$(MG,FE)SIO_3$-PEROVSKITE AND OTHER HIGH-PRESSURE MINERALS IN ACFER 040: EVIDENCE OF VERY HIGH PRESSURES

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Introduction: The impact history of meteorite parent bodies can be extracted by using shock effects in meteorites to estimate shock pressures and durations. Highly shocked chondrites generally contain shock veins with associated high-pressure minerals that form by crystallization of the shock melt or by transformation of host-rock fragments entrained in the melt [1]. The crystallization assemblage can constrain shock pressure and the kinetics of transformation processes can be used to constrain the duration of the shock event [2-5].

Background: Acfer 040 is a highly shocked S6 L5-6 chondrite with numerous melt veins and pockets. This sample was the first in which akimotoite and silicate perovskite were identified as products of melt-vein crystallization [6]. In that initial study, only a small amount of the melt-vein matrix was examined by TEM. The purpose of this study is to characterize the mineralogy and microstructures of the transformed host fragments to understand transformation mechanisms and to investigate how the shock-vein assemblages vary through the sample. Our methods include polarized light microscopy (PLM), Raman spectroscopy, field-emission SEM, FIB and TEM.

Results: *Melt-vein matrix:* There are two distinct crystallization assemblages: 1) akimotoite + $(Mg,Fe)SiO_3$-perovskite + ringwoodite, as described in [6] and 2) $(Mg,Fe)SiO_3$-perovskite + ringwoodite. The perovskite-ringwoodite assemblage is visible in PLM images as a finely-granular blue matrix. The akimotoite-bearing assemblage has 10-µm colorless laths of akimotoite.

Ringwoodite: Ringwoodite occurs as pure polycrystalline-aggregate grains and as rims on and lamellae in partially transformed olivine. These olivines have a distinctly brown color and a lamellar texture with Fayolite-poor (Fa_{21}) olivine cores and fayalite-rich (Fa_{26}) ringwoodite rims in contact with melt.

$(Mg,Fe)SiO_3$-perovskite: Microstructures in BSE images suggest that enstatite is completely transformed to $(Mg,Fe)SiO_3$-perovskite plus a second minor phase. The perovskite appears to have vitrified, but this is being confirmed with TEM.

Discussion: Variations in melt-vein assemblage reflects variations in melt composition and cooling history. Partially transformed olivines have increasing ringwoodite contents toward melt veins, indicating that thermal heterogeneities drive the olivine-ringwoodite transformation during the shock-pressure pulse. The lack of majorite garnet and the ubiquity of $(Mg,Fe)SiO_3$-perovskite indicate that this sample experienced pressures in excess of 26 GPa and higher than other S6 samples.

References: [1] Chen, M. et al. (1996) *Science* 271, 1570-1573. [2] Sharp T. and De Carli P. (2006) *MESS II*, 653-677. [3] Xie, Z. et al. (2006) *GCA, 70.* 504-515. [4] Ohtani, E. et al. (2004) *EPSL 227(3-4)*, 505-515. [5] Chen et al. (2004) *Proceedings. of NAS 101(42)*, 15033-15037. [6] Sharp et al. Science 277, 352-355.