A MIXING MODEL APPROACH TO OBTAINING QUANTITATIVE MINERALOGY FROM SPECTRA OF LUNAR SOILS; Paul G. Lucey, Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 2525 Correa Rd. Honolulu HI 96822.

An important goal of lunar spectroscopy is the derivation of quantitative mineralogy from spectra of lunar materials, both in the laboratory and remotely. While many approaches are available (e.g. 1), the use of nonlinear mixing models using endmember minerals is an attractive one given the relatively simple mineralogy of the Moon. Attempts at quantitative analysis using Hapke-based theory have been attempted, but none have fully exploited the range of tools available, addressed compositional variation within lunar mineral endmembers, nor included the effects of maturity in any but a rather ad hoc manner. Presented here is a model which, in addition to the relative abundances of endmembers, takes into account the grain size of the material, the powerful effect of Mg-number on the spectra of mafic minerals (2), and a theoretical approach using optical constants of iron to model the effects of maturity.

The endmembers used in the model are ortho- and clino-pyroxene, olivine, anorthite, and submicroscopic iron metal. For each of the mafic minerals, sample spectra covering a wide range of Mg-number (3,4,5) were converted to absorption coefficient using the RADTRAN program developed by Roger Clark at USGS Denver. The absorption coefficient at each wavelength versus Mg-number was then fit with a polynomial to obtain a method to input the Mg-number as a variable in the model. In this model all minerals share the same Mg-number. Grain size effects are taken into account by using the absorption coefficients for a given Mg-number, a given grain size, and equation 33 of Hapke (1981) (6). Relative abundances of the minerals are modeled using equation 17 of Hapke once single scattering albedos for the desired endmembers are computed. The effect of maturity was modeled using the method described in a companion abstract, which employs the optical constants of iron assuming the reduced iron metal behaves as a discontinuous 220 angstrom thin film. Finally, after a model mixture single scattering albedo has been computed and “matured”, reflectance is computed using equation 16 of Hapke.

One result is shown in Figure 1, which is the spectrum and model spectrum of the 15 km crater Aristarchus A. The agreement between the model and spectrum is excellent between 750 nm and 2 microns. Beyond 2 microns the linear fit to the absorption coefficient data breaks down; in future a higher order fit will be employed. The poor fit shortward of 750 nm is likely due to rather subtle differences in iron content between Aristarchus A and the model fit. The summary model composition is:

Mg-number: .55; 7.4% orthopyroxene; 8.4% clinopyroxene; 10.5% olivine; 73.7% anorthite; .55% iron metal; mean grain size = 50 microns.

REFERENCES

FIGURE 1. Spectrum of Aristarchus A. Solid line is model, points are data.