340 and 640 km (CIT 109P) (C. B. Archambeau and E. A. Flinn, see *Anderson* [1937c]).
375 km [*Kanamori*, 1967]. (See Figure 4.)
365 and 610 km (CIT 204) [*Johnson*, 1967]. (See Figure 4.)

These values are obtained by using surface wave dispersion, travel times, and apparent velocities of body waves. The apparent velocity method gives accurate velocity gradients but give slightly inaccurate values for the absolute velocities. In travel time method the absolute velocity values may be accurate but the velocity gradients are in error. In the present discussion the latest two models of *Kanamori* [1967] (oceanic near island arc) and *Johnson* [1967] CIT 204 (continental) (both models are based directly on apparent velocities) are used (see Figure 4) because the velocity gradient is of great importance in this kind of discussion.

Although the depths of the first step of the sharp velocity gradients are approximately equal, the velocity gradients of the two models used are quite different from each other within the transition layer. CIT 204 corresponds quite well to the olivine model with two main steps of velocity increase. Kanamori's model seems to be equivalent to the olivine-pyroxene model with all three steps coupled. Accordingly, if these two models for two different areas hold true in fine details, it seems very difficult to account for this disagreement in the velocity gradients in the transition region only by the different temperature distributions in the two areas. The disagreement may be attributed to the difference in the amount of pyroxene and garnet in the mantle materials in the two areas. There is not, however, at present sufficient knowledge of the various phase changes and

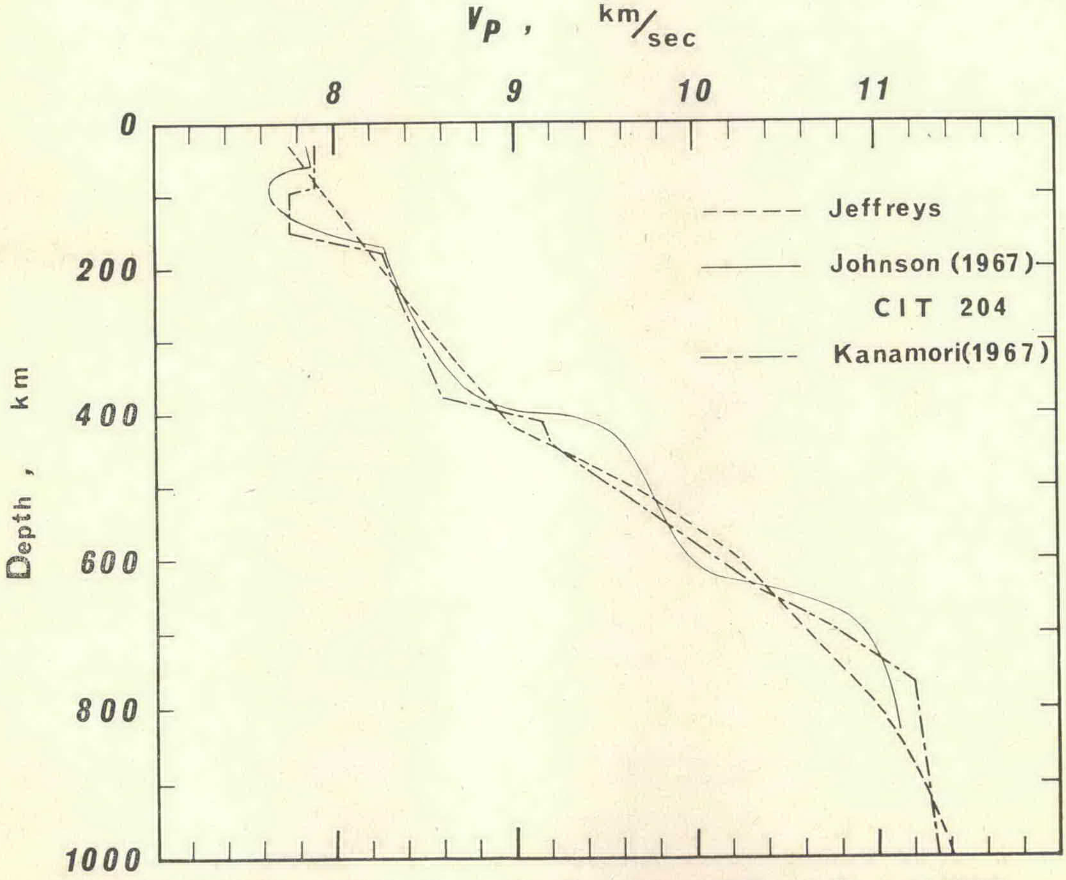

Fig. 4. The latest V_p models for the mantle after *Johnson* [1967] and *Kanamori* [1967], together with Jeffreys' velocity-depth curve.

the elasticity of high-pressure minerals to make a detailed discussion.

In Figure 5 the present two velocity-depth models and the olivine-spinel phase relations (in $(Mg_{0.9}Fe_{0.1})_2SiO_4$ and $(Mg_{0.8}Fe_{0.2})_2SiO_4$; arranged from Figure 1) are shown. As is seen from the figure, for the olivine-spinel transition in olivine with $(Mg_{0.9}Fe_{0.1})_2SiO_4$, a two-phase region 50 to 80 km thick could be expected under the temperature gradients less than 2°C/km through this region. As for $(Mg_{0.8}Fe_{0.2})_2SiO_4$ olivine, the thickness would reach 110 to 140 km under the same temperature gradients. In Figure 6 the increase of zero-pressure density in pure olivine is compared with the strong velocity gradients around 400-km depth in the present two velocity models, although the over-all density increase will be slightly lowered by the coexisting minerals other than olivine.

As is seen from the figure, the width of the two-phase region of the olivine-spinel transition in the composition about $(Mg_{0.9}Fe_{0.1})_2SiO_4$ seems approximately equal to the width of the steps at the depth of about 400 km, which appeared in the velocity-depth curves of the present velocity models. It is not necessarily clear, however, that the entire two-phase region of the olivine-spinel transition accurately corresponds to the observed high velocity gradient zone, since the zero-pressure density increases so slowly in the upper half of the two-phase region that it reaches only about 25% of the whole density increase in the olivine-spinel transition at the midpoint of this region. It seems fairly possible that the region of the sharp velocity gradient would correspond approximately to the lower half of the two-phase region.

From the discussion based on model CIT 204 using the empirical equation of state [*Anderson,*

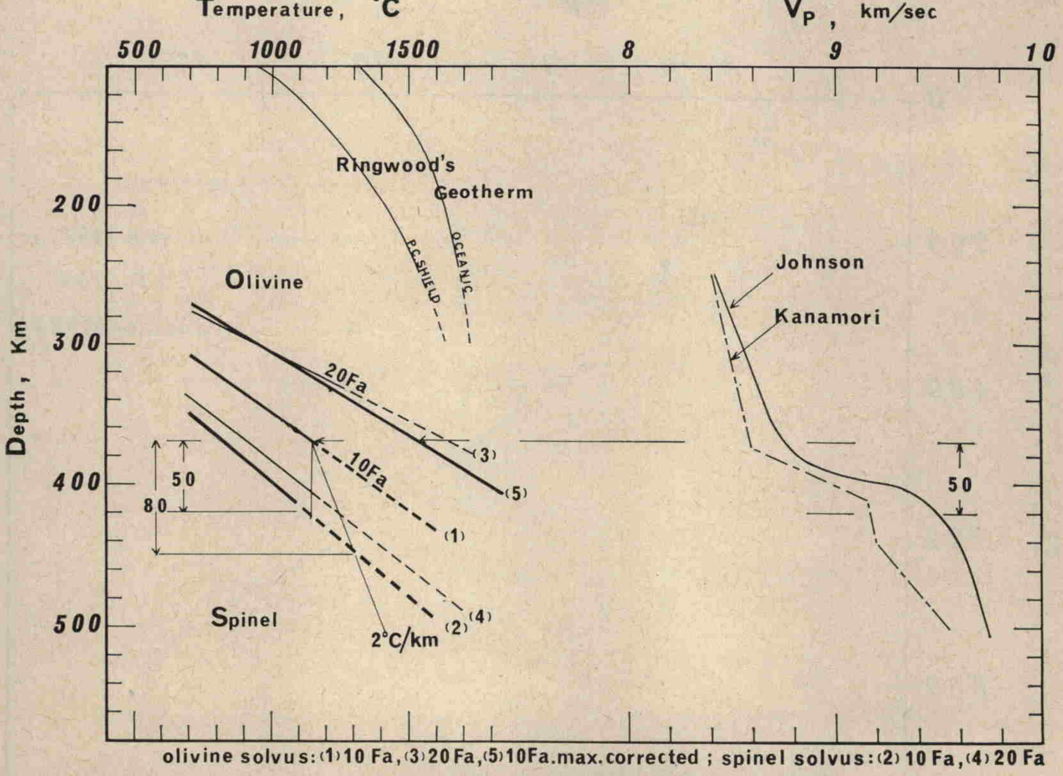

Fig. 5. Stability relations of olivine-spinel transition in 10Fa-90Fo and 20Fa-80Fo deduced from Figure 1 with the aid of the pressure-depth relation based on the Bullen model A-i, the upper sharp velocity gradient zone of the V_p models of *Johnson* [1967] and *Kanamori* [1967] and *Ringwood*'s [1966] geotherm. Variation of the width of the two-phase region with increasing of temperature gradient is also shown.