CHARACTERIZATION OF EXPERIMENTAL SHOCK EFFECTS IN CALCITE AND DOLOMITE BY X-RAY DIFFRACTION. M. S. Bell[1,2], F. Horz[3], and A. Reid[2], [1] Lockheed-Martin Space Mission Systems & Services, C23, 2400 NASA Rd. 1, Houston, TX 77058 msbell@ems.jsc.nasa.gov, [2] Department of Geosciences, University of Houston, Houston, TX, 77204-5503, [3] SN2, NASA - Johnson Space Center, Houston, Texas 77058.

Introduction: Limestone and dolomite are common target materials for large terrestrial impacts such as Chicxulub; therefore, the shock behavior of calcite and dolomite is important in understanding the KT-event and other impacts with carbonate platform sediments in their target(s). An understanding of detailed carbonate shock behavior should also help constrain the timing of shock events to which carbonate containing meteorites (e.g. ALH84001) have been subjected [1]. Most interest in shocked carbonate focuses on issues of devolatilization to quantify the liberation of CO_2 and to thereby gain some understanding of its role in generating a temporary atmosphere and subsequent effects on climate and biota [2,3,4]. Shock recovery experiments for calcite yield seemingly conflicting results: the majority of experimental devolatilization studies [5] suggest that calcite is substantially (> 50%) outgassed at 30 GPa, yet the petrographic work of Martinez et al. [6] presents evidence that essentially intact calcite and dolomite are recovered from 45 and 60 GPa shocks, respectively.

Our x-ray diffraction (XRD) study of experimental shock effects in limestone and dolomite support the decarbonation pressure thresholds of Martinez et al. Shock experiments to 60 GPa on calcite and dolomite produce sharp peaks on x-ray diffractograms indicating the materials retain their crystalline structure. It may be possible to use internal lattice strain data obtained from unshocked and shocked samples by XRD to develop pressure scales of shock effects in carbonate and dolomite.

Experimental Methods: Target charges consisting of solid limestone and dolomite discs were packed into stainless steel targets and shocked in the Johnson Space Center Experimental Impact Laboratory. Equations of state are known for both the target and projectile in which case it is necessary to measure only the impact velocity of the projectile and to use a graphical technique to determine the peak shock pressure [7]. The recovered materials sieved to < 500 μm were grain mounted for XRD analysis. One unshocked reference sample and three shocked equivalents of both limestone and dolomite were examined. Data were collected on a Scintag XDS 2000 diffractometer using CuKα radiation over the angular range 10 to 70^0 2 θ counting continuously at 0.5 degrees min^{-1}. Sample mass was approximately the same for all XRD runs.

Experimental Results: Shocked samples are characterized by significant peak broadening. Half height, full width measurements indicate 0.1^o increases in hkl(104) peak width for the 48 GPa shock experiments. Figure 1. compares the hkl(104) peaks of calcite and dolomite unshocked and shocked to 60 and 59 GPa respectively. Peak widths measured on the spectra are corrected for instrumental errors by measurements on a quartz standard. Calcite displays 0.075^o broadening of the hkl(104) peak for the 60 GPa shock experiment. Intensity of the 60 GPa peak is approximately half that of the unshocked peak. Dolomite displays a slightly greater 0.145^o broadening of the hkl(104) peak. Intensity of this peak also decreases (~ one third of unshocked intensity) with increasing shock pressure. Hkl(110) and (113) peaks were also measured and display broadening. Although calcite and dolomite sustain measurable internal deformation, significant proportions of both materials remain crystalline at shock pressures up to 60 GPa.

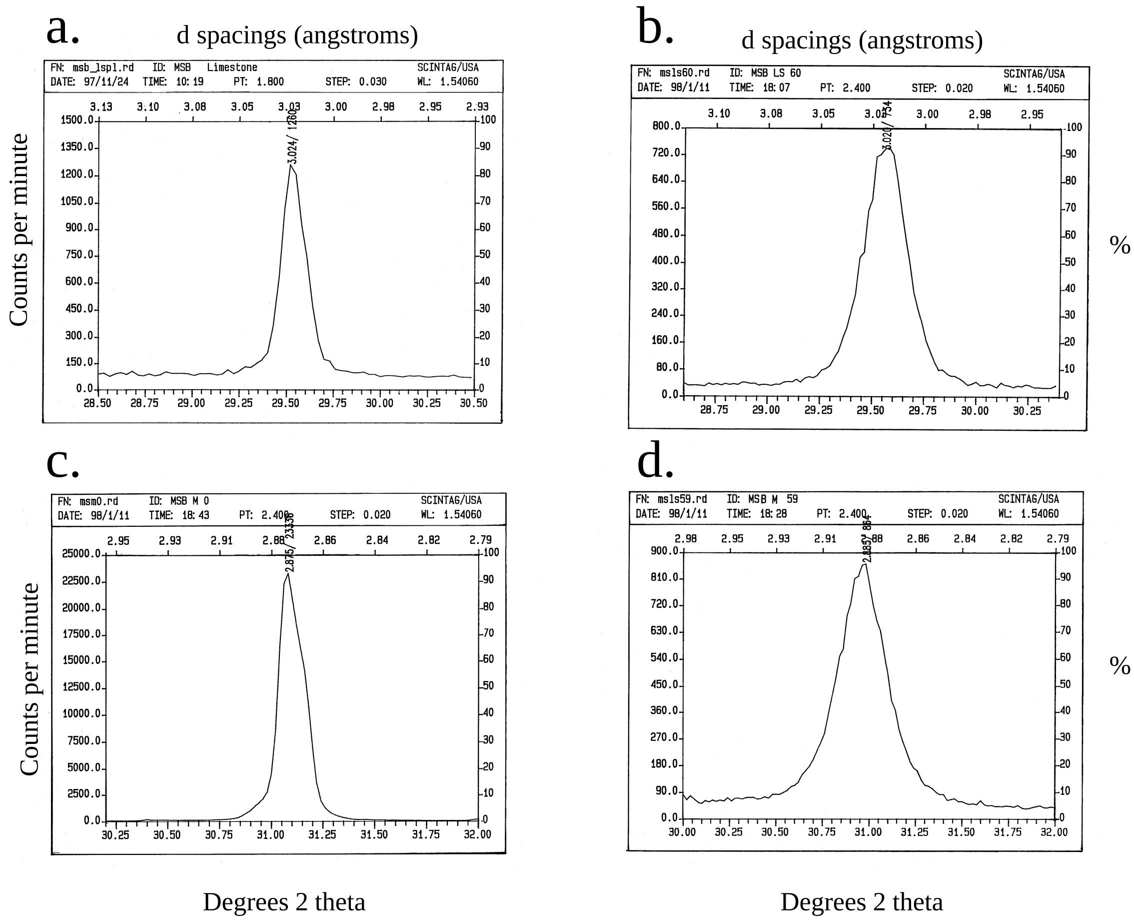

Figure 1. Slow scan x-ray diffractograms of the hkl(104) peaks for unshocked calcite (a.), calcite shocked to 60 GPa (b.), unshocked dolomite (c.), and dolomite shocked to 59 GPa (d.). This peak broadens and loses intensity with increasing shock pressure, although both calcite and dolomite samples retain their crystalline structure to ~60 GPa.

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