**SOME FEATURES OF THE DISTRIBUTION OF VH-NUCLEI TRACKS OF GALACTIC COSMIC RAYS IN ORDINARY CHONDRITES.** G. V. Kalinina, T. A. Pavlova and V. A. Alexeev. Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow 119991 Russia; e-mail: AVAL37@mail.ru

**Introduction**: The tendency of decreasing of the track formation rate with increasing of cosmic ray exposure age of meteorites has been found in result of systematization of the literature data and the data obtained by us also. The investigations were carried out on the basis of the study of the distribution of VH-nuclei tracks of galactic cosmic rays (GCR) in olivine crystals of ordinary chondrites. There were identified two sets of the meteorites with different rates of track formation, with different average contents of the cosmogenic $^{26}$Al, and also with different representativeness of chondrites of the various chemical groups. Detected features of the track distributions may be stipulated by the different average sizes of chondrites of various chemical groups after their separation from the parent bodies. The tendency of decreasing of the average rate of track formation with increasing of cosmic ray exposure ages of meteorites was found [1] in the detailed analysis of track data of about 160 meteorites according to the data published in [2]. Here we present the results of the study of the larger set of published and new data also.

**Results and discussion:** The procedure of our track studies was reviewed in [3-5]. Olivine and pyroxene grains with the fraction sizes of 50-200 μm from the meteorites were used to measure the track parameters. Using 0.5-1 g of each chondrite sample, we allocated up to several tens of silicate grains which were suitable for the track studies. The olivine grains were handpicked under a binocular microscope and then they were packed in epoxy resin tablets, which were polished and etched in the chemical multicomponent WN-type solution at 110°C [6]. The chemical etching was used to detect the tracks formed by VH-nuclei of GCR in olivine crystals. Before the etching, the surface of each crystal was examined under a microscope to reveal the various kinds of dislocations and other defects or micro-irregularities of crystal structure similar to tracks. Control and efficiency of chemical etching of the natural tracks in olivine grains were carried out by recording of the artificially induced tracks from the fission fragments of $^{252}$Cf.

We analyzed the distribution of the average values of the rate of track formation $D = \rho_{av}/T$ in 45 ordinary chondrites, in depending on cosmic ray exposure ages $T$ of chondrites. The average value of the track density ($\rho_{av}$) is: $\rho_{av} = N/S$, where $N$ is total number of tracks counted on the total area $S$ of all meteorite grains.

The distribution of the track formation rates for all selected meteorites is shown in Fig. 1. From the published results of Bhandari et al. [2] we used the data for meteorites with the number of studied grains $n \geq 3$. In our measurements, this condition is satisfied for all studied meteorites. It can be seen, the number of meteorites with high $D$ values is decreased with increasing of the cosmic ray exposure age $T$. For example, among meteorites with $T < 27$ million years (area to the left from vertical dotted line in Fig. 1), 16 from 30 values of track formation rate lie in the range of $D \geq 1.3 \cdot 10^5$ см$^{-2}$ Myr$^{-1}$, whereas for 15 chondrites with $T > 27$ million years (area to the right from the vertical dotted line in Fig. 1) there is no a meteorite with $D \geq 1.3 \cdot 10^5$ cm$^{-2}$ Myr$^{-1}$. For presentation, this decreasing in Fig. 1 is shown by the tracing of the "boundary" regression line $y = a + bx$. For the construction of this regression line in the semi-logarithmic scale, the points were selected (the group I), that have the deviation on the ordinate from the regression line calculated for these points no more than ± 5% (triangles in Fig. 1). The equation of thus obtained line (*1*) is: $lg\ D = 6.30 - 0.033T$. Within the errors of determination, the parameters of this equation $a$ and $b$ coincide with previously obtained parameters for the smaller number of meteorites [1].

More representative data set, in comparison with the data [1], made it possible to identify the second group of meteorites (II), for which the regression line (*2*) was also calculated by the above used method: $lgD = 5.81 - 0.032T$. The coefficient $b$ in the equation for the line *2* (0.032) was almost the same also for the line *1* (0.033). This coefficient characterizes the main tendency of decreasing of the track formation rates in meteorites with increasing of the cosmic rays exposure ages of meteorites. The difference of the parameters $a$ in the equations of the regression lines *1* and *2* is 0.49 ± 0.09. This value corresponds to differences between the track formation rates in meteorites of groups I and II, in average, 3.1 ± 0.7 times. This result may be due, in average, to the higher pre-atmospheric sizes of meteorites of the group II in comparison with the sizes of the group I meteorites.

Comparison of the representativeness of meteorites of the different chemical classes in the groups I and II showed that the group I is presented, mainly, of L- and LL-chondrites (9 of 12; unfilled triangles in Fig. 1), while the group II consists mainly of H chondrites (8 of 14; filled circles in Fig. 1). In view of the found difference in the track formation rates of group I and II meteorites, it can be assumed that the L- and LL-chondrites, the most common of the group I, are characterized generally by smaller pre-atmospheric sizes and, consequently, the higher of track formation rates in comparison with H chondrites, more represented in group II.

To verify this conclusion, we had attracted the results of measurements of cosmogenic radionuclide $^{26}$Al in meteorites of the both groups. The average content of $^{26}$Al for the group I meteorites was found as 48.5 ± 2.1, whereas for the group II meteorites this value was significantly higher: 60.9 ± 3.9. Taking into account the differences in the of track formation rates [7] and $^{26}$Al [8] in meteorites in depending on the pre-atmospheric sizes of meteorites and the degree of shielding, the obtained data testify the higher pre-atmospheric sizes (degree of shielding) in group II in comparison with group I.

Noted effects are likely connected with the existence of the large proportion of the chondrites with the small exposure ages among the meteorites with the small degree of shielding (small sizes). This fact, as supposed in [1], may be due to the more rapid delivery of the small size meteorites to the orbits which crossing the Earth's orbit, that, in turn, is associated with the more efficient transfer of small bodies in the asteroid belt to the resonance regions.

**Conclusions**: The study of the reducing of the track formation rate (D) in ordinary chondrites with the increasing of their cosmic ray exposure age was continued in comparison with [1]. Two groups of meteorites with a similar dependence, but differing in the average value D of about 3 times, were selected. Group of chondrites with the higher track formation rates and, consequently, with the smaller pre-atmospheric sizes (less degree of shielding) consists mainly of L- and LL-chondrites. The second group of chondrites with the smaller values D and the larger pre-atmospheric sizes are represented mainly by H-chondrites. The presence of the high proportion of chondrites with the small exposure ages among meteorites with the small sizes (small degree of screening) may be due to the more rapid delivery of the meteorites with the small sizes to the orbits crossing the Earth's orbit. That, in its turn, is connected with the more efficient transfer of the small bodies from the asteroid belt to the resonance regions mainly under the influence of the "daily" component of Yarkovsky effect.

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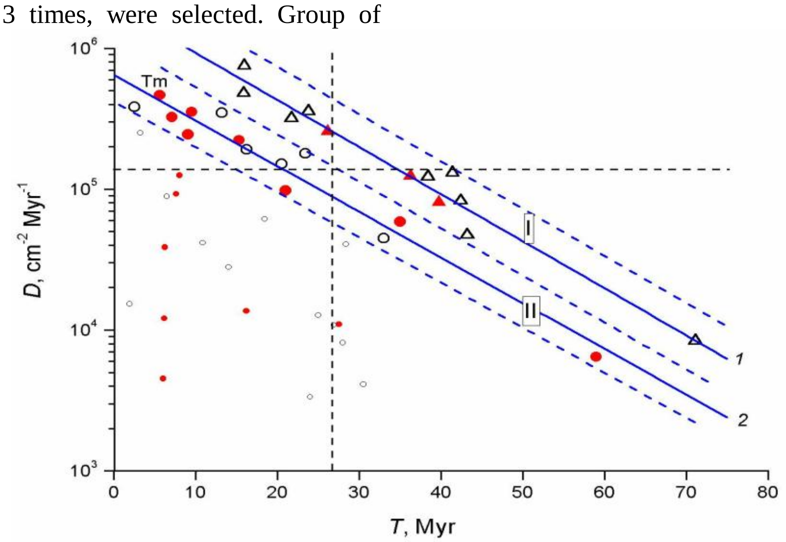


Fig. 1. The track formation rates (*D*) vs the cosmic ray exposure ages (*T*) of meteorites. The regression lines *1* and *2* are constructed in according to data for meteorites of group I (triangles) and group II (large circles), respectively. Small circles are the data outside of the I and II groups. Filled and empty symbols refer to the H- and L-, LL-chondrites, respectively. Oblique dashed lines limit the meteorite groups I and II. The vertical and horizontal dotted lines refer to the values of $T$ = 27 million years and $D = 1.3 \cdot 10^5$ cm$^{-2}$ million years$^{-1}$, respectively.