JET PROPULSION LABORATORY *California Institute of Technology • 4800 Oak Grove Drive, Pasadena, California 91103*

APPLICATION OF ERTS AND EREP IMAGES TO GEOLOGIC INVESTIGATIONS OF THE BASIN AND RANGE - COLORADO PLATEAU BOUNDARY IN NORTHWESTERN AND NORTH-CENTRAL ARIZONA

September 15, 1974

GSFC No. PR 522

Type 1 Progress Report
for the period

15 August 1973 - 15 September 1974

A. F. H. Goetz, F. C. Billingsley
Jet Propulsion Laboratory, Pasadena, California

D. P. Elston, I. Lucchitta
U. S. Geological Survey, Flagstaff, Arizona

E. M. Shoemaker
California Institute of Technology, Pasadena, California

Significant Results

In the course of the ERTS investigation in the Cataract Creek Basin of the Coconino Plateau it was recognized that shallow perched ground water associated with the Kaibab Limestone could be discovered by means of drilling guided by geologic mapping aided by the use of ERTS imagery. At the Globe Ranch, the perched water table is only 5 meters beneath the surface at the site of the original, hand dug well. Recharge occurs from local runoff and from direct precipitation on the outcrop belt of the sandstone. This well provides water for the ranch at the rate of about 1,000 gallons a week. In order to explore the possibility of further developing this aquifer, unit 5 was mapped over an area of about 50 square miles in the vicinity of the Globe Ranch. Subsequently, fourteen exploratory wells were drilled in the vicinity of the hand-dug well, with negative results. A new location was then picked for drilling based on the occurrence of unit 5 in a favorable structural setting. This location was along

a normal fault, and it was anticipated that water might be structurally trapped within the down-dropped block of the fault. Four shallow testholes were drilled and all encountered water. These four water-bearing holes are currently being monitored and will be tested to determine potential production of water from the local sandstone aquifer.

Analysis of ERTS imagery can be a viable means of mapping unit 5. This unit is typically reddish-brown in color. Slope-forming and colluvial slopes developed on this clastic unit are also red. The results of this study show that shallow ground water supplies in the Alpha Member of the Kaibab Limestone can be found by an inexpensive program of exploratory drilling guided by ERTS-aided geologic mapping.

Accomplishments and Plans

Shivwits Plateau

The period has been spent compiling data and summarizing them in various papers, abstracts and oral presentations.

Considerable time has also been spent in completing and checking field maps and in studying RB 57 positive color transparencies of the area. These photographs are of excellent quality and amazing resolution -- cars are plainly visible with adequate enlargements. The photographs have revealed several faults that had not been discovered previously and have permitted mapping of contacts that could not be reached on the ground.

Contact has been established with various people and agencies who are potentially interested in using ERTS images for regional geologic studies.

Oral Presentations

Physiography and structure of the Shivwits Plateau area, Arizona: 4th Annual ARETS Conference.

Abstracts

Physiographic development of the Shivwits Plateau, northwest Arizona. In press. GSA - Cordilleran Section Meeting, 1974.

Papers

Structural evolution of northwest Arizona and its relation to the adjacent Basin and Range Province. In press. Guidebook for the 1974 GSA - Rocky Mountain Section meeting. (USGS Professional Paper).

Structure and physiography of the Shivwits Plateau, Arizona. In press. Proceedings of the 4th ARETS Conference, 1973.

Course of the Ancestral Colorado River before capture and integration. In preparation (80% written). To be published in the GSA Bulletin.

Coconino Plateau

In the course of the ERTS investigation in the Cataract Creek Basin of the Coconino Plateau it was recognized that shallow perched ground water associated with the Kaibab Limestone could be discovered by means of drilling guided by geologic mapping aided by the use of ERTS imagery.

Due to the aridity of the climate, and rapid downward percolation of the scant precipitation, water must be obtained through three principal sources: (1) tanks formed by earth dams bulldozed across natural drainages, (2) deep wells reaching the water table (1-2000 ft), and (3) water hauled in from considerable distances at great cost. The tanks are an unreliable source of water. Most of the rocks capping the Plateau are so pervious that there is very little accumulation from runoff. In many years tanks remain dry all year. At some ranches the water obtained from a single existing well is distributed through an expensive system of pipes to strategically located storage tanks.

The development of adequate supplies of water is critical for the livestock industry and, to some extent, to the tourist industry of the area.

Except for the scarcity and expense of obtaining water, the area is well suited for livestock. In fact, in 1973 the annual production of cattle was about 45,000 head.

A possible solution to this problem is the development of shallow wells. A production capability of as little as 100 gallons of water per day can be profitably utilized. One of the few such occurrences is at the Globe Ranch, near the rim of the Grand Canyon, where a small amount of water is produced from a shallow hand-dug well in a sandstone lens within the Alpha Member of the Kaibab Limestone. Through detailed geologic mapping of the Globe Ranch area, it was found that the perched ground water was associated with a sandstone lens in unit 5 in the Alpha Member of the Kaibab Limestone. The sandstone is interbedded with red claystone and siltstone which form an impervious layer beneath the sandstone. The perched water table is only 5 meters beneath the surface at the site of the well. Recharge occurs from local runoff and from direct precipitation on the outcrop belt of the sandstone. This well provides water for the ranch at the rate of about 1,000 gallons a week. In order to explore the possibility of further developing this aquifer, unit 5 was mapped over an area of about 50 square miles in the vicinity of the Globe Ranch. Subsequently, fourteen exploratory wells were drilled in the vicinity of the hand-dug well, with negative results. A new location was then picked for drilling based on the occurrence of unit 5 in a favorable structural setting. This location was along a normal fault, and it was anticipated that water might be structurally trapped within the down-dropped block of the fault. Four shallow testholes were drilled and all encountered water. These four water-bearing holes are currently being monitored and will be tested to determine potential production of water

from the local sandstone aquifer.

Analysis of ERTS imagery can be a viable means of mapping unit 5. This unit is typically reddish-brown in color slope-forming and colluvial slopes developed on this clastic unit are also red. The task of mapping the distribution of this unit is greatly facilitated by color difference images produced by computer from the raw MSS data tapes. Figure 1 is the completed geologic map of the portion of the Coconino Plateau studied in this investigation. The results of this study show that shallow ground water supplies in the Alpha Member of the Kaibab Limestone can be found by an inexpensive program of exploratory drilling guided by ERTS-aided geologic mapping.

Future work will concentrate on finishing the final report.

GEOLOGIC MAP OF THE COCONINO PLATEAU, ARIZONA

GEOLOGIC MAP OF THE COCONINO PLATEAU, ARIZONA

GEOLOGIC MAP OF THE COCONINO PLATEAU, ARIZONA

GEOLOGIC MAP OF THE COCONINO PLATEAU, ARIZONA

GEOLOGIC MAP OF THE COCONINO PLATEAU, ARIZONA