
We have extended our observations of fossil tracks produced by heavy nuclei in solar flares and galactic cosmic rays in selected lunar samples to understand the irradiation histories of lunar samples and to put constraints on different time scales involved in the deposition and mixing history of the lunar regolith material. For this purpose, fossil track data are combined with those on spallogenic and heliogenic rare gases and thermal neutron produced isotopes. In addition, we have analysed grain size distribution patterns in several lunar soil and gas rich meteorite samples and have made an attempt to understand these data in relation to the observed track densities and solar wind gases. We believe that these data are adequate to characterize the regions and environments where different gas rich meteorites originated.

I. Irradiation history of Apollo 15 samples

We have analysed Apollo 15 rock and soil samples collected from the ejecta of Elbow crater (15081, 15065, 15085), Dune crater (15471, 15476), Spur crater (15459) and the two fresh craters at station 9 (15501, 15511) and station 6 (15285) site. The experimental techniques are the same as described earlier (Arrhenius et al. 1971).

Although all three craters at this site, Elbow, Dune and Spur are subdued craters and could be Copernican in age, yet, at the sample collection site it was observed that most of the rocks do not have well defined fillet and also lack burial. Consistent with this observation, we find that the rocks 15476 and 15085, 15065 and 15459 all show track densities in the range of \((6-20) \times 10^6\) cm\(^{-2}\) indicative of a maximum subdecimeter exposure age (Bhandari et al. 1972) varying between \((10-30)\) m.y. The integrated surface exposure ages of the soil samples (15081, 15471, 15302) associated with these events are also quite low \(~10-15\) m.y. The spallogenic rare gas ages of these and other samples from these sites are much longer, being in the range of \(100-520\) m.y. (Jordan et al. 1972, Husain et al. 1972, Stettler et al. 1973).

Implications of the above data to regolith dynamics at these sites will be discussed in detail.
II. Apollo 16 surface samples

In our earlier paper (Goswami and Lal 1974) we have attempted a correlation of track parameters with data on contents of agglutinates, solar wind implanted carbon, spallogenic and solar implanted rare gases with a view to ascertain certain time scales of interest and to get some information on principal surface dynamical processes. We have now extended our observations to additional Apollo 16 soil samples where agglutinate and grain size studies were made earlier; the results are shown in Table 1. The observed correlation gives credence to our earlier estimate of the production rate of agglutinates. A detailed summary of these data for different lunar samples and their implications to lunar surface dynamics in relation to other observable parameters will be presented.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Location</th>
<th>Fossil track data</th>
<th>Petrographic data*</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Quartile track</td>
<td>Agglutinate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>density (10^6 cm^-2)</td>
<td>content (%)</td>
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<tr>
<td>61161</td>
<td>Station-1</td>
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<tr>
<td>61241</td>
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<td>67941</td>
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<tr>
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<td>North Ray Ejecta</td>
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</tr>
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</table>

* The grain size and agglutinate data are from Heiken et al. (1974).
LUNAR REGOLITH AND GAS RICH METEORITE...

Bhattacharya et al.

III. Grain size distribution in lunar and gas-rich meteorite samples

Attempts to interpret various effects resulting from micrometeorite bombardments and solar wind irradiation of silicate grains in lunar soils and gas-rich meteorites have been made by several authors. Certain recent results on some meteorites, such as the observations of micrometeorite induced craters in Kapoeta (Brownlee and Rajan, 1973 and agglutinate formation (Rajan, Private communication) are opening up new avenues for studying the above problem. Clearly different types of analysis are essential to delineate these irradiation features as well as to provide a unified picture of gas-rich meteorite formation, in general. At present, information on the morphology of the regolith on gas-rich meteorite parent bodies where these irradiations have taken place is poorly known. In view of this, we have undertaken detailed experimental and theoretical analyses of solar cosmic ray induced tracks and solar wind implanted gases by taking into account the differences in grain sizes in various lunar and meteorite samples. Our studies are so far confined to Pantar, Fayetteville, Kapoeta, Bansur and Rangala meteorites. These analyses prove extremely valuable and seem promising towards indentifying possible source regions where such meteorites got brecciated.