COMPLEX ORGANICS AND ELEMENTAL SULFUR IN NORTHWEST AFRICA 8159: MARTIAN OR EXTRA-MARTIAN?

A. C. O'Brien[1], L. Hallis[1], A. Steele[2], L. Daly[1], M.R. Lee[1], [1]School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ, UK (a.obrien.1@research.gla.ac.uk) [2]Geophysical Laboratory, Carnegie Institute, Washington D.C., USA.

Introduction: Inclusions of macromolecular organic carbon (MMC) have been found in several martian meteorites (both in falls and finds) e.g. [1-3]. These MMC are made of organic material, primarily polycyclic aromatic hydrocarbons. These organic compounds are of astrobiological interest since such molecules can be a key component in the synthesis of amino acids [4]. These inclusions are unlikely to be terrestrial in origin, since they have been found enclosed in magmatic minerals and below thin-section surfaces [2]. The organic material may be indigenous to the martian mantle [1] or could have been deposited on its surface by carbonaceous chondrites (CC)[2].

Here we characterise MMC in Northwest Africa (NWA) 8159, a recently discovered augite-rich Shergottite. The unusual Cr isotopic composition of NWA 8159 relative to other maritian meteorites suggests it may have a unique mantle source [5], which may produce distinct MMCs. Characterising these MMCs and determining their origin will therefore inform our understanding of the martian, and potentially interplanetary carbon cycle. It will also inform mission science undertaken by MOMA (martian organic material analyser) onboard ESA's ExoMars rover.

Methods: MMC bearing regions of NWA 8159 were identified and analysed using Confocal Raman spectroscopy at the Geophysical Laboratory, Carnegie Insitute. A Focused Ion Beam Scanning Electron Microscope was used at the University of Glasgow to extract these regions for further analysis by synchrotron techniques.

Initial Results and Discussion: Raman spectroscopy identified several MMC in NWA 8159 (Figure 1). The full width half maximum (FWHM) peak centre positions of these MMC are distinct from other martian MMC (Figure 2). In addition, an unusual inclusion of elemental sulfur was also identified (Figure 3). The MMC identified and measured in NWA 8159 appear to be distinct from those found in other martian meteroties. This supports the notion that NWA 8159 samples a distinct martian reservoir [1], however, we cannot rule out a CC origin.

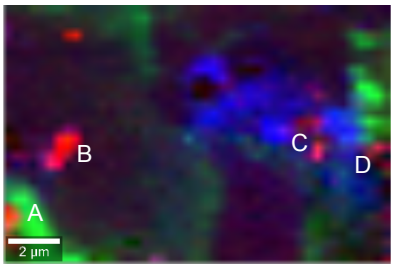

Fig.1 Raman map of MMC (red) , labradorite (green) and and augite (blue) is displayed. Brightness represents intensity. MMC inclusions are labelled A-D.

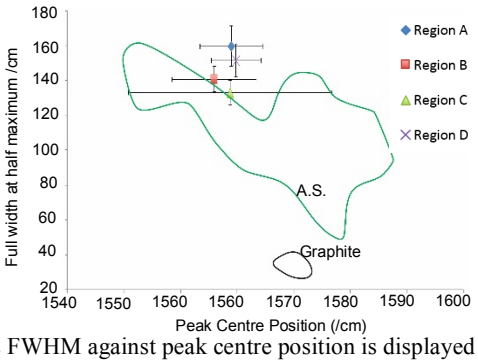

Fig. 2 FWHM against peak centre position is displayed for MMC inclusions A-D. Data overlays MMC from martian meteorite data (A.S.) from [1]. Position of crystalline graphite [6] is also shown.

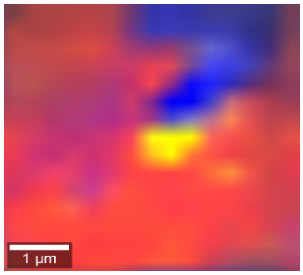

Fig. 3 Raman map displaying the distribution of elemental sulfur (yellow), augite (blue) and hematite (red). Brightness represents intensity.

We report the first findings of elemental sulfur in a martian meteorite. Most sulfur containing minerals on Mars are sulfates [8], therefore, the presence of elemental sulfur is puzzling. We will be investigating the origin of this material to determine if terrestrial weathering (e.g. through oxidation of phyrrotite as outlined by [7]) or indigenous martian processes are responsible for its formation. If this elemental sulfur is martian this has significant implcations for astrobiology as it is has been suggested that any martian lifeforms would be chemotrophic, using material such as elemental sulfur to metabolise [9].

Future Work: We will carry out near edge surface X-ray absorption structure analysis (XANES) at the Diamond Light Source, UK, to determine the molecular structure of MMC. These data will be compared to that of CCs to establish whether an extra-martian origin for these MMC is plausible.

References: [1] Steele A. et al. 2012. *Science* 6091, 337 [2] Sephton M. A. et al. 2002. *Planetary & Space Science* 50: 711-716. [3] Lin Y. et al. 2014. *Meteoritics & Planetary Science* 49,12. [4] Shock E. L. & Schulte M. D. *Nature* 343: 729-731. [5] Herd C. et al. 2017. *Geochemica et Cosmochemica Acta* 218:1-26. [6] Sandford S. A. et al. 2006 *Science* 314, 1720. [7] Buckley A. N. 1985. *Applications of Surface Science* 20: 472-480. [8] Tosca N. J. et al. 2008. *Journal of Geophysical Research:Planets* 113. [9] Westall F. et al. 2015. *Astrobiology* 15, 11.