XRD ANALYSES OF SILURIAN DOLOSTONES FROM THE CENTRAL UPLIFT OF THE KENTLAND IMPACT STRUCTURE, NEWTON COUNTY, INDIANA, USA.

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Introduction: The Kentland impact structure located in northwestern Indiana (N 40° 45’ W 87° 24’) represents the remains of an ~13km diameter complex crater. Ordovician-Devonian strata have been uplifted ~600 m to the surface following impact and subsequently exposed by local quarrying operations. Large megablocks of carbonates, sandstones, and shales have been uplifted along thrust faults to comprise the central uplift [1]. Some megablocks provide evidence for shock metamorphism in the form of shatter cones [2-4], impact breccias [3,5], shocked quartz [3,4], and coesite [6]. Shatter cones are indicative of lower shock pressures (~3-10 GPa) [7]; however, coesite formation requires higher pressure conditions (>30 GPa) [8]. This may demonstrate the potential degree of hetereogeneity in the distribution of peak shock pressures across the central uplift or highlight the role in which target rock composition affects the propagation of shock waves throughout a target.

This research project seeks to quantitatively analyze and constrain peak shock pressures across the central uplift utilizing X-ray diffraction (XRD) spectra from Paleozoic dolostones collected from the Kentland central uplift. In this study, we rely on more recent experimental [9-10] and empirical investigations [10-12] of shock pressures in carbonate sedimentary targets and the techniques used therein to estimate shock pressures across the central uplift. This work highlights a preliminary study performed on shatter-coned, Middle Silurian dolostones collected from the eastern half of the Kentland central uplift.

Methods: Seven specimens were hand collected from a single exposed megablock approximately 800 m from the geographic center of the uplift (Figure 1). Specimens were ground into <25 micron powders using mortar and pestle for XRD analysis to avoid introducing any artificial lattice strain. Resulting XRD spectra were processed using the Rietveld peak refinement technique [13] and full width half maximum (FWHM) values were calculated. FWHM values represent the level of peak broadening compared to unshocked or undeformed standards. Peak broadening has been shown to increase with increasing shock pressures in experimentally-shocked samples [9,11].

Kentland FWHM curves were thencompared to experimentally-shocked dolomite [11] and that from a known impact analog, Sierra Madera [12] to estimate peak shock pressures. Sierra Madera specimens all contain shatter cones [12] Kentland samples were compared to unshocked dolomite standards from the Mascot Dolomite in Gordonsville, TN, the Beck Springs Dolomite in Inyo County, CA, and the Peebles Dolomite from Adams County, OH. The unshocked standard used in [12] (Yates Formation, TX) was also utilized to supplement the data set. Future work will involve comparisons to tectonically-deformed dolostone in an effort to distinguish peak broadening resulting from tectonism from that of shock metamorphism. These tectonically-deformed analogs were collected from the Helena Formation, Belt Supergroup from the Hungry Horse Dam, MT, the Noonday Dolomite in Inyo County, CA, the Johnnie Formation from Inyo County, CA, and the Tomstown Dolomite found in Hagerstown, MD.

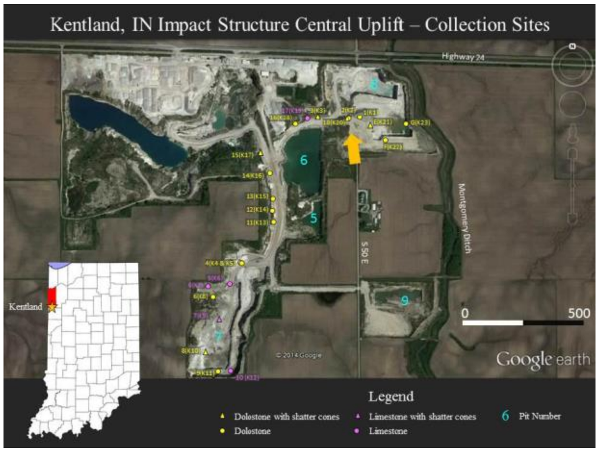

Figure 1: Sample collection sites within the Kentland impact structure, Indiana, USA. The inlay image denotes the location of the area of study marked with the star. Sample collection site for this study denoted with an orange arrow.

Initial Results: FWHM values of shatter-coned specimens from the northeastern section of the Kentland central uplift (Figure 2) display evidence of peak broadening when compared to the 2 unshocked dolomite standards. The magnitude of peak broadening ranges between the unshocked dolomite standards and those of shocked (shatter-coned) dolostones (Pg, Pv, and Ph in Figure 2) from Sierra Madera.

Compared to the unshocked specimen used in [11], all 7 Kentland specimens show evidence of peak broadening (Figure 3). When compared to experimentally-shocked dolomite from [11], it is clear that the megablock from which these shatter-coned specimens were collected was not shocked beyond ~17 GPa.

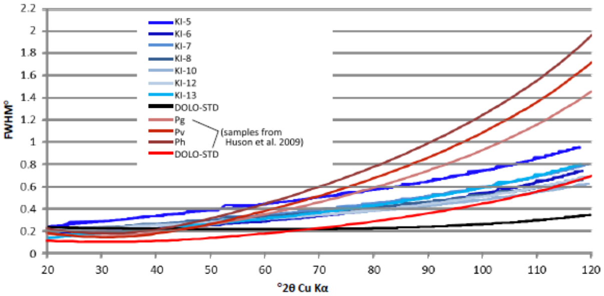

Figure 2: FWHM comparison of Kentland shatter-coned specimens versus shatter-coned specimens from the Sierra Madera impact structure (Pg, Pv, Ph) and an unshocked dolomite standard from Huson et al. 2009.

Ongoing Work: Further sampling from the exposed southern and eastern margins of the impact structure will allow us to ascertain an approximate range of peak shock pressure conditions across the impact structure. It is hypothesized that samples collected closer to the middle of the central uplift will provide evidence of higher shock pressures (as represented by an increase in peak broadening) due to shock wave dissipation across the target. As a shock front expands it loses energy and strain on target rock is reduced [14]. Additional results will be presented from the analyses of 18 dolostone samples collected along 2 transects (E-W and N-S) at variable distances from the center of the central uplift in an effort to estimate peak pressures across a broader portion of the structure.

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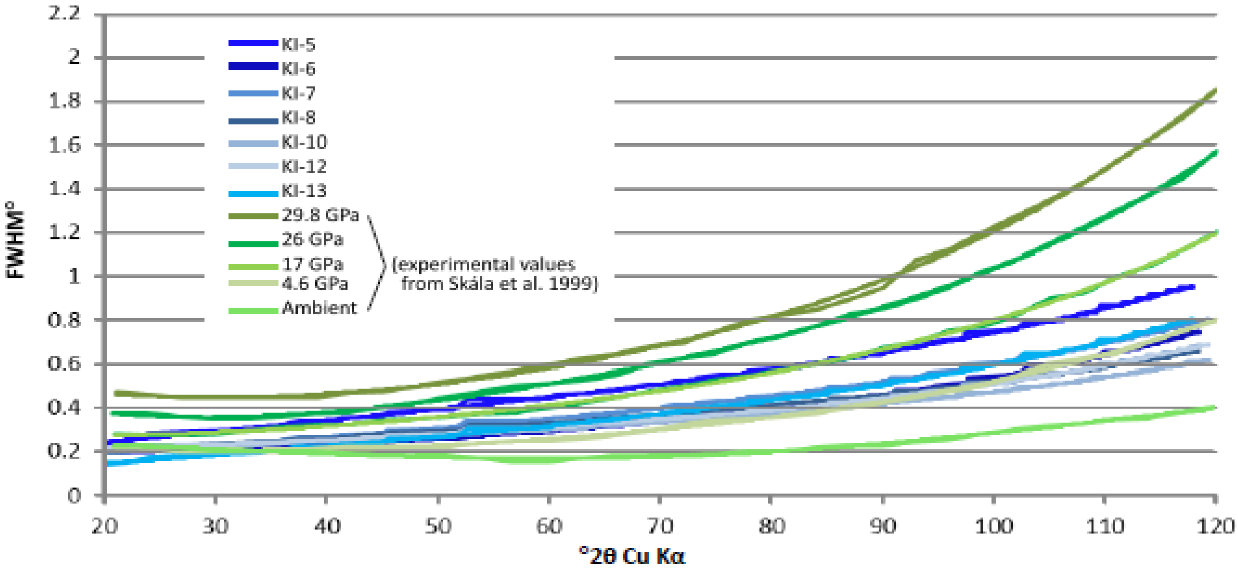

Figure 3: FWHM comparison of Kentland shatter-coned specimens versus experimentally shocked dolomite from Skála et al. 1999.