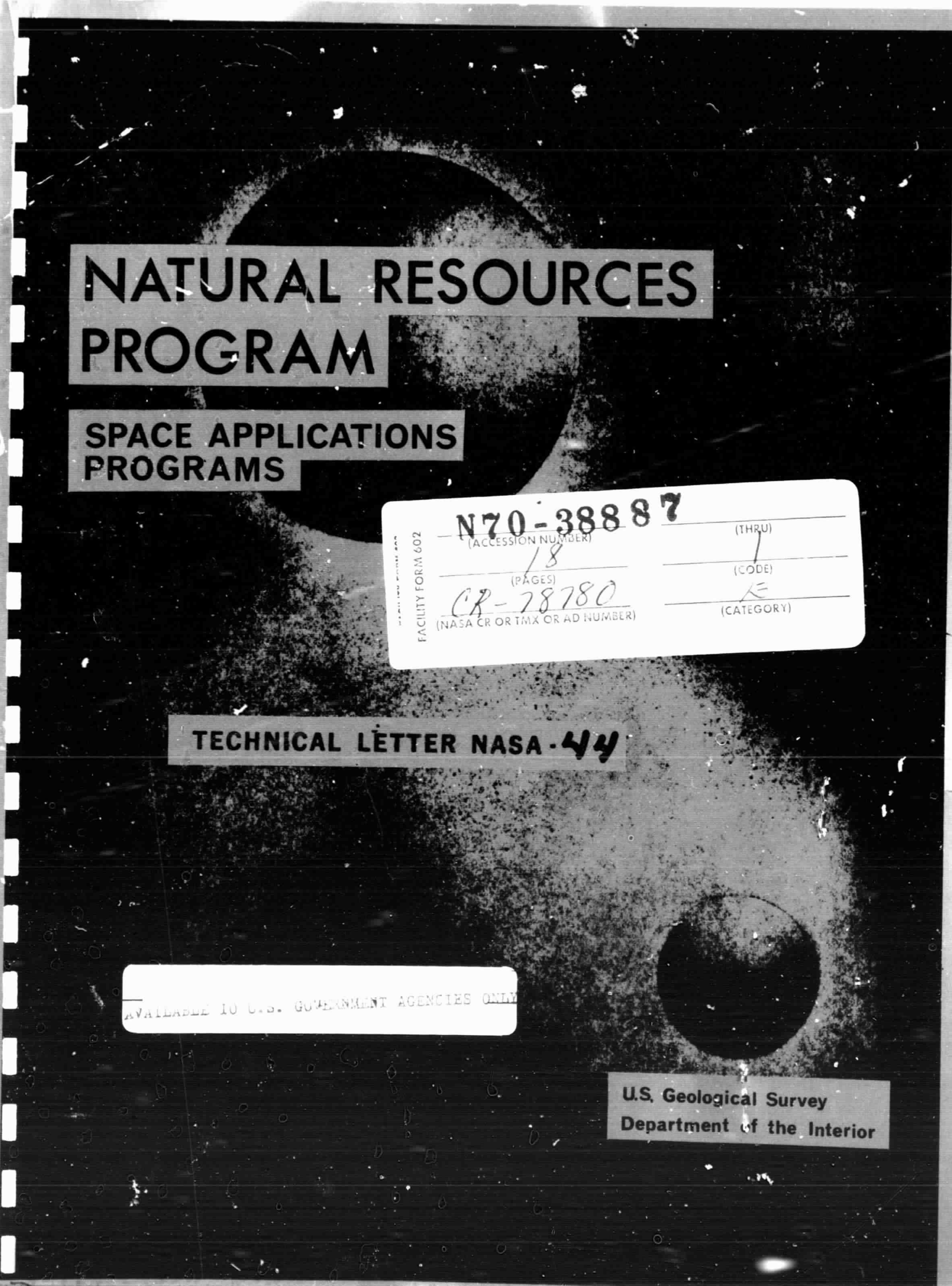


NATURAL RESOURCES PROGRAM

SPACE APPLICATIONS PROGRAMS

N70-38887
(ACCESSION NUMBER)
18
(PAGES)
CR-78780
(NASA CR OR TMX OR AD NUMBER)
(THRU)
1
(CODE)
13
(CATEGORY)
FACILITY FORM 602

TECHNICAL LETTER NASA-44

AVAILABLE TO U.S. GOVERNMENT AGENCIES ONLY

U.S. Geological Survey
Department of the Interior

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

Technical Letter
NASA-44
September 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-44

PRELIMINARY REPORT ON RADAR IMAGERY OF CEDAR CITY-

IRON SPRINGS AREA, UTAH*

by

Paul L. Williams**

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbiter Program

*Work performed under NASA Contract No. R-09-020-015
**U.S. Geological Survey, Denver, Colorado

[redacted]

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-44

PRELIMINARY REPORT ON RADAR IMAGERY OF CEDAR CITY - IRON SPRINGS AREA, UTAH

by

Paul L. Williams

September 1966

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-09-020-015
**U.S. Geological Survey, Denver, Colorado

Photo copies of illustrations are available for viewing at the following places:

Author(s); Discipline Coordinators; NASA Data Bank (Houston); Remote Sensing Evaluation and Coordination Staff (RESECS) and the U.S. Geological Survey Libraries (Denver, Menlo, Washington).

TABLE OF CONTENTS

Cedar City - Iron Springs Area

The area consists of about 800 square miles in Iron County, Utah between latitude 37°48', longitude 112°55' and 113°35'. It includes the Hurricane Cliffs, which mark the boundary between the High Plateaus on the east and the Basin and Range province on the west. In the latter province within the map area are several laccolithic intrusions of Tertiary age, with some of which are associated magnetic iron ore deposits.

Geologic features thought to be interpretable from the radar images alone, without recourse to prior geologic information, aerial photographs, or field work, are indicated on the sketch maps of figure 1 and 2.

The image scale is about 1:164,500.

Topography: Topographic features are well expressed by radar shadows. Because the images are high angle obliques taken from the same side of the sensing aircraft, position of the radar shadows, north or south of the objects casting them, is dependent on flight direction, not position of the sun. The images are, in effect, shaded relief models of the topography.

Geology: Where geologic contrasts are well expressed by topography, geologic interpretation is possible. For example, hogbacks of resistant beds alternating with weak beds are well shown along the Kanarraville Fold (Fig. 1). Similarly, resistant beds mark an arcuate hogback around the east and south sides of Iron Mountain. Flat-lying or gently dipping beds are also clearly portrayed; examples are the rocks on the Kolob Terrace and in the Harmony Mountains (Fig. 1), and the gently dipping beds that form a cuesta, the Swett Hills (Fig. 2).

Faults are well shown by linear scarps and by erosion of straight valleys along fault zones. Good examples are the faults in the Markagunt Plateau east of Cedar City (Fig. 2). Joints in the monzonite of the Mount Stoddard intrusion (Fig. 1), which are prominent linear features on aerial photographs even at a scale of 1:317,000, appear faintly on the radar images.

Little if any tonal contrast between rock types is discernible on the images. The area includes Paleozoic, Mesozoic and Tertiary sedimentary rocks, Tertiary volcanics and hypabyssal intrusions, and Quaternary to Recent sediments and basalt flows. Flat areas underlain by Quaternary alluvium are readily distinguished from bedrock areas. None of the various types of bedrock, however, appear to be distinguishable from each other, with the possible exception of Quaternary basalt flows in the Markagunt Plateau and the Kolob Terrace. In the headwaters of Crystal Creek, dark areas appear on both like and de-polarized images; these correspond in part to outcrops of Quarternary basalt shown on the 1:250,000 Utah State geologic map, and in part extend beyond the mapped basalt outcrops. The dark patches may, on the other hand, be due to vegetation differences or to variation in moisture content of the soil.

Hydrologic features: Streams in the area are too small to appear at the image scale. Lakes are prominent and black.

Vegetation: Flat areas of farm land provide ideal comparisons of the effects of different vegetation types on the images - other variables such as topography and geology are at a minimum. Most of the farm lands are on pediment and fan surfaces mantled with alluvium. Farm tracts appear on the images as squares and rectangles of variable light and dark tones. In comparing the images with aerial photographs taken in mid-June 1953, it is apparent that many of the light-toned tracts on the radar images are dark on the air photographs. Comparison is made difficult by the probability of changes in the farms in the 13 years since the photos were taken, and the fact that they were taken during the growing season, whereas the radar images were taken after harvest. Without field checking or comparison with recent aerial photography (photographs taken simultaneously with the radar imagery would be ideal), it is difficult to relate tone on either radar images or photographs to such variables as type of crop, recency of tilling of the soil, soil mixture etc.

In bedrock areas, vegetation is of two types: dense to sparse pinyon and juniper below 8,000 feet, and mixed conifer and aspen above; on ordinary aerial photographs conifers generally appear slightly darker than the aspen. On the radar images in bedrock areas at lower elevations there appear to be no contrasts in tone that can be attributed to the effects of vegetation. On the Kolob Terrace, the surface of which is 9,000 feet and above, flat interfluves are of darker tones with considerable lighter mottling; this contrast is best developed on the like image. It is likely that the dark areas are covered with coniferous trees, and that the lighter mottled areas are groves of aspen, although total differences between radar images and aerial photograhs in the farmlands, described above, suggest that the reverse may be true-dark areas are aspen and light areas, conifers. The aspen leaves, at the time the radar images were taken, were yellow, orange and red, and hence would have a higher light reflectivity than earlier in the year-but possibly more important for radar imagery the leaves were dead and lower in moisture content than the conifers. Field checking with aerial photographs would quickly show whether the contrast in tone is due to vegetation or to some other factor, such as the presence of basalt, or greater moisture content of the soil.

Cultural features: Urban areas such as Cedar City appear prominently as light-toned patterns mottled with black, especially in the like image. Most roads appear as faint black and white lines; the tone on the images does not appear to be dependent on whether or not the road is paved. Railroads between Cedar City and the iron mines to the west show as white lines more conspicuous than the roads. The iron mine pits and dumps at Desert Mound and Iron Mountain are conspicuous light-toned features on both images. Between Cedar City and Iron Mountain a line of small white dots indicates the metal towers of a power line. The landing strips at Cedar City airport are faintly visible.

The reflectivity of the iron mine dumps,[1] especially those at Desert Mound, appears greater than would be expected for such minor topographic features. Possibly their high reflectivity is related to their high magnetite content. If so, it is possible that magnetite deposits outcropping at the surface in remote parts of the world could be similarly detected.

1/ According to aerial photography taken in 1953, the mine dumps have approximately the following dimensions:

Desert Mound Pit -	2,000 x 1,200 feet
	2,400 x 1,000 "
	2,000 x 800 "
	2,000 x 700 "
Iron Mountain Pit -	1,000 x 1,000 feet
	800 x 800 "
	1,500 x 1,000 "
	1,500 x 800 "
	1,500 x 1,000 "
	1,400 x 500 "

Of course considerable mining has been done in the 13 years since the photos were taken, and the dumps are now much larger.

The dumps are flat on top; the sides slope at the angle of repose of loose rock, about 40 degrees from the horizontal. They are composed of low grade ore, high-grade ore with excess impurities, and gangue; but we do not know which dumps contain which components, nor in what proportions.

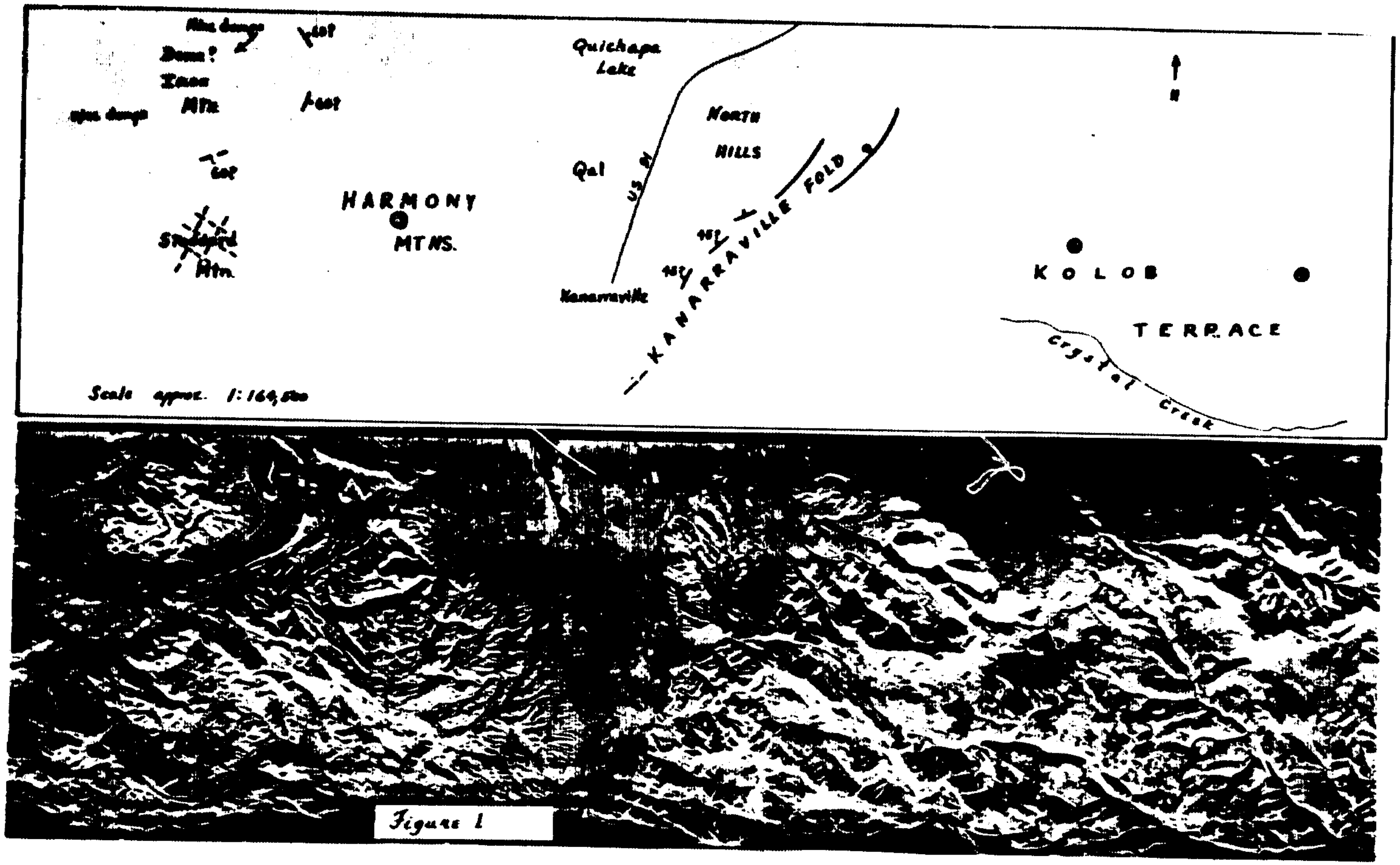
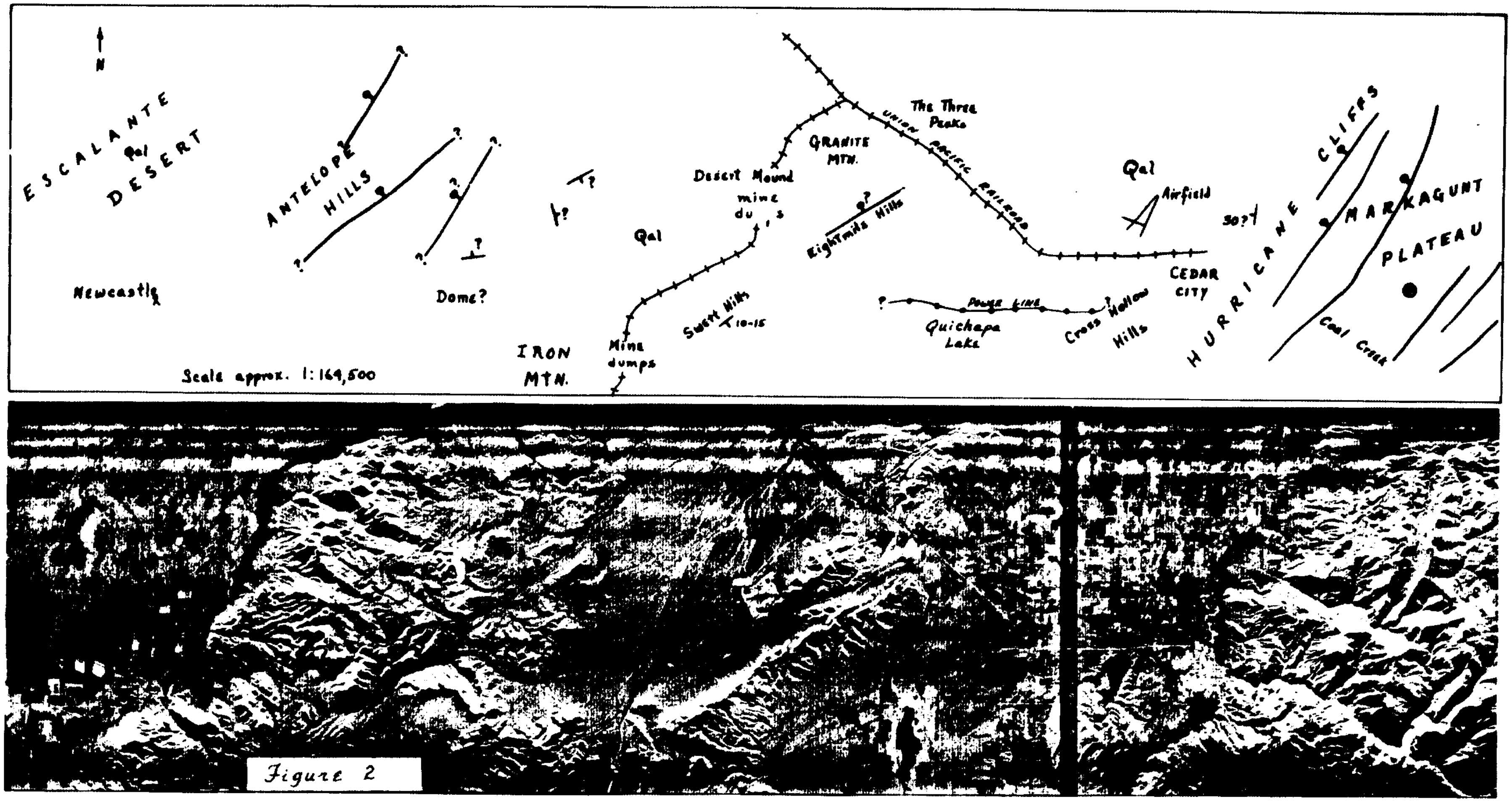

Quichapa Lake
North Hills
Qal
Kanarraville
KANARRAVILLE FOLD
HARMONY MTNS.
KOLOB
TERRACE
Crystal Creek

Figure 1



N
ESCALANTE
Qal
DESERT
Newcastle
ANTELOPE
HILLS
Dome?
Scale approx. 1:164,500
IRON
MTN.
Mine
dumps
Qal
Sweet Hills
10-15
Desert Mound
mine
du s
GRANITE
MTN.
Eightmile Hills
The Three
Peaks
UNION PACIFIC RAILROAD
Qal
Airfield
30?
Power Line
Quichapa
Lake
Cross Hollow
Hills
CEDAR
CITY
HURRICANE
CLIFFS
MARKAGUNT
PLATEAU
Coal Creek

Figure 2