COSMOGENIC IRON-60 IN IRON METEORITES: MEASUREMENTS BY LOW-LEVEL COUNTING.

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Introduction: ^{60}Fe with a half-life of 1.5 Myr is produced from ^{62}Ni and ^{64}Ni by cosmic rays. The production rate of ^{60}Fe in meteorites is far lower than for other cosmogenic nuclides such as ^{10}Be, ^{26}Al, ^{36}Cl, or ^{53}Mn because of the low isotopic abundance of ^{62}Ni (3.63%) and ^{64}Ni (0.93%). Previous measurements of ^{60}Fe in meteorites have been very limited due to the low specific activity of the nuclide in addition to its low concentration. Since the first ^{60}Fe measurement in the Odessa iron meteorite [1], only a few results have been published based on accelerator mass spectrometry (AMS) measurements [2, 3]. Even with the high sensitivity of AMS, ^{60}Fe measurements are very difficult due to the low isotopic ratio measured, ~10^{-14} ^{60}Fe/Fe. In this work, ^{60}Fe in iron meteorites was measured using low level counting methods.

Sample and Methods: 2.37 kg of Odessa (IAB, 7.25% Ni) [1], 0.74 kg of Bogou (IAB, 7.15% Ni), 1.5 kg of Carbo (IID, 10.02% Ni), 1.5 kg of Grant (IIIAB, 9.24% Ni), 0.5 kg of Williamstown (Kenton County, IIIAB, 7.38% Ni), and 0.5 kg of Aroos (Yardymly, IICD, 6.71% Ni) were dissolved and Fe fractions from each iron meteorite were separated in 1958-1963. ^{60}Fe β-decays to ^{60}Co ($t_{1/2}$=5.27 yr). In 1980, we extracted Co from each Fe fraction using a series of isopropyl ether solvent extractions and anion ion exchange columns. The activity of ^{60}Co in the Fe solutions was near secular equilibrium with ^{60}Fe by 17-20 yrs after separation of the Fe fraction. First, the milked ^{60}Co was measured using a well-type Ge detector. Then we measured the ^{60}Co in 3 samples by β−γ coincidence using a gas-flow GM counter and a 3" well type NaI(Tl) detector equipped with an anti-coincidence guard counter.

Results and Discussion: We found 0.16±0.06 dpm ^{60}Fe/kgFe (2.0±0.7 dpm ^{60}Fe/kgNi) for Odessa, 0.26±0.09 (2.5±0.8) for Grant, 0.33±0.26 (4.2±3.3) for Bogou, and 0.20±0.08 (1.8±0.7) for Carbo using Ge detector measurements. ^{60}Co measurements for Aroos and Williamstown are indistinguishable from the blank. The β−γ coincidence technique reduced uncertainties but required more than a 2-month counting period for each sample. As we expected, the dpm ^{60}Fe/kgNi is well correlated with the observed ^{53}Mn concentration for each iron meteorite. Goel and Honda [1] found an ^{60}Fe specific activity of 0.9±0.2 dpm/kgFe in Odessa, a factor of 6 higher than this work. On the other hand, ^{60}Fe measurements by AMS [2] gave about a factor 2 lower than this work. It has been 27 years, 5 half-lives of ^{60}Co, since the last Co extraction from these 6 iron meteorite solutions. It would be possible to extract Co from the iron solutions and to measure ^{60}Co again. The counting time would be 2-3 weeks per sample for ±10% uncertainty using the present high-sensitivity Ge detector system. Aliquots of the Fe solution, an amount of <10^{-5} of the solution, could be used for AMS measurement of ^{60}Fe to allow comparison of the two determination methods. On the other hand, the low-level counting method used in this work is not applicable for new meteorite samples.

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