CLASSIFICATION OF THE LUNAR SURFACE USING REMOTE SENSING DATA

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The recent advances of the La Jolla Consortium in standardizing the remotely sensed geochemical and geophysical images of the lunar surface (1) have made possible the application of classification techniques developed by NASA for LANDSAT multispectral images. HINDU is an unsupervised non-parametric classifier developed at Marshall Space Flight Center by B.V. Dasarathy (2) and is well suited for lunar image classification since neither lunar ground truth training nor information about the distributions underlying the data are available. HINDU has recently been integrated into the VICAR/SMIPS image processing system developed at JPL/GSFC. It is extremely efficient and requires minimal operator interaction (2). Density based clustering in the N-dimensional frequency space is the foundation of the method. The colored plates of Ref. (1) are cases of simple classification by density slicing in one dimension. An example of other classification techniques has been presented by Johnson et al. (3).

Figure 1 and 2 show typical results from the classification of the area around M. Crisium (40-70^{o}E, 0-20^{o}N) using the orbital X-ray Mg/Al ratio and the ground based normal albedo data (Plates 5 and 6 of Ref. 1) as the distinguishing compounds. Images in this region are given by Bielefeld et al. (4). Figure 1 displays the clustering of 0.25^{o} x 25^{o} data units of the Crisium region in the Mg/Al-albedo space. HINDU attempts to locate the peaks in the frequency distribution and partition them by constructing hyper planes (here simple lines) which follow the valleys. The data in the Figure 1 frequency histogram maps into the lunar surface of Figure 2 by the following scheme: class A (vertical lines), class B (black area), class C (diagonal lines), class D (crosshatched area), class E (horizontal lines), and class F (dotted area). The global correlation between albedo and Mg/Al exhibits a 0.8 linear coefficient but it appears to be more logrithmic than linear in the wide range of Mg/Al values at the abrupt lower limit of the albedo values. Permitting HINDU to further subdivide class F will locate the high Mg/Al dark soils noted by Andre (5) and Schonfeld (6). We hope to extend this initial effort to multidimensional classification of this and other regions of interest.

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References:

(1) Frontispiece (1977) Proc. Lunar Sci. Conf. 8th, Plates 1-25. (2) Jayroe, R.R. et al. (1976) Classification Software Technique Assessment NASA TN D-8240. (3) Johnson, T.V. et al. (1977) Proc. Lunar Sci. Conf. 8th p 1013-1028. (4) Bielefeld, M. J. et al. (1977) Conference on LUNA 24 p. 28-33, No. 304 Lunar Science Institute, Houston. (5) Andre, C. G. et al (1977) Conference on Luna 24 p. 8-11, No. 304 Lunar Science Institute, Houston. (6) Schonfeld, E. and Bielefeld, M. J. (1977) Conference on LUNA 24 p. 167-169, No. 304, Lunar Science Institute, Houston.

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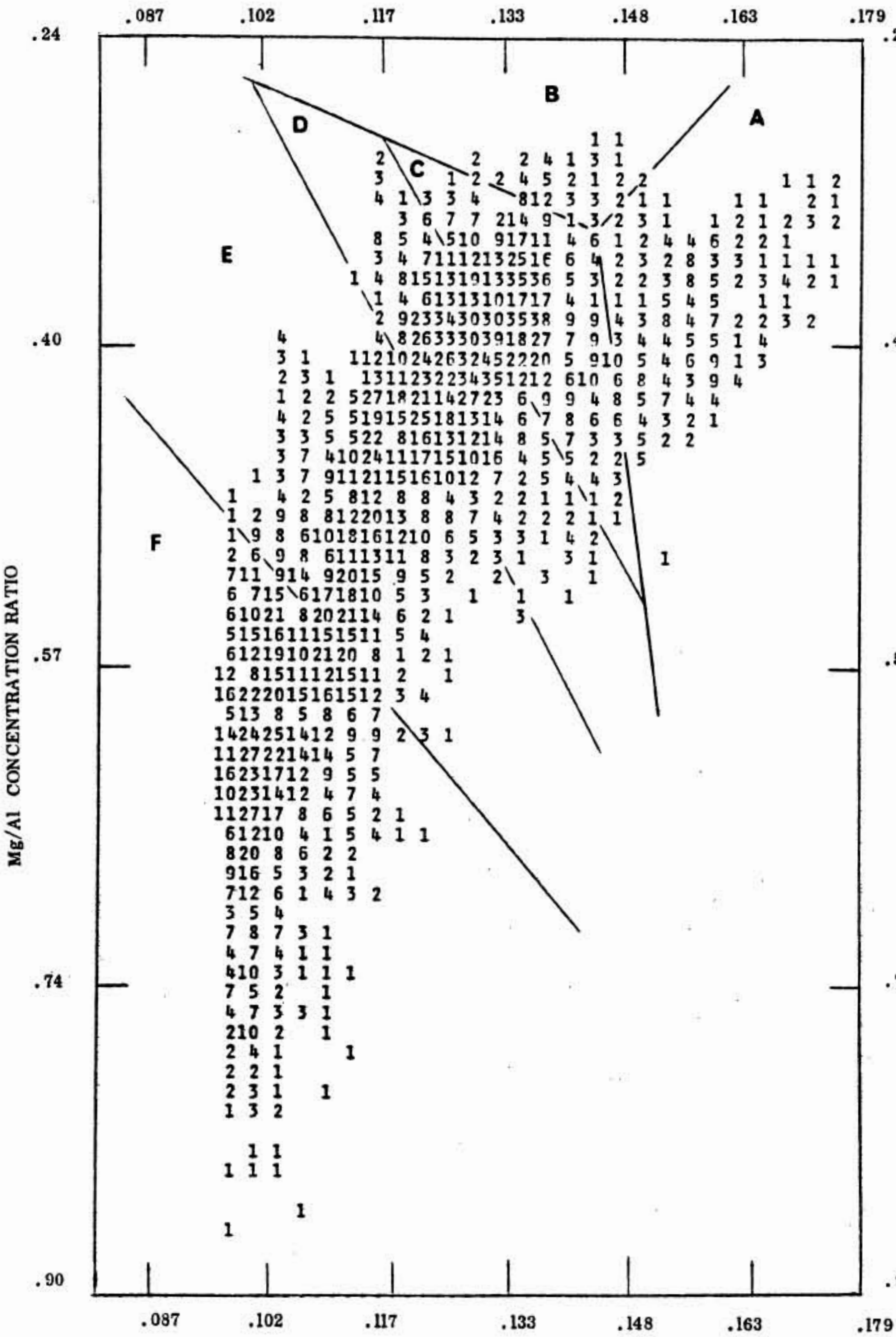

Fig. 1. Frequency distribution of Mg/Al vs albedo values of common coverage in the 40–70°E, 0–20°N region. Values are proportional to the number of 0.25° x 0.25° areas having the appropriate Mg/Al and albedo values. Data has been segmented into six classes by the HINDU unsupervised classification system.

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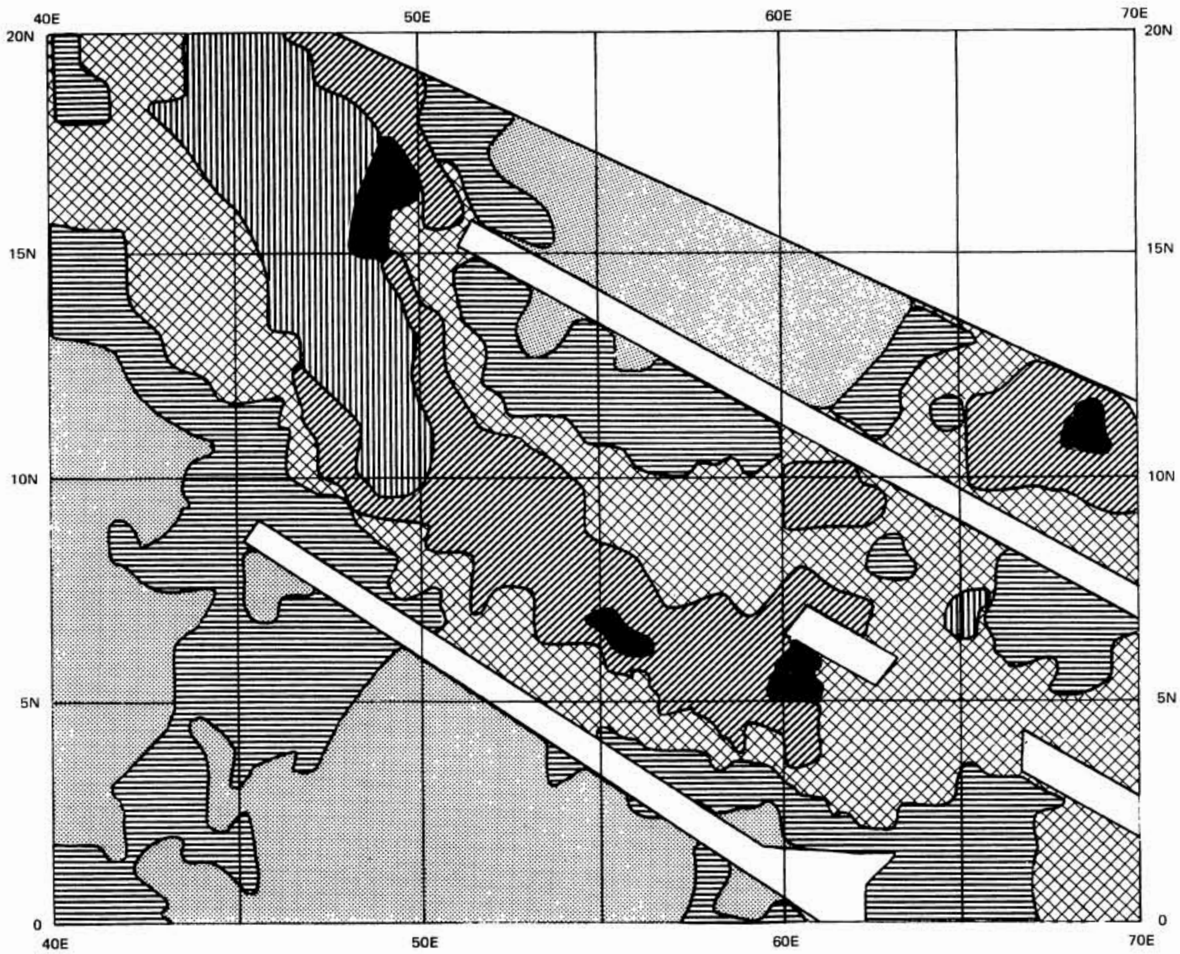

Fig. 2. Classified map of the Crisium region of the moon using the natural clustering of the Mg/Al orbital X-ray data with ground based normal albedo measurements. See text for details.