

CONCENTRATION VS. DEPTH PROFILES OF CARBON AND HYDROGEN IN LUNAR ROCK SURFACES; Gerald M. Padawer, Edward A. Kamykowski, Michael C. Stauber, Michael D. D'Agostino, Research Department, Grumman Aerospace Corporation, Bethpage, New York, 11714 and Werner Brandt, Physics Department, New York University, New York, New York, 10003.

The carbon and hydrogen content of lunar materials has been the subject of extensive research (e.g. Refs. 1 and 2). In the case of lunar fines an approximately inverse variation of the carbon content with the mean grain diameter has been observed (Ref. 1) from which it has been inferred that the observed carbon is of solar wind origin. Probing techniques offering sub-micron depth resolution are able to reveal the implantation of a more energetic flux component and to trace the diffusion of surface carbon into deeper-lying regions. We report on such measurements in 62255,27, using the nuclear reaction  $^{12}\text{C}(\text{d},\text{p})^{13}\text{C}$  as the probing mechanism. The lunar rock sample was bombarded with deuterons from the Grumman Research Van de Graaff accelerator; reaction protons from the transition to the ground state of  $^{13}\text{C}$  were sensed in a surface-barrier detector positioned at  $130^\circ$  with respect to the incident beam direction. For 1.5-MeV deuterons, for example, more than 99 per cent of the carbon constituency measured resides within 4 microns of the surface. The technique offers a detection sensitivity of 40  $\mu\text{g}$  carbon/g sample with a depth resolution of  $\sim 0.3 \mu\text{m}$ . For each specimen surface probed (lunar exterior and interior) two distinct spatial carbon components were observed: a  $\sim 2 \mu\text{g}\cdot\text{cm}^{-2}$  surface layer and a volume distribution. The observed implantations are interpreted in terms of the carbon flux components of the solar radiation.

We also report on additional measurements of hydrogen depth distribution in the (lunar-) exterior surfaces of 61016,135 and 61016,171. These measurements utilize the resonant nuclear reaction  $^1\text{H}(^7\text{Li}, \gamma)^8\text{Be}$ , initiated by a fast  $^7\text{Li}^+$  beam. We have previously demonstrated a sensitivity of 10  $\mu\text{g}$  H/g sample in lunar material with a depth resolution of  $\sim 0.2 \mu\text{m}$  (Ref. 3). For comparison we also probed a (lunar) interior surface of 68815,25. In each case the  $^1\text{H}$  concentration profile was measured to a depth of  $\sim 0.5 \text{ mg}\cdot\text{cm}^{-2}$  ( $\sim 2 \mu\text{m}$ ); absolute concentrations were inferred from calibration bombardments of Kapton (a polyimide) and of NBS-certified H-in-Ti standards. The results of these measurements are shown in Fig. 1. We note that the concentration profile obtained in the 68815,25 surface, which had been shielded from the lunar exterior, does not differ significantly from the profiles in the exterior surfaces of 61016,135 and 171. This implies that the observed hydrogen in the latter samples was largely introduced subsequent to their retrieval from the lunar surface, and most likely occurred in the course of preparing the samples for analysis.

## CONCENTRATION VS. DEPTH PROFILES

Padawer, G. M. et al.

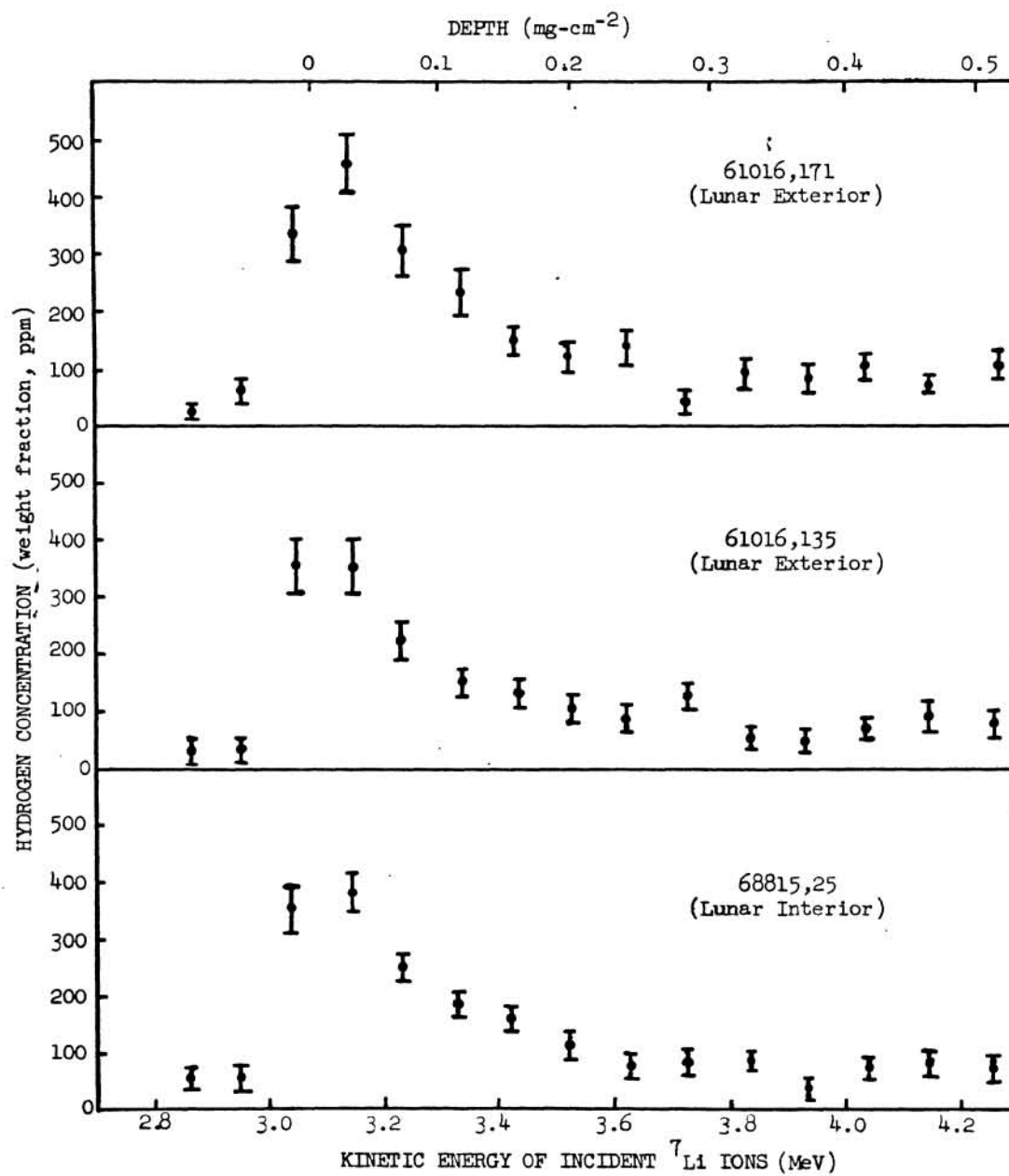


Fig. 1

## CONCENTRATION VS. DEPTH PROFILES

Padawer, G. M. et al

## REFERENCES

DesMarais, D.J., Hayes, J.M., and Meinschein, W.G. (1973)  
The distribution in lunar soil of carbon released by pyrolysis.  
Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochim. Acta,  
Suppl. 4, Vol. 2, pp 1543-1558. Pergamon

Epstein, S., and Taylor, H.P. Jr. (1973) The isotopic composition  
and concentration of water, hydrogen, and carbon in some Apollo 15  
and 16 soils and in the Apollo 17 orange soil.  
Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochim. Acta,  
Suppl. 4, Vol. 2, pp 1559-1575 Pergamon

Stauber, M.C., Padawer, G.M., Brandt, W., D'Agostino, M.D.,  
Kamykowski, E.A., and Young, D.A. (1973) Nuclear microprobe  
analysis of solar proton implantation profiles in lunar rock  
surfaces.  
Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochim. Acta,  
Suppl. 4, Vol. 2, pp 2189-2201. Pergamon