MINERALOGY OF THE ALMAHATA SITTA UREILITE.

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Introduction: On October 6, 2008, a small asteroid called 2008 TC3 was discovered and found to be on a collision course with Earth. 19 hours later it exploded at an unusually high ~37 km altitude over the Nubian Desert, spreading meteorites widely. Searches organized by P.J. and M.S. have recovered ~250 stones of the Almahata Sitta meteorite to date [1].

Mineralogy & Petrography: Samples range from black, porous and friable (black lithology) to denser, white stones (white lithology) – we have mainly examined the former. The meteorite is a fine-grained, fragmental breccia with subrounded mineral fragments and olivine- and pyroxene-dominated clasts embedded in a cataclastic matrix. Mineral fragments include polycrystalline olivine (Fa_{8-15}; CaO=0.15–0.51wt%; Cr_2O_3=0.03–1.58wt%), low-calcium pyroxene (Fs_2Wo_5-$Fs_{17}Wo_4$; Cr_2O_3=0.33-1.02 wt%), pigeonite ($Fs_{15}Wo_5$-$Fs_{18}Wo_{11}$; Cr_2O_3=0.72-1.11wt%) carbonaceous aggregates, kamacite ($Fe_{0.92}Ni_{0.08}$-$Fe_{0.96}Ni_{0.04}$), and troilite (containing up to 4.3 wt% Cr). The compositional range of the silicates is characteristic of the ureilites as a group, but unusually broad for an individual ureilite [2&3]. Olivine exhibits no prominent zoning, though pyroxene can.

The examined samples of the black lithology have considerable porosity (up to 40%); walls of pores are commonly coated by anhedral to euhedral crystals of olivine (Fa_{12-14}), and in some instances spherules of kamacite and botryoidal masses of troilite. A search for carbides using Mössbauer spectroscopy was unsuccessful. Most olivine and pyroxene-dominated clasts have interstitial silicates whose Si-content increases adjacent to metal grains [4]. Some clasts consist of rounded pigeonite grains containing an abundant nanophase metal and minute domains of Ca-rich pyroxene. These rounded pigeonite grains are separated by thin zones of silica - mostly amorphous but locally crystalline. Aggregates of carbonaceous material contain fine-grained troilite and kamacite. The major carbon phase is graphite, carrying nanodiamonds (as determined by Raman spectroscopy).

Classification: Almahata Sitta is an anomalous, polymict ureilite (verified by oxygen isotope and bulk compositional data [1]). Anomalous features include lack of zoning of olivine, large compositional range of silicates, high abundance and large size of pores, crystalline pore wall linings, and overall fine-grained texture. Tomography reveals that the pores define thin, discontinuous "sheets" connected in three dimensions, suggesting that they outline grains that have been incompletely welded together. The crystals lining the pore walls are probably vapor phase deposits. Therefore Almahata Sitta may represent an agglomeration of fine-grained, incompletely reduced pellets formed during impact, and subsequently welded together at high temperature.

References: [1] Jenniskens et al. (2009) *Nature* **458**, 485-488; [2] Goodrich (1992) *Meteoritics* **27**, 327-352; [3] Mittlefehldt et al. (1998) *RiM* **36**, ch. 4; [4] Herrin et al. (2009) This volume.