SHOCK-DARKENING IN ORDINARY CHONDRITES: WHAT NUMERICAL MODELLING CAN DO AND WHAT THE RESULTS TELL US.

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Introduction: Shock-darkening in ordinary chondrites is the process during which metals and iron sulphide melt into a network of veins rendering the chondrites lithology darker [1]. This shock process does not melt silicates and has an implication on the reflectance spectra of ordinary chondrites. In order to study shock-darkening, we used the shock physics code iSALE [2] to investigate the material behaviour under shock pressure. To assess peak-pressures, post-shock temperatures and melt, we used a mesoscale approach on the millimeter scale, where individual mineral phases embedded in a matrix are resolved. The shock wave is generated analogous to the experimental setup where a planar shock wave is induced by a flyer plate impacting a buffer plate that covers the actual sample. After the passage of the shock wave (after release to normal pressure) we determined the melt fraction in the sample for each mineral phase. To simulate ordinary chondrites, iron and troilite grains are resolved in an olivine matrix.

Peak-pressures and post-shock temperatures (PST's): The peak-pressures are the maximum pressures the material has experienced during the passage of the shock wave. PSTs can be calculated from the peak-pressures by relaxing the material (tracers with recorded peak-shock pressures) along a release adiabat (approximated by the Hugoniot curve) to normal pressure in a post-processing step after the numerical model has been carried out ([3], [4], [5]). Assuming a melt temperature for each material (for olivine, between the liquidus and solidus of the solid-solid solution), we can determine whether a tracer is molten after release from shock pressure and estimate the total amount of molten material for each component (olivine matrix, iron and troilite grains).

Materials: Three ordinary chondrites, H, L and LL types were analysed using data from [6] in troilite and iron distribution. Kamacite and iron are thermodynamically similar in our models [7] and we approximated troilite with pyrrhotite ([8], [9]) using the former melting temperature. Olivine was 6 % porous Fo_{90} with thermal properties of an average composition in Fo_xFa_{1-x} for each ordinary chondrite type [1].

Results: For each ordinary chondrite type, we ran 8 models (repeated 3-5 times) varying the shock pressures in the buffer plate. Figure 1 shows some results at 61 GPa (nominal pressure in buffer plate). Troilite readily melts at lower shock stages, a lead to the shock-darkening. Late melt of iron is due to several parameters that cannot be taken into account by the numerical model..

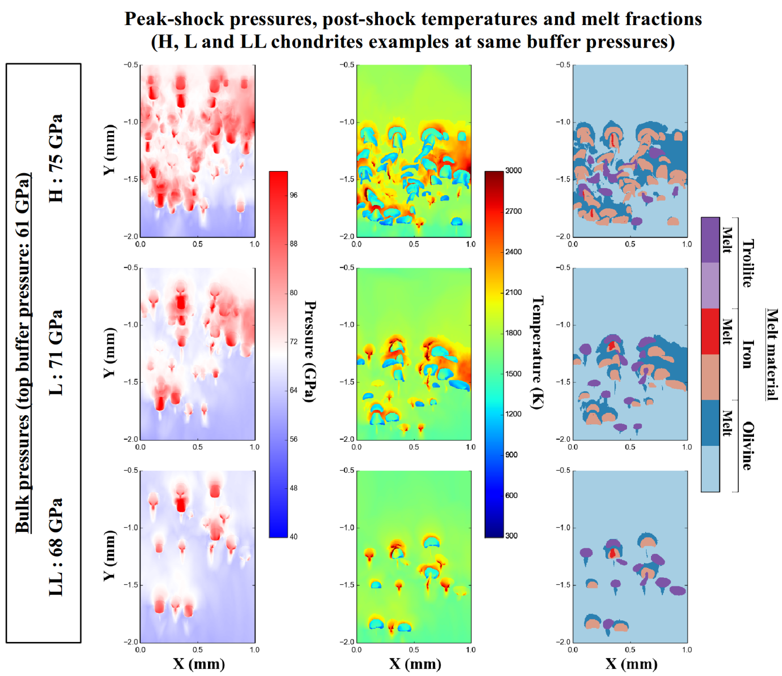

Fig. 1. Example results at 61 GPa (nominal pressure in buffer plate) where the sample plate is delimited by the grains. Temperature and melt panels are shown at release (compressional stage).

References: [1] Kohout, T. et al., 2014. *Icarus* 228:78-85. [2] Wünnemann, K. et al., 2006. *Icarus* 180:514-527. [3] Artemieva, N. and Ivanov, B., 2004. *Icarus* 171:84-101. [4] Fritz, J. et al., 2005. *Meteoritics & Planetary Science* 40:9/10:1393-1411. [5] Watters, W.A. et al., 2009. *Journal of Geophysical Research* 114:E02001. [6] McSween Jr., H.Y. et al., 1991. *Icarus* 90:1:107-116. [7] Langenhorst, F. and Hornemann, U., 2005. *Notes in Mineralogy* 7:15:357-387. [8] Ahrens, T.J., 1979. *Journal of Geophysical Research* 84:B3:985-998. [9] Brown, J.M. et al., 1984. *Journal of Geophysical Research* 89:B7:6041-6048.