

MATERIALS AND PROCEDURES

Natural stishovite was the starting material. It was concentrated from Coconino sandstone from Meteor Crater by Fahey (1964) and most generously supplied by him. Stishovite was the only mineral detectable by x-ray diffractometry. The initial mean refractive index was 1.778 ± 0.003 and corresponds to the presence of about 4% SRO phase by weight as calculated by the method of Skinner and Fahey (1963).

Ninety runs were made in which about three mgs of stishovite were held at various p-t conditions for periods of 6 hours to 25 days. These runs can be divided into three groups. First, stishovite held over anhydrous CaSO_4 served as the "dry" starting material. Second, a mineralizer of water or a dilute aqueous solution of ammonium chloride was added to the starting material. Third, continuously oscillating shear stresses were superimposed on the opposed anvil apparatus (Dachille and Roy 1962 b) while using the "dry" starting material.

Hydrostatic and opposed anvil devices were employed to obtain a range of pressure from 1 to 110 kbars. Steel "test tube" or "cold seal" bombs (Roy and Tuttle 1956) with a water pressure medium and samples sealed in welded gold capsules were used for conditions of up to 2 kbars and 680°C . The opposed anvil apparatus provided conditions from 9 to 110 kbars and temperature to 450°C . For these runs, the sample was pelleted in a nickel ring (3/16 in. O.D.X. 0.125 in. I.D.) and sandwiched between Pt-10% Rh foil disks. The samples were "quenched" from p-t conditions by air-blast cooling of the bomb or anvils, then releasing the pressure.

Samples were analyzed for the various components by means of optical, infrared, and x-ray techniques. X-ray diffractometry was used to detect and estimate the proportions of the crystalline phases. The method described by Klug and Alexander (1954) was employed to determine the proportions of crystalline phases present in mixtures of two polymorphs.

The starting material was a powder consisting of aggregate grains. The individual crystallites in the grains of both products and reactants could not be adequately resolved with a petrographic microscope. Consequently, only the mean refractive index (n) of the grains could be determined by the Becke line method.

The infrared absorption spectra of the samples were obtained by using the KBr pellet technique for solids in conjunction with a Perkin Elmer 621 Spectrometer. A quantitative measure of the reactants was hoped for but could not be satisfactorily accomplished on account of broadness and overlap of the absorption bands. This technique was used to detect and characterize the SRO phase.

RESULTS

P-t phase boundaries of the silica system have been reported by a number of authors employing a variety of methods. Representative boundaries of interest here are plotted in Figure 1. It is obvious that agreement is not perfect; thus the transition boundaries are approximated by an area. The stippled areas are reduced to average lines in the succeeding diagrams in order to provide a background for presenting experimental results.

"Dry" System. Stishovite held over a desiccant was the starting material for these experiments. Zones based on the products of the reversal reaction of three-day duration define areas in p-t phase space and are plotted in Figure 2. Representative runs are given in Table I.

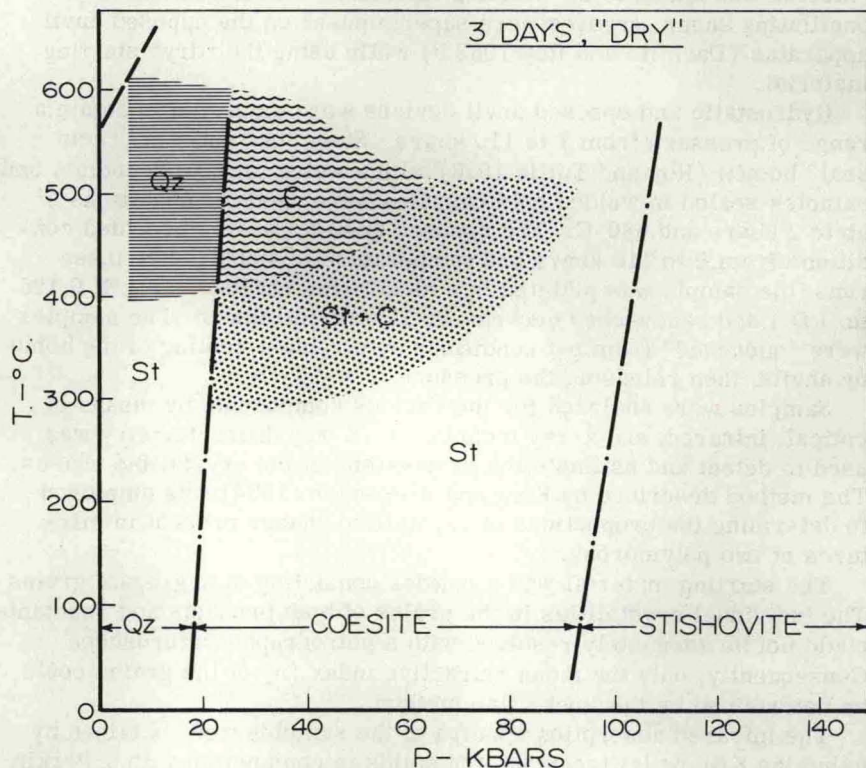


FIGURE 2—"Dry" system. Three zones which are based on the products of the reversal reactions define areas in p-t phase space. Further details are in text. The zones are: 1) complete conversion to quartz (Qz) or coesite (C), 2) partial conversion to coesite (St+C), and 3) partial conversion to SRO phase only (St). The dot-dash lines represent average phase boundaries and the equilibrium phases are indicated along the bottom of the diagram.