SPECTRAL MIXTURE MODELING: FURTHER ANALYSIS OF ROCK AND SOIL TYPES AT THE VIKING LANDER SITES

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We have applied a new image-processing technique to Viking Lander multispectral images (Adams et al., 1986). Spectral endmembers were defined that included soil, rock and shade. Mixtures of these endmembers were found to account for nearly all of the spectral variance in a Viking Lander 1 image, thus one spectral type of soil and one type of rock mixed in various proportions accounted for the observed "color" differences.

Further work on the Viking Lander 1 image has solved the problem of the nature of a minor spectral endmember that we originally identified as being due to secondary illumination effects. That endmember can now be shown to be the result of lighting effects (especially near-far/field spectral phase changes) and the effects of a foreground misregistration of the three IR bandpass images with the three visible bandpass images in the original Viking data. The misregistration of the data is not apparent when viewing individual bandpass images or color composites; however it is distinct in the RMS (root mean squared) error image which displays the accumulated error between the model image and the real image. The pixels with high RMS error do not correspond spectrally or spatially to reasonable soil or rock types, however they force the introduction of another spectral endmember.

The misregistration was corrected by Dr. E. Guinness at Washington University (St. Louis). When the spectral mixing model was calculated for the rectified images using rock, soil and shade as endmembers the RMS error image showed only a weak spectral phase shift from near to far-field, and no additional endmember was required. These results further emphasize the usefulness of the mixing model for isolating geologically meaningful spectral variance from that introduced by the imaging system or by lighting effects.

Analysis of other Viking Lander 1 and 2 images shows that the spectral phase effect is strong at certain lighting geometries. In all cases the effect is expressed as a gradual shift in the reflectance spectra of all objects from near field to far field. The spatial patterns of these shifts are unrelated to geological features. However, the phase effect must be isolated and removed in order to compare soil or rock spectra in different parts of an image.

We have applied the mixing model to other Lander 1 and 2 images using the same spectral endmembers for soil and rock that fit the data in the Viking Lander 1 image. The objective has been to test for the presence of other soil and rock types by analysing the RMS error images. Materials that appear spectrally different from the endmembers (and their mixtures) used in the model appear bright in the RMS error image. Preliminary results show that the same soil and rock types carry through all images studied at both Viking sites, however there are important local exceptions where areas of spectrally different rocks also occur. As discussed above we can establish that these spectral differences are not produced by lighting effects or by system defects. An evaluation of the nature and extent of these new spectral rock types is underway.

REFERENCE

Adams, J.B., Smith, M.O., and Johnson, P.E., Spectral mixture modeling: A new analysis of rock and soil types at the Viking Lander 1 site, J. Geophys. Res., 91, 8098-8112, 1986.