



Fig. 8. Isobaric curves in the Ca-rich portion of the system $\text{CaCO}_3\text{-MgCO}_3$. 1 kb, 9 kb, and 20 kb solvi are shown. One kb solvus terminates by decomposition at the dot at approximately 820°. See text and figure 7 for explanation of the curves. A thin two-calcite phase field (area 4 in fig. 7) is omitted for the sake of clarity.

positions of the phase boundaries can be seen. The calcite I-II two-phase field (area 4 in fig. 7) has been deleted for simplification inasmuch as it cannot be located precisely and has no observable effect on the solvus. The suggested melting relations have also been omitted. The configuration of the aragonite-calcite field boundary (the line between points 5 and 6 in fig. 7) was not directly determined, but its position is fixed by the location of points 5 and 6, which are well located. At rather low pressures, the upper portion of the solvus is terminated by decomposition of the carbonates (see 1 kb solvus), and the locus of all such points determines the unique polybaric solvus of figure 6.

Comparison of piston-cylinder apparatus with simple squeezer.—Many runs were made in this system with an externally heated opposed anvil device (simple squeezer) as early as 1956 by one of the present authors. Much criticism has been written of the squeezer (Kitahara and Kennedy, 1964, for example), and many of the phase diagrams based on squeezer runs, especially in silicate systems, have required revision. However, considerable studies using the squeezer for systems appear to have produced valid results (MacDonald, 1956; Goldsmith and Graf, 1960). It is of interest, therefore, to compare the present piston-cylinder determination of the phase relations with the earlier squeezer work as evidence regarding the effectiveness of the squeezer as a tool for petrologic research, at least in carbonate systems. The pure CaCO_3 calcite-aragonite curve based on simple-squeezer runs rises in pressure to about 20 kb at 800°C and is essentially coincident with the present piston-cylinder determination. The calcite-aragonite curve based on simple-squeezer runs for the CaCO_3 - MgCO_3 system is everywhere with 1 kb of the piston-cylinder determination. This curve also shows the break of slope, although at the time the experiments were made, this effect was attributed to the increasing MgCO_3 concentration in calcite with increasing temperature. Finally, considerable number of squeezer experiments made at much higher pressures to determine an effect of pressure at constant temperature on the calcite-dolomite solvus are in agreement with the piston-cylinder determination. These data constitute strong evidence that the squeezer can produce quantitatively correct results in carbonate systems. The probable reasons for better success with carbonates compared to silicates in squeezers are greater rate of reaction among carbonates and higher plasticity at elevated temperatures, which gives more uniform pressure distribution under the flat pistons.

It is essential to state how the squeezer runs were performed. A 0.005 in.-thick stainless steel containing ring was used which had an internal diameter slightly less than the $\frac{1}{4}$ in. diameter piston faces. The powdered sample was placed within the ring, and the assembly was brought to a pressure of 15 to 20 kb or higher to consolidate the sample and the gasket. The gauge pressure was then bled off to the desired nominal value. The sample was brought up to temperature, and gauge-pressure was kept constant by continual bleeding during the period of thermal expansion. It is of interest to note that the transition pressures of several metals, notably barium and cesium, determined by Bridgman (1952) at 25° in an opposed anvil device on decrease of pressure are in much better agreement with the presently-accepted values (Kennedy and LaMori, 1962) than the transition pressures found by Bridgman on the increasing-pressure cycle, which are erroneously high. It is thus possible that pressures in the opposed-anvil device can be homogeneous and rather accurately computed on the basis of geometry alone if the sample is relatively plastic and has first been pressed to elevated pressures, and the pressure released to the desired value before heating.