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NATURAL RESOURCES PROGRAM

SPACE APPLICATIONS PROGRAMS

TECHNICAL LETTER NASA-66

U.S. Geological Survey
Department of the Interior

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Washington, D. C. 20242

Technical Letter
NASA-66
November 1966

Dr. Peter C. Badgley
Chief, Natural Resources Program
Office of Space Science and Applications
Code SAR, NASA Headquarters
Washington, D. C. 20546

Dear Peter:

Transmitted herewith are 3 copies of:

TECHNICAL LETTER NASA-66

STATUS REPORT OF INFRARED INVESTIGATIONS
(JULY 1, 1966 TO SEPTEMBER 30, 1966)*

by

Robert M. Moxham**

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbiter Program

*Work performed under NASA Contract No. R-146
**U.S. Geological Survey, Washington, D. C.

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-66

STATUS REPORT OF INFRARED INVESTIGATIONS

(JULY 1, 1966 TO SEPTEMBER 30, 1966)*

by

Robert M. Moxham**

These data are preliminary and should not be quoted without permission

Prepared by the Geological Survey
for the National Aeronautics and
Space Administration (NASA)

*Work performed under NASA Contract No. R-146
**U.S. Geological Survey, Washington, D. C.

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ILLUSTRATIONS

INTRODUCTION

Aerial infrared surveys have been completed for the projects listed below:

Location	Description	Area Covered (Mi^2)
Mono Craters, California	Test site	54
Long Valley, California	Caldera and hot springs	19
Pisgah Crater, California	Test site	20
The Geyers, California	Geothermal power area	25
Mt. Lassen, California	Volcano	330
Mt. Shasta, California	Volcano	35
Mt. St. Helens, Washington	Volcano	20
Mt. Adams, Wasnington	Volcano	25
Mt. Rainier	Volcano	2 passes

The infrared surveys were made with a Reconofax IV scanner mounted in the Geological Survey's Twin Beech aircraft. The quality of the infrared data was generally good, although some difficulty was experienced by discharge of static electricity in the film magazine at high altitudes. We are attempting to overcome this by placing a small sponge inside the magazine. Water is supplied to the sponge through a hole in the magazine in the hope that the increased moisture will reduce the tendency toward static discharge.

Aerial photography was obtained in all of the areas and radiometric data was obtained with a Barnes fixed field 8-14 micron radiometer utilizing a graphic milliameter.

One of the principal problems previously encountered in all infrared surveys was aircraft navigation at night. Several different techniques have been tried with varying degrees of success, but all were highly undesireable due to the great amount of time lost in logistics. It has been customary to place rotating high intensity beacons at strategic places in the area to be surveyed. In some instances this system works satisfactorily, but elsewhere the beacon lights proved to be nearly useless. This problem has been solved in a highly satisfactorily way by utilizing the distance measuring system

now available for light aircraft. In order to obtain coverage of a given area, parallel flight lines are layed out normal to the most convenient Vortac. The flight lines are terminated on radii from the Vortac. In practice the pilot flies along one of the flight lines during the daytime to determine the DME range, and from this value the DME range for all other flight lines in the survey area can be determined. Thus, the course and spacing of each flight line can be followed quite accurately and the beginning and end of each flight line can be determined from the radii indicated on the Omnireceiver. If the given DME range were flown over a long distance, the flight path, of course, would follow a circle centered on the Vortac, but in practice the survey lines represent arcs whose length are very small compared to the radius so that the curvature of the survey line is inconsequential. Furthermore, there is nothing sacred about straight survey lines as one is usually interested only in achieving total coverage of an area.

Three north south flight lines covering 54 linear miles were flown during a sequence of 6 surveys in a 24 hour period in the Mono Craters area (fig. 1 and 2). The lines were oriented such that infrared data was obtained over materials having a wide range thermal properties. The quality of the aerial infrared data was the best yet obtained. Simultaneous ground measurements of temperatures and other parameters were made at selected ground stations. The ground data will yield diurnal temperature curves whose phase and amplitude should reflect the thermal parameters K, and C. These in turn are being related to the corresponding tonal densities on the infrared images to try to determine, at least in a qualitative way, the extent to which the airborne infrared data may convey information on the thermal (and therefore physical) properties of target materials.

As the Long Valley area is an interesting geologic structure containing several hot springs, 19 linear miles were repeatedly flown as the opportunity arose. Extensive thermal anomalies were detected, apparently related to zones of hydrothermal alteration and to structure.

A 1:31,680 scale geologic map on an orthophotographic base has been completed on the Mono Craters area. Preliminary copies of the map have been printed and are presently being edited by the several authors whose data has been used in compilation of the maps. The map will be transmitted to NASA upon completion of this editing. The final report on the Mono Craters test site is under way and completion is expected in the third quarter.

Aerial infrared surveys were made at four hour intervals through a diurnal cycle at Pisgah Crater test site, California (fig. 3). As at Mono Craters, simultaneous surface measurements were made so that the infrared data can be evaluated in terms of the thermal parameters of the several rock types of this area.

The Geyers area, about 80 miles north of San Francisco, is the only site in the United States at which electrical power is being produced from geothermal stream (McNitt, 1963). The area was flown both during the day and during pre-dawn hours.

In addition to the expected thermal anomalies in the vicinity of the present stream production area, abnormal surface temperatures were found about 4 miles to the southeast, on the north slopes of the valley of Big Sulfur Creek. Repetitive surveys were made over the area during pre-dawn hours to obtain data in several spectral regions. The equipment was operated unfiltered as well as with band pass interference filters of 8-14, 8.9-10, 10-15, and 2-6 microns. No data was obtained in the 2-6 micron region, apparently owing to the very low response of the Ge:Cu detector employed in the surveys.

Lassen Peak, California is the most recently active volcano in the conterminous United States, having last erupted in 1915. The fumarole and hot springs areas, ("Bumpass Hell", Devil's Kitchen, Sulfur Works, Hot Springs Creek, Boiling Lake, and Terminal Geyser) lying enerally to the south and southeast of Lassen Peak, were all imaged in considerable detail.

Two small fumarole areas previously reported by climbing parties were found at the summit of Mount Shasta. A small fumarole was also detected at the west base of "The Boot", at about the 8000 foot level on Mt. St. Helens. No thermal anomalies were seen at Mt. Adams or at Crater Lake, though at the latter site our coverage was incomplete and the quality of the data was not completly satisfactory.

At Mt. Rainier, there is considerable fumarolic activity in two summit craters which are circumscribed by a third outer ring (concentric fracture patter or crater?) as found on a previous infrared survey in 1963 (Moxham, 1965). No substantial change in thermal pattern has evidently taken place in the three year interim. The present survey results, however, show much more detail, owing to the longer wavelength detector now in use as opposed to the InSb. detector used during the 1963 survey.

Field experiments on a two layer thermal problem is being undertaken at a site kindly provided by Ames Research at Moffett Field, California. It is intended to determine experimentally

the diurnal changes in surface temperature of a semi-infinite source of fragmental materials overlying bedrock. A concrete slab has been laid and will be used as a simulated bedrock. Surface materials will be various size fractions of materials ranging from basalt to pumice. The concrete slab has been poured, an instrument shed has been constructed, and the pumice is on hand. Arrangements for instrumentation are under way.

A study of the infrared spectral emittance of rocks from the Pisgah Crater and Mono Craters area, California, has been completed. (Daniels, 1966). It is concluded that the spectral signatures of rocks from these areas are recognizable in spite of their rough and weathered surfaces.

Design is under way of an apparatus for investigation of possible infrared luminescence of rock-forming minerals in the vicinity of their characteristic frequences. Luminescence will be sought under a variety of excitations, including x-rays and visible light, with samples being adjusted in temperatures from 77° K through room temperature. The detector and necessary optics are to be maintained at 77° K to reduce the background against which any luminescence is viewed.

Experiments have shown that a liquid nitrogen black body may be used as a reference source in measurement of spectral emissivities with an interferometer spectrometer (Stoddard and Daniels, 1966). The primary advantage is that the unknown sample may be at ambient temperature, not only making possible insitu field measurements, and also simplifying the problem of calibration.

Construction has been completed on an emissivity box which will permit rapid field or laboratory determination of 8-14 micron emissivity, utilizing a Barnes radiometer.

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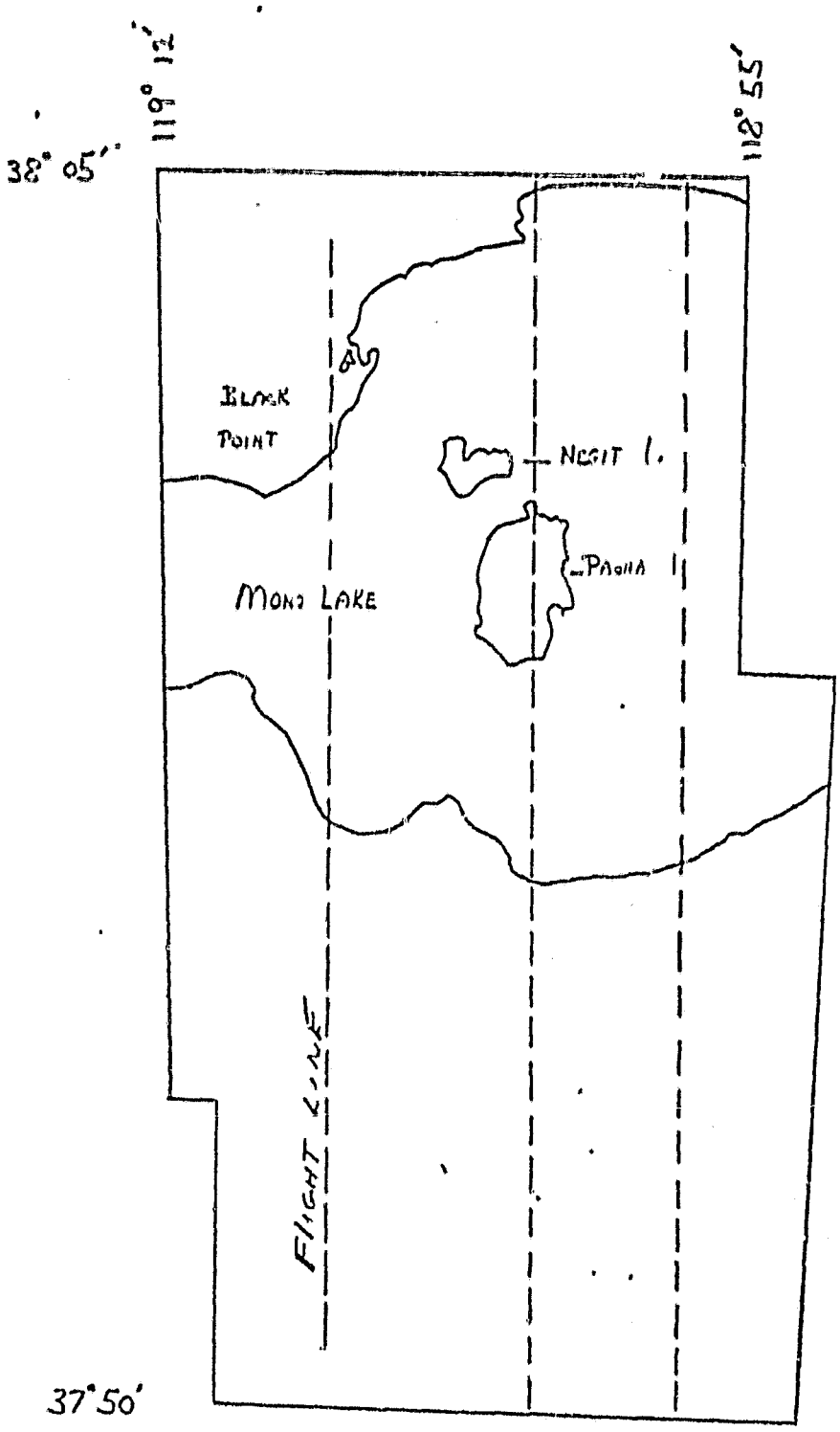
MEETINGS ATTENDED

R. M. Moxham conferred with Donald Lowe, University of Michigan, and R. J. P. Lyon, Chairman of the IR Instrument Team, regarding the Survey's engineering design study for a lunar scanning IR radiometer. At NASA's request, it was decided to re-orient this study toward a design for an earth orbit but retaining work already completed on the lunar orbitting scanner.



BODIE QUADRANGLE
TRENCH CANYON Q-
MONO CRATERS Q-
COWTRACK MTN. Q-
(ALL 1:62,500)

FLIGHTLINES — — — —

TOTAL 54 MILES SURVEYED EACH TIME
DURING 6 SEQUENCES OF FLIGHTS
PRODUCING USEFUL IMAGERY

APPROXIMATELY 1:190,000

Mono Craters test site, Calif.

FIG. 1

MT. MORRISON QUADRANGLE
1:62,500

118° 55'

37°40'

118° 50'

19 MILES SURVEYED
(SEVERAL OVERPASSES)
PRODUCING USEFUL
IMAGERY

CASA DIABLO
HOT SPRINGS

HIGHWAY 301

WHITMORE HOT
SPRINGS

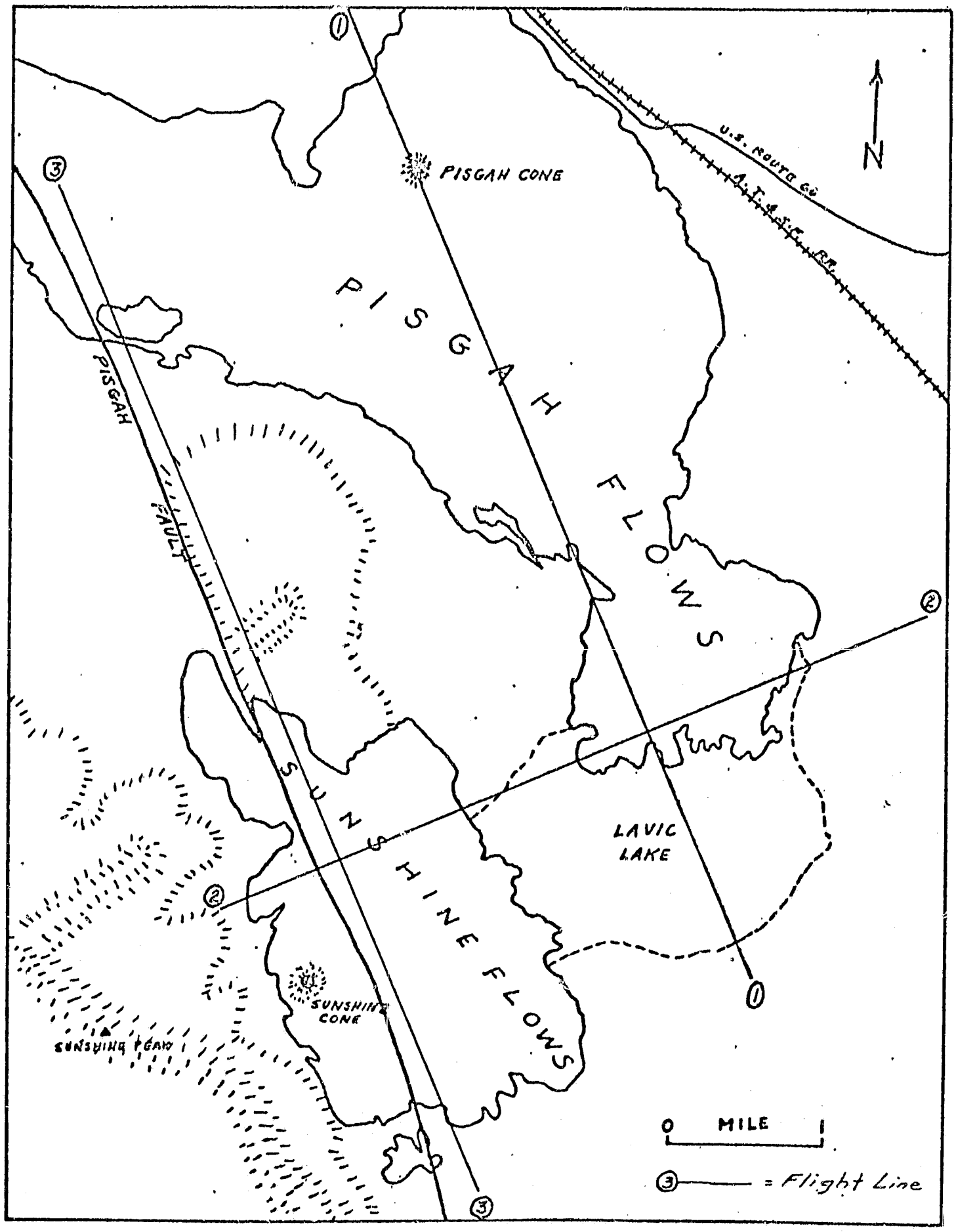
LONG VALLEY SURVEYS

APPROX: 1:62,500

37°35'

FIG. 2

FIG. 3



PISGAH CRATER & VICINITY, CALIFORNIA - TEST SITE

FIG. 3