PRE-ATMOSPHERIC SIZE AND ORBIT OF THE BUKHARA CV3-CHONDRITE.

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Introduction: The Bukhara carbonaceous chondrite fell in Uzbekistan on July 9th 2001, one fragment of mass of 5.3 kg being only found [1]. It belongs to the carbonaceous chondrites of the chemical CV-group, i.e. to the group of the Vigarano carbonaceous chondrite; the most famous and well-studied representative of that group is the Allende chondrite [2-4 et al.]. We have investigated the specimen N 16697 of mass of 320 g. The exposure age of the Bukhara chondrite is not measured yet. According to the density of tracks of VH-nuclei, the shielding depth of that sample from the pre-atmospheric surface of the chondrite ranged within $d \sim 5$ - 17 cm [5].

Using the complex of low-level gamma-spectrometric instruments of the laboratory of cosmochemistry of GEOKHI RAS [6], the contents of the following radionuclides are measured non-destructively in the Bukhara chondrite: ^{54}Mn - 120 ± 40, ^{22}Na - 88 ± 10, ^{60}Co - 6 ± 2 and ^{26}Al - 56 ± 6 in dpm/kg, respectively [7].

By means of the analytical method developed beforehand [8,9], modeling of the production rates of the radionuclides measured in the Bukhara chondrite is performed with using the stratospheric data [10] on the average galactic cosmic ray intensity for $\sim 1.5T_{1/2}$ of the radionuclides before the fall of the chondrite to the earth. The analysis of the experimental data and regularities of the theoretical modeling has allowed us to estimate the pre-atmospheric size and ablation of the Bukhara chondrite, as well as the extent of its orbit.

Pre-atmospheric size and ablation: The most efficient approach to estimation of pre-atmospheric sizes of chondrites is a combination of the data on VH-nuclei track density (which are the most sensitive to the shielding depth of the sample from the surface) with the data on the ^{60}Co content (which are the most sensitive to the sizes of the chondrites) [8,11-13]. Indeed, radionuclide ^{60}Co is produced in the reaction of ^{59}Co(n,γ)^{60}Co with thermal and resonance neutrons, the accumulation of which is very sensitive to the size of the bodies [8, 14]. It is obvious that the ^{60}Co generation increases directly with the content of Co, which varies over a sufficiently wide range in the chondrites [15,16]. When modeling ^{60}Co depth distribution in the Bukhara chondrite, we used the average content of Co of 0.06% in carbonaceous chondrites (in particular, in the Efremovka CV3-chondrite) [16]. The ^{60}Co content, measured at the time of the Bukhara chondrite fall to the earth, was produced under the average galactic cosmic ray intensity $I_0 \sim 0.2705$ cm^{-2} s^{-1} sr^{-1} for ~8 years (i.e. about $\sim 1.5T_{1/2}$ of ^{60}Co) before the fall [10,17]. It is clear that, using ^{60}Co, we obtain the estimate of the average pre-atmospheric size of the Bukhara chondrite for the last ~8 years before its entrance to the earth atmosphere. The results of the modeling are presented in Fig.1.

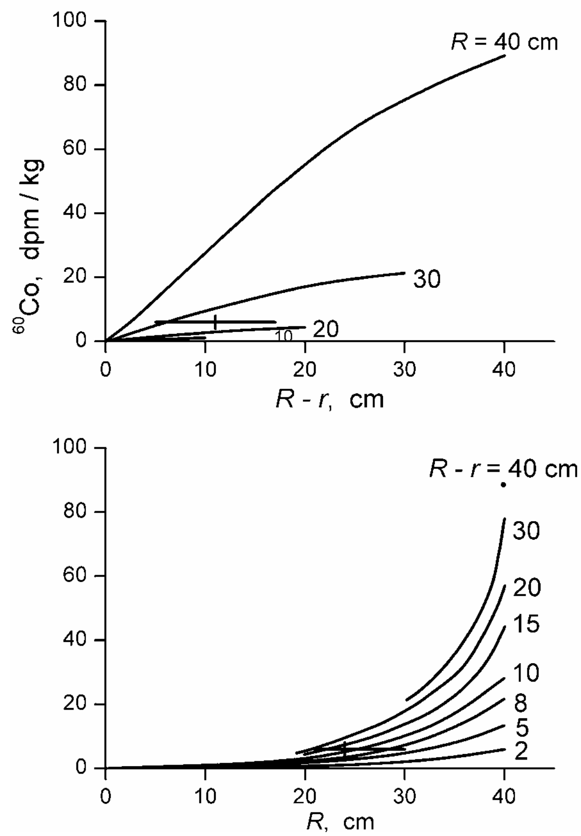

Fig.1 *- Dependence of ^{60}Co depth distribution in chondrites of different pre-atmospheric radii R on the distance d=R-r from the surface (upper plot), and dependence of ^{60}Co distribution at different distances from the surface on radius of the chondrites (lower plot). Crosses show the measured content of ^{60}Co in the sample of the Bukhara chondrite at the depth of d=11±6cm, as fixed by the track method.*

The upper plot shows the ^{60}Co distribution in spherical chondrites of radii *R,* depending on the shielding depth *d=R-r* of samples from the surface. The cross is the measured ^{60}Co content in the Bukhara chondrite (6±2 dpm/kg) at the depth of the investigated sample of *d* = 11±6 cm, as identified by the track evidence. The cross corresponds to the average pre-atmospheric radius of the Bukhara chondrite of $R = 24^{+6}_{-3}$ cm, which is shown on the lower plot describing the dependence of ^{60}Co distribution at various depth *d=R-r* from the surface on radius *R.* Using the density of CV-chondrites of 2.95 g cm^{-3} [18], one may obtain that the pre-atmospheric mass of the Kilabo chondrite average for the last ~ 8 years before the fall to the earth equaled ~171 kg, and the ablation through the passage of the earth atmosphere amounts ~96.9%. Within the limits of errors, it is in accordance with the statistic estimates of the ordinary chondrite ablation [19].

Orbit: The previously elaborated isotopic approach [8,13,20], based on the content of cosmogenic radionuclide ^{26}Al, is used to estimate the position of aphelia q' of the chondrite orbit. According to that approach, the measured level of the ^{26}Al radioactivity of 56±6 dpm/kg at the depth of 5-17 cm from the pre-atmospheric surface of the Bukhara chondrite of radius of ~ 24 cm corresponds to the orbit with aphelion of *q'* = 2.0±0.19 AU and to the most probable semi-major axis *a* = 1.5 AU, eccentricity *e* = 0.333, and orbital period *P* = 670.5 days. This orbit as the regularity *r(t)* (where *t* is time and *r* is a heliocentric distance), calculated with the Kepler formulae [21], is shown in Fig.2. It corresponds to the orbits of the majority of the chondrites, the maxima of the aphelion distributions of which fall on the range of *q'* ~ 1.9-2.0 AU [8,13]. Apparently, due to the increase of the population density of cosmic bodies near the inner boundary of the main asteroid belt, and, hence, due to their ever-growing fragmentation [22,23], the population peak of bodies of the 'chondrite' size (~1 m [13]) falls just on that range. It testifies to the universality of the mechanisms of evolution and selection of cosmic bodies in the solar system, the majority of which being stochastic processes of their collisions and resonance interactions with planets [13]. Unfortunately, any statistic data on the extent of orbits of the carbonaceous chondrites, as well as their direct measurements, are not available yet.

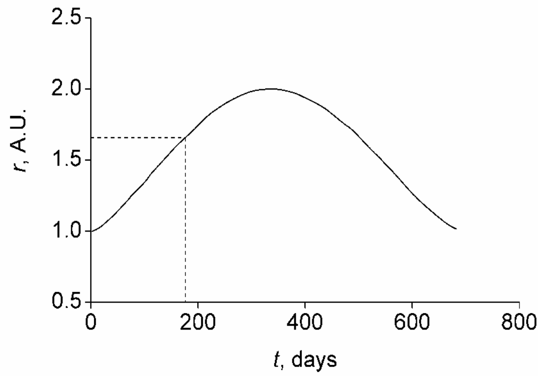

Fig.2 *– The orbit of the Bukhara chondrite (dashed lines mark the average heliocentric distance of the orbit r_c=1.66 AU)*

References: [1] Russell S.S. et al. (2003) *Meteoritics & Planet. Sci., 38,* A189-A248. [2] Dodd, R., *Meteorites: A Petrologic Chemical Synthesis*, CUP, 1981. [3] Wasserburg G.J. and Papanastassiou D.A. *Essays in the Nuclear Astrophysics*, CUP, 1982, 77-140. [4] Clarke R.S. et al. (1970) *Smithson. Contrib. Earth Sci. 5,* 1-53. [5] Kashkarov L.L. and Kalinina G.V. (2007) *LPS XXXVIII, # 1067.* [6] Lavrukhina A.K. et al. *Low-level Counting,* M.: Nauka, 1992. 212 c. [7] Gorin V.D. and Alexeev V.A. (2006) *LPS XXXVII,* # 1034. [8] Lavrukhina A.K. and Ustinova G.K. *Meteorites as probes of cosmic ray variations.* M.: Nauka, 1990. [9] Ustinova G.K. and Lavrukhina A.K. (1990) *Proc. 21st ICRC, Adelaida, 7,* 141-144. [10] Bazilevskaya G.A.and Svirzhevskaya A.K. (1998) *Space Sci. Rev. 85*, 431-521. [11] Alexeev V.A. and Ustinova G.K. (1995) *Nucl. Geophys. 9,* 609-618. [12] Ustinova G.K. et al. (1988) *Geokhimiya, 10,* 1379-1395. [13] Alexeev V.A. and Ustinova G.K. (2000) *Geokhimiya, 10,* 1046-1066. [14] Eberhardt P., Geiss J., and Lutz H. *Earth science and meteoritics.* North-Holland, 1963, 143-168. [15] Mason B. *Handbook of elemental abundances in meteorites.* N.Y.: G & B, 1971. 600 p. [16] Jarosewich E. (1990) *Meteoritics, 25,* 323-337. [17] Krainev M.B. and Weber W.R. (2005) *Izv.RAS. Ser.phys., 69,* 838-841. [18] Britt D.T. and Consolmagno G.J. (2004) *LPS XXXV*, #2108. [19] Alexeev V.A. (2003) *Astron. Vestn., 37,* 229-239. [20] Lavrukhina A.K. and Ustinova G.K. (1972) *EPSL, 15,* 347-360. [21] Landau L.D. and Lifshitz E.M. *Mechanics*, M.: FisMatGiz, 1958, 49-54. [22] Ipatov S.I. (1995) *Astron.Vestn, 29,* 304-330. [23] Migliorini F. et al. (1997) *Icarus, 128,* 104-113.