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DISCRIMINATION OF GEOLOGIC MATERIALS USING SKYLAB S-192 DATA

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Introduction

The Skylab Skylab S-192 multispectral scanner has proved useful in the discrimination of several types of materials in the southwestern Nevada desert. Although the extremes in DN (density number) in any single channel are small, a comparison within and among channels has shown that five different types of materials can probably be distinguished.

Technique

An S-192 multispectral scanner tape (accession number 33-32882) for a portion of the U.S. Geological Survey Nevada test area (fig. 1) was supplied to us by the Johnson Space Center. This tape was reformatted using the U.S. Geological Survey DEC-1070 to make it compatible with our Optronics Photomation 1700 write/scan microdensitometer. The images produced by the DEC-1070 were played back on film using the Optronics system and software written by the Remote Sensing Image Processing Group.

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The images thus produced were compared with a geologic map of the area (Stewart and Carlson, 1974) and two or three test sites were selected for each of five different materials. The location of the test sites is seen on figure 2. The materials included basalt, andesite, welded ash-flow tuff, playa, and salt-marsh deposits. The DN values values of brightness in a 256-step gray scale) for each test site were extracted from the tape, and means and standard deviations were determined for each of the channels. The results are given in table 1.

Analysis

In most channels the basalts cannot be distinguished from andesites; however, channels 1 and 17 (0.52-0.56 μm and 12.0-13.0 μm, respectively show a reasonably unambiguous set of densities that can be used to discriminate basalt from andesite. This observation is borne out by examining the laboratory spectral curves for the two materials in Hunt et al (1973, 1974). The curves show a relatively high reflectivity for andesite at 0.5-0.6 μm when compared with basalt; this reflectivity is probably due to the higher percentage of ferric iron and the concomitant reddish color observed on the surface of many andesites. The ambiguity in the rest of the characteristic spectra of andesites and basalts may be caused by the usually low albedo of the andesites in this region (L. Rowan, oral communication, 1975). The higher DN for andesites in the daytime image at

12.0-13.0 μm is at present unexplained, but it may be due to the lower percentage of mafic minerals (and lower density) in the andesites. This lower percentage of mafic minerals would also cause the andesites to have a lower thermal inertia and suggests that they could be discriminated from basalts using thermal images.

Welded ash-flow tuffs are easily distinguishable from basalts and andesites by the higher DN values of the tuffs at all wavelengths except for 1.09-1.19 μm, where it is ambiguous.

A rather peculiar phenomenon occurs in the spectra of the playas and salt marshes. The spectra for playas are relatively higher than for salt marshes at all wavelengths from 0.46-1.03 μm; however, in the two channels from 1.09-1.75 μm, this relationship is reversed. At still longer wavelengths, the higher DN values of the playas persist.

The cause of this phenomenon is not known, but the observations appear to be contrary to the expected result. The channel from 1.55-1.75 μm occurs at the edge of a water absorption band, and it would be expected that a salt marsh (most probably a deposit of evaporites and muds containing a large amount of water) would have a lower DN value than a playa, which, in the Nevada desert, is typically a deposit of silts and clays with very low water content.

Qualifications.

The preceding statements must be qualified. First, the test areas have not been carefully examined in the field. Thus, it is difficult to say with certainty that we are detecting differences in playa and salt-marsh deposits, because the compositions of salt marsh and playa were inferred. Second, a sampling of two or three areas on a single Skylab image is not felt to be sufficiently representative to make a broad unequivocal statement as to its capability to discriminate materials using spectral information. And third, the calibrated Skylab S-192 radiance values need to be correlated with field and laboratory spectra of the test areas to see if they are comparable.

References Cited

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Figure 1 Location map of the U.S. Geological Survey Nevada test area

Figure 2. Negative print of S-192 channel 5 (.62-.67 μm) showing location of the test sites. B=basalt, A=andesite, W=welded ash-flow tuff, P=plays, S-salt marsh. Note: the incompatibility between figures 1 and 2 is due to the fact that the S-192 tape received by the U.S. Geological Survey was not corrected for the circular scan mode used on board the spacecraft. There is extreme distortion in the southwest; for this reason, no scale is provided.

Table 1 Means and standard deviations in DN for the test sites. (0 is dark, 255 is bright).