PRE-ATMOSPHERIC SIZES AND ORBITS OF THE ASH CREEK AND TAMDAKHT CHONDRITES ACCORDING TO THE RESULTS OF TRACK AND COSMOGENIC RADIONUCLIDE INVESTIGATION.

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Introduction: The track density of VH-nuclei (iron group) of cosmic rays is measured by means of the track method in olivine crystals extracted from the fresh-fallen Ash Creek L6 and Tamdakht H5 chondrites, in order to determine the shielding depth of the investigated specimens from the pre-atmospheric surfaces of the chondrites. The cosmic-ray exposure ages of the chondrites, as well as the efficiency of VH-nuclei track recording and the dependence of track production rate in crystals on their shielding depth from the pre-atmospheric surface are taken into account [1]. In the case of the Ash Creek chondrite, the shielding depth of the investigated specimen is 12 ± 3 cm, in accordance with the measured density of tracks of $(1.6\pm0.1)\times10^5$ tracks cm^{-2}. In the case of the Tamdakht chondrite, the lower limit of the shielding depth of ~3-4 cm from the pre-atmospheric surface can be pointed out only because of the very high track density of $(2.64\pm0.05)\times10^6$ tracks cm^{-2}, due to possible irradiation of its matter at the regolith stage.

The contents of cosmogenic radionuclides of ^{60}Co and ^{26}Al are measured by means of the non-destructive low-level counting at our low-level γ-spectrometric complex, which is commonly used for many years for measurement of radioactivity of meteorites, lunar matter and other natural samples [2]. At the moment of the Ash Creek chondrite fall on 15.02.2009 they were 41±5 dpm/kg and 66±7 dpm/kg for ^{60}Co and ^{26}Al, respectively, as well as at the moment of the Tamdakht chondrite fall on 20.12.2008 they were 16±3 dpm/kg and 55±6 dpm/kg for ^{60}Co и ^{26}Al, respectively.

Pre-atmosperic sizes: Using the analytical method developed earlier [3], the modeling of radionuclide production rates in the Ash Creek and Tamdakht chondrites is carried out with taking into account the stratospheric data on the GCR intensity (I_0(>0.1 GeV) [4] for the periods of ~$1.5T_{1/2}$ of the radionuclides before the fall of the chondrites to the Earth. The analysis of the experimental data and the results of the theoretical modeling have allowed us to estimate pre-atmospheric sizes and ablation of the chondrites, as well as the extension of their orbits.

The developed methods of estimation of the meteoritic pre-atmospheric sizes are described in detail in a number of our previous works [3,5, etc.]. The most sensitive indicator of pre-atmospheric sizes of chondrites is the ^{60}Co radionuclide, which is produced with thermal and resonance neutrons in the reaction of $^{59}Co(n,\gamma)^{60}Co$ [6]. The depth distributions of ^{60}Co production rates in spheric chondrites of different size and composition are presented in [3]. In Fig.1 they are demonstrated for the Ash Creek and Tamdakht chondrites. In order to calculate them, the data on ^{59}Co contents in L6 and H5 chondrites (0.06 and 0.078 weight.%, respectively) [7], as well as the average GCR intensities during ~8 years (~1.5 $T_{1/2}$ ^{59}Co) before the fall of the chondrites to the Earth, according to stratospheric measurements of [4] were used. The most efficient approach to estimation of the pre-atmospheric sizes of chondrites is a combination of the data on ^{60}Co content with the data on density of tracks of *VH*-nuclei, which fixed the shielding depth of the investigated samples [3,5, etc.].

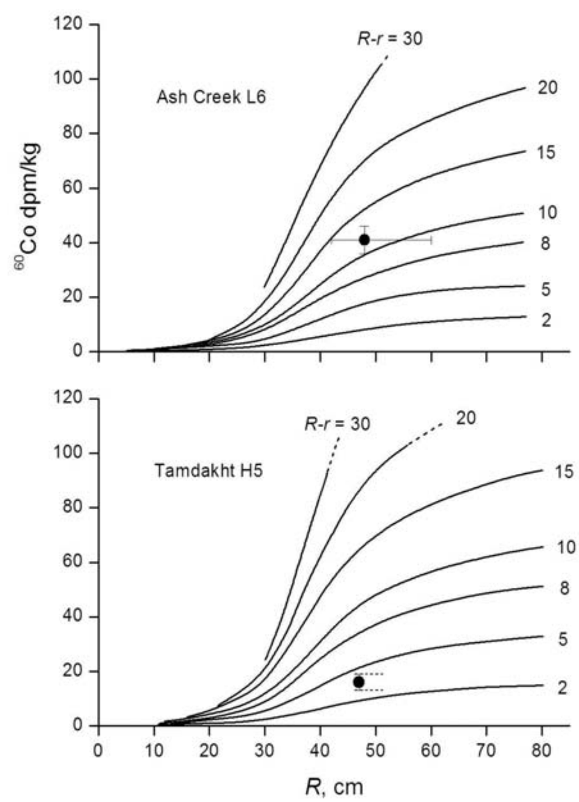

Fig.1 – *The ^{60}Co production rates in the Ash Creek (above) and Tamdakht (below) chondrites at the different depth d=R-r from the surface (figures on the plot), depending on radius R.*

It is well seen in Fig.1 that the measured content of ^{60}Co in the Ash Creek chondrite (cross corresponding to 41±5 dpm/kg) at the depth of 12±3 cm, as fixed by track data, points to the average pre-atmospheric radius of the chondrite of R=48^{+12}_{-6} см, which corresponds to the pre-atmospheric mass of ~1500 kg and ablation of ~99.2%. Such a high ablation degree of the Ash Creek chondrite is in accordance with its supposed high velocity of entering the earth atmosphere as well as with the observed characteristic crushing in small fragments. At the same time, since for the investigated sample of the Tamdakht chondrite the low limit of the shielding depth is fixed only, the measured content of ^{60}Co (16±3 dpm/kg) in the chondrite allows us to determine only the low limits of its pre-atmospheric radius $R \geq 47$ cm, and, respectively, of its pre-atmospheric mass ≥ 1470 кг and ablation degree ≥ 93%.

Orbits: The previously developed "isotopic" approach based on the observed variation of ^{26}Al content, depending on the extent of meteoritic orbits [3,5,8], is used to estimate the size of orbits of the chondrites (location of aphelion q'). Indeed, according to ^{26}Al radioactivity in the chondrites of known orbits (Pribram, Lost City, Innisfree and Peekskill), the integral gradient of the GCR intensity of about ~20-30%/AU (average over ~ 1 Myrs) along their orbits exists, so that the ^{26}Al content in the chondrites of more extensive orbits is considerably higher [8,9]. Such a regularity can be successfully expressed by the phenomenological formula through the value of aphelion q', and, hence, the aphelia of orbits of chondrites can be evaluated according to their ^{26}Al saturated activity [10]. The modeling of ^{26}Al production rates in L and H chondrites of different size is carried out. According to the measured level of ^{26}Al radioactivity, the most probable orbital elements of the Ash Creek(L) chondrite are as follows: aphelion $q' \sim 3.99$ AU, semi-major axis $a \sim 2.495$ AU, eccentricity $e \sim 0.599$, and orbital period $P \sim 1438$ days. The orbit of the Ash Creek(L) chondrite is similar in extension to the known orbit of the Pribram(H) chondrite ($q' = 4.05$ a.e), as well as to the calculated orbit of the Bruderheim(L) chondrite ($q' = 4.06$ a.e) [3]. In the case of the Tamdakht(H) chondrite the most probable elemenets of its orbit are: $q' \sim 3.54$ AU, $a \sim 2.27$ AU, $e \sim 0.559$, $P \sim 1248$ days. Both the orbits, calculated by the Kepler equation as a dependence $r(t)$ [11], are demonstrated in Fig. 2. The average heliocentric distances of the chondrites are close enough: $r_c = 3.24$ AU and $r_c = 2.87$ AU for the Ash Creek and Tamdakht chondrites respectively (marked by dotted lines in Fig. 2), so that the chondrites approach the Earth within the interval of about two months from practically the same heliocentric distances.

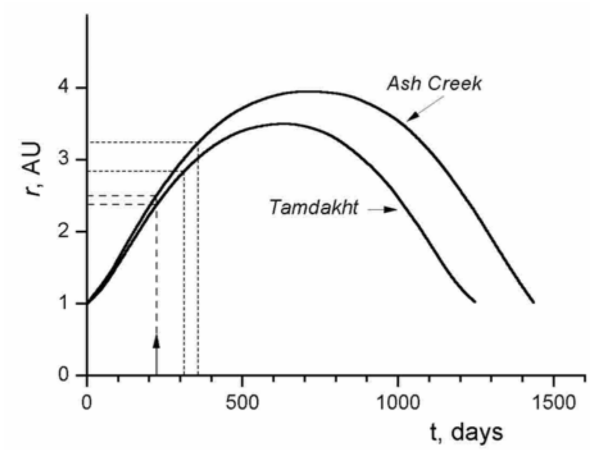

Fig. 2 – *Orbits of the Ash Creek and Tamdakht chondrites (r is heliocentric distance; t is time on the orbit before passage the perihelion; arrow points out r'_c , i.e. the heliocentric distance, beginning from which the observed ^{54}Mn content in the chondrites was mainly accumulated before their fall to the Earth)*

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