CONSTRAINING PIGEONITE ON MARS; FURTHER DEVELOPMENTS IN RESOLVING ZONED PYROXENES WITHIN THE MARTIAN METEORITES.

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Introduction: Pigeonite, a low-Ca clinopyroxene, is an elusive mineral on Earth yet is relatively common within both Martian [e.g. 1] and Lunar samples [2]. It has already been shown that pigeonite and Ca-enriched augite, are both present in the Martian Shergottites and are significantly zoned [3]. It can therefore be challenging to resolve pigeonite on Mars, in terms of both spectral studies from orbiter data [e.g. 3, 4] or in scanning electron microscope (SEM) studies using EDS or electron backscatter diffraction (EBSD) of the Martian meteorites [5].

In this study we aim to build upon previous work that used EDS, EBSD and high-precision micro-FTIR [6] to fully resolve and characterize the Martian-specific phases including pigeonite, using new developments in micro-beam techniques.

Samples & Analytical Techniques: Various samples were used in this investigation; polished resin blocks of both Zagami fragments and Tissint fragments were available from previous studies of the Shergottite meteorites [3, 6]. Further polished thin sections were available from the Plymouth University collection; NWA2373, NWA1110, NWA856, Dhofar 019, DaG476 and SAU005. All samples were re-polished for EBSD using a Buehler Vibromet 2 and carbon-coated prior to analysis.

The JEOL 7001 FE SEM at the Plymouth Electron Microscopy Centre was used for analysis, making use of the Oxford Instruments AZtec software, Nordlys Nano and TruPhase capabilities. Low kV imaging (3-5 kV) was used to identify zonation and/or twinning/exsolution within the meteorites before EBSD analysis at 20 kV. Analysis times varied between samples to maximize data quality.

Results & Discussion: Previous attempts to study the Martian meteorites using EBSD [5] have been hampered by the variable zonation observed within the Shergottite meteorites between augite and pigeonite [3]. The two clinopyroxenes, despite definitive geochemical differences, are crystallographically similar; Euler angle differences between the two phases are ~1.5°, which is below the margin of error in most instruments. However, new developments allow for simultaneous collection of both EBSD and EDS data, and that a geochemical reference spectrum can be specified by the user for similar phases within EBSD analysis.

Using this technique, this study has improved the resolution of EBSD analyses for the Shergottite meteorites and can, therefore, clearly define not only the IR pigeonite spectrum [6] but also the definitive crystallographic structure relevant to Martian-specific material in that spectra. This has aided automated mapping of these samples, modal and petrologic analysis; the results of which will be presented at the meeting.

References: [1] Yukio, I. (1998) Proceedings NIPR 1, 14-37; [2] Clark, J. R. Et al. (1971) AmMin 56, 888-908; [3] Stephen, N. R. et al. (2012) Abs. #2199, 42nd Lunar & Planetary Science Conference; [4] Klima R. & Pieters C. (2006) JGR 111:E01005; [5] Stephen, N. R. Et al. (2010) Abs. #5008, 73rd Meteoritical Society Meeting; [6] Stephen, N. R. et al. (2014) Abs. #5185 77th Annual Meteoritical Society Meeting