Figure 10. The orientation diagram for [0001] axes (Fig. 10A) is based on measurements of the mean position of the optic axis in each of 100 grains[5] (in every grain the crystal struc- axis of compression, and orientation of *s* surfaces of shear are seen in "moderately strained" specimens compressed at 45° to the initial foliation. (*Cf.* Plate 2C, and Figures 7C and 8C.)

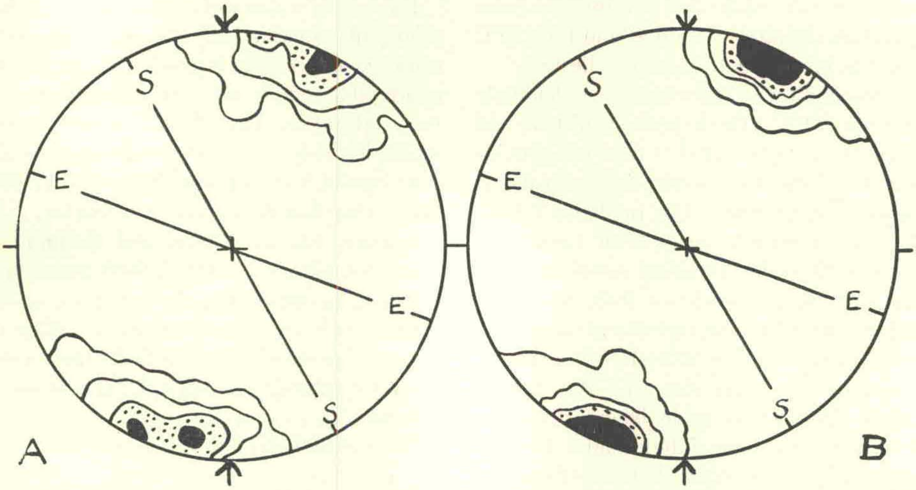

Figure 10.—Orientation Diagrams for Highly Deformed Yule Marble Deformed at 300°C

Specimen 400 (*1* cylinder) shortened 37% by compression (indicated by arrows) applied normal to initial foliation. SS = shear zone. EE = mean direction of elongation of grains.

A. 100 [0001] axes in 100 grains. Contours 1%, 5%, 10%, 15%, per 1% area. B. 103 poles of prominent {0112} lamellae in 100 grains. Contours 1%, 5%, 10%, 20% per 1% area. Maximum concentration, 40%.

ture is so strained that the position of [0001] varies through a range of 10° or more). Orientation of strongly developed nontwinned $\{01\bar{1}2\}$ lamellae in the same grains is illustrated in Figure 10B. Both diagrams give a very strong maximum coinciding with the pole of the new foliation plane EE, though the lamella-pole maximum is the sharper and stronger of the two. Thus there is a very pronounced tendency for both [0001] and the normal to visible nontwinned $\{01\bar{1}2\}$ lamellae to lie at a high angle (approaching 90°) to the AB plane of the strain ellipsoid of marble deformed by combined shear and compression under the conditions of this particular experiment. This AB plane (EE of Plate 5 and Figure 10) occupies a position between the plane of shear SS and the plane normal to applied compression. Similar relations between grain elongation, orientation of [0001], parallel alignment of $\{01\bar{1}2\}$ lamellae,

[5] These grains lie on three widely separated traverses across the shear zone SS. Half of them lie within the area embraced by Plate 5B. In comparing Figure 10 with Figures 7B and 8B, note that the contour intervals are different.

Two possibly significant analogies are noted in conclusion. Single crystals of calcite deformed by compression, either parallel to [0001] at 20°C or normal to $\{01\bar{1}2\}$ at 300°C, develop undulatory extinction bands bounded by $\{10\bar{1}1\}$ surfaces and crowded internally with nontwinned $\{01\bar{1}2\}$ lamellae. Many natural marbles are composed of strongly elongated grains of calcite whose parallel alignment defines a single prominent foliation. In some such rocks [0001] is strongly concentrated in the vicinity of the pole of the foliation plane, and there is a similar maximum for poles of nontwinned sets of $\{01\bar{1}2\}$ lamellae. The pattern of such fabrics is in many ways similar to that just described for our experimentally deformed specimen. To assume that simple compression normal to the foliation is necessarily responsible for natural marble fabrics of this general type is obviously unwarranted.

Conclusion

The most pronounced difference between Yule marble deformed at 300°C and that deformed at room temperature and at 150°C is the microscopic appearance of thin sections of the deformed material. These differences can most aptly be summarized by saying that the marble deformed at 300°C looks like naturally deformed marble, while that deformed at room temperature definitely does not, and the 150°C material is intermediate between the two.

The mechanism of deformation is definitely different at 300°C. The hypothesis of twin and translation gliding on $\{01\bar{1}2\}$ does not provide correlation of the stress-strain data as it did at the lower temperatures. The predicted fabrics of Part II, however, agree with those here observed within the statistical sampling error.

The microscopic evidence indicates intergranular motion in these experiments at 300°C. The development of intergranular slip surfaces, the reduction in grain size, and the lack of marginal distortion at grain boundaries leave little doubt that some intergranular flow or recrystallization has occurred. These effects are most pronounced in the specimen deformed 37 per cent in 48 hours.

Preliminary studies of single crystals of calcite deformed at 300°C indicate that translation on $\{10\bar{1}1\}$ is the most important mechanism in addition to twinning on $\{01\bar{1}2\}$. This translation can be distinguished only with difficulty under the microscope, so that while the evidence from fabric studies of Yule marble deformed at 300°C does not prove that $\{10\bar{1}1\}$ translation is important, it is consistent with such an interpretation.

It is concluded that three mechanisms of deformation are roughly of equal importance at 300°C: (1) twin gliding on $\{01\bar{1}2\}$; (2) translation gliding on $\{10\bar{1}1\}$; and (3) intergranular flow (recrystallization). The first mechanism is most important in reorienting fabrics initially so oriented as to favor twin gliding. The last two mechanisms produce smaller changes in crystallographic orientation for a small amount of deformation, but predominate at high deformations.

The trend of fabric changes is similar to that observed at room temperature and at 150°C. In orientation diagrams for fabrics formed by uniaxial compression or extension, *c*-axes maxima and *e*-lamella-pole maxima tend to occur at the point of emergence of the compression axis or within a girdle normal to the axis of extension. In addition, diagrams for fabrics developed by deformation involving shearing strain at 300°C have *c*-axes maxima and *e*-lamella-pole maxima tending to coincide with the pole of the AB (largest) plane of the strain ellipsoid.

Interstitial water seems, as at 150°C, to have principally mechanical effects. There is no evidence as yet that interstitial water has any appreciable effect on intergranular flow or recrystallization. The effect of time, or rate of strain, has not been strictly segregated in these experiments, but it appears likely that at 300°C longer time favors intergranular motion.

Granite, basalt, dunite, and dolomite are somewhat plastic at 300°C, 5000 atmospheres confining pressure. For short periods of time granite and basalt will support differential compressive stresses some 5 times their normal laboratory strength as measured at atmospheric pressure.

Work at 400 and 500°C is now under way.

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