PETROGRAPHY AND MODAL ABUNDANCE OF METAL IN UREILITES: A COMBINED 2D AND 3D STUDY.

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Introduction: Most unbrecciated ureilites are believed to represent intact samples of the ureilite parent body (UPB) mantle, consisting predominantly of olivine and pyroxenes with accessory carbon, metal and sulfide [1]. Although much of the original metal has been lost [2], what remains records partial melting and differentiation processes on the UPB. Knowing the modal abundances of metals within ureilite samples helps with the interpretation of bulk siderophile elements [2,3] and of magnetic susceptibility [4]. X-ray computed tomography (CT) scanning allows non-destructive 3D imaging of samples, visualising 3D spatial relationships which are not apparent in traditional petrographic studies of individual 2D thin sections.

We have analysed a range of ureilite samples in 2D and 3D, including several samples of the anomalous ureilite Almahata Sitta (AS) [5]. As a quickly recovered fall, AS samples do not show oxidation of metal as seen in most other ureilites.

Methods: Samples were scanned using the Metris X-Tek HMX ST 225 CT system at the NHM and reconstructed using CT-PRO 2.0. Analysis of the scans was performed using VG Studio Max 2.0, using greyscale thresholding to separate phases. Thin sections or probe blocks were examined using the LEO 1455 VP SEM at the NHM. Whole section EDS X-ray chemical maps were acquired using Oxford Instruments INCA software and combined to differentiate minerals. These were processed by pixel counting in Photoshop to obtain modal mineralogies.

Results and discussion: Metal in Almahata Sitta shows a large variation in modal percent and appearance between samples. For example, from SEM data AS#22 has ~1.8% metal with grain boundary metal not exceeding ~35μm in width, whereas AS#44 shares many features with the anomalous ureilite LAR 04315 and is particularly metal-rich, with ~3.4% metal and some unusually large grains >250μm in size. These percentages include siderophile-bearing metal in veins and primary inclusions as well as siderophile-free secondary reduction metal. All metal affects magnetic susceptibility, whereas bulk siderophile concentrations are not affected by reduction metal. Reduction metal makes up a greater percentage of the metal content of AS#22 than AS#44. Preliminary data analysis suggests that whilst it is easier to differentiate metal and sulfide using the SEM, carbon is harder to quantify in 2D as SEM samples are carbon-coated. The main sources of error in extrapolating the data are likely to be small sample size and sample heterogeneity.

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