SEARCH AND CHARACTERIZATION OF VOLATILE-RICH CLASTS IN BRECCIATED METEORITES.

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Introduction: Volatile-rich, hydrous, or carbonaceous chondrite fragments have been identified in many types of chondrites including carbonaceous, ordinary, and Rumuruti chondrites as well as in breccias of differentiated meteorites (aubrites, HEDs, and ureilites; e.g., [1-7]). Many of these documented fragments are from CR and CH chondrites, in which they are most abundant (e.g., [1,2,4]). We searched for more of these fragments in breccias from other chondritic classes and from differentiated meteorites including howardites, and polymict eucrites and ureilites.

Results: We have identified these fragments by light and scanning electron microscopy (SEM) and studied volatile-rich clasts in eleven meteorites. The fragments were mineralogically and chemically characterized using SEM, electron microprobe (EMPA) and LA-ICP-MS. Different types of clasts were observed varying in their matrix composition, magnetite and pyrrhotite abundances and morphologies, the presence of carbonates, and anhydrous silicates. Chemically, they show flat REE patterns having concentrations similar to CI. By focusing on the texture, two main groups of clasts can be distinguished:

Group 1 fragments contain abundant chondrules or chondrule and mineral fragments which are surrounded by fine-grained, accretionary rims [8] and matrix. Clumps of Fe-rich phyllosilicate occur in the matrix beside abundant carbonate grains. Fragments of this type share some textural similarities with CM chondrites.

Group 2 fragments are dominated by a fine-grained matrix. Their low analytical totals of ~85 wt% and the textural appearance indicate the presence of phyllosilicates; the partly high S content (~1-4 wt%) can be attributed to tochilinite or the occurrence of submicrometer-sized sulfides. Magnetites are embedded within the matrix and either occur as isolated framboids or as aggregates of many crystals with sizes ranging from << 1 µm to several µm. Furthermore, the abundances of pyrrhotite and pentlandite grains (mostly <20 µm) vary within these clasts. Sometimes the pyrrhotites exsolved lamellae or blobs of pentlandite.
Rare carbonates and fragments of anhydrous minerals (mostly Fe-poor olivine) occur in some inclusions. Fragments of this group contain phases typical for CI chondrites, but their textures also distinct differences to CI chondrites [9].

Discussion: The presence of such inclusions in meteoritic breccias can provide information on the conditions under which they were incorporated into the host meteorite, the mixing of different types of planetary materials in the early solar system and perhaps the timing of aqueous alteration on planetesimals.

References: [1] Bischoff A. et al. 1993. *Geochim. Cosmochim. Acta* 57:2631-2648. [2] Endress M. et al. 1994. *Meteoritics* 29:26-40. [3] Zolensky M.E. et al. 1996. *Meteoritics & Planet. Sci.* 31:518-537. [4] Bischoff A. et al. 2006. *Meteorites and the Early Solar System II* (eds. D.S. Lauretta and H.Y. McSween Jr.), 679-712, Univ. of Arizona, Tucson. [5] Funk C. et al. 2011. *Meteoritics & Planet. Sci.* 46:A71. [6] Briani G. et al. 2012. *Meteoritics & Planet. Sci.* 47: 880-902. [7] Greshake A. 2014. *Meteoritics & Planet. Sci.* 49: 824-841. [8] Metzler K. et al. 1992. *Geochim. Cosmochim. Acta* 56:2873-2897. [9] Morlok A. et al. 2006. *Geochim. Cosmochim. Acta* 70:5371-5394.