A SYSTEMATIC STUDY OF THE COSMIC-RAY-EXPOSURE HISTORY OF IRON METEORITES: ^{10}Be-^{36}Cl/^{10}Be TERRESTRIAL AGES.

K. Nishiizumi[1], M. W. Caffee[2], J.-P. Jeannot[3], B. Lavielle[3], and M. Honda[4], [1]Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450, USA, (kuni@ssl.berkeley.edu), [2]Geosciences and Environmental Technologies Division, Lawrence Livermore National Lab., Livermore, CA 94551, USA, [3]URA 451 C.N.R.S, C.E.N. Bordeaux-Gradignan, University of Bordeaux I, F-33175 Gradignan Cedex, France, [4]Department of Chemistry, Nihon University, Tokyo, Japan.

Systematic studies of cosmogenic nuclides in iron meteorites are important because their integrated exposure to energetic particles extends back in some instances to ≥10^9 years. The most immediate goals of this work are to delineate the exposure histories and conditions of these objects using pairs of cosmogenic nuclides. A long-term goal is to employ these objects as intra-solar system probes from which secular variations of the cosmic ray intensity during the last 10^9 years can be investigated.

Since the pre-atmospheric size of iron meteorites varies considerably, cosmic ray exposure ages cannot be obtained without taking into consideration the shielding conditions under which the meteoroid was exposed. Once the exposure conditions are unequivocally determined it is possible to obtain exposure ages and, by using different pairs of cosmogenic nuclides, examine secular changes in the cosmic ray intensity.

The saturation activity of a radionuclide represents the production integrated over the last several half-lives of that radionuclide, independent of the exposure duration. Stable nuclides, by contrast, integrate the entire exposure. Exposure ages based on radionuclide to stable nuclide pairs yield shielding independent exposure ages based on the production rate integrated over the radionuclide's half-life. We will first determine exposure ages based on shorter radionuclide-stable nuclide pairs, such as ^{36}Cl-^{36}Ar and ^{26}Al-^{21}Ne, verifying the efficacy of the technique, and will ultimately compare them to the existing ^{40}K-^{41}K exposure ages of iron meteorites.

The cosmogenic radionuclides ^{10}Be, ^{26}Al, and ^{36}Cl in iron meteorites and in metallic phases of stony and stony-iron meteorites were measured. Since many iron meteorites have terrestrial ages representing a significant fraction of the ^{36}Cl half-life (3.01×10^5 years) it is necessary to correct for the decay of ^{36}Cl. Chang and Wänke [1] proposed using the radionuclide pair ^{10}Be-^{36}Cl for terrestrial age determinations. The basis for this chronometer is the assumption of a constant production ratio of ^{36}Cl/^{10}Be, 4.3 ± 0.4, independent of depth. Ratios lower than this value are attributed to ^{36}Cl decay during terrestrial residence. More recent measurements indicate a depth dependence of this ratio [2]. As the results in Fig. 1 indicate the ^{36}Cl/^{10}Be ratio varies between 3.4 and 6. The best fit line (R=0.973) follows the relation ^{36}Cl/^{10}Be = 5.98 - 0.20(^{10}Be) - 0.023(^{10}Be)^2. Although the ^{36}Cl/^{10}Be ratio is not constant under all conditions any deviations below the line are taken as evidence of ^{36}Cl decay during terrestrial residence. Since excursions below the line follow predictable trajectories the terrestrial ages can be determined.

We obtained ^{36}Cl-^{36}Ar and ^{26}Al-^{21}Ne exposure ages of 32 iron meteorites (finds). Terrestrial age corrections were made using the ^{36}Cl-^{10}Be pair. Among the 32 iron meteorite measured both pairs yielded concordant exposure ages (1.01 ± 0.07) for all samples. The excellent agreement of the different techniques indicates that corrections for terrestrial ages were done correctly and that the cosmogenic nuclide pairs utilized thus far are robust.

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References: [1] Chang C. and Wänke H. (1969) in *Meteorite Research* 397-406. [2] Nishiizumi K. *et al.* (1996) *Meteorit. Planet. Sci. 31*, A98-A99.

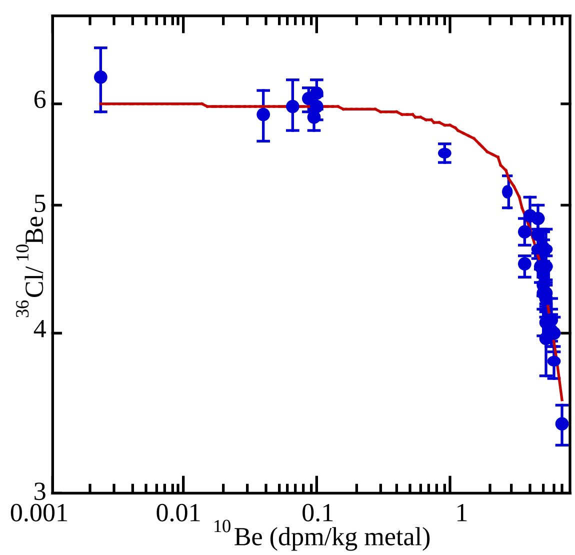

Figure 1. ^{10}Be vs. ^{36}Cl/^{10}Be for iron (falls) and metal phases of stony and stony-iron meteorites.