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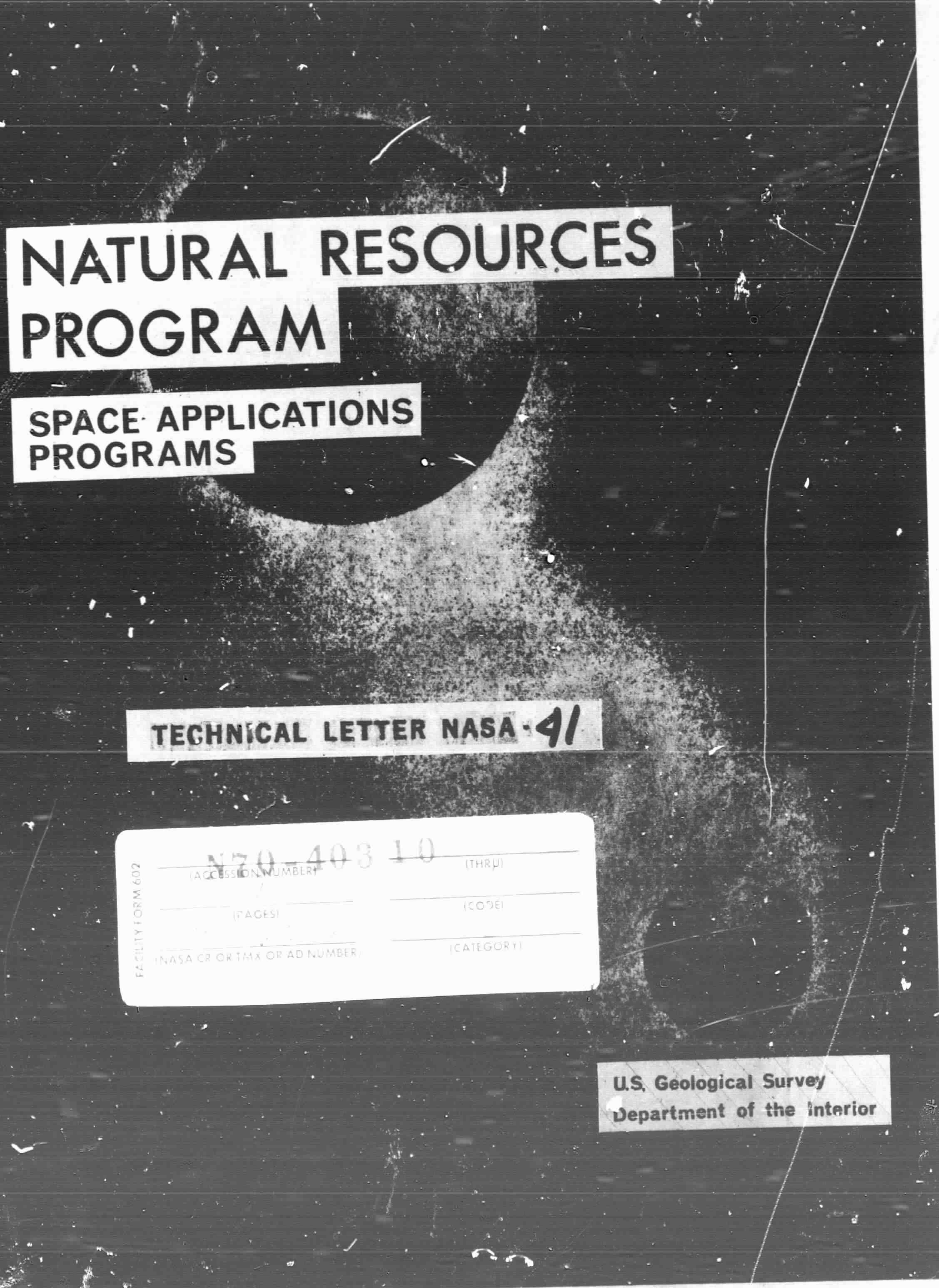

NATURAL RESOURCES PROGRAM

SPACE APPLICATIONS PROGRAMS

TECHNICAL LETTER NASA-41

U.S. Geological Survey
Department of the Interior

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

Technical Letter
NASA-41
June 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-41

POSSIBLE APPLICATION OF REMOTE-SENSING TECHNIQUES

AND SATELLITE COMMUNICATIONS FOR

EARTHQUAKE STUDIES*

by

Robert E. Wallace, U.S. Geological Survey
Menlo Park, California

David B. Slemmons, Mackay School of Mines,
University of Nevada, Reno, Nevada

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbital Program

*Work performed under NASA Contract No. R-09-020-015

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Technical Letter
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June 1966

POSSIBLE APPLICATION OF REMOTE-SENSING TECHNIQUES AND SATELLITE COMMUNICATIONS FOR EARTHQUAKE STUDIES*

by

Robert E. Wallace, U.S. Geological Survey
Menlo Park, California

David B. Slemmons, Mackay School of Mines,
University of Nevada, Reno, Nevada

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

*Work performed under NASA Contract No. R-09-020-015

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

POSSIBLE APPLICATION OF REMOTE-SENSING TECHNIQUES AND SATELLITE COMMUNICATIONS FOR EARTHQUAKE STUDIES*

Robert E. Wallace, U.S. Geological Survey
Menlo Park, California

David B. Slemmons, Mackay School of Mines,
University of Nevada, Reno, Nevada

1971

ABSTRACT

The National Aeronautics and Space Administration (NASA) has been sponsoring research in the development and application of remote-sensing techniques and in communication by satellite. Some of these techniques may prove to be of value in earthquake studies, and are being tested for this purpose by the U.S. Geological Survey and the University of Nevada.

A variety of remote-sensing techniques and instruments are under development and appraisal, including both passive and active types. They make use of energy ranging from radar and microwave wavelengths through the visible part of the spectrum to ultraviolet and X-ray. Some techniques depend upon spectral analysis of the radiant energy, some instruments produce imagery by scanning techniques, and a variety of special cameras produce more nearly conventional photography.

*The paper was presented by Slemmons at the Second U.S.-Japan Conference on Research Related to Earthquake Prediction, June 8, 1966 and will be reproduced in the syllabus of the conference.

Applications for earthquake studies can be divided into two main types: 1) utilization of space vehicles for rapid and relatively inexpensive telemetering of data from remote regions to central observatories, and 2) use of remotely sensed data for geologic and geophysical analysis of seismic regions.

Space vehicles may prove to be extremely useful for collecting data from remote stations, for storing, and then for transmitting the data to central stations. Although the total bits of data that can be handled with currently scheduled equipment is limited, this capability will undoubtedly improve. Thus, although a seismogram would be difficult to cope with at present, many simpler forms of data such as a sampling of tiltmeter or strain-gauge readings, gravity or magnetic measurements, or number of microearthquakes per unit of time might be readily handled.

Some remote-sensing techniques that are being appraised and that may be useful in earthquake studies and prediction are listed below.

1. Radar imagery.--Side-looking radar imagery obtained from aircraft or satellites can provide sidelight effects similar to the lighting effects of morning or evening sunlight. Low, generally inconspicuous fault scarps are accentuated in such illumination; and radar can obtain this effect night or day, through clouds or fog, and in any orientation. The character of the radar return--whether polarized or nonpolarized--also may accentuate faults, fracture patterns, or other structural fabrics of the terrain.

2. Infrared imagery and spectrometry.--Infrared imagery can show the surface temperatures of the ground, and thus the thermal properties of the rock and soil units can be studied and compared. The thermal

inertia of these units is controlled by such factors as moisture content and degree of compaction--properties that cannot be assessed as satisfactorily, or at all, by visible light. Such thermal activity as hot springs along faults or heat related to volcanic activity can be very effectively studied by infrared. Since certain gross chemical differences can be distinguished by infrared spectroscopy, the technique might be used for delineating major rock masses of different compositions.

3. Photography.--Color and certain special types of black-and-white photography have been used very little in geologic analysis, but have great potential. In addition, photography from high altitudes or from space holds some unique possibilities. For example, synoptic coverage of large areas can be obtained rapidly, and under nearly uniform lighting conditions. Parallax resulting from topographic relief is minimized, so that, in effect, an orthophotograph is obtained. The entire world--areas that are accessible as well as inaccessible--can be covered with photographs of uniform quality. Furthermore, photography from satellite altitudes is less effected by turbulence in the atmosphere. Regional geologic analysis of such large structures as the San Andreas fault system or the Basin and Range province could be greatly assisted by such synoptic photography.

4. Multispectral techniques.--Photography which makes use of a narrow band or the combination of two or more selected bands in the spectrum can give marked enhancement over normal panchromatic photography. Therefore multispectral methods, which need not be confined to the visible wavelengths, can possibly be used to discriminate rock and soil units both in local studies and in regional tectonic or lithologic analyses.

5. <u>Synoptic coverage</u>.--Use of any of the remote-sensing techniques either in a high-altitude aircraft or satellite makes possible rapid synoptic coverage. Thus large areas can be covered in a single view; rapid sequences of views around the earth can be obtained; the number of separate image models can be reduced; and ultimately costs can be lowered.