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UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-25

EVALUATION OF RADAR IMAGERY OF HIGHLY FAULTED VOLCANIC TERRANE IN SOUTHEAST OREGON*

by

G.W. Walker**

May 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, Menlo Park, California

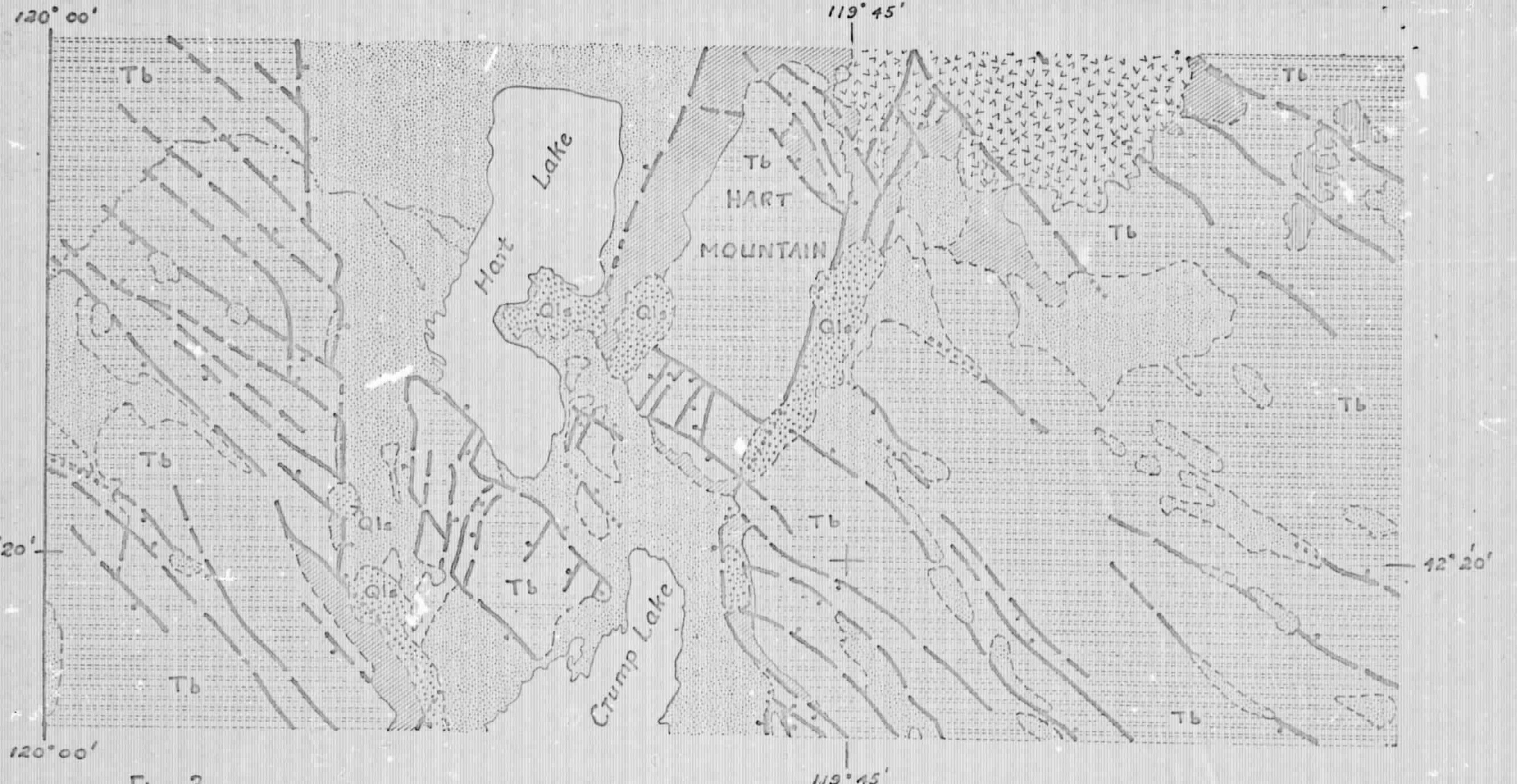

Fig. 3
Generalized geologic map of the Hart Mountain area, Lake County, Oregon

0 1 2 3 4 5 miles

Surficial deposits — Landslides (Qls) — Pliocene sediments and tuffs — Tertiary basalt flows (Tb) — Tertiary volcanic rocks — Silicic vent rocks

Contact, dashed were approximately located

Fault, dashed where approximately located. Ball on downthrown side

Evaluation of radar imagery of highly faulted volcanic terrane in southeast Oregon

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By George W. Walker

Introduction

Radar imagery, along a single east-west overflight about 25 miles north of the Oregon border and extending from the Idaho border to the Pacific Ocean, is compared with recent geologic maps (Wells and Peck, 1961; Walker, 1963, Walker and Repenning, 1965, 1966) made by reconnaissance and standard photogeologic methods for areas east of the Cascade Range. Geology of a strip about 10 miles wide and 20 miles long is interpreted from the radar image (approx. scale, 1:180,000) and is compared directly with geology mapped and plotted on high altitude, black-and-white photographs (approx. scale, 1:60,000).

Both polarized and depolarized imagery were obtained in October 1965 from a radar system that operates in the K band. A image recording the polarized (horizontal) component of the returned radar signal and an image recording the depolarized (vertical) component were obtained simultaneously. Apparently, much of the returned signal remained polarized, and as a result the image recording the depolarized (vertical) component of the signal shows less contrast and is less grainy than the polarized one; this affects both resolution and interpretation of ground-surface features. Both polarized and depolarized images are considerably distorted.

UNITED STATES
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WASHINGTON, D.C. 20242

Technical Letter
NASA - 25
May 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-25

EVALUATION OF RADAR IMAGERY OF HIGHLY FAULTED

VOLCANIC TERRANE IN SOUTHEAST OREGON*

by

G.W. Walker**

Sincerely yours,

William A. Fischer
Research Coordinator for
USGS/NASA Natural Resources Program

*Work performed under NASA Contract No. R-09-020-015
**U.S. Geological Survey, Menlo Park, California

[redacted]

The radar strip crosses an area noted for very extensive Tertiary volcanism, including a north-south chain of inactive or dormant andesitic and dacitic volcanoes in the Cascade Range, several major silicic vent areas probably related to Miocene and Pliocene ashflows, several large volcano-tectonic depressions, well-developed mid-Tertiary and younger Basin and Range fault structures, and extensive surfaces of basalt that contrast with widespread sheets of welded tuff and tuffaceous sedimentary rocks. Soil and vegetation cover vary widely from extensive bare rock outcrops to areas of deep soil and sparse to dense forests.

Radar imagery

Evaluation of the radar imagery demonstrates that most physiographic and some geologic features, clearly depicted on conventional aerial photographs, also are well defined by radar. In general, the geologic features evident on the radar images are those strongly reflected by topography. The degree of resolution and, hence, the interpretive nature of different surface features varies with the density of vegetation cover and with the character (polarization?) of the radar image, most features being more readily apparent on the high-contrast horizontally polarized image whereas others are more easily seen on the vertically polarized image. Some cultural features, including plowed fields, graded gravel or dirt roads, a pipeline right of way, are darker and more clearly defined on the depolarized image.

Large- and small-scale normal faults related to fault-block basins or volcano-tectonic depressions are clearly evident on the radar images, and are particularly prominent in untimbered areas on the polarized image. Linear scarps and valleys mark the position of many of the faults and, in areas of dense forest cover where topographic relief is partly obscured, the radar imagery depicts some of the faults better than on conventional photographs.

Some of the basins between major faults are filled with fine-grained, poorly indurated, tuffaceous sedimentary rocks which in places are water saturated. They absorb much of the radar energy so the images tend to be darker than those of adjoining areas underlain by denser rocks with little or no water.

Several brighter and more highly reflective areas which commonly have dendritic drainage are present on the east end of the radar strip. They are underlain by widespread dacite or quartz latite flows with a discontinuous veneer 1 cm to 1 m thick of grussy detritus composed of angular, well-sorted, mostly equant fragments 0.5 cm or less in diameter. In most places the veneer of fragmental material and the underlying flows are well drained and contain little water. The high reflectivity of these areas may result from the angular fragments in the surficial veneer, acting as corner reflectors, from near-surface bedrock, from the low water content of these materials, or from a combination of these factors. No other surface features which contrast basalt flows with welded tuffs or tuffaceous sediments have been recognized in the imagery.

Geologic analysis was made of an enlarged radar image (fig. 1) of a small test area that includes Hart Mountain--a complex horst and a major silicic vent area--and parts of the adjacent, highly faulted Warner Valley graben. The results (fig. 2) are compared with a geologic map (fig. 3) obtained by reconnaissance traverses and much photogeology. The radar image accentuates some structures, particularly those marked by pronounced topographic expression, so that many, but not all, faults are clearly depicted (fig. 2). Vertical separation, or apparent offset, is visible on some faults, but on others seems to be obscured, partly because of the grainy image. The radar image also shows that some of the rock units are distinctly layered and are probably well indurated, for they form large steep scarps. Most of the layered rocks seem to dip less than 10° and are only slightly deformed.

Nothing in the radar image, however, indicates that the area is composed dominantly of volcanic rocks, including widespread basalt flows, welded tuffs, rhyodacite flows, and small intrusives. In contrast, different lithologies shown on the geologic map (fig. 3) are commonly recognizable on high-altitude aerial photographs because of differences in tonal contrast or because of distinctive patterned ground that characterizes many basalt flows, some rhyodacitic flows, and some welded tuffs. These features and other comparable ones that are important in distinguishing the various rock types are not visible on the radar images.

Summary

The synoptic view afforded by the radar image of southeast Oregon is useful in tracing regional structures reflected by topography. Geologic features are generally more apparent on the high-contrast (horizontally) polarized image, although several cultural features (plowed fields, graded gravel or dirt roads, a pipeline right-of-way) are more clearly delineated on the depolarized image. Comparison of the radar image with conventional high-altitude photographs of the same area indicates that the photographs supply considerably more complete and detailed geologic information than does the radar image, perhaps partly because of the appreciable scale difference.

References

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Wells, F. G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geol. Survey Misc. Geol. Inv. Map MI-325, scale 1:500,000.

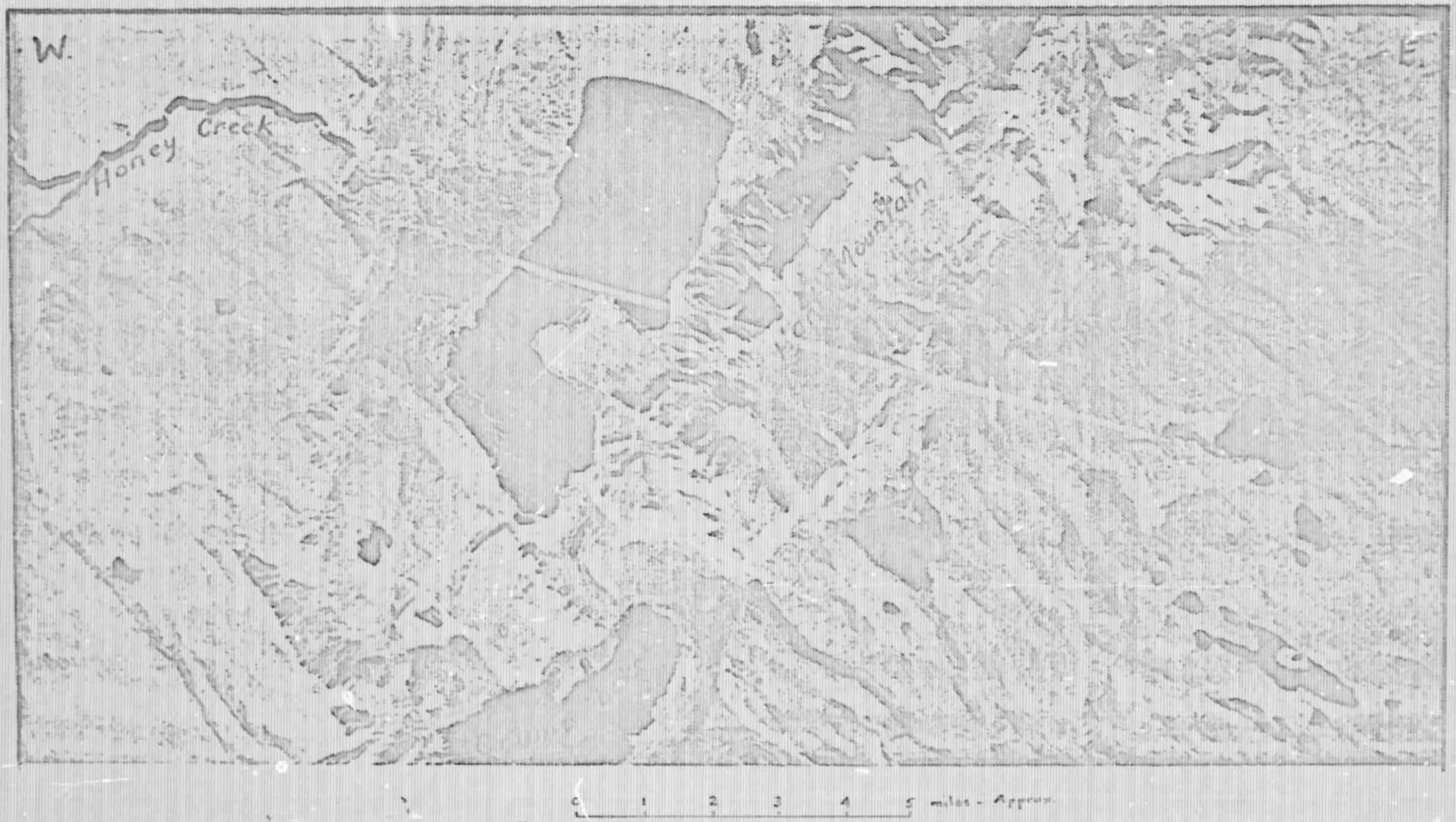

Figure 1. Radar image of the Hart Mountain area, Lake County, Oregon. Reader should view from north (top) to remove effect of inverted relief. Arcuate dark line 4 to 5 miles west of Hart Lake is, in part, a graded roadbed that follows a segment of curved fracture zone. Dark area adjoining Hart Lake on west includes irrigated hayfields on Honey Creek pluvial delta and fan. Arcuate channel, with elongate pond, connects Hart and Crump Lakes. Dark areas along east base of Hart Mountain underlain by alluvium and some fanglomerate, probably with high water content. Cause of conspicuous light spot, with dark center, in southeast corner of image is unknown; dark area in which light spot occurs in playa and dark spot may be excavated stock pond. Vertical and horizontal light and dark lines inherent in instrumentation and do not reflect surface features.

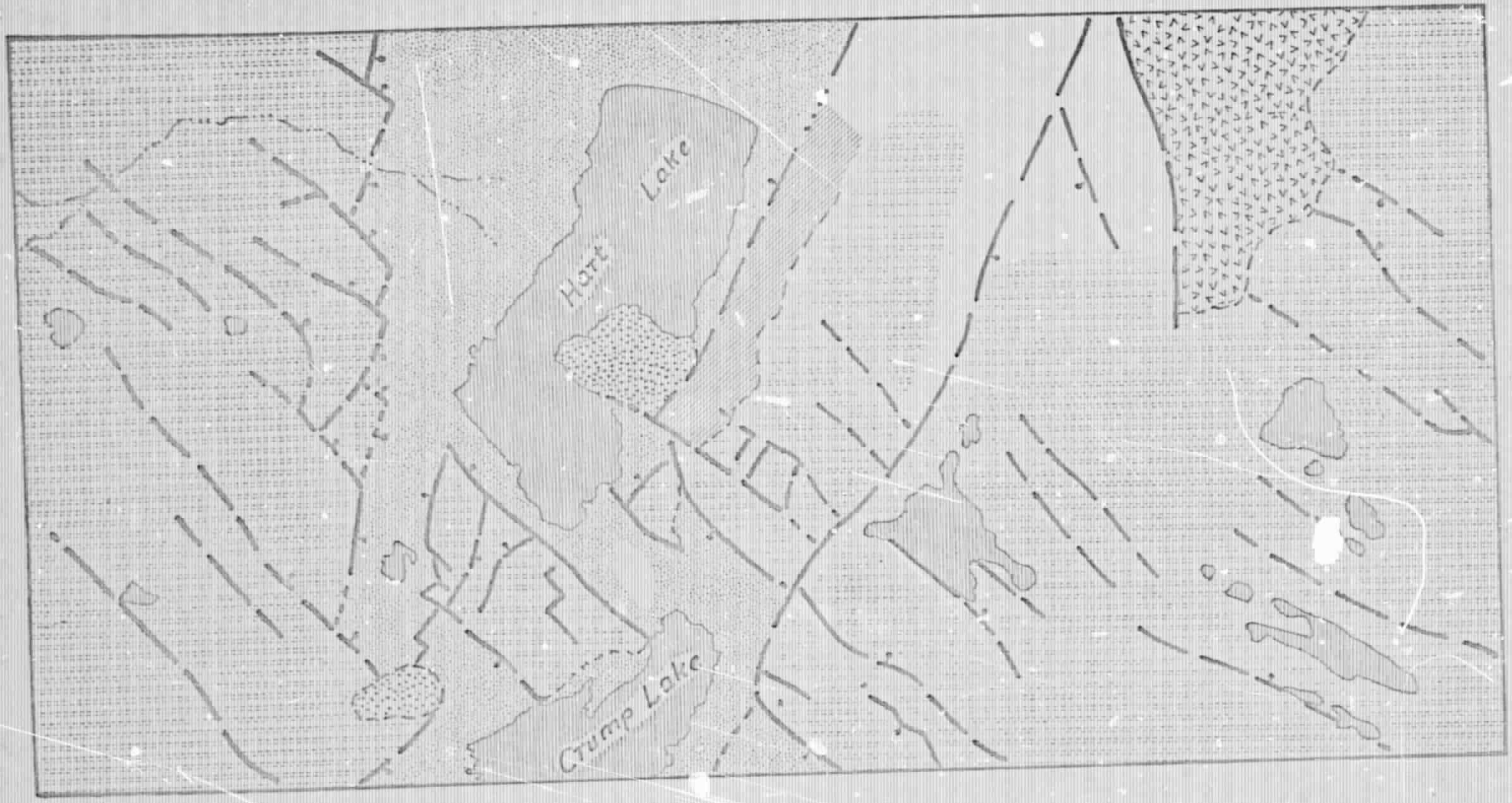

Fig. 2
Interpretive radar-geologic map of Hart Mountain Area, Lake County, Oregon

0 1 2 3 4 5 miles - Approx.

Water and water-saturated, fine-grained sediments, playa deposits

Valley fill

Possible landslides (from topographic expression)

Layered rocks characterized by steep scarps, well indurated

Apparently non-layered rocks with few scarps

Homogeneous, highly reflective material; Shows no evidence of layering.

Apparent contact

Scarp or linear break mostly faults with ball on down-thrown side.