**OPTICAL AND X-RAY DIFFRACTION ANALYSES OF SHOCK METAMORPHOSED DOLOSTONE AT INCREASING DEPTHS WITHIN THE CENTRAL UPLIFT OF THE WELLS CREEK IMPACT STRUCTURE.** J. R. Seeley[1] and K. A. Milam[1], [1]Ohio University, Department of Geological Sciences, 316 Clippinger Laboratories, Athens, OH 45701-2979 (js961716@ohio.edu).

**Introduction:** Studies of shock metamorphism have traditionally focused on silicate-dominated target rocks, but carbonate minerals are present in part or in whole in 39% of terrestrial impact craters [1]. Recent studies have worked to understand the effects of shock metamorphism in these carbonates both experimentally [2-5] and observationally [1, 6-8]. These studies have indicated that calcite and dolomite respond to low to moderate shock metamorphic pressures mechanically via twinning, cleavage, fracture [2, 7, 8], and deformation in the crystal lattices detectable via X-Ray Diffraction (XRD) [1-6, 8]. At peak pressures greater than 55-65 GPa and 35-45 GPa in dolomite and calcite respectively, these minerals may experience decarbonation and melting [2-4]. [7] observed melting and recrystallization of calcite in target rock. Irregularities detectable via XRD – that is, the introduction of disorder into the crystal lattice – have chiefly been analyzed following Rietveld structure refinement of diffraction patterns. This refinement has been utilized to associate the magnitude of X-ray peak broadening to peak experimental shock pressures [4], to relative shock pressures in relation to the point of impact within the Sierra Madera Impact Structure [6] and to compare and contrast the magnitude of shock metamorphism across the central uplifts of similarly-sized complex impact structures [6]. This study analyzes dolostone samples collected in megablocks from the upper 401m of an 800m long, 5cm diameter, drill core collected from the central uplift of Wells Creek impact structure to determine if shock metamorphic fabrics and lattice distortions decrease with depth in the central uplift. The magnitude of shock metamorphic effects is expected to decrease with distance from the point of impact.

**Geologic Setting:** The Wells Creek impact structure is a ~12km diameter post-Paleozoic complex impact structure located in the vicinity of Wells Creek, Tennessee [9]. Exposed strata of the central uplift are dominated by the Cambrian-Ordovician Knox Group, a dolostone that is comprised of massive to thinly bedded silty or (rarely) sandy dolomite. Numerous shatter cones are found at the surface of the uplift [9] and observed to a depth of at least 377m in the core.

**Methods:** *Sample preparation.* Seven samples were taken from the upper 401 m of core, avoiding highly brecciated specimens to avoid strain that was introduced by rise and collapse of the central uplift. Specimens showing more than accessory amounts of other minerals were avoided to focus on dolomite and to minimize anisotropy of strain during sample processing caused by varying mineral hardnesses and tenacities when possible. Care was taken during sample preparation to minimze the introduction of strain during processing, as detailed in [10]. Introduction of strain could result from striking rocks with hammers or from excessive grinding (either too long or too hard) [10]. Each sample was cut perpendicular to the length of the core into two aliquots using a Hilquist SF-9 trim saw. Fractures with secondary mineralizaion were cut around to minimize inclusion of secondary mineralization. One aliquot was made into a thin section and the other used for XRD and XRF. These XRD and XRF core aliquots were cut into strips thin enough to be broken by hand to avoid the use of a hammer and then broken by hand into chips. They were then ground by hand in an agate mortar and pestle in alcohol for the least amount of time necessary (14 – 35 minutes) and sieved to produce a total of ~0.5g/sample of <25μm crystallite for XRD. The <25μm size was chosen to ensure that dolomite cleavage planes would not introduce a preferred orientation in the crystallite. A preferred crystallite orientation could bias the dolomite diffraction pattern by introducing a preffered diffraction plane. This grain size provides theoretically infinite crystallite orientations and thus a dolomite diffraction pattern representative of all possible orientations [10].

*Petrographic Analysis.* Petrographic analysis for twinning, cleavage sets, and cleavage planes was conducted on a petrographic polarizing microscope with a mechanical stage. Photomicrographs were taken in a grid pattern on each thin section, and the grain at the center of the crosshairs of each image was analyzed for twinning, the number of visible cleavage planes, and sets of cleavage planes. To avoid double-counting that may arise via grid-image analysis, fractures were counted via high-resolution grayscale scans of the thin sections against a black background that were contrast-enhanced in Adobe Photoshop. The number of fractures for each thin section was analyzed per $cm^2$ as determined by dimensions measured in Adobe Acrobat. To facilitate direct comparison of all counts, the surface area in $cm^2$ is currently being determined for each grain counted via grid sampling.

*XRD Analysis.* The <25µm crystallite aliquots were placed on a quartz zero plate and analyzed on a Rigaku Mini-Flex II at 30 kV and 15 mA. Samples were run from 20˚-120˚ 2θ to include all major dolomite peaks. Twenty diffraction patterns were collected for each sample to assess any variability in patterns due to instrumental drift. Unshocked dolostone pattern standards were also collected before and after each 20-pattern set was collected, also to track any instrumental drift. Average, maximum, and minimum intensities and standard deviations were calculated using the R software package. Rietveld refinements will be run via the PDXL software package and peak broadening will be compared and contrasted with other results.

*XRF Analysis.* The size fractions not used for XRD were analyzed via fused-bead XRF bulk geochemical analysis with a Rigaku Super-Mini 200 to determine the composition of the dolomite, as variations in chemical composition could cause distortions in the crystal lattice and interfere with the analysis of lattice distortion caused by shock pressure [3, 11]. Standards with known chemical compositions were run before and after each batch of samples to confirm machine accuracy.

**Results:** XRF results indicate the seven samples used in this study are mostly dolostone. Petrographic observations indicate a general lessening of shock pressure with depth in the central uplift of Wells Creek Crater. Fractures per cm$^2$ (Figure 1) show a very strong ($R^2 = 0.94$) logarithmic decreasing trend with depth in the upper 401m. Similar work on cleavage planes per unit area is in progress. No twinning was observed in any samples. This could be due to differences in calcite and dolomite twinning mechanisms or diagenetic overprinting in the target rocks.

XRD patterns of the top 401m of the core qualitatively indicate peak broadening in the central uplift of the Wells Creek impact structure (Figure 2) by the shorter, wider peaks of the dolomite diffraction pattern compared to unshocked dolomite. Initial inspection of this peak broadening does not reveal the systematic decrease in peak broadening with depth one would expect in a shock metamorphosed target.

**Preliminary Summary:** Fracture densities in 401m of core in the central uplift of Wells Creek impact structure do support the notion of shock wave dampening with depth. Typical XRD pattern peak broadening associated with shock metamorphism is present in the core, but the qualitative assessment does not indicate a systematic decrease in peak broadening with depth as is expected.

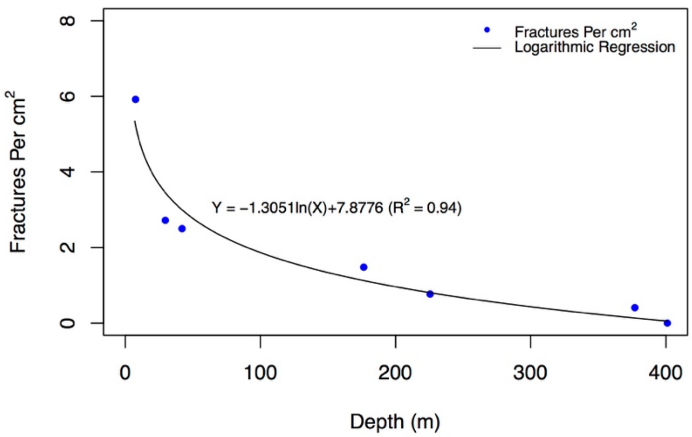


**Figure 1**: Fractures /cm$^2$ vs depth in a core from the central uplift of Wells Creek Impact Structure.

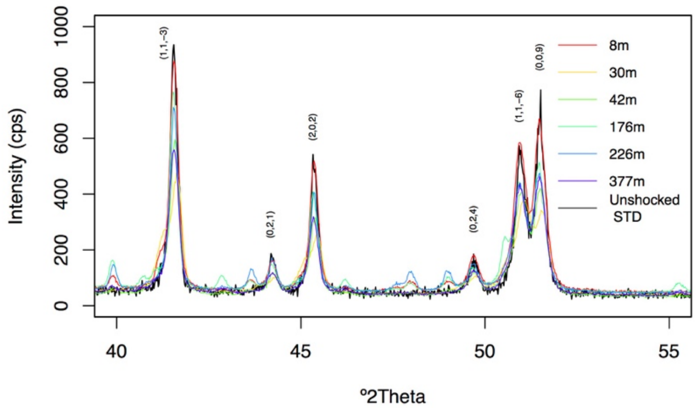


**Figure 2**: XRD patterns through 400m of core from the central uplift of Wells Creek Impact Structure.

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