NEW VOLATILE-RICH CLASTS FROM BRECCIATED CHONDRITES AND ACHONDRITES

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Introduction: Brecciated meteorites can contain fragments of unique materials, which are not available as individual meteorites in collections around the world. Among all types of fragments volatile-rich, hydrous or carbonaceous chondrite clasts are of special interest. These clasts have been identified in many types of chondrite breccias including carbonaceous, ordinary and Rumuruti chondrites as well as in breccias of differentiated meteorites such as aubrites, several HEDs and polymict ureilites; (e.g. [1-7]). A majority of the clasts has been found in CR and CH chondrites, where they are very common (e.g. [1,2,4]). We searched for more volatile-rich clasts in brecciated ureilites, HEDs and chondrites.

Analytical Techniques: We identified and studied >80 volatile-rich clasts by optical microscopy in reflected light and by scanning electron microscopy (SEM), also used for qualitative phase determination. Chemical data were obtained by electron microprobe (EMPA, major elements) and Laser Ablation-ICP-MS (minor and trace elements).

Results: We identified different types of clasts, which can be distinguished by their mineralogy and texture. Important characteristics are (a) the matrix composition, and (b) the abundances of magnetite, sulfide, carbonates, and anhydrous silicates. The REE patterns of all clasts analyzed so far are mostly flat having REE concentrations similar or slightly enriched relative to those of CI chondrites. Three groups of volatile-rich clasts can be distinguished by mineralogy:

Group 1 clasts contain abundant (~5-20 vol%) chondrules, chondrule and mineral fragments, which are surrounded by fine-grained accretionary rims [8]. Clumps of tochilinite-cronstedtite-intergrowth occur within the matrix beside abundant carbonate grains. The modal abundances of all phases are variable and nearly all clasts are rounded. Based on the texture and mineralogy of the clasts, a close relationship to CM chondrites can be established.

Group II clasts are dominated by fine-grained matrix, which yields low analytical EMPA totals of ~85 wt% indicating the presence of volatiles (OH, H_2O, CO_2) and a micro-porosity. Magnetite is embedded within the matrix and occurs as isolated spherules or framboids with individual grain sizes ranging from << 1 µm to several µm (Fig. 1). Furthermore, pyrrhotite and troilite grains (both <20 µm) occur with varying abundances. Pyrrhotite sometimes shows exsolution of pentlandite. Rare carbonates (with variable composition) and anhydrous minerals (mostly Fo-rich) occur in some clasts. The clasts are less rounded compared to group I. Clasts of this group show textural and mineralogical similarities to CI chondrites. Nevertheless, considering the Mg- and Fe-concentrations the matrix composition is more variable compared to those of the silicate matrix of Orgueil.

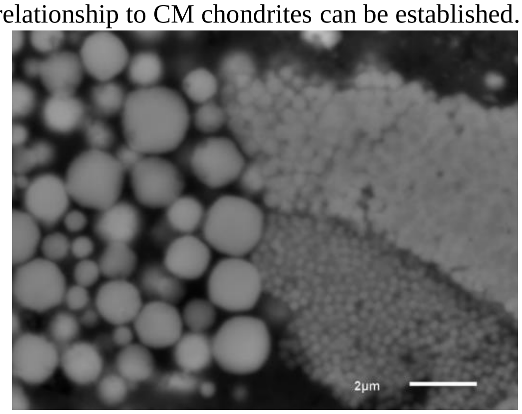

Fig. 1: Different generations of magnetite within a clast from the polymict ureilite DaG164.

Group III clasts and group II clasts are similar to indistinguishable if only their matrix composition is considered. However, differences exist concerning specific mineral abundances: The scarcity of magnetite is one feature, which distinguishes these clasts from group II clasts.

Discussion: Based on the very similar compositions of the silicate-rich matrix it is suggested that the origin of group II and group III clasts is closely related. Both types of fragments may represent different lithologies of a common parent body, which was (partly) destroyed and fragments of different lithologies were dispersed and mixed to the host parent body regolith. Alternatively, the volatile-rich projectile was brecciated upon impact and fragments of its different lithologies were mixed with fragments of the target. The rounded shapes of group I clasts indicate strong mechanical modification of the clasts in the parent body regolith.

Conclusion: The presence of such volatile-rich clasts in breccias may offer a completely different solar system material, which is not present in today's meteorite collections and thus needs to be investigated carefully. Isotopic studies on H, O, N, and Cr are planned.

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