SEARCH FOR EFFECTS OF A SUPERNOVA EXPLOSION 30-40 THOUSAND YEARS AGO IN CHONDRITES; V.A.Alexeev and G.K.Ustinova,
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The relative increases in Al-26 and Mn-53 equilibrium radioactivity of chondrites with different cosmic-ray exposure and terrestrial ages due to possible supernova explosion 30-40 thousand years ago have been calculated.

The analysis of the data on Be-10 radioactivity in the Antarctic ice core /1/ and C-14 in stalagmites /2/ has allowed /3,4/ to suppose that prominent peaks in the temporal profiles of radioactivity of these radionuclides are conditioned by a close supernova explosion 30-40 thousand years ago. The relative increase of the radiation intensity over the considered time period, reconstructed according to these data in /4/, is shown in Fig.1 (the filled and empty points have resulted from Be-10 and C-14 data, respectively; the curve is from the theory of cosmic ray generation during the supernova explosion). There are two peculiar peaks along the intensity enhancement testifying in favour of a supernova explosion as a reason for this effect: the first, with approximately double increase of intensity, is caused by immediate generation of particles during the supernova explosion, and the second, with nearly threefold intensity increase, is conditioned by the generation of accelerated particles in the vicinity of shock waves from the supernova.

To what extent could such a strong increase of the radiation intensity be manifested in radioactivity of cosmogenic nuclides in meteorites ? The influence of other probable factors on the level of radioactivity of the different cosmogenic nuclides in meteorites was investigated in detail in /5/, including, in particular, the effects of cosmic ray modulation. As regards a possible display of the short-time intensity increase in the radioactivity of cosmogenic nuclides, it should be studied in connection with the observed differences of the radioactivity in the Antarctic and non-Antarctic chondrites /6/. In the non-Antarctic H- and L,LL-chondrites the average Al-26 radioactivity is the same within the limits of standard deviation; meanwhile, in the Antarctic H-chondrites it is 15±3 % higher than in the Antarctic L,LL-chondrites. However, this effect is not observed for Mn-53: its average radioactivities in the Antarctic and non-Antarctic chondrites of every chemical group are mutually consistent /6/. In comparison with the non-Antarctic chondrites, the Antarctic ones are characterized also by lower average Al-26 radioactivity: by 20±2 % and ~5% in the case of L,LL- and H-

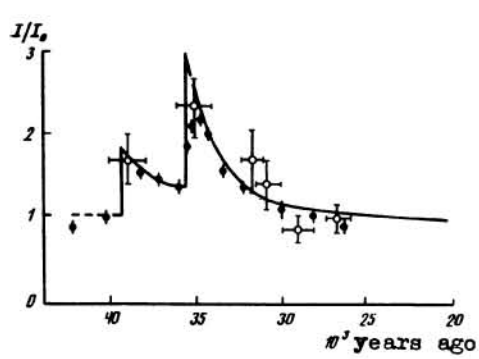

Fig.1

SUPERNOVA EFFECTS IN CHONDRITES: Alexeev V. and Ustinova G.

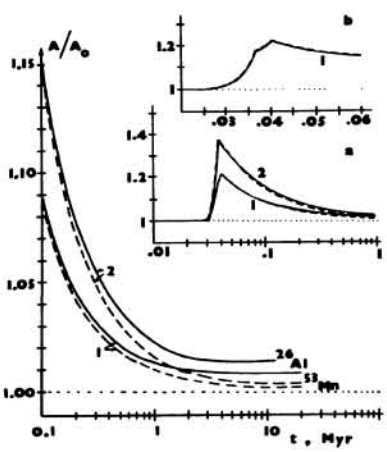

Fig.2

chondrites, successively. This effect is most surely caused by high terrestrial age of the Antarctic chondrites (~230 and ~40 thousand years for L,LL- and H-chondrites, respectively) if the Al-26 radioactivity in the Antarctic H-chondrites has not been affected by any other factors.

We have calculated the relative change of Al-26 and Mn-53 equilibrium radioactivity A due to the sudden enhancement of radiation intensity, conditioned by the supernova explosion, in contemporary chondrites (Fig.2) and in the ones fallen 30 thousand years ago (see it for Al-26 in Fig.3), depending on their cosmic-ray exposure age t (A_0 is the equilibrium radioactivity in absence of the explosion). The calculation was performed for two models of change of the radiation intensity: 1 - for the reconstructed behaviour of the intensity in Fig.1, and 2 - for the 2.5 times increase of it 30-40 thousand years ago.

According to Fig.2, where in inserts a and b the regions of ages, corresponding to the period of the supernova explosion, are shown on larger scales, the maximum increase of radioactivity of both the nuclides (by ~20% and ~40% in models 1 and 2, respectively) falls on the chondrites with cosmic-ray exposure age ~40 thousand years, while in the case of higher ages the increase is unessential. However, the highest effect of the supernova explosion should be observed in the chondrites of t ~ 10 thousand years which fell to the earth ~30 thousand years ago. At the time of their fall the radioactivity of both the nuclides increases by ~1.6 and ~2.5 times in models 1 and 2, respectively. Taking into account the terrestrial age of these chondrites leads to little decrease of the radioactivity level (dashed curves in Fig.3).

Thus, the possible supernova explosion 30-40 thousand years ago did not affect essentially the Al-26 and Mn-53 radioactivity in most chondrites (Antarctic and non-Antarctic) due to their high cosmic-ray exposure age: usually t > 1 Myr. An appreciate effects can only be detected in chondrites with t < 0.1 Myr, e.g., in the Farmington chondrite with t ~ 0.05 Myr.

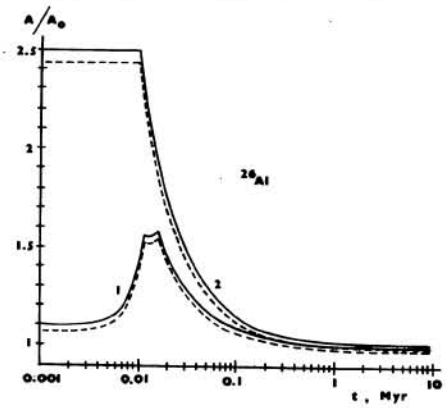

Fig.3

References

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