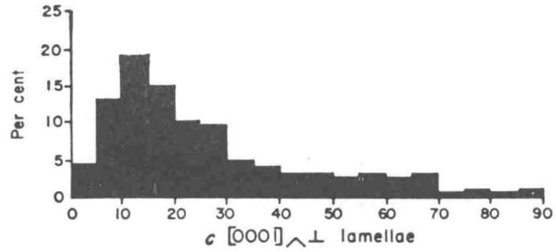
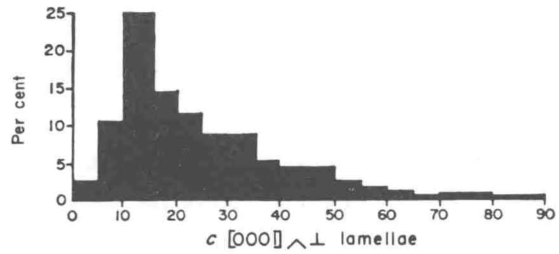


(a) COMPOSITE DIAGRAM FOR 2471 LAMELLAE



(b) COMPOSITE DIAGRAM FOR 457 LAMELLAE
IN SIX SECTIONS
ORISKANY SANDSTONE

Fig. 39—Histograms showing the orientation of quartz deformation lamellae with respect to the c_V in host grains (from Hansen and Borg, Ref. 120, Fig. 1). (a) Composite histogram compiled from previous literature: 775, Christie and Raleigh (1959); 885, De (1958); 102, Saha (1955); 373, Ingerson and Tuttle (1945); 336, Fairbairn (1941). Sources cited by Hansen and Borg, Ref. 120. (b) Histogram for the Oriskany sandstone studied by Hansen and Borg.

Brace,[139] and Christie and Raleigh[140] have suggested that the lamellae are a result of gliding mechanisms. Ingerson and Tuttle (Ref. 130, p. 105), on the other hand, concluded that the lamellae are not controlled by definite crystallographic planes or zones in the quartz structure and that they are "apparently controlled almost entirely by the stress pattern which determined the fabric of the quartz in the rocks." Riley,[141] Turner,[2] and Weiss[116] suggested that the lamellae are only partially controlled by the structure of quartz and that they are formed late in the deformation history. Bailey _et al._[142] found that grains with deformation lamellae have Laue photograph patterns that are somewhat more disturbed than those from grains with no lamellae, but they found no evidence to establish whether or not the lamellae represent gliding planes. The controversy seems to center mainly on whether the lamellae are caused by intracrystalline gliding or by fracture.

Attempts to produce this feature experimentally have only recently been successful. Work on quartz sand and on quartz single crystals[143-146] has produced deformation lamellae and provided a better understanding of their genesis. The sand specimens, compressed at confining pressures from 12 to 50 kb and temperatures from 25° to 700°C, contain abundant undulatory extinction, deformation bands, and deformation lamellae. Lamellae occur in over half the grains and at low angles to {0001}. Their inclination to the load axis indicates that they formed in planes of high shear stress with about as many inclined at < 45 degrees to σ, as at > 45 degrees to σ.[146] All the single crystals deformed at confining pressures of about 15 kb and at temperatures between 300° and 1500°C contain deformation lamellae. The lamellae are almost parallel to {0001} in those crystals compressed so that there was a high shear stress on {0001}. In crystals compressed along a line parallel or perpendicular to {0001}, the lamellae developed at angles from 30 to 60 degrees to {0001}, but always in planes of high resolved shear stress. Subsequent studies show conclusively that these artificial deformation lamellae result from translation gliding on {0001} with an a axis as the glide direction.[145]

<u>Dynamic Interpretation of Quartz Deformation Lamellae</u>. Even if natural deformation lamellae result from translation gliding, they can not be dynamically interpreted as, for example, calcite twin lamellae because the gliding direction (an a axis) cannot be located optically in quartz. Also there would be difficulties in establishing the sense of shear.* It is possible, however, to draw dynamic inferences from their orientation pattern in naturally deformed rocks based on their experimentally determined formation in planes of high shear stress

*Recently, Carter, Christie, and Griggs[146] have shown experimentally that the more deformed parts of kink bands and zones of undulatory extinction in quartz contain more abundant and closely spaced near-basal lamellae (the active slip plane) than the less deformed parts. They point out that a sense of shear can be established for the lamellae from consideration of the sense of external rotation within the kink bands or within zones of undulatory extinction.