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EXPERMENTAL DETERMINATION OF KYANITE-SILLIMANITE EQUILIBRIUM RELATIONS AT HIGH TEMPERATURES AND PRESSURES*

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ABSTRACT. The equilibrium curve between kyanite and sillimanite has been found to lie at 18,200 bars at 1000°C and 21,000 bars at 1300°C; the kyanite field lies on the high-pressure side of this curve. Kyanite and sillimanite could not be synthesized consistently below 1000°C, and it proved necessary to extrapolate the equilibrium curve to the lower temperatures encountered in regional metamorphism. Thermochemical data suggest that a curvilinear extrapolation is required, although curvature is not demanded by the experimental points. It is concluded that the assemblage quartz plus corundum, which was formed in most of the runs, is metastable under all conditions investigated.

The results demonstrate conclusively that kyanite can be formed in the absence of shearing stress. They also suggest that horizontal gradients of temperature, pressure, or both are required to account for the distribution of kyanite and sillimanite observed in regionally metamorphosed rocks.

INTRODUCTION

Knowledge of the physical conditions existing during their formation is essential to the understanding of metamorphic and igneous rocks. Once the fields of stability of their constituent minerals are known, the possible pressures and temperatures of formation of these rocks can be inferred. The simplest diagrams of mineral stability are those depicting polymorphism in a one-component system, and two very important polymorphs in metamorphic rocks are the aluminosilicates, kyanite and sillimanite. Analyses of these minerals show that the composition of each is remarkably close to Al_2SiO_5.

The results of 55 quenching runs, made in the enlarged version of Bridgman's 30,000-bar apparatus described by Robertson, Birch, and MacDonald (1957), are reported here. Most of the data apply to that portion of the kyanite-sillimanite boundary between pressures of 18,000 and 23,000 bars and at temperatures between 1000 and 1300°C.

APPARATUS AND PROCEDURE

The apparatus is described by Robertson et al. (1957), and only recent modifications will be considered in detail here. The pressure vessel is a tapered cylinder, forced into a conical hole in supporting rings by a hydraulic ram. The pressure is generated inside the cylinder by a piston advanced by an opposing hydraulic ram. The pressure medium is nitrogen.

Charges are held in gold or platinum capsules and are heated by a furnace inside the pressure vessel. The furnace is supported in a steel or copper tube, and it plugs into insulated electrical connections at the bottom of the pressure vessel. For temperatures up to 1000°C, the furnace is wound of kanthal wire on a porcelain tube, one-quarter inch inside diameter. For higher temperatures, the winding is of platinum-10 percent rhodium wire, and the core is an alundum tube, one-eighth inch inside diameter. The use of a smaller furnace at higher temperatures prevents overheating of the inner wall of the

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