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Aqueous alteration in CV carbonaceous chondrites

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Abstract

Several sections of CV chondrites belonging to the NASA Antarctic collection are being studied by our group in order to better understand the nature and physical processes occurred on the CV parent asteroid. We compare them with several sections of more common representative specimens from historic falls like e.g. Allende and Mokoia to find evidence of impact-induced heating and aqueous alteration. Once identified relevant features, we obtain mineralogical clues by using a Raman spectrometer.

1. Introduction

The CV group of carbonaceous chondrites is usually represented in meteorite collections by the famous and well represented Allende fall. Recent Antarctic findings have increased the number of meteorites of this group to 224 [1]. CV chondrites have been extensively studied in the literature, and are dominated by FeO-rich olivines and other phases that could be originated by aqueous alteration followed by thermal metamorphism [2]. Another possibilities include nebular formation of some of these minerals [3]. A recent paper has demonstrated that for example Mokoia exhibits clasts that have suffered extensive aqueous alteration [4]. We describe here the texture, mineralogy and petrological features of several pristine CV chondrites in order to get clues on the parent body processes that participated in the processing of its forming constituents. Among the questions we wish to answer: is there evidence in these rocks of impact compaction, and shock induced by collisions? New clues are required, particularly after recent suggestions that carbonaceous chondrites should have suffered significant impact compaction [5, 6]

2. Procedure and experimental setup

To study the thin sections we created high-resolution reflectance mosaics by using a Carl Zeiss petrographic microscope. We selected in the imaged sections several areas to be precisely characterized (see top of Fig. 2). Micro-Raman spectra were recorded in backscattering geometry at room temperature using the 5145 Å line of an Argon-ion laser with a Jobin-Yvon T-64000 Raman spectrometer attached to an Olympus microscope and equipped with a liquid-nitrogen-cooled CCD detector [see e.g. 7]. The lateral spatial resolution was ~ 1µm and the laser power onto the sample was kept below 1mW to avoid degradation due to overheating of the proved volume. The meteorite sections were brought to a Raman spectrometer in order to identify the main forming minerals, also searching for evidence of shock. The Raman spectrometer allowed us to get high-resolution spectra in a typical working window of 200 to 1,400 cm^{-1}. When needed to identify other minerals the window was expanded until 1,900 cm^{-1}.

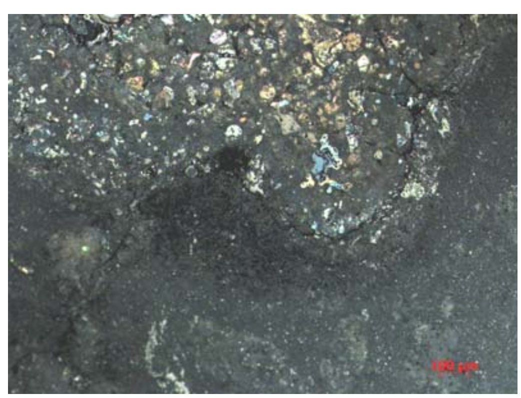

Figure 1 : Compaction is noticeable in the matrix surrounding a porphyritic chondrule of Allende.

3. Discussion

The thin sections studied of different CV chondrites Allende, Mokoia and MET 01074 exhibit different aqueous alteration patterns. While Mokoia and MET 01074 exhibit clear features of aqueous alteration, like e.g. formation of magnetite from metal-rich grain precursors (see e.g. Fig. 2), the most available CV3 chondrite (Allende) seems to have been dehydrated before more extensive aqueous alteration occur. MET 01074 seems to be one of the most pristine CVs, but the existence of magnetite suggests it experienced “static” aqueous alteration [2]. Collisional shock waves could have induced compaction and sintering of the CV-forming materials. Small scale fragmentation by collisional gardening probably created breccias as those found in Mokoia [4]. In fact, we have found fragmented chondrules in Mokoia. Thus searching for shock features would bring relevant ideas about the physical conditions under which occurred those processes, and in what extent they might have influenced aqueous alteration in their parent body.

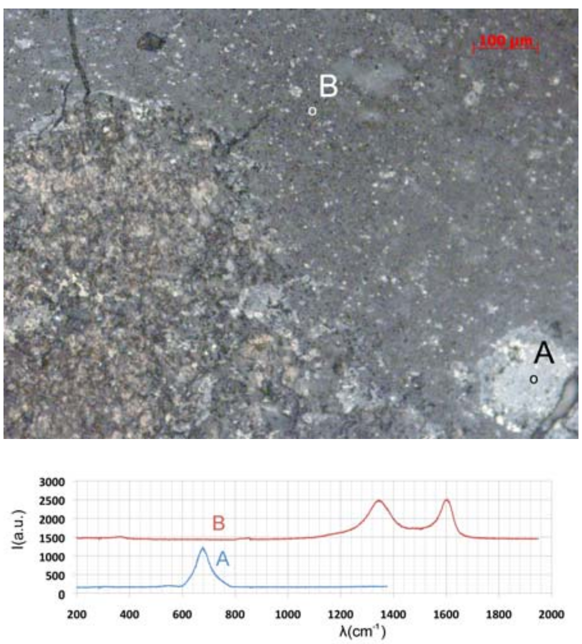

Figure 2 : Two regions characterized of MET 01074 that are surrounding a nice porphyritic chondrule (left side). The spectrum labeled A corresponds to magnetite and that in B shows the two strong C peaks associated with the organic-rich matrix.

4. Summary and Conclusions

Some CV carbonaceous chondrites exhibit different degrees of aqueous alteration. Future studies should try to answer if this is a consequence of the structure of their parent body, and the possible alteration by collisional sintering as function of depth. We cannot rule out a differentiated evolution of fragments towards the NEO region experiencing different degrees of aqueous alteration.

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