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SPATIALLY RESOLVED MID-IR SPECTRA FROM METEORITES; LINKING COMPOSITION, CRYSTALLOGRAPHIC ORIENTATION AND SPECTRA ON THE MICRO-SCALE

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Introduction: Spectral data from spacecraft are often used to infer the surface mineralogy of a body by unmixing the bulk spectrum into constituent components and comparing these to spectral databases [e.g. 1, 2]. It is widely accepted that mineral spectra derived from meteorites can provide a more accurate match to their parent body than terrestrial databases alone [3, 4]. Recent work has sought to resolve mid-IR spectra in Martian pyroxenes in terms of crystallographic orientation [3] and zonation [5], and more generally for Martian meteorites using the increased spatial resolution of synchrotron-source µFT-IR [6]. Linking these studies together, one can extract a suite of Martian-specific mineral spectra with respect to various Martian meteorites, both Shergottites and Nakhlites, which should provide a more precise match to the phases observed on the Martian surface. This study looks further than Martian meteorites alone, to also include both HEDs for comparison to Vesta and LL Chondrites to Itokawa, in order to define comparable mineral spectra throughout the solar system.

Samples & Analytical Techniques: Data has been previously collected using the Diamond Light Source, beamline B22, in Oxfordshire, UK, as well as a standard benchtop system at Plymouth University, UK. Both laboratories use a Bruker Continuum microscope attached to the Bruker µFT-IR system, running OPUS software. SEM facilities at the Plymouth Electron Microscopy Centre, Plymouth University were used for both chemical mapping (EDS) and electron backscatter-diffraction (EBSD) analysis of whole sections.

Several meteorite thin sections and polished blocks were prepared for analysis; DaG 476, SaU 005, Tissint, Zagami, NWA 1110 & Dhofar 019 (Martian); NWA 3141, NWA 8266, NWA 8595 & NWA 8594 (HEDs); Benguerir, NWA 2398, NWA 8602 & Parnallee (LL Chondrite). Meteorite samples vary in size from 3 – 27 mm and full chemical maps were acquired prior to EBSD and µFT-IR analysis. The resolution of this analysis was defined by the grain size of each sample, ranging from a 0.5 – 10 µm step size.

Results: Advances in microscopic techniques have allowed spatially resolved mineral spectra to be extracted from thin sections and polished resin blocks, mapping whole samples with an aperture of 25 - 8 µm in the mid-IR range. This includes the typical silicate *fingerprint region* of 1200 – 800 cm^{-1}, as well as the potential for hydrous signatures at 3600 cm^{-1} [7]. In addition, scanning electron microscopy (SEM) techniques can be employed to determine precise crystal composition and orientation in order to better define the IR spectra; band positions shift up to 40 cm^{-1} with composition and ~15 cm^{-1} with orientation within the Martian meteorites, which is also observed in other achondrite groups to a varying degree. µFT-IR mapping of whole thin sections/polished blocks allow for the targeted extraction of phase spectra across compositional zones and orientation changes on the larger scale, revealing spatially resolved data that can be compared across meteorite classes. The aim of this study is to compare these band shifts in other achondrite groups and better define meteorite-specific phase spectra.

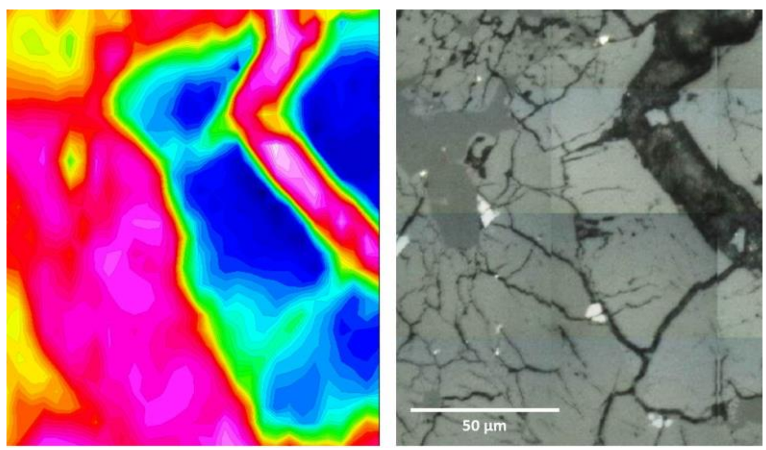

Figure 1: Spectral mapping of the Tissint meteorite reveals compositional zoning within olivine (blue) between an Mg-rich core (dark blue) and Fe-rich rim (green) using the 900 cm^{-1} band, attributed to asymmetrical stretching vibrations.

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