tinguish the positive and negative unit rhombohedra, r $\{10\bar{1}1\}$ and z $\{01\bar{1}1\}$ respectively, and also to detect the presence of twinning (on the Dauphiné or Brazil laws) at the surface of the crystals. Twinned crystals were rejected. The etch-pits revealed the "hand" of the crystals and the orientation and polarity of the a-axes. The cylinders were marked in such a way that their orientations were fully known from the markings.

Eight orientations of cylinders, designated $\|c$, $\perp r$, $\perp z$, $\perp m$, A, B, C, and D (fig. 3), were used. The axes of all the cylinders lie in a plane normal to one of the a-axes; they are inclined to the c-axis at the angles shown in figure 4. One end of each cylinder was marked with an arrow parallel to an a-axis and pointing to the positive end of this a-axis. Another arrow inscribed on the cylindrical surface, parallel to the cylinder axis, in a position corresponding to the point of the arrow on the end of the cylinder (see fig. 5); the longitudinal arrow was marked with the direction of the cylinder (c, r, z, m, A, B, C, or D) and a^+ to indicate that the positive end of the a-axis emerges on this side of the cylinder. This convention has the advantage that all the cylinders carry analogous but distinctive markings, and the orientation of a cylinder is known if the marking on either the end or the side of the cylinder survives the experiment.

After deformation the jacketed samples were removed from the bismuth. They generally retained their cohesion, though planes with displacements were visible in the copper jacket (pl. 1A). The jackets were perforated or partially removed, and the samples were impregnated with and embedded in a clear thermo-setting plastic to prevent disintegration during the preparation of thin sections. The sections were prepared, with one of two orientations (see below) from each of the deformed cylinders.

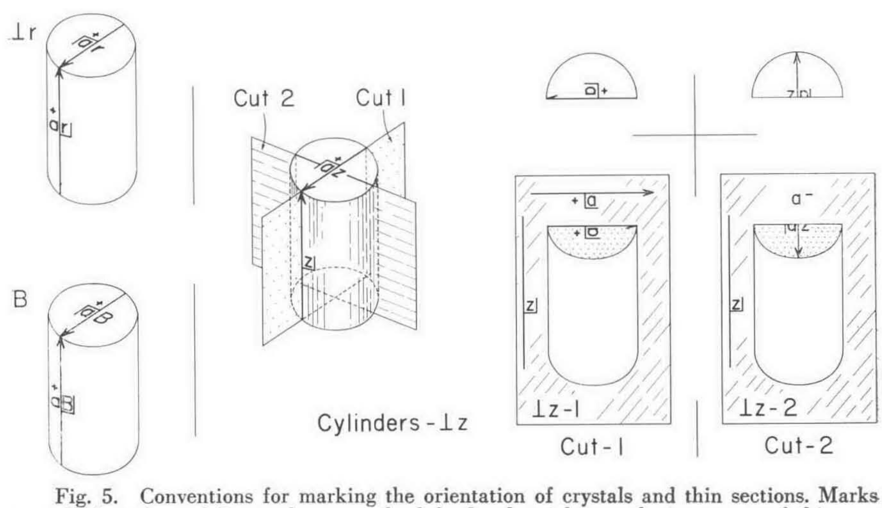

Fig. 5. Conventions for marking the orientation of crystals and thin sections. Marks on cylinders $\perp r$ and B are shown on the left. On the right are the two types of thin section cut from a $\perp z$ cylinder and the stages in the preparation and marking of the thin section: top, half of the cylinder ground away; bottom, the half-cylinder mounted on marked slide ready for grinding and finishing.

The convention for sectioning and marking the orientation on the thin sections (fig. 5) is the same for cylinders of all orientations. The two orientations of thin sections are designated *1-cut* (parallel to the cylinder axis and parallel to the *a*-axis arrow) and *2-cut* (parallel to the axis of the cylinder and perpendicular to the *a*-axis arrow). The selection of section-plane for any specimen depended on the orientation of the planes of displacement visible on the copper jacket; the specimens were sectioned so that the main shear-planes would be almost perpendicular to the section. Half of the cylinder and plastic mount were ground away in the manner illustrated (fig. 5), and the half-cylinder was cemented to a slide as shown. Care was taken that in all 1-cut sections the slide would be viewed on the microscope stage with the positive end of the *a*-axis distinguished (to the right) and in all 2-cut sections, the slide would be viewed from the positive to the negative end of the *a*-axis. By following this convention it is possible to index any planar structures of rational orientation present in the deformed samples (subject to small errors inherent in the sectioning operations, which may be determined in part and are discussed below).

Petrographic examination of the samples.—The thin sections were placed on a four-axis universal stage on a polarizing microscope, and the structures in them were examined in detail in transmitted light. Since one of the objectives of the study was to try to reproduce the structures found in naturally deformed rocks, such as undulatory extinction and deformation lamellae, a very careful search was made for these features.

EXPERIMENTAL RESULTS

The ultimate strengths of the quartz cylinders were determined, by the method outlined above, for all the samples in which the records showed clearly that the deformation began and proceeded to rupture within the range of the two bismuth transitions. These are listed in table 1. The confining pressure is represented as the least principal stress (σ_3), and the total axial stress on the sample as the maximum principal stress (σ_1). This convention, in which a compressive stress is considered positive, is that usually used by geologists.

The larger samples used in the first experiments showed considerable variation in the axial stress at rupture, but reduction of the data showed that most of these had failed at confining pressures above 27 kb. The strengths of the smaller cylinders, all of which failed in the BiII $\rightleftarrows$ BiIII transition at 27 kb, showed much better reproducibility. For this reason rupture strengths are reported only for the second group of samples. Petrographic studies have been

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PLATE 1

A. Components of equipment and sample assembly. In front of the pressure vessel are, left to right, the piston, two deformed samples in copper jackets, an undeformed sample, carbide endpiece, copper jacket, bismuth slug, and steel packing.

B. Thin section of a large crystal compressed normal to *z* (759), showing development of main fault parallel to the base and subsidiary sets of rhombohedral faults (*r*). Plane-polarized light.

C. Thin section of a large crystal compressed parallel to B (765), showing two sets of rhombohedral (*r*) faults more or less equally developed. Between crossed polarizers.