IMPACT-INDUCED DEVOLATILIZATION OR MELTING OF CALCITE? OR BOTH? ANSWERS FROM MEMIN EXPERIMENTS.

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Introduction: The reaction of carbonates (such as calcite, $CaCO_3$) upon impact is still a matter of considerable debate [1,2]. Specifically, the question is whether they will decompose and liberate CO_2 (*e.g.*, [3]) or will be preserved as melt in impactites (*e.g.*, [2]). Since evidence from natural impactites is often ambiguous [2,3], laboratory experiments with well-defined conditions may help answering this question. Here, we report latest results from the Multidisciplinary Experimental and Modeling Impact Research Network (MEMIN; *cf.* [4]) and present first evidence of calcite melts in impact and laser melting experiments.

Results: Impact experiment A30-5610 and the accompanying laser melting experiment A5 were conducted in order to ascertain the behavior of calcite upon impact. The impact experiment was performed with a two-stage light-gas gun at Fraunhofer Ernst-Mach-Institute, Freiburg, Germany. It involved the impact of a 6.17-mm-diameter basalt projectile (composed of olivine phenocrysts in a fine-grained matrix of plagioclase, pyroxene, feldspathoids, and FeTi oxides) onto a block of Carrara Marble (~95 vol.% calcite, accessories are dolomite, feldspar, and apatite) at 4.94 km s^{-1}, resulting in a bulk peak pressure of ~51 GPa. The laser experiment was performed with a pulsed Nd:YAG laser at Technische Universität Berlin, Germany. It involved rapid melting and subsequent quenching of the contact zone between blocks of basalt and Carrara Marble. Both experiments yielded calcite grains that mostly show low-grade shock effects, *i.e.*, pronounced twinning. In the impact experiment, we detected ejecta particles composed of calcite and a silicate melt (most likely originating from the basalt projectile). Calcite grains in these composite particles show textures indicative of degassing and melting. In the laser melting experiment, *in-situ* melting of calcite is indicated along a narrow zone adjacent to a large pool of basaltic melt. In both experiments, the presumable melting of calcite is recognized by (i) loss of grain boundaries between calcite grains, (ii) *in-situ* appearance of flow textures and vesicles, (iii) isotropization of the material, and (iv) distinctly different Raman spectra characterized by disappearance of the characteristic calcite bands at 155, 287, 714, 1087, and 1439 cm^{-1}.

Discussion and Outlook: This ongoing work suggests that calcite melts were produced not only in the impact experiment, but also in the laser melting experiment. Based on the calcite phase diagram [1], *P-T* conditions of up to 100 GPa and 4000 K were locally reached in both types of experiments, resulting in incipient melting and/or degassing of calcite (depending on the exact *P-T* path during quenching). Our next step is to characterize the presumed calcite melts with TEM.

References: [1] Ivanov B. A. and Deutsch A. 1997. *Physics of the Earth and Planetary Interiors* 129:131–143. [2] Hörz F. et al. *Meteoritics & Planetary Science* forthcoming. [3] Osinski G. et al. 2008. *Geological Society of America Special Paper* 437:1–17. [4] Poelchau M. et al. 2015. Abstract #2447. 46th Lunar and Planetary Science Conference.