UPDATE ON EXPOSURE AGES OF DIOGENITES: THE IMPACT HISTORY OF THE HED PARENT BODY AND EVIDENCE OF SPACE EROSION AND/OR COLLISIONAL DISRUPTION OF STONY METEOROIDS.

K. C. Welten[1*], K. Nishiizumi[1], M. W. Caffee[2] and L. Schultz[3], [1]Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450, USA, [2]CAMS, Lawrence Livermore National Laboratory, Livermore, CA 94551, USA, [3]MPI für Chemie, Postfach 3060, 55020 Mainz, Germany (*kcwelten@uclink4.berkeley.edu).

Introduction: Cosmic-ray exposure ages of howardites, eucrites and diogenites (HED) have provided insight in the recent impact history of the HED parent body [1,2]. We measured light noble gases and cosmogenic radionuclides in one new diogenite fall, Bilanga, and four new Antarctic diogenites. We first determined their ^{21}Ne exposure ages and then re-evaluated the exposure ages of all diogenites using the ^{10}Be/^{21}Ne method [3]. For meteorites exposed under high shielding, this method is believed to provide more reliable ^{21}Ne production rates than the ^{22}Ne/^{21}Ne ratio used previously [1,2].

^{21}Ne exposure ages. Using equations proposed in [2], the ^{21}Ne exposure ages are 4.7 Myr for GRA 98108, 21 Myr for the paired meteorites QUE 93009 and 97991, 49 Myr for Bilanga and 50 Myr for GRO 95555. The exposure ages of Bilanga and GRO 95555 coincide with the age of Garland, suggesting a distinct impact around 50 Myr.

^{10}Be/^{21}Ne exposure ages. Based on results described herein and previous results [2] we re-evaluated the exposure ages of all diogenites using the ^{10}Be/^{21}Ne method [3]. For most diogenites with ^{21}Ne ages <25 Myr, the ^{21}Ne and ^{10}Be/^{21}Ne ages agree within 20%, i.e. within 2σ uncertainties of the age methods. Exceptions are Tatahouine and QUE93/97, for which the ^{10}Be/^{21}Ne ages are 40-60% higher. The ^{22}Ne/^{21}Ne ratios in these samples indicate high shielding conditions, and the ^{10}Be/^{21}Ne ages are thus more reliable. The revised ages of Tatahouine and QUE 93/97 coincide with the HED peak at 38 Myr [1].

Four of the six diogenites with ^{21}Ne ages >40 Myr show relatively low ^{10}Be concentrations, resulting in ^{10}Be/^{21}Ne ages, that are 25-50% higher than the corresponding ^{21}Ne ages. Since the ^{22}Ne/^{21}Ne ratios of 1.11-1.13 indicate average shielding conditions, the question is what caused the low ^{10}Be? Although it is possible that all four meteorites were irradiated close to the surface of large objects, we consider this scenario unlikely.

Discussion. An alternative explanation is that some physical process reduces the size of meteoroids in space, either by space erosion due to micrometeoroid impacts and/or by collisional destruction. If we consider the gradual process of space erosion as the dominant factor, an erosion rate of ~5 mm/Myr is required to explain the present data. This erosion rate seems high relative to estimated erosion rates of 0.5-2.0 mm/Myr for lunar rocks and boulders [4-6].

Impact experiments indicate that collisional fragmentation is much more efficient in destroying meter-sized boulders than space erosion [7]. In fact, collisional destruction is not limited to a single impact delivering a critical threshold energy, but is acquired cumulatively by substantially less energetic events. It is therefore plausible that a combination of space erosion and collsional disruption results in a semi-continuous reduction in size for most stony meteoroids, whereas some experience a single catastrophic collision.

Conclusions. The updated exposure ages confirm the previous HED peaks at 6, 12, 23 and 38 Myr and suggest an additional peak at ~50 Myr. Our data also suggest that space erosion and/or collisonal disruption gradually reduce the size of stony meteoroids in space. This implies that for stony meteorites with long exposure ages, discrepancies between noble gas and radionuclide data are not necessarily the result of a complex exposure history.

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