

$\text{Ca(OH)}_2$ ; and vapor (V), with composition almost pure  $\text{H}_2\text{O}$ . The crystalline phases were identified by their optical properties, with X-ray diffraction patterns being used for occasional confirmation and to seek additional phases that might be overlooked in the optical examination. No solid solution was detected. The compositions of these phases and of others in the system are plotted in the quaternary tetrahedron of Fig. 1. The legends for Fig. 1 and 2 provide the key to the abbreviations for the additional phases plotted.

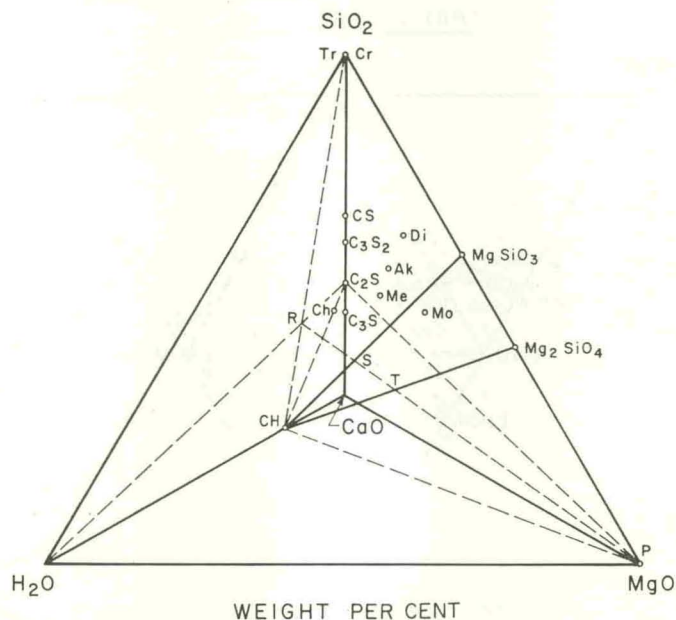


Fig. 1. Phases in the system  $\text{CaO-MgO-SiO}_2\text{-H}_2\text{O}$ . Abbreviations not explained in the text: Tr—tridymite, Cr—cristobalite, CS—wollastonite,  $\text{C}_3\text{S}_2$ —rankinite,  $\text{C}_3\text{S}$ —tricalcium silicate, Di—diopside, Ak—akermanite, Mo—monticellite. The composition triangle CH— $\text{MgO-SiO}_2$  contains the two joins investigated,  $\text{Ca(OH)}_2\text{-Mg}_2\text{SiO}_4$  and  $\text{Ca(OH)}_2\text{-MgSiO}_3$ . This triangle intersects the upper face of the tetrahedron  $\text{C}_2\text{S-CH-MgO-H}_2\text{O}$  in the line RSTP.

The liquid could not be quenched to a glass, and former liquids were recognized by a combination of physical and microscopic characteristics of the samples, following the procedures described in detail by WYLLIE and TUTTLE (1960). Small spherical pits in the sample and on its surface were taken as evidence for the presence of a vapor phase in all runs containing a liquid phase. The diagnostic characteristics of portlandite, calciochondrodite and dicalcium silicate have been described by WYLLIE and TUTTLE (1960) or by WYLLIE and HAAS (1965). Primary periclase was easily identified by its octahedral habit, high refringence, and lack of birefringence. When quenched from the liquid, periclase formed minute specks in the quench portlandite.  $\beta\text{-Ca}_2\text{SiO}_4$  and merwinite have rather similar optical properties, and X-ray diffractometer patterns were used to confirm their coexistence in one of the phase elements intersected (Fig. 4).

#### PREVIOUS STUDIES

The only previous study of the melting relationships in the quaternary system is YODER's (1958) study of the effect of water vapor under pressure on the melting temperature of diopside. At a pressure of 1 kilobar on the join  $\text{CaMgSi}_2\text{O}_6\text{-H}_2\text{O}$  the melting temperature is about  $1330^\circ\text{C}$ , compared to  $1390^\circ\text{C}$  for diopside at 1 bar pressure. The amount of water dissolved in the liquid was not determined. By analogy with other silicate-water systems it is probably less than

5 wt.%. There is information available for the melting relationships in some of the bounding binary and ternary systems, and this is summarized in Fig. 2.

The relationships illustrated for the binary systems  $\text{CaO-SiO}_2$ ,  $\text{CaO-H}_2\text{O}$  and  $\text{SiO}_2\text{-H}_2\text{O}$  are based on reviews by WYLLIE and HAAS (1965), with the temperatures for  $\text{CaO-H}_2\text{O}$  being revised after HARKER (1964) and WYLLIE and RAYNOR (1965). The liquidus relationships for the system  $\text{CaO-MgO-SiO}_2$  are from the revision by MUAN and OSBORN (1965, p. 92). Note that the

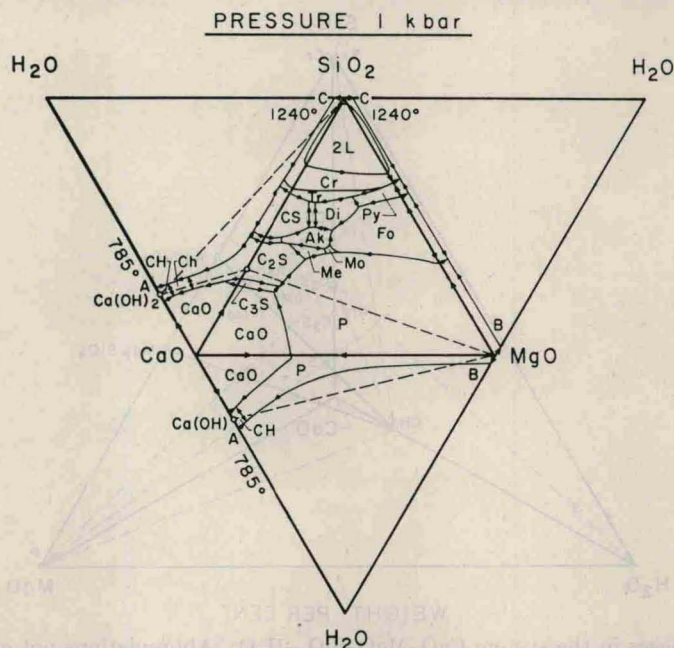


Fig. 2. The system  $\text{CaO-MgO-SiO}_2\text{-H}_2\text{O}$  at 1 kilobar pressure: phase relationships for the four bounding ternary systems, in part schematic. For sources see text. Liquids on the boundaries AB, BC and AC are  $\text{H}_2\text{O}$ -saturated. The dashed lines are located in Fig. 1. Abbreviations not explained in the text or in Fig. 1: 2L—liquid miscibility gap, Py—pyroxene, Fo—forsterite.

dashed line  $\text{Ca}_2\text{SiO}_4\text{-MgO}$  is a "thermal divide" over which liquids cannot cross during crystallization, equilibrium or fractional. The two field boundaries crossing the line (one binary and one ternary) pass through temperature maxima at the points of intersection. The probable phase relationships for the system  $\text{CaO-SiO}_2\text{-H}_2\text{O}$  are taken from WYLLIE and HAAS (1965, Fig. 4), with the primary phase field for  $\text{Ca}_3\text{SiO}_5$  being added. The probable phase relationships for the system  $\text{CaO-MgO-H}_2\text{O}$  are adapted from Wyllie (1965a, Fig. 2). The liquidus phase relationships for the system  $\text{MgO-SiO}_2\text{-H}_2\text{O}$  are schematic; the solubility of  $\text{H}_2\text{O}$  in the liquid phase of the system  $\text{SiO}_2\text{-H}_2\text{O}$  at 1 kilobar pressure is 3.8 wt. % (KENNEDY *et al.*, 1962), and it is assumed that about the same amount of  $\text{H}_2\text{O}$  dissolves in all silicate liquids of the system  $\text{MgO-SiO}_2$  at this pressure. It is also assumed, for convenience of representation, that the two-liquid field extending from the binary system terminates in a critical point at a liquid composition which is unsaturated with respect to  $\text{H}_2\text{O}$ . A similar assumption had been made in the system  $\text{CaO-SiO}_2\text{-H}_2\text{O}$  (WYLLIE and HAAS, 1965).

#### THE VAPOR-SATURATED LIQUIDUS SURFACE

A liquidus is defined as the locus of liquids that are just saturated with respect to crystals at a specified pressure. In an isobaric ternary system a liquidus is