MIXING MODEL ANALYSIS OF TELESCOPIC LUNAR SPECTRA; Paul G. Lucey, Beth C. Clark, and B. Ray Hawke, Planetary Geosciences, University of Hawaii, Honolulu, HI, 96822.

We have analyzed very high quality reflectance spectra of the lunar surface from the University of Hawaii lunar spectral data collection using a spectral mixing model. The spectra analyzed are those of 45 mare sites and 75 highland sites. The spectra were selected on the basis of very high signal to noise ratios based on error bars and point to point scatter, and on quality of removal of telluric water bands. The spectral mixing model used 7 components, not all of which were used in each fit. Four of the components were mineral spectra of an orthopyroxene, a clinopyroxene, an olivine and an anorthite, measured at the Brown University's RELAB . All of the minerals were 45-90 μm splits. Lunar soil contains other components which have the effect of reddening and darkening the soil as well as reducing spectral contrast. In addition, lunar soil contains spectral neutral bright material (likely very fine grained feldspar) which serves to reduce spectral contrast and brighten soils. Early attempts to fit many of the spectra pointed out the need for a component which has a very broad smooth absorption feature centered near 1.1 microns. Glass is a good candidate for this component. For the bright component we used a flat reflectance of 70% to represent fine grained feldspar. For the "glass" component we used a telescopic spectrum of a pyroclastic glass present on the Aristarchus plateau which is characterized by a strong smooth band centered at 1.07 microns (1). This spectrum was converted to albedo using the map of (2). In addition to exhibiting the glass band this spectrum is very red and has a low albedo. On the assumption that the dark component and the red component are agglutinates, which is reasonable but not necessarily true (Pieters, pers. comm, 1992) we sought a dark red component. To derive its properties we modelled the spectrum of an Apollo 16 soil (16xxx) using mineral proportions from (3), and assumed the dark red component to comprise 60% of the soil, appropriate to agglutinate abundance in mature soil. We adjusted the albedo and slope of a straight line representing the dark red component until the contrast and albedo of the model spectrum matched the soil spectrum. The mixing was done after conversion to single scattering albedo using the equations of (4) and average single particle phase functions for silicates measured by (5).

Fit criteria: The intent of this stage of the modelling is principally to match the spectral shape and contrast of the bands present in the telescopic spectra in order to determine relative abundances of crystalline components. These ratios are relatively insensitive to grain size if the grain sizes of the components vary in concert. We also matched the scaled continuum slope with an appropriate mixture of the flat bright component and the dark red component. From this fit of shape and continuum slope we derive a model feldspar abundance from the sum of the crystalline component and the bright component.

Systematic errors in the abundance of the neutral components lie in under or overestimate of the grain size of the crystalline components and incorrect assignment of the albedo and slope of the neutral and glass components. Overestimate of the grain size will increase the proportion of the neutrals (and hence model feldspar). Underestimate of the grain size of the crystalline components will have the opposite effect. Overestimate of the slope of the dark red component or underestimate of the slope of the bright component will result in too much of the amount of model bright component.

Systematic errors in the opx:cpx ratio lie in the choice of Fe-poor ortho- and clinopyroxenes for fitting. More Fe-rich pyroxenes will yield higher opx:cpx ratios as the opx band center shifts to longer wavelengths. The width of the mixture bands changes significantly with Fe content while holding either mixing proportion or composite band minimum constant. This observation may offer a method for determining the Fe/Mg ratio of the pyroxene assemblage remotely.

A subset of the results is shown in the accompanying figures showing crystalline plagioclase over mafics versus opx over total pyroxene, and model plagioclase over mafics versus opx/total pyroxene. The mare locations tightly cluster in the latter plot while the highland areas vary widely in pyroxene chemistry and model plagioclase. It should be noted that crystalline plagioclase was often not required. The best developed plagioclase bands were in the gabbroic highlands areas.

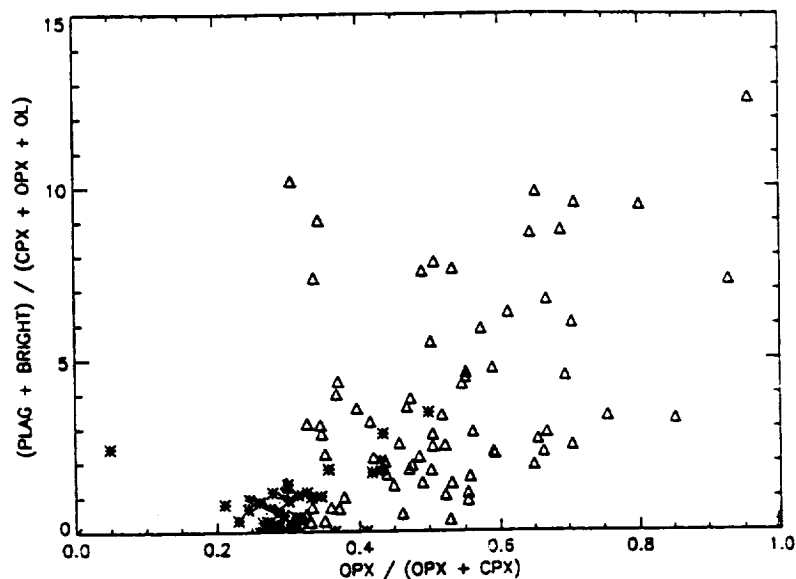SPECTRAL MIXING MODELS: Lucey et al.

Figure 1. Model plagioclase (abundance of crystalline anorthite plus neutral bright component) over crystalline mafics versus model opx/(opx+cpx). Asterisks are mare locations, triangles are highland locations.
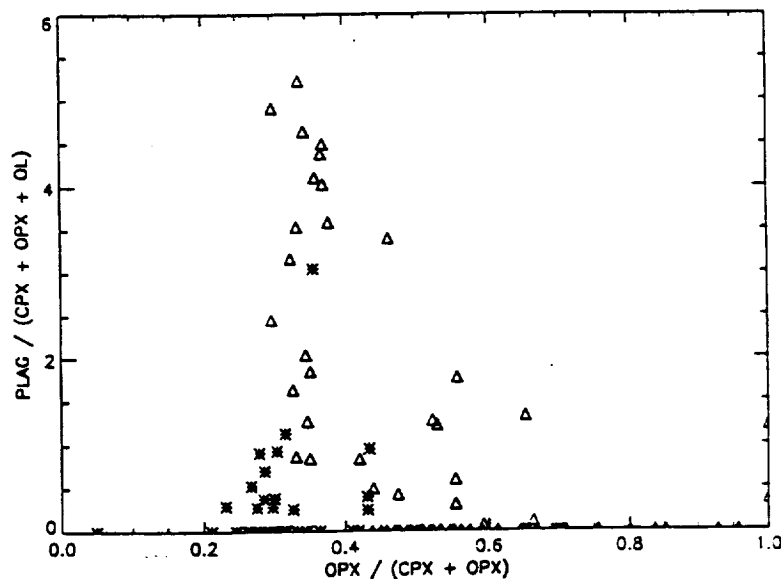

Figure 2. Abundance of crystalline anorthite over crystalline mafics versus model opx/(opx+cpx). Asterisks are mare locations, triangles are highland locations.

References: 1) Lucey, P.G., Hawke, B.R., Pieters, C.M., Head, J.W., and McCord, T.B., *Proc. Lunar Planet. Sci. Conf.* 16th, in *JGR* 91 D344-D354, (1986), 2) Pohn, H.A. and Wildey , R.L.,US Geol. Surv. Prof. Pap. 599-E, Plate 1.;3) The Lunar Source Book, University Cambridge Press,1991; 4)Hapke B. JGR 86, 3039-3054, (1981); 5).Mustard, J.F.and Pieters, C.M.,JGR 94, B10,13619-13634, 1989.