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THE USE OF INFRARED IMAGERY

Accomplishment Report (Final Report) on the
BPR Financed Research Project

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Calif., Highways, Materials and Research

68-47

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ACCOMPLISHMENT REPORT ON THE BPR FINANCED RESEARCH PROJECT "THE USE OF INFRARED IMAGERY"

Report Prepared by M. L. McCauley
Senior Engineering Geologist

This report describes the work done under our research project titled "Use of Infrared Imagery" D-5-9.

The purpose of this project was to compare the information that was interpreted from the infrared images with that obtained from the black and white photography. A minimum amount of money was expended on this project and maximum use was made of available infrared imagery and available black and white photography. The study provided an evaluation of the application of infrared imagery to highway problems.

We intended to study three sets of infrared imagery, each with a different purpose in mind. However, imagery of the Pisgah Crater area, to be studied to determine its application to the location of materials, was not available. Imagery near Troy Dry Lake was examined to determine its application to the location of wet areas. Imagery in the Casa Diablo area was studied to determine its usefulness in highway location through a hot springs area. All of this imagery was obtained from the U.S. Geological Survey.

CONCLUSIONS

The following conclusions were drawn from the results of this study:

1. Much of the equipment used to obtain infrared imagery is in the developmental stage and is subject to considerable operational difficulty.

2. Security regulations imposed on both infrared instruments and on imagery are a hindrance to productive work.

3. Considerable additional expenditure of time and money is necessary to obtain useful infrared imagery than to obtain black and white photography. No cost figures were obtained because no flights were arranged specifically for this study.

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4. Consideration of Items 1, 2 and 3, makes it necessary that the infrared imagery provide considerable information in addition to that obtainable by black and white photography.

5. The only application that appears promising from this study is route location through a geothermal area.

ACKNOWLEDGMENTS

Personnel of the U.S. Geological Survey working on infrared imagery studies were extremely helpful and cooperative. They provided the infrared imagery used in this evaluation as well as considerable information pertinent to infrared imagery. Their help is sincerely appreciated.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

in cooperation with the
U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

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PISGAH CRATER AREA

In mid-February 1965, the field operations of a U. S. Geological Survey team headed by Mr. William A. Fischer were observed. They were conducting an experiment on the use of infrared imagery in the Pisgah Crater area, east of Barstow, California. One purpose of their project was to determine the best time for flying an infrared survey. Ground preparations for a 0200 flight, a 0600 flight and a 1400 flight were observed. During the time of each flight, measurements of the emissivity of the various materials were taken with radiometers. Temperatures of the various materials were taken with pyrometers. Other data such as wind velocity and the amount of moisture in the air were also taken. This information was not obtained by the California Division of Highways. The imagery taken during this time was also not available to the Division of Highways.

Imagery in this area would have been of interest to the Division of Highways for its possible application to the location of materials. In this area of recent volcanic activity, surface textures definitely affected the infrared imagery although imagery was not obtained. The radiometer readings indicated that this was true. Black and white aerial photography also indicated these textural changes. In this particular area it seems doubtful that infrared imagery would add significant information to that obtainable from the black and white photography.

TROY DRY LAKE AREA

Infrared imagery of the Troy Dry Lake area was obtained during the operations at Pisgah Crater. Troy Dry Lake is located several miles westerly of Pisgah Crater along U.S. Highway 66. Imagery obtained by the U.S. Geological Survey was done as a service to the Division of Highways and was made available for inspection. Subsurface water is known to exist along a fault which crosses a portion of the lake bottom. The purpose of examining this imagery was to determine whether the fault or the associated water would be visible on the infrared imagery.

Two sets of imagery were available. One set recorded the 4.5 to 5.5 micron band and was taken between 0757 and 0800. The other set recorded the 8 to 14 micron band and was taken between 0757 and 0800. The scale for this imagery is approximately 1 inch equals 1500 feet. The quality of this imagery is described by the U.S.G.S. as "poor to fair, mostly poor, due to ineffective cooling of detector." Black and white aerial photography taken March 8, 1962 was available for comparison. The scale for this photography is 1 inch equals 250 feet. The quality of the black and white photography is excellent. No ground control information was obtained in the Troy Dry Lake area.

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A valid comparison between the black and white aerial photography and the infrared imagery is not possible for a number of reasons. There is a wide difference beteen the scales of the imagery and the photography. The difference in quality between the imagery and the photography is great. Also it is probable that the imagery was not taken at the time that would be most favorable for detecting near surface water.

The fault was not detectable on the infrared imagery or the black and white photography. Near surface water was not detected by the imagery under these flight conditions.

CASA DIABLO HOT SPRINGS AREA

The ground preparations for an infrared imagery flight in the Mono Craters area were observed during June of 1965. Instrument problems forced the abandonment of this scheduled flight. The flight was rescheduled late September 1965, and during this operation the Casa Diablo Hot Springs area located to the south of Mono Craters was also flown. Imagery of the Casa Diablo area was made available to the Division of Highways. The area was of special interest because a highway relocation was scheduled through this Hot Springs area. Exploratory drilling indicated that warm temperatures existed approximately 50 feet below ground surface in a few areas.

Prints of 4.5 to 5.5 micron infrared images of the Casa Diablo area were obtained from the U.S. Geological Survey. The imagery was taken between 1017 and 1018 on September 30, 1965. The quality of the imagery is poor. The scale is 1 inch = 2,000 feet. Ground temperature information was obtained by Division of Highways personnel during the early dawn flight, however imagery from these flights was not available. Infrared imagery in the 8 to 14 micron band was given to the Division of Highways by the geological survey. This flight was run on July 30, 1966 at 0524 hours. The quality of this imagery is good. Isodensity scans of this imagery were also made available. The scale of the isodensity scan is approximately 1 inch = .735 feet. The available black and white photography of the Casa Diablo area was taken in 1961. The scale is 1 inch = 2000 feet. Quality of the black and white photography is very good.

A direct comparison between the infrared imagery and the black and white photography cannot be made because of the difference in scale, the difference in the time when the photography and imagery were taken and some difference in quality between the two. However, in spite of these problems, some interesting features are present on the infrared imagery that was taken in July 1966. The isodensity scans represent this information most graphically. Cultural features, such as roads, are sufficiently clear to allow orientation in the imagery. The known hot springs show as hot areas. Two other "hot" anomolies are detectable on the scan. These

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would require field checking to determine the cause of the anomoly. In this particular case, neither of these anomolies fell near the proposed highway realignment.

In this particular application, that of highway relocation through a hot springs area, infrared imagery provided additional information to that obtainable from black and white aerial photography. This information is useful and would be applicable to the highway relocation through a hot springs area.

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STATE OF CALIFORNIA—TRANSPORTATION AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
P. O. BOX 1499, SACRAMENTO 95807

March 13, 1968

HPR-1(5) D0509
19-632695

Mr. D. J. Steele
Division Engineer
Bureau of Public Roads
Sacramento, California

Dear Mr. Steele:

Attached for your review and acceptance are 12 copies of an accomplishment report, which is considered a final report, on our research project titled "Use of Infrared Imagery." The work is included in the Work Program HPR-1(5), Part 2 Research, as Item D-5-9.

This report was prepared by the Materials and Research Department. It contains the answers to questions raised by Dr. H. T. Rib in your letter of September 11, 1967.

With acceptance of this report we will close the project. A total of approximately $1,350 has been expended to date. The infrared imagery studied was provided by the U. S. Geological Survey. We realize that the controlled experiment you requested is not possible under these conditions. However, considerable insight was gained in the use of infrared imagery.

If the opportunity arises to further evaluate available infrared imagery, we will do so under an ongoing State-financed research project. We appreciate the loan of the two-volume report titled "An Optimum Multi-Sensor Approach for Detailed Engineering Soils Mapping," by

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Dr. H. T. Rib. His work is more extensive than any that we had anticipated doing. This report has been returned under separate cover; however, we would like to have a copy for our library when available.

Sincerely,

J. A. LEGARRA
State Highway Engineer

By Original Signed
D. L. WIEMAN

D. L. Wieman
Urban Planning Department

Attachments:
Final report on "The Use of Infrared Imagery," dated March 1968.

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cc: SHelwer
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