DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1195

EXPLANATION

1 Bare or dwarf sage, mat phlox

2 Maple, choke cherry, snowberry, shadbush, elderberry, green rabbitbrush

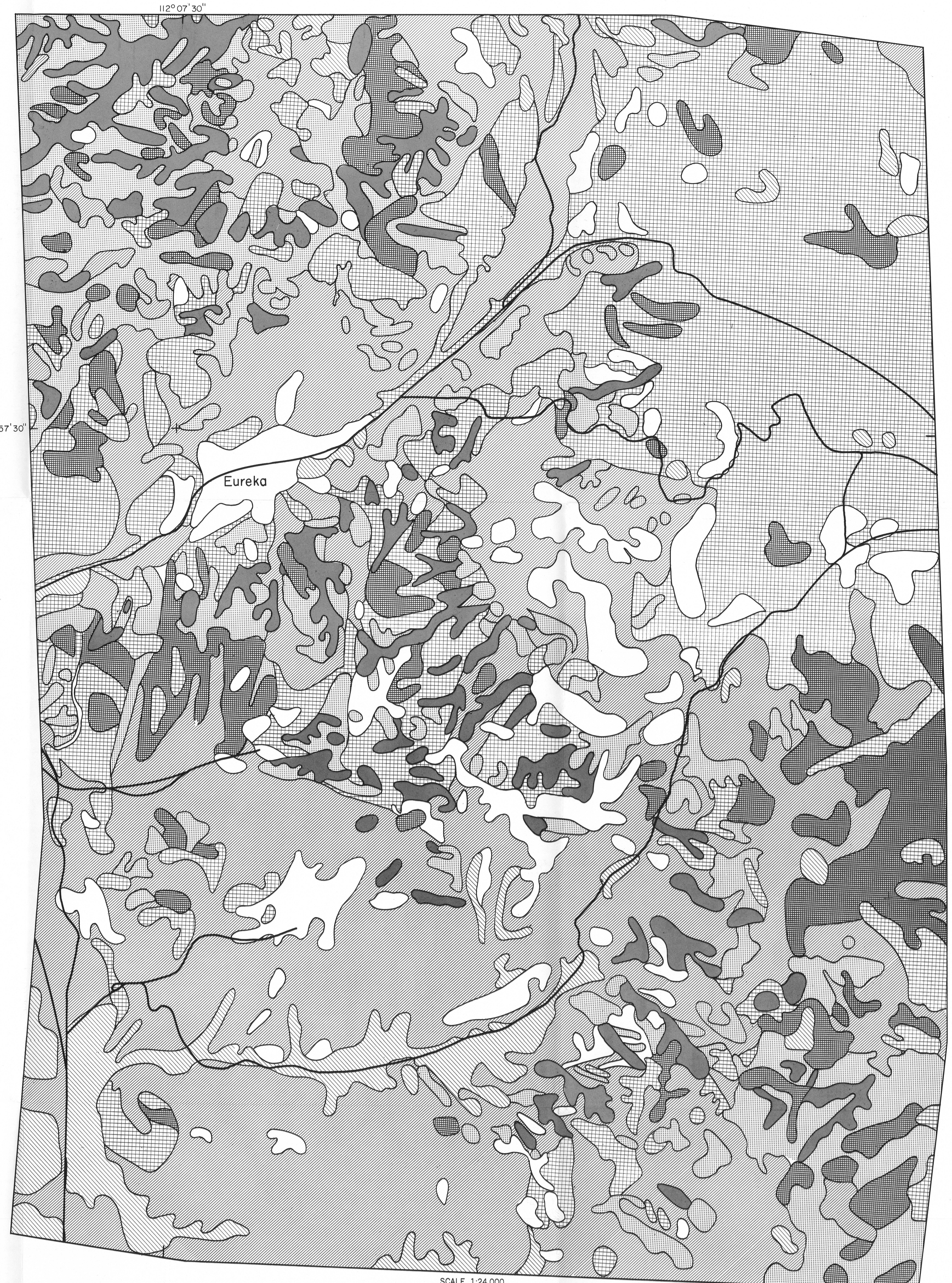
3 Snowberry, shadbush, green rabbitbrush

4 Juniper, rarely dense antelope brush

5 Juniper with pinyon and(or) curl-leaf mountain mahogany, alder-leaf mountain mahogany, cliffrose, shadbush

6 Big sagebrush, gray rabbitbrush, antelope brush

7 Grasses, sparse sagebrush, green or gray rabbitbrush




Map compiled from NASA Mission 340, Site 5, Line 2, June 14, 1975

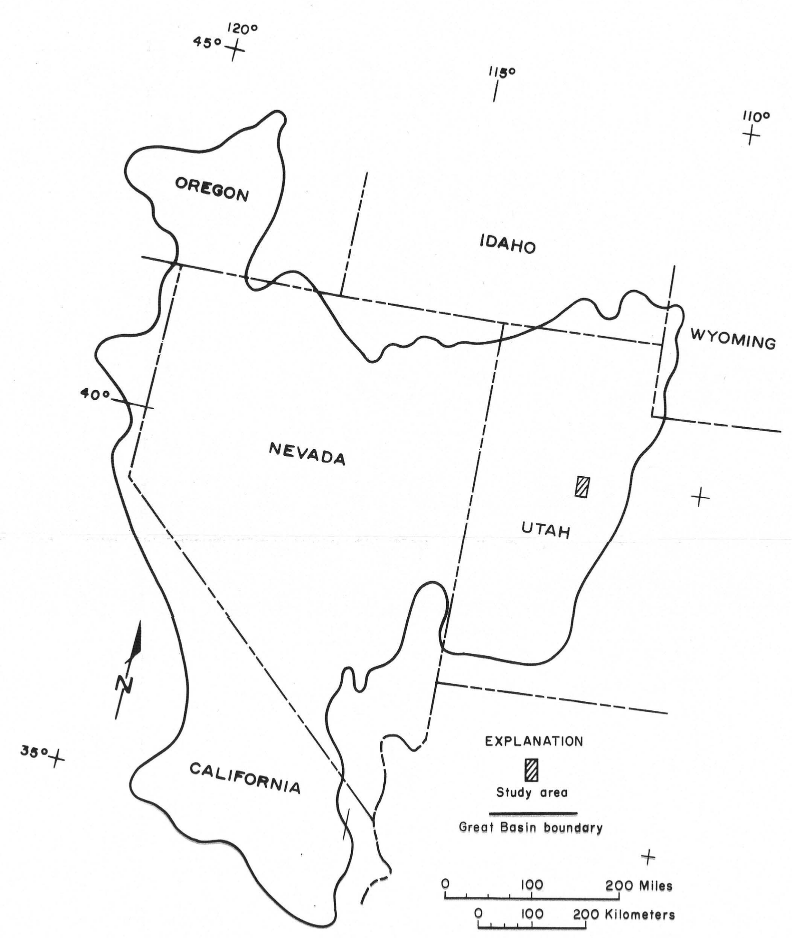



Figure 1.--Index map showing location of the study area.

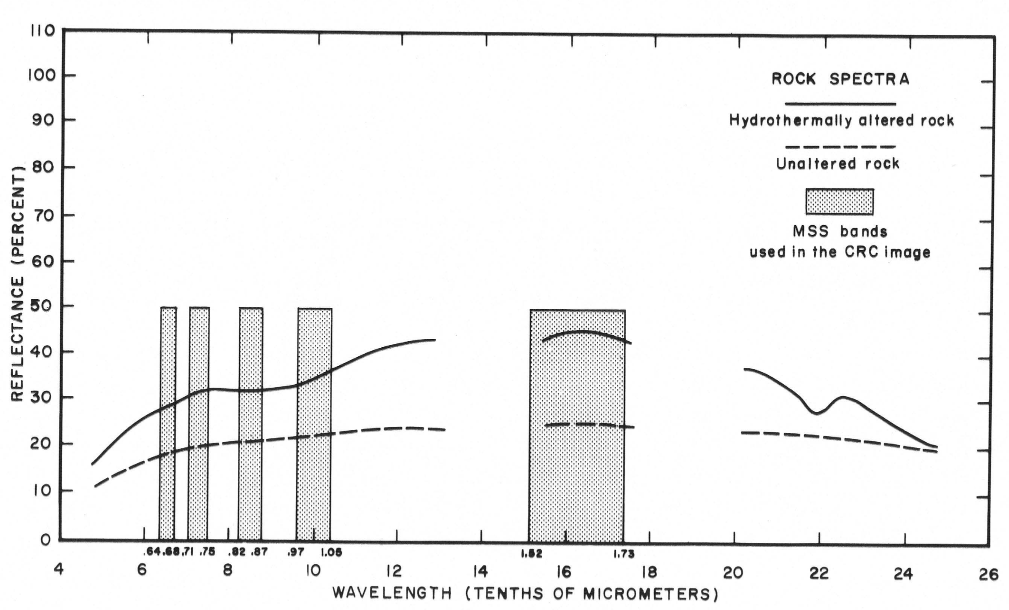



Figure 2.--Rock spectra.

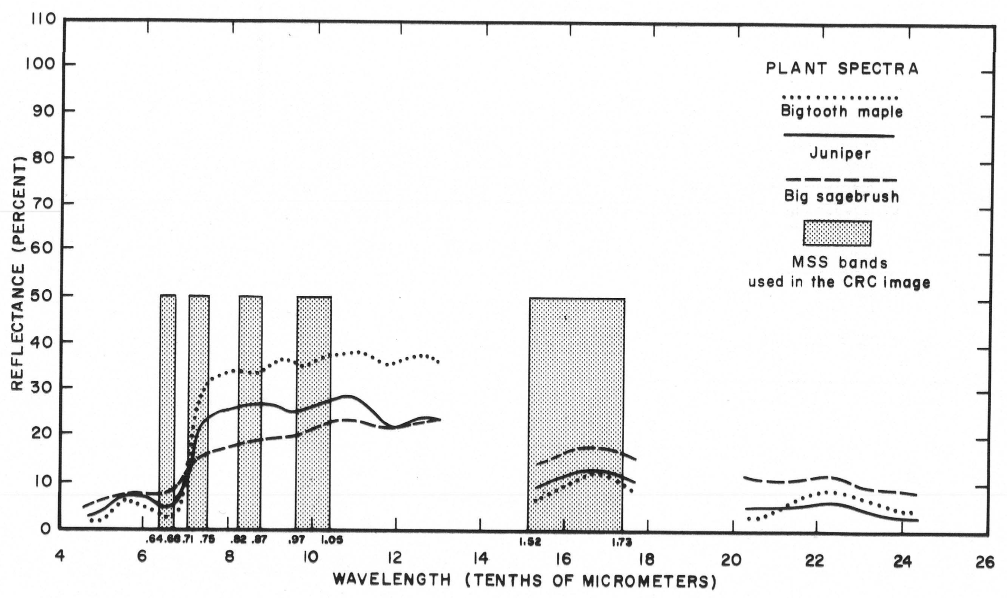



Figure 3.--Plant spectra.

## Introduction

With the development of remote sensing technology has come the capability of defining and mapping plant communities by means of their spectral properties. Such maps will be an important aid in resource evaluation and management, especially in densely vegetated and remote areas of the world.

This study is part of a broader program to determine the usefulness of multispectral scanner aircraft and satellite images for mapping lithologic units and vegetation communities (Rowan and others, 1974; 1977; Abrams and others, 1977; Rowan and Abrams, 1978a; 1978b; Kahle and Rowan, 1979, written commun.). The East Tintic Mountains, Utah, are an excellent test area because of the presence of a wide variety of hydrothermally altered rocks and unaltered sedimentary and igneous rocks (Lovering, 1949; Morris and Lovering, 1961; 1979) and substantial vegetation cover, the areal distribution of which is influenced by hydrothermal alteration (Rowan and Abrams, 1978b). In addition, both visible and near-infrared (0.4 - 2.5 μm), and middle-infrared (8 - 14 μm) multispectral aircraft images are available for evaluation. This report presents a map of the distribution of vegetation in the central part of the East Tintic Mountains and briefly describes the techniques used to compile this map from visible and near-infrared multispectral aircraft images. A detailed report on the relationship between lithologic and vegetation distribution in the area is expected to result from the current studies.

## Study Area

The East Tintic Mountains are a north-trending fault block range on the eastern edge of the Great Basin Province in central Utah (fig. 1). Folded and faulted sedimentary rocks of Paleozoic age are partly overlain by Tertiary volcanic rocks of latitic and quartz latitic composition (Morris, 1957; 1964a; 1964b; 1975; Morris and Lovering, 1961; 1979). Emplacement of the intrusive equivalents of these volcanic rocks resulted in alteration of the host rocks to form silicified, argillized, and chloritized rocks as well as calcitic volcanic rocks and hydrothermal dolomite (Lovering, 1949; Morris and Lovering, 1961; 1979).

The area is classed as semi-arid desert and receives an average of 30 centimeters/year of precipitation. The vegetation is part of the Upper Sonoran member of the Great Basin flora. The dominant shrub in the central part of the range is big sagebrush. It is commonly accompanied by several species of rabbitbrush and antelope brush. The dominant tree, Utah juniper, occurs in stands with little undergrowth or scattered among the shrub communities. Pinyon pine commonly occurs with juniper. Stream valleys and moist north-facing slopes contain a dense growth of trees, especially bigtooth maple and choke cherry, and shrubs such as snowberry and shadbush. Table 1 shows scientific names of the species mentioned in this report. It is not a comprehensive list for the area. Nomenclature follows Welsh and Moore (1973).

Table 1.—*Scientific and common names of vegetation species discussed in this report*

| | |
|---|---|
| *Acer grandidentatum* Nutt. | bigtooth maple |
| *Amelanchier utahensis* Koehne | shadbush |
| *Artemisia nova* A. Nels. | dwarf sagebrush |
| *A. tridentata* Nutt. | big sagebrush |
| *Cercocarpus montanus* Raf. | alder-leaf mountain mahogany |
| *C. ledifolius* Nutt. | curl-leaf mountain mahogany |
| *Chrysothamnus nauseosus* (Pall.)Britt. | gray rabbitbrush |
| *C. viscidiflorus* (Hook.)Nutt. | green rabbitbrush |
| *Cowania mexicana* D. Don. | cliffrose |
| *Juniperus osteosperma* (Torr.)Little | Utah juniper |
| *Phlox hoodii* Richards. | mat phlox |
| *Pinus monophylla* Torr.and Frem. | single-leaf pinyon |
| *Prunus virginiana* L. | choke cherry |
| *Purshia tridentata* (Pursh.)DC | antelope brush |
| *Sambucus coerulea* Raf. | elderberry |
| *Symphoricarpos oreophilus* Gray. | snowberry |

## Method

The visible and near-infrared images evaluated in this study were obtained during June, 1975, using the Bendix 24-channel multispectral scanner (MSS)[1] flown onboard the NASA C-130 aircraft. The images were acquired from an altitude of 5600 m, resulting in a maximum spatial resolution of approximately 10 m. All data were recorded in digital form. Color aerial photography of the area was acquired simultaneously.

Five spectral bands of the aircraft data that maximize the spectral reflectance differences between vegetation and rock and among vegetation communities were chosen. Selection of these bands was guided by analysis of field spectra (Milton, 1978; Rowan and Abrams, 1978a) collected with the Jet Propulsion Laboratory's Portable Field Reflectance Spectrometer (Goetz and others, 1975).

Previous work (Rowan and others, 1977; Rowan and Abrams, 1978a) has shown that limonitic-altered volcanic and intrusive rock spectra for the study area are characterized by $Fe^{3+}$ absorption bands in the 0.45 - 1.1μm region and a relatively sharp Al-O-H band centered near 2.2μm, as figure 2 illustrates. These features are absent or weakly expressed in the unaltered rock spectrum (fig. 2). In contrast, figure 3 shows that sagebrush and juniper spectra are dominated by chlorophyll absorption bands in the visible wavelength region (0.45 - 0.7μm) and intense bands beyond 0.9 μm due to water content. Resulting gross differences in spectral shape can be used to easily distinguish vegetation from rocks in multispectral images. For example, the large relative spectral reflectance differences between the bands centered near 1.0 and 1.6μm are entirely adequate for making this distinction.

Separation of the vegetation communities requires the use of the ratio images of other spectral bands that better express subtle spectral differences between vegetation communities and minimize brightness variations due to topographic slope and albedo (Rowan and others, 1974; 1977). Table 2 lists the spectral band ratios, linear contrast stretch limits, and diazo colors used to make the color-subtractive color ratio composite (CRC) image. The image processing techniques used have been described by Krohn (1979) and Rowan and others (1974; 1977).

Table 2.—*Components used to make the CRC image*

| Spectral band ratio | Contrast stretch limits | Diazo color |
|---|---|---|
| 0.64-0.68μm / 0.82-0.87μm | 17-209 | yellow |
| 0.71-0.75μm / 0.97-1.05μm | 31-225 | cyan |
| 1.52-1.73μm / 0.97-1.05μm | 29-207 | magenta |

The rationale for choosing the ratio images can be seen by comparing the spectra in figure 3. A lower ratio value results in a higher intensity of color on the image. The maple spectrum has low values for all three ratios, resulting in the brown color produced by magenta, yellow, and cyan on the image. Juniper has a low 1.52-1.73μm / 0.97-1.05μm ratio and is magenta to pink on the image; sagebrush has a relatively high value for this ratio and hence no magenta component. The 0.71-0.75μm / 0.97-1.05μm ratio is smaller on the sagebrush spectrum than on the juniper spectrum, resulting in a cyan component on the image for sagebrush. The other image colors can be reconciled in a similar manner. Although the estimated ratio values used in predicting color components are not true radiance values, due to unevaluated factors in the scanner system, they appear to be sufficient for comparison.

## Discussion

Seven color separations were made from the CRC image. Field checking of the image color units in June 1978 yielded the following corresponding vegetation units:

1. White: bare ground, e.g. mine dumps and roads, or very sparse dwarf sagebrush, mat phlox, and other low matted forbs and shrubs.
2. Dark brown: bigtooth maple, accompanied by any or all of choke cherry, snowberry, shadbush, elderberry, green rabbitbrush, and forbs.
3. Light brown: little, if any, maple with dense stands of the accompanying shrubs, especially snowberry, shadbush, green rabbitbrush, and forbs.
4. Magenta and pink: juniper or rarely dense antelope brush.
5. Orange: juniper with large amounts of pinyon pine and(or) curl-leaf mountain mahogany, alder-leaf mountain mahogany, cliffrose, or shadbush.
6. Bluegreen: big sagebrush with varying amounts of gray rabbitbrush, antelope brush, grasses, and forbs.
7. Blue: grasses with sparse sagebrush and green or gray rabbitbrush.

The two brown units (nos. 2 and 3 above) generally occur on northeast- to northwest-facing slopes, especially, though not exclusively, in ravines. The orange unit (no. 5) occurs most often on upper north- or east-facing slopes. The white unit (no. 1) may be bare ground of any orientation, or ridge tops and upper south slopes where the vegetation is very low and sparse. The remaining units occur on slopes of all orientations.

In many places boundaries between units are not sharp, rather one vegetation type grades gradually into another. In particular, juniper occurs scattered throughout much of the sagebrush unit while sparse sagebrush is common in the understory of the juniper units.

Presence and intensity of color on the CRC image depend upon density as well as species composition of vegetation. In addition, background soil and rock reflectance influence the intensity of color on the image. A brighter rock background tends to decrease the intensity of color for the same density of vegetation. Presence rather than intensity of color was used in making this map because the vegetation communities could not be quantified without considerably more field work.

Another vegetation map was compiled using the color aerial photography acquired at the same time as the MSS data. Some of the units are essentially the same on both maps, for example the bare ground (no. 1) and the maple (no. 2). However, it was not possible to separate the two coniferous units (nos. 4 and 5), or the shrub and grass units (nos. 6 and 7). In addition, variations in brightness due to topograhy made it difficult to define a unit over the entire color aerial photograph, whereas the choice of bands and the ratioing effectively minimized these problems on the CRC image.

## Summary

Five bands of Bendix 24-channel multispectral scanner[1] data were ratioed, and the resulting black and white images were exposed on diazo film to form a color-ratio composite (CRC) image of the central part of the East Tintic Mountains, Utah. A vegetation map of 7 units was compiled from the CRC image and field checked in June, 1978. The map provided more vegetation separations and greater accuracy than a map made from a color aerial photograph of the area. The procedure used in this study offers a relatively quick way to map vegetation communities on a medium to small scale using MSS data.

[1] Any use of trade names in this report is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

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# MAP SHOWING VEGETATION DISTRIBUTION IN THE CENTRAL PART OF THE EAST TINTIC MOUNTAINS, UTAH

By

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1981

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