

(2a) the MgO-Al₂O₃-SiO₂ system. RINGWOOD *et al.* (1964) and RINGWOOD (1966) integrated the data from the enstatite + pyrope studies with the pyrolite (RINGWOOD 1966a) composition* to infer stability fields for the assemblages olivine + pyroxenes + spinel, olivine + aluminous pyroxenes, and olivine + pyroxenes + garnet. Direct experimental study (GREEN and RINGWOOD, 1967a) of the pyrolite III revealed a much lower solubility of Al₂O₃ in orthopyroxene than that predicted from the study of the simple systems—this resulted in persistence of spinel to higher temperature (≈ 1200 °C, 11 kb to ≈ 1300 °C, 23 kb) than the 900 °C predicted by RINGWOOD *et al.* (1964) and in appearance of garnet from breakdown of aluminous pyroxene at lower pressures (≈ 26.5 kb at 1400 °C) than previously predicted (≈ 39 kb at 1400 °C). These surprisingly large differences imply that the presence of coexisting olivine or clinopyroxene considerably alters the solubility of Al₂O₃ in orthopyroxene—this can readily occur if the coexisting phases can enter solid solution in either garnet or orthopyroxene. The addition of clinopyroxene to the assemblage obviously establishes new partition relations involving grossular solid solution in garnet and diopside solid solution in enstatite. However MACGREGOR and RINGWOOD (1964) found higher solubilities of garnet in orthopyroxene for the natural enstatite (0.82% CaO) + garnet (5.21% CaO) mixes than for the pure enstatite + pyrope system. MACGREGOR and RINGWOOD (1964) homogenized mixtures of 50% garnet, 50% enstatite to a pyroxene phase at 30 kb, 1500 °C implying that the pyroxene contained 3.0% CaO (by weight)—this either exceeds or is very close to saturation in diopside solid solution for these *P-T* conditions (DAVIS and BOYD, 1966; GREEN and RINGWOOD, 1967b). Thus it does not appear that diopside solid solution greatly inhibits Al₂O₃ solubility in enstatite. If the addition of olivine to garnet-enstatite assemblages is the factor inhibiting Al₂O₃ solubility then it is implied that olivine has a significant solid solubility in enstatite. This possibility requires further investigation but it may be noted that KUSHIRO (1964) reported olivine solid solution in diopside and BOYD and ENGLAND (1960) noted that natural enstatites from peridotites had values of the molecular ratio $M^{2+}/Si > 1$. The observation of spinel exsolution lamellae within ensta-

* This composition is denoted as pyrolite III in the rest of this paper (see table 1).

lite of lherzolite nodules and some intrusive peridotites also implies non-stoichiometric composition of the orthopyroxene (cf. reaction (2)).

MACGREGOR (1967) briefly reported data on mixtures of natural orthopyroxene + clinopyroxene + spinel using separated minerals from lherzolite inclusions. Two assemblages differing mainly in Cr₂O₃/Al₂O₃ ratio were used and the preliminary data indicate that high Cr₂O₃/Al₂O₃ ratios of spinel will have a marked effect on stabilizing the olivine + orthopyroxene + clinopyroxene + spinel assemblages to higher pressures. ITO and KENNEDY (1967) presented data on the solidus and melting relations in a garnet lherzolite nodule from kimberlite. They obtained solidus temperatures approximately 100 °C lower than those of GREEN and RINGWOOD (1967a) but the pressure obtained for the incoming of garnet (≈ 23 kb, 1320 °C) agrees with that obtained by GREEN and RINGWOOD (1967a) on pyrolites I and II*. ITO and KENNEDY (1967) did not obtain a field of olivine + aluminous pyroxenes (without spinel) although this would be anticipated from a comparison of their composition with that of GREEN and RINGWOOD (1967a) for pyrolites I, II and III. Ito and Kennedy used a natural garnet lherzolite as starting material—this presents difficulties in representative sampling of the initial coarse-grained rock and in the avoidance of sample composition change during the extremely fine-grinding needed to ensure some chance of reactions proceeding to equilibrium.

From the preceding summary of published data, it is apparent that there is as yet no general agreement on the *P, T* coordinates of reactions (1), (2) and (3), either in simple systems or in complex natural peridotitic compositions. More detailed work is required, attempting to eliminate the possibility of metastable reactions or other experimental uncertainties. From the data already obtained, it is clear that the reaction (1) is one in which the pyroxene will vary in composition along the reaction boundary. This boundary is actually the locus of intersections of reactions (2) and (3) which define the curves of constant Al₂O₃ content of pyroxene in peridotitic compositions. The position of reaction (1) will also depend sensitively on the spinel composition

* This agreement may be fortuitous as GREEN and RINGWOOD (1967a) applied a (-10%) pressure correction while ITO and KENNEDY (1967) applied no pressure correction. It should also be noted that MACGREGOR (1964, 1965, 1967) did not apply a pressure correction.