Discussion

Bowen and Schairer [1935], using the Clapeyron-Clausius equation, calculated an initial slope for the melting curve of fayalite to be 3.5°/kb. The latent heat of fusion of fayalite used in their calculation was derived from the solidus and liquidus curves for the Mg_2SiO_4-Fe_2SiO_4 system. The volume change of fayalite upon melting was roughly estimated by extrapolating the refractive index data of both crystal and glass in the Mg_2SiO_4-Fe_2SiO_4 system. They also stated that direct measurement by Goranson [*Bowen and Schairer*, 1935, p. 208] showed the rise of melting point to be approximately twice as much as the calculated value. The slope of 7.5°/kb obtained in the present study essentially verified Goranson's earlier result. Inaccurate estimation of both the latent heat and the volume change of fayalite may be chiefly responsible for the disagreement between the calculated and experimental values.

Experimental results on the olivine-spinel transition in Fe_2SiO_4 obtained in this study essentially agree with those by *Boyd and England* [1960], who used a piston-cylinder type of high-pressure apparatus with similar furnace assembly. The stability field of Fe_2SiO_4 spinel shown in Figure 2 consistently involves the experimental conditions of 1400°C at 65 kb which were determined by them to be in the spinel field.

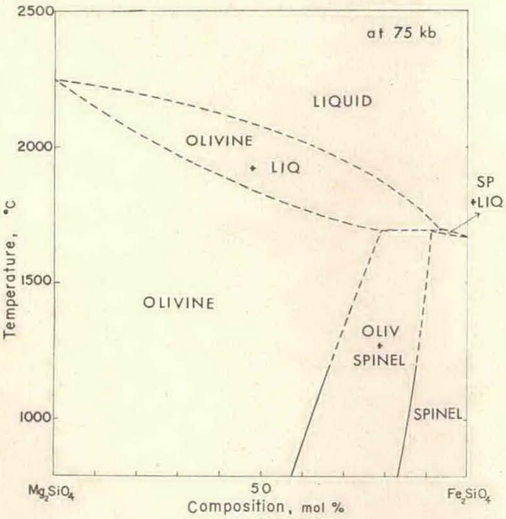

Fig. 3. Equilibrium diagram of the system Mg_2SiO_4-Fe_2SiO_4 at pressures near 75 kb. Melting point of forsterite is obtained by extrapolating the curve given by *Davis and England* [1964]. The liquidus and solidus are assumed. The solvus is based on the olivine-spinel transition in the system Mg_2SiO_4-Fe_2SiO_4 at 800, 1000, and 1200°C (Akimoto and Fujisawa, unpublished data).

The average slope of the melting curve for fayalite is 5.1°/kb, being close to that for forsterite, 4.77°/kb, in the pressure range up to about 50 kb [*Davis and England,* 1964]. It is expected, therefore, that the melting relations in the system Mg_2SiO_4-Fe_2SiO_4 at pressures up to 62 kb would be essentially the same as those at atmospheric pressure. At pressures higher than 62 kb, however, $(Mg,Fe)_2SiO_4$ spinel appears to be on the liquidus, and the solidus of olivine solid solution is intersected by the solvus between olivine and spinel solid solutions. Figure 3, the estimated equilibrium diagram of the system Mg_2SiO_4-Fe_2SiO_4 at about 75 kb, shows such relations. With increasing pressure the solvus shifts toward Mg_2SiO_4, and the liquidus and solidus of spinel solid solution become wider.

The remarkable inflection in the melting curve of Fe_2SiO_4, which coincides with the melting of Fe_2SiO_4 spinel, is of considerable geophysical importance. This suggests that a similar inflection should be anticipated in the melting-point gradient of the earth's mantle, provided that the olivine-spinel transformation takes place in the transition zone of the mantle. Positive support of the above inference is found in calculations on the melting curve of the mantle. *Uffen* [1952] estimated quite independently the change in melting temperature of the mantle with depth using seismic data on the basis of the Einstein-Debye theory of solids and Lindemann's theory of fusion. *Clark* [1963], considering thermodynamics and the effect of the transition zone, derived a melting curve for the mantle. We can find a considerable inflection in both melting curves around the transition zone. Since the chemical composition of the olivine in the mantle is generally supposed to be in the Mg_2SiO_4-rich side of the Mg_2SiO_4-Fe_2SiO_4 system, it is highly desirable to extend this work to a comprehensive study of the fusion of the Mg_2SiO_4-Fe_2SiO_4 system at high pressures.

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