DISCOVERY OF HIGH-PRESSURE POLYMORPHS IN THE RECENT FALL OF VIÑALES (L6 ORDINARY CHONDRITE): IMPLICATIONS FOR COLLISIONS ON ITS PARENT BODY.

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Introduction: Ordinary chondrites record impact-related features, including high-pressure (HP) minerals, usually occurring in melt veins (MVs), yielding constraints on shock conditions and hence parameters such as the size of colliding bodies, impact velocity, etc. Here, we report the first observations of HP mineral polymorphs in the recent L6 chondrite fall of Viñales (Cuba, 1st February 2019; proposed shock stage S3 [1] and partly S4 [2]). The investigated thin section shows at least nine major, subparallel, MVs (50-600 μm wide) and a few thinner MVs at an angle to these. It is unclear whether they are of a single or multiple generations. We have so far identified, within a single melt vein, a region hosting the HP polymorphs majorite and albitic jadeite. These observations define a definite pressure range for this meteorite and contribute to the shock record of the L-chondrites in general.

Material and analytical methods: One polished thin section (from a private collection) of the Viñales meteorite was examined for shock indicators with a focus on the MVs. Optical microscopy, scanning electron microscopy (Field-emission SEM; JEOL JSM-IT300LV and Zeiss 1550VP), electron microprobe (EPMA; JEOL JXA 8900 and JEOL JXA 8530F), micro-Raman spectroscopy, and electron back-scatter diffraction (EBSD) were used. Fifteen areas located in nine MVs were analyzed for their texture and mineral chemistry. Several regions were studied with co-located Raman spectroscopy; one site, so far, contains HP polymorphs.

Results and Discussion: Although no HP minerals have previously been reported in the Viñales meteorite, we have observed two HP minerals: majorite and albitic jadeite. A Raman spectrum, obtained from a grain located within a melt vein (grain size ~2-3 μm in diameter), displays the characteristic major peak at ~925 cm^{-1} and minor peak at ~583 cm^{-1}, reported from both synthetic and natural majorite. The EBSD pattern collected from the same point can be indexed only with the garnet structure. The EPMA compositions of grains in this area, with these Raman and EBSD characteristics, show nearly end-member majorite composition, $Ca_{0.15}Mg_{2.96}Fe_{0.55}Al_{0.41}Si_{3.87}O_{12}$. The albitic jadeite has been identified as crystals with irregular shape (<1-2 μm) within a Na-rich melt pool, adjacent to the majorite-bearing melt vein. The Raman spectrum of the albitic jadeite shows distinct peaks at ~700, 375, and 381 cm^{-1}. Unfortunately, the peaks at ~988 and ~1034 cm^{-1}, related to vibration of $[Si_2O_6]^{4-}$ groups in jadeite, which are not resolved in albitic jadeite, were not observed. EPMA analysis yields the following empirical formula: $(Na_{0.52}Ca_{0.06}Mg_{0.04}K_{0.01}\square_{0.37})(Al_{0.75}Si_{0.26})Si_2O_6$, with Ca# [100×Ca/(Ca+Na)] of 10.2; the M2 vacancies and Si on M1 show that this is albitic jadeite [3]. No suitable EBSD signal was obtained for this beam-sensitive material, but we plan to confirm the pyroxene structure by transmission electron microscopy.

If a part of the melt veins reached peak temperatures above the liquidus of the matrix material and maintained that state long enough to reach complete melting, then the MV would have evolved according to the liquidus relations of a cooling chondritic liquid. The texture of the melt vein hosting the majoritic garnet suggests an evolution from a liquid, as indicated by the equigranular crystal shape and 120° triple junctions. Although Raman spectra from the Na-rich fine-grained region suggest a jadeite-like pyroxene, the non-stoichiometric composition currently precludes use of the jadeite stability field as a constraint. However, the *absence* of lingunite suggests maximum $P < 21$ GPa [4] and the absence of Ca-ferrite, Ca-perovskite, or Ca-rich garnet suggests, at least locally, $P \leq 15.5$ [5] GPa.

Conclusions: Pending further analyses, it is already clear that Viñales hosts a mineral record of high-*P*,*T*. In contrast to previously published works, we identified two HP polymorphs. The investigated section of Viñales shows features more consistent with shock stage S5-S6 [6]. The presence of discrete melt veins indicates heterogeneity of the *T* field, likely the result of the collapse of spatially variable porosity during shock compression or slip along localized shear bands [7]. We cannot presently define the range of peak conditions or *P*-*T* paths experienced by the meteorite or rule out the recording of multiple shock events on its parent body.

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