10	1·03	0·83
FeO	22·58	27·84	28·09	22·38	8·58	11·61	12·41	8·18
MnO	0·70	0·80	0·88	0·60	0·30	0·45	0·50	0·25
MgO	19·51	16·34	15·88	20·84	12·32	12·01	11·57	13·69
CaO	0·60	0·95	1·09	0·70	21·17	21·61	20·54	21·56
Na_2O	0·05	0·07	0·25	0·06	0·70	0·21	0·44	0·42
K_2O	0·02	0·04	0·05	0·02	0·04	0·03	0·07	0·05
H_2O^-	0·03	0·01	0·02	0·03	0·03	0·01	0·02	0·02
	99·93	100·17	100·48	99·03	99·77	99·83	100·17	100·98

Atomic ratios to 6 oxygen atoms and Z = 2·00

Si	1·898	1·931	1·933	1·954	1·847	1·928	1·904	1·935
Al^{iv}	0·102	0·057	0·067	0·046	0·153	0·072	0·096	0·065
Al^{iv}	0·037	—	0·035	0·026	0·053	0·006	0·030	0·062
Ti	0·006	0·012*	0·007	0·006	0·014	0·013	0·011	0·013
Fe^{3+}	0·082	0·068	0·044	0·027	0·074	0·031	0·029	0·023
Fe^{2+}	0·714	0·897	0·905	0·708	0·271	0·370	0·394	0·252
Mn	0·022	0·011	0·029	0·019	0·010	0·014	0·016	0·008
Mg	1·098	0·938	0·912	1·175	0·694	0·682	0·649	0·750
Ca	0·024	0·039	0·045	0·028	0·857	0·882	0·836	0·850
Na	0·004	0·005	0·019	0·004	0·051	0·015	0·032	0·030
K	0·001	0·002	0·002	0·001	0·002	0·001	0·003	0·002
$X+Y$	1·988	1·960	1·998	1·994	2·026	2·014	2·000	1·990
X_{Mg}	0·606	0·511	0·502	0·624	0·719	0·648	0·622	0·749

Analyses recalculated in terms of Ca, Mg, and Fe end-members†

$CaSiO_3$	1·3	2·0	2·4	7·5	45·2	44·9	43·8	45·3
$MgSiO_3$	57·2	48·3	47·8	60·6	36·6	34·7	34·0	40·0
$FeSiO_3$	41·5	49·7	49·8	37·9	18·2	20·4	22·2	14·7

* Included in Z. † Neglecting Al and including Fe^{3+} with Fe^{2+}.

samples studied. The metamorphic status of the selected rocks will be evident from table I; three of them correspond to the hornblende–granulite subfacies, and one (3C) to the pyroxene–granulite subfacies of Fyfe, Turner, and Verhoogen (1958).

Rock samples were chosen after thin section study (modal analyses are given in table I), and the mineral concentrates were prepared to a purity of 98 % or better. Chemical analyses were carried out by standard wet chemical procedures; Na and K, however, were determined flame photometrically. The results of chemical analyses are given in table II.

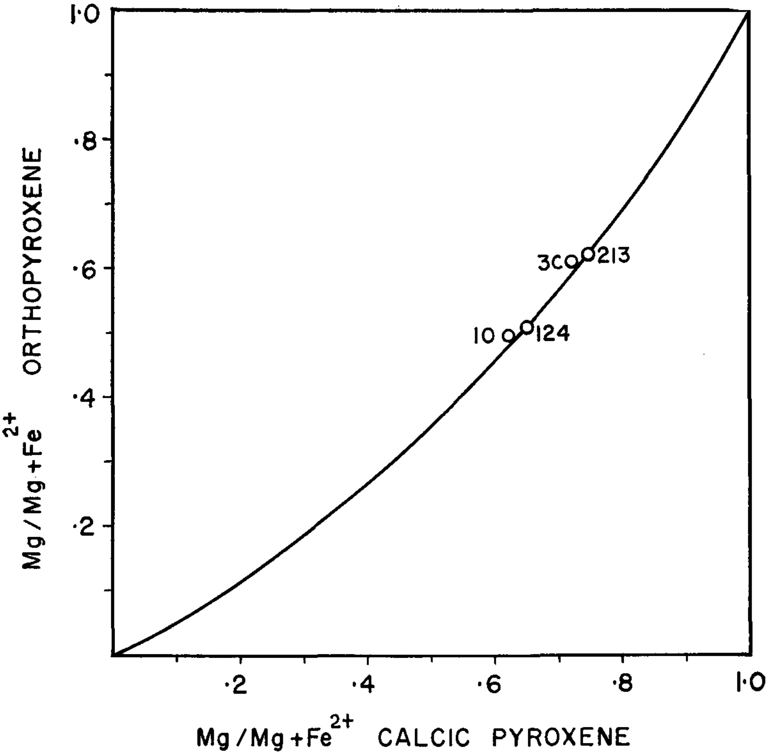

FIG. 1. Relation between the atomic fraction of magnesium in coexisting orthopyroxenes and calcic pyroxenes of Saltora. The curve represents $K_D = 0{\cdot}57$.

Using these data, the calculated K_D values (Kretz, 1963) were found to be 0·60 (3C), 0·57 (124), 0·61 (10) and 0·56 (213), where

$$K_D = X_{opx}(1-X_{cpx})/X_{cpx}(1-X_{opx}),$$

X_{opx} and X_{cpx} being $Mg/(Mg+Fe^{2+})$ atomic fractions in orthopyroxene and calcic pyroxene respectively. Fig. 1 shows the relation between the atomic fractions of Mg in the coexisting pyroxenes.

These data strengthen the finding of other workers (Kretz, 1963; Bartholomé, 1962) that pyroxenes from high-grade metamorphic rocks appear to have distinctive K_D values. The values obtained in this study are within the range of 0·51 to 0·65 given in Kretz's compilation, and they reflect the temperature and pressure, especially temperature of formation of these rocks. The plotting of the points on a smooth curve in fig. 1 also suggests that Mg–Fe distribution among coexisting pyroxenes corresponds, within limits, to a function based on ideal solution behaviour of the two mineral series as pointed out by Kretz (1963, with references to earlier work) and Mueller (1961).

As regards the distribution of other elements like Mn, Ti, etc., it was found possible to fit distribution curves visually, the only exception being titanium. It is well known that the distribution patterns for such elements are more complex (Kretz, 1960); hence it was deemed unwise to venture an interpretation with so few samples.

Thanks are due to Prof. T. C. Bagchi of the Indian Institute of Technology for providing facilities for work.

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[*Manuscript received 24 August 1965*]