

# Universal Stage Determination of Crystallographic Orientations of Planar Deformation Features In Quartz: Quality, Precision, Repeatability, and Representativeness of Measurements

FERRIÈRE, Ludovic<sup>1</sup>, MORROW, Jared R.<sup>2</sup>, AMGAA, Tsolmon<sup>1</sup>, and KOEBERL, Christian<sup>1</sup>, (1) Department of Lithospheric Research, University of Vienna, Althanstrasse 14, Vienna, A-1090, Austria, ludovic.ferriere@univie.ac.at, (2) Department of Geological Sciences, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-1020

Universal stage (U-stage) analysis is a standard technique used for determining crystallographic orientations of shock-induced planar deformation features (PDFs) in quartz. The detection and orientation of these are crucial evidence confirming the impact origin of suspect structures. However, quality, precision, repeatability, and representativeness of measurements have not been thoroughly tested. To evaluate these, crystallographic orientations of a maximum number of PDF sets within ~50-100 shocked quartz grains, in thin sections from Bosumtwi crater (Ghana) and Manson crater (Iowa), were independently analyzed by three operators with different experience, using a U-stage microscope and following previously published measurement and indexing techniques. The analyses were “blind”, in that the operators had no prior knowledge of grains measured by the others.

Results on the frequency% distribution of indexed PDFs show that no major difference occurs from operator to operator; the average standard deviation on measurements between the three operators being only 1.2%, with a maximum standard deviation of 4.1%. For the relative proportion of unindexed planes, observer ability had an influence, as only ~7-8 relative% of the planes measured by two experienced operators were unindexed, whereas the inexperienced operator reported 12-15 relative% unindexed planes. For each section, number of PDF sets per grain varies from operator to operator. However, this variation, which does not exceed ~20%, is not directly influenced by observer experience and is probably related to localized sample heterogeneity or unintentional selection of more heavily shocked grains. This study shows that it is critical that published PDF orientation histograms clearly define what frequency measurements are used, i.e., relative or absolute frequency, whether or not unindexed PDF sets are included in frequency calculations, and numbers of grains and plane sets analyzed. This is essential for comparing datasets from different studies or from different workers examining the same samples.