

melting. In this case, the rocks that are parental to basalt must contain potassium-rich phases such as phlogopite and/or K-rich amphibole.

#### HYDROUS SYSTEMS

##### PHLOGOPITE-H<sub>2</sub>O-CO<sub>2</sub>: AN EXAMPLE OF THE MULTICOMPONENT GAS PROBLEM

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The study of phlogopite-H<sub>2</sub>O by Yoder and Kushiro (1969) revealed extensions of the stability field of phlogopite in the absence of a gas phase and documented the existence of new melting relationships of hydrous phases where gas is absent. It was suggested that melting in the mantle was best approximated by gas-absent conditions rather than gas-present conditions because of the belief that the H<sub>2</sub>O content of the mantle was very small and was mainly in hydrous minerals.

Many rocks contain other potentially gaseous components in addition to water, and it is pertinent to investigate the effects of these components on the melting behavior of hydrous minerals. For example, excluding those minerals in rock fragments adventitiously incorporated, the rock kimberlite consists primarily of olivine, phlogopite, and calcite. The presence of the latter two minerals implies H<sub>2</sub>O and CO<sub>2</sub> in the magma if such existed. Inclusions in olivine from some nodules in kimberlite contain both liquid and gaseous CO<sub>2</sub>, as well as H<sub>2</sub>O (Roedder, 1965, p. 1760, 1764). The effect of CO<sub>2</sub> on the melting of phlogopite is, therefore, relevant to the general problem of melting under conditions where the H<sub>2</sub>O pressure is less than the total pressure.

##### *Phlogopite-H<sub>2</sub>O*

The join K<sub>2</sub>O·6MgO·Al<sub>2</sub>O<sub>3</sub>·6SiO<sub>2</sub>·H<sub>2</sub>O was first restudied in the more H<sub>2</sub>O-rich compositions (Fig. 22), following the experimental procedures of Yoder and Kushiro (1969). The boundary be-

tween the forsterite (Fo)+liquid (L)+gas (G) region and the Fo+G region was delineated for  $P=10$  kb and  $T=1225^{\circ}\text{C}$ . The criterion was the presence or absence of interstitial glass, which was presumed to represent in part the more siliceous liquid phase distinct from glass spheres believed to represent a portion of the less siliceous gas phase. The relations deduced from these data are shown in projection on the plane leucite:kalsilite (1:1 mole)-forsterite-H<sub>2</sub>O. Only the gas compositions in the G region are believed to lie on the plane. The ratio of dissolved silicate to H<sub>2</sub>O in the less siliceous gas in the Fo+L+G region appears to be about 1:1 by weight, whereas the ratio of silicate to water in the more siliceous liquid phase was previously determined to be about 4:1. Partial confirmation of the H<sub>2</sub>O content of the more siliceous liquid is obtained from an examination of the inclusions in the larger forsterite crystals. Several types of inclusions were observed, which contained the following phases after quenching to room temperature and an undetermined pressure.

Most of the inclusions consisted of a glass with a very low index of refraction, containing a globule of liquid in which was suspended a small gas bubble in constant thermal motion. The relations in an exceptionally symmetrical inclusion from the Fo+L+G region are shown in the photograph of Plate 1A. Assuming that the inclusion is circular in cross-section, was entrapped at the conditions of the experimental run, and is solely representative of the total fluid phase, the volume proportions of silicate to H<sub>2</sub>O can be calculated, neglecting mutual solubility at containment conditions and diffusion through the forsterite crystal. The silicate:H<sub>2</sub>O is approximately 56:44 by volume and is approximately 74:26 by weight. In the light of the large possible errors, the agreement with the composition of the more siliceous liquid phase estimated by construction is surprising.