MICROPROBE ANALYSES OF TWO ALMAHATA SITTA UREILITES. K. I. Hutchins[1] and C. B. Agee[1], [1]Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131.

Introduction: On October 6, 2008, a small asteroid ~3 m in size was spotted on an impact trajectory with Earth [1]. The asteroid (named 2008 TC_3) impacted the Earth on October 7 in the Nubian desert of northern Sudan. The meteorites recovered from this impact are called Almahata Sitta (meaning "Station 6", referring to the location where the meteorites were recovered). Approximately 600 meteorites have been recovered. Most of these meteorites are polymict ureilites. However, about 20-30% (in mass) of the recovered meteorites are ordinary, enstatite, and carbonaceous chondrites. The freshness of the collected meteorites (W0-W0/1), along with the detection of short-lived cosmogenic radioisotopes in two chondritic fragments, suggests that most, if not all, of the Almahata Sitta meteorites belong to the same fall [2]. It is likely that asteroid 2008 TC_3 was ejected from a second-generation asteroid that accreted from both ureilitic and chondritic components. Asteroid 2008 TC_3 was probably very loosely consolidated and broke up into mainly monolithic fragments during disruption in the atmosphere.

Sample Analysis: We analyzed two Almahata Sitta meteorites. One of them weighed 155.5 g and is coarse grained (Figure 1). The other sample weighed 24.4 g and is fine grained (Figure 2). Portions of each meteorite were donated to the Institute of Meteoritics by a private collector. Small chips from each meteorite were set in epoxy for analysis with the electron microprobe. Samples were analyzed using a JEOL 8200 electron microprobe at the Institute of Meteoritics, University of New Mexico. Analyses were made using an accelerating voltage of 15 kV, a beam current of 20 nA, and a spot beam (<1 μm) for mineral phases and a broad beam (20 μm) for the fusion crusts.

Results: Originally, we thought we had received one ureilite and one chondrite; however, microprobe analyses revealed that we have two ureilites with different textures. Figure 3 shows the bulk compositions of the two samples (we are using the compositions of the fusion crusts to represent the bulk compositions). Within the one-sigma uncertainties, the two bulk compositions are equivalent. The textures of the two samples, however, are quite different. One ureilite is dominated by coarse grained olivine (a few hundred microns up to ~one millimeter). These olivine grains have reduced rims, with the cores consisting of Fa_{20} and the rims consisting of Fa_3 (Figure 4). This sample contains a small amount (~1%) of pyroxene: 3 grains (~5-20 microns) of Ca-poor pyroxene ($En_{84}Fs_{11}Wo_5$) and 6 grains (~5-20 microns) of Ca-rich pyroxene ($En_{61}Fs_6Wo_{32}$). The Fe metal is low in Ni (a few wt%). No sulfides were found in this particular sample.

Figure 1: Our coarse grained Almahata Sitta ureilite. Weight = 155.5 g.

Figure 2: Our fine grained Almahata Sitta ureilite. Weight = 24.4 g.

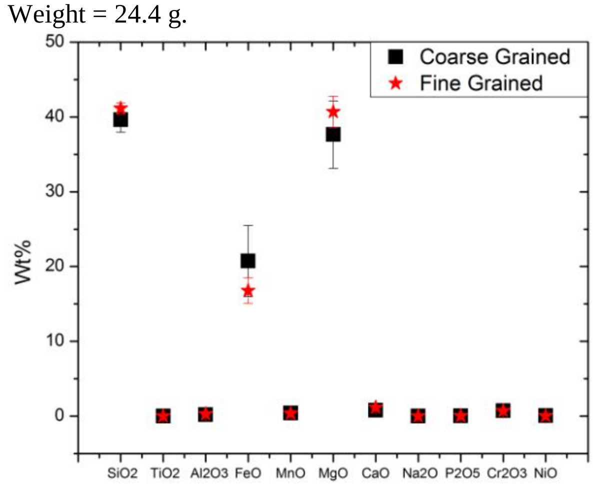

Figure 3: Comparison of the bulk compositions for our two Almahata Sitta meteorites. Within the one-sigma uncertainties, the two compositions are equivalent.

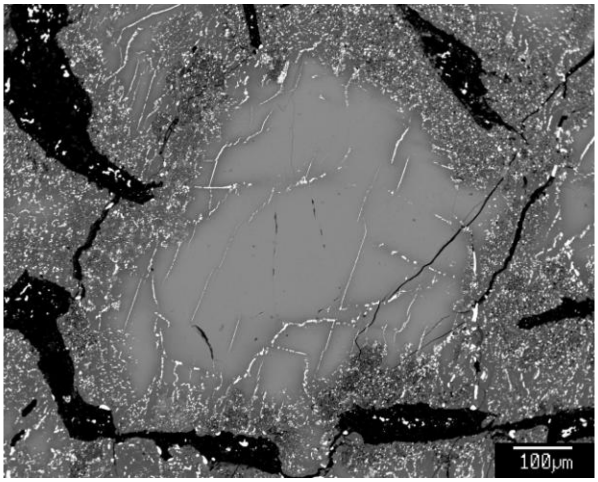

Figure 4: Backscattered electron (BSE) image of a reduced olivine grain found in our coarse grained ureilite sample. Core = Fa_{20} and rim = Fa_3. White blebs = Fe metal. Large black patches = a carbon phase. Smaller black regions = cracks and pits.

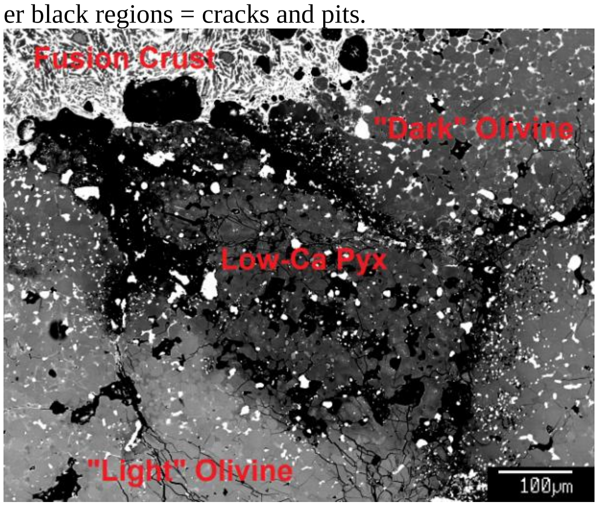

Figure 5: BSE image of various phases in our fine-grained ureilite sample. Low-Ca Pyx = $En_{86}Fs_9Wo_5$, "Dark" Olivine = Fa_{12}, and "Light" Olivine = Fa_{18}. White blebs are metal. Black patches are either a carbon phase or voids/pits/cracks. A patch of fusion crust is shown at the top left of the image.

The other ureilite is dominated by very fine grained olivine (~10-20 microns). Most of the olivine is Fa_{18}, but there are a few darker patches of olivine with Fa_{12} (Figure 5). This sample contains a small region (a few %) of very fine grained pyroxene (~10-20 microns) that is low in Ca ($En_{86}Fs_9Wo_5$). There are a few small (≤10 microns) silica grains within this region of low-Ca pyroxene. There are a few tiny (<5 micron) Ca-rich pyroxene grains that are too small to get good probe totals. The Fe metal in this sample is also low in Ni (a few wt%). Three FeS grains were found. This fine grained ureilite is very porous, with numerous void spaces. The mosaic texture of this sample, combined with the presence of diamonds in the carbon phase, could be indicative of shock metamorphism. Figure 6 demonstrates that the composition of the olivines in our samples fits the chondritic Mn/Mg trend of main group ureilites from Goodrich et al. (2004). The reduced olivine rims fall to the left of 0.1 molar Fe/Mg, while the other olivine compositions fall to the right, consistent with higher Fe concentrations compared to the reduced rims.

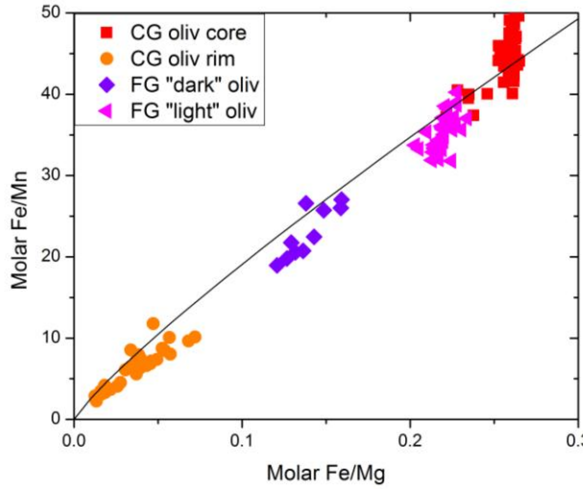

Figure 6: Olivine analyses from our coarse grained (CG) and fine grained (FG) ureilites. Our analyses follow the chondritic Mn/Mg trend of main group ureilites (black line) with some displacement to the right, which is consistent with the presence of a minor Ca-rich pyroxene phase [3].

Conclusion: We have analyzed two of the Almahata Sitta meteorites. They are both ureilites. One is coarse grained and the other is fine grained. They are both dominated by olivine, with a very minor amount of pyroxene. They both have Fe metal that is low in Ni.

References:

[1] Jenniskens P. and Shaddad M. H. (2010) *Meteoritics & Planet. Sci., 45,* 1153–1156. [2] Bischoff A. et al. (2010) *Meteoritics & Planet. Sci., 45,* 1638-1656. [3] Goodrich C. A. et al. (2004) *Chemie der Erde, 64,* 283-327.