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# EVALUATION OF RADIOMETRIC AND GEOMETRIC CHARACTERISTICS OF LANDSAT-D IMAGING SYSTEM

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NASA ORDER



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1. PROBLEMS - With the gain currently used on TM detectors, histograms are too narrow and bunched at the low end of the DN range for most bands. This does not take full advantage of the dynamic range of the system. It also appears that Scrounge processing included an edge enhancement that results in undesirable overshoot or ringing at abrupt radiance change boundaries. TM bands 5 and 7 have relatively low signal to noise ratios over dark targets in winter images, such as shadows and water bodies. This is especially evident in a band ratio image which employs both these bands.

2. ACCOMPLISHMENTS - Significant progress has been made in developing ways to mask out unwanted scene components and noise, without losing desired data from rocks and soils. Vegetation masking has been accomplished using both 3/4 and 2/4 TM band ratios, in which low DN values representing vegetation are driven to zero. The 2/4 ratio appears to yield better results, at least in a humid (south Florida) environment with very lush vegetation.

Water bodies in any scene introduce noise when TM bands 5 and 7 are ratioed (see problems above) because the near zero radiance values in both bands result in widely varying ratios from pixel to pixel. Band 5 proved superior to Band 7 for masking out water bodies. Band 7 showed confusion between water and lush vegetation.

Shadows (see problems above) were effectively masked out in high relief terrain using the Munsell hue and value parameters applied to a standard color infrared composite (CIR) image. Blue hues associated with low Munsell values can be used to identify shadow areas. TM 5/7 band ratios were more readily interpretable with shadowed areas and water bodies masked out.

Relatively dark hydrothermally altered rocks (sericitic alteration) were readily recognized in a CRC image of a portion of TM scene 40149-17440 (Las Vegas, NV). Other rocks containing absorption bands in the 2.2-um region include bright, bleached hydrothermally altered rock containing alunite and kaolinite, primary gypsum in a sedimentary rock unit, gypsum associated with supergene alteration of hydrothermally altered rocks, and limonitic hydrothermally altered rocks containing clays and sericite.

Vegetation and some argillized hydrothermally altered rocks showed as similar colors on a TM band 5/2, 3/4, 5/7, color ratio composite (CRC) image. The vegetated areas were filtered out using Munsell red hues derived from a TM CIR image as the criteria, leaving the argillized rocks unambiguously defined on the CRC image.

Desert varnish can be readily identified in band ratio images employing both visible and near infrared bands, because of the characteristic high reflectance of desert varnish coated rocks in TM bands 5 and 7, compared to their low reflectance in the visible part of the spectrum.

Density slicing of a TM 5/7 band ratio image for a portion of TM scene 40050-15333 (Macon, GA) with vegetation masked out reveals separation of rocks containing different clay minerals.

Montmorillonite, because of its weaker 2.2-um absorption band, can be discriminated from kaolinite, whose absorption bands are more intense.

Bright fringes of noise (see Problems section above) along the margins of water bodies produced by overshoot were masked out using the 3/1 TM band ratio.

Coherent noise was minimized in color ratio composites by avoiding multiple use of any one band.

A Washington, D.C. and Vicinity Thematic Mapper image map is being produced at a scale of 1:100,000. The map design has been completed and Bands 1, 3, and 5 have been enhanced and imaged on separate film at 1:100,000 scale. During the enlargement process a fine line screen has been superimposed on each of the three black-and-white film separates. It is anticipated the final printing will be complete by approximately January 30. Following are the basic specifications:

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|---|---|
| Name: | Washington, D.C, and Vicinity Landsat Image Map |
| Scale: | 1:100,000 |
| Sheet boundaries: | $38^{\circ}30'$N and $39^{\circ}15'$N; $76^{\circ}22'30''$W and $77^{\circ}37'30''$W |

Projection and Grid: UTM with 10,000 meter grid spacing; and State Plane Coordinate Systems ticks with 25,000 foot tick spacing.

Source Data: Landsat 4 TM image E40109-15140 dated November 2, 1982. Control derived from 7.5-minute quadrangles.

3. SIGNIFICANT RESULTS - With vegetation masked and noise sources eliminated or minimized as above, different carbonate facies could be clearly discriminated in a south Florida scene. Laboratory spectra of grab samples indicate that a 20% change in depth of the carbonate absorption band was detected, despite the effects of atmospheric absorption in such an environment.

Both bright and dark hydrothermally altered volcanic rocks can be discriminated from their unaltered equivalents. A previously unrecognized altered area was identified on the basis of the TM images.

The ability to map desert varnish in semi-arid terrains has economic significance as it defines areas that are less susceptible to desert erosional process and suitable for construction development.

4. PUBLICATIONS, etc. a) "Lithologic Mapping Using Landsat Thematic Mapper Data" by M.H. Podwysocki, J.W. Salisbury, O.D. Jones and D.L. Mimms was presented by Jack Salisbury at the Eighth William T. Pecora Memorial Remote Sensing Symposium, October 4-7, Sioux Falls, SD.

5. RECOMMENDATIONS - o NASA should reevaluate the gain settings for TM bands 1, 2, 3, 5, and 7 with a view toward taking better advantage of the dynamic range of the system.

o NASA should make sure that TIPS processing does not introduce the overshoot or ringing problem that is apparent in Scrounge data.

6. DATA UTILITY - We have now demonstrated the utility of the 2.2 micrometer band for detection of rocks containing both hydroxyl- and carbonate-bearing minerals in both arid and humid environments.

We have shown that rocks covered with desert varnish coatings can now be discriminated from dark rocks lacking the coatings.