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HIGH-PRESSURE DECOMPOSITION OF THE SYSTEM FeSiO_3 - MgSiO_3

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Stability relations of $(\text{Mg, Fe})\text{SiO}_3$ solid solutions ranging in composition from pure FeSiO_3 to $(\text{Mg}_{0.3}\text{Fe}_{0.7})\text{SiO}_3$ have been studied at high temperatures in the pressure range to 96 kb. High-pressure decomposition of $(\text{Mg, Fe})\text{SiO}_3$ clinopyroxene

into $(\text{Mg, Fe})_2\text{SiO}_4$ spinel solid solution and stishovite was established. The decomposition curve for FeSiO_3 , clinoferrosilite, was found to coincide with the coesite–stishovite transformation curve.

The pyroxenes are accepted to be the most abundant class of minerals next to the olivines in the upper mantle. Reconnaissance study of the high-pressure transformation of $\text{A}^{2+}\text{B}^{4+}\text{O}_3$ type silicates and germanates with pyroxene structure has already been reported by Ringwood *et al.* (RINGWOOD, 1967; RINGWOOD and MAJOR, 1966a, b, c, 1967, 1968; RINGWOOD and SEABROOK, 1963). They successfully discovered various types of transformations such as the transformation to ilmenite, to garnet and to perovskite, and the decomposition into spinel and rutile-type structure. Construction of the reliable transformation diagram of the MgSiO_3 – FeSiO_3 system over the wide range of pressure and temperature is, however, indispensable for the quantitative analysis of the high-gradient zone of seismic wave velocities in the mantle. In the present study, some preliminary experimental results upon phase equilibria at high pressures in the iron-rich side of the pyroxene system MgSiO_3 – FeSiO_3 are reported.

High-pressure and high-temperature experiments were carried out by means of a tetrahedral press using pyrophyllite as pressure transmitting material. Two different sizes of cemented tungsten carbide anvils with 9 mm and 7 mm edge length were used. Pressure values were calibrated at room temperature on the basis of the pressure standard proposed by JEFFERY *et al.* (1966).

Powder samples were directly embedded in the graphite tube which was used as a heating element as well. Temperatures were measured with a Pt/Pt–13% Rh

thermocouple without any corrections for the effect of pressure on the emf of the thermocouple.

Starting materials used in the present study are in general orthopyroxenes of known composition which were synthesized at 40 kb and at 1200 °C. Equimolar mixtures of fayalite and amorphous silica were also used as starting materials for the study of high-pressure transformation in ferrosilite. The experimental method used in determining the stability diagram of $(\text{Mg, Fe})\text{SiO}_3$ at high-pressures and high-temperatures was the usual quenching method. Samples were subjected to desired pressures at desired temperatures for a predetermined interval of time and quenched isobarically by turning off the heating power. After relaxation of the pressure and recovery of the samples, the phases present were examined by optical and X-ray diffraction technique.

Equilibrium data of ferrosilite at various pressure–temperature–time conditions are summarized in table 1 and illustrated in fig. 1. A previous report by RINGWOOD and MAJOR (1966a) that clinoferrosilite decomposes into Fe_2SiO_4 spinel plus stishovite was confirmed over a wide temperature range. The present data also indicate that the boundary curve for this decomposition of clinoferrosilite is well represented by the boundary curve for the coesite–stishovite transition which was determined as $P(\text{kb}) = 69 + 0.024 T(^{\circ}\text{C})$ in our recent study (AKIMOTO and SYONO, 1969) and reproduced by the solid straight line in fig. 1. The olivine–spinel transformation in Fe_2SiO_4 is known to take