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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN
COOPERATION WITH THE
NEW MEXICO STATE ENGINEER

OPEN-FILE 75-282

TEXT

Introduction

The Capitan aquifer is an important source of the ground water used for municipal, industrial, and agricultural purposes in the vicinity of Carlsbad, N. Mex. In addition, water pumped from this aquifer in southern Lea County, New Mexico, and Winkler and Ward Counties, Texas, is injected into other reservoirs by oil companies to increase the recovery of petroleum from partially depleted oilfields (Hiss, 1971). A knowledge of the dimensions of the Capitan aquifer in southeastern New Mexico and western Texas will be useful in programs designed to manage this important resource. The map depicting the position and thickness of the Capitan aquifer will also be helpful to petroleum companies who may wish to control lost circulation while penetrating this porous and permeable unit as they explore for oil and gas in underlying strata.

The Capitan aquifer

For all practical purposes, the Capitan aquifer is a lithosome that includes the Capitan and Goat Seep Limestones and most or all of the Carlsbad facies of the Artesia Group (Meissner, 1972). Some of the shelf-margin carbonate banks or stratigraphic reefs in the upper part of the San Andres Limestone are included within the Capitan aquifer whenever they cannot be readily distinguished from the Goat Seep Limestone and Carlsbad facies.

The position and dimensions of the Capitan aquifer closely agree with the Capitan and Goat Seep Limestones and porous and permeable shelf-margin limestone and dolomite members in the San Andres Limestone (Silver and Todd, 1969, figs. 12 and 13). However, observations of the geometry and lithologic relationships of the shelf-margin and shelf sediments in the field suggest that the width of the Capitan Limestone is considerably less than is usually shown by others who have mapped this stratigraphic reef. The relationships between the Carlsbad Limestone and Capitan Limestone expressed by Dunham (1972, fig. I-1) appear to more closely match the field relationships observable in the vicinity of Carlsbad and White City, N. Mex.

The Capitan aquifer is generally composed of relatively "clean" carbonate rock, especially near the fore-reef edge. The radioactivity recorded on a gamma-ray electrical log of the Capitan and (or) Goat Seep Limestone is characteristically very low as shown in stratigraphic sections A-A' and B-B'.

The tops and bases of the Capitan aquifer were determined primarily on the basis of the vertical extent of the relatively "clean" carbonate rock as indicated by the low gamma-ray activity levels shown on the electrical logs, and the general stratigraphic position. Lithologic logs, oilfield scout tops, report of lost circulation, and other information were used whenever available to confirm these determinations. Zones containing 50 percent or less of interbedded back or fore-reef lithofacies were included with the Capitan aquifer as a matter of convenience; therefore, the net aggregate thickness of the Capitan aquifer may have been increased slightly by this arbitrary procedure.

It is often difficult or impossible to distinguish between other reefs and carbonate mounds in the back-reef sediments and the Capitan and Goat Seep Limestones solely on the basis of the responses recorded on gamma-ray, sonic, and neutral electrical logs. Adjacent units shelfward from the Capitan and Goat Seep Limestones in the Carlsbad facies of the Artesia Group are included as part of this aquifer whenever either the chemical composition of water, the water-level declines, or the natural radioactivity in the adjacent units are similar to that in the main aquifer (Hiss, 1973 and 1974a).

Units previously described as reefs of Yates or Seven Rivers age, part of the Grayburg Formation, and the shelf-margin carbonate banks in the upper part of the San Andres Limestone are considered to be part of the Capitan aquifer whenever they cannot be distinguished as separate entities; and the water quality, electrical log characteristics, or hydraulic response justify inclusion.

Dimensions of the Capitan aquifer

Determination of extent and thickness

The locations of nearly 400 wells that have been drilled through the Capitan aquifer within the project area, along with the corresponding thickness of the Capitan aquifer penetrated in each well, are plotted on this map. Gamma-ray-sonic, gamma-ray-neutron, or other combinations of electrical logs of the Capitan aquifer interval were obtained for nearly all of these wells. Lithologic logs were available for approximately 15 percent of the wells.

Lateral extent

The Capitan aquifer parallels the north and east margins of the Delaware basin in an arcuate strip extending from the Guadalupe Mountains southwest of Carlsbad, N. Mex. to the Glass Mountains southwest of Fort Stockton, Tex. Outcrops of the Capitan Limestone have been found in the Glass, Guadalupe, Apache, and Delaware Mountains. Undoubtedly it is present elsewhere in the subsurface along the west and southwest margins of the Delaware basin.

As shown on the map, the Capitan aquifer is one continuous unit along the north and east margins of the Delaware basin. Major displacements of the Capitan aquifer by faulting appear to be limited to the mountainous areas along the western and southern parts of the Delaware basin. Faults have not been observed in the subsurface along the western edge of the Central Basin platform and the southern edge of the Northwestern shelf. The irregular top and bottom surfaces and the lobate fore and back-reef edges are depositional forms (map and stratigraphic sections A-A' and B-B'). What might appear as a major lateral displacement of the Capitan aquifer in the vicinity of T.23 S., R.25 E., approximately 15 miles (24 km) southwest of Carlsbad, is not a post-Capitan age fault. This shift in position is probably due to growth of the Capitan reef along a pre-Guadalupian age fault-controlled alignment of the Delaware basin (Hills, 1963, p. 1715; and 1970).

The width of the Capitan aquifer varies from about 10 to more than 14 miles (16 to 23 km) along the edge of the Northwestern shelf from the vicinity of Carlsbad to the central part of southern Lea County, New Mexico. The Capitan aquifer is much more restricted along the western edge of the Central Basin platform, where it seldom exceeds 11 miles (18 km) in width.

The fore-reef edge of the Capitan aquifer appears to be relatively steep throughout the area. If exposed, this abrupt slope would undoubtedly resemble the reef escarpment southwest of Carlsbad in the Guadalupe Mountains (Green and others, 1964; Newell and others, 1953). Well control is adequate for definition of the fore-reef slope of the Capitan aquifer at several locations in the subsurface. Approximately 1,200 feet (366 m) of vertical relief along the fore-reef edge of the Capitan aquifer was detected in two oil tests drilled within a few hundred feet of horizontal distance in secs. 5 and 9, T.22 S., R.33 E., Lea County, New Mexico (Meissner, 1972, plate 11). Similar evidence of the relative steepness of the fore-reef side of the Capitan aquifer can be obtained where deep-well drilling is concentrated in the newly discovered gasfields in the vicinity of Pyote, Wink, and Fort Stockton in Winkler, Ward, and Pecos Counties, Texas, respectively.

The back-reef edge of the Capitan aquifer is much more irregular than the fore-reef edge and is gradational. In some areas, especially along the western edge of the northern part of the Central Basin platform, it is difficult to distinguish the Capitan aquifer from the upper part of the San Andres Limestone. In this area the Capitan aquifer has been extended to include the stratigraphic reef facies of the San Andres Limestone because of the proximity, similar lithology, and hydraulic behavior of the two units (stratigraphic section B-B').

Thickness

As is readily observed from the map, the thickness of the Capitan aquifer is quite variable. The Capitan aquifer appears to be composed of irregularly shaped and spaced thick accumulations of carbonate rock alternating with thinner units composed of similar material. Many of the locally thick areas are behind the reef front and may represent the carbonate banks, islands, or mounds which flourished behind the protection of the reef crest (Kendall, 1969, p. 2509 and pls. 2 and 3). Motts (1968 and 1972) has mapped and described both current oriented and irregularly oriented "shelf dome" carbonate mounds in the vicinity of Dark Canyon southwest of Carlsbad, N. Mex.

A number of small oilfields located along the trend of the Capitan aquifer are apparently localized on carbonate "buildups" that have been referred to by Stipp and Haigler (1956) as "reef knobs" interspersed between "surge channels." The majority of these carbonate mounds or "buildups" are also located within the thick areas shown in the Capitan aquifer thickness map. The Capitan aquifer attains a known maximum thickness of 2,357 feet (718 m) in the Odessa Natural Gas Federal Dooley well located on one of these mounds in sec. 24, T.20 S., R.29 E., about 13 miles (21 km) northeast of Carlsbad.

Hiss (1974b) has identified several of the most prominent linear, thin areas oriented transversely to the arcuate main trend of the Capitan aquifer as submarine canyons. The submarine canyons are contemporary in age to the stratigraphic reefs that comprise the Capitan aquifer.

The Capitan aquifer is slightly thicker along the edge of the Northwestern shelf in New Mexico than in Texas. In addition, the areal extent of the thick areas is correspondingly larger. These differences probably reflect the shape of the structural framework of the Delaware basin at the time of the deposition of the Capitan aquifer. The more extensive stratigraphic reefs were developed along the margin of a broad, shallow shelf on the northern part of the basin, whereas narrow, linear reefs grew along the faulted western margin of the Central Basin platform.

Acknowledgments

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EXPLANATION FOR STRATIGRAPHIC SECTIONS

ORDER OF ELEMENTS
Operator, lease, well number, land-grid location, reference datum, total depth.

ELECTRICAL LOG IDENTIFICATION
ACSTC — Acoustic log
GRL — Gamma ray log
NEUT — Neutron log
SONL — Sonic log

WELL IDENTIFICATION
ABBREVIATIONS:
FNL — Distance, in feet, from north line
FSL — Distance, in feet, from south line
FEL — Distance, in feet, from east line
FWL — Distance, in feet, from west line
FNEL — Distance, in feet, from northeast line
FNWL — Distance, in feet, from northwest line
FSEL — Distance, in feet, from southeast line
FSWL — Distance, in feet, from southwest line

SEC — Section
T — Township
S — South
R — Range
E — East
(New Mexico only)
BLK — Block
T — Township
S — South
(Texas only)
LGRD — Log reference datum, in feet, above sea level
TD — Total depth of well, in feet, below log reference datum

(Conversion factors: 1 mile = 1.609 kilometres; 1 foot = .3048 metres.)

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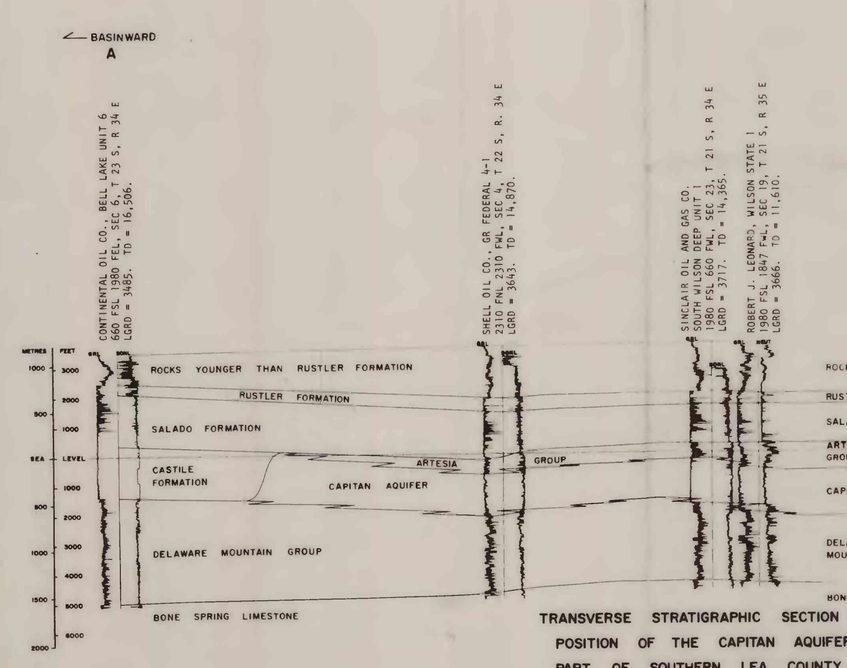
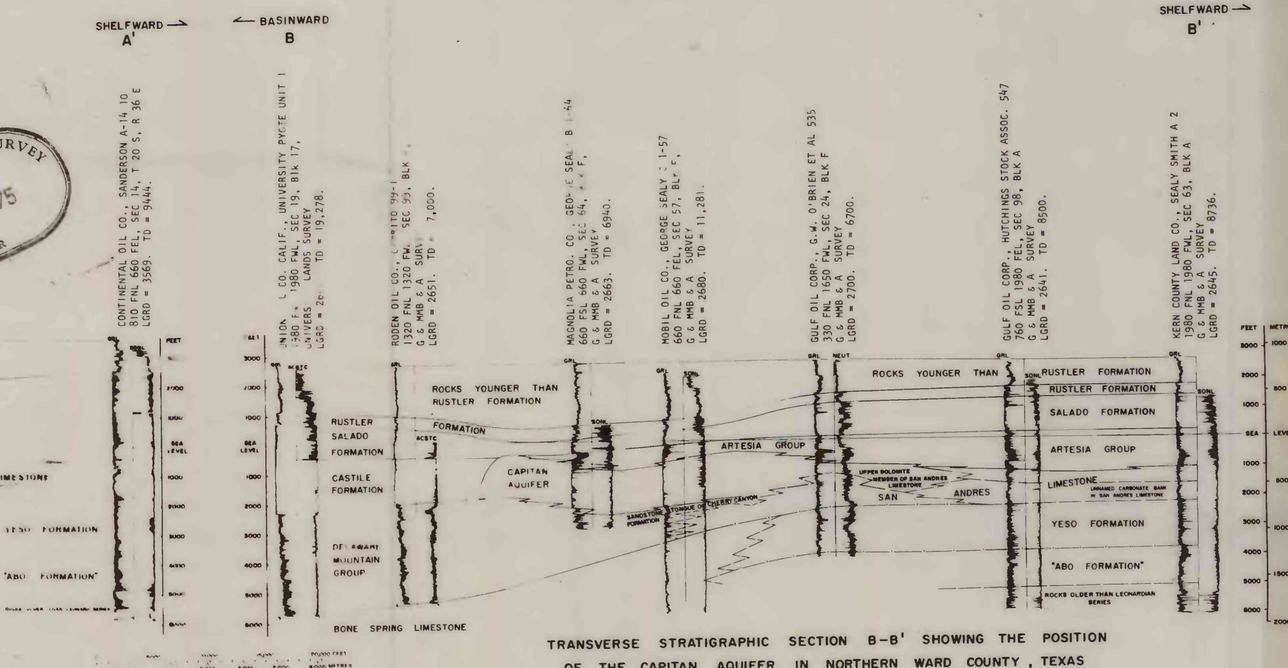


TRANSVERSE STRATIGRAPHIC SECTION A-A' SHOWING THE POSITION OF THE CAPITAN AQUIFER IN THE CENTRAL PART OF SOUTHERN LEA COUNTY, NEW MEXICO



TRANSVERSE STRATIGRAPHIC SECTION B-B' SHOWING THE POSITION OF THE CAPITAN AQUIFER IN NORTHERN WARD COUNTY, TEXAS

MAP SHOWING THICKNESS OF THE PERMIAN (GUADALUPIAN) CAPITAN AQUIFER, SOUTHEAST NEW MEXICO AND WEST TEXAS.

W. L. HISS - JUNE 1975

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