PLANAR MICROSTRUCTURES (LAMELLAR SUBGRAINS) IN FELDSPAR FROM THE CHICXULUB IMPACT STRUCTURE

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Introduction: Planar deformation features (PDFs) in quartz are one of the most reliable indicators of shock metamorphism, and are useful both in identifying new impact craters and in constraining the pressures to which rocks were exposed during impact [e.g., 1 and references therein]. In contrast to quartz, planar microstructures are a pre-shock characteristic of most feldspar group minerals, therefore great care must be taken to distinguish shock-related microstructures (such as PDFs) from those formed prior to impact such as exsolution lamellae, veins, cleavages, and twin planes [e.g. 2]. We investigated the microstructures of Or-rich alkali feldspar phenocrysts from granitoid rocks recovered from the peak ring of the Chicxulub impact structure during the recent IODP-ICDP Expedition 364 [3].

Methods: We studied grains in polished thin sections using light microscopy, secondary electron microscopy (SEM), and transmission electron microscopy (TEM); electron-transparent foils for TEM work were prepared using the focused ion beam (FIB) technique. All of the analytical work was undertaken at the University of Glasgow (UK).

Observations: Individual alkali feldspar phenocrysts are ~2-3 cm in size, and often rimmed by plagioclase. They are untwinned, but display microtextures that are characteristic of Or-rich alkali feldspars from undeformed igneous rocks, i.e., albite exsolution lamellae and veins of patch perthite comprising a micropore-rich mosaic of subgrains of Ab- and Or-rich feldspar [4]. Additional semi-planar microstructures are pronounced in the phenocrysts, and the surrounding plagioclase. These microstructures are typically sub-micrometer in width, and in any one grain are frequently developed in more than one orientation. The angle of intersection between the two main sets is ~85°, however there are at least two additional sets that intersect at lower angles (~30°-60°). Optically, the two main sets appear to be parallel to exsolution and twin lamellae in some grains, and sub-parallel to cleavage planes in others. TEM work was conducted on a foil cut and extracted from a set of planar microstructures that is oriented roughly parallel to – but distinct from – exsolution lamellae. These planar microstructures comprise sub-micrometer wide subgrains with low angle semicoherent boundaries that are parallel to the trace of {110}. Subgrain boundaries are neither straight nor consistently spaced (spacing varies from 0.2-0.6 µm within one subgrain), and there is no evidence for glassy material. Subgrains are absent from veins of patch perthite, which may mean that the fluid-mineral interaction that was responsible for forming the patch perthite postdated shock metamorphism.

Discussion: The planar microstructures resemble strain-induced semicoherent twins, but they are too closely spaced and too narrow to be twins. They likewise show no chemical variation and are therefore not exsolution lamellae. As they appear to be different to microstructures that characterise unshocked feldspars, we suggest that these very narrow subgrains were likely generated by the impact event, but are distinctive from PDFs as they are not straight and preserve no evidence of amorphous material. Work is continuing to determine the microstructure and crystallographic orientation of the other sets of planar elements within these samples.

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