

The compositions of a typical nodule from California [Hess, 1960a], a nodule from olivine basalt at Mount Gambier, South Australia [Stanley, 1910], and of two averages of several nodules from each of two new South Wales localities [Wilshire and Binns, 1961] are given in Table 2. These analyses are strikingly similar in both major and minor constituents.

As discussed in the preceding section, the Lizard peridotite contains a primary core having a 'pyroxene pyrolite' assemblage (Table 2, column 9) and differs from the nodule compositions only in its higher  $Al_2O_3$  content. A detailed comparison [Green, 1963] of the compositions of the minerals of the Lizard peridotite with those of peridotite nodules argues convincingly for similar conditions of crystallization.

Except for its low  $K_2O$  and  $Na_2O$  contents the dunite mylonite from St. Paul's rocks [Tilley, 1947] has nearly the same composition as the peridotite nodules and garnet peridotites. The analysis given in column 8, Table 2, is of a mylonite containing both enstatite and diopside augen in fine, recrystallized olivine and brown, translucent spinel. Data on the  $Al_2O_3$  contents of the large pyroxenes would be particularly welcome, but, bearing in mind the rock composition and mineralogy, we can compare the rock most closely with the 'pyroxene pyrolite' assemblage.

From the experimental and field evidence discussed in the preceding section, it is clear that the characteristic assemblage olivine + aluminous pyroxenes + aluminous spinel has crystallized under greater load pressure than the plagioclase pyrolite assemblage. As implied by Ringwood's [1962b] model, this assemblage may well occupy an extensive region in the upper mantle. As would be expected, the calculated density of the pyroxene pyrolite assemblage (about  $3.32 \text{ g/cm}^3$ ) is significantly higher than that of the corresponding plagioclase pyrolite assemblage ( $3.24 \text{ g/cm}^3$ ).

6. *The assemblage olivine + pyrope garnet + pyroxene(s).* The three analyses of garnet peridotites given in Table 2 include two inclusions in African kimberlites [Dawson, 1962; Holmes, 1936] and one analysis from a garnet peridotite lens occurring in association with eclogite as lenses in gneiss in Switzerland [Johannsen, 1938, p. 422]. From their mineralogy,

dotites within dunite in Amklovdaalen, Norway [Eskola, 1921], may also approach this composition.

The Swiss garnet peridotite differs from the other two analyses in having a higher CaO content, and it differs mineralogically in lacking enstatite. Nevertheless, the analyses are remarkably similar to the analyses of peridotite nodules in basalt and to the pyrolite model composition.

The contrast in mineralogy between the aluminous pyroxene-bearing assemblage and the garnet-bearing assemblage must be attributed to different *P-T* conditions of crystallization. The absence of the assemblage olivine + pyrope garnet + pyroxene(s) (garnet pyrolite) in the Lizard peridotite sequence, and as nodules in basaltic rocks, compared with its characteristic occurrence in the diamond-bearing pipes, suggests that garnet pyrolites derive from greater depths in the mantle than the aluminous pyroxene + olivine assemblages.

Such a relationship would be expected upon crystallographic and general mineralogical grounds. Thompson [1948] has pointed out that high pressure strongly favors mineral assemblages in which aluminum lies in octahedral coordination. Minerals in which aluminum occurs in tetrahedral coordination appear to be unstable at high pressure. The change in coordination from tetrahedral to octahedral is accompanied by a substantial increase in density due to closer packing.

In aluminous pyroxenes, approximately half of the Al atoms lie in tetrahedral coordination. A change in coordination with resultant increase in density can be obtained if, under high pressure, the highly aluminous pyroxene breaks down into a low alumina pyroxene and pyrope-rich garnet. Transition from the pyroxene pyrolite to garnet pyrolite appears to be due to this effect. The calculated density of garnet pyrolite is  $3.37 \text{ g/cm}^3$  as compared with  $3.32$  for pyroxene pyrolite.

The *P-T* conditions governing the transition from pyroxene pyrolite to garnet pyrolite are not known. Ringwood [1962b] has pointed out that garnet pyrolite requires higher pressures for its stability than eclogites, at corresponding temperatures. A possible boundary between the two assemblages, derived from indirect seismic evidence, was outlined in that paper. Hence, an