CRYSTALLIZATION OF SOME NATURAL ECLOGITES AND GARNETIFEROUS ULTRABASIC ROCKS AT HIGH PRESSURE AND TEMPERATURE S. Howells, C. Begg and M.J. O'Hara, Grant Institute of Geology, University of Edinburgh.

Results of short (1-15 mins in presence of liquid; 15 muns - 1 hr in subsolidus) solid media equipment experiments in platinum capsules on dry charges of natural eclogite, garnet-olivine-pyroxenite and garnet-lherzolite from kimberlite are presented and results for eclogite summarised in fig 1. Chemical analyses of the four samples investigated appear in O'Hara <u>et al</u> (1973 a,b).

O'Hara and Yoder (1967) reported solidus temperatures at 30 kb in two natural eclogites and several reconstituted mineral assemblages from kimberlite. Their samples 37079 and TAN 503 resemble sample 1044 (fig 1) in being soda-poor and relatively low M(=Mg/Mg+Fe). They yielded a solidus temperature of c.  $1515^{O}C$  at 30 kb, similar to that observed in the new experiments. Garnet was present to the solidus, and clinopyroxene was liquidus phase as for 1044, but the new sample displays a higher liquidus temperature.

In the new study, garnet does not appear as a liquidus phase below 40 kb but there is an immediately subsolidus field at 20 kb within which all garnet of the sample has dissolved in the pyroxene. O'Hara and Yoder (1967) also reported a high solidus temperature of c.  $1535^{\circ}C$  in a kyanite



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eclogite, TAN 501, at 30 kb, confirming solution of oriented kyanite intergrowth in the clinopyroxene prior to the onset of melting.

Eclogite 1058 from the Roberts Victor mine has high M, combined with high Na/Ca in the pyroxene; the solidus temperatures are lower than for 1044 (fig 1) despite the higher M value. The garnet does not dissolve entirely in the pyroxene under any investigated conditions, and garnet appears as the liquidus phase at pressures below 25 kb. Or¢thopyroxene appears near the liquidus at 20 kb but reacts out after garnet appears.

Olivine-garnet websterite 1031, suggested (O'Hara 1973; O'Hara et al 1973a) as a possible cumulate from the fractionation of two pyroxenes plus olivine from a liquid proceeding down the trend D-B (O'Hara 1970) apparently develops the predicted mineral assemblage in the solidus only at pressures less than 30 kb. The large liquidus-solidus interval  $c_{\rm c}^{\rm C}$ early orthopyroxene crystallization <sup>(S)</sup> consistent with the proposed cumulus origin

The very fertile looking garnet lherzolite 1032 (O'Hara <u>et al</u> 1973a, No. 1) which might represent a very high pressure primary magma, has been run at 45 kb. At this pressure olivine is still the liquidus phase, persisting to temperatures greater than 1750°C. Orthopyroxene is present from c. 1715°C and the solidus lies below 1650°C. If this rock is to represent a primary liquid in equilibrium with garnet harzburgite or garnet lherzolite, the pressure of its derivation must be greater than 45 kb.

No significance can yet be attached to the pressure at which garnet and clinopyroxene are cotectic at the liquidus of these eclogites; we can -not be sure that the hand specimen samples fairly represent the garnetpyroxene ratio of the source region, nor is there a secure basis for assuming that the pressure at which garnet and pyroxene appear simultaneously at the liquidus in this bulk composition bears any predictable relationship to the pressure or temperature at which the original eclogite may have accumulated from some more complicated magmatic system.

If the eclogites are cumulates, the temperature of the magmas must have been lower than the observed solidus temperatures, i.e. less than  $1385\pm35^{\circ}C$  at 20 kb, or less than  $1480\pm30^{\circ}C$  at 30 kb (perhaps very much lower).

Bimineralic eclogite is most unlikely to represent the total crystallization product of a high pressure liquid because of the special restricted nature of bulk compositions which develop bimineralic assemblages on solidification (O'Hara and Yoder 1967). The liquidus temperatures are c. 100°C higher than the solidus temperatures for these two eclogites, and these compositions would only have existed as dry liquids at temperatures higher than the solidus temperature of garnet-lherzolite. It is impossible for them to represent total crystallization products of dry primary magmas (olivine and orthopyroxene do not appear on the liquidus). The dry primary magmas would have formed by partial melting of garnet-lherzolite at lower temperatures than required to convert these eclogites to liquids. It is, therefore, unlikely that higher temperature eclogite liquid has been produced by fractional crystallization of a lower temperature parental liquid, (even taking into account the effects of pressure decrease).

Olivine does not appear in the liquidus/solidus interval of these or other investigated bimineralic eclogites. The partial melting of dry eclogite cannot, therefore, yield peridotite or garnetiferous peridotite residua in the pressure range investigated (20-40 kb) and is even less likely to do so at higher pressures due to the contraction of the primary liquidus phase volume of olivine (O'Hara 1968). At lower pressures the eclogite mineralogy is not stable to the solidus, olivine may appear in the melting interval joined perhaps by orthopyroxene but spinel-lherzolites rather than garnet-lherzolites would be the residual peridotite assemblage.developed (O'Hara <u>et al</u> 1971). While such peridotites might recrystallize to garnet-lherzolite on cooling in the sub-solidus, the simplest interpretation of the experimental data suggests that this could not have happened at less than 15 kb (O'Hara <u>et al</u> 1971). Models which call for bimineralic eclogite upper mantle to yield garnetlherzolite residua in partial melting presuppose initial restriction of the process to c. 45-60 km depth, or selective sampling by diatremes of wall rocks from those depths (because peridotites greatly exceed eclogites in abundance).

These restrictions would not necessarily apply if eclogite were to undergo partial melting in a water-bearing or water-saturated system (e.g. Bravo and O'Hara 1973) but the liquids produced would then necessarily be much richer in silica than, for example, kimberlite fluids.

## References

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