INVESTIGATION OF TOCHILINITE CRONSTEDTITE INTERGROWTHS (TCI's) IN THE WINCHCOMBE CM2 CARBONACEOUS CHONDRITE

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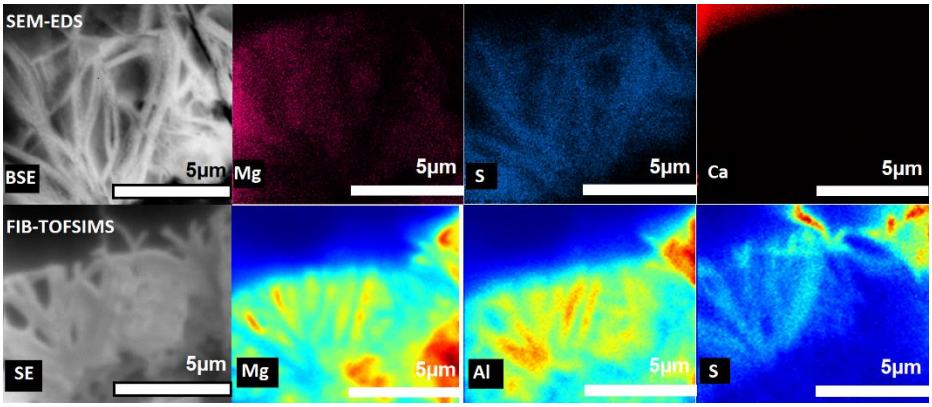
Introduction: On 28th February 2021 a bright fireball was observed across the UK; its trajectory, orbit and strewn field were subsequently defined by image and video capture from the UK Fireball Alliance [1,2]. The main mass of the resulting meteorite was recovered within 12 hours of its fall in the town of Winchcombe [1,2]. This meteorite was subsequently classified as a CM2 chondrite breccia with numerous distinct lithologies displaying a range of aqueous alteration from CM2.0 to CM2.6 [3]. This pristine sample had severely restricted opportunity for terrestrial alteration, thus making it ideal for trace level chemistry studies of its aqueous alteration microstructures derived from water rock reactions on the meteorite's parent body. Of particular interest are tochilinite cronstedtite intergrowths (TCIs) that form during aqueous alteration and whose chemistry and structure are used as indicators for the nature and extent of hydration in CM chondrites [4].

Methods: A sample of the Winchcombe meteorite set within a polished resin block on loan from the NHM, UK, was examined using scanning electron microscopy (SEM). Multiple TCI features were selected as specific targets for more detailed study. The selection of the specific TCIs for study was based on their differing extent of alteration textures and chemistry. SEM-energy dispersive X-ray spectroscopy (EDS) was used to define a range of TCI inclusions with point analysis composition data and mapping data to show elemental distributions. Focused Ion Beam (FIB)-SEM based Time of Flight Secondary Ion Mass Spectrometry (TOFSIMS) was then applied to these same areas to give much higher resolution major, minor, and trace elemental maps, as well as isotope maps gathered as two and three dimensional datasets.

Results: FIB-TOFSIMS data shows sub micron scale resolution of the elemental distribution of the tochilinite growth structures that were difficult to define with standard EDS techniques. The data is suggestive of multiple generations of microstructures formed by successive aqueous alteration events in the Winchcombe meteorite parent body (see figure below), the generational growth being associated with either discrete aqueous events with distinct fluid chemistry or an evolution of fluid chemistry during aqueous alteration.

Discussion and Conclusions: FIBSEM based TOFSIMS is a very useful in-situ analytical technique to characterise two and three dimensional microstructures in meteorites. The aqueous alteration structures that formed within the Winchcombe meteorite parent body have localized variations that most probably relate to changes in its permeability. Further research is planned to explore these results producing data sets with transmission electron microscopy (TEM) and transmission Kikuchi diffraction (TKD) of the exact same study target sites within this sample, to reveal the nanoscale growth structures and infer growth mechanics.



References: [1] King A.J., et al., (submitted) *Sci. Adv.* [2] Daly et al., (2021) *Elements*, [3] Suttle M.D. et al., (This meeting) 85th Metsoc [4] Lentfort S. et al., (2020) *MAPS*, 56, 1, 127-147.