COSMOGENIC RADIONUCLIDES AND NOBLE GASES IN CHELYABINSK METEORITE.

K. Nishiizumi[1], M. W. Caffee[2], L. Huber[3], K. C. Welten[1] and R. Wieler[3]. [1]Space Sciences Laboratory, Univ. of California, Berkeley, CA 94720-7450, USA. E-mail: kuni@ssl.berkeley.edu. [2]Dept. of Physics, Purdue Univ., West Lafayette, IN 47907-1396, USA. [3]ETH Zürich, CH-8092, Switzerland.

Introduction: The Chelyabinsk LL5 chondrite fell in Russia on February 15, 2013. Thus far, 500 kg has been recovered. Based on observations of the fireball the pre-atmospheric radius is >5 m. We measured cosmogenic radionuclides and noble gases in this meteorite to investigate its exposure history and pre-atmospheric shielding conditions.

Samples and Experiments: We received three fragments of the Chelyabinsk meteorite; MB001 [1], 10-95 (impact melt breccia), and 10-134 (main chondritic lithology). Each sample was split for radionuclides and noble gas measurements. The light noble gases from 3 bulk samples were measured at ETH, Zürich [2]. Samples 10-95 and 10-134 were separated into non-magnetic (NM) and metal fractions. Concentrations of cosmogenic ^{10}Be ($t_{1/2}$=1.36 Myr) and ^{36}Cl (0.30 Myr) in these fractions and in a bulk sample of MB001 were measured by accelerator mass spectrometry at Purdue University.

Results and Discussion: Concentrations of cosmogenic nuclides in Chelyabinsk are lower than those found in smaller stony meteorites, as expected. The abundance patterns of all the spallogenic cosmogenic nuclides in the three fragments are similar to each other; the differences represent different shielding conditions (different pre-atmospheric depths). Cosmogenic ^{36}Cl in bulk and NM fractions is mainly produced by thermal neutron capture on ^{35}Cl, with some contribution from spallation reactions, so its production does not track the other cosmogenic nuclides. We estimate the ^{21}Ne/^{10}Be exposure age of Chelyabinsk using an empirical relationship [3], but the age has a large uncertainty due to short exposure age. The high ^{36}Cl/^{10}Be ratios in the metal phases, 11.7 and 10.1 respectively, likely indicate that ^{10}Be is not in saturation. The ^{36}Cl/^{10}Be-^{10}Be methodology [4] yields a short exposure age of ~1.5 Myr in a large object. We do not have accurate ^{21}Ne production rates for ~10 m objects but we can estimate a rough ^{21}Ne production rate using the ^{36}Cl in the metal phase as shielding indicator [e.g.,5]. A very approximate ^{36}Cl-^{21}Ne age is ~1.2 Myr. Based on our preliminary data we conclude that the exposure age of Chelyabinsk is much shorter than most LL chondrites, which have an exposure age distribution with a ~15 My peak [6]. Our preliminary exposure ages place Chelyabinsk near that of Appley Bridge, an LL6 with the shortest exposure age of all LL chondrites, 1.2 Myr [7]. Assuming a pre-atmospheric size of ~10 m, we estimate that the three samples came from depths of <150 cm, based on thermal neutron capture ^{36}Cl [8] and spallogenic nuclides.

Acknowledgements: We thank the University of New Mexico (MB001) and the Vernadsky Institute (10-95 and 10-134) for providing Chelyabinsk meteorite samples.

References: [1] Jones R. H. et al. 2013. *(This meeting)*. [2] Wieler R. et al. 1989. *GCA* 53:1449-1459. [3] Graf T. et al. 1990. *GCA* 54:2521-2534. [4] Lavielle B. et al. 1999. *EPSL* 170:93-104. [5] Leya I. and Masarik J. 2009. *MAPS* 44:1061-1086. [6] Graf T. and Marti K. 1994. *Meteoritics* 29:643-648. [7] Cressy P. J., Jr. and Bogard D. D. 1976. *GCA* 40:749-762. [8] Spergel M. S. et al. 1986. *Proc. LPSC* 91:D483-D494.