

interpretations. But enough evidence points in the same direction to make a study of the effect of pressure on melting relations in systems of petrological interest worth while. Furthermore, an upper limit to the temperature in the mantle is set by the liquidus of whatever material is down there, for superheated liquid must either move relatively rapidly toward the surface or lose its superheat by reaction with surrounding solid material. Effects of pressure on liquidus relations must be studied in systems of moderate complexity before inferences about melting in the mantle can be drawn with any confidence. It has been found that a pressure of 20 kb produces large effects on the liquidus that could not have been predicted from data obtained at atmospheric pressure alone.

The quaternary system $\text{CaO-MgO-Al}_2\text{O}_3\text{-SiO}_2$, which contains the join $\text{CaMgSi}_2\text{O}_6$ (diopside)- $\text{CaAl}_2\text{SiO}_6$ (lime Tschermak's molecule)- SiO_2 , is of great importance, because it is sufficiently complicated to represent qualitatively the phase relations of the basic igneous rocks, particularly basalts, and rocks arising from their metamorphism. The main constituents commonly present in such rocks and absent from this quaternary system are iron in both its valence states, soda, water, and to a lesser extent K_2O , TiO_2 , and MnO . In this simplified system it is impossible to study such important relationships as the effects of the fugacities of water and oxygen or changes in composition of feldspars. Experimental difficulties occasioned by the various possible oxidation states of transition elements and the volatility of alkalis and water at high temperatures, however, are avoided. Despite the simplifications, a number of reactions of petrological importance take place in this system; because of this and its relative chemical tractability the system is well suited for a beginning to the study of complex chemical equilibria at high pressures.

Among the important phases lying in this system are the oxides spinel and

corundum, forsterite, the melilites akermanite and gehlenite, wollastonite, diopside, enstatite and its polymorphs, the aluminosilicates andalusite, kyanite, sillimanite, and mullite, the garnets pyrope and grossularite, cordierite, anorthite, and the polymorphs of silica. During the report year a new phase, with the composition of lime Tschermak's molecule ($\text{CaAl}_2\text{SiO}_6$), was synthesized for the first time at a pressure of 20 kb.

Because of the importance of this quaternary system, much previous work has been done to elucidate phase relations in it. Most were investigations of lines and planes joining two or three of the phases listed above. In this way the tetrahedron is crossed in many directions, and, given enough such studies, it should be possible to deduce with high precision the quaternary equilibrium relations at atmospheric pressure.

For initial study in this system at high pressure we selected the join diopside-anorthite. As Bowen recognized, this is a simple, pseudobinary representation of many basalts and diabases. The system was first shown not to be truly binary by Osborn (1942). We expected that the nonbinary behavior would be accentuated by pressure, and this has proved to be so. Part of the join is quaternary because of the incongruent melting of anorthite at high pressures. We have, however, only studied compositions lying in the plane diopside-lime Tschermak's molecule-silica, which contains the join diopside-anorthite.

For purposes of orientation it is helpful to consider the composition plane enstatite-wollastonite-corundum (fig. 3). All phases shown in the figure lie precisely in this plane; none are projected. Of particular interest are the intersecting joins diopside-lime Tschermak's molecule and grossularite-pyrope. The pyroxene join is characterized by complete solid solution at 20 kb; the garnet join, by complete solid solution above 30 kb. Magnesian Tschermak's molecule, shown on the diagram, has never been synthe-