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TECHNICAL LETTER NASA-28

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U.S. Geological Survey
Department of the Interior



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

Technical Letter
NASA - 28
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-28
GEOLOGIC EVALUATION - RADAR IMAGERY OF
TWIN BUTTES AREA, ARIZONA TEST SITE 15*

by

John R. Cooper**

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, Denver, Colorado

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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John R. Cooper**

May 1966

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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

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GEOLOGIC EVALUATION - RADAR IMAGERY OF
TWIN BUTTES AREA, ARIZONA TEST SITE 15

by

John R. Cooper

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ABSTRACT

Outcrops of glass-rich igneous rock appear as conspicuous dark spots on the depolarized radar image but are obscure on the polarized image and on aerial photographs. Both types of radar imagery clearly outlined an ancient, previously unrecognized flood plain.

Outcrops of glass-rich rock

Depolarized radar imagery in the southeastern part of the Twin Buttes quadrangle clearly shows two hitherto unknown outcrops of pyroxene rhyodacite, part of a middle of late Tertiary volcanic formation which ranges in composition from potassic olivine-pyroxene andesite to hornblende-biotite rhyodacite. The outcrops appear as conspicuous dark spots on the depolarized image but are obscure on the polarized image and on aerial photographs (Fig. 1).

A field check confirmed the existence of the outcrops, which are on a slightly dissected alluvial plain and are not expressed topographically. The dark spots on the depolarized image include exposures of rhyodacite bedrock and also residual soil littered by

pebble- and cobble-sized fragments derived from the rhyodacite. Surface roughness is about the same as on the surrounding alluvium, but the composition is very different for the alluvium consists of detritus transported from an older igneous, sedimentary and metamorphic terrane that lacked rhyodacite.

Inasmuch as the radar phenomena cannot be readily related to topography, surface roughness or water content, they may be related to the high content of fresh glass characteristic of the pyroxene rhyodacite. In support of this hypothesis: (1) a large previously known outcrop of the pyroxene rhyodacite also appears as a dark patch on the depolarized image; (2) previously known outcrops of the associated hornblende-biotite rhyodacite, which is also rich in glass, show dark on the radar images, particularly on the depolarized image; and (3) previously known outcrops of the associated olivine-pyroxene andesite, which contains a little glass, show slightly dark on the depolarized image but are not everywhere distinguishable. As data are few and obscured in places by topographic effects, no firm conclusion is possible. The glass hypothesis is pointed out for possible testing in other areas containing glassy igneous rocks.

Regardless of genetic interpretation, the radar imagery has proved a valuable tool in revealing exposures of glassy igneous rock. These exposures pointed the way to another outcrop which is beyond the limits of the radar imagery and was found by careful time-consuming search on the surface. These outcrops far out on the alluvial plain are of local geologic interest because they suggest a buried bedrock ridge connecting the Sierrita Mountains and the Tumacacori Mountains to the south. Such a connection would impound

ground water in a large alluvium-filled basin to the west, forming a separate reservoir of potential importance as present sources of water in the region become more and more depleted.

Ancient flood plain

Radar imagery in the southeastern part of the Twin Buttes quadrangle also shows a previously unrecognized flood plain evidently formed by Demetrie Wash and later abandoned by that stream because of piracy by a tributary of Esperanza Wash (Fig. 2). The old flood plain appears as a broad dark band on both radar images, as do flood plains along present washes. A field check shows that the dark-appearing band, which starts about 50 feet above the present level of Demetrie Wash at this point, is very similar to the modern flood plains in topography, surface roughness and geology. It is a smooth nearly plane surface underlain by a few feet of silty material and lying at a very small angle to the impinging radar beam. The surface lacks the litter of subangular pebbles, cobbles, and boulders characteristic of the adjacent older and coarser-textured alluvial basin fill.

Details of the old flood plain discernible by lighter color on the radar images include small hills of older basin fill which rise above the old flood plain, present stream courses that are incised through the old flood-plain alluvium, and pebbly flood-plain material along a present wash that follows the old flood plain for about 2 miles.

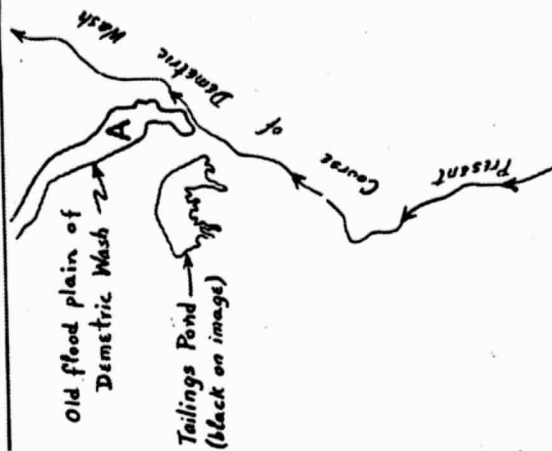
As the radar imagery shows the old flood plain conspicuously and in considerable detail, it is useful to the geologist, particularly

one like myself who is primarily concerned with bedrock geology. A careful study of the physiography and the basin-fill deposits would doubtless have revealed the feature without the aid of radar imagery.

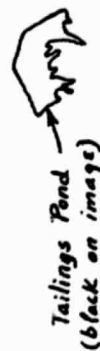


Figure 1. Radar imagery of the Twin Buttes area, Pima County, Arizona. A) Polarized image clearly shows Mineral Hill mine and tailings ponds at left; Twin Buttes at right. B) Depolarized image, below, showing pyroxene rhyodacite (dark tones) at extreme right.

Polarized
Image



Depolarized
Image



Px rhyodacite

B

Hb-Bi rhyodacite

Previously unknown outcrops
revealed by radar imagery

Figure 2. Sketch map showing old flood plain of Demetrick Wash (A) and rhyodacite outcrops (B) in Twin Buttes area, Pima County, Arizona.