CRYSTALLIZATION OF WADSLEYITE AND RINGWOODITE IN SAHARA 98222, 00293 AND 00350: CONSTRAINTS ON SHOCK CONDITIONS

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Introduction: High-pressure phases in shocked meteorites provide information on shock pressure and temperature conditions during collisions on their parent bodies. Wadsleyite and ringwoodite are high-pressure polymorphs of olivine that can form by solid-state transformation or crystallization from shock melt. These minerals have been well studied [1, 2], however their coexistence in transformed olivine has not [3, 4]. The purpose of this study is to understand why ringwoodite and wadsleyite coexist together in shocked L chondrites, and to use this coexistence to constrain shock conditions. We report results on three ordinary L6 chondrites: Sahara 98222, 00293 and 00350.

Methods: A thin section from each sample was studied with polarized and reflected light microscopy (PLM and RLM). Transformation textures were characterized with BSE-SEM imaging and chemical compositions of olivine polymorphs were measured with WDS and EDS. Mineralogy associated with transformation features was determined by PLM and Raman spectroscopy.

Results: Sahara 98222 and 00293 have similar networks of 0.5-2.0 mm shock veins and pockets with associated high-pressure phases in the quenched melt, in the entrained polycrystalline fragments and along the melt-host rock interface. Wadsleyite occurs as polycrystalline rims on transformed olivine clasts in contact with shock melt. Ringwoodite generally occurs as lamellae in olivine within clast interiors as well as in direct contact with shock melt.

Sahara 00350 is distinguished from the other samples by having a larger (3.0-4.0 mm) shock vein with blue and transparent ringwoodite as well as green wadsleyite. Olivines located in the host rock show similar transformation textures as the other chondrites, with polycrystalline wadsleyite or ringwoodite in contact with melt, progressing to ringwoodite lamellae in olivine away from the melt. Within the melt vein, wadsleyite is distributed along the melt-host rock boundaries whereas ringwoodite occurs in the melt-vein center. Both phases rarely coexist in the same transformed clast within the melt. Transformation textures of some clasts show evidence of back-transformation from ringwoodite to olivine.

Discussion: WDS and EDS measurements indicate a lack of iron partitioning between the olivine polymorphs (Fa_{24-25}), implying a solid-state transformation that is not diffusion controlled. The coexistence of wadsleyite and ringwoodite can be attributed to a shock pressure of approximately 18-20 GPa, and a range of temperatures that cross the wadsleyite-ringwoodite phase boundary [5]. The overall absence of wadsleyite and abundance of ringwoodite in most L6 S6 chondrites likely reflects higher-pressure shock conditions, beyond the ringwoodite-wadsleyite phase boundary [6].

References: [1] Binns R. A. et al. (1969) *Nature,* 221, 943-944. [2] Price G. D. et al. *Canadian Mineralogist* Vol. 21, 29-35. [3] Ohtani et al. (2006) *Shock Waves,* 16, 45-52 [4] Miyahara et al. (2008) *Proceedings of National Academy of Science,* 105, 8542-8547. [5] Fudge C. et al. 2015. Abstract #2659 46th Lunar and Planetary Science Conference. [6] Fudge C. et al. 2014. Abstract #2237 45th Lunar and Planetary Science Conference.