TEPHRA DEPOSITS AT THE APOLLO 17 LANDING SITE USING TELESCOPIC CCD IMAGES; Donald E. Sabol Jr., Milton O. Smith, John B. Adams, (Department of Geological Sciences University of Washington, Mail Stop AJ-20, Seattle WA 98195), and Patrick C. Pinet, (UPR 234/GRGS/OMP, 14, Av. E. Belin, 31400 Toulouse, France)

Introduction: Band ratios and spectral mixture analysis (SMA) employing image endmembers avoid the need to calibrate an image to reflectance. These approaches have proven to be effective for mapping compositional variability on the lunar surface ([1], [2]). However, to assess detection thresholds it is necessary bring the image data into alignment with the framework of lunar samples, allowing direct comparison with known, "pure" surface components. In this study, we used CCD images collected at the 2-meter telescope (F/D=25) of the Pic du Midi Observatory in France of the Apollo 17 landing site to examine the composition and spatial distribution of the varying backgrounds in the image, and then determined the detectability of the Apollo 17 orange and black glasses for these different backgrounds.

Methods: The CCD image data was calibrated to reflectance using spectral mixture analysis [3]. Several mixing model approaches were then applied to the CCD image. A simple model of four library (reference) endmembers (convolved to the 8 bands of the CCD image) was initially used (mature mare [R70051], light mantle [R73121], orange glass [R74220], and mature highland [R76261]). A new type of model consisting of multiple image-endmember pairs was then used to find bright and dark image endmember pairs for each pixel [4]. Lunar sample reflectance spectra were used to determine likely identities of each light/dark image endmember. Finally, a foreground/background mixing model [5] was used to determine the detectability of orange (R74220) and black (R74001) glass relative to the image endmember pairs found using the multiple endmember model.

Results: The simple, reference-endmember model was useful in mapping the general spatial variability of the main surface components in the image. However, negative endmember fractions imply that the simple model did not account for the actural spectral heterogeneity in the image. Furthermore, not all of the four endmembers are present in every pixel, thereby reducing the detectability of the endmembers that are present [6]. The multiple endmember mixing model identified 4 main bright/dark mixing lines (Figure 1). Comparison of the bright/dark spectra (Figure 2) to lunar sample spectra (Figure 3) suggests that mixing line 1 describes a dark mare/high albedo highland trend. Line 2 indicates either a dark mantle/ basalt or a difference between mature and dark highland materials. Line 3 suggests a fresh basalt/mixed highland and mare mixtures, while line 4 implies fresh basalt/ dark highland (light mantle material) mixtures. The differences between the spectra of these models is dominated by albedo with very small spectral differences. In the framework of determining detection thresholds of lunar materials, these binary mixtures describe the background of the image data. In this context, 16% of the surface must be composed of black glass (74001) for it to be detectable. This value increases to 60% for orange glass, making it detectable only in locally high concentrations such as at Shorty Crater which is below the resolution limit of the CCD image.

Conclusions Given the heterogeneous background at the Apollo 17 site, the black glass and orange glass are not unambiguously detectable in the CCD image. However, higher spatial resolution would allow detection of locally concentrated deposits. The image reveals a geologic background more variable than can be explained by the Apollo samples used as references spectra, implying that the the full variety of rock and soil types was not sampled at the landing site.

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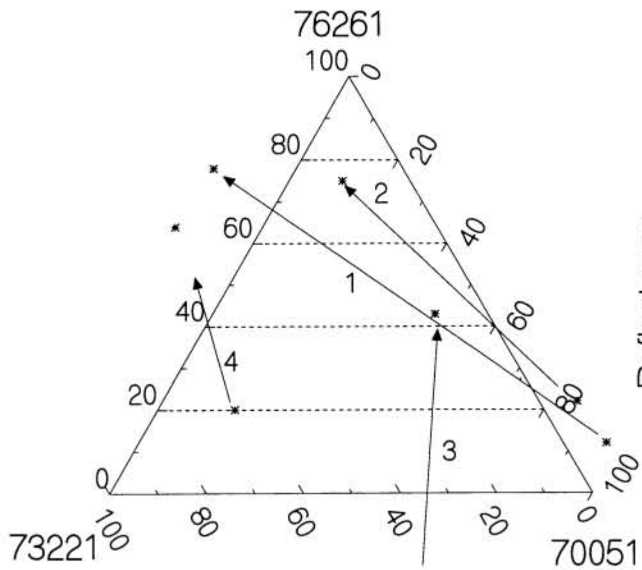

Figure 1. The distribution of fractions is confined to four lines inside the larger mixture volume defined by the spectra of lunar samples.

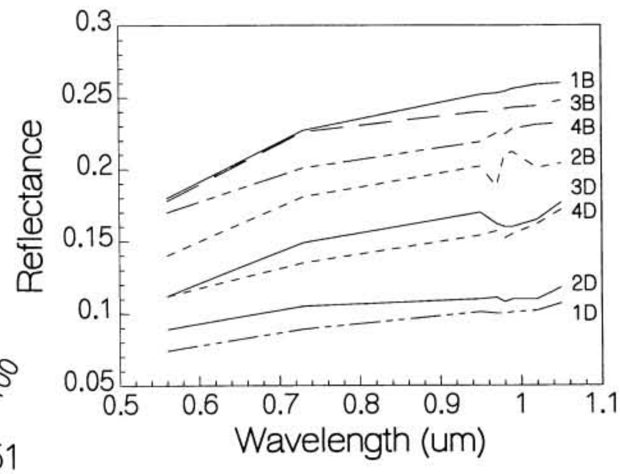

Figure 2. Main spectral variation in the image occurs along four endmember pairs (numbered at right) derived from the image. Model 1: 1B - bright highland 1D - dark basalt - dark mantle/mare
Model 2: 2B - ? 2D - basalt
Model 3: 3B - highlands 3D - fresh basalt
Model 4: 4B - light mantle, mixed highland mare 4D - basalt

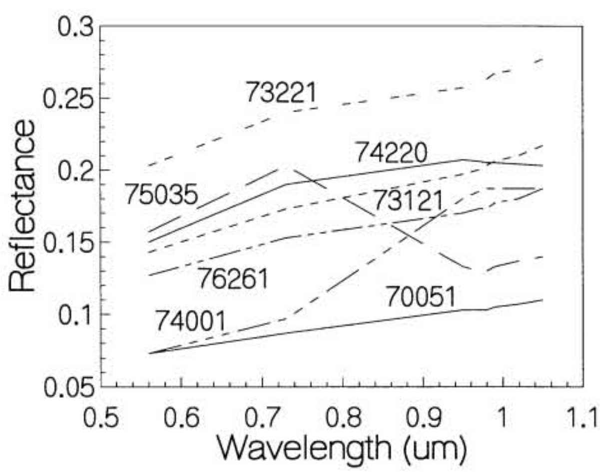

Figure 3. Reference endmember spectra of lunar samples used to constrain the interpretative framework of the CCD images.

References: [1] Bell, J.F. III (1994) LPSC XXV, pp. 81-82., [2] Chevel, S.D., Pinet, P.C., and Head, J.W. (1994) LPSC IV, pp.249-250., [3] Gillespie A.R., et al. (1990) Proc. Second AVIRIS Workshop, JPL Pub. 90-54, 243-270., [4] Smith et al. (1992)) Proc. Third AVIRIS Workshop, JPL Pub. 92-14, 69-70., [5] Smith et al. (1994) J. Hiill and J Megier (eds), Imaging Spectrometry - A tool for environmental observations, 125-143., [6] Sabol, D.E. Jr., J.B. Adams, M.O. Smith (1992) JGR, 97, 2659.