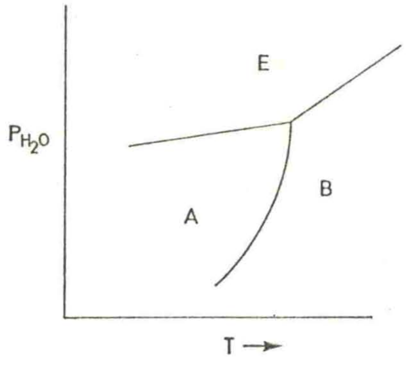

Fig. 1. Form of phase relations between amphibolites (*A*), basalts (*B*) and eclogites (*E*) proposed by Essene and Fyfe (1967). Melting phenomena have been ignored

also be negative. Hence the phase boundary of the above reaction could have positive slope, even if only at low temperatures, and eclogites could be stable with excess water at low temperatures and moderate pressures. This would lead to a phase diagram as in Fig. 1. Such an $A \to E$ boundary would be in accord with Miyashiro's (1961) well known facies diagram.

The Amphibolite-Eclogite Transition

At the present time, no direct experimental study of the $A \to E$ boundary is available. However, data is available which indicates that Essene and Fyfe's conclusion is most improbable.

Firstly, the entropies of amphiboles seem rather low on the additivity model (see Fyfe, Turner and Verhoogen, 1958) compared to pyroxenes Thus, if we use the normal approach we might estimate the entropy of tremolite by adding diopside, enstatite, quartz and ice:

$$S(\mathrm{Ca_2Mg_5S_8iO_{22}(OH)_2}) = 2\,S(\mathrm{CaMgSi_2O_6}) + 3\,S(\mathrm{MgSiO_3}) + S(\mathrm{SiO_2}) + S(\mathrm{ice}).$$

This would give:

$$S_{\mathrm{trem}} = 136.54 = 68.4 + 48.66 + 98.8 + 9.6 \text{ e.u.}$$

The observed entropy of tremolite is 131 e.u., considerably lower than the additivity estimate. If this is also true for hornblendes, then Essene and Fyfe's guessed negative ΔS of $A \to E + W$, looks unlikely. The boundary between amphibolite and eclogite will therefore be negative in slope and continue to go to increasingly high P_{H_2O} with lowering of temperature.

More significantly, we now know approximately the positions of the boundaries

$$\begin{array}{lcl} \text{amphibolite (with plagioclase)} & \to & \text{basalt} + \text{water} \\ A & \to & B \;+\; W \end{array} \qquad (1)$$

and:

$$\begin{array}{lcl} \text{basalt} & \to & \text{eclogite} \\ B & \to & E \end{array} \qquad (2)$$