Cosmogenic-radionuclide Profile of the Mocs Meteorite Strewnfield; T.E. Ferko and M.E. Lipschutz, Purdue University, West Lafayette, IN 47907-1393.

Cosmic-ray produced nuclides were measured in samples from eight pieces of the L5-6 chondrite Mocs from known locations in the strewnfield. We measured ^{10}Be and ^{26}Al in the bulk phase along with ^{36}Cl in both the metal and silicate phases. Relationships of the activities of these radionuclides from various meteorite pieces in the Mocs strewnfield provide new insight into the association of meteorite fragments to each other in the pre-atmospheric parent body. Results suggest a $>2\pi$ irradiation for the Mocs meteoroid which was less than 1 meter in radius.

Cosmogenic radionuclides are produced by the interaction of cosmic radiation with target elements in objects in space. The production of cosmogenic radionuclides has been the basis for the estimation of cosmic ray exposure (CRE) ages in small objects. These nuclides have also been used to determine the terrestrial ages of Antarctic meteorites. However, little work has been done on large meteorites, with one exception being the depth profile of the Canyon Diablo meteorite by Michlovich et al.[1]

Measurements of cosmogenic radionuclides in individual meteorites has also been used to provide information on the geometry of meteoroids.[2] However, no similar data exist on the strewnfield of a meteorite shower. It is well-known that larger fragments tend to travel farther and impact at the far-end of the strewnfield. As a working hypothesis, we might expect a systematic variation of cosmogenic radionuclides with position of fragments in a strewnfield.

Meteorite Background and Samples

The Mocs meteorite fell in the Cluj district of Transylvania (present day Romania) on February 3, 1882 at 1600 hrs. Approximately 3000 stones with a total mass of 300 kg fell over an area of approximately 14.5 x 3 km.[3,4] For this study, we obtained pieces of the following from the British Museum (Natural History): (54647) Báré; (54649) Gyulatelke; (54650) Visa; (54772) Oláhgyéres; (54773) Keszu; (54774) Palatka; (54775) Vajdakamarás; (54776) Marokháza. The location of these fragments in the strewnfield is shown in Figure 1.[5]

Measurements

^{10}Be, ^{26}Al and ^{36}Cl were chemically separated as described by Vogt and Herpers.[6] Of approximately 1.5 g of each meteorite that was ground, 100 mg of the bulk material was used for ^{10}Be and ^{26}Al analysis. Of the remaining material, 1.0 g was separated into metal and non-metal phases for ^{36}Cl measurements. This resulted in 50mg of clean metal being available for analysis while between 150 and 300 mg of the non-metal (silicate) phase was also analyzed. In addition to the previously listed isotope/sample combinations, ^{10}Be and ^{26}Al were separated from the metal phase and ^{41}Ca was separated from both metal and silicate phases for possible future analysis. All samples were measured at the Purdue accelerator mass spectroscopy facility.[7]

Results

Based on the 300 kg of material that was collected from the strewnfield and the density of ordinary chondrites (3.4-3.8 g/cm^3), the minimum radius of the pre-atmospheric meteoroid can be calculated to be about 27 cm.[3,8]

^{10}Be values in this work ranged from 20.5 +/- 0.5 to 23.7 +/- 0.4 dpm/kg. Previous measurements of noble gases resulted in ^{22}Ne / ^{21}Ne ratios of 1.04 - 1.10. [9-12] Based on relationship of ^{10}Be activities to ^{22}Ne / ^{21}Ne ratios, all samples probably originated from depths of 60 to 80 cm from the surface of the parent meteoroid. [13]

Activities of ^{26}Al measured in this work also varied little, ranging from 66 +/- 2 dpm/kg to 74 +/- 4 dpm/kg. These values agree well with previously published results which range from 69 +/- 2 to 74 +/-3

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dpm/kg. [14] This also suggests that these samples originated from a depth of approximately 70 cm in the parent meteoroid.[15]

Activities of ^{36}Cl showed slightly more variation than either ^{10}Be or ^{26}Al, with metal phase ^{36}Cl ranging from 13.1 +/- 0.2 to 16.5 +/- 0.4 dpm/kg and preliminary ^{36}Cl in the silicate phase ranging from 7.5 +/- 0.1 to 12.1 +/- 0.2 dpm/kg.

Despite large uncertainties, the three cosmogenic nuclides exhibit an interesting trend in Figure 2. Six of the eight samples apparently define a linear trend between ^{10}Be / ^{26}Al and ^{36}Cl / ^{26}Al. By comparing the location of meteorite fragments in the strewnfield (Figure 1) to the representative points on this graph, it is seen that the two outliers of this trend likely came from a secondary strewnfield (y--> y' on Figure 1) superimposed on the main strewnfield. These data hint at a one-stage irradiation for most Mocs samples with a more complicated history for some. Clearly, additional data are needed.

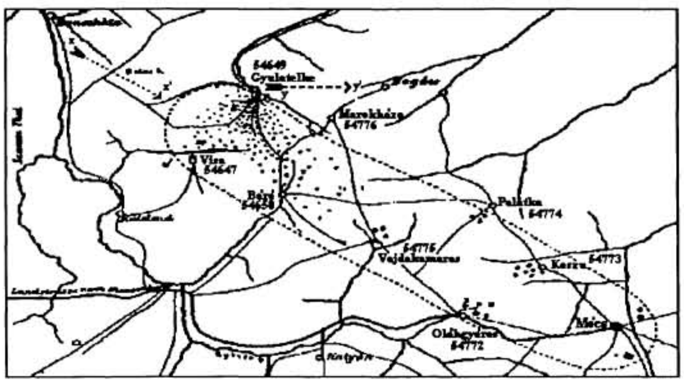

Figure 1: The Mocs meteorite strewnfield, as was originally drawn in Koch's 1882 work. Locations of samples used in this study are marked with the name of the town near where the each fragment was located and the number of each fragment in the collection of the British Museum (Natural History).[3,5]

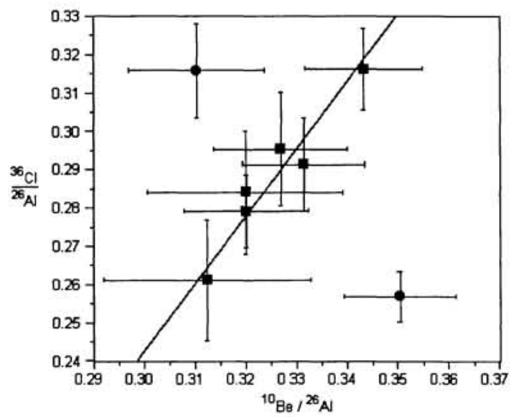

Figure 2: Relationship between ^{10}Be and ^{36}Cl (both normalized to ^{26}Al) in fragments from the Mocs meteorite strewnfield.

References

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