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Simulation modeling and preliminary analysis of TIMS data from the Carlin area and the northern Grapevine Mountains, Nevada.

Ken Watson, Susanne Hummer-Miller and Fred A. Kruse
U.S. Geological Survey
PO Box 25046, MS 964
Denver, CO 80225

A theoretical radiance model has been employed together with laboratory data on a suite of igneous rocks to evaluate various algorithms for processing Thermal Infrared Multispectral Scanner (TIMS) data. The algorithms tested were two methods based, respectively on principal component(PC) and Munsell transformation decorrelations; a third method based on assuming unit emissivity in TIMS band 6; and a fourth method derived for this study. The fourth method is based on two assumptions: the ground emissivity is temporally invariant and the diurnal temperature change of the atmosphere is small compared to that of the ground. We recognize that testing these methods using the radiance model will always provide a more optimistic result (and thus an upper bound) than can be achieved in nature owing to the simplicity of assumptions about the instrument, the atmosphere, the ground radiation, mixing effects, etc.

We are currently examining two aspects of the general problem. The first is how to extract emissivity information from the observed TIMS radiance data. Simulation tests indicate that the decorrelation models are useful in an approximate way but often merge band-depth and band-position effects. The second aspect is how to use emissivity data in a way that is geologically meaningful. It has been previously reported that for a suite of igneous rocks the emission minima progresses to longer wavelengths as the composition changes from felsic to mafic. Our attempts to correlate emissivity values that correspond to the TIMS bands indicate only a very general correlation with percent silica . The only statistically distinct categories were pure quartz, felsic to intermediate, mafic, ultramafic, and non-silicate.

The four algorithms were evaluated for appropriate band combinations of TIMS data acquired on both day and night overflights of the Tuscarora Mountains, including the Carlin gold deposit, in north-central Nevada. In addition to those areas where mining activity is taking place, only the Eureka Quartzite and part of a jasperoid unit were obviously distinguishable on the processed images. Subtle differences were observed within parts of the carbonate units and the surficial materials, but these did not coincide with mapped unit boundaries. Moreover, a quartzite unit was not distinguishable from surrounding cherts and siliceous shales, possibly due to vegetation cover. The day and night decorrelation images were somewhat similar; however, sufficient color differences could be observed to indicate that these images show differences that are inconsistent with our expectation that the emissivity of the ground is constant in time.

Analysis of a color composited PC decorrelated image (Bands 3,4,5--blue/green/red) of the Northern Grapevine Mountains,Nevada., area showed some useful correlations with the regional geology. Felsic volcanic rocks appear red, a quartz monzonite stock is dark green, and a coarse grained granite appears light blue-green. A small quartz stockwork outcrop can also be detected on both this and the corresponding Munsell decorrelated image. Color variations in alluvial gravels can be related to different parent rock types.

The thermal infrared region provides fundamental spectral information that can be used to discriminate the major rock types occurring on the earth's surface. These preliminary results using TIMS data indicate that spectral emission differences associated with high silica content can be detected on decorrelated TIMS images, but that optimum use of the thermal infrared region will require appropriate methods of analysis, additional spectral bands, and day and night data acquisition.