



Fig. 2. Diagram illustrating the  $P, T$  fields of different mineral assemblages in pyrolite III composition. The figures 1% $\text{Al}_2\text{O}_3$ , 2% $\text{Al}_2\text{O}_3$  etc. refer to the  $\text{Al}_2\text{O}_3$  content of orthopyroxene in equilibrium with garnet in the garnet pyrolite field. The oceanic and Precambrian shield geotherms are those illustrated by RINGWOOD *et al.* (1964). (From GREEN and RINGWOOD, 1967a.)

roxenes + spinel field but such curves, combined with data on the pyroxene miscibility gap, will ultimately provide a very useful means of estimating the  $P, T$  conditions of equilibration of natural spinel and garnet lherzolite (O'HARA, 1967). With variation in bulk composition, the conditions for appearance of garnet will vary; compositions with higher  $\text{Al}_2\text{O}_3$ /pyroxene ratio will yield spinel up to solidus temperatures and garnet will appear at 23–24 kb at the solidus. For a bulk composition such that, with all  $\text{Al}_2\text{O}_3$  in pyroxenes, the orthopyroxene would contain only 3.0%  $\text{Al}_2\text{O}_3$ , then spinel would be expected to disappear above 1000 °C, 10–18 kb and there would be a greatly expanded field of olivine and aluminous pyroxenes. Garnet would not appear on the solidus of such a composition until pressures of approximately 60 kb.

#### 4. Mineralogy in a pyrolite upper mantle

In the following discussion, it is assumed that the average composition of the upper mantle beneath oceanic and geologically "young" regions is that of pyrolite III. In continental regions and particularly in Precambrian shield regions, there is probably a much greater proportion of refractory residual peridotite at shallower levels and the upper mantle may be chemically zoned. Mineralogical variation in the upper oceanic mantle is thus determined by the intersection of geothermal gradients with the stability fields of fig. 1. The variation of temperature in the continental and oceanic crusts and upper mantle has been discussed by CLARK (1962) and CLARK and RINGWOOD (1964). It is clear from these papers that there is a large difference

Minor melting, Ol + Opx + Cpx + spinel  
 Nil, uncommon spinel  
 Trace garnet, uncommon spinel  
 2.2  
 2.1  
 4.2  
 5.0  
 —  
 —  
 3.0  
 5.9  
 Opx  
 Opx  
 Pt  
 Pt  
 1  
 1  
 22.5  
 24.8  
 1400  
 1400