SHOCK RECOVERY EXPERIMENTS (2.5-17.5 GPa) WITH POROUS SANDSTONE: COMPARISON WITH MESO- AND MACRO-SCALE NUMERICAL MODELS

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Introduction: This project of the MEMIN (**M**ultidisciplinary **E**xperimental and **M**odelling **I**mpact Research **N**etwork) research group is focused on experimental shock deformation in dry, porous and wet (in progress) sandstone, for the low shock-pressure range from 2.5 to 17.5 GPa. Special attention is given to the influence of porosity on progressive shock metamorphism.

Experiments: Shock recovery experiments were carried out with a high-explosive set-up generating a plane shock wave, and using the shock impedance method. Seeberger sandstone cylinders (Ø 1.5 cm, length 2 cm) from two lithological layers with slightly different properties (grain size: 0.17 and 10 mm; SiO_2 content: 96 and 94.6 wt.%; porosity: 19 and 23 vol.%, respectively) were shock-deformed.

Results: Our first 5 experiments (5-12.5 GPa) yielded these results: (i) Already at 5 GPa pore space is entirely closed. Dark vesicular melt of phyllosilicate composition occurs at ~1.6 vol.%. (ii) At 7.5 GPa two additional kinds of phyllosilicate-based melts - a lighter, vesicular melt and another containing large iron particles - could be observed. The total amount of melt (all types) increases to 2.4 vol.%. With Raman spectroscopy, shock-deformed quartz grains could be identified near the impacted surface. (iii) At 10 and 12.5 GPa the amount of melt (all types) increases to 4.8 vol.%. Diaplectic quartz glass could be observed locally near the target-surface.

Additional local effects, most likely caused by shock wave interaction with the steel sample-container, include enhanced formation of sub-planar micro-features and shear zones associated with cataclastic microbreccia, diaplectic quartz glass, and SiO_2 melt.

Analysis of the second experiment series (in progress) has shown already that even at 2.5 GPa pore space is almost completely closed; mica forms distinct kink bands and quartz grains could be, according to Raman spectroscopy, slightly shock-deformed. At pressures of 15 and 17.5 GPa distinct PDF are generated and entire quartz grains are transformed into diaplectic quartz glass.

The large contrast in the shock impedance between quartz grains and pores, or between quartz grains and other mineral species leads to a distinctly heterogeneous distribution of shock pressures and temperatures. Therefore, numerical analysis of pore crushing was carried out with macro-scale models. This indicates a total closure of pores already at <6 GPa. Calculations of peak pressures on the basis of meso-scale models results in three to four times higher shock pressures, locally, than the initial one, which may locally lead to much enhanced shock temperature that would facilitate the formation of melts, PDF and diaplectic glass, even at these relatively low nominal experimental pressures.

Conclusion: Overall, we note that characteristic shock effects (e.g. PDF) that would be well-suited to confirm shock overprint on natural sandstone samples, or which would allow well-constrained pressure calibration, are rare. At this stage of our work only diaplectic quartz glass can be used as a shock indicator for samples shocked to pressures in excess of 10 GPa.