DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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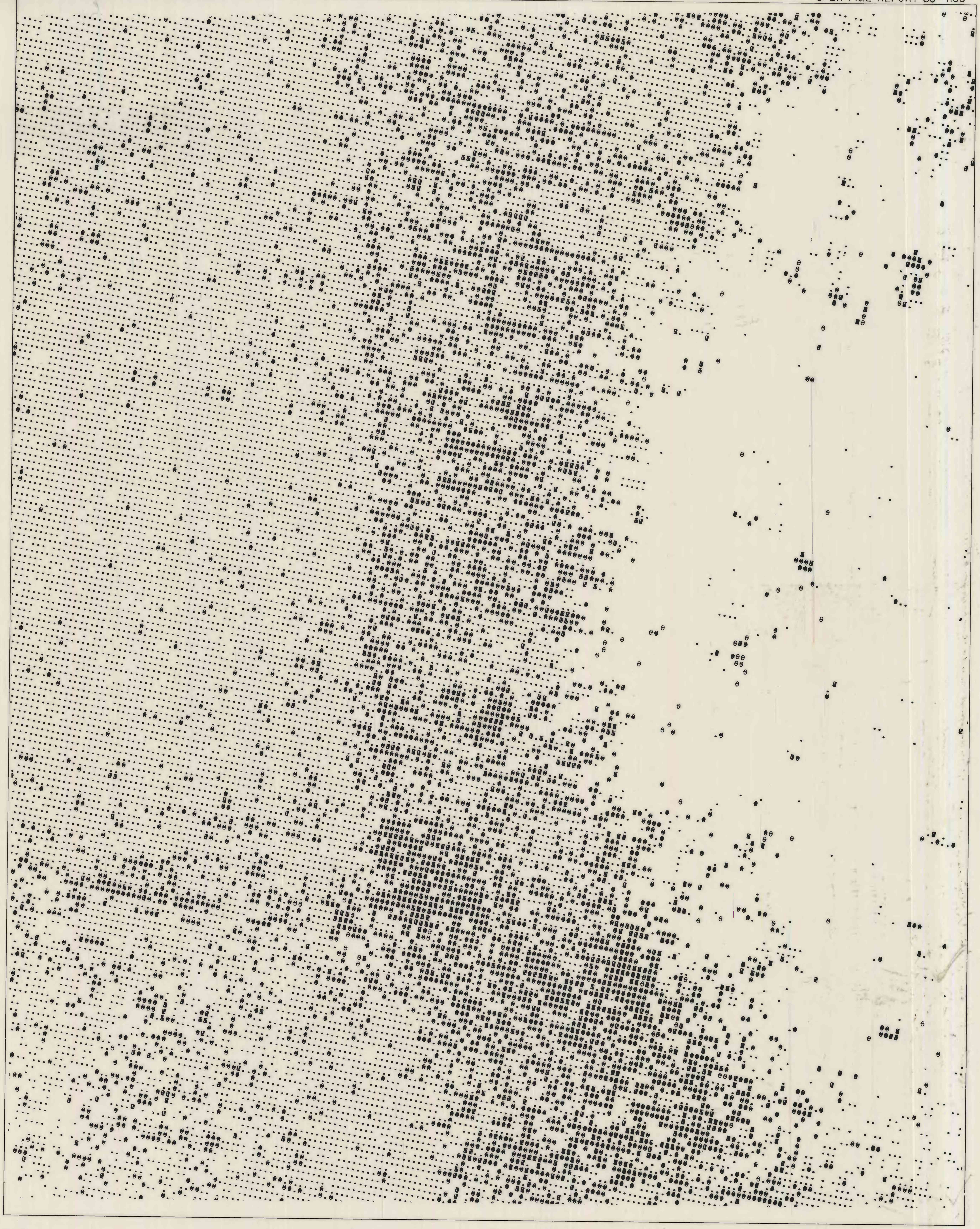
38° 22' 30"



38° 15' 00"

113° 45' 00"

113° 37' 30"

1 0 1 Mile

1 0 1 Kilometer

SCALE 1:24000

PRELIMINARY DIGITAL CLASSIFICATION MAP OF LIMONITIC ROCKS, PINE GROVE RESERVOIR 7½' QUADRANGLE, UTAH

By
M. H. Podwysocki and D. B. Segal

This preliminary map is the result of a digital classification of Landsat MSS (Multispectral Scanner) ratio data for mapping limonitic rocks as possible indicators of hydrothermal alteration. The term limonite is used as defined by Blanchard (1968), and covers a wide variety of ferric iron-bearing materials including goethite, hematite, jarosite and lepidocrosite, among others.

The printer characters on this map represent the approximate unit area of a Landsat picture element (pixel). Due to the satellite's oversampling along scan lines, a pixel is approximately 56 meters x 79 meters on a side. The rectangular aspect of the line printer characters removes most of the geometric error associated with the oversampling. However, to maintain proper geometry, about every 23rd-24th pixel is dropped along a scan line and scan lines are repeated about every 17-18 lines. Therefore the user of this map should be aware that two adjacent scan lines with identical line characters are an artifact of the geometric correction procedure. Positional accuracy on this map is estimated to be within two pixels.

Landsat MSS ratios 4/5, 4/6, 5/6, and 6/7 were used as variables in a supervised Euclidian Distance classifier. A color-ratio composite image (Rowan and others, 1974) was used as an aid in defining training areas necessary for a supervised classification. Spectral signatures were derived for 12 training sets of limonitic rocks. Based on the geology of known areas and the relative mean values in the ratios, the limonitic rocks in these training sets were divided into three classes (Fig. 1):

1) Strong Fe^{+3} absorption - rocks with a low 4/5 ratio and a relatively lower 4/6 ratio. Typically, these rocks appear red, vermillion, a strong yellow, or pink.

2) Weak Fe^{+3} absorption - rocks with a higher 4/5 ratio than the prior category; the 4/6 ratio is approximately the same value as 4/5. Some dark to medium brown rocks fall into this class.

3) Limonitic rocks with a thin vegetation cover. These rocks have 4/5 ratios comparable to the strong Fe^{+3} absorption class, but their 4/6 and 5/6 ratios are lower, reflecting the influence of vegetation. Vegetative cover may be as high as 40-50%.

Twelve classes of non-limonitic rocks were defined for comparative purposes. All twelve were assigned to the "other" (non-limonitic rocks) category in the map classification. Efforts were not as exhaustive in defining all possible non-limonitic classes, as they were not pertinent to the study. Those pixels that did not fall into any of the above classes are left blank in the classification map. Commonly, the blank areas represent heavy vegetation, areas of strong shadows in the raw MSS data, or playa surfaces. Occasionally, some pixels were unclassified for none of the above reasons. These fell mainly into the non-limonitic class and their omission from the classification was due to non-exhaustive training on non-limonitic materials.

The following is a summary of classification results for the majority of the Richfield 1°x 2° quadrangle, and all tentative conclusions may not necessarily apply to this quadrangle.

Results show that the 6/7 ratio indicated primarily the presence or absence of vegetation and was redundant with respect to information present in the 4/6 and 5/6 ratios. In addition, none of the limonitic signatures studied showed the low 6/7 ratio characteristic of rocks lacking the prominent 0.95 micrometer Fe^{+3} absorption band. Thus, because the 6/7 ratio provided no unique ratio information, it was excluded from the classification scheme. The 6/7 ratio, however, is included in the spectral signature graph (Fig. 1) for the sake of completeness and to demonstrate its redundancy.

Generally, all known hydrothermally altered limonitic rocks fell into the strong Fe^{+3} absorption class. However, some non-altered limonitic rocks were also allocated to this class, such as pink tuff, purple quartzite, limonitically stained limestone, etc. Many areas classified as showing strong Fe^{+3} absorption are fringed by zones showing weak Fe^{+3} absorption, presumably reflecting the dimunition in the amount of limonite away from the source. Rocks exhibiting only weak Fe^{+3} absorption cannot altogether be ignored, as some relatively small altered areas were grouped into this class. Because of the non-uniqueness of the limonitic signatures, field checking, examination of available geologic data and studying the spatial relationships of the limonitic areas are necessary to make a judgement as to their significance.

Rowan, L.C., Wetlaufer, P.H., Goetz, A.F.H., Billingsley, F.C., Stewart, J.H., 1974, Discrimination of rock types and altered areas in Nevada by the use of ERTS imagery: U.S. Geol. Survey Prof. Paper 883, 35p.

Blanchard, R., 1968, Interpretation of leached outcrops: Nevada Bur. Mines Geol. Bull. 66, 196p.

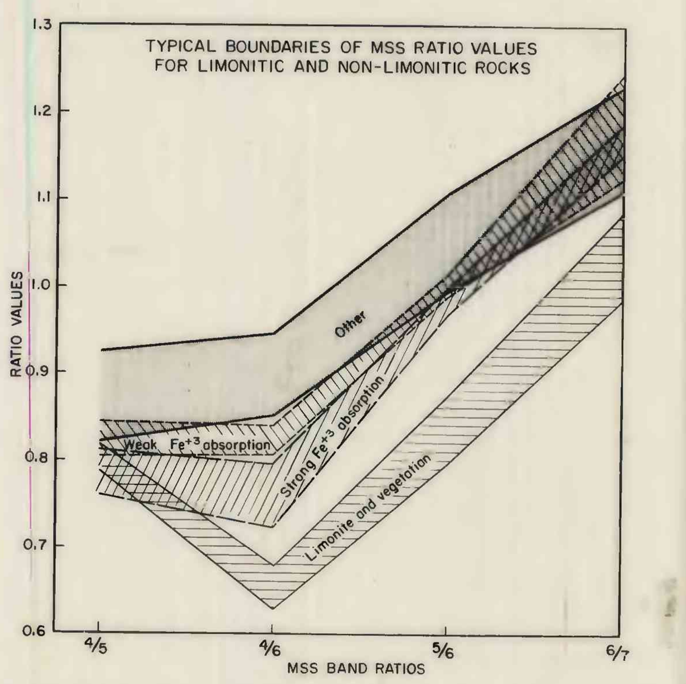


Figure 1. The lines bounding each class represent the extreme mean values for each ratio within the class. Generally, the shape of the bounding limits reflects the shape of the ratio curves for any training area within the class. The overlap between classes is misleading, as each of the individual training areas within a class has a distinctive set of mean ratio values that is separable from other training areas. Standard deviations associated with each of the training area mean ratio values typically range from 0.02-0.05.

EXPLANATION

Strong Fe +3 Absorption

Weak Fe +3 Absorption

Limonitic rocks and vegetation

Non-limonitic rocks

Unclassified materials

This map is preliminary and has not been edited or reviewed for conformity with Geological Survey standards