ALUMINIUM-26 IN MARTIAN AND LUNAR METEORITES: A COMPARISON OF COSMIC-RAY EXPOSURE AGES.

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Introduction: From more than 61,000 meteorites currently known, only over 300 (total mass of about 190 kg) are meteorites from the Moon and over 220 (total mass of about 120 kg) are of Mars origin. Many of the stones are paired fragments of the same meteoroid. They were produced by impacts of asteroids or comets on the Moon or on the Mars planet, orbiting then for the order of 10^4-10^7 years around the Sun (or the Earth in the case of some lunar meteorites), and afterwards they finally landed on the Earth. A meteorite to be released from the Moon needs to overcome the velocity of 2.38 km/s, which is only possible to attain after an impact of a large asteroid, which will form on the planet a crater of several hundred meters in diameter and up to several tens meter deep. In the case of Mars the required velocity is 5.4 km/s and the impact crater diameter can be several kilometers in diameter and up to several hundred meters deep. Lunar and Martian meteorites represent therefore important extraterrestrial samples carrying information on the composition and characteristics of the Moon and Mars surface and subsurface depending of the crystallization and ejection depth. They are unique samples, as there are currently no other possibilities to investigate the subsurface of Moon and Mars at depths several tens or hundred meters, respectively. In contrast to APOLLO samples, the lunar meteorites are random samples of the Moon providing a more representative sampling of the lunar surface, including sampling from the farside of the Moon [1,2].

Samples and methods: One fragment of the Lunar meteorite – NWA 482 (13.10 g, obtained from private collection), and two meteorites of Martian origin - Chassigny (15.79 g) and Nakhla (153.67 g, obtained from the Vatican Observatory) were analysed non-destructively in the Low-level gamma-spectrometry laboratory of the Department of Nuclear Physics and Biophysics of the Comenius University in Bratislava. The gamma-spectrometer consisted of a large volume lead-iron-polyethylene-copper passive shield where HPGe detector (70% relative efficiency), NaITl and plastic scintillations detectors for coincidence-anticoincidence measurements were installed [3,4,5]. **Results:** As short lived cosmogenic radionuclides have already decayed, only long-lived ^{26}Al (half-life of 0.717 Myr) has been found in all analyzed samples. The obtained values were 39.6±3.6 dpm/kg for Chassigny, 61.8±4.8 dpm/kg for Nakhla and 61.4±7.8 dpm/kg for NWA 482. The Chassigny value is in very good agreement with recently measured ^{26}Al levels in the Tissint meteorite (the average value from analysis of two Tissint fragments was 36.9±3.1 dpm/kg) [6]. The measured low ^{26}Al activities in the Chassigny meteorite may be explained, similarly as in the case of the Tissint meteorite, by an unsaturated production of ^{26}Al, which could be caused either by short cosmic-ray exposure (CRE) ages and/or by small dimensions of the meteoroids which prevented development of higher (saturated) ^{26}Al levels, and/or by long terrestrial ages (not the case for Chassigny – fall in 1815, and Nakhla – fall in 1911). The Tissint meteorite (fall in 2011) has short CRE age (0.9±0.3 Myr [7]), which is not the case for Chassigny and Nakhla meteorites (having CRE ages of 10-11 Myr [8]). Therefore, the reason for unsaturated production of ^{26}Al in Chassigny could be in its small pre-atmospheric radius (about 10 cm (for comparison <20 cm in the Tissint case). For the lunar NWA 482 the measured ^{26}Al activity is probably higher due to contributions from solar protons as for the CRE age of about 0.3 Myr and the measured terrestrial age of 8.6 kyr [9], the pre-atmospheric radius could be <10 cm. The activities of the primordial radionuclides measured in the Chassigny meteorite (460±90 dpm/kg for ^{40}K, 97±13 dpm/kg for ^{226}Ra, and 17±9 dpm/kg for ^{232}Th) are much higher than in the Tissint meteorite. **Acknowledgement:** Support provided by the Slovak Science and Grant Agency (VEGA - 1/0891/17) and by the by the Slovak Research and Development Agency (APVV-16-0148) has been highly appreciated.

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