INDUCED RADIOACTIVITY, TRACKS AND RARE GAS STUDIES IN SOUTH RAY CRATER ROCKS, N. Bhandari, M.B. Potdar and P.N. Shukla, Physical Research Laboratory, Ahmedabad 380009, India.

Solar and galactic cosmic ray effects in lunar samples resulting in induced radioactivity, stable rare gas isotopes and particle tracks have shown that most lunar rocks have had complex exposure history. Rocks with simple one-stage exposure history can easily be identified from concordance of exposure ages based on different methods like tracks, craters, various rare gas isotopes and radio-isotopes with different half-lives. Such rocks should be ideal for estimating the long-term characteristics of solar and galactic cosmic radiation, but hardly any rock exists which satisfies these criteria. We have earlier studied surface samples of several rocks to obtain the average solar flare fluxes (1), based on radionuclide Al-26. Of these, rock 61016 is one where discordance in tracks, rare-gas and crater ages is minimal. They all give an exposure age of nearly 1.5 Myr. and the track density profile is similar to the production expected (1). We have now studied Al-26 in this rock at finer depth intervals to obtain the production profile with a better depth resolution. Five samples taken at4.5, 6.6, 7, 13.5 and 14.7 $\pm$ 2 mm depth were prepared. The samples were processed chemically for Al_2O_3 which was counted on a β-γ coincidence spectrometer. By a modification of our earlier counting system and combination of different energy channels we have been able to achieve a counter performance of 27% efficiency with 1.4×10^{-2} cpm background. These data together with the measurement in the surface sample (0-0.3 mm) provide the Al-26 profile in this rock. The data are consistent with the profile given earlier (1) and yield solar flare flux parameters, J = 125 protons/(sq.cm. sec. 4π sr,> 10 MeV), R_o = 150 MV. The Ne-21, Ne-22 data in this rock are shown in Fig. 1, where measurements in rock 64435 are also included. The experimental data are compared with profiles calculated with various flux parameters in this figure which indicates that the Ne-21 and Ne-22 points fit best (J, R_o) = (110, 100). The helium-3 yields still lower flux of (70, 100) (2). The lower fluxes obtained from rare gas data thus seem to reflect gas loss on the lunar surface since several processes, such as chipping, shock and heating by micrometeorite impacts, are known to occur on the moon which can result in severe gas loss, as has been demonstrated in case of rock 68815 where over 97% of helium and 30% neon has been lost(3). Al-26 activity on the other hand is not effected by such processes and thus appears to be the best tracer for estimating the long term average cosmic ray characteristics.

We have also studied two rocks 69935 and 69955 taken from the top and bottom face of a boulder with complex exposure history (4,5). Some studies have already been reported on these rocks. Because of the possibility of loss of gas as discussed above, we have made measurements of Al-26 and tracks. Since rare gases and tracks are cumulative over the whole exposure period whereas Al-26 activity is only representative of exposure during the past 3 half-lives ($\sim$ 2 Myr),it provides some information about the most recent exposure of the boulder. Various results are summarised in Table 1. The separation of 69935 and 69955 is about 180 $g.cm^{-2}$. The track profile in 69935 shows a good plateau(7) and gave a surface exposure of 0.5 Myr. The bottom sample 69955 did not reveal any tracks indicating a short exposure at shallow depths. The table shows that exposure ages obtained by different

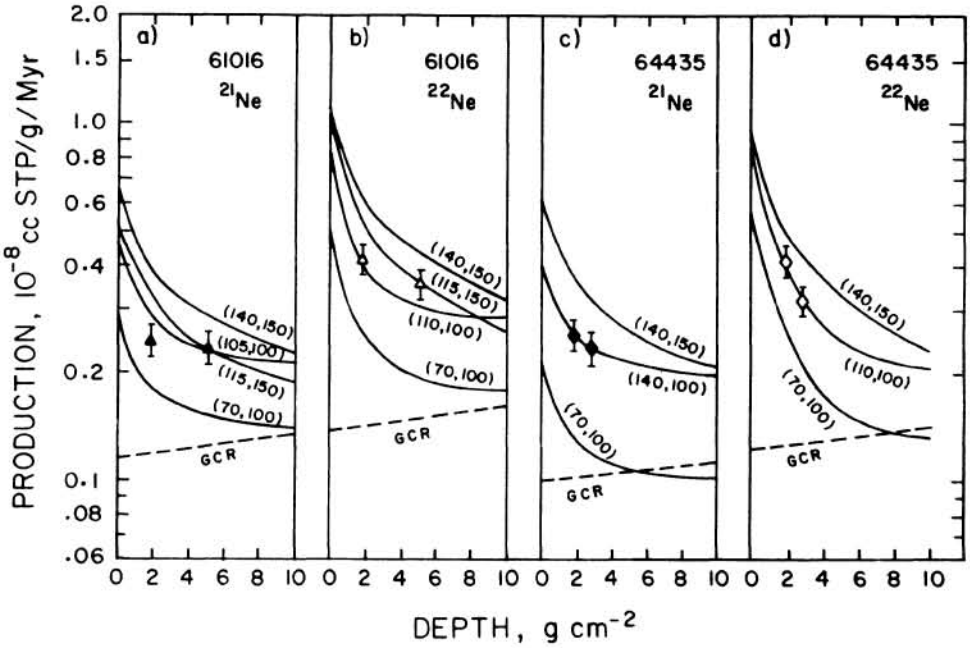

Fig. 1. Calculated (SCR+GCR) production profiles for rocks 61016 and 64435. The effects due to erosion and exposure geometry have been taken into account in the calculations. The data are from (6).

Table 1

Exposure ages of rocks 69935 and 69955 (Myr)

Rock	^{81}Kr-Kr(5)	^{21}Ne(5)	Tracks(7)	^{26}Al(7)
69935	1.99±.37	1.40±.33	0.5±.1	0.4±0.3
69955	4.23±.41	2.13±.50	*	@

* No tracks were seen in this rock giving a limit of $\sim 10^3$ per cm^2.

@ Al-26 in this sample has been measured to be about 120 dpm per kg of rock.

methods are discordant in both the rocks. Thus the boulder shows multiple exposures within the top few meters of the lunar regolith and at least four events at approximately 4, 2, 1.5 and 0.5 Myr. period must have taken place, as indicated by various exposure ages given in Table 1.

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