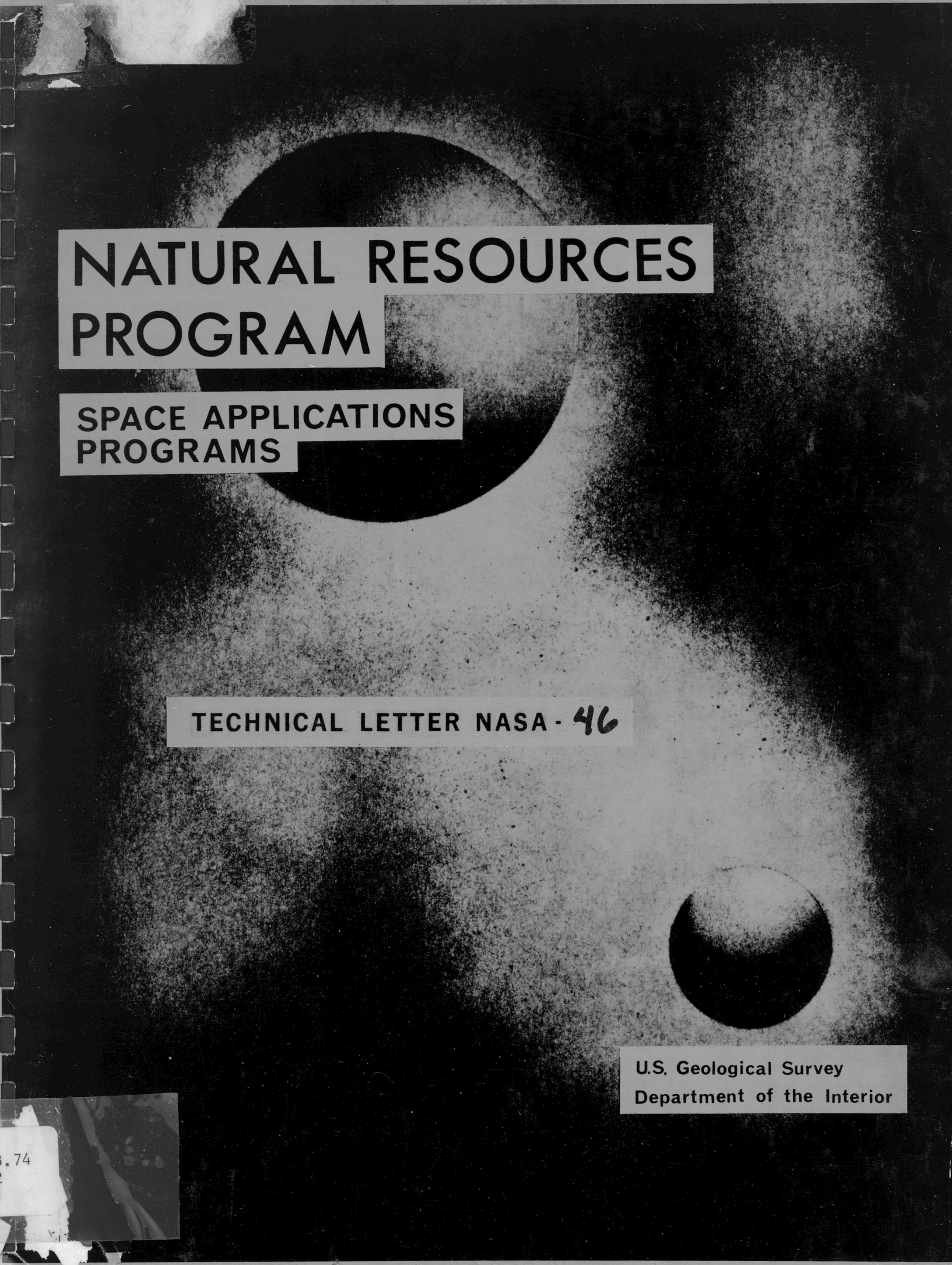

NATURAL RESOURCES PROGRAM

SPACE APPLICATIONS PROGRAMS

TECHNICAL LETTER NASA- 46

U.S. Geological Survey
Department of the Interior

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

Technical Letter
NASA-46
October 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-46

AN EVALUATION OF THE GEMINI IV COLOR PHOTOS

OF THE GULF OF CALIFORNIA - CENTRAL TEXAS AREA*

by

H. Drewes**

Sincerely yours,

William A. Fischer
Research Coordinator
Earth Orbiter Program

*Work performed under NASA Contract No. R-09-020-013
**U.S. Geological Survey, Denver, Colorado

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TECHNICAL LETTER NASA-46

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by

H. Drewes**

October 1966

These data are preliminary and should not be quoted without permission

Prepared by the Geological Survey for the National Aeronautcis and Space Administration (NASA)

*Work performed under NASA Contract No. R-09-020-013
**U.S. Geological Survey, Denver, Colorado

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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, Flagstaff).

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CONTENTS

An evaluation of the Gemini IV color photos

of the Gulf of California - Central Texas area

by

H. Drewes

On the Gemini IV mission a series of overlapping photographs were taken June 5, 1965, from the Gulf of California to central Texas. These photos have a limited value as an aid to geologic mapping. Their chief value to geologic interpretation lies in their fine definition of surficial deposits and some younger volcanic rocks. They also show, in a much less reliable way, some kinds of older sedimentary and igneous rocks, and show a little of the geologic structure of the region. The photos in Texas are oblique shots, which sufficiently distorts large portions of the photos to impair their value as a geologic tool. A large amount of cultural detail can be identified in areas with which I am familiar; they include roads, small reservoirs and fence lines.

Three areas were selected for review to illustrate what geologic interpretations can be made of different geologic terrances and what interpretations can be made of areas with which I am familiar to various degrees. I shall first review an area (Fig. 1) of mixed rock types near Tucson, Arizona, with which I am most familiar. Next I will evaluate the Pinacate volcanic area (Fig. 2), about which there is a little published information and finally, an area southwest of El Paso, Texas, (Fig. 3) which I know practically nothing, and try to apply there some of the guides to rock types learned in the first 2 areas.

Tucson area -- Photos 9 (Fig. 1) and 10 of Magazine 8 center about the Santa Rita Mountains in which I have been mapping the geology for 3 years. On the photos Nogales lies near the southern edge; Tucson lies along the northern edge, and the Santa Cruz River flows between them. Reference will be made to the Sierrita Mountains, southwest of Tucson, and to the Rincon, Whetstone and Huachuca Mountains, located along the eastern edge of the photos, in that order from north to south.

A familiarity with the area helps considerably in interpreting the culture and vegetation of this area. Towns are the most conspicuous cultural features. Linear objects such as roads and railroads can only be seen in some places, perhaps those in which the reflectivity of the road metal contrasts with that of the adjacent areas. For example, the new interstate highway southeast of Tucson escapes detection, but the equally new 2-lane highway east of the Whetstone Mountains shows up clearly. Fields, both fallow and cultivated, and mine dumps and tailings ponds are conspicuous features south and southwest of Tucson. Fence lines appear east northeast of the darkest (highest) part of the Santa Rita Mountains as short straight north-trending breaks between lighter-and darker-colored patches, which are pastures that have been grazed different amounts (Fig.1). The large dark areas in the mountains are oak and evergreen forests, which commonly are sufficiently dense to seriously interfere with the geologic interpretation of photos taken from lower altitudes.

Several types of surficial deposits can be delineated by their color and drainage texture. The deepest reddish-brown areas in which the drainage density is low are underlain by a thin sheet of gravel of roughly mid-Pleistocene age on which a soil has been well developed. Lighter-brown areas with a finer drainage texture are underlain by younger gravels, and the gray areas with the finest pattern of anastomosing drainages are the youngest deposits on which the amount of soil developed is inconsequential. Gravel or semiconsolidated conglomerate of late Tertiary to early Pleistocene age makes a fine herringbone pattern, as southeast of the highest part of the Santa Rita Mountains and the northwest flank of the Whetstone Mountains.

Areas underlain by older bedrock give more trouble, at least partly because the rock types are complexly mixed. Moderately young (mid-Tertiary) rhyodacite volcanics underlie the irregularly mottled area southwest of the Santa Rita Mountains and in most of the low mountains northwest of Nogales. Other younger volcanics of more basic composition underlie the dark patch between Tucson and the northermost mine tailings. Some areas underlain by granitic rocks can be recognized by their uniform light-gray color and moderately regular fine-grained drainage pattern, as in the core of the Sierrita Mountains, and much of the northern end of the Santa Rita Mountains. In a few small areas Paleozoic sedimentary rocks underlie light bluish-gray areas but elsewhere these and other older rocks, the Mesozoic volcanics and the metamorphic rocks are not readily recognized.

Since many of the large structural features involve older rocks, it is not surprising that these features are obscure. The strong lineation along the west flank of the Huachuca Mountains and extending across the north-central part of the Santa Rita Mountains is largely fault-controlled. The small area of linear pattern on the west flanks of the Sierrita Mountains is made up of upened metamorphic rocks. The ridges on the west flank of the Rincon Mountains resemble, and are, gently westward plunging anticlines, in this case in metamorphic rocks.

Pinacate volcanic area -- Photos 4, 5 and 6 of Magazine 8 cover a little-studied young volcanic area in northwestern Sonora, Mexico. Puerto Peñasco lies at the prominent hook-shaped point of land in the Gulf of California, and Mexico Hwy. 5 cuts across the northeast corner of Photo 5 (Fig. 2) close to the U.S. border. The Pinacate volcanic area underlies the dark-gray roughly elliptical area covering slightly more than the central ninth of the photo. Much-subdued mountains are scattered north and east of the volcanic field but most of the area around the field is veneered with surficial deposits.

A variety of surficial deposits such as aeolian, beach, and tidal deposits can be recognized on this photo, in addition to those described in the Tucson area. Constructional geomorphic features such as dunes and beach and submarine bars stand out plainly, as they do in all aerial photos. The medium-gray area with the straight eastern margin east of the northwest corner of the photo may be a playa surface, darkened either by a phreatophyte vegetation or a dark clay. The straight eastern margin suggests fault control.

The uniform light-gray color and fine drainage texture suggest that the hills north and east of the volcanic field are largely underlain by granitic rock.

The rocks of the Pinacate volcanic field include a small amount of very young lava flows, possibly of basic composition, shown as black patches, and a large amount of pyroclastic material (and possibly weathered older flows), shown in medium-dark gray. Cinder cones appear as small dark-gray spots abundantly scattered over the northern half of the volcanic field. At least 7, and possibly 12 large craters or calderas appear in the northeast half of the field, and some of them contain cinder cones. A few calderas have been mapped and illustrated by low-altitude oblique aerial photos by R. H. Jahns (1959, p. 165-184) in the Arizona Geological Society, Guidebook II.

El Paso area -- The third area to be described lies west-southwest of El Paso and is covered by Photos 16, 17 and 18 of Magazine 8. The playa, Ojo De Los Mosquitos, Mexico, forms the white patch near the center of Photo 17 (Fig. 3) and the Tres Hermanos Mountains, New Mexico, form the dark range along the right side of the upper edge of the photo.

Applying the lessons learned in the other two areas examined, 3 ages of alluvium, beach, playa, and dune deposits can be delineated. A large medium-gray area of younger volcanics lie east-northeast of the playa on the photo, and on the east side of this field there may be an east-trending row of cinder cones and perhaps a crater. The core of the Tres Hermanos Mountains may be granitic rock. The relatively subdued-looking light-gray ridges north and northwest of the playa are underlain by one type of sedimentary rock that strikes northwestward; the sharper dark-gray ridges east and southeast of the playa are underlain by another type of sedimentary rock that strikes dominantly northwestward but is folded. These two types of sedimentary rocks may be separated by a major structural or stratigraphic break that is not observable on the photos. A hill southwest of the playa contains a northwest-trending linear feature that truncates beds, and thus may be a fault.

Evaluation -- Two aspects of the Gemini IV color photos ought to be evaluated separately, their very high altitude, and their color. Seeing the surface of the earth from such great heights - about 100 miles - gives the advantage of seeing at a glance a large area relatively free of distortion due to topography. However, this advantage seems to be a geographic rather than a geologic one, for few of the major structural features known in southeastern Arizona and probably also present in Mexico, can be seen on the photos. In no place was a dip direction on bedded rocks observed. Too few subdivisions of bedrock types can be made reliably to enable me to make a reconnaissance geologic map comparable to the kind expected of Survey geologists today. In all fairness, I should add that the 1:20,000 aerial photos available in the Santa Rita Mountains are not too satisfactory for photogeologic mapping either, because the rocks there are not "photogenic" and the structure is complex. Under these circumstances I think 1:10,000 photos may be more useful than 1:500,000.

A little more can be done with a photogeologic interpretation of surficial deposits and of young volcanic fields, but part of this is due to the color aspect of the photos rather than the high altitude at which they were taken. In fact, I suspect that their great altitude is actually a handicap, for a far smaller range of color values appears in the Gemini photos than I have seen in some low-altitude colored aerial photos of a nearby region. Very likely the atmosphere preferentially filters out some wave-lengths of light.

Since the potential geologic value of these photos seem to be greatest in areas of little eroded volcanics and of surficial deposits, and presumably in places where atmospheric interference is low, I expect such photogeologic efforts on the surface of the moon to be more useful than on the earth.

I would be curious to see the film negatives, rather than prints of the photos to see whether more detail is preserved.

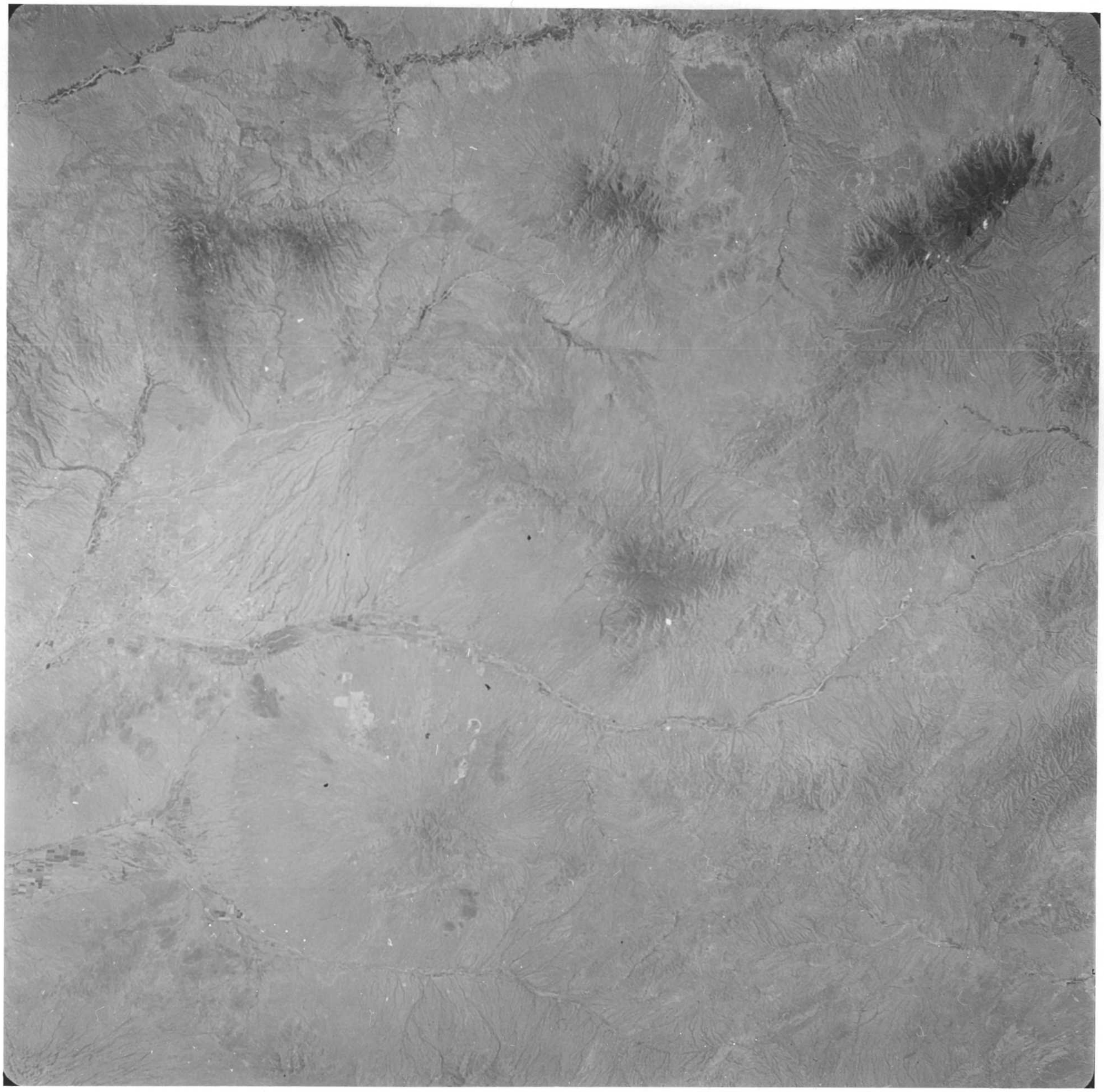

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Fig. 1

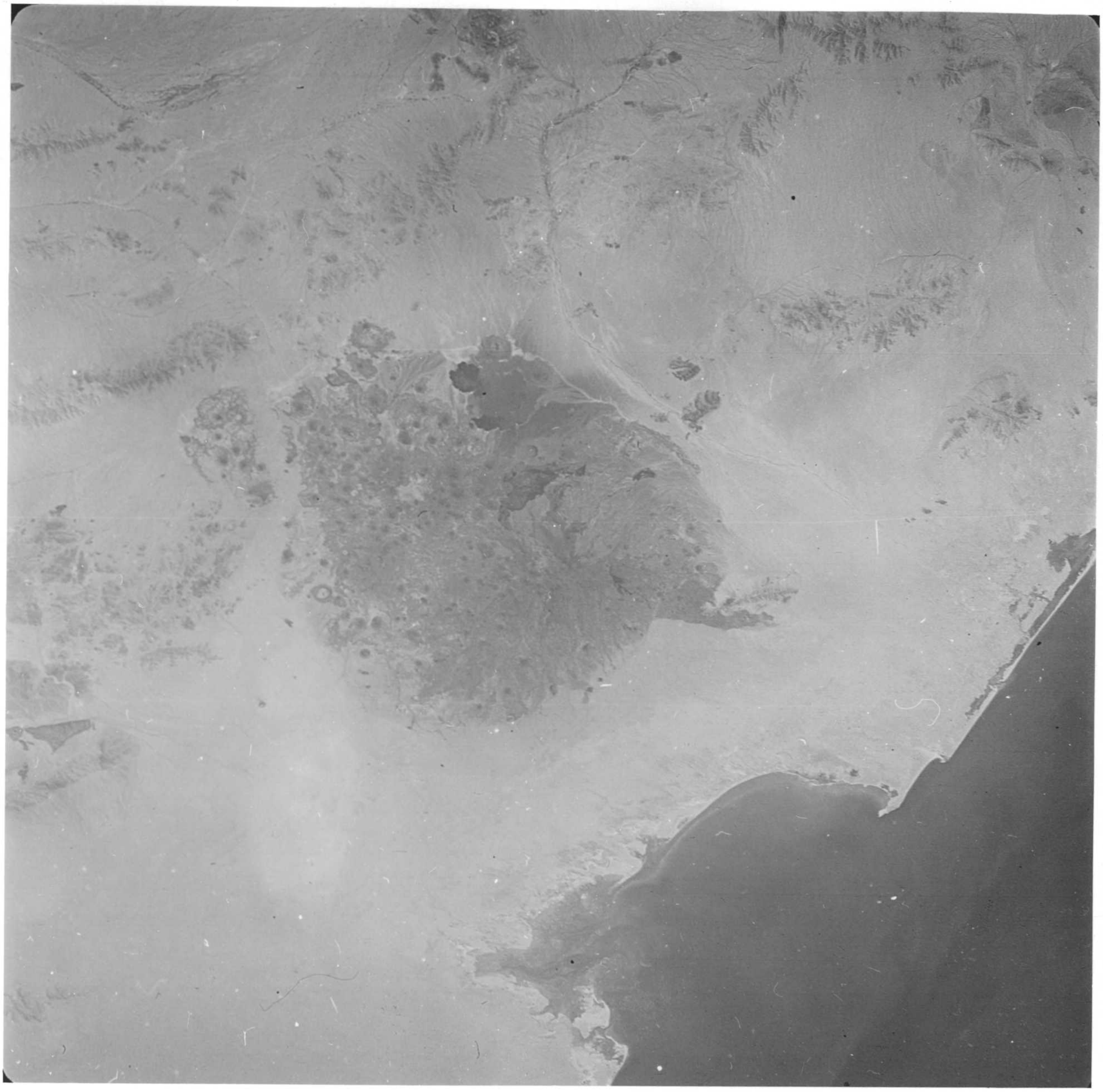

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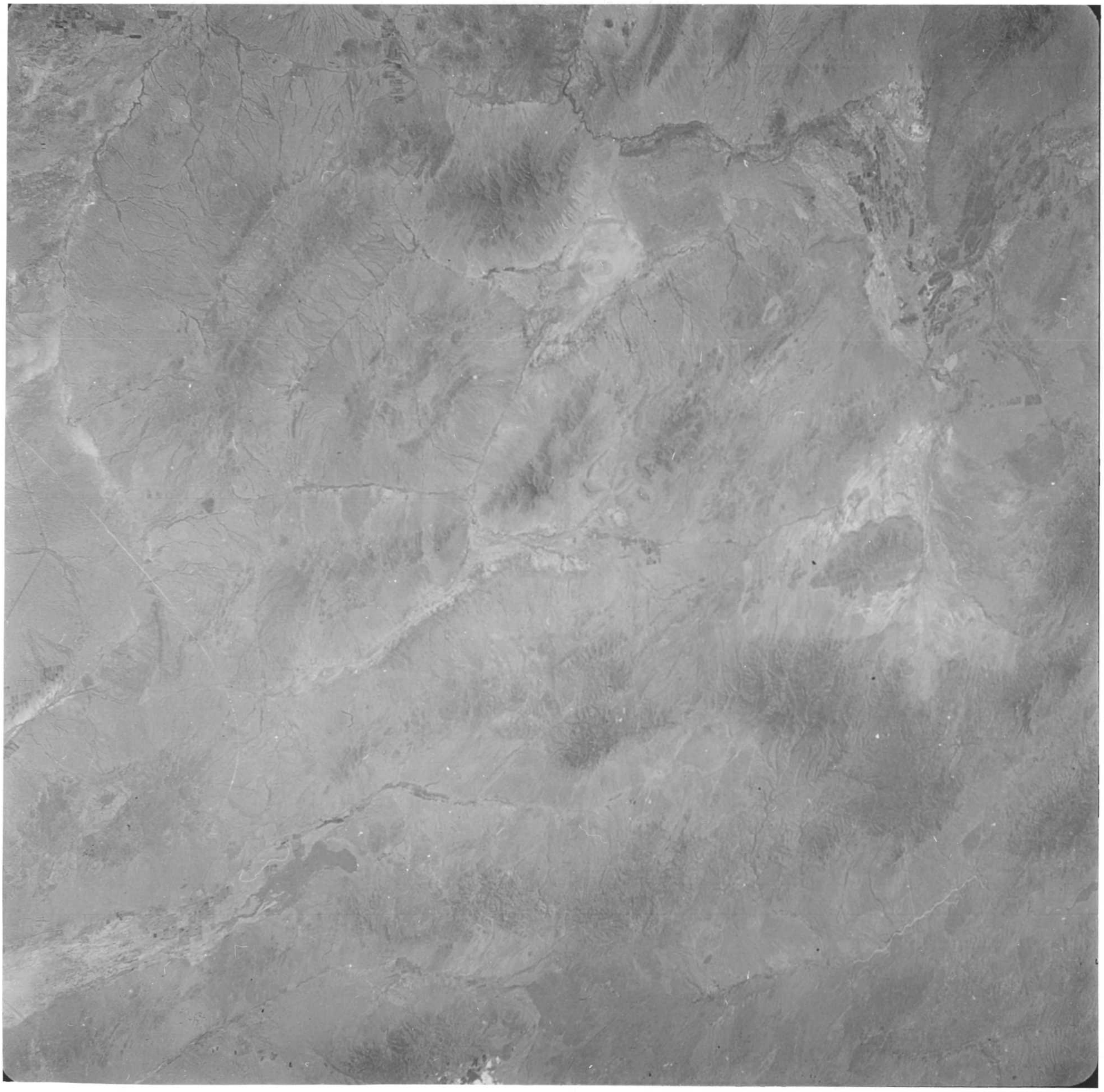
Fig. 2

Fig. 3



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