X-RAY DIFFRACTION POWDER PATTERNS AND THIN SECTION OBSERVATIONS FROM THE SIERRA MADERA IMPACT STRUCTURE.

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Introduction: X-ray powder diffraction (XRD) analysis of carbonate and siliciclastic samples from the Sierra Madera structure indicates moderate shock pressures (8 to 30 GPa) were generated during the formation of this crater. Three sets of samples (quartz-rich, carbonate-rich and impact generated) are being analyzed using a method developed by Skála and Jakeš [1]. These same three sample groups are also being studied using microscope thin sections to visually identify deformational features.

Sampling Procedures and Set Up: Samples of the sandstone members of the Permian Word Formation and Gilliam Limestone, Cathedral Mountain Formation and the Basal Cretaceous sandstone were collected from the central uplift of the structure. The Basal Cretaceous sandstone also was sampled on the crater rim.

Carbonate-rich rocks were sampled from the Permian Hess and Word Formations, Gilliam and Tessey Limestones. All carbonate-rich samples were collected from within the central uplift of the structure.

Samples containing impact generated features (mixed breccias, shattercones, and centimeter-scale dikes from within mixed breccias) were also analyzed. Shattercone samples were collected from the sandstone member of the Word Formation and the Tessey Limestone.

Samples were powdered and sieved with a 63 µm mesh sieve to ensure a uniform size and sifted onto a vaseline coated zero background plate to reduce preferred orientation of grains. Patterns were collected using a Siemans D500 diffractometer in the range from 15° – 120° 2θ with a step width of 0.02° 2θ and count-time of 10s per step and analyzed using MDI Jade 7.0 software. Three additional mineral patterns were collected for quartz, calcite and dolomite using minerals from our in-house mineral collection to be used as standards for comparison.

Results: XRD patterns show slight to pronounced peak broadening (Figure 1) indicating the presence of low to moderate shock pressures. Variable shock results were expected for the central uplift due to complex rock motion during the formation of the structure.

Deformation features documented from thin section study of quartz-rich samples include planar deformation features (PDFs) and fractures in quartz grains. In carbonate rocks thin twinning and stylotitic zones were identified. Breccias include fractured clasts, sandstone clasts with intense PDF development in quartz grains, and flow features in breccia matrix. Some calcite-rich shattercones include silt-sized quartz grains containing PDFs. Centimeter-scale dike samples from within mixed breccias show partitioning and fracturing in quartz grains from rock adjacent to dike walls, and thin twins in calcite grains, and a decrease in grain size of dike material.

Generally, the XRD patterns of samples showing more deformation in hand sample (shattercones, etc.) and thin section (PDFs, mineral grain fracturing, etc.) have broader peaks when compared to less deformed samples.

The assignment of moderate shock will be assessed using Rietveld crystal refinement methods however, the current classification agrees well with previously documented macro- and micro-scale shock features from the Sierra Madera structure such as impact generated breccias, shattercones, planar deformation features (PDFs) in quartz, grain fracturing, and deformed quartz and carbonate minerals.

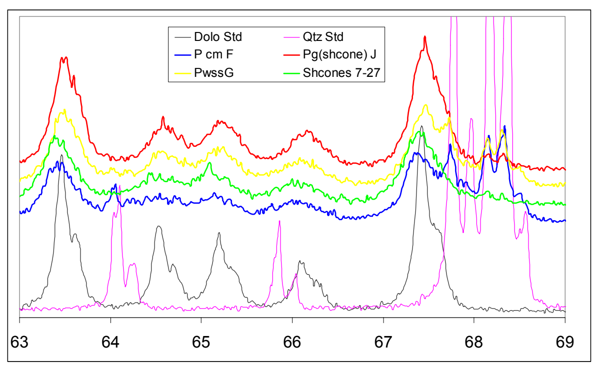

Figure 1. XRD powder patterns of two quartz-rich samples (Cathedral Mtn Fm (P cm F, blue) and Word Fm (PwssG, yellow), two shattercone samples (Pg(scone)J, red and Shcone7-27, green), and dolomite (black) and quartz (purple) standard patterns. X-axis is the region from 63° – 69° 2θ . Peak broadening is especially apparent in the 64.5° – 65.5° 2θ range for the Sierra Madera samples when compared to the dolomite standard.

References: [1] Skála R. and Jakeš P. (1999) GSA Spec. Pap. 339, 205-214.