MICROSCOPIC LAMELLAR DEFORMATION FEATURES IN QUARTZ FROM DIFFERENT GEOLOGIC ENVIRONMENTS. J. Alexopoulos, Dept. of Geology, Univ. of Ottawa, Ottawa, Canada K1N 6N5, R.A.F. Grieve and P.B. Robertson, Geophysics Division, Geological Survey of Canada, Ottawa, Canada K1A 0Y3

The occurrence of crystallographically oriented microscopic planar deformational features in quartz from Cretaceous/Tertiary (K/T) boundary samples has been presented as further evidence that the K/T boundary layer is associated with a large impact event (1). This interpretation has been challenged by Carter et al. (2), who concluded that extreme shock pressures produced by the endogenic process of explosive volcanism can result in the formation of equivalent deformational features. As knowledge of the geologic processes responsible for the K/T event is of considerable interest, we have attempted to address these apparently conflicting conclusions through detailed petrographic and universal stage observations on deformational features in quartz from various geologic environments.

Seventy-five sets of intersecting planar features were measured in 20 quartz grains in a sample from the Lake Mistastin, Labrador, impact structure. The ω {1013} and π {1012} crystallographic orientations were prominent in 90% of the grains. These intragranular lamellar features are distinctly planar, well defined, straight, sharp and mainly continuous. They occur in multiple sets of 3 or 4 per grain, extend across the entire grains and have a narrow regular spacing of ~ 2μm and strict parallel alignment. Typical development is shown in Fig. 1.

Quartz grains from K/T boundary clay, Scollard Canyon, Alberta, display planar deformational features that closely resemble those observed at Mistastin. They are equivalent in optical appearance, such as definition, continuity, sharpness, parallelism of planes, and in their preferred ω and π crystallographic orientations. Again they occur in multiple sets with a narrow spacing of 2-3μm and cross entire grains. According to the scheme of (3), these planar feature record shock pressures of up to 23 GPa. Their characteristic appearance is shown in Fig. 2.

Eleven sets of lamellar features were observed in seven quartz grains from one of 12 tuff samples from the Toba caldera, Sumatra. The features are distinctly different from those produced by impact (cf Fig. 3 and 1,2). Although they are moderately well-defined, they are slightly curved, with indistinct margins, often discontinuous, with irregular, narrow spacing of ~ 10μm and a sub-parallel alignment within each set. In contrast to the Mistastin and K/T planar features, 75% of these features extend only 25 - 75% of the way across the quartz grains. Although orientations within 5° of ω and π can be found, there are others without obvious crystallographic constraint. The exact crystallographic orientation of these features is sometimes ambiguous because of their curved nature and overall lack of sharpness. Multiple sets are uncommon. The deformational features observed at Toba are qualitatively similar to those present in samples from the Shanghewan structure, China. Although this structure has been attributed to meteorite impact (4), the lamellar features do not meet our criteria for impact produced planar features. Numerous samples from the Bishops Tuff, western USA, showed no evidence of lamellar deformation features in quartz.

Observations and measurements were made on 12 sets of lamellar deformation features from 10 grains from the Salmon Fork craterform structure, Alaska. Their poor definition, curved nature, lack of sharpness, discontinuity, irregular spacing of 10μm or greater and sub-parallel alignment,

gives these features an indistinct appearance, as illustrated in Fig. 4. Again, although some orientations are within ±5° of ω planes, only ~50% of the planes cross entire grains and single sets are the rule.

Deformational features in quartz in an ophiolite sequence from the Caribbean have resulted from tectonic deformation. Twenty-one sets of features from 18 grains are similar in appearance and crystallographic orientation to those observed from the Salmon Fork samples. Seventy percent of the features, however, cross entire grains.

From microscopic observations performed on lamellar deformational features in quartz grains from these various geologic environments, we conclude that the appearance and orientation of planar features from a known impact structure and those observed in samples from the K/T boundary are essentially identical. Although other lamellar deformational features in quartz can result from other geologic processes, they only superficially resemble those from the K/T boundary and those believed to have resulted from impact. They differ principally in their poor and indistinct appearance, and often cross only part of a grain. Their slightly curved nature makes orientation measurement difficult, and even when they have orientations similar to ω and occasionally π planar features, they have a relatively wider spacing, and there is seldom more than 1 set.

REFERENCES (1) B.F. Bohor, et al., Science, 224, 867-869, 1984. (2) N.L. Carter et al., Geology, 14, 380-383, 1986. (3) P.B. Robertson, and R.A.F. Grieve, Impact and Explosion Cratering, p. 687-702, Pergamon, 1977. (4) Wu Siben, Beijing, (pers. comm.).

Fig. cap: Photomicrographs of lamellae in quartz. (see text for details). All x polars, fields of view (1) 0.31 mm (2) 0.31mm, (3) 0.21mm, (4) 0.12mm.