COSMIC RAY EXPOSURE AGES FOR ALMAHATA SITTA NON-UREILITE SAMPLES

M. M. M. Meier[1], K. C. Welten[2], P. Jenniskens[3], H. Baur[1], R. Wieler[1]. [1]Departement of Earth Sciences, ETH Zurich. E-mail: meier@erdw.ethz.ch. [2]Space Sciences Laboratory, University of California. [3]SETI Institute, Carl Sagan Center, Mountain View.

Introduction: On October 7th, 2008, a small asteroid, 2008 TC_3, exploded in the atmosphere above the Nubian Desert of northern Sudan. Search expeditions yielded several hundred meteorite fragments, and all the meteorites found are now referred to as Almahata Sitta (AS) [1]. Most of the fragments were classified as anomalous polymict ureilites, some of them containing several different lithologies. In addition, some non-ureilite fragments have been found in the area and have also been attributed to the AS fall, based on short-lived radionuclides and plausibility arguments [2]. Questions remain on how these non-ureilites relate to the rest of AS, e.g. whether the non-ureilites have been pre-exposed to cosmic radiation before incorporation into the AS parent body. Here we report noble gas data. Radionuclide data will be presented at the conference.

Samples & Methods: Two samples, of L-chondritic (sample A100, 228 mg) and H-chondritic (sample #25, 251 mg) composition, were each divided into two aliquots. These were wrapped in aluminum foil, preheated in vacuum at 130° to remove atmospheric gases and then heated to 1800° for ~30 min to extract and analyze the noble gases in a custom-built mass spectrometer.

Results: All results are in units of 10^{-8} ccSTP/g. The measured cosmogenic $^{3}He_{cos}$ (A100: 29.7, #25: 23.1), $^{21}Ne_{cos}$ (A100: 7.73, #25: 6.51) and $^{38}Ar_{cos}$ (A100: 1.14, #25: 0.94) concentrations of the non-ureilites are, after applying a chemistry-based correction of the production rates based on [3], on average a factor of about ~1.19, 1.27 and 2.27 (for He, Ne and Ar) higher than the ones observed in six samples of AS ureilite (average $^{3}He_{cos}$: 24.2, average $^{21}Ne_{cos}$: 6.96, average $^{38}Ar_{cos}$: 0.51). Depending on shielding and nuclide production model applied, this yields a cosmic ray exposure age of ~20-30 Myrs (average AS: 19±2 Myrs [5]). The measured ratios relevant for cosmic ray exposure age dating are $^{22}Ne/^{21}Ne$ = 1.10 and 1.08, $^{3}He/^{21}Ne$ = 3.85 and 3.55, $^{36}Ar/^{38}Ar$ = 4.30 and 3.30 for the L and H chondrite samples, respectively. Both L and H chondrite samples show a remarkably high ^{40}Ar concentration (of probably radiogenic origin) of 7630 and 7540, respectively.

Discussion: While we can not exclude a short pre-irradiation of a few Myrs, on first order our results confirm the conclusion of [2] that these non-ureilites are likely derived from the same body as the other AS meteorites, not representing a separate fall. From the He and Ne results, we can exclude a large pre-irradiation of >~10 Myrs. The Ar results are more ambiguous, with a cosmogenic concentration in the L and H chondrite samples that is more than double the value of the ureilite samples. This could possibly be explained with large Ca inhomogeneities within the AS samples. The high concentration of radiogenic ^{40}Ar, compared to typical L chondritic values, implies that the L chondritic AS sample does not belong to the ~500 Myrs gas retention age peak.

References: [1] Jenniskens P. et al., 2009 *Nature*, Volume 458, Issue 7237, pp. 485-488 [2] Bischoff, A. et al, *Lunar and Planetary Science Conference 41*, 2010, #1763. [3] Leya, I. and Masarik, J. 2009, *Meteoritics and Planetary Science 44*(7), 1061–1086. [4] Welten, K.C. et al., *Lunar and Planetary Science Conference 41*, 2010, #2256. [5] Welten, K.C. et al., *Meteoritics & Planetary Science*, 2010 (submitted).