First evidence of calcite melts in recent MEMIN impact experiments

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A frequently discussed topic in impact cratering is the fate of carbonates upon impact [1]. Specifically, the question is whether carbonates released from high shock pressures (sufficient to melt coexisting silicates) will decompose and liberate CO_2 (e.g., [2]), or will be preserved as melt in impactites (e.g., [3]). Here, we present first evidence of calcite melts in impact and laser melting experiments recently performed in the context of the Multidisciplinary Experimental and Modeling Impact Research Network (MEMIN) [4].

Impact experiment A30-5610, performed with a two-stage light-gas gun at Fraunhofer Ernst-Mach-Institut, Freiburg, Germany, involved the impact of a 6.17-mm-diameter basalt sphere onto a block of Carrara Marble at 4.94 km s^{-1}, resulting in a peak pressure of ~51 GPa. The accompanying laser melting experiment A5, performed with a pulsed Nd:YAG laser at Technische Universität Berlin, involved the rapid melting and subsequent quenching of parts of the contact zone between a basalt block and a calcite block. Both experiments yielded calcite grains that mostly show low-grade shock effects, e.g., pronounced twinning (up to three sets of twins in a single grain). Occasionally, ejecta particles composed of calcite and a silicate melt (presumably originating from the basalt projectile) are found in the impact experiment, showing degassing and melting of calcite. In the laser melting experiment, degassing and melting of calcite is indicated in direct contact to a basalt melt zone. In both cases, calcite melts are recognized by (i) loss of calcite grain boundaries, as well as in-situ appearance of flow textures and vesicles, (ii) isotropisation of presumably glassy areas, and (iii) distinctly different Raman spectra characterized by disappearance of the characteristic calcite bands at 155, 287, 714, 1087, and 1439 cm^{-1}. Based on optical microscopy, SEM, and Raman spectroscopy, we conclude that calcite melts were produced in both types of experiments.

[1] Ivanov and Deutsch (2002) *PEPI* 129, 131–143 [2] Osinski et al. (2008) *GSA Spec. Pap.* 437, 1–17. [3] Pierazzo and Artemieva (2012) *Elements* 8, 55–60. [4] Poelchau et al. (2013) *MAPS* 48, 8–22.