ANCIENT SOLAR FLARE NEON AND SOLAR COSMIC RAY PROTON FLUXES FROM GAS-RICH METEORITES. C.M. Nautiyal, M.N. Rao and T.R. Venkatesan, Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India.

Assuming that the gas-rich meteorites formed during the early solar system (1), we have studied some gas-rich meteorites by step-wise heating methods with a view to decipher the solar flare neon composition and the solar cosmic ray proton fluxes during the early history of the solar system.

In Fig.1, we have plotted the step wise heating Ne-data for two gas-rich meteorites, Fayetteville (2) and Pantar (our work) and two lunar soils 10084 (3) and 24087 (our work). The data points in Fig.1 (inset) for temperatures less than about 600°-800°C fall along the line joining Ne-20/Ne-22 value of 13.6 for contemporary solar wind (SW) and 11.8 for contemporary solar flare (SF) with a narrow spread 0.033-0.045 for the Ne-21/Ne-22 values. In the low temperature (below about 600° to 800°C) release fractions, the neon observed seems to be varying mixtures of SW and SF components.

The release pattern of SW and SF implanted neon in case of both gas-rich meteorites and lunar soil grains is similar as shown in fig.1. The observation that most of the low temperature data points lie near or above the Ne-20/Ne-22 value of 11.8 in case of both gas-rich meteorites and lunar soils provides an important constraint on the determination of the SF-Ne end point composition. Using chemical etching, however, we have earlier demonstrated that SF-Ne composition in lunar feldspars and pyroxenes is $11.8 \pm 0.3$ (4,5,6). This shows that the value observed for SF-Ne in gas-rich meteorites agrees with that measured in lunar samples within experimental errors. This agreement signifies that the solar flare neon composition has not changed essentially over the entire evolutionary history of the Sun in the last 4.5 B.Y.

On examining the profile of high temperature points in case of both lunar soils and gas rich meteorites, we observe that the high temperature points (upto 1600° to 1700°C) fall near the lines joining SF-Ne end point with the GCR pyroxene end point. However, on closer examination we find that the high temperature data points of Fayetteville and Pantar (mostly olivine-pyroxene mixture) do not fall on the line joining SF-Ne and GCR pyroxene end points but they fall in a triangular field encompassed by SF-Ne, GCR- and SCR spallation end points for pyroxene (7,8). Applying the three component neon decomposition methods developed by us (9) to the case of well-known gas-rich meteorite Fayetteville, we resolve the SCR and GCR produced spallation Ne contents along with the trapped (i.e. SF-Ne) neon component based on the high temperature data (2). Using appropriate SCR (at $0.5 g.cm^{-2}$) and GCR production rates for H-chondrites, we estimate a GCR-exposure age of 28 M.Y. for Fayetteville-dark and a SCR exposure age of 500 M.Y. after taking care of mass-correction due to 20% of irradiated grains in Fayatteville.

The GCR-exposure age of Fayetteville-light (having no irradiated grains) is 23 M.Y. (10). The agreement of the GCR exposure age of the Fayetteville-dark deduced here, with that determined from the light portion independently shows that the methods used for resolution of the components is correct. The SCR production rate used in this calculation is based on today's proton flux at 1 a.u. If we consider the Fayetteville parent body to be originating in asteroidal belt, the proton flux goes down by a factor of about 10, following

$1/R^2$ relation. This leads, in turn, to a further increas : in the SCR-exposure age of Fayetteville to the incredibly high value of ~ 5000 M.Y.

This high exposure age is incongruous with the present day knowledge of the planetary regoliths. The average surface residence time of regolith grains on the lunar surface is about a million year or less. As, on the regolith of meteorite parent bodies, the residence durations of the grains are still less, it is clear that this high SCR age is due to the low proton flux used in the calculation. If the proton flux (assuming the same energy spectrum) at the time and place of Fayetteville regolith irradiation is about 1000 times higher than what it is today, then the SCR exposure age of irradiated grains in Fayetteville works out to be a few million years. These results suggest that the activity of the early Sun might have been higher compared to the present solar activity.

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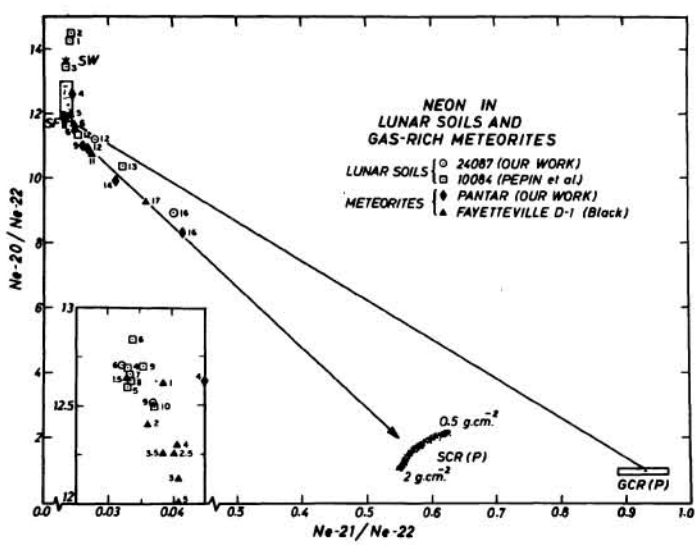


Fig.1

The best fit line for our Pantar points and Black's Fayetteville points indicates ~ 11.8 as the value for trapped SF (Ne-20/Ne-22) which compares favourably with lunar soil based values (4,5,6,11). G(P) is GCR spallation end point for pyroxene.