STUDY OF FOSSIL TRACKS DUE TO Fe-GROUP AND Z≥36 COSMIC RAY NUCLEI IN OLIVINE CRYSTALS FROM LUNA-16 AND LUNA-24

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We used the track etch technique [1] to investigate the tracks due to Fe-group (VH) and Z≥36 cosmic ray nuclei (VVH) in lunar olivine crystal.

The lunar soil is a complex mixture of fragments produced by continuous meteroid bombardment of the lunar surface. The lunar soil contains individual single crystals of common minerals such as olivines, feldspars and pyroxenes with plenty of glass spherules. We have received olivine crystals from lunar regolith samples taken by the Soviet unmanned spacecrafts Luna-16 and Luna-24 (ref.[2]). The crystals are rather small and vary in size from 300 μm to 900 μm.

The lunar olivine crystals were mounted in epoxy and then grinded and polished. The modified WO_4 solution [3] has been used for the etching of these crystals at a temperature of 100°C for 8-10 hrs. The track densities have been measured under optical microscope. Track densities $\geq 10^8$ t/cm^2 cannot be measured accurately and are grouped together. The tracks of length greater than 20 micron are simply counted for VVH track density measurements. The microphotograph of VH tracks in the lunar olivine crystal is shown in Fig. 1. The track density of VH and VVH tracks is plotted in Fig. 2, for various lunar olivine crystals.

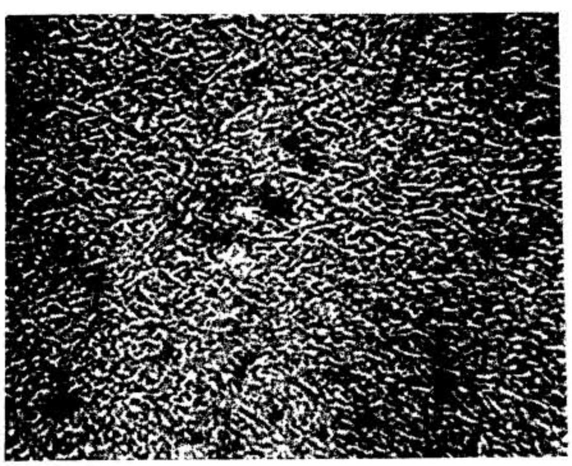

Fig. 1. Microphotograph of VH tracks.

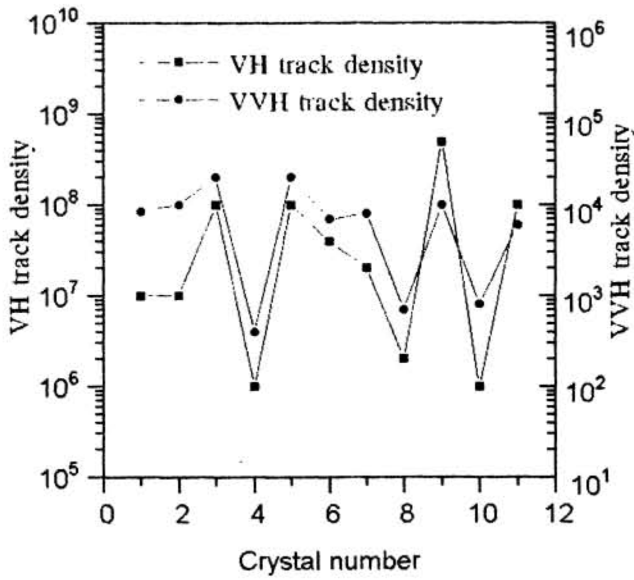

Fig. 2. The track density of VH and VVH nuclei in various lunar olivine crystals.

Fig. 2 shows that the crystals for which VH track density is $\geq 10^8$ t/cm^2 had probably been at least once on the moon surface during their irradiation history while the crystals which possess low track density ($\sim 10^6$ t/cm^2) might have suffered vigorous mixing or had never been on the lunar surface. The VVH track density also varies in a wide range, from 10^3 t/cm^2 to 2x105 t/cm^2.

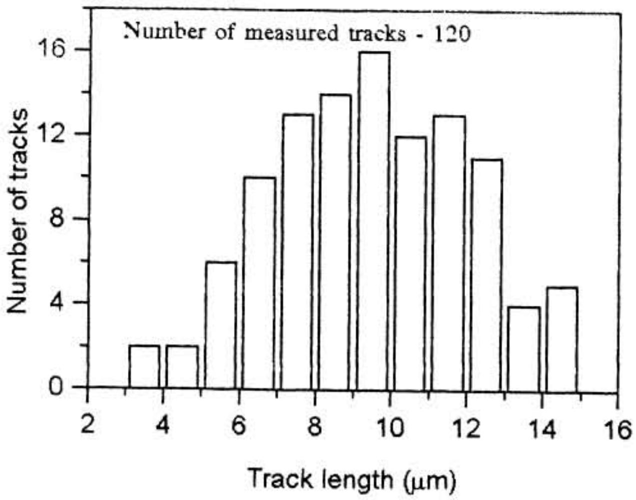

Fig. 3. The VH track length spectra.

The VVH/VH track density ratio for these lunar olivine crystals varies from 1.25×10^{-4} to 2×10^{-3}, It corresponds the depth of these crystals in lunar soil 3-8 cm. The measured VH length spectra are presented in Fig. 3. The peak falls around 8-10 μm. Thus the fossil tracks are shortened down in comparison to fresh Fe tracks. This may be attributed to the high moon surface temperature (~120°C) during daytime. The measurement of Fe group track length spectra in different lunar crystals shows no change in the peak position.

Lunar crystals are well suited for VVH track studies due to a very high track density. The crystals are annealed at 430°C for 32 hrs [4]. This anneals the overlapped iron group tracks completely and leaves etchable tracks of nuclei with $Z \geq 50$, even in the olivine crystals with Fe-group track up to $1\text{-}2 \times 10^8$ t/cm^2. We were able to measure two tracks with the length 195 and 210 μm, which were produced with Th-U group of Galactic cosmic ray nuclei [4,5]. It means that lunar olivine crystals can be used for the investigations of $50 \leq Z \leq 110$ cosmic ray nuclei. We are thankful to International Science Foundation and Russian Foundation of Fundamental Research for financial support of our work.

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