EVALUATION OF XRD AND RAMAN PEAK BROADENING IN SHOCK-METAMORPHOSED CARBONATES FROM CARBONATE-TARGET BOLIDE IMPACT STRUCTURES. K. M. Bliss[1], J. R. Morrow[1], J. C. Weber[2], and M. Vice[3], [1]Department of Geological Sciences, San Diego State University, San Diego, CA, 92182 (KMB: lewi0165@yahoo.com), [2]Department of Geology, Grand Valley State University, Allendale, MI 49401, [3]Department of Geography, University of Wisconsin, Platteville, WI 53818.

Introduction: Peak broadening recognized in X-ray diffraction (XRD) and micro-Raman (MRS) spectra of experimentally and naturally shock-metamorphosed carbonates from carbonate-target bolide impact structures has been shown to be a reliable indicator of impact-related shock-metamorphism [1-7]. However, studies have not yet shown whether this peak broadening is unique to or diagnostic of all carbonate-target impact structures.

Samples from eight confirmed carbonate-target impact structures that represent a range of potential shock conditions are being analyzed to determine whether diagnostic peak broadening can be recognized in impact structures of various ages and potential magnitudes of impact energy. Samples include matrix and clasts from polymict lithic breccia (Figs. 1-2) and shatter cones (Fig. 3). In addition, XRD spectra from potentially shock-metamorphosed samples are compared to spectra generated from samples that represent other natural terrestrial high pressure-temperature conditions (e.g., fault breccia, carbonatite, marble, etc., Fig. 4) to determine whether peak broadening in carbonates is unique to shock-metamorphism caused by impact-generated pressures. All sample spectra are compared to unaltered Iceland and dolomite spar control standards. Shock-metamorphism in carbonate target rocks should manifest as angstrom-scale reductions in crystallite size and an increased crystallite strain (%), which result in the peak broadening observed in XRD generated spectra.

Duplicate MRS analyses of samples representative of a variety of potential shock-metamorphic and natural high pressure-temperature conditions will be compared to the XRD results to test the viability of the MRS as a reliable method for analyzing shock-metamorphic effects in carbonates. MRS analysis is more versatile, virtually non-destructive, and requires a smaller sample size than does XRD analysis.

Sample Collection and Methodology: All samples were prepared, analyzed, and reduced using procedures developed by [8]. Rock chips were first prepared for each sample using a hammer and chisel to isolate desired sample areas. Chips were then powdered with an agate mortar and pestle under alcohol to reduce the possibility that grinding might artificially alter the crystal structure properties. Sample powders were then sieved through a 45-μm sieve to obtain a uniform fine grain size for optimal XRD analysis results. Powders were affixed to low-background single-crystal silicon plates as an alcohol slurry to reduce preferred orientation of powder grains.

Analyses were performed on a Phillips X'Pert Pro X-ray diffractometer across a range of 15°–145° 2θ with a step width of 0.02° 2θ, using a count time of 10 s per step, and then processed using X'Pert High Score software. Subsequently, raw powder diffraction spectra from the XRD were run through FullProf and WinPLOTR data reduction and pattern refinement software in order to remove the machine-generated portions of the spectra and to fit the data to ideal crystal structures. This process aids in determining quantitatively the degree of peak broadening for each sample.

Results: Analysis of raw data indicates that broadening of spectral peaks occurs for the diagnostic peaks of carbonate minerals under shock-metamorphic conditions when compared to carbonates from other high pressure-temperature regimes, unaltered carbonates, and the spar standards.

Potentially shocked vs. standard samples. Preliminary data reduction and spectral pattern refinement values indicate that crystallite size has generally decreased by half or more in all potentially shocked samples compared to the unshocked Iceland and dolomite spar standards. Additionally, crystallite strain values for shocked samples are generally three times larger than strain values obtained for the unshocked spar standards.

Potentially shocked vs. unshocked samples. Potentially shocked samples show significantly decreased crystallite sizes when compared to carbonates from other natural high pressure-temperature regimes. Several exceptions occur, which may be explained by recrystallization of the potentially shocked sample or a sample that consists of polymict lithic breccia containing tiny unshocked clasts that cannot be effectively separated from the surrounding matrix before analysis.

Spar standards vs. unshocked samples. In a comparison of the spar standards and the unaltered carbonate samples from natural settings, unaltered carbonates show a consistently smaller crystallite size value and larger strain values than the spar standards. However, these values are generally still respectively higher and lower than the values obtained from the potentially shocked samples. Samples from other high pressure-temperature regimes (i.e., carbonate fault breccia, Fig. 4) consistently show values comparative to those of

unaltered carbonates, lending credence to the hypothesis that decreased crystallite size, increased crystallite strain, and significant raw data peak broadening are all effects that are unique to shock-metamorphosed carbonates.

Conclusions: Preliminary sample analysis shows that significant peak broadening observed in shocked carbonate samples from carbonate-target bolide impact structures is unique to impact structures, and is not definitively generated by any other analyzed high pressure-temperature regime process.

This result will aid not only in continued identification of shocked carbonate phases in proven impact structures, but also in recognizing previously undocumented carbonate-target impact deposits (ejecta, tsunamiites, etc.) that are not tied to a preserved crater and/or that lack shocked silicate mineral phases.

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References: [1] Skála, R., and Jakeš, P. (1997a) *LPI*, *Large Meteorite Impacts and Planetary Evolution*, Abstracts, 6081–6082. [2] Skála, R., and Jakeš, P. (1997b) *LPS XXVIII*, Abstract #1597. [3] Skála, R., and Jakeš, P. (1999) *GSA Special Paper 339*, 205–214. [4] Skála, R., Hörz, F., and Jakeš, P., (1999) *LPS XXX*, Abstract #1327. [5] Skála, R., Matějka, P., and Hörz, F. (2000) *LPS XXXI*, Abstract #1567. [6] Huson, S. A., Foit, F. F., Watkinson, A. J., and Pope, M. C. (2006) *LPS XXXVII*, Abstract #2377. [7] Lewis, K. M., Morrow, J. R., and Nesse, W. D., 2006, *GSA Abstracts with Programs*, *38(7)*, 298. [8] Skála, R., and Jakeš, P. (1999) *GSA Special Paper 339*, 205–214.

Figure 1. (DEC-1-Lt) Decaturville structure polymict breccia.

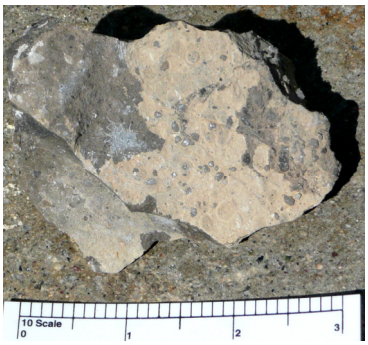

Figure 2. (HAS-Lp) Alamo Breccia dolomitized lapillistone exhibiting shocked swirled matrix material.

Figure 3. (KENT-3) Kentland Dome carbonate shatter cone.

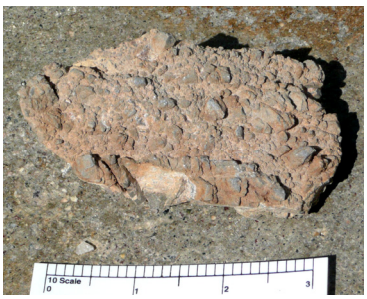

Figure 4. (Dlbc) Death Valley carbonate cataclastite fault breccia.