IN-SITU FORMATION OF HALITE IN THE SIDI EL HABIB 001 ORDINARY CHONDRITE.

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Introduction: All ordinary chondrites (OCs) experienced secondary alteration on their parent asteroids which has produced a diverse suite of secondary phases [e.g., 1]. However, because most OCs are finds, they experienced varied amounts of terrestrial weathering that could have altered their primary and secondary phases. The effects of terrestrial weathering can be minimized by studying fresh samples that were recovered soon after their fall. Sidi El Habib 001 (SEH 001) is an H5-anomalous ordinary chondrite that was discovered in December 2020 in Bordj Badji Mokhtar, Algeria (24.298°N, 3.745°E). It is a possible fall, i.e., it may correlate with the witnessed bright fireball in western Algeria on December 20, 2020 (Meteoritical Bulletin Database). The broken surface of the rock shows relatively abundant bright blue to purple grains of halite (up to 1 mm in size). Here we report preliminary results on SEH 001, with the aim of revealing potential textural relationships between halite and other phases.

Sample and methods: A one-inch round polished-thick section of SEH 001 from the Buseck Center for Meteoirte Studies at Arizona State University was prepared and kindly loaned to us by Prof. Laurence Garvie. We acquired reflected light optical images using a Keyence VHX-7000 Series 4K digital microscope as initial sample documentation. Wavelength dispersive X-ray maps of the section were then acquired on a Cameca SX-100 electron microprobe to determine the overall sample petrography. More detailed information on sample microstructure was acquired with a Hitachi S-4800 scanning electron microscope equipped with energy-dispersive X-ray spectrometry (EDS).

Results: The reflected light images reveal abundant (modal abundance: ~5.5%), randomly distributed, light blue anhedral halite grains. The largest grain measures ~2.5×1.5 mm, and most grains clearly visible in the optical images are a few hundred micrometers in size. Several halite-free clasts occur in the sample, as unveiled by the Na and Cl X-ray maps. Most of these clasts have roughly rounded shapes, except for one clast with a nearly rectangular shape (~8×4 mm). These clasts do not show significant differences in texture and mineralogy from the halite-rich matrix and their boundaries are otherwise obscure, although the rectangular clast contains a slightly higher abundance of metal and sulfides (~13.7%, compared with ~7.3% of the matrix). Backscattered electron (BSE) images show that the halite grains predominantly occur adjacent to olivine, pyroxene, and feldspar, and many protrude into the interstitial regions. Minor fine-grained inclusions of silicates (mainly olivine, but also pyroxene and feldspar), sulfides, and chromite occur in halite. We also observe rare occurrences of sylvite partially replacing halite along grain boundaries. The largest halite grain contains widespread sylvite inclusions (<15 μm), some of which have cubic or elongate shapes. We observe a replacement texture of Cl-apatite by halite. Relict Cl-apatite grains occur in halite, and they have embayed or corroded interfaces (Fig. 1). Merrilite intergrows with Cl-apatite, but it does not replace halite. Halite is virtually absent in chondrules, but the albitic mesostases are compositionally heterogeneous and contain Cl enrichments on the periphery of chondrules based on EDS analyses.

Implications: SEH 001 represents the third meteorite sample, apart from Monahans (1998) and Zag, that contains ubiquitous halides [2, 3]. Our study provides unambiguous textural evidence for the in-situ formation of halite on OC parent bodies. A sequential replacement relationship is revealed: merrillite→Cl-apatite→halite. We hypothesize that this alteration process contributed Cl to chondrule mesostases. The halite-free clasts are texturally equilibrated with the matrix, which might imply that halite formed during aqueous alteration prior to metamorphic equilibration. Halite can be thermally stable without metamorphic reactions with albite up to ~700 °C at low pressures [e.g., 4], and therefore could have survived metamorphism. Post-peak metamorphism disruption of OC parent bodies, as described in a rubble-pile model [e.g., 5], could also facilitate the preservation of halite.

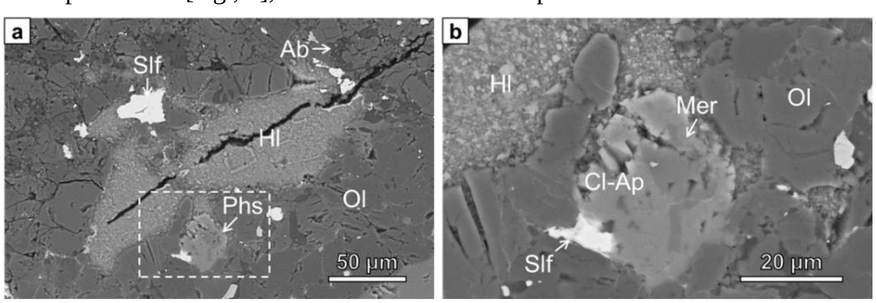

Fig. 1. BSE images showing the replacement sequence of merrillite (Mer)→Cl-apatite (Cl-Ap)→halite (Hl). The outlined region in (a) is shown in (b). Additional abbreviations: Ab, albite; Ol, olivine; Phs, phosphates; Slf, sulfides.

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