

Antarctic Meteorites: MIL 07687 and ALHA77307 - A Novel Approach of In-Situ Micro-XRD Study Of The Matrix. E. Vaccaro^{1,2}, A. J. King¹, J. Najorka¹, N. A. Starkey², I. A. Franchi², S. S. Russell^{1,2}. ¹Dept of Earth Sciences, Natural History Museum, London, UK. ²Planetary & Space Sciences, Open University, Milton Keynes, UK.

Introduction:

The study of primitive carbonaceous chondrites can provide information on the processes that took place in the early stages of Solar System formation, but often Antarctic meteorites can show effect of terrestrial weathering that can challenge our understanding of Solar System processes. In this study we report a new approach of in-situ micro-XRD investigation and comparison of the matrix of two primitive Antarctic carbonaceous chondrites MIL 07687 and ALHA77307. We will discuss the effects of parent body processes such as aqueous alteration taking into consideration also the Antarctic environment where the two samples were collected. MIL 07687 has previously been classified as a CO3 chondrite [1] but has distinct characteristics compared to typical COs, e.g. localised aqueous alteration characterised by a peculiar fibrous FeO-rich phase that electron diffraction data suggests is ferrihydrite or akaganeite [2, 3]. The matrix of ALHA77307 (CO3) shows similarities to the Fe-poor matrix of MIL 07687 [3, 4].

Methods:

In this study ultra-high resolution (≤ 5 nm) image maps of five selected regions of the matrix of MIL 07687 and ALHA77307 were acquired using a Carl Zeiss Ultra Plus Field Emission SEM. Micro-XRD analyses were directly collected from the selected areas on the thin sections using the Rigaku D max Rapid II. We used Cu radiation and a pin-hole of 30 μm to achieve an X-ray beam footprint on the sample of $\sim 50 \times 500$ μm . The data for MIL 07687 was acquired on areas showing evidence of progressively increasing degrees of aqueous alteration. This enabled us to investigate possible trends and/or changes in the mineralogy of different matrix regions.

Results:

In the micro-XRD patterns of the matrix of sample MIL 07687 we identify the following crystalline phases: forsterite, enstatite, iron sulphide and metal. All areas are characterised by diffraction patterns with shapes similar to our poorly crystalline ferrihydrite standard. Despite being collected on areas with different degrees of alteration we observe only small variations in the XRD patterns. This might be due to the fact that at this scale even the least altered regions also experienced some aqueous alteration. Ultra-high resolution image maps of the Fe-poor matrix regions of MIL 07687 reveal similarities to the matrix of ALHA77307, consistent

with previous work [3]. The micro-XRD patterns of ALHA77307 indicate the presence of olivine, enstatite, metal, iron sulphide, and magnetite. In previous TEM investigations we also observed poorly ordered phyllosilicates embedded in a groundmass of amorphous material [5]. This amorphous material is abundant in ALHA77307 (16 vol. %, [6]), and although it does not produce peaks, it still contributes to the intensity and shape of the XRD pattern.

References:

- [1] (2009) *Antarctic Meteorites Newsletter*, 32, No.1.
- [2] Brearley A. J. (2012) *LPSC*, Abstract #1233
- [3] Brearley A. J. (2013) *Meteorit. Planet. Sci.*, 48, 206.
- [4] Brearley A. J. (1993) *GCA*, 57, 1521-1550
- [5] Vaccaro E. et al. (2014), *Meteorit. Planet. Sci.*, 49, 5348.
- [6] Howard K. T. et al. (2015) *LPSC*, Abstract #2244.