UNRAVELING THE EXPOSURE HISTORIES OF AUBRITES. K. C. Welten[1], K. Nishiizumi[1], D. J. Hillegonds[2], M. W. Caffee[2,3] and J. Masarik[4], [1]Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450, USA (e-mail: kcwelten@uclink4.berkeley.edu); [2]CAMS, Lawrence Livermore National Laboratory, Livermore, CA 94550, USA. [3]Department of Physics, Purdue University, West Lafayette, IN 47907, USA, [4]Nuclear Physics Department, Komensky University, Bratislava, Slovakia.

Introduction: Aubrites show very long cosmic-ray exposure (CRE) ages, up to ~120 Myr, which are poorly understood, since aubrites seem to be very fragile. Recent studies [1,2] revealed that many aubrites show large isotopic shifts in Sm and Gd due to neutron-capture reactions. These large isotopic shifts are believed to be mainly due to exposure on the aubrite parent body (APB) [2]. In this work we present ^{41}Ca results in aubrites to determine the thermal neutron flux in space (4π). We compare these fluxes with total neutron fluences [1,2] and noble gas CRE ages [3] to unravel the CRE history of aubrites in space (4π) and on the APB (2π).

Results and Discussion: Most aubrites show very low contributions of neutron-capture ^{41}Ca (<0.1 dpm/gCa), indicating they were relatively small objects in space (R<30 cm). The only exceptions are Norton County (NC) and Cumberland Falls (CF), which show neutron-capture ^{41}Ca contributions of 0.4-0.9 dpm/gCa (NC) and ~3 dpm/gCa (CF), respectively. The values in NC are much lower than those reported in [4], indicating our samples came from much closer to the surface (<5 cm). The high neutron-capture ^{41}Ca in CF confirms that this aubrite had a large pre-atmospheric size [5]. Based on a CRE age of ~60 Myr for CF [3], we calculate a total thermal neutron fluence of ~1.5×10^{16} n/cm^2 during 4 -exposure. This value is still a factor of 2.7 lower than the one based on the Sm-Gd isotopic shifts [1]. Also for other aubrites, the total neutron fluences derived from neutron-capture ^{41}Ca are lower than those given in [1,2]. This confirms that the high neutron fluences found in many aubrites can not be explained by exposure in space alone, but must be due to a previous exposure on the APB. Assuming that the aubrites were exposed at an average depth of ~150 g/cm^2 (at the maximum thermal neutron flux) on the APB, we find minimum 2π-exposure ages of 24 Myr for NC, 45 Myr for Mayo Belwa (MB), 57 Myr for Bishopville, 70 Myr for Pesyanoe and ~105 Myr for CF. Despite significant exposure times on the APB, most of the ^{21}Ne in NC and MB must have been produced during 4 -exposure, yielding 4π exposure ages of 90-100 Myr.

An alternative explanation for the high Sm-Gd isotopic shifts in some aubrites is that they changed in size during their long irradiation in space, either due to a single break-up event or due to space erosion. We tested the space erosion hypothesis for our sample of NC, which came from <5 cm from the surface of an object with a pre-atmospheric radius of ~60 cm. We conclude that the neutron fluence of ~1.2×10^{16} n/cm^2 reported by [1] can be explained by a space erosion rate of ~0.5 mm/Myr, which is similar to the value of 0.65 mm/Myr for stone meteoroids determined in [6].

Conclusions. Many aubrites were exposed on the surface of the APB before irradiation in space. Despite a significant exposure on the APB, some aubrites still have long CRE ages as m-sized objects in space. This conclusion provides constraints on the collisional lifetime of aubrites and their delivery mechanism to Earth.

References: [1] Hidaka H. et al (1999) EPSL 173, 41-51. [2] Hidaka H. et al (2003) MAPS 38, A60. [3] Lorenzetti S. et al. (2003) GCA 67, 557-571. [4] Fink D. et al. (1992) LPSC 23, 355-356. [5] Welten K. et al. (2002) LPSC 33, #2043. [6] Schaeffer O. et al. (1981) Planet. Space Sci. 29:1109-1118.