FURTHER INSIGHT ON MASKELYNITE AND ACCESSORY MINERALS IN THE NORTHWEST AFRICA 8657 SHERGOTTITE BY COMBINED MICRO COMPUTED TOMOGRAPHY AND MICRO X-RAY FLUORESCENCE SPECTROSCOPY. P. Manzari[1], C. Porfido[2], I. Allegretta[2], R. Terzano[2], E. Ammannito[1], O. De Pascale[3], G. S. Senesi[3], [1]Space Italian Agency-Rome, Italy, paola.manzari@asi.it, [2]Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari "Aldo Moro", Via G. Amendola 165/A, 70126 Bari, Italy, [3]CNR - Istituto di Nanotecnologia (NANOTEC) - PLasMI Lab, Via Amendola 122/D, 70126 Bari, Italy, giorgio.senesi@cnr.it

Introduction: Only 219 of the 68,000 meteorites that have been discovered on Earth have been identified as originated from the planet Mars [1]. Martian meteorites are fascinating because they can reveal very interesting information about Mars environment. Martian meteorites also display a very little surface alteration which confirms that the atmosphere and surface soil of Mars contain very little moisture and free oxygen. The study of Ca-phosphates is of great interest for Martian meteorites as these phases carry more volatiles than other minerals in shergottites.

Non-destructive and non-invasive micro computed tomography (μ-CT) and micro X-ray fluorescence spectroscopy (μ-XRF) were used to study the textural and mineralogical properties of a Northwest Africa 8657 shergottite meteorite fragment. In particular, μ-CT provided a 3D insight of the meteorite and allowed the identification of different domains, on the bases of their morphology and X-ray absorption contrast. The μ-CT technique is an efficient tool to highlight and investigate the melt and veins as well as microstruc-tures and distribution of mineral phases [2]. The μ-XRF is a sensitive analytical technique used for the elemental mapping of a sample, and is very useful to evaluate the nature, distribution and abundance of ele-ments in meteorites.

Sample and methods: A fragment of the Northwest Africa 8657 meteorite classified as a basaltic shergottite was investigated in this work. This meteor-ite is composed predominantly of complexly zoned, prismatically-twinned clinopyroxene (Fe-rich augite and pigeonite) and maskelynite laths with accessory ilmenite, ulvöspinel, pyrrhotite, merrillite, whitlockite, chlorapatite and vesicular glass. Minor components are anorthoclase (containing blades of silica polymorph) and symplectitic intergrowths of ferrosilite+silica [3-5].

An M4 Tornado μ-XRF spectrometer (Bruker Nano GmbH) was used to map the elements distribution on the sample. The instrument was equipped with a Rh tube combined with policapillary optics (50 kV, 600 μA, 25 μm spot size), and two XFlash® silicon drift detectors (resolution<140 eV@Mn Kα line) with an active area of 30 mm^2. A Bruker-SkyScan 1272 high resolution μ-CT instrument (Bruker Nano Gmbh) was used to investigate the morphological and structural features of the sample. The instrument was equipped with a W micro-focus source (<5 μm spot size) and a 16 Mp CCD detector. The sample was scanned using a tube voltage of 60 kV, a current of 166 μA and a 0.25 mm-thick Al filter to improve the signal to noise ratio.

Results and discussion: The combination of these two techniques was particularly suited to infer the melts/maskelynite/veins/fractures in the shergottite. In particular, μ-CT highlighted the different features of fast crystallized acicular dendritic plagioclase/maskelynite and euhedral/subhedral pyroxene crystals, which showed a texture difficult to see by Scanning Electron Microscopy analyses. Further, the 3D rendering (Fig. 1) showed the presence of voids, some of which featuring nearly smooth surfaces similar to bubbles, indicating the presence in the melt of gaseous species probably formed after shock by impact. Some other voids were characterized by irregular internal surfaces related to secondary fractures.

The combined results of μ-CT and μ-XRF analyses allowed to group the mineral species on the basis of their average densities and chemical composition: 1) maskelynite, zoned Ca-Fe clinopyroxenes; Ca-phosphates; 2) ulvospinel/ilmenite, pyrrhotite; 3) K, Fe-sulfates and Ca-carbonates.

As each group contains different mineralogical phases characterized by similar density, new methodological efforts are needed to separate each phase. This, with the aim of combining the two techniques not only for microstructural studies, but also for localizing specific isolated phases for further investigations by means of other techniques.

For example, the presence of Ca-phosphates as merrillite, whitlockite or apatite has implications on the history of the meteorite.

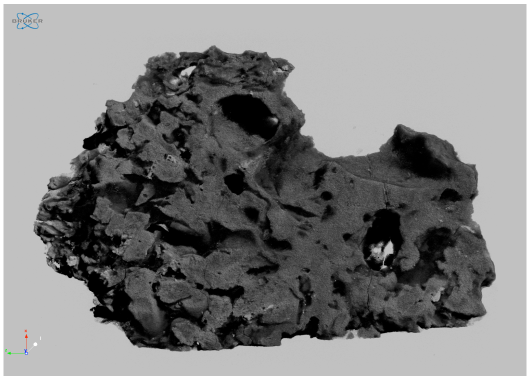

Figure 1 - *Three-dimensional rendering of the Northwest Africa 8657 shergottite fragment.*

Conclusions: The combined use of μ-CT and μ-XRF techniques revealed the presence of microstructures, density contrasts and differences in chemical composition of the shergottite Northwest Africa 8657. Further studies are ongoing aiming to the structural characterization of this meteorite in order to enrich and complete previous results [4] to reconstruct its history and explore new ways to apply and customize μ-CT and μ-XRF to other meteorite types.

References:

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In this work, micro computed tomography and micro X-ray fluorescence were used to study the textural and mineralogical properties of a NWA 8657 fragment.