POSSIBLY BACK-REACTION CARBONATES FROM IMPACT CRATERS: EVIDENCE THROUGH MAGIC ANGLE SPINNING NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. R. Skála1 and J. Rohovec2, 1Department of Mineralogy, Czech Geological Survey, Geologická 6, CZ-15200 Praha 5, Czech Republic (skala@cgu.cz), 2Department of Inorganic Chemistry, Faculty of Science, Charles University, Hlavova 2030, CZ-12843 Praha 2, Czech Republic.

Introduction: Ahrens and Gregson [1] presented Hugoniot data for calcite and calcite-rich rocks. Lange and Ahrens [2] speculated on the role of CO2 released during impact events in early Earth's atmosphere. Boslough et al. [3], Kotra et al. [4], Lange and Ahrens [2], Martinez et al. [5] and Tyburczy and Ahrens [6] pointed out based on shock experiments that shock compression of carbonates results in degassing which starts at about 10–20 GPa. Evidence for limestone and/or dolomite decomposition in natural impacts was presented recently by study of chemistry of impact glasses from the Meteor Crater, Arizona, USA [7,8]. Love and Ahrens [9] found that in addition to partial vaporization of CaCO3 the melting is induced at about 80 GPa pressure along the Hugoniot. They also did not exclude that melting of CaCO3 can be achieved upon isentropic release from lower shock pressures of about 50 GPa. Miura and Okamoto [10] on the basis of experiments with limestones and marbles supposed that C is formed at the expense of calcite during the impact.

On the other hand, Martinez et al. [11], Bell [12], and Bell and Hörz [13] using common shock-recovery experiment setups showed that even under shock loads up to 60 GPa, 40 GPa, and 60 GPa respectively, carbonate-rich materials do not decompose and CO2 is not released.

Miura [14] determined the unit cell dimensions of calcite from powder data for limestone samples from the Ries impact crater in Germany. He distinguished two types of calcite – one formed under reducing conditions of the vapor plume and the other under oxidizing conditions outside it. Unfortunately, he did not provide experimental details. Moreover, his cell dimensions are systematically lower than those published in literature [15].

Agrinier et al. [16], Deutsch et al. [17], and Martinez et al. [5] has speculated on possible role of back-reaction of carbonates. This back-reaction in carbonates is supported also by observations by Liu and Schmitt [18], who did not find any significant change in the Earth's partial CO2 pressure at the moment of K/T impact.

During the study of the system CaCO3 under elevated static pressures, high pressure metastable polymorphs CaCO3 (II) and CaCO3 (III) were produced and characterized [19,20]. Ahrens and Gregson [1] speculated that there are several phase transitions to these metastable CaCO3 polymorphs in the region below 10 GPa during shock compression of CaCO3.

Experiments on natural materials: In course of recently solved research project (Grant Agency of the Czech Republic, No. 205/95/098) focused on shock-induced phenomena in natural carbonate lithologies more than 100 samples of rock-forming carbonates (i.e. calcite- and/or dolomite-rich rocks) were studied by means of powder diffraction in detail being previously selected from a set of roughly 200 samples. These samples represented material from following impact craters on the Earth: Haughton, Kalkkop, Kamensk, Kara, Karla, Manson, Mishina Gora, Morokweng, Puchezh-Katunki, Ries, Steinheim, and Vepria. None of the samples studied did reveal either the presence of sometimes expected high-pressure polymorphs or traces of decomposition.

Nevertheless, several samples from fallback breccia lens or suelites not only have extremely broadened reflections in powder patterns but they appeared to be very intensively altered in thin sections. Some of them were also examined using 13C MAS NMR spectroscopy. This technique has revealed up to 10-fold increase in chemical shift peaks compared to unshocked standards.

Conclusion: Extremely high broadening of chemical shift peaks in 13C MAS NMR spectra of some studied materials indicating high degree of structure disorder together with finely dispersed character of calcite grains in those materials may allow us to speculate that those materials were probably decomposed during the impact event but almost instantaneously back-reacted again. Such behavior when confirmed on larger amount of samples and even experimentally could be of crucial importance with respect to currently widely accepted hypotheses of global warming due to greenhouse effect after large impacts into carbonate targets.