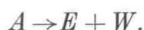Fig. 2. Form of the vapor pressure curve of tremolite. The numbers must be considered very approximate because of the distance of some extrapolations involved

These boundaries give a fix on the free energies of these separate reactions and hence, by addition, $\Delta G_1 + \Delta G_2$ gives the ΔG_3 of the reaction:

$$A \rightarrow E + W.$$

Using data from GREEN and RINGWOOD (1966) and YODER and TILLEY (1962); at 900° C, reaction (1) is in equilibrium at about 1 kb (water pressure) and reaction (2) at 15 kb (total pressure). Assuming that the water content of an amphibolite is about 2% and densities of 3.42 (E), 2.96 (B) and 2.99 (A), then based on 100 g of amphibolite, $\Delta G_{(3)}$ is about 1350 cal at 900° C and 1 kb. From this figure and thermodynamic data for water of SHARP (1962), reaction (3) will be in equilibrium at about 35 kb (water pressure) at 900° C. The estimate is very approximate but can hardly be in error by as much as 15 kb which would be necessary to accomodate ESSENE and FYFE'S positive boundary.

It is interesting to note that for the comparable reaction

tremolite → 2 diopside + 3 enstatite + quartz + water
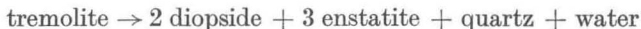
the phase diagram must be about as shown in Fig. 2. This type of diagram is probably general for all known mineral hydrates if we consider lower crust and upper mantle presures, and obviously has bearing on water in the deeper portions of th earth.

In Fig. 3 we give a schematic diagram for some phase relations in the basalt water system.

Line X-Y is the basalt-eclogite transition line of GREEN and RINGWOOD.

Curve C-D is the amphibolite-basalt transition of TILLEY and YODER.

Line D-Z is the calculated amphibolite-eclogite transition.

Curve F-G-H is the beginning of melting curve of basalt with excess water.

Portion F-G is based on YODER and TILLEY; portion G-H is based on data of LAMBERT and WYLLIE (1968).
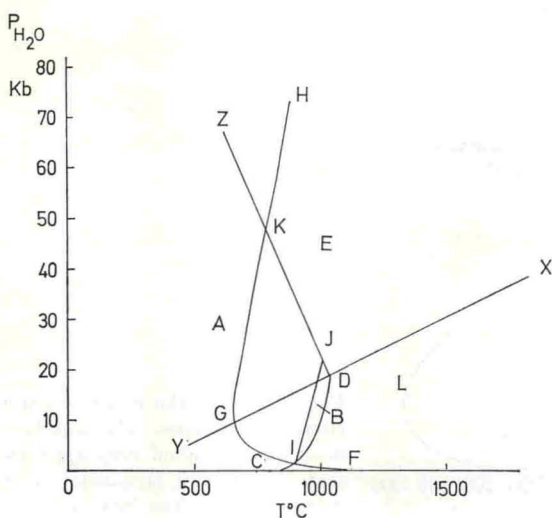
Fig. 3. An approximate diagram showing the region of stability of eclogites (region bounded by Z-K-H) in a system with excess water. For further details see text

Line I-J is a curve for the reaction: amphibolite-melt without excess water, a reaction which must have positive slope.

The field of amphibolite lies below the curves C-I-J-K-Z. Partial melting will occur in the field bounded by F-G-K-H is excess water is present. If excess water is not present, then liquids will form from amphibolites to the right of the F-I-J-K-H. Eclogite and water, without melt, will exist in the area bounded by Z-K-H. It is clear that this region is not within any normal crust.

All the simple boundaries shown must be highly smeared by solid or liquid solution phenomena. It should be noted that the amphibolite-eclogite boundary (D-K-Z) represents a metastable equilibrium between eclogite and plagioclase amphibolite. As the latter will transform to more stable plagioclase-free amphibolite somewhere above X-Y, amphibolite will restrict the eclogite field even further than shown.

Our conclusion is, that crustal eclogites form in dry environments where $P_{Load} \gg P_{H_2O} \cdot P_{Load}$ need not be very high according to the line X-Y. P_{H_2O} is likely to be determined and buffered by incomplete hydration reactions.

It perhaps seems feasible that the necessary conditions for eclogite formation could be generated by suitable water buffers in the environment. Thus, one might ask the question: is the not uncommon association of eclogites with partially serpentinized ultrabasic rocks due to a low partial pressure of water generated by the buffer system

$$\text{pyroxene} + \text{olivine} + \text{water} = \text{serpentine ?}$$
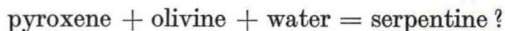
For such a buffer system to lower water pressure to an extent that amphiboles are dehydrated requires that their vapour pressure should be lower than that of hornblendes at the same temperature. As amphiboles tend to have very low vapor pressures and hence high thermal stability relative to almost all common hydrates, it appears unlikely that this is a common way by which eclogites could be formed. In fact, if water could diffuse freely, eclogites would be expected to