TRAPPED NITROGEN AND NOBLE GASES IN ALMAHATA SITTA UREILITE.

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Introduction: Almahata Sitta (AS) is the only meteorite fall so far, with an identified parent-body, a class F asteroid (2008 TC_3) [1]. AS has been classified as an anomalous polymict ureilite, with a large porosity (>20%) [1]. As trapped nitrogen and noble gases provide some distinguishing features between monomict and polymict ureilites [2,3], we have investigated N and noble gases in two bulk samples (#36, #44) and an HF/HCl resistant carbonaceous residue prepared from #44. Standard mass spectrometric procedures [2, 3] have been employed in the stepwise combustion/pyrolysis study of N and noble gases.

Trapped noble gases: Ne isotopic data fall on the mixing line between Ne-U and cosmogenic components and no solar Ne is seen, as observed in some polymict ureilites [4]. Kr and Xe isotopic compositions are also typical of ureilite gases. There are two anomalous noble gas features in AS, observed for the first time in ureilites; 1) trapped $^{38}Ar/^{36}Ar$ ratio in the acid residue shows a monotonic increase with release temperature during combustion, varying from 0.1891 to 0.1916 and 2) the elemental ratios $^{84}Kr/^{36}Ar$ and $^{132}Xe/^{36}Ar$ in all the combustion steps of the acid residue are broadly uniform, as against the general observation of decrease in these ratios by more than an order of magnitude as the combustion temperature increases [3], a feature interpreted as supporting ion implantation from plasma as the noble gas acquisition mechanism for the diamond (the chief noble gas carrier). Another feature is the difference in the elemental ratios $^{84}Kr/^{36}Ar$ and $^{132}Xe/^{36}Ar$ of the bulk sample (#36) and the acid residue (obtained from #44). The elevated ratios (enrichment of ^{84}Kr and ^{132}Xe, as compared to the residue) in the AS bulk (#36) are similar to what has been earlier seen in the ureilite ALH82130 [3]. The bulk sample of #44 on the other hand does not show the excess ^{84}Kr and ^{132}Xe observed in #36. The abundance of ^{36}Ar (in 10^{-8} ccSTP/g units) in our sample of #44 (1837) is comparable to the reported value of another split of #44 (1390), though for #36, they differ by a factor of 3.3 [5], indicating heterogeneous noble gas distribution in AS.

Trapped Nitrogen: Peak release of C (monitored as CO + CO_2), N, $\delta^{15}N$ (-115‰, at peak release) and trapped noble gases, at 700°C combustion clearly indicate diamond as the principal carrier of noble gases. Two populations of diamonds, a sub micron size which combusts at ~700°C and a coarser (several microns) diamond which combusts at >900°C are indicated. SEM pictures and confocal Raman imaging spectroscopy [4, 6] further support the presence of coarse size diamonds in AS.

Discussion: The isotopic signatures of N and Ar clearly show a distinction between the low temperature (LT up to 500°C) fraction with normal $^{38}Ar/^{36}Ar$ and heavy $\delta^{15}N$ [probably hosted in amorphous C] and a high temperature (HT > 500°C) fraction with higher $^{38}Ar/^{36}Ar$ and lighter $\delta^{15}N$ [carried by diamond]. We interpret the observed monotonic increase of $^{38}Ar/^{36}Ar$ with extraction temperature as a two component mixing between the LT and HT components.

References: [1] Jenniskens P. et al. 2009, *Nature* **458**,485-488; [2] Rai V.K. et al. 2003, *GCA* **67**, 2213-2237; [3] Rai V.K. et al., 2003, *GCA* **67**, 4435-4456; [4] Murty S.V.S. et al., 2010, *MAPS* (Accepted); [5] Welten K.C. et al., 2010, *MAPS* (submitted); [6] Zolensky M. et al., 2010, *MAPS* (submitted).