one of the first investigators, did not exhaustively describe all types of tectonic quartz deformation structures later found. For pioneering studies see ZIRKEL (1893). A compilation of the literature up until 1959 is given by CHRISTIE and RALEIGH (1959).

Böhm lamellae appear in thin sections as fine striae or lamellae which are darker or different in brightness from the surrounding quartz. The following description by CHRISTIE and RALEIGH (1959) summarizes the numerous observations of previous authors:

"They are narrow, subplanar structures which occupy a part or the complete area of a grain and generally are only found with one orientation in any grain. They are not all structurally similar when seen under the highest magnification available: some consist entirely of minute brownish inclusions concentrated in planar zones; others cannot be resolved into individual inclusions and apparently have a different refractive index from the host grain; still others, intermediate between these two types, show a slight difference of refractive index and yet appear to consist in part of planes of inclusions. Although the lamellae are gently undulating they may all be measured by the U-stage . . . Many of the lamellae have an extinction position which is slightly but markedly different from that of the neighboring part of the host grain. These lamellae are very conspicuous between crossed Nicols, particularly when the grain is closely to the extinction position. The differences in the extinction position between lamellae and host grain are generally less than 3°." The brownish inclusions are supposed to be cavities filled with gas or liquid.

Somewhat similar to Böhm lamellae are deformation bands which are considerably broader than lamellae and bounded by fractures which are not distinclty planar and the orientation of which cannot be accurately measured. Lamellae and deformation bands occurring in the same grain, are parallel and have probably the same origin (WEISS, see CHRISTIE and RALEIGH, 1959).

Böhm lamellae are arranged in parallel sets which do not transgress grain boundaries. Most commonly one set per grain exists, rarely more than two. The individual planes are not exactly parallel to each other and generally they show a wave-shaped bending. Very often zones of undulatory extinction extend perpendicular to these planes, indicating that gliding occurred parallel to the planes of Böhm striation combined with folding (undulatory zones).

Recently CARTER and FRIEDMAN (1965) gave a different description of quartz lamellae observed in a folded calcite-cemented sandstone. In this particular rock three types of deformation lamellae were distinguished:

Type I. In bright field illumination: fuzzy platelets or lenticles, 0.5 to 2 microns thick, brighter than the host quartz when in focus, extinguishing within less than one degree of rotation from the adjacent quartz. In phase contrast illumination they are much more prominent when the incident light vibrates parallel to n_e of quartz rather than n_0, characterized by a sharp planar discontinuity, being dark on one side respectively brighter on the other, thus indicating higher indices and birefringence than the host quartz on one side (dark side) of the discontinuity and lower indices and birefringence on the other side.

Type II consists of very minute brownish cavities or inclusions, showing little or no change in indices of refraction or birefringence.

Type III is intermediate between I and II. Differences in indices of refraction and birefringence between lamellae and host quartz appear to decrease with increasing numbers of the cavities or inclusions.

All investigators of Böhm lamellae agree to attribute them to gliding processes caused by tectonic stress. Investigations by CHRISTIE and RALEIGH (1959), NAHA (1959), HANSEN and BORG (1962), SCOTT, HANSEN and TWISS (1965), CARTER and FRIEDMAN (1965) and others confirmed earlier studies that a strong relation exists between the orientation of quartz lamellae and the principal stress axes of the deformed rocks.

The planes of Böhm lamellae cluster parallel to planes of maximum resolved shear stress. They are most abundant in planes inclined at slightly smaller angles than 45° to the axis of maximum compressive stress. The lamellae are interpreted as

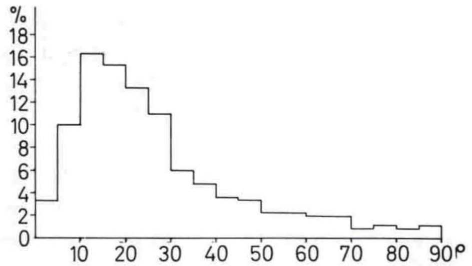

Fig. 17. Böhm lamellae. Frequency distribution of 3835 measured angles between normals to Böhm lamellae and c-axis of quartz grains from seven different sources, measured by several authors. (After CARTER and FRIEDMAN, 1965)

traces of slip causing internal rotation either of the entire quartz grain or most commonly of confined domaines. These zones have been rotated with respect to the surrounding crystal and appear as zones of undulatory extinction or when sharply confined as deformation bands. Because most lamellae are inclined at small angles to (0001), slipping tends to move the c-axis of quartz towards the axis of maximum compressive stress.

Fig. 17 shows the frequency distribution of 3835 measured angles between the quartz c-axis and normals to Böhm lamellae, according to a compilation of CARTER and FRIEDMAN (1965) summarizing the results of seven investigations of various rock types (CHRISTIE and RALEIGH, 1959; DE, 1958; SAHA, 1955; INGERSON and TUTTLE, 1945; FAIRBAIRN, 1941; HANSEN and BORG, 1962; CARTER and FRIEDMAN, 1965).

Most lamellae are inclined at angles between 10 and 30° to the optic axis, a prominent maximum being between 10 and 20°. There is considerable uncertainty as to the degree of crystallographic control of the Böhm lamellae. FISCHER (1925) and earlier investigators assumed orientation parallel to (0001), $(10\bar{1}1)$, $(01\bar{1}1)$ and flatter rhombohedra. SANDER (1930) attributed his lamellae to $(10\bar{1}3)$ and $(10\bar{1}2)$. HIETANEN (1938) considers gliding along (0001) and rupturing parallel to c as the responsible process for quartz deformation in Finnish quartzites. Though occasionally particular sets can be identified with low index lattice planes of quartz, no crystallographic quartz plane matches with the 10—20° maximum of Böhm lamellae (Fig. 17). Furthermore, the smooth frequency distribution of lamellae poles without prominent peaks presents no convincing evidence for any crystallographic control.