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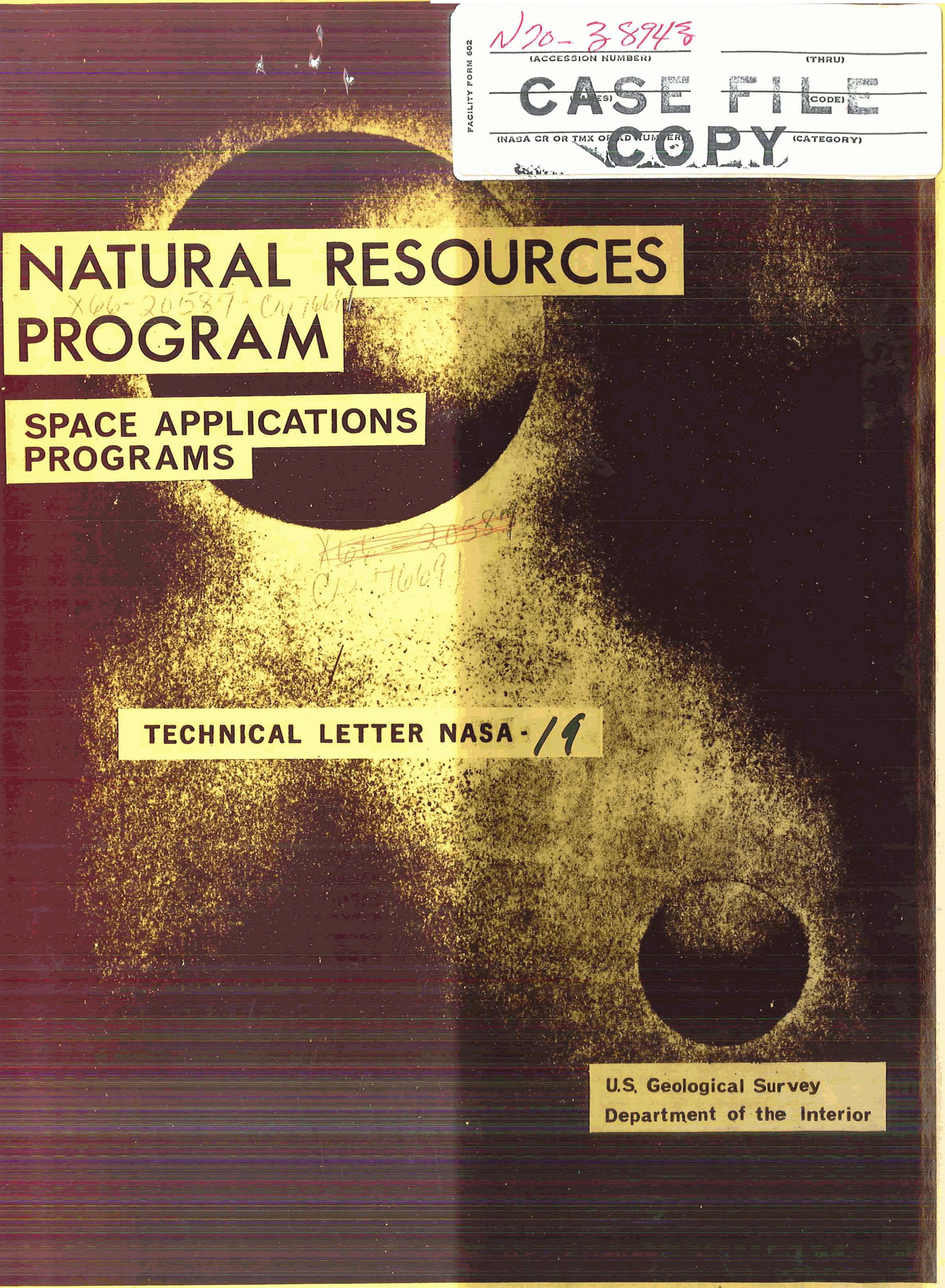

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TECHNICAL LETTER NASA-19

U.S. Geological Survey
Department of the Interior

March 3, 1849

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

Technical Letter
NASA - 19
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-19

GEOLOGIC EVALUATION OF RADAR IMAGERY OF THE CENTRAL PART OF THE OREGON HIGH CASCADE RANGE*

by

D.A. Swanson**

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

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-19

GEOLOGIC EVALUATION OF RADAR IMAGERY OF THE CENTRAL PART OF THE OREGON HIGH CASCADE RANGE*

by

D.A. Swanson**

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)

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

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGIC EVALUATION OF RADAR IMAGERY OF THE CENTRAL PART OF THE OREGON HIGH CASCADE RANGE

By Donald A. Swanson

Introduction

Continuous radar imagery was flown in conventional aircraft from about the northern boundary of Crater Lake National Park, Oregon, northward to Black Butte and return (fig. 1). Both like and cross polarized images were obtained. This report evaluates geologic features shown on the imagery as compared with the known geology shown on published maps (Wells and Peck, 1961; Williams, 1957), especially in a small (100 mi. sq.) area of youthful volcanism near South Sister (Peterson and Groh, 1965, p. 5).

General geology

The flight line is continuously over the High Cascades, which are composed chiefly of Pliocene to Recent high-alumina basalt and basaltic andesite with minor dacitic obsidian. In this area, volcanic constructional forms, such as cinder cones, stratovolcanoes, smooth extensive lava plains, and dacite domes and flows are little modified by erosion and are clearly reflected by topography. Some high volcanoes, however, are glaciated and no longer typically symmetrical, thus hindering their radar identification. North-northwest-trending faults cross the northern end of the flight path. Pumice ejected from Crater Lake mantles lowlands surrounding Diamond Lake.

General evaluation of the radar image

A large portion of the area, especially north and south of Diamond Lake, was storm covered. The cross polarized mode gets through much of the storm but still leaves a washed-out, blurry image. Reliable geologic interpretation under these conditions is impossible. Rather thick pine forests blanket most of the area; radar imagery of these forested areas has a grainy appearance in contrast to the smooth texture of timber-free areas (such as the logged patches in fig. 5). The grainy texture due to vegetation somewhat obscures surface geologic features, as comparison of figures 4 and 5 with imagery of essentially vegetation-free areas in southeast Oregon (Walker, 1966, fig. 1) shows.

Except for penetrating the storm clouds, the cross polarized image is generally less effective for geologic uses than the like image, for it has less contrast and seems fuzzier. In places, however, it shows certain cultural features, such as roads and logged areas, better than the like image. Most roads, both surfaced and graveled, are surprisingly difficult to see, however. Both images highly distort surface features.

The radar imagery best depicts geologic features with topographic expression, so that cinder cones (such as those from south of South Sister to Black Butte), stratovolcanoes (such as South Sister, Mount Thielson, and Broken Top), and viscous lava flows (dacite flows near South Sister) are well shown, whereas extensive featureless lava plains (such as those on which the stratovolcanoes are built) are unrecognizable. Craters atop volcanoes (South Sister, cinder cones) are especially clear, as are pressure ridges and lobes of viscous flows and domes on the southern flanks of South Sister; their appearance on the imagery clearly identifies them as volcanic in origin. At least three linear ridges appear east and northeast of Black Butte (fig. 5) which coincide with known fault scarps (Wells and Peck, 1961).

Tonal differences between rock units are slight or absent on the imagery, in contrast to what Snavely and Wagner (1966) found in western Oregon. The general lithologic similarity of the rocks of the High Cascades may account for the lack of tonal differences. Moreover, the widespread storm cloud cover suggests that the ground surface was wet from recent rains, which would tend to reduce differences in tone between rock units by the effective absorption of radar energy.

South Sister-Broken Top area

The South Sister-Broken Top area (fig. 4) contains Recent cinder cones and dacite domes and flows, slightly older lofty stratovolcanoes, and part of an extensive lava plain. A geologic map is available (Peterson and Groh, 1965, p. 5), and is compared with the radar-geologic map made from photographic enlargement of the image (figs. 2 and 3). Both maps are approximately the same scale, but distortion in the radar image causes size and shape discrepancies. The radar geologic map covers more area in order to show the crater atop South Sister (in northwest corner of map).

Comparison of both maps (figs. 2 and 3) shows that radar outlines the viscous lava (dacite) domes and flows (Qd) south of South Sister faithfully, and accurately depicts most cinder cones (Qcc). The imagery even shows in which direction the viscous flows advanced, for pressure ridges on their surfaces are clearly evident. The radar also crudely outlines steeply dipping lavas emitted from South Sister and Broken Top volcanoes. The imagery fails to distinguish between certain geologic units; for example, it does not show the contact of andesitic flows from Broken Top and South Sister and basaltic and basaltic andesite lavas which underlie the volcanoes, because these have similar compositional and topographic characteristics.

The imagery locates most of the lakes, although some dark areas simulating lakes on the radar image (fig. 4) are apparently merely shadows or water-soaked meadows.

Pertinent aerial photographs are not at hand, so direct comparison with the imagery (fig. 4) cannot be made. One aerial photo published with the geologic map (Peterson and Groh, 1965, p. 5) shows many features more clearly than the radar images, especially small-scale structures on basaltic lava flows, even though the photograph is of poor quality. Stereoscopic photo coverage would be even more effective.

Evaluation of radar imagery for geologic purposes in this area

In comparison to the geologic map based on photogeology and ground work, radar imagery shows very clearly many geologic features with characteristic topographic expression, but fails to bring out certain subtle distinctions, such as between the topographically and compositionally similar andesite and basalt lava flows. It clearly shows the volcanic nature of much of the terrain, especially the volcanoes and viscous lava flows and domes, but gives no indication of the nature of the flat lava plain. The imagery shows linear scarps which most probably are faults, an interpretation confirmed by geologic mapping. The imagery is hindered by storms, though the cross polarized strip cuts through some of the cover. Imagery flown during better weather conditions would undoubtedly supply many more details. The radar shows topographic features in forested terrain less clearly than in barren areas, but it is better in timbered areas than aerial photography. The radar permits better interpretation in forested areas of some geologic features, such as linear structures with topographic expression, than does black and white aerial photography.

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Walker, G. W., 1966, Evaluation of radar imagery of highly faulted volcanic terrane in southeast Oregon: Unpub. U.S. Geol. Survey Tech. Letter 25.

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.

Williams, Howel, 1957, A geologic map of the Bend quadrangle, Oregon, and a reconnaissance geologic map of the central portion of the High Cascade Mountains: Oregon Dept. Geology and Mineral Industries, in coop. with U.S. Geol. Survey, scale 1:125,000 (about 1 in. to 2 mi.), and about 1 in. to 4 mi.

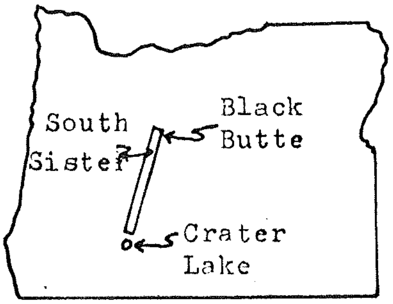


Figure 1. Index map, showing area covered by radar imagery.

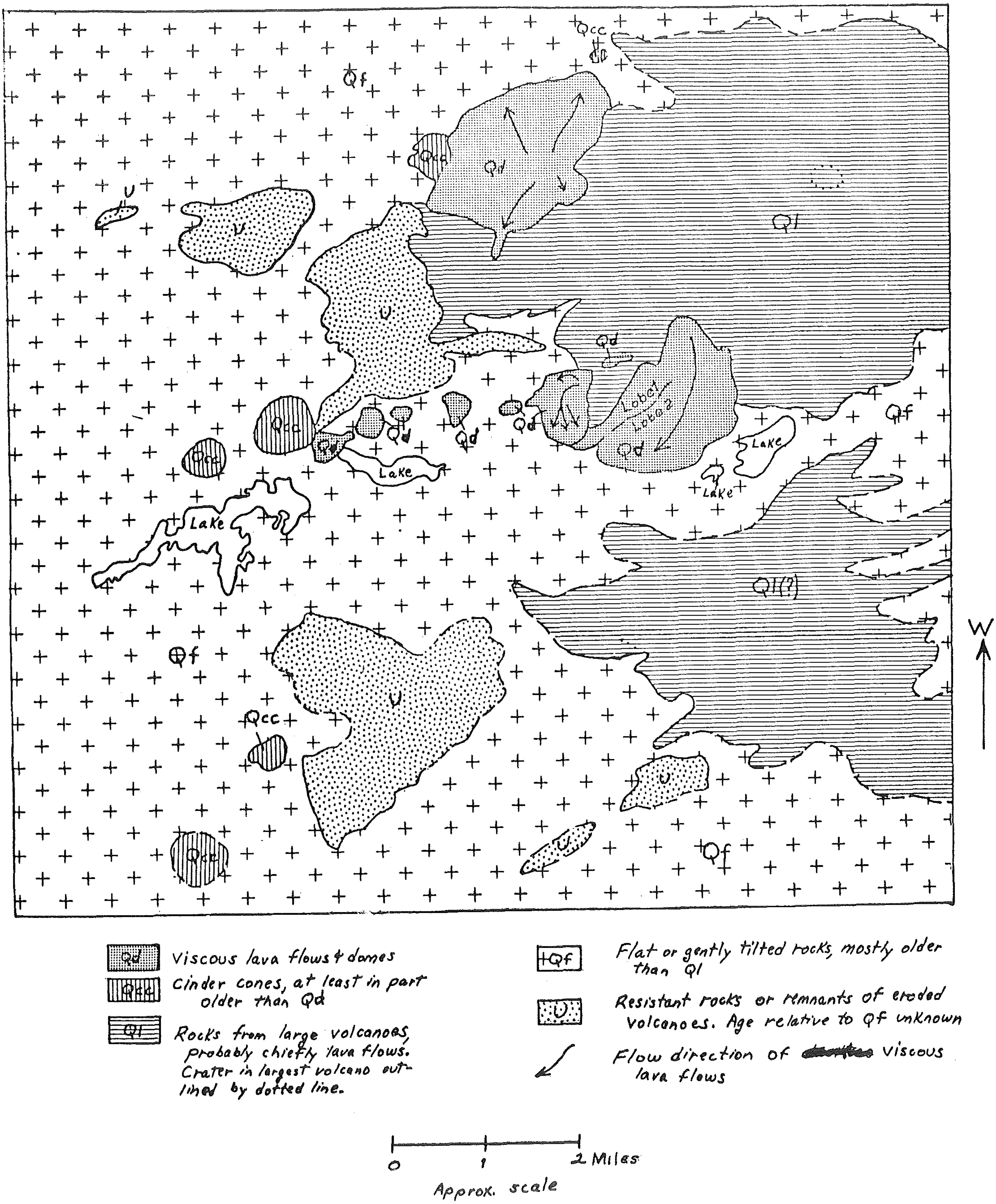


Figure 2. Radar geologic map of South Sister - Broken Top area, central Oregon

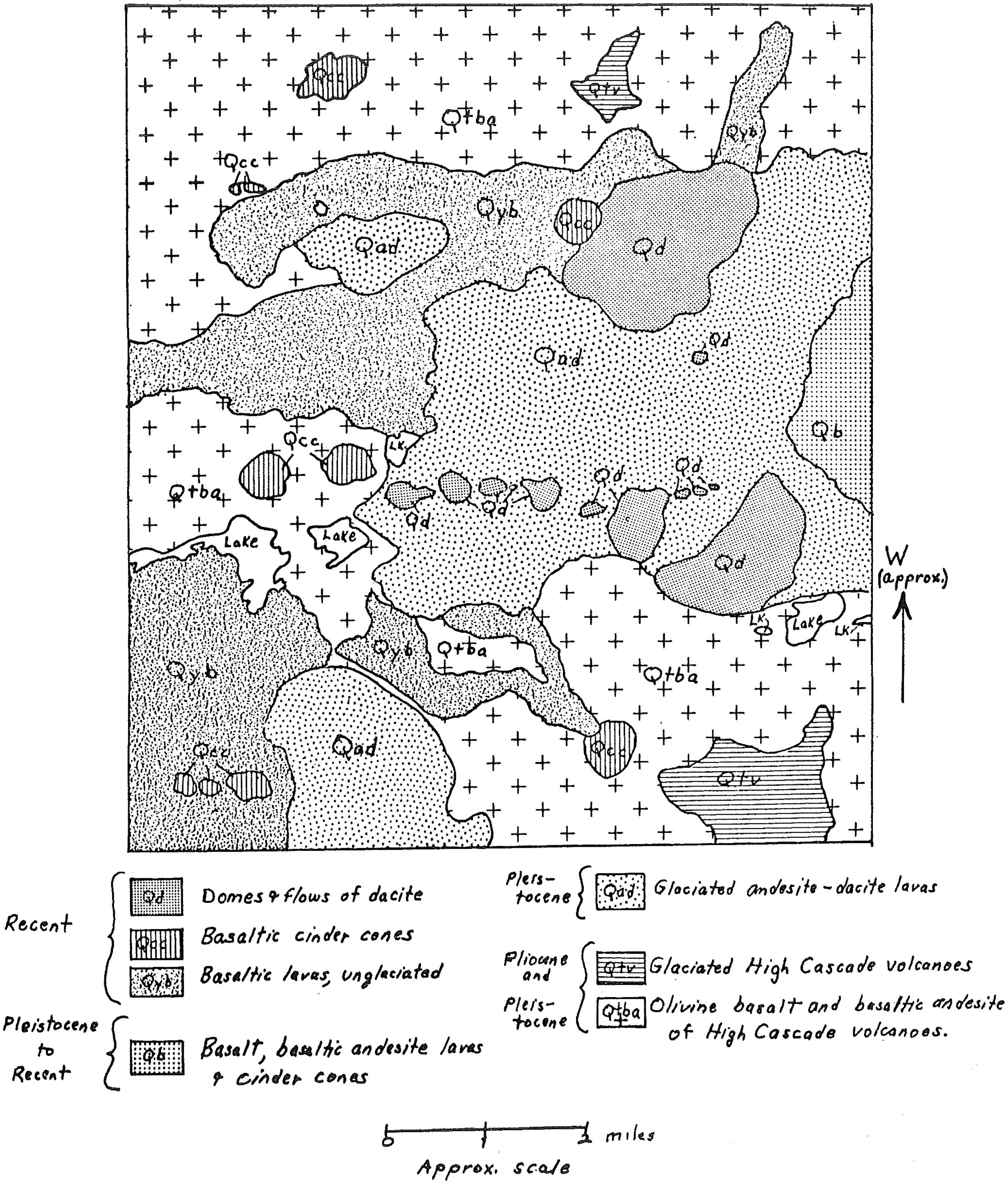
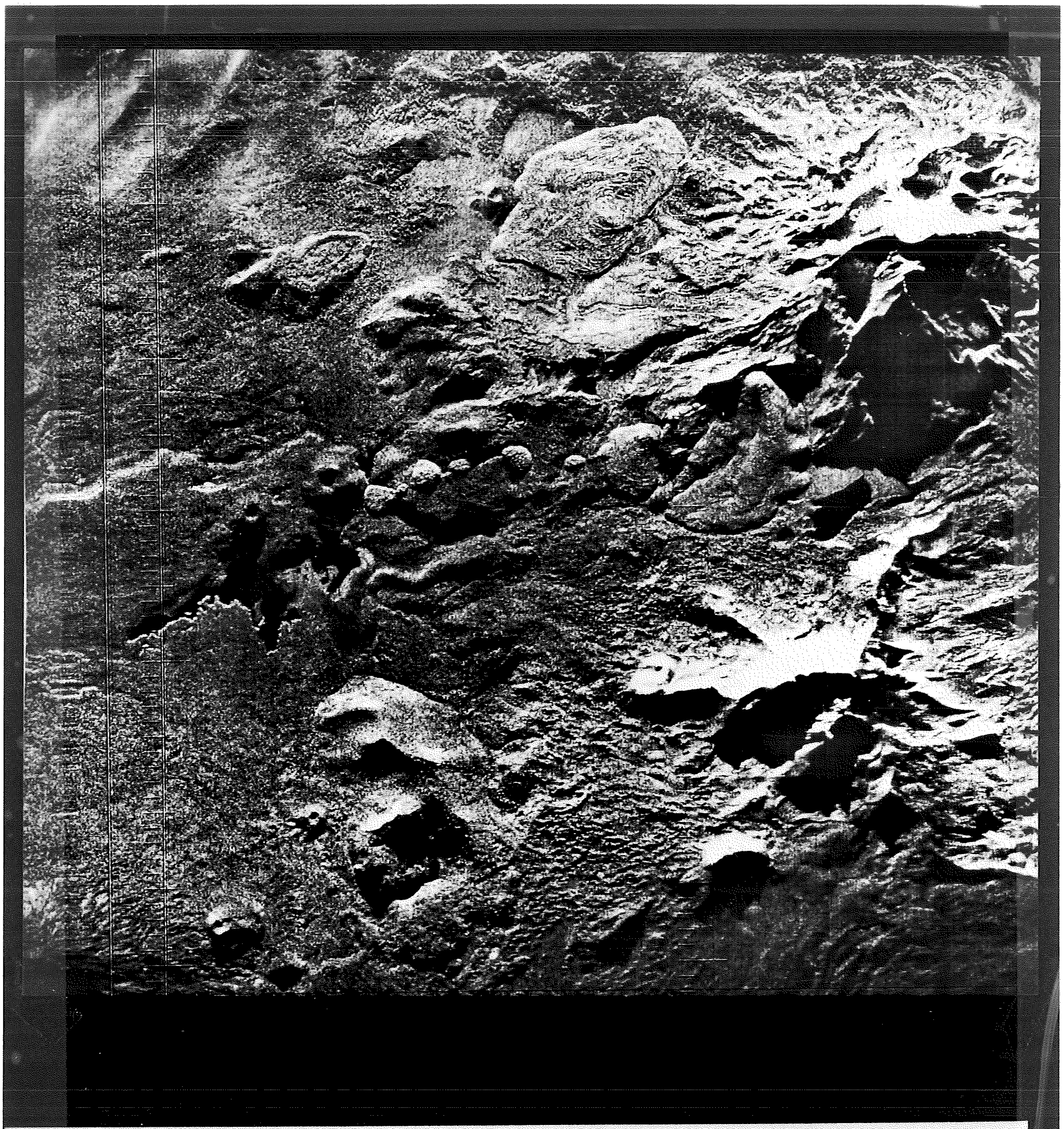


Figure 3. Geologic map of South Sister-Broken Top area, Central Oregon. From Peterson and Groh, 1965, p. 5.



Enlarged photograph of radar image of South Sister-Broken Top area. West is toward top of page, South Sister is in upper right, Broken Top in lower right. Scale same as in figure 2.

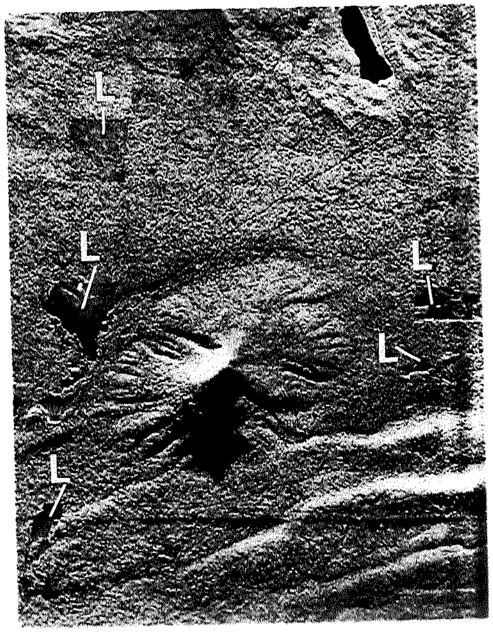


Figure 5. Photograph of radar image of Black Butte area. West is toward top of page. Linear features in lower right corner are fault-line scarps. Patches marked L are logged areas or meadows. Note grainy texture of most of image as compared to smooth texture of logged areas. Photo is same scale as radar image.

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