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A distinction between bedrock and unconsolidated deposits on 3-5 infrared imagery of the Yellowstone Rhyolite Plateau

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DEPARTMENT OF THE INTERIOR

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A DISTINCTION BETWEEN BEDROCK AND UNCONSOLIDATED DEPOSITS ON 3-5 μ INFRARED IMAGERY OF THE YELLOWSTONE RHYOLITE PLATEAU*

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CONTENTS

ILLUSTRATIONS

FORWARD

The infrared imagery (3-5 micron band) discussed in this report was acquired on August 14, 1966, at 2130 hours by the HRB Singer Corporation using a Reconofax IV imaging scanner on contract to the U. S. Geological Survey. The data is referred to as Mission 4027, flight 21, line 5.

The analysis contained herein was conducted under the Geologic Applications Program, NASA Task No. 160-75-01-44-10 entitled "Ground Truth Investigations".

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INTRODUCTION

Infrared imagery covering most of Yellowstone National Park was obtained in August 1966, by H. R. B. Singer Company, using the Reconofax IV system in an aircraft flying at about 20,000 feet. This imagery has been examined in order to evaluate the geologic information it contains in relation to a current study of the Yellowstone rhyolite plateau. As most of the findings contained no new information about the capabilities of the system, they will be reviewed here only very briefly. However, one particular aspect of the interpretation, a clear local distinction between bedrock and surficial deposits, seems to be of sufficient interest to be illustrated and noted specifically.

Because of the nature of the terrain and vegetation at Yellowstone, the parameters affecting the infrared sensor are mainly ones which are themselves only poor-resolution indicators of primary geologic features. Certain geologic features not directly related to the rhyolite plateau do show up fairly well but are not discussed here as they have been described in other reports based on this imagery (Smedes, 1968; Pierce, 1968; Keefer, in preparation).

TERRAIN AND GEOLOGIC FEATURES

Following is a list of terrain and geologic features which I found to be consistently differentiated on the imagery:

hot springs and related thermal features

snow and ice

lakes and rivers

floodplains and meadows

grassy vs. timbered areas

steep sun-facing slopes (daylight imagery)

steep west-facing slopes (post-sunset imagery)

flat-surfaced uplands

certain valley bottoms not included in above categories (shown in some images apparently resulting from the presence of cooler air than that over surrounding areas)

talus and bare-rock exposures

very light-colored rocks, such as sinter (daylight imagery)

The thermal responses of these features, of course, vary markedly with time of day and less markedly with other variables such as cloudiness; all of these features, however, are distinguishable consistently on the images.

TOPOGRAPHIC EFFECTS

Topographic effects are marked enough to show the pressure-ridge patterns and flow fronts on some of the rhyolitic lava flows of the area where conditions during overflight were favorable (e.g. the Pitchstone Plateau). They are not as well shown, however, as they are on radar imagery.

DETAILED ANALYSIS

In one small area, in the upper part of Gibbon Canyon, there is a particularly good correlation between previously mapped geologic relations and the 3-5 μ imagery, that was not clearly distinguishable on ordinary aerial photographs. A tonal contrast on the infrared imagery marks areas mapped respectively as glacial deposits and bedrock. The distinction can be made on aerial photographs only with some difficulty, knowing the geologic relations beforehand, but the contrast is very clear on the infrared image obtained in flight 4027/21, line 5, illustrated in figure 1. This image was obtained at about 9:30 p.m. on August 14, 1966, under dry conditions with only scattered high cirrus clouds and light atmospheric haze. The image was obtained about 2 hours after the local sunset. A downdropped fault block largely covered by glacial deposits is dark in tone in comparison to most of the surroundings, which are uplands with only scattered glacial erratics and small patches of till. Two small isolated areas of bedrock within the fault block, having little or no glacial cover yet essentially equally dense timber growth, are lighter in tone than the surrounding glacial deposits. Figure 2 is a simplified geologic map of the same area as that shown in figure 1. The mapping was done independently before the imagery was obtained. Although the available data are insufficient to determine the cause of this infrared anomaly, it is possible that the imagery reflects primary differences in thermal properties of the bedrock and surficial deposits, as tree cover is not complete. It is also possible, however, that the anomaly is related to subtle differences in vegetation or topography.

CONCLUSIONS

In summary, the geologic features of direct interest in the study of the rhyolite plateau that are readily discerned on the infrared imagery are:

1. distribution of hydrothermal features,
2. pressure ridges on rhyolitic lava flows, some faults, and certain other features directly reflected in topography,
3. some local contacts, e.g. between rhyolite and basalt, and between alluvium and basalt, which are reflected by marked vegetation changes, and
4. local differences between bedrock and surficial deposits not noticeably reflected in topography or vegetation.

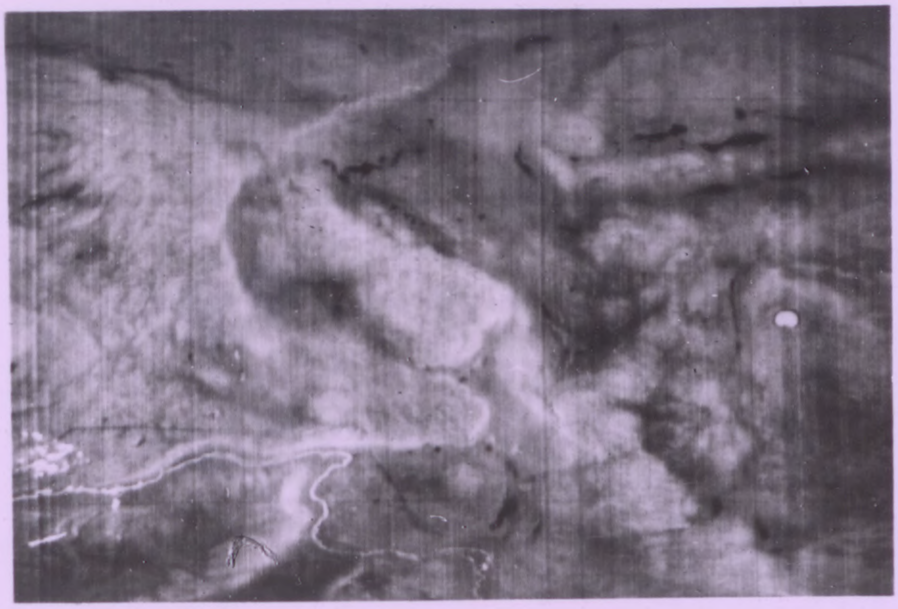
Of these, only those in class 1 and, in one instance, in class 4 are not distinguished more readily by other sensors.

REFERENCES

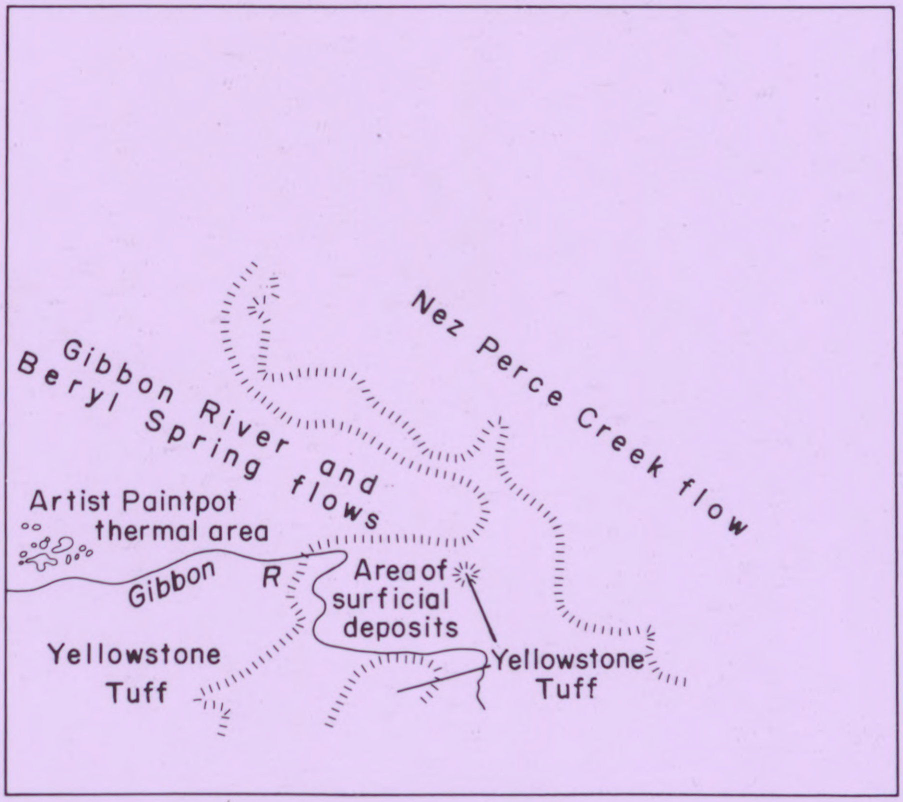
Keefer, W. R., Evaluation of radar and infrared imagery of sedimentary rock terrane, south-central Yellowstone National Park: U. S. Geol. Survey Interagency Report NASA-106, in preparation.

Pierce, K. L., 1968, Evaluation of infrared imagery--applications to studies of surficial geology, Yellowstone Park: U. S. Geol. Survey Interagency Report NASA-93.

Smedes, H. W., 1968, Geologic evaluation of infrared imagery, eastern part of Yellowstone National Park, Wyoming and Montana: U. S. Geol Survey Interagency Report NASA-83.



A.



B.

Figure I.--Infrared image and explanation of Gibbon Canyon area

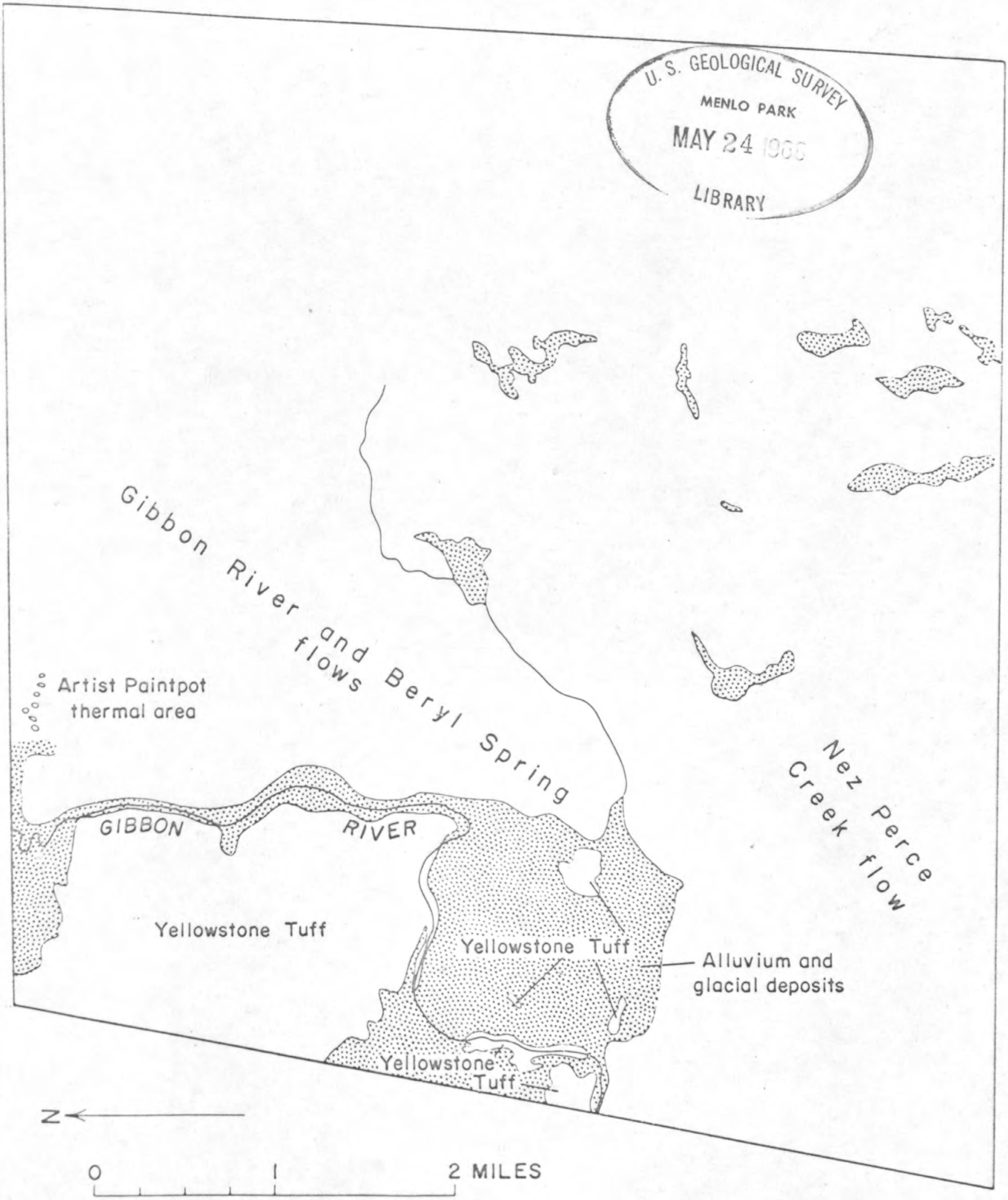


Figure 2.--Geologic map of parts of Madison Junction and Norris Junction quadrangles