COSMOGENIC RADIONUCLIDES AND NOBLE GASES IN CHELYABINSK METEORITE.

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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 10Be (t1/2=1.36 Myr) and 36Cl (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 spallation cosmogenic nuclides in the three fragments are similar to each other; the differences represent different shielding conditions (different pre-atmospheric depths). Cosmogenic 36Cl in bulk and NM fractions is mainly produced by thermal neutron capture on 35Cl, with some contribution from spallation reactions, so its production does not track the other cosmogenic nuclides. We estimate the 37Ne/10Be exposure age of Chelyabinsk using an empirical relationship [3], but the age has a large uncertainty due to short exposure age. The high 36Cl/10Be ratios in the metal phases, 11.7 and 10.1 respectively, likely indicate that 10Be is not in saturation. The 36Cl/10Be-38Ar methodology [4] yields a short exposure age of ~1.5 Myr in a large object. We do not have accurate 21Ne production rates for ~10 m objects but we can estimate a rough ~21Ne production rate using the 36Cl in the metal phase as shielding indicator [e.g.,5]. A very approximate 36Cl-21Ne 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 Appleby 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 36Cl [8] and spallogenic nuclides.

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