CLASSIFICATION OF THE LUNAR SURFACE USING ORBITAL ALTIMETRY, GEOCHEMISTRY AND GEOLOGY DATA. Michael J. Bielefeld, Computer Sciences Corporation, Silver Spring, Md. 20910

Through the use of some of the geochemical and geophysical images of the lunar surface recently produced by the La Jolla Consortium (1), a systematic study of approximately 4% of the lunar surface is herein made. An automatic classifier has been applied to the Apollo laser altimetry data (1, Plate 14) and the orbital x-ray aluminum geochemical data (1, Plate 4). The results of this classification procedure are compared with the generalized geologic map of the stratigraphy of the moon (1, Plate 10).

Figure 1 shows a two dimensional frequency distribution of the 23000 quarter degree square units on the lunar surface where there is commonality between the laser altimetry data and the X-ray data. The closed contours show grouping within the distribution indicative of distinctive surface units. A suitable automatic classifier was used which is well suited to this work wherein neither a priori knowledge about the nature of the distribution nor ground truth training sites are available. HINDU is an unsupervised non-parametric classifier developed at Marshall Space Flight Center by B. V. Dasarathy (2). This classifier has also been used to study the relationship of normal albedo and orbital geochemistry in the Mare Crisium region. (3)

HINDU partitioned the frequency distribution (Fig. 1) into six distinct clusters, namely, clusters A to F. The geographical location of the 23,000 units now labelled by HINDU can be presented in the form of a classification map, the presentation of which is beyond the scope of this abstract. However, cluster A is primarily the non-mare highlands; B, northern M. Tranquilitatis; C, M. Serenitatis; D, M. Fecunditatis; E, M. Crisium; and F, the non-mare rim of M. Smythii.

Figures 2 and 3 are the frequency distributions of two subsets of the spatial units presented in Figure 1. Figure 2 presents the data marked strategraphically as mare material, see Ref (1) Plate 10. Figure 3 presents units labelled as either Prenectarian, Nectarian, Nectarian craters or Imbrian material as defined by Plate 10. Clearly, Cluster A with admixtures of B and F coincide with the non-mare materials. Mare material is made up of clusters B, C, D and E. A companion abstract (4) discusses the chemistry of the individual stratigraphic units.

The methodology presented here addresses in a systematic fashion the relationship known for sometime that higher topography is in general Al rich. However, when all of the orbital data available for making such a comparison on a global scale is included, the relationship is seen to be more complex. This is especially true in the M. Smythii region and the area near Archimedes. Besides the six clusters partitioned in Figure 1, the suggestion of a seventh is seen in the extremely high topography at 1739.3 km and 12% Al. Hopefully this question will be resolved and presented at the time of the Conference.

CLASSIFICATION OF THE LUNAR SURFACE

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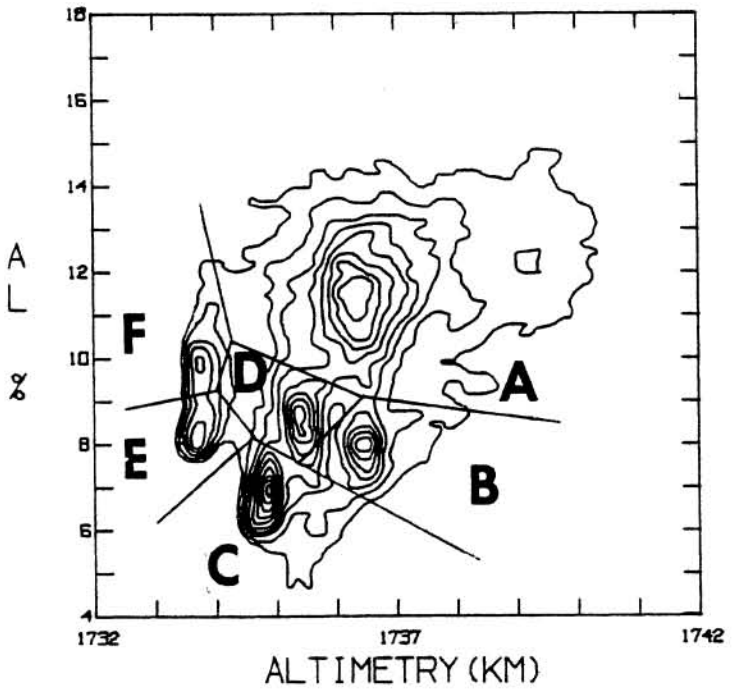

Fig. 1. Frequency distribution of some 23000 quarter degree square units overflow by the Apollo orbital laser altimetry (5) and x-ray (6) experiments. Conversion of x-ray data to absolute Al% is outlined by Bielefeld (7) and assumes a 21% by weight uniform composition of Si. Density clusters were partitioned by the automatic HINDU classifier (2).

Acknowledgements: Use of the La Jolla Consortium data sets of W. Sjogren and D. Wilhelms, is gratefully acknowledged. This work was supported by NASA Contract NASW 3167.

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) Bielefeld, M. J., Wildey, R. and Trombka, J. I. (1978) Mare Crisium: The View from Lunar 24 Peramon Press NY p. 33-42. (4) Bielefeld, M. J. this volume. (5) Kaula, W. M. et al. (1974) Proc. Lunar Sci. Conf. 5th p. 3049-3058. (6) Adler, I. et al. (1973) Proc. Lunar Sci. Conf. 4th p. 2783-2791. (7) Bielefeld, M. J. (1977) Proc. Lunar Sci. Conf. 8th p. 1131-1147.

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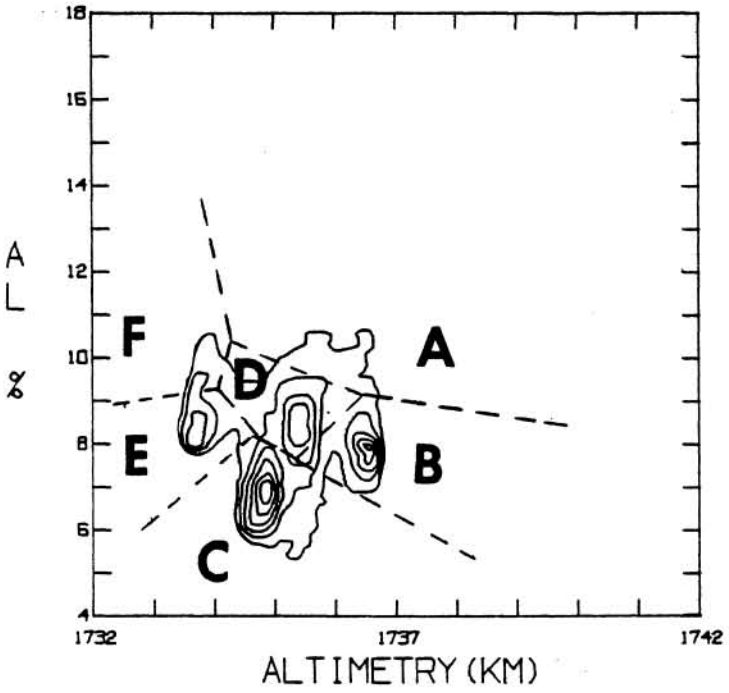

Fig. 2. Subset of lunar surface units of Figure 1 which are marked as mare material by geological map (1, Plate 10)

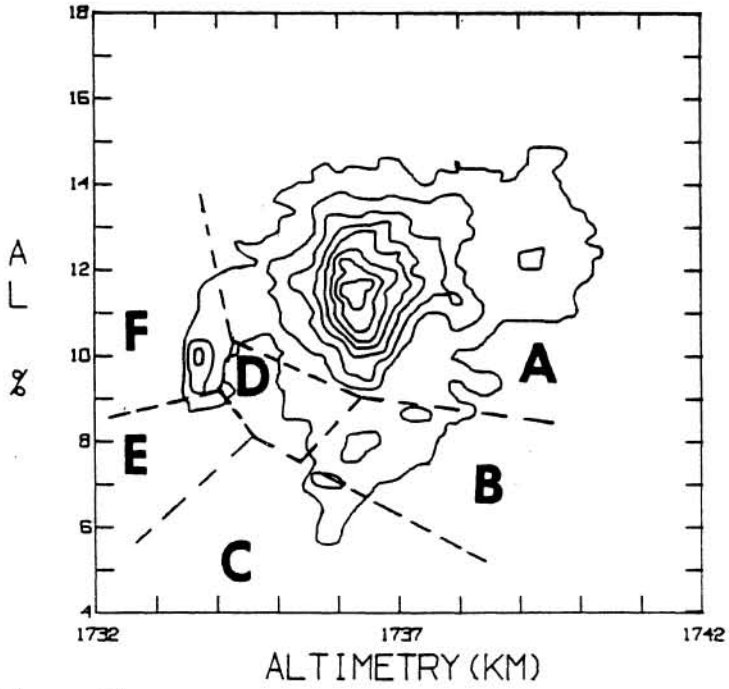

Fig. 3. Subset of lunar surface units of Figure 1 which are marked as Prenectarian, Nectarian, Nectarian craters and Imbrian material by geological map. (1, Plate 10).