^{60}Co ISOTOPE CONTENT IN IRON METEORITES.

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Introduction: The results of ^{60}Co measurements all meteorites vary depending on their type but also on the date of meteorite fall. The production rate of isotopes by cosmic rays is modulated by 11-year cycle of solar activity. This cycle is particularly important for short lived isotopes (^{60}Co half-life is 5.27 years). The typical values of the ^{60}Co concentration obtained by measurements of "fresh" chondrites were in the range of 0 – 2.0 mBq·g^{-1} [1],[2]. ^{60}Co isotope content in iron meteorites have been studied less than in the stones, mainly due to the lack of observations of iron meteorites falls in the last century (49 total observed falls of which only 16 occurred after 1945). The measurement results show that the typical specific activities of ^{60}Co in the iron meteorites were in the range of 0 – 1.0 mBq·g^{-1}. One of the first meteorites in which scientists studied the isotope content was the Sikhote-Alin (IIAB) and the values were in the range 3.3 – 6.5 mBq·g^{-1} (calculated on the day of the fall, Dec. 12, 1947) [3],[4],[5].

Aim: Since the probability of iron meteorite fall is very low and thus the access to the "fresh iron" with a very short terrestrial age is highly limited, it was decided to conduct an experiment using radioactive standards made of cast steel with a low activity of ^{60}Co isotope. In our work we were guided by the postulate of easily obtaining information about the ^{60}Co content in an iron meteorite by a standard non-destructive method which is gamma spectrometry. Such measurements guaranteed to achieve a minimal detection activity (MDA) for the ^{60}Co isotope in the high density matrix (analog of iron meteorite) in a gamma-spectrometry system equipped with HPGe detector. The study was based on steel radioactive standards of 10 mm thick and cylindrical geometries (discs) with diameters: Φ=80 mm and Φ=35 mm respectively [6],[7].

Methodology: Measurements were performed at the Laboratory of Radioactivity Standards located in the Radioisotope Centre POLATOM at the National Center for Nuclear Research in Otwock-Świerk near Warsaw. The study utilized a non-destructive method of gamma spectrometry using high purity germanium detectors HPGe with good energy resolution and relative efficiency at 1332 keV line - 15% and 20% respectively. The results were analyzed in connection to Monte Carlo simulations allowing the calculation of coincidence summing corrections of the gamma lines. Measurements were carried out for 6 - 18 hours by placing the steel sources at a distance of 2.0 cm above the detector head.

Results: The specific activities of the ^{60}Co in the measured samples were in the range of (291 – 1544) mBq·g^{-1}. The selected acquisition time as 6, 10 and 18 hours guarantee the uncertainty at the level of 1.9% - 3.4%. The analyzes showed the dependence on the acquisition time and the weight (volume) of the sample. The values obtained using an HPGe detectors were between 6.1 and 8.5 mBq·g^{-1}. These results correspond to the ^{60}Co content in iron meteorites with short terrestrial age fallen in the period of the increased solar activity. The lower result (6.1 mBq·g^{-1}) for the smaller samples (Φ=35 mm, 75.4 g) was obtained for the longer measurement time lasting 18 hours. An analogous result was obtained for the 10 hours long measurement of larger iron mass (Φ=80 mm, 362.4 g). Using longer acquisition time and larger samples one can achieve lower values of MDA.

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