INITIAL RESULTS OF MGM ANALYSIS ON APOLLO 17 SOIL SUITE.

S. K. Noble[1], C. M. Pieters[1], T. Hiroi[1], L. A. Taylor[2], R. V. Morris[3], L. P. Keller[4], D. S. McKay[3], and S. Wentworth[3] [1]Brown University Box 1846 Providence RI 02912, noble@porter.geo.brown.edu, [2]Univ. Tenn, Knoxville TN 37966, [3]SN JSC Houston TX 77058, [4]MVA Inc. Norcross GA 30093.

Introduction: The purpose of this study is to compare the spectral properties of lunar soils with their petrologic and chemical compositions. These initial results concentrate on the four Apollo 17 samples for which detailed petrologic and chemical data were previously presented [1], though spectra are now available for the entire suite of mare soils [2].

Methods: This study utilizes the Modified Gaussian Model developed by Sunshine [3],[4]. We have developed a new method of continuum removal utilizing a 3 component solution consisting of a linear in energy term, a linear in wavelength term, and an offset. This 3 term continuum allows more realistic solutions than the earlier method of double-linear removal [5]. Please see [6] for a more detailed discussion. The same starting parameters are given for the center and widths of bands for every sample to ensure continuity, while the initial strengths and continuum values are taken from a double linear fit.

Pyroxene Bands: The dominate absorption bands in lunar soils are the pyroxene bands centered around 1 and 2 μm. Table 1 provides the relative abundance of pyroxenes in the Ap 17 samples measured using x-ray imaging analyses [1]. The pyroxenes are broken down into four categories, Mg-rich cpx, Fe-rich cpx, opx, and pigeonite. For simplicity, we have grouped the opx and pig, and the Mg-rich and Fe-rich cpx together to form 2 groups. The soils are quite similar to each other with roughly 40/60 opx(+pig)/cpx ratios.

20-45 Sample	Total pyx	opx	pig	Mg-cpx	Fe-cpx	opx + pig	Mg+Fe cpx
79221	13.2	11.2	28.2	36.8	23.8	39.4	60.6
70181	15.7	9.6	29.9	51.8	8.7	39.5	60.5
71501	21.2	6.8	29.8	52.4	11.1	36.6	63.5
71061	20.5	5.6	33.5	50.2	10.6	39.1	60.8

Table 1. Total pyroxene and relative abundance of pyroxenes in 20-45μm Ap 17 samples [1].

The spectral properties of pyroxene have been well studied [7] and it is well understood that both absorptions in opx occur at shorter wavelengths than cpx.

MGM Results: MGM analysis was performed on the samples using bands for a single pyroxene with initial centers at 0.97 and 2.1μm. The same samples were also deconvolved for the presence of two pyroxenes using bands at 1.01 and 2.27μm as well as at 0.91 and 1.83μm to separate the shorter wavelength opx bands from the longer wavelength cpx bands. In figure 2 are shown examples of deconvolution using 1 pyroxene (a) and 2 pyroxenes (b). For this sample, clearly the solution for 2 pyroxenes is preferred since using only 1 creates unacceptable errors. As predicted by the roughly 40/60 pyroxene ratio in Table 1 and the well defined effects of pyroxene abundance on relative band strength [7], the longer wavelength cpx bands are

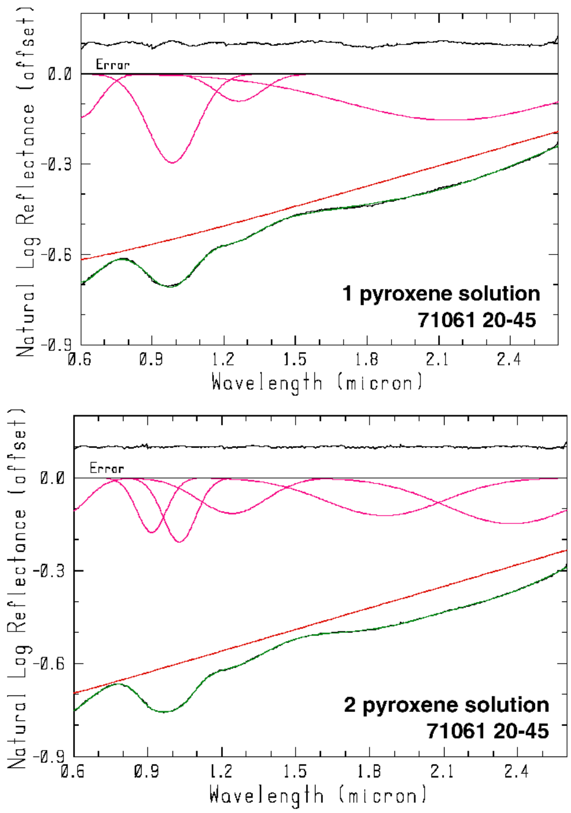
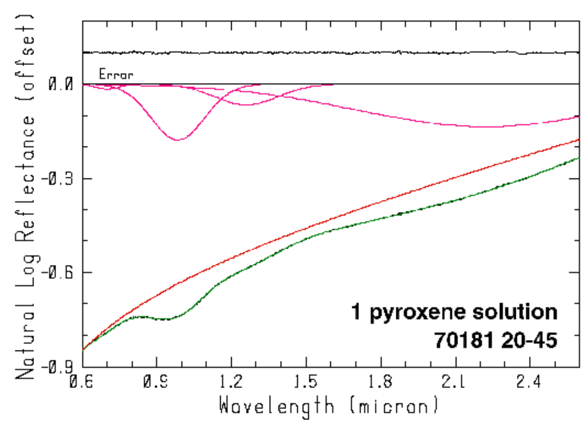


Figure 1. MGM deconvolution of the 20-45μm size fraction of mare soil 71061 with 1 and 2 pyroxenes. Note the large errors when only 1 pyroxene is used.

stronger than the opx bands.

Many of the samples with weaker bands fit quite well with only 1 pyroxene, or with 2. In figure 2 is such an example. The petrologic data tells us that there is in fact 2 types of pyroxene there, but modeling it with just one appears to adequately describe the spectra within acceptable errors.



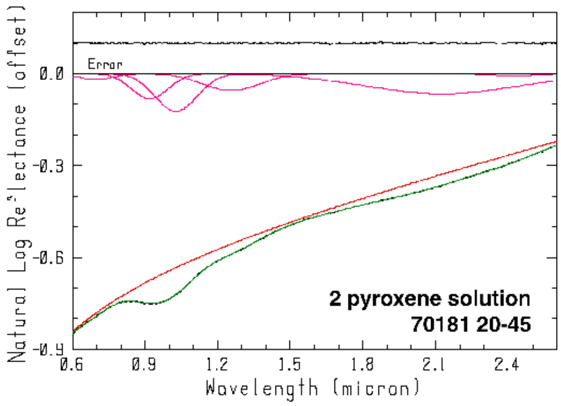


Figure 2. MGM deconvolution of the 20-45µm size fraction of mare soil 70181 modeled with 1 and 2 pyroxenes. Note that the error is small for both.

If 2 pyroxenes are used, the 2 bands centered near 1µm follow the expected trend with the longer wavelength (cpx) band being slightly stronger than the shorter wavelength (opx) band. The 2µm bands often do not follow this trend however. This is probably due largely to disproportionate weakening of the 2µm bands related to space weathering effects. This makes the 2 µm band less useful. Immature soils, such as 71061 (fig 1), are less prone to such complications.

Widths: The relation between band width and band center for the Apollo 17 size separates are shown in fig 3. We expect larger widths when basaltic soils are fit with only 1 pyroxene band as it needs to accommodate the range of pyroxene compositions present. If the two pyroxene model is an accurate representation, the bands should be narrower, comparable to those of individual pyroxenes [8].

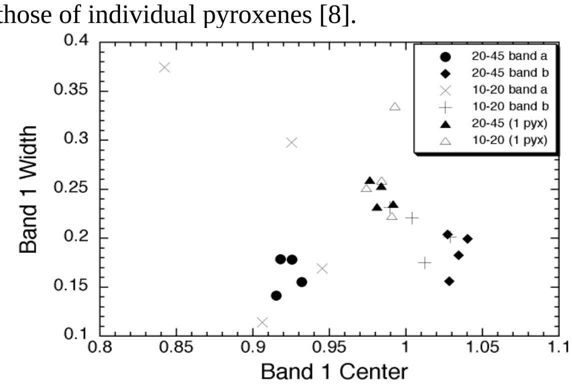


Figure 3. A comparison of band widths and centers for the pyroxene absorption band centered near 1µm for the Ap17 soil separates.

For both size fractions, when the pyroxenes are combined into one band, the band widths are large (~0.25µm) and closely clustered. When the bands are split in two to accommodate the opx and cpx, the larger size fraction (20-45) band widths become narrower as expected. The smaller size fraction (10-20) shows significant scatter. The weaker bands of the small particles appear to be insufficient to separate pyroxene composition.

Volcanic Bead Content: Because the pyroxene contents of these samples are so similar, there is little variation between samples. However, the amount of volcanic beads varies significantly and appears to have a quantifiable effect on the spectra, particularly on the 1.2 µm band. As shown in Fig 4, with increasing bead abundance, the 1.2 µm band center moves to shorter wavelengths and the band strength increases for the 20-45µm separates.

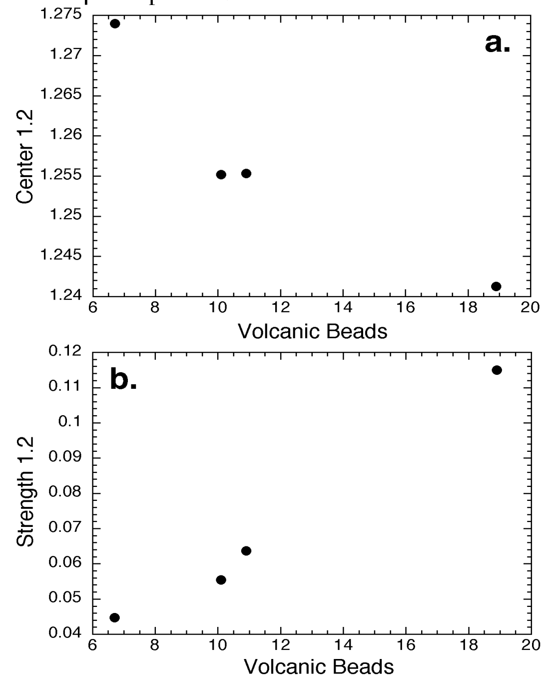


Figure 4. Volcanic bead content vs center (a.) and strength (b.) of the 1.2µm band of the 20-45µm size fractions of the Ap 17 soils.

Initial Conclusions: This method of spectral deconvolution allows pyroxene abundance and composition to be distinguished, at least in the 20-45µm size fractions. Other important petrographic features can be quantified as well, such as the amount of Apollo 17 devitrified glass beads (black). Data from the rest of the soil suite will provide a more complete assessment. A wider variety of soils should allow us to test the limits of this technique and quantify other mineralogic and petrologic features in the spectra.

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