MULTISPECTRAL INTERPRETATION OF GEOLOGIC MATERIALS EXPOSED AT THE VIKING LANDER SITES

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INTRODUCTION: Work was performed on Viking Lander data with a newly refined calibration developed at Washington University in St. Louis. The calibration provides absolute reflectance values for both Lander scenes, using three channels in the visible wavelength region between 0.4 and 0.75 microns. These data are sensitive to ferric iron absorptions, and can be used to help constrain both composition and mineralogy of landing site materials. Toward this end, the reflectances of a variety of soils and rocks at both sites were derived. Laboratory spectra of previously studied martian analog materials and Earth-based telescopic spectra were then convolved to Viking lander bandpasses and compared to the three-channel lander data. The data were separated into three groups on the basis of spectral shape, defined as amount of curvature (see Figure 1). The interpretations which follow combine both spectral shape and overall reflectance.

DISCUSSION: The least curved group contains one soil and three rock units. A martian rock in this category with low absolute reflectance closely matches a laboratory-measured basalt coated by ~30 microns of palagonite (see Figure 2), and therefore, the martian rock is consistent with dark, volcanic, and relatively fresh basalt or dark andesite thinly coated by palagonite. The martian rock data are also consistent with convolved Earth-based telescopic spectra of martian dark regions (Figure 2). Furthermore, a close match was obtained between the soil in this group and a laboratory-measured palagonite (see Figure 3). However, the fit was obtained by scaling down the palagonite by a factor of 1.6, which suggests that the soil's spectral signature may be dominated by palagonite, but that additional factors are causing a lower overall reflectance for the lander material. A phase effect may be involved, or the soil may contain rock and glass contaminants, in addition to the palagonite. It is also significant to note that this soil is consistent with Earth-based telescopic bright region spectra (Figure 3). One of the two rock units remaining in this spectral category is higher in overall reflectance and in red/violet ratio than the one previously discussed, and is consistent with both laboratory-measured palagonite and telescopic bright region spectra. These units are interpreted as dark volcanic rock similar to the type previously noted, coated by an optically thick layer of palagonite. The most sharply curved spectral group contains a soil unit which is an excellent match to a laboratory-measured red, hematitic cinder (see Figure 4). Previous tests with lander bandpasses have proven them to be sensitive towards determining different ferric oxide phases, thus supporting but not proving mineralogical similarity. The possibility that crystalline hematite may exist on Mars is highly significant, since it implies a different alteration environment than the one in which amorphous palagonite would form. The final spectral category is intermediate in curvature between the two spectral groups just discussed. It contains the overwhelming majority of soils at the landing sites, as well as additional rock units. This category was not consistent with any of the laboratory or telescopic spectra to which it was compared, and thus its compositional interpretation remains unclear. However, it is possible that this group's mineralogy represents an intermediate degree of crystallinity between amorphous palagonite and crystalline ferric oxide. If this is true, it might represent the maturation or further alteration of initially amorphous palagonitic soil. Alternately, this common soil type may represent a physical mixture of other surface components, although a simple linear mixing model is inadequate to relate this unit to other observed units.

CONCLUSIONS: It is important to stress that our use of only three points to infer composition and mineralogy was done with caution, and in the context of previous interpretation from Earth-based spectra, Viking Lander chemistry results, and terrestrial analog research. Although a possibility of ambiguous interpretations exists, we feel confident in making the following conclusions: 1) Certain soils are spectrally similar to amorphous palagonites, and these soils closely match telescopic spectra of martian bright regions; 2) Many rocks appear to be coated to varying degrees by these palagonites. Thinly coated rocks resemble telescopic spectra of dark regions, while thickly coated ones resemble bright regions; 3) Certain soils may be hematitic and represent a much greater degree of ferric oxide crystallinity than do the palagonites above; 4) Most soils and some coated rocks at both landing sites do not match laboratory or telescopic spectra. These materials may represent a genetically separate unit, matured (further crystallized) palagonitic material, or a complex physical mixture of other compositional units.

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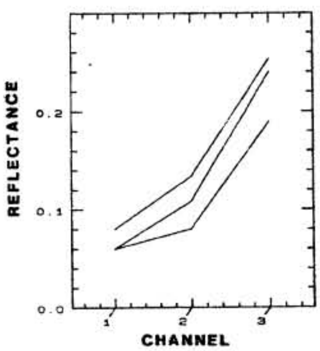

Figure 1. The three spectral categories; least curved at top, intermediate in middle, most sharply curved at bottom.

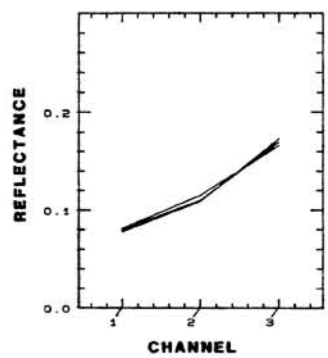

Figure 2. Overlay of data for a thinly-coated basalt, telescopic dark region, and one martian rock unit.

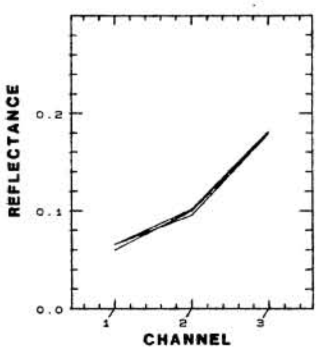

Figure 3. Overlay of amorphous palagonite, telescopic bright region, and one martian soil unit.

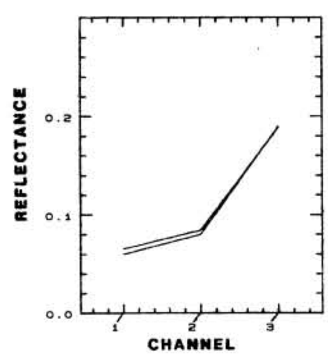

Figure 4. Overlay of red, hematitic cinder with an area of martian soil at VL2.