grains, having no relationship to the spherulitic structure, were occasionally observed in the sections.

A striking identity was noted between the structure of these concretions and an unaltered pyrite concretion from a different locality which was sectioned for comparison. The writers feel this similarity, along with the evidence presented above concerning replacement, indicates that these dahllite spherulites are pseudomorphs after pyrite.

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# THE MELTING OF CALCITE IN THE PRESENCE OF WATER AND CARBON DIOXIDE

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In the course of attempts to recrystallize calcite, it was found that the calcite could be melted at temperatures above about 900° C. in an atmosphere of water and carbon dioxide at a total pressure of 50 bars. The experiments were done in the following way. The specimen, of about 0.1 gm. weight, was wrapped in platinum foil and put in a pressure vessel, supplied by G. C. Kennedy, of approximately 1 cc. volume. A few drops of water were introduced and the pressure line was connected to a reservoir of carbon dioxide at 50 bars pressure. The pressure vessel was then put in a muffle furnace at the desired temperature. This produced an atmosphere in which the partial pressures of carbon dioxide and water totalled 50 bars but the proportions were not known. The same total pressure was maintained during the cooling of the pressure vessel.

The melting is best demonstrated with a cleavage rhomb of calcite. If this is heated under the above conditions at about 1000° C. for an hour, its original shape is lost and the material takes the shape of the enveloping platinum as if it were wetting the platinum (Fig. 1A). After cooling, a thin section of the specimen shows it to be polycrystalline, with a marked dendritic texture (Fig. 1B) which suggests that it has crystallized from a melt. An *x*-ray diffraction pattern shows no trace of CaO. Further evi-

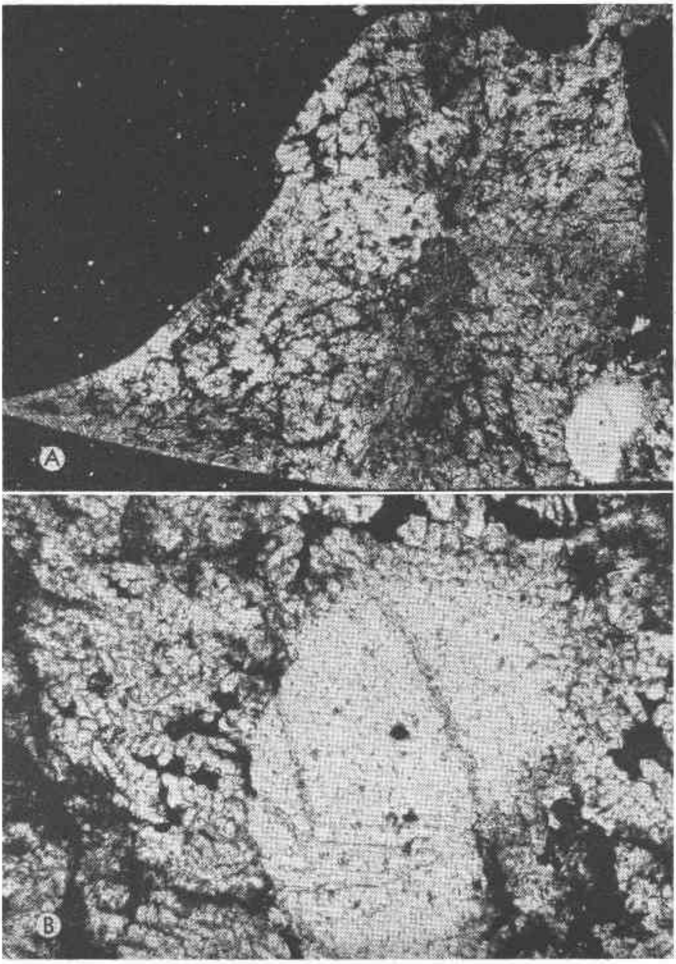

Fig. 1. Thin section of calcite after melting in the presence of $CO_2$ and water at 1000° C.
A. Complete specimen. ×12.
B. Bottom right corner of A, showing remnant of initial crystal surrounded by dendritic crystals. ×54.

dence that the calcite has been melted is obtained if the pressure is released while the pressure vessel is hot; the resulting specimen has a vesicular texture, suggesting the escape of bubbles of gas from a viscous liquid.

Melting of a thin surface layer of the calcite was apparent at temperatures down to about 900° C. under the same conditions, but very little effect was observed below 900° C. After heating at 930° C. well-formed dendrites of lengths up to 1/10 mm. were seen in cavities in the layer of material that had apparently melted (Fig. 2).

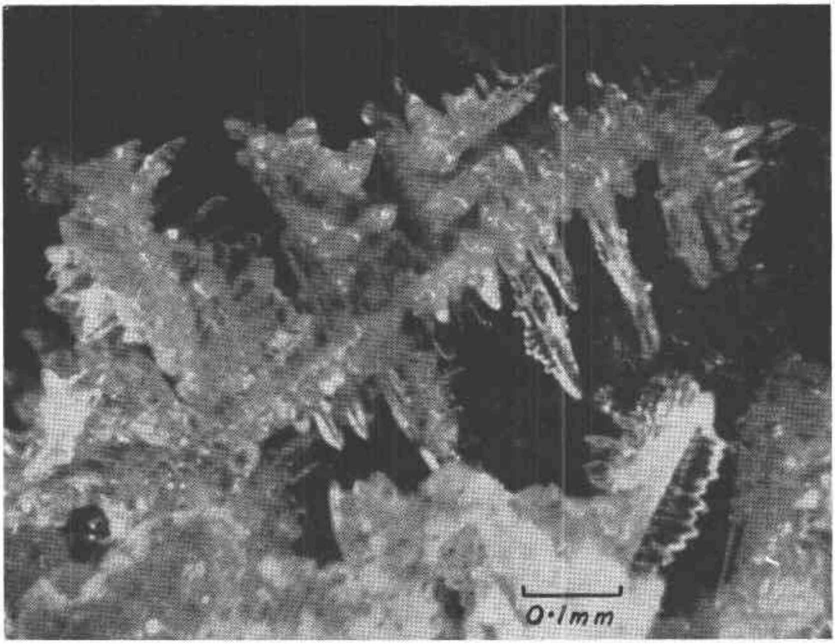

FIG. 2. Dendrites of calcite in cavity in melted and recrystallized grain. Formed at 930° C.

Since the experiments were not done in a closed system, the conditions for melting the calcite are not exactly known; it is even likely that conditions in the pressure vessel changed during the course of heating. Therefore, the principal conclusion from these experiments is the qualitative one that calcite will melt in the presence of carbon dioxide and water at quite low partial pressures and a temperature around 900 to 1000° C., that is, some three to four hundred degrees below the melting point in the presence of carbon dioxide alone (1340° C. at the dissociation pressure, Smyth and Adams, 1923). It may be noted also that in the presence of water only, at 5000 bars pressure, there is no melting up to 800° C. (Heard 1957).

The melting observed in the presence of water and carbon dioxide in the present experiments is probably the same as that observed by Sir James Hall (1812) in some of his classic experiments during 1798 to 1805. He found that the addition of water greatly helped in obtaining "fusion" of calcium carbonate at temperatures around 1000° C. It would appear that, at least in those experiments in which he intentionally added water, he was not observing fusion to a melt of pure calcium carbonate but rather to one containing water and carbon dioxide (there was also probably CaO present since he found some loss of weight of the $CaCO_3$).

The author is grateful to the Institute of Geophysics, University of California at Los Angeles, and especially to Professor D. T. Griggs and Professor G. C. Kennedy, for the use of their laboratory facilities for these experiments during the summer of 1957, and for many stimulating discussions.

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# A NEW LOW-TEMPERATURE, LIQUID HEATING STAGE*

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A new low-temperature, liquid heating stage for the study of liquid inclusions has been designed and constructed at the U. S. Geological Survey. The stage (Figs. 1 and 2) is mounted on the microscope and has an operating range of 30° to 300° C. Features of the heating stage are: (1) a totally immersed mercury thermometer, (2) a three-way adjustable crystal mount that will take a variety of attachments for holding crystals, (3) the accommodation of crystals as much as 3 inches in length, and (4) an easily controllable heating rate.

The basic construction of the heating stage is of a high-temperature resistant material composed of asbestos fibers, diatomaceous silica, and an inorganic binder. The material is light, mechanically strong, and easily fabricated. Aluminum is used as an inside shield and viewing-cell holder on the cover of the stage (Fig. 2A). Clamps for the cover and for securing the stage to the microscope are also made of aluminum. The crystal-mount assembly (B) is made of brass. The heating cell (C) is made from the bottom of a 600 ml. beaker cut to a height of 1¼ inches. An 8-mm. glass tube, 15½ inches long, is fused to the side of the heating cell. This tube is just large enough to allow the passage of a 360° C. mercury thermometer (K) graduated in degree intervals. A stiff wire attached to the thermometer and extending through a cork in the end of the tube permits the thermometer to be moved in and out of the heating cell.

The glass viewing cell (D), 45 mm. outside diameter by 35 mm. deep, was specially made with an optical-glass bottom for maximum visibility. A 50-ml. beaker cut to a height of 35 mm. and ground and polished on

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