NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

EARTH RESOURCES SURVEY PROGRAM

TECHNICAL LETTER NASA-89

EKTACHROME AND EKTACHROME INFRARED PHOTOGRAPHY OF THE TWIN BUTTES AREA, ARIZONA

By

John R. Cooper
U.S. Geological Survey
Denver, Colorado

January 1968

Prepared by the Geological Survey for the National Aeronautics and Space Administration (NASA) under NASA Contract No. R-09-020-011

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

NR-05-DL-015-008

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

Interagency Report
NASA-89
January 1968

Mr. Robert Porter
Acting Program Chief,
Earth Resources Survey
Code SAR - NASA Headquarters
Washington, D.C. 20546

Dear Mr. Porter:

Transmitted herewith is one copy of:

INTERAGENCY REPORT NASA-89

EKTACHROME AND EKTACHROME INFRARED

PHOTOGRAPHY OF THE TWIN BUTTES AREA, ARIZONA*

by

John R. Cooper**

The U.S. Geological Survey has released this report in open files. Copies are available for consultation in the Geological Survey Libraries, 1033 GSA Building, Washington, D.C. 20242; Building 25, Federal Center, Denver, Colorado 80225; 345 Middlefield Road, Menlo Park, California 94025; and 601 East Cedar Avenue, Flagstaff, Arizona 86001.

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbiter Program

*Work performed under NASA Contract No. R-09-020-011
**U.S. Geological Survey, Denver, Colorado

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

INTERAGENCY REPORT NASA-89

EKTACHROME AND EKTACHROME INFRARED PHOTOGRAPHY OF THE TWIN BUTTES AREA, ARIZONA*

by

John R. Cooper**

January 1968

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

*Work performed under NASA Contract No. R-09-020-001
**U.S. Geological Survey, Denver, Colorado

CONTENTS

ILLUSTRATIONS

Ektachrome and Ektachrome Infrared Photography of the Twin Buttes area, Arizona

by
John R. Cooper

Introduction

Ektachrome and Ektachrome Infrared photography of the Twin Buttes area, Arizona (Test Site No. 15) was exposed January 9 and 10, 1966, during NASA Flight Mission No. 18. Resulting materials studied are as follows:

Material	Ektachrome Infrared Taken with Type G, wratten No. 15 deep yellow filter (Factor 2.0) transparencies	Ektachrome glossy paper prints
Approx. scale	1:13,000	1:13,000
Frame size	9 X 9 in.	9 X 9 in.
Strip No. 1--S. 32° E. from Robbles Junction to Arivaca Junction, showing part of Altar Valley, Sierrita Mountains, Tinaja Hills, and Santa Cruz Valley--in Cocoraque Butte, Palo Alto Ranch, Twin Buttes, and Tubac 15-minute quadrangles.		
Time exposed	1:36 - 1:45 p.m.	---------
Photo numbers	4472 - 4526	---------
Strip No. 2--S. 85° W. through Twin Buttes, showing part of Santa Cruz Valley, Sierrita Mountains and Altar Valley--in Twin Buttes and Palo Alto Ranch 15-minute quadrangles.		
Time exposed	1:58 - 2:04 p.m.	10:53 - 11:00 a.m.
Photo numbers	4527 - 4562	4619- 4653

These photographs were compared with each other and with black-and-white aerial photographs (approximate scale 1:55,000) in order to determine the relative value of each in interpreting the geology. The value of black-and-white photographs is well known, and therefore only the advantages and disadvantages of Ektachrome and Ektachrome Infrared will be discussed.

Ektachrome

Most geologic features apparent on the color prints also appear by contrast in tone on black-and-white photographs. Color differences aid in interpreting these features, however, and also reveal a few other features not recognizable on black-and-white photographs.

West of Twin Buttes, flight strip 2 crosses the main pluton of Laramide granodiorite appears very pale orange in the northern part of the strip and grayish orange to light brown in the southern part. The change in color is fairly abrupt (fig. 1). It does not correspond with any evident change in lithology or alteration and was not previously recognized on the ground or on black-and-white aerial photographs. However, the browner part does contain barren propylitic alteration bands which appear conspicuously light on black-and-white and color photographs (right side of figure 1). It also contains indications of copper mineralization in the form of (1) widespread but sparse quartz-sericite veinlets that contain pyrite and chalcopyrite, (2) trace concentrations of copper revealed by spectrographic analyses of apparently unmineralized surface samples, and (3) sparse dissemination of pyrite and chalcopyrite in apparently unaltered granodiorite of drill cores. If the browner color is due to oxidized sulfides, as seems likely, color photography is a potent and valuable tool in recognizing and mapping mineralized areas.

Near Twin Buttes, which is several miles directly downslope from the area shown in figure 1, there is a similar contrast in color of pediment-capping alluvium (fig. 2). The very pale orange alluvium at the north is characterized by light-colored soil which effervesces vigorously with acid at the surface. Caliche layers occur at a depth of a few inches, and pebbles recently brought to the surface by burrowing animals are coated with snow-white calcite. The brown part at the south contains no $CaCO_3$ at the surface but does contain calcite-rich layers at depths of 2 to 5 feet.

The color and lithologic differences within the alluvium reflect differences in source. The brown alluvium contains debris from the very weakly mineralized granodiorite indicated in figure 1 and from mineralized rocks near Twin Buttes (Precambrian granite and diorite, and Paleozoic sedimentary rocks--mostly limestone). Weathering of sulfides stimulated leaching of $CaCO_3$ and formation of brown limonite. The light-colored alluvium was derived from virtually unmineralized silicate rocks and from calcareous postmineralization fanglomerate. As a result, formation of limonite and leaching of $CaCO_3$ were impeded.

The brown alluvium near Twin Buttes is a little more yellow and less red on the photographs than widespread alluvial surfaces, which have nearly the same tone. Reddish orange seems characteristic of mature soils regardless of the parent material from which they are derived. The soils near Twin Buttes are relatively immature as they grade toward reddish orange downslope at the east end of the flight strip. To recognize and

define mineralized areas, it would appear that the photo-interpreter should look for immature soils and for yellow to brown rather than pink to reddish orange colors.

About 2 miles west of Twin Buttes, diorite within the Precambrian granitic complex is recognizable as gray patches in the relatively dark corners of photographs; but the same features are indistinguishable nearer the center of photographs. Perhaps the techniques of exposure, developing and printing could be modified and carefully controlled to bring out features of this type more consistently and thereby make the photography more useful to the geologist.

Color photography appears to have great value in revealing mineralized rocks in outcrops, detrital material, and residual soils. It is also definitely, though not consistently, superior to black-and-white photography in distinguishing some other rock units--a superiority that might be increased by refinements in photographic and processing techniques. Prints on paper having sufficient tooth to permit pencil annotations would have some practical advantages.

Ektachrome Infrared

The infrared transparencies resemble conventional aerial photographs in which blues have been substituted for grays. Most features are clear blue or greenish blue, but some of the vegetation is red purple. There are no highly contrasting reds, greens, and other colors found on some photographs of this type; if this is due to substandard printing as I suspect, the transparencies may not provide a proper basis for appraising the technique.

The transparencies are very clear, sharp pictures and hence are excellent in revealing small ledges and other topographic details useful in interpreting geologic structure. However, all major structural features found on the transparencies are perceptible on black-and-white photographs.

A few cultural features are more readily distinguished on the infrared. Black-top roads (dark) are readily distinguishable from dirt roads (light); whereas both look the same (light) at many places on the Ektachrome and black-and-white prints. Fence lines are conspicuous because the infrared reveals the degree of grazing better.

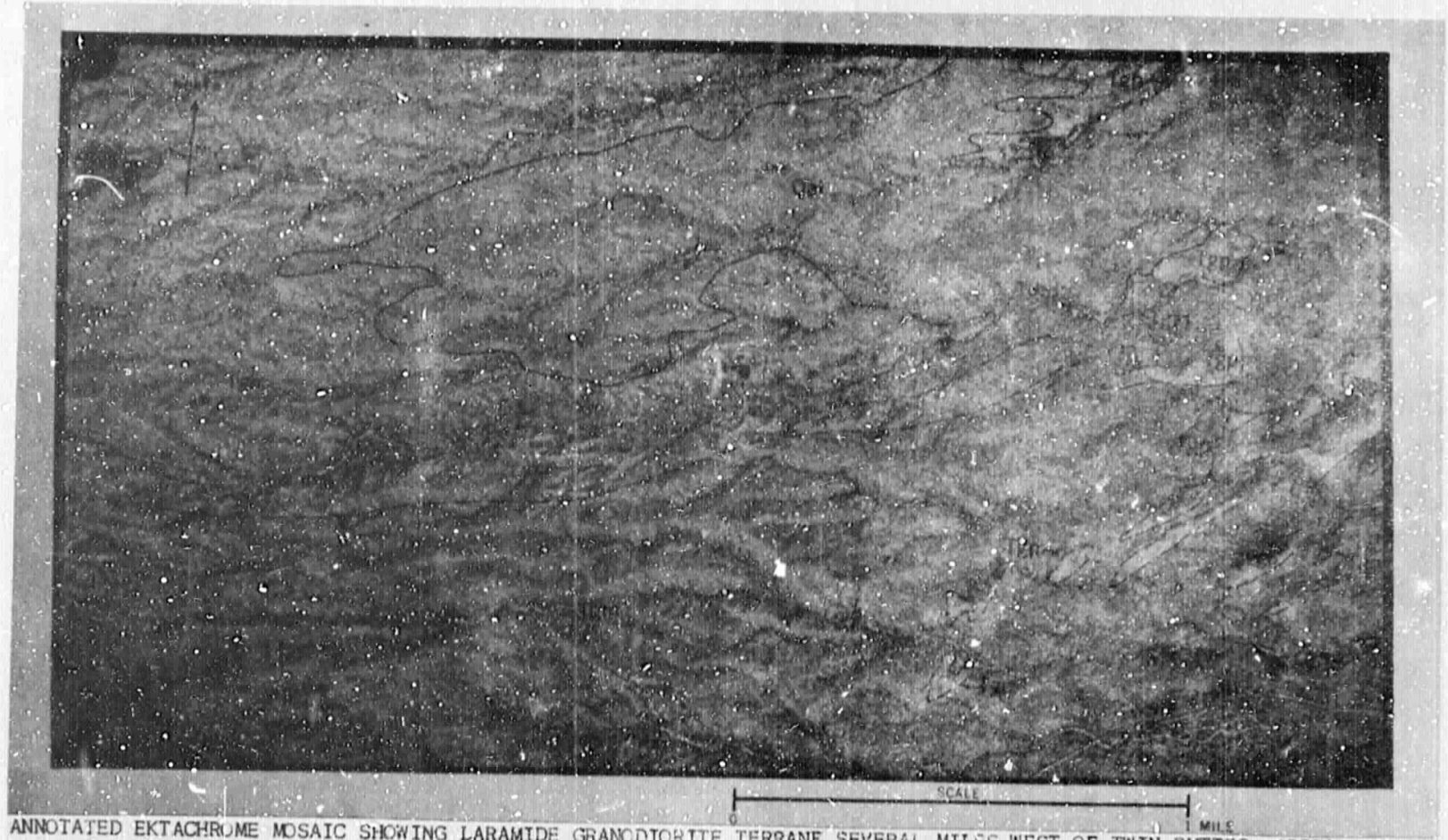
Two rock units are slightly better defined on the infrared. Residual soil over unconsolidated mid-Tertiary fanglomerate on flight strip 2 has a darker tone than adjacent Quaternary alluvium derived from this formation; the contrast is greater than on black-and-white photographs and is almost lacking on Ektachrome photographs where both units are very pale orange.

Laramide diorite on flight strip 1 is relatively darker and more distinct than on black-and-white photographs--possibly because of larger scale; no Ektachrome coverage of this area is available.

In general, the contrast of rock units is less than on the Ektachrome and black-and-white photographs. For overall geologic interpretation, the infrared transparencies are definitely less useful than other kinds of photography studied.

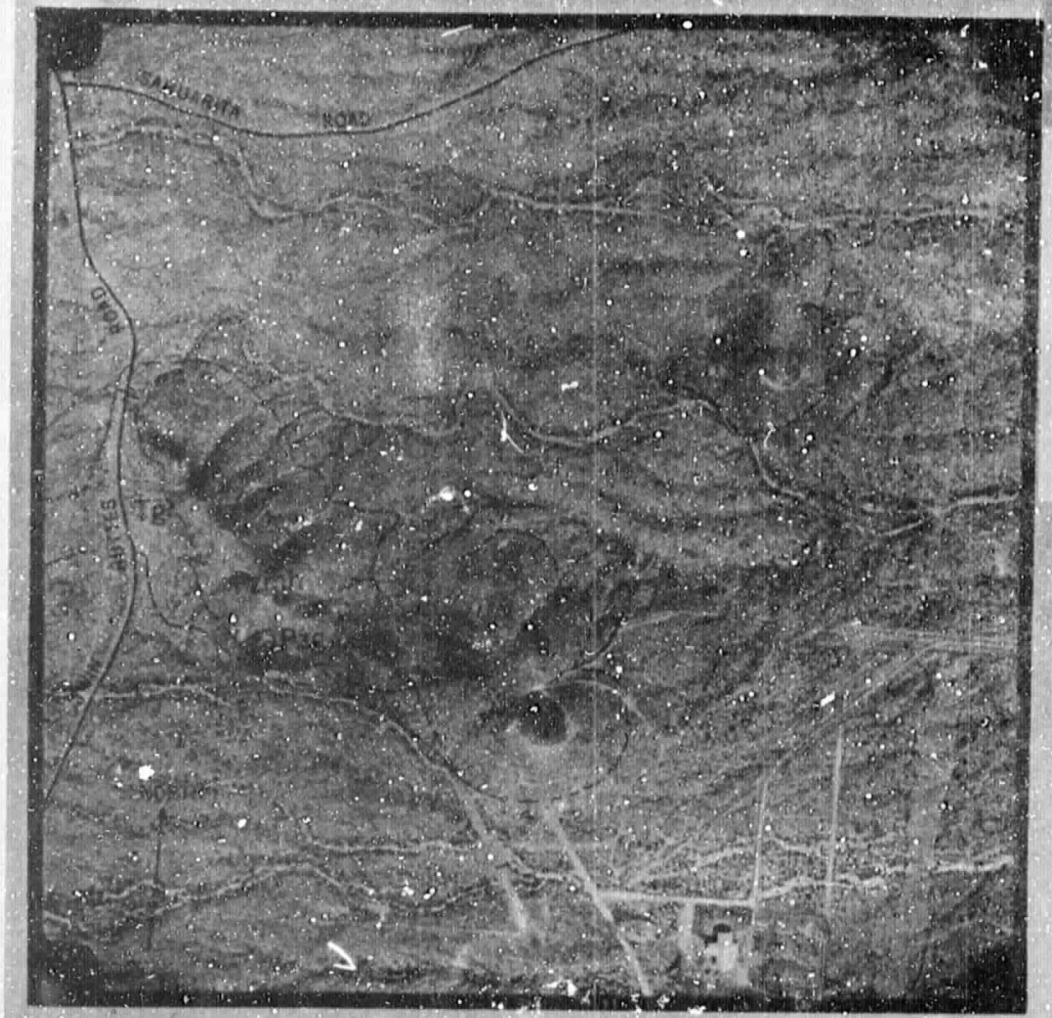
Captions for Illustrations

To acquire color copies of figure 1 (Laramide granodiorite terrane) and figure 2 (Twin Buttes Area), requests should be made to the U.S. Geological Survey Library in Washington, D.C. The reader will be provided with inner negatives for printing and with names of color processing firms equipped to produce quality prints.



ANNOTATED EKTACHROME MOSAIC SHOWING LARAMIDE GRANODIORITE TERRANE SEVERAL MILES WEST OF TWIN BUTTES, ARIZONA BROWNISH ORANGE PART AT BOTTOM IS VERY WEAKLY MINERALIZED GRANODIORITE (Tgm), WHICH CONTAINS BARREN PROPYLITIZED BANDS (Tgp). LIGHT PART AT UPPER LEFT IS BARREN GRANODIORITE (Tgb). ALLUVIUM (Qal) GENERALLY HAS AN INTERMEDIATE COLOR. DARK CORNERS NOT SIGNIFICANT GEOLOGICALLY.

Figure 1



ANNOTATED EKTACHROME PRINT OF TRIN BUTTES AND SURROUNDING AREA, SHOWING BROWN ALLUVIUM DOWNSLOPE FROM MINERALIZED ROCKS, AND LIGHT ALLUVIUM DOWNSLOPE FROM BARREN ROCKS.

INTERPRETATION BY J. R. COOPER, USGS NASA HQ S68-15150 8-Y-67

Figure 2