FOSSIL METEORITES OF SWEDEN: PECULIARITIES OF THE NEON ISOTOPIC RATIOS

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Introduction: More than 80 fossil meteorites have been found in the ~4 m quarry layer of mid-Ordovician marine limestone in southern Sweden (Thorsberg quarry) [1, 2]. The analysis of noble gas data [2] in chromite grains from these meteorites has revealed a clear negative correlation between ^{4}He, ^{20,21,22}Ne concentrations and weight of the samples [3]. Similar correlation has been found also for cosmic-ray exposure ages of fossil meteorites. However, the cosmic-ray exposure age (duration of an irradiation of a meteorite by cosmic radiation) cannot depend on weight of the investigated sample. This unreal dependence has been disappeared after corresponding correction [3.] The obtained data have allowed us to draw a conclusion on falling one meteoric shower but not many meteorites ~470 Ma ago. Here we report results of the analysis of neon isotopic ratios according to data [2, 4].

Results: We have analysed the data for meteorites of two groups: *Ark* group (meteorites from the Arkeologen bed in the Thorsberg quarry) and *non-Ark* group (all other meteorites from this quarry and a meteorite from the Gullhogen quarry located in 47 km from the Thorsberg quarry).

Fig. 1: As shown in Fig. 1a,b, we can see the ^{21}Ne/^{22}Ne ratios depending on weight of the samples. This dependence is sharply defined for meteorites of *non-Ark* group: the correlation coefficient between lg (^{21}Ne/^{22}Ne) and lg M values is equal to $R = 0.76 \pm 0.10$. Here high values of the ^{21}Ne/^{22}Ne ratios are inherent in well-preserved chromite grains (index preservation is 1) with high weight of samples; low values of the ratios are peculiar to badly preserved grains (indexes preservation are 4 or 5) with low weight of samples. The preservation indexes are given according to [2]. Any dependence of the ^{21}Ne/^{22}Ne ratios vs. weight of the samples in *Ark* group meteorites does not found; the correlation coefficient does not significantly differ from zero: $R = -0.3 \pm 0.4$.

Changes of the ^{21}Ne/^{22}Ne ratios depending on the 1/^{22}Ne values are shown in Fig. 1c,d. For *Ark* group meteorites, the ^{21}Ne/^{22}Ne ratio practically does not change at a change of the 1/^{22}Ne values almost in 10 times. The correlation coefficient does not significantly differ from zero: $R = 0.3 \pm 0.4$. At the same time, the meteorites of *non-Ark* group display the sharply defined dependence between the ^{21}Ne/^{22}Ne and the 1/^{22}Ne values: $R = 0.42 \pm 0.05$. Here, the change of the 1/^{22}Ne values in ~20 times corresponds to the change of the ^{21}Ne/^{22}Ne values more than 3 times (from 0.065 up to 0.20).

Fig. 2: The revealed dependence of the ^{21}Ne/^{22}Ne ratios vs. a meteorite position in the stratigraphic column was greatly unexpected. In Fig. 2, we can see the tendency to reduction of the ^{21}Ne/^{22}Ne ratios (from ~0.15 up to ~0.05) at increase of location depth H of *non-Ark* group meteorites; i.e. the meteorites found in younger beds have lower ^{21}Ne/^{22}Ne ratios. We shall note, the preservation state of *non-Ark* group samples also decreases with increasing the location depth H of meteorites - from the best (preservation index is 1) for H <1 m up to the worst preservation state (indexes are 4 and 5) on location depths of H >3 m. Any changes of the ^{21}Ne/^{22}Ne values depending on preservation state or location depth for meteorites of the *Ark* group does not visible (really, for smaller intervals of location depth and of a preservation states). It is essential to note, the average value of the ^{21}Ne/^{22}Ne ratio for *Ark* group meteorites is equal to 0.047 ± 0.004. This value is considerably below of the value ~0.15 for samples of Gol 001 meteorite found in a following bed (after the bed with meteorites of *Ark* group).

Discussion and conclusion: The found dependences of the ^{21}Ne/^{22}Ne ratios according to the 1/^{22}Ne values or weight of the samples can be explained by higher part of the trapped neon of atmospheric composition in samples of smaller weight with badly preserved chromite grains. Differences between meteorites of *Ark* and *non-Ark* groups are most likely caused by different history of a burial place of these meteorites on the Earth at formation of the limestone beds. The received dependences can be explained in the assumption of fall of one meteorite as large shower about 470 million years ago. The main number of the individual specimens of this shower has been concentrated and isolated in the Arkeologen bed. Other specimens have falling down in radius of ~n10-n100 km and they were introduced (redeposited) in the formed limestone beds during ~1-2 million years when these beds were formed. The composition, the sizes, and preservation state of chromite grains changed during this transportation and redeposition. These processes could cause the observable features in distribution of neon isotope ratios.

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References: [1] Schmitz B. et al. (2001) *EPSL, 194*, 1-15. [2] Heck R.P. et al. (2004) *Nature, 430,* 323-325. [3] Alexeev V.A. (2009) *LPSC XL*, CD-ROM, 1003.pdf. [4] Heck Ph.R. et al. (2008) *Meteoritics Planet. Sci., 43*, 517-528.

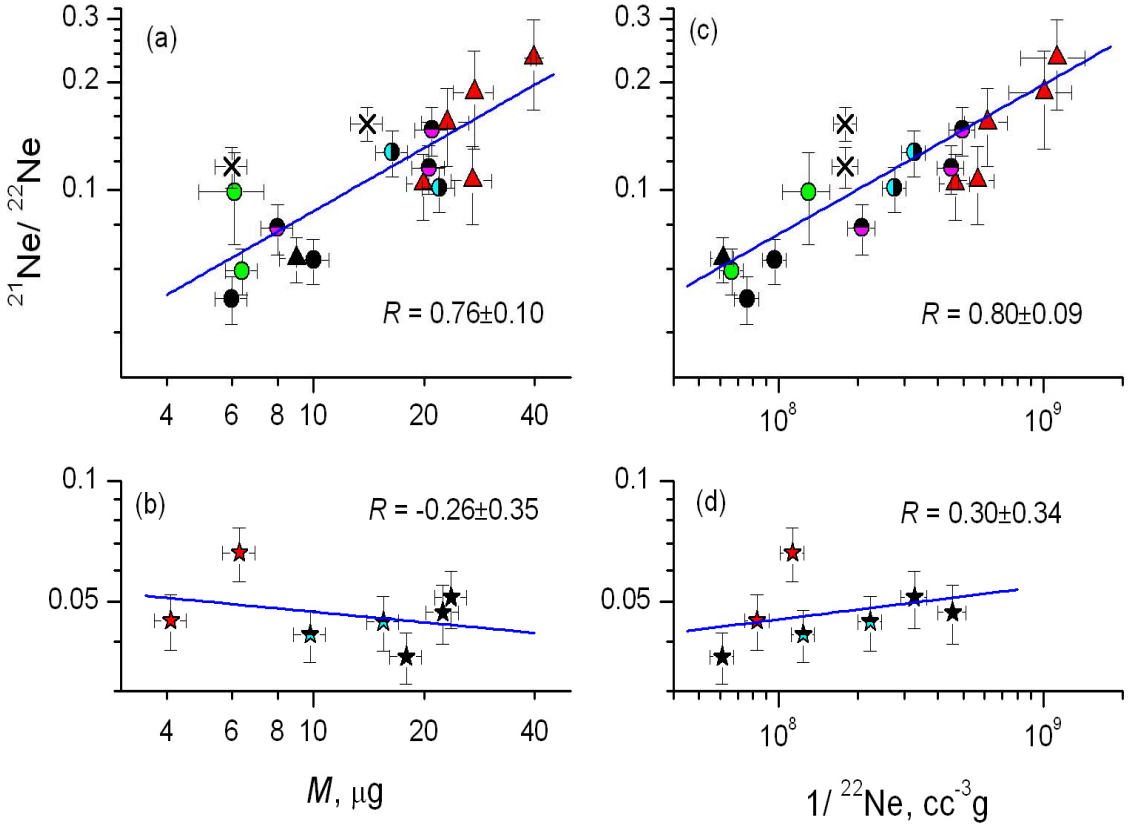

Fig. 1. The $^{21}Ne/^{22}Ne$ ratios vs. *M* (a, b) and $1/^{22}Ne$ (c, d) for chromite grains from fossil meteorites of *non-Ark* (a, c) and *Ark* (b, d) groups. Symbols see in Fig. 2. The ratio of $(^{21}Ne/^{22}Ne)atm = 0.0292$.

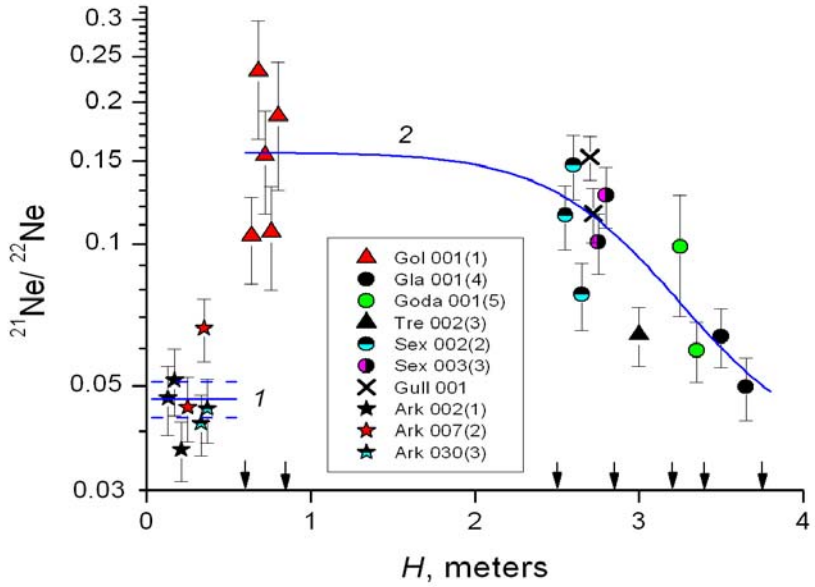

Fig. 2. The $^{21}Ne/^{22}Ne$ ratios in chromite grains depending on location depth of the fossil meteorites of *Ark* and *non-Ark* groups. *1* - Average value of the $^{21}Ne/^{22}Ne$ ratio for meteorites of the *Ark* group (0.047 ± 0.004); *2* – the regression line for meteorites of the *non-Ark* group. The value of *H*=0 corresponds to the base of the Arkeologen bed. Arrows designate boundaries of the beds. Indexes of preservation are given in parentheses. (According to [2, 4].)