DEPENDENCE OF COSMIC-RAY EXPOSURE AND GAS-RETENTION AGES OF ORDINARY CHONDRITES ON THEIR PHYSICAL PROPERTIES. V. A. Alexeev, Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow 119991 Russia; e-mail: AVAL37@mail.ru

Abstract: Dependence of cosmic-ray exposure and gas-retention ages of ordinary chondrites on their porosity is analyzed. Meteorites of the high shock classes (Sh > S3) have not only low values of porosity, but also the understated ages.

Asymmetry of distributions: In earlier studies [1, 2], it was found that meteorites, which underwent intensive impact, are characterized by low porosity. For further analysis, we considered the distributions of cosmogenic ^{21}Ne and radiogenic ^{4}He, ^{40}Ar isotopes of noble gases as well as the calculated cosmic-ray exposure (T_{21}) and gas retention ages (T_4 and T_{40}) for H and L chondrites depending on their porosity. The information on the content of the listed isotopes and on the ages was taken from the results of previous studies ([3] and the references cited therein). Information on porosity is taken from [4]. The analysis showed that asymmetry is characteristic for all distributions. For example, the **Fig. 1a** shows the distribution of U,Th-He ages of L chondrites depending on their porosity.

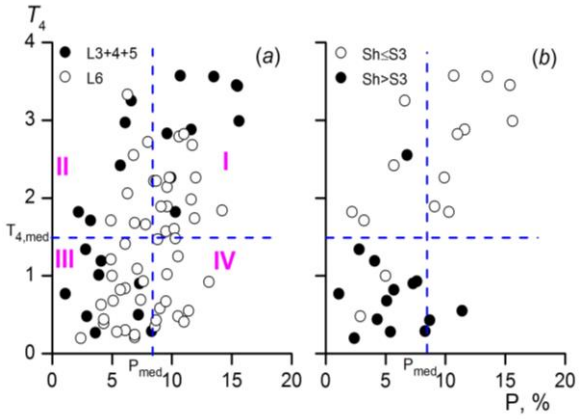

Fig. 1. Distribution of gas retention ages (T_4, Gyrs) of falls of L chondrites, in depending on porosity (P). (*a*) - All L chondrites (n = 74). I - IV are quadrants. P_{med} and $T_{4,\ med}$ are median values of porosity (8.3%) and age (1.48 Gyrs). The filled symbols refer to L3, L4 and L5 chondrites, open – to L6 chondrites. (*b*) - Data for L chondrites with a known degree of impact (Sh) according to classification [5]).

The asymmetry was determined from the coefficient α = [N(I) + N(III)] / N, where N(I) and N(III) are the number of meteorites in quadrants I and III, and N is the number of all meteorites. For the distribution in Fig. 1a the value α = 0.68 ± 0.10. This value is noticeably higher than the value of 0.5, which should be in the absence of asymmetry. At the same time, no difference in the distributions for meteorites of different petrological types has been observed. For all the distributions of gas contents and calculated ages for L chondrites, the mean value of the coefficient α = 0.61 ± 0.01 was found. A similarly significant deviation of the coefficient α from a value of 0.5 was also found for H chondrites: α = 0.62 ± 0.01.

A characteristic picture was manifested when considering the distribution of T_4 as a function of porosity for L chondrites with a known intensity of impact (Fig. 1*b*). Here we can see a clear differentiation – meteorites with a high degree of impact (Sh > S3 according to classification [5]) are grouped in the region of both low values of porosity and low ages.

Table 1. Values of the n_1/n_2 ratio in the distributions of T_{21}, T_4 and T_{40} ages for L chondrites; n_1 and n_2 are the number of meteorites with $T < T_b$ and $T \geq T_b$, respectively (see **Figs 2-4**). The values of T_b are given in parentheses.

Meteorites	T_{21} (22 Myrs)	T_4 (1.4 Gyrs)	T_{40} (4 Gyrs)
All	1.14±0.12	0.92±0.11	1.31±0.15
P > 0	1.29±0.20	0.90±0.15	1.30±0.21
P < P_{med}	**2.55±0.48**	**1.85±0.38**	**2.78±0.56**
P ≥ P_{med}	**0.70±0.18**	**0.42±0.13**	**0.67±0.13**

Table 2. The same as in Table 1, for H chondrites.

Meteorites	T_{21} (10 Myrs)	T_4 (3 Gyrs)	T_{40} (4 Gyrs)
All	1.28±0.12	0.42±0.06	32±0.05
P > 0	1.58±0.23	0.35±0.08	0.22±0.06
P < P_{med}	**2.64±0.49**	**0.75±0.20**	**0.31±0.11**
P ≥ P_{med}	**1.00±0.23**	**0.09±0.06**	**0.15±0.07**

Distributions of ages of L chondrites: Characteristic features in the distributions in depending on the porosity were manifested for all ages: T_{21}, T_4 and T_{40}.

The **Fig. 2** shows the distributions of T_{21} for the falls of L chondrites. The distribution of the ages of all meteorites is similar to the distribution of ages of meteorites with known porosity (Figs 2*a*, *b*). However, meteorites with low porosity have predominantly smaller ages than meteorites with a high porosity (Figs 2*c*, *d* and the **Table 1**).

A similar picture is observed for the distributions of T_4 (**Fig. 3**) and T_{40} (**Fig. 4**). H chondrites show similar features in age distributions (**Table 2**).

Conclusions: The differences in the distributions of the contents of cosmogenic and radiogenic gases and the corresponding ages of L and H chondrites, depending on their porosity, are due to the different shock history of meteorites. The chondrites, which undergo high shock pressures, are characterized by a decrease in porosity due to the filling of pores by the finely dispersed mineral fractions formed during impacts. This causes an increase in the diffusion loss of cosmogenic and radiogenic gases and a decrease in the corresponding cosmic-ray exposure and gas retention ages. The found effect must be taken into account when establishing the chronology of destructive, meteorite-forming events on the parent bodies of meteorites.

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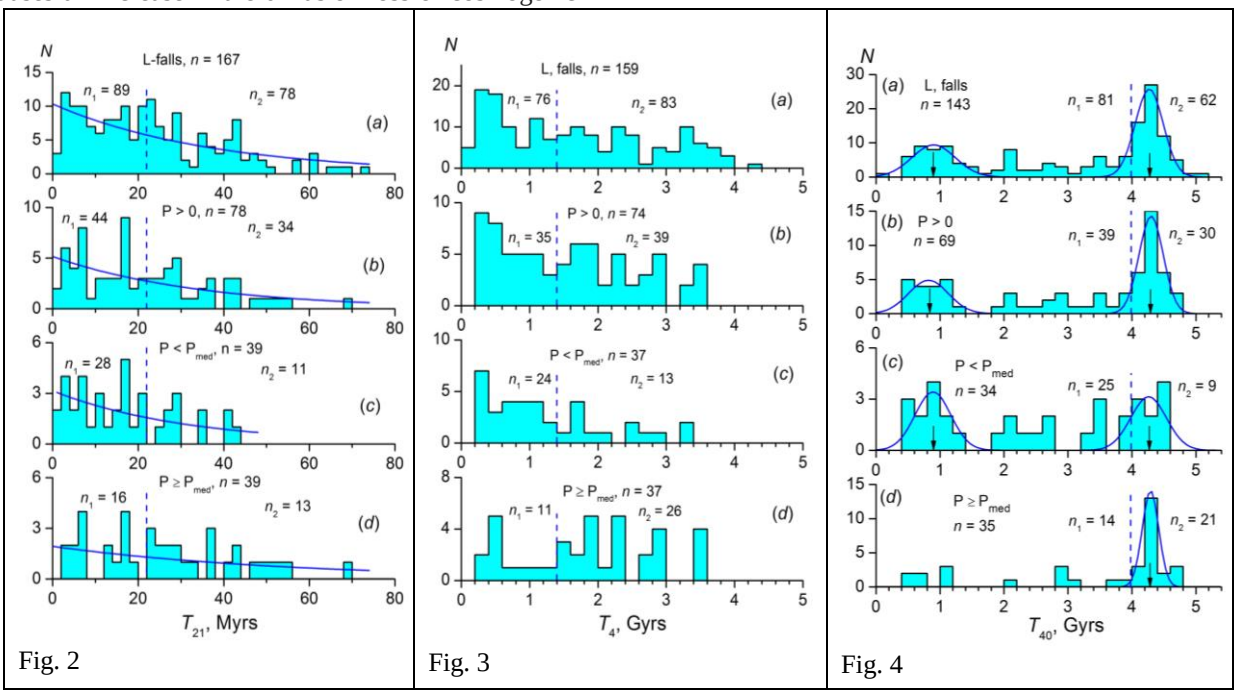

Fig. 2 Fig. 3 Fig. 4

Fig. 2. Distributions of the cosmic-ray exposure ages (T_{21}) of falls of L chondrites. (*a*) - All meteorites; (*b*) - meteorites with known values of porosity P; (*c*) and (*d*) are meteorites with $P < P_{med}$ and $P \geq P_{med}$, respectively. *n* - Number of all meteorites; n_1 and n_2 are the number of meteorites with age $T_{21} < 22$ and $T_{21} \geq 22$ Myrs, respectively. P_{med} is the median value of porosity.

Fig. 3. Distributions of the U,Th-He ages (T_4) of falls of L chondrites in depend on their porosity; n_1 and n_2 - the number of meteorites with age $T_4 < 1.4$ and $T_4 \geq 1.4$ Gyrs, respectively. The rest is in the caption to Fig. 2.

Fig. 4. Distributions of the K-Ar ages (T_{40}) of falls of L chondrites in depend on their porosity; n_1 and n_2 - the number of meteorites with age $T_{40} < 4$ and $T_{40} \geq 4$ Gyrs, respectively. The arrows indicate the position of the maxima of the Gaussian curves. The rest is in the caption to Fig. 2.