CORRESPONDENCE

CO-EXISTING PYROXENES

SIR.—Three papers dealing with the distribution of Mg and Fe between co-existing orthopyroxene and clinopyroxene have recently appeared in the *Geological Magazine*. Muir and Tilley (1958) concluded that the distribution is the same for metamorphic and plutonic igneous rocks. Wilson (1960) suggested that the distribution may vary as a function of temperature. O'Hara (1960) arrived at a conclusion which concurs with that of Muir and Tilley. In each paper the distribution is discussed in terms of tie-lines in a three-component diagram; the intersection point of a side of the diagram and the projection of a tie-line is taken as a measure of the distribution.

The subject can be examined from a thermodynamic viewpoint (Ramberg and DeVore, 1951). The distribution of Mg and Fe between two minerals can be expressed by use of a distribution diagram (Kretz, 1959). When this is done for co-existing pyroxenes from six Indian charnockites studied by Howie (1955) we obtain a curve, the shape of which indicates that both phases are ideal mixtures (Mueller, 1960). Thus the distribution coefficient can be taken as a direct measure of the distribution of Mg and Fe between the two minerals. The distribution coefficient (K_D) has the form (Ramberg and DeVore, 1951):

$$K_D = \frac{X^o}{1 - X^o} \cdot \frac{1 - X^c}{X^c}$$

where $X^o = Mg/(Mg + Fe^{2+})$ in orthopyroxene, and $X^c = Mg/(Mg + Fe^{2+})$ in clinopyroxene.

Values of K_D for orthopyroxene-clinopyroxene combinations from two groups of rocks are presented in Table 1. The first group of rocks was supposedly equilibrated at metamorphic temperatures and the second group at near-liquidus temperatures. Note that K_D is nearly constant in the first group and consistently higher in the second group.

TABLE 1

Spec. No.	K_D	*Source*
Metamorphic rocks:		
3709	0·553	Howie (1955)
4645	0·510	,, ,,
2270	0·532	,, ,,
2941	0·561	,, ,,
4642A	0·567	,, ,,
115	0·598	,, ,,
O	0·578	Muir and Tilley (1958)
S	0·564	,, ,, ,, ,,
35–5	0·541	Ward (1957)
35–6	0·548	,, ,,
35–8	0·534	,, ,,
35–9	0·515	,, ,,
35–19	0·525	,, ,,
Igneous rocks:		
1	0·716	Brown (1957)
1.H	0·690	Muir and Tilley (1957)
A	0·710	Carstens (1958)
B	0·762	,, ,,

Three rocks studied by Muir and Tilley (1958) are of special interest. The specimens are numbered X, R, and T, and contain mineral pairs which yield K_D values of 0·856, 0·776, and 0·782 respectively. These are metamorphic

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rocks with values of K_D characteristic of igneous rocks. Specimen X is a metamorphosed basalt and the remaining two may also have experienced igneous temperatures, as indicated by the presence of olivine. The possibility exists that K_D in the three rocks is a relic of a pre-metamorphic high-temperature equilibrium.

On theoretical grounds we find that K_D is dependent on (1) temperature, (2) pressure (Ramberg and DeVore 1951), and (3) variable concentrations of a third element (Kretz, 1961). It is reasonable to suspect that large variations in K_D (Table 1) have resulted from a variation in the equilibration temperature. It is uncertain, however if small variations in K_D (as found in the first group of rocks in Table 1) may be attributed entirely to the temperature dependence of the distribution coefficient.

The subject will be discussed in detail in a forthcoming paper. At present I should like to make a special plea to abandon the meaningless operation of projecting tie-lines and to propose that we discuss the distribution of Mg and Fe in co-existing pyroxenes in terms of the distribution coefficient.

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