MELTING OF SANDSTONE AT LOW PRESSURE IN SHOCK RECOVERY EXPERIMENTS.

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Introduction: Within the framework of the MEMIN (**M**ulti-disciplinary **E**xperimental and **M**odelling **I**mpact Research **N**et-work) research group shock recovery experiments have been performed to investigate the shock deformation of sandstone in the low shock pressure regime from 2.5 to 17.5 GPa. In this study, special attention was given to the formation of SiO_2-rich melts and metallic melts.

Experimental setup: The 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, which is mainly comprised of ~89 wt.% quartz, ~10 wt.% clay minerals (kaolinite, illite and muscovite), and traces of heavy minerals, and has a porosity between 19 and 23 vol.%, were cut into centimeter-sized cylinders and experimentally shock-deformed. The produced target melts were characterized by electron microprobe and SEM analysis.

Results: Three different types of melts were generated in situ at pores and fractures in the shocked samples. A fourth type is a result of the response of the experimental setup to shock. (1) The first type of silicate melt is highly vesicular and occurs as small melt pockets (<1 to ~5 µm). In BSE images it is much darker than the surrounding quartz. It shows foamy and/or flow texture with schlieren. The average composition is dominated by Al_2O_3 and SiO_2, which favors kaolinite (± iron oxides/hydroxides) as source phase. This dark melt was formed in all shock experiments, but the melt proportion increases with increasing shock pressure. (2) The second type of melts is identical in appearance to the first one but chemical compositions indicate that these melts were formed due to melting of two different types of illite (i.e., a high K_2O, low FeO, and a high FeO, low K_2O variety) and/or muscovite. The iron content is typically higher than in type 1 and results in a comparatively lighter color in BSE images. This melt was not observed in the 5 GPa experiment but in all experiments at higher shock pressures. The abundance of this melt type increases with increasing pressure as well. At 15 and 17.5 GPa chemical mixing of all phyllosilicate-based melts with silica melt derived from quartz could be observed. (3) The third type of melt has a similar chemical composition to types (1) and (2), except for higher FeO contents. Also, type 3 contains small iron droplets (0.5-2.0 µm), which originate from the ARMCO iron driver plate. In some cases this Fe enrichment induced a phase separation of a Si-rich and Fe-rich silicate phase (observable as emulsion textures), due to liquid immiscibility. Melt 3 occurs from 7.5 GPa on. (4) The fourth type of melt represents iron injected from the ARMCO iron driver plate into fractures initiated at the surface of samples shocked to 10 GPa or higher.

Conclusion: The total (combined) amount of melt types 1-4 increases drastically with increasing shock pressure from 1.6 % at 5 GPa to ~ 14 % at 17.5 GPa. The amount of silicate melt depends on the type of phyllosilicate minerals that occur in the sandstone matrix. The higher the amount of water in these minerals, the lower the shock pressure needed to induce silicate melting.