

and is difficult to explain on crystal-chemical grounds. It is clear that the presence of clinopyroxene with K contents of this order as an upper-mantle phase would be important for controlling the distribution of K in basaltic liquids. Hence, it appeared desirable to seek confirmation for this feature.

We have attempted to determine experimentally the amount of K that could enter the clinopyroxene structure under upper-mantle conditions by reacting together, at high temperatures and pressures, various clinopyroxenes and potassium-rich phases and measuring the potassium content of the resultant pyroxenes by electron-probe analysis. The experiments were made in the pressure range 15 to 32 kb with a piston-cylinder type apparatus similar to that designed by Boyd and England (1960). Sealed Pt tubes were used for the hydrous runs. The starting materials are mechanical mixtures of the following materials: synthetic pure diopside made by Hytönen and Schairer; a mixture of phlogopite composition consisting of forsterite, quench forsterite, and glass; a mixture crystallized at 1 atm from a glass of composition anorthite 50 forsterite 50 (mole %); a natural omphacite from Kaminaljuyu, Guatemala, originally described by Foshag (1957), with a composition close to diopside 45 jadeite 55 (mole %) (Clark and Papike, 1968); and a natural potassic richterite from Wolgidee, Australia, which is similar in composition to that analyzed by Wade and Prider (1940) and is described elsewhere in this report (see Table 17, No. 1).

In all the hydrous runs, diopside and omphacite were recrystallized to euhedral or subhedral crystals even at subsolidus temperatures. During the electron-probe analysis for K the other two spectrometers were set for Ca and Mg, and comparison of the starting materials and reactants indicated the recrystallization of the clinopyroxenes. Additional measurements for Na also revealed the nature of the pyroxenes formed. Phlogo-

pite occurs as hexagonal plates forming thick books; when glass is present, however, it often appears as feathery crystals, believed to be quench crystals. Richterite that had been ground finely was also recrystallized to relatively large, euhedral or subhedral crystals. Because of recrystallization in the presence of excess vapor, equilibrium is believed to have been attained in the hydrous runs. In the anhydrous run made for the 1:1 mixture of diopside and phlogopite composition, the temperature was raised above the solidus to secure equilibrium.

A great deal of difficulty has been experienced in making the electron-probe measurements. The small size of the reaction products necessitated the use of a 1–2 μm electron beam and low sample current (0.025 μa), with resultant low intensity. The main problem has, however, been caused by the presence of minute inclusions and intergrowths of these crystals with K-rich phases (phlogopite and glass), frequently resulting in anomalously high K contents for apparently clear clinopyroxene grains. Consequently several runs have been discarded, and only those measurements in which a fair amount of consistency has been established are reported here. Particular care has been taken in making background measurements, often by using the pure starting materials, which were always mounted together with the reaction products. It is to be noted that the results have been corrected only for background and drift, but it is believed that they are accurate to within 10–20% of their true values; this level of accuracy is adequate for present purposes. A detailed account of the technique used will be given elsewhere.

The assembled data are listed in Table 18. It is immediately apparent that regardless of variation in mineral assemblage, temperature, pressure, and water content, the amount of K that has entered the clinopyroxene reaction products is small, <150 ppm. Even where clinopyroxene has crystallized directly