

clinopyroxenes analyzed from 1320 °C and 1330 °C runs.

The experimental runs at 18 kb yielded orthopyroxene as the liquidus phase, joined by clinopyroxene at lower temperatures. Orthopyroxene is slightly more magnesian than coexisting clinopyroxene and has lower Al<sub>2</sub>O<sub>3</sub> content (cf. GREEN and RINGWOOD, 1967a). The clinopyroxene compositions have CaO contents of 14–16%. The most reliable clinopyroxene analyses obtained from the runs were those at 18 kb, 1200 °C; in most runs the crystals were smaller than orthopyroxene and with quench outgrowths and were analyzed with difficulty. The Na<sub>2</sub>O contents of the clinopyroxenes in equilibrium with the olivine basalt liquid increase with increasing pressure – thus in both the dry and “wet” runs at 13.5 kb, the clinopyroxenes contained 0.2–0.3% Na<sub>2</sub>O with apparently slightly lower contents in the higher temperature clinopyroxenes. At 18 kb however the clinopyroxenes contain 1.0% Na<sub>2</sub>O, probably in jadeite solid solution.

A puzzling feature of the compositions listed in table 5 is that olivine has a consistently lower 100 Mg/(Mg+Fe<sup>++</sup>) ratio than co-existing orthopyroxene in the “wet” runs. This differs from the pattern previously obtained at 9 kb, 1290–1250 °C (GREEN and RINGWOOD 1967a) where olivine has essentially the same 100 Mg/(Mg+Fe<sup>++</sup>) ratio as co-existing orthopyroxene. Except for the 13.5 kb, 1150 °C run, co-existing pyroxene pairs have clinopyroxene with lower 100 Mg/(Mg+Fe<sup>++</sup>) ratio than coexisting orthopyroxene. The differences are very small at 13.5 kb, 1320–1330 °C i.e. where the compositional differences between the two pyroxenes are relatively small, but are larger in the 18 kb, 1240–1200 °C runs. The partition coefficients for Fe and Mg between pyroxene pairs in natural rocks are such that the clinopyroxene is relatively enriched in magnesium although for magnesian igneous pyroxene pairs the coefficients approach unity. The apparent reversal of this trend in the experimental runs may in part be due to appreciable Fe<sup>+++</sup> contents (not determinable by microprobe analyses) in the clinopyroxenes or may be a real feature of the high temperature of equilibration of these assemblages.

*Comparison of natural xenocryst compositions with experimentally crystallized phases:* The experiments under dry conditions show that olivine, orthopyroxene and

clinopyroxene (the three natural xenocryst phases) occur together on the liquidus at 11.3 kb, 1310 °C; the two pyroxenes occur without olivine on the liquidus at 13.5 kb and olivine occurs on the liquidus at 9 kb. The analyzed synthetic phases are similar or slightly lower in 100 Mg/(Mg+Fe<sup>++</sup>) value than the natural xenocryst phases and it is probable that accurate matching of this parameter could be obtained at 11–12 kb and appropriate temperature (1310–1320 °C). However, the analyzed clinopyroxene at 11.3 kb and the pyroxene pairs at 13.5 kb are very different in composition from the natural pyroxenes, particularly in the extremely sub-calcic nature of the clinopyroxene and the slightly higher CaO content of the synthetic orthopyroxene.

Comparison of tables 2 and 5 shows that the natural pyroxene compositions are very closely matched by analyzed pyroxenes from “wet” runs at 13.5 kb and 18 kb. CaO contents in both pyroxenes, TiO<sub>2</sub> contents, 100 Mg/(Mg+Fe<sup>++</sup>) ratios and Na<sub>2</sub>O contents are closely matched. In detail the Na<sub>2</sub>O content of the natural clinopyroxenes (0.7%) is between the values for the 13.5 kb (0.3) and 18 kb (1.0) clinopyroxene; the CaO content of the natural orthopyroxene is slightly greater and the CaO content of the more Fe-rich natural clinopyroxene slightly lower than the 18 kb, 1200 °C pyroxene pair. These differences suggest that a pressure of 14–16 kb and a temperature slightly above 1200 °C would yield near-liquidus pyroxenes identical to the natural xenocrysts. It may be noted also that while olivine precedes orthopyroxene in the crystallization sequence at 13.5 kb, and is absent at 18 kb, it should occur together with orthopyroxene on the liquidus at about 15 kb. The natural pyroxenes encompass a small range in 100 Mg/(Mg+Fe<sup>++</sup>) ratio and thus represent crystal/liquid equilibria over a small range of P, T conditions such as might be anticipated in a cooling magma chamber or in a static or slow moving feeder dyke. The range of experimental conditions in the wet melting experiments appears to exceed the range required to produce the observed compositional variations.

#### 4. Conclusions

The experimental study of the crystallization of the Auckland Id. olivine basalt has shown that the olivine basalt can precipitate, as near-liquidus phases, crystals which closely match the observed partly resorbed “xe-