

Thermal Gravimetric Analysis of Experimentally Shocked Calcite M. S. Bell, University of Houston/Lockheed Martin, Houston, TX 77058, msbell@ems.jsc.nasa.gov.

Introduction: A number of experimental shock studies on calcium carbonate investigated the loss of CO₂ at pressures as high as 60 GPa [1-4]. However, most of the above studies characterized the refractory residue only, thus addressing the loss of CO₂ rather indirectly. We employ Thermal Gravimetric Analysis (TGA) in the present study and thus a rather direct method to determine CO₂ loss. The present investigation concentrates on samples shocked between 30 and 60 GPa, and intends to refine the observations of [5].

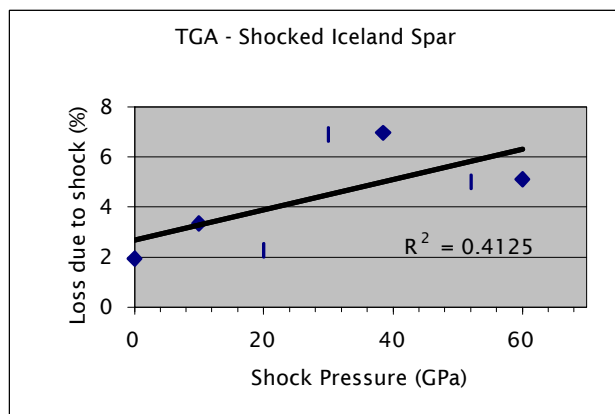
Experimental: Optical quality, single crystal Iceland Spar was chosen for the shock experiments. Target disks were sliced from a single core and encased in metal holders as described by [6]. The TGA employed a TA Instruments model SDT 2960 Simultaneous DSC/TGA. The stoichiometry of calcite yields a maximum CO₂ loss of 44 % (weight). The absolute weight loss determined by TGA upon complete outgassing represents the fraction of gas that remained in the sample; the difference between observed and stoichiometrically expected mass loss thus represents the shock-induced CO₂ loss. Additionally, the onset and completion temperatures of weight loss and absolute rates of weight loss should be affected as CO₂ is released from and must diffuse through shock-deformed calcite.

Results and Discussion: Samples shocked at 10, 20, 29.9, 38.4, 51.6, and 60 GPa were analyzed and compared to unshocked standards. The weight loss curves of all samples are of grossly similar shape and nothing dramatically happened at any pressure. Minor CO₂ loss occurs in all samples (see Fig.1) and is a modest 7% at 60 GPa, in complete agreement with [5] and the indirect residue characterizations [1-4]. In detail there is uncomfortable data scatter and only a weak positive correlation ($R=0.6423$) exists between CO₂ loss and shock pressure.

The onset temperature of CO₂ loss for calcite is at 675 °C and outgassing is complete at 900 °C [7]. Onset-temperatures of the shocked materials were substantially lowered as were the completion temperatures. The temperature interval over which most (> 90%) of the outgassing occurs is also increased. This suggests a wide variety of bonding conditions for CO₂ and increased diffusivity through a shock deformed and most likely mechanically disaggregated calcite lattice.

Conclusions: Iceland Spar shocked to pressures as high as 60 GPa exhibits some 7% loss of CO₂, consistent with [5]. Note that quartz and feldspar will melt at 45-50 GPa [8], thus attesting to the surprising stability of calcite against shock deformation and decomposition that was also noted by e.g. [2-4] and which is observed for dolomite as well [9].

References: [1] Lange and Ahrens (1986) *EPSL*, 77 [2] Martinez et al. (1994) *EPSL*, 121.[3] Langenhorst and Deutsch (2000) LPSC XXXI, CD-ROM, 1851 [4] Bell et al. (1998) LPSC XXX, CD-ROM, 1422 [5] Kotra et al. (1983) LPSC XIV,401-402 [6] Gibbons et al. (1975) Proceedings Lunar Sci. Conf. XI, 3143-3171 [7] Todor (1976) Thermal Analysis of Minerals [8] Stoffler et al. (1988) *in Meteorites and the Early Solar System*, 165-202 [9] Skala et al. (2001) Proceedings of the Catastrophic Events and



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Figure 1. CO₂ loss (% weight) due to shock deformation of Iceland Spar.