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DEFORMATION OF YULE MARBLE: PART IV—EFFECTS AT 150°C.

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ABSTRACT

Yule marble has been experimentally deformed at 150°C under conditions otherwise identical with those at room temperature reported in Part I. The strength is lowered about 40 per cent by this increase in temperature, and the relative ease of translation versus twinning on {01$\bar{1}$2} is increased. Fabric measurements on the deformed material show trends nearly identical with those at room temperature (Part III). The individual grains are more homogeneously deformed, and, perhaps as a consequence, the fabric changes appear to be somewhat more sharply defined. Effects of interstitial water and of slow rate of deformation are negligible except for a lowering of strength similar to that observed at room temperature. The fabric changes are completely consistent with those predicted in Part II under the hypothesis of homogeneous deformation. By all tests applied, the mechanism of deformation is thus the same as at room temperature, and is dominantly twinning and translation on {01$\bar{1}$2}. The observed lowering in strength and greater homogeneity of texture suggest an approach to conditions of natural deformation.

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INTRODUCTION

Parts I, II, and III of this paper (Griggs and Miller, 1951; Handin and Griggs, 1951; Turner and Ch'ih, 1951) described the physical properties and fabric changes in Yule marble deformed dry, at room temperature, under 10,000 atmospheres confining pressure. Taylor's hypothesis of homogeneous deformation was shown to be consistent with the observations. The high stresses, low temperature, and unnatural texture of the deformed material made it seem unlikely that these observations and this hypothesis would apply to naturally deformed marble. Accordingly, additional studies are being made in an attempt to approach more nearly the natural environment and phenomena. This paper reports the first step—an increase of temperature to 150°C, and the addition of interstitial water. All other conditions remain the same.

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Experiments

Apparatus

The apparatus used in these experiments is identical in principle and similar in design to that described in Part I. The high-pressure cylinder containing the specimen is heated by an external furnace, and is designed to minimize temperature gradients insofar as practicable. The temperature is controlled by a thyratron regulator, using a separate resistance winding as a sensing unit. The temperature of the cylinder is measured by a thermocouple deep in the cylinder wall. The difference between the cylinder temperature and the specimen temperature was determined in a mock-up at low pressure, with a second thermocouple in the place normally occupied by the specimen, and with all the rest of the apparatus the same. This difference is 8°C at 150°C, 15°C at 300°C. During a run the cylinder temperature varies less than 1°C on the average.

The specimen assembly is identical to that described in Part I. Pressure, force, friction, and piston displacement are measured, calibrated, and reduced as described in Part I. Experimental accuracies are about the same, but the reproducibility of the stress-strain curves is not so good. The average deviation from the mean is about 5 per cent as compared to 3 per cent in Part I. This is supposed to be due to the greater importance of undetermined variations in friction on these weaker specimens.

Procedure

The assembly is first brought to the operating pressure, then heated. Two hours is required for the cylinder to come to thermal equilibrium. The test run is then made as described in Part I, either in extension or compression. The pressure is then reduced and the furnace turned off. Cooling takes about 2 hours. The whole run thus takes about four times as long as a room-temperature test.

For tests with interstitial water, the copper jacket is soldered to the two end pieces (*see* Part I, Fig. 2) leaving a small vent hole. The assembly is then filled with water (or other fluid) under vacuum, and the vent soldered shut. Since some water boils off while the vent is being soldered, there is no means of determining the exact amount of water before an experiment. After an experiment the specimen is removed from its jacket and weighed immediately. It is then heated to 150°C for 3 hours to evaporate the water, and weighed again. The difference in weight is taken to be the weight of the interstitial water present. Subsequent heating for longer periods showed no further change in weight.

Since the amount of water present, and hence its pressure under the test conditions, cannot be accurately determined in advance, it is generally impossible to perform extension tests with water present. When the water pressure exceeds the difference between the confining pressure and the longitudinal stress, the end