GRAPHITE AND ORGANIC MATTER IN ABEE ENSTATITE CHONDRITE

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Introduction: Abee is a EH4 enstatite chondrite. It has been described as an impact breccia, with some parts having been exposed to temperature over 880°C [1]. The shock induced by the impact has likely resulted in the segregation of metal and enstatite, leading to an heterogeneous structure with metal-rich clasts included in enstatite sulfide assemblage. It contains 0.36% of carbon [2], mainly described as graphite, but some of the carbon is poorly organized, being likely organic matter [3]. We have extended the data we have already reported by using NanoSIMS and HRTEM [3], to precise the structure of both graphite and organic matter and to understand their relationship in Abee.

Results and Discussion: The organic matter in Abee is characterized by the lowest D content in extraterrestrial carbonaceous matter (δD = -330 ±25 ‰ by NanoSIMS, consistent with previous bulk measurements [4]), making it a unique organic component. It has a poorly organized structure like insoluble organic matter (IOM) in other chondrites, but it sometimes exhibits an intriguing porous microtexture, not observed in other enstatite or carbonaceous chondrites. This could be the result of the dissolution of encapsulated minerals during the chemical treatment to recover the residue. Graphite is found as single crystals, as revealed by electron diffraction patterns. They are almost pure C as indicated by very low H/C (<0.2 at. %) and N/C (<0.0001 at. %). Their $\delta^{13}C$ (-11 ±3 ‰) shows their solar origin, likely by processing of organic matter on the parent body or before accretion.

In other chondrites, such well organized pure carbon materials are often encountered in metal grains [5], formed by catalytic effect with the metal. SEM imaging of Abee does not reveal any inclusion of C material in metal grains. Some C-rich rims are observed around big metal grains. But C-rich grains are more abundant in metal-poor regions than in metal-rich regions. In the metal-poor ones, some elongated structures (up to 40 μm) embedded in enstatite and/or sulfides and similar to "laths" previously described [1] are observed. Nevertheless preliminary Raman measurements tend to indicate that they are constituted by poorly organized material, likely the IOM. More Raman measurements and SEM imaging are under progress to find C-rich grains in both lithologies and study the petrographic relations of the graphite vs organic matter and minerals.

Conclusion: Abee contains a unique assemblage of carbonaceous phases. Its IOM has likely been subjected to D-depleted regions of the solar nebula, to induce its unusual D/H ratio, even compared to other enstatite chondrites [6]. On the other hand, it contains perfect large graphite grains whose origin (thermal processing of the IOM? exsolution from metal?) needs to be clarified.

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