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

Technical Letter
NASA-29
May 1966

Dr. Peter C. Badgley
Chief, Natural Resources Program
Office of Space Science and Application
Code SAR, NASA Headquarters
Washington, D.C. 20546

Dear Peter:

Transmitted herewith are 3 copies of:

TECHNICAL LETTER NASA-29

RADAR IMAGERY: SALTON SEA AREA, CALIFORNIA*

by

Edward W. Wolfe**

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]

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Edward W. Wolfe**

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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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**U.S. Geological Survey, Menlo Park, California

Radar imagery: Salton Sea area, California

by

Edward W. Wolfe

Introduction

Radar imagery of the Salton Sea area of southern California was obtained by NASA in November 1965. Polarized and depolarized images at a scale of approximately 1:160,000 were studied. Although the two types of imagery are close in quality, the polarized image shows slightly greater tonal contrast and is less obscured by noise, which appears on the depolarized imagery as banding parallel to the line of flight. Segments of the polarized imagery are reproduced in figures 3, 4, and 5.

Geologic setting

The Salton Sea lies within a northwest-trending structural trough bounded on the northeast and southwest by pre-Tertiary plutonic and metamorphic rocks (fig. 1). The axis of the trough parallels the trends of the major faults. The San Andreas fault lies within the trough near its northeastern margin and cuts Tertiary strata exposed in the low hills at Durmid and in the Mecca Hills. The San Jacinto fault system passes along the southwest side of the Santa Rosa Mountains in the southwestern part of the area shown in figure 1.

Resting unconformably on the pre-Tertiary basement is a thick sequence of Miocene to Recent sedimentary rocks and rare lava flows of local extent. The sedimentary rocks contain detritus derived from erosion of the adjacent mountain ranges and from the Colorado River drainage basin. Predominantly nonmarine, they grade laterally from conglomerates near the bordering mountains to sandstones and clays toward the axis of the trough. Figure 2 summarizes the stratigraphic succession southwest of the Salton Sea, where Dibblee (1954, p. 22) reported a maximum exposed thickness of 18,700 feet of Cenozoic sedimentary rocks.

Radar imagery

Figure 3 shows radar imagery along the northeast side of the Salton Sea. The grid-like pattern at the northwest end of the Salton Sea (fig. 3B) is formed by tilled fields. State Highway 111 and the Southern Pacific Railroad are represented by the white line following the northeast shore. Subparallel to and intersecting the Southern Pacific tracks at a low angle near the northwest end of the imaged area is the Whitewater River. The well defined sinuous line at the base of the Mecca Hills (fig. 3B) is a canal. U.S. Highway 60, 70 runs approximately east-west between the Little San Bernardino Mountains and the northwest end of the Mecca Hills.

The trace of the San Andreas fault is expressed in the low hills near Durmid by a linear tone change (fig. 3A, no. 1) trending parallel to the northeast shore. Presumably the tone change reflects juxtaposition of contrasting lithologies along the fault. The channel of the small stream (fig. 3A, no. 2) emptying into the Salton Sea northwest of Durmid has been offset in a right lateral sense along the fault trace. The San Andreas fault passes through the southwestern edge of the Mecca Hills (fig. 3B), where steeply dipping sandstones and clays on the southwest side of the fault are well displayed in the image (fig. 3B, no. 3).

Traces of many small faults (fig. 3B, no. 4) in the Mecca Hills northeast of the San Andreas fault as well as the trace of the San Andreas fault (fig. 3B, no. 5) are clearly expressed in the radar image. At least in part these faults are distinctive in the imagery because of good topographic expression.

The contact between alluvium (dark) and Tertiary bedrock (light) is sharply defined along the edge of the Mecca Hills. The alluvium has much less surficial relief than the bedrock, and, consequently, contains few if any surfaces properly oriented to give strong reflection to obliquely incident radar waves. The contrasting tones of the alluvium and bedrock might also reflect significant differences in lithology (e.g. grain size, degree of cementation) or moisture content.

Figures 4 and 5 are reproductions of a radar image of an area on the southwest side of the Salton Sea. The Santa Rosa Mountains lie at the northwest end (fig. 4) and the Superstition Hills at the southeast end (fig. 5) of the area.

The most apparent geologically significant feature of figures 4 and 5 is the contrast between areas underlain by pre-Tertiary crystalline rocks (Santa Rosa Mountains and Superstition Mountain) and the remainder of the area, which is underlain by Cenozoic sedimentary strata. The main reason, if not the only reason, for the obvious distinction is that the very steep relief of the areas underlain by crystalline rocks provides maximum tonal contrast in the record of the obliquely incident radar beam, whereas the low relief and relative absence of steep slopes in the areas underlain by sedimentary deposits minimize the tonal contrast in the radar record. Where the relief of the pre-Tertiary crystalline rocks (fig. 4A, no. 6) and Cenozoic sedimentary rocks (fig. 4A, no. 7) is similar in magnitude and steepness, the distinction between them is largely lost; however, a distinctive erosional pattern distinguishes the two outcrops of sedimentary rock (no. 7) from the nearby crystalline rocks.

North of San Felipe Creek are low hills in which the local relief does not exceed 200 feet. Striking banding, trending roughly east-west through the area, is terminated by alluvium at the San Felipe Hills fault (fig. 4B, no. 8) and at a second fault (fig. 4B, no. 9) farther east. That the banding is superficial and not directly related to bedrock structure is clearly shown in small areas (fig. 4B, no. 10) where bedding oblique to the banding is discernible. At the southeast end of the imaged area, similar banding crosses the Superstition Hills fault (fig. 5, no. 11) and can also be seen in the area of alluvium east of the hills. Faint banding in the same areas is discernible on the colored Gemini photographs. T. W. Dibblee, Jr. (personal communication) indicated that the bands represent low ridges of sand transported by the prevailing west wind. The banding is not visible in figure 6, an aerial photograph of a small area near the southeast end of the San Felipe Hills fault. Intricate folding, spectacularly displayed in the aerial photograph, is almost completely obscured in the radar imagery.

Partially enclosing the Superstition Hills (fig. 5) is a distinct line which coincides with the mapped shoreline of Lake Coahuila, an early Recent lake that stood at a higher level in the Salton trough.

Traces of several faults are visible in figures 4 and 5. The San Felipe Hills fault (fig. 4B, no. 8) and the shorter fault (no. 9) east of it have good topographic definition. The Superstition Hills fault (fig. 5, no. 11) can be recognized as a faint linear tone change. Near the southeast end of the Santa Rosa Mountains a fault (fig. 4A, no. 12) displacing alluvium is clearly defined by the bright radar reflection from the fault scarp.

Conclusions

In the Salton Sea area many geologic features, particularly those that have distinctive topographic expression, are well portrayed in the radar imagery. Undoubtedly aerial photographs of the same area at a comparable scale would show many of the same features.

Large scale aerial photography (fig. 6) and relatively small scale radar imagery (fig. 4B) differ greatly in portrayal of the area north of San Felipe Creek. The aerial photograph shows the intricate bedrock structure in fine detail but suppresses the parallel streaks of wind blown sand. The radar image, on the other hand, emphasizes the streaks of wind blown sand at the expense of the bedrock structure. Whether the difference in imaging expression is controlled mainly by scale or by imaging technique is unknown, but the fact that bedrock structure does show through the overlying sand streaks in a few places north of San Felipe Creek suggests that the scale of the radar imagery is large enough to resolve the bedrock pattern.

Radar imagery has potential application as a tool for geologic mapping. Its resolution of topography seems good, but comparison with photographs at the same scale would be of interest.

Reference

Dibblee, T. W., Jr., 1954, Geology of the Imperial Valley Region, California: Calif. Div. of Mines, Bull. 170, p. 21-28.

Figure 1. Generalized geologic map of the Salton Sea area. (Modified from Dibblee, 1954, Chap. 2, Plate 2)

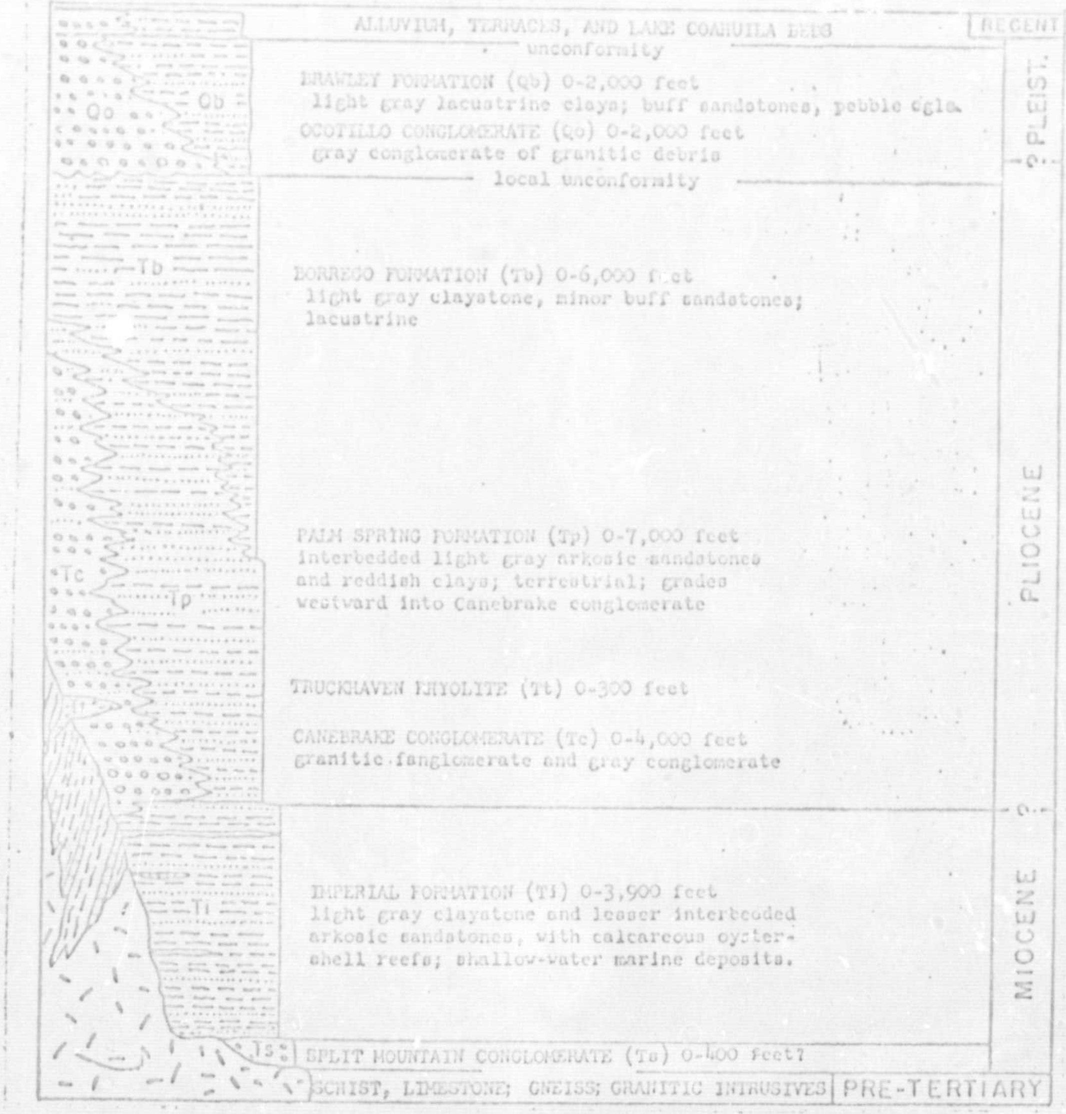

Figure 2. Columnar section for northwestern Imperial Valley (Dibblee, 1954).

A B

Figure 3. Radar imagery on the northeast side of the Salton Sea. Figure 3A shows the low hills at Durmid. Figure 3B shows the Mecca Hills lying immediately northwest of the area of figure 3A. Numbers refer to features described in text.

A B

Figure 4. Radar imagery southwest of Salton Sea. Figure 4A shows the southeastern part of the Santa Rosa Mountains. Figure 4B shows an area of low hills between the Santa Rosa Mountains on the northwest and San Felipe Creek on the southeast.

Figure 5. Radar imagery southwest of the Salton Sea in the area of Superstition Mountain and the Superstition Hills. San Felipe Creek lies at the northwest end of the image.

Figure 6. Aerial photograph of an area near the southeast end of the San Felipe Hills fault. Scale is approximately 1:24,000. North at top of photo. Markings are topographer's notations.