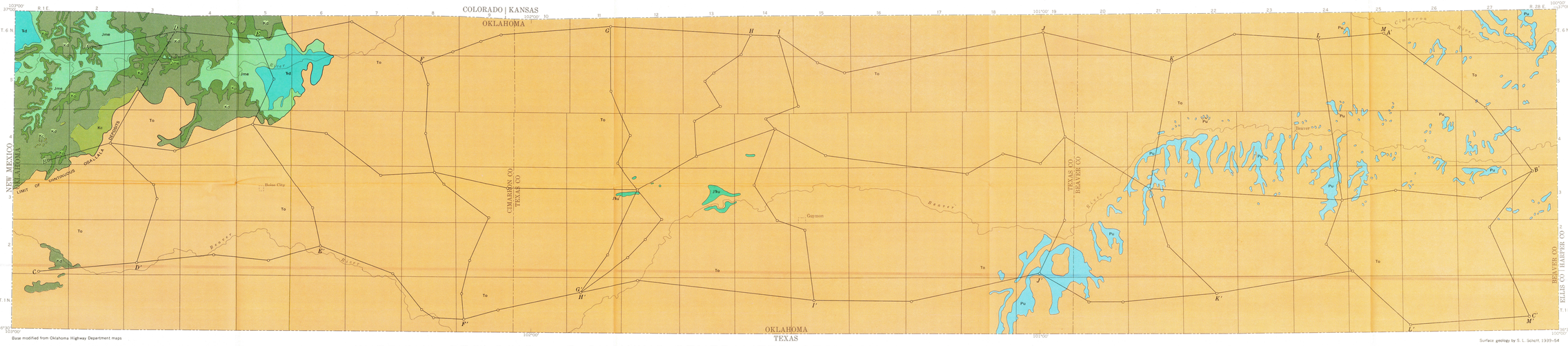
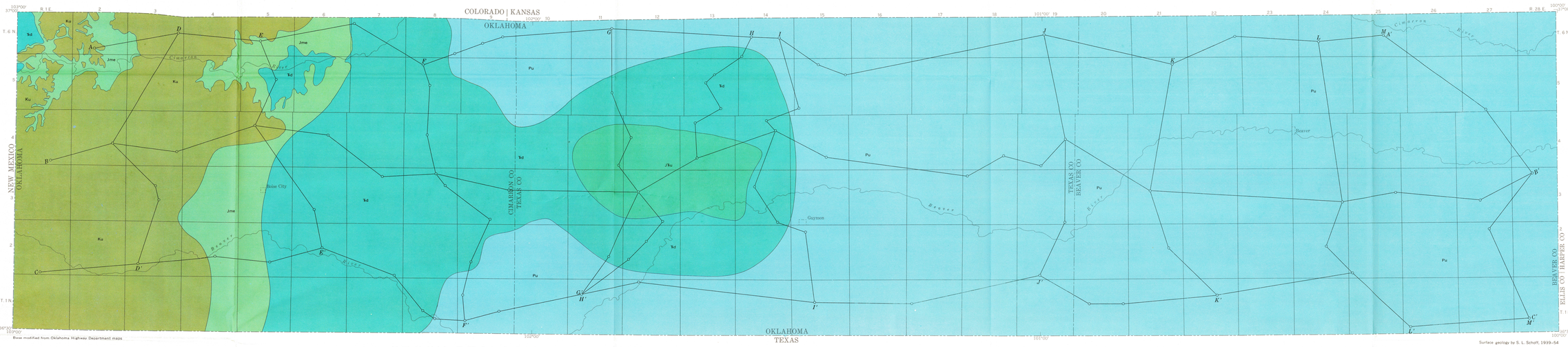
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
OKLAHOMA WATER RESOURCES BOARD

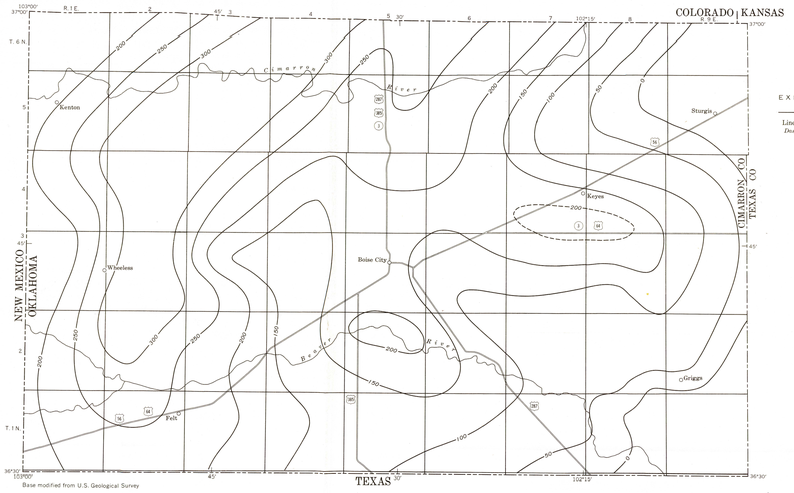
MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-738 (SHEET 1 OF 2)



SURFICIAL GEOLOGIC MAP SHOWING GENERALIZED GEOLOGY EXCLUSIVE OF QUATERNARY DEPOSITS



BEDROCK GEOLOGIC MAP SHOWING APPROXIMATE SUBSURFACE LIMITS OF PRE-TERTIARY ROCKS



MAP SHOWING APPROXIMATE AGGREGATE THICKNESS OF SANDSTONE IN ROCKS OF MESOZOIC AGE IN CIMARRON COUNTY

INDEX MAP SHOWING LOCATION OF THE REPORT AREA

INTRODUCTION

The Oklahoma Panhandle, Beaver, Texas, and Cimarron Counties, (see index map) extends 166 miles east-west, 34.5 miles north-south, and includes an area of about 5,700 square miles.

The economy of the area depends heavily on agriculture and cattle raising which must cope with the semiarid climate of the region. In contrast to an annual average precipitation of 33 inches for the State, precipitation in the Panhandle averages about 18 inches, which falls mostly during local heavy thunderstorms in the spring and summer. To assure moisture for crops at the proper time and in adequate amounts, much of the agricultural industry relies increasingly on ground water for irrigation.

The purpose of this investigation was to identify the rocks immediately underlying the Ogallala Formation, outline their distribution patterns, and determine their probable water-bearing characteristics.

The scope of the study is restricted for several reasons. The relatively small number of electric and sample logs extending to, or near, the land surface limits the number of control points available for determining the subsurface limits of younger pre-Tertiary rocks. Aquifer-test data are lacking for pre-Tertiary rocks; therefore, their probable water-bearing characteristics are inferred from electric log curves and sample descriptions of well cuttings. The data presented, nevertheless, are useful in exploring for sources of fresh water in rocks older than Tertiary.

Acknowledgment is made to those oil companies that operate in the area and made available many sample logs of drill cuttings and chemical analyses of ground-water samples.

TOPOGRAPHY AND DRAINAGE

The Oklahoma Panhandle is part of the High Plains section of the Great Plains physiographic province. Most of the area is a gently undulating to flat upland plain, broken locally by the principal streams and their tributaries. Relief from the High Plains to the river bottoms ranges from 100 to 200 feet in Cimarron County to as much as 400 feet in eastern Beaver County. The upland plain slopes southeastward at an average rate of approximately 15 feet per mile.

The major streams of the area are the Beaver and Cimarron Rivers. The Cimarron leaves the Panhandle in northeastern Cimarron County, flows northward into Kansas, and re-enters Oklahoma in northeastern Beaver County. Both streams generally are intermittent, but in some reaches, the flow is perennial.

GEOLOGIC SETTING

The surficial geologic map shows the generalized surface geology of the area. Mesozoic rocks are exposed principally in the northwest corner of Cimarron County; elsewhere they are covered by varying thicknesses of Tertiary and Quaternary deposits. The approximate limits of the pre-Tertiary rocks in the subsurface are shown on the bedrock geologic map. The Mesozoic rocks previously extended farther east but have been eroded to the limits shown on the bedrock map. The Cretaceous and most of the Jurassic rocks are limited by truncation to the western half of Cimarron County; whereas the Triassic and a small outlier of Triassic and Jurassic rocks extend into the western half of Texas County. Permian rocks underlie all of the Oklahoma Panhandle.

The average regional dip across the Oklahoma Panhandle is to the southeast at approximately 6.5 feet per mile, or less than 1°, as determined by elevations of the top of the Cimarron Anhydrite of Schweer (1937), which is the most reliable shallow horizon for determining structural dip. The north-trending Cimarron arch (see sections sheet 2), near the Texas-Cimarron county line, is the only significant break in the regional dip.

The map showing approximate aggregate thickness of sandstone in the Dakota Sandstone and the Cheyenne Sandstone Member of the Purgatoire Formation, the Morrison and Exeter (Entrada) Formations, and the Dockum Group in Cimarron County, although based on sparse control, is a useful guide in exploring for fresh ground water in rocks below the Ogallala Formation. For example, at Wheeless, approximately 275 feet of sandstone may be present collectively, from the five rock units. As shown on the bedrock geologic map, the Dakota and the Cheyenne underlie the western part of Cimarron County and constitute much of the sandstone thickness. The sandstone thickness in the eastern part of the county consists mostly of the lower sandstone unit of the Dockum.

Eastward into Texas County the ground-water potential from the Mesozoic rocks diminishes rapidly; however, a potential source of additional water may be available from an estimated 100 feet of sandstone in the lower unit of the Dockum Group in western Texas County.

STRATIGRAPHY

Rocks of Permian age.—Undifferentiated older Permian rocks include the Wellington Formation and possibly the upper few hundred feet of the Chase Group. The Wellington Formation typically consists of a lower salt-anhydrite unit, a mottled maroon-green and gray-green shale unit, and an upper anhydrite unit, and is about 600 feet thick in the Oklahoma Panhandle.

The Hennessey Shale is a mixture of red and green shales with local stringers of anhydrite, gypsum, or dolomite, and is approximately 300 feet thick.

The Cimarron Anhydrite of Schweer (1937), the equivalent of the Stone Corral Formation of Kansas (Lee and Merriam, 1954, p. 3), consists of varying amounts of interbedded white anhydrite, finely-crystalline buff-colored dolomite, and salt. Commonly the Cimarron Anhydrite is 50 feet thick in the Oklahoma Panhandle, but locally may be more than 100 feet, mostly because of a greater thickness of bedded salt.

The Glorieta Sandstone is the shallowest Permian sandstone of significant thickness and continuity in the Oklahoma Panhandle. Well samples show that it is generally a white to pink, fine to medium grained, slightly gypsiferous, unconsolidated sand; the sand grains are rounded and polished. The Glorieta commonly is 200 feet thick in Texas County, is slightly lenticular, and apparently is absent locally approximately 6 miles southeast of Boise City in Cimarron County. The geologic sections show that the Glorieta undergoes a facies change into an evaporite-shale sequence to the east.

The Flowerpot Shale overlies the Glorieta Sandstone in most of the area, but may be absent locally. It is varicolored and gypsiferous; the usual thickness is 30 to 35 feet but it increases locally to 125 feet.

The salt zone in the Flowerpot Shale consists generally of salt-bearing shale near the base and grades upward into relatively pure salt near the top. Locally, the salt zone is nearly 500 feet thick, more commonly it is about 350 feet, and generally terminates abruptly. The top of the salt zone occurs at the base of the Blaine Gypsum.

Removal of salt from the Flowerpot by migrating ground water prior to or during deposition of the Ogallala resulted in general subsidence of the Permian surface in eastern Texas County. The resulting topographic relief is responsible for thicker Ogallala deposits in eastern Texas County. By contrast the Flowerpot salt body has not been removed in most of Beaver County and the Permian surface is at a higher elevation. The Permian red beds crop out in areas underlain by the salt in Beaver and southeastern Texas Counties because of erosion of the thinner Ogallala.

The Blaine Gypsum in subsurface commonly consists of six or seven distinct white gypsum or anhydrite beds separated by lesser amounts of red shale, dolomite, and salt. The Blaine ranges in thickness from slightly less than 100 feet to approximately 350 feet but generally is about 100 to 130 feet thick. The thicker sections are the result of the addition of anhydrite and salt to the top of the Blaine. On well logs the thick section appears as a single lithologic unit, but the upper part may be an evaporite facies of the overlying Dog Creek Shale (Jordan and Vosburg, 1963, p. 42).

The undifferentiated Permian rocks above the Blaine Gypsum include the Dog Creek Shale, Whitehorse Group, Cloud Chief Formation, and Quartermaster Formation. These rocks range in thickness from approximately 200 to 600 feet and consist mostly of red shale and red to pink fine-grained sandstone or siltstone; varicolored shale, gypsum or anhydrite, dolomite, and salt are present in lesser amounts.

The top of the Permian section is placed at the top of a red shale zone, generally 70 to 80 feet thick, overlying the Alibates Dolomite Lentil of the Quartermaster Formation. The red shale interval shows a strong gamma-ray reading and the Alibates is an excellent marker in samples and on most electric logs.

Rocks of Triassic age.—In the Oklahoma Panhandle and adjacent areas, rocks of Triassic age are represented by the Dockum Group (Cummins, W. F., 1890, p. 189). As shown on the bedrock geologic map, the Dockum underlies most of Cimarron County, but the subcrop narrows as it enters Texas County, and its eastern limit is at the approximate longitude of Guymon, Okla. The Dockum Group has an approximate maximum thickness of 650 feet and for the convenience of discussion is divided into upper and lower units.

The lower unit of the Dockum is mostly a pink to red sandstone. The grains are of medium size and subrounded. Polished loose sand grains ranging from fine to coarse sizes are reported and in places the sandstone is slightly micaceous and shaly. The aggregate thickness of sandstone in the lower unit ranges from approximately 50 to more than 200 feet and averages about 100 feet. The remaining part of the lower unit of the Dockum consists of thin layers of varicolored shale and siltstone interbedded with sandstone. The upper unit of the Dockum principally is red and green shale and lesser amounts of thinly bedded, mostly fine-grained pink to red shaly sandstone.

Rocks of Jurassic age.—The Exeter (Entrada) Sandstone is the basal member of the Jurassic in the Panhandle area. Generally, the Exeter (Entrada) is a soft, white to pink sandstone. The grains are of medium size, subrounded to rounded, and well sorted. In the Oklahoma Panhandle the thickness of the sandstone ranges from zero at the subcrop limit to about 35 feet, and, because of its thinness, is difficult to identify in subsurface.

The Morrison Formation overlies the Exeter (Entrada) Sandstone and from its subcrop limit reaches a thickness of about 325 feet in the Oklahoma Panhandle. It consists principally of pale green and red shale and siltstone interbedded with lesser amounts of thin reddish shaly sandstone. Locally, it contains thin limestone and anhydrite.

Rocks of Cretaceous age.—The Cheyenne Sandstone Member of the Purgatoire Formation is the basal unit of the Cretaceous in the Oklahoma Panhandle and ranges in thickness from zero at the subcrop to approximately 125 feet. Typically, the Cheyenne is a white to brown sandstone. Sand grains are medium to coarse and are rounded to subrounded. Isolated erosional remnants of Cretaceous rocks, probably the Cheyenne Sandstone Member, occur in the Oklahoma Panhandle but are too small to be shown on a map drawn to the scale used for the surficial geologic map.

The Kiowa Shale Member of the Purgatoire Formation, which overlies the Cheyenne Sandstone Member, ranges in thickness from zero to 65 feet and commonly is about 30 feet thick. The Kiowa consists of dark-gray to black shale, is locally fossiliferous and calcareous, and in places may contain thin beds of dense, gray limestone. The Kiowa commonly grades upward into a sandy shale or sandstone.

The Dakota Sandstone conformably overlies the Kiowa Shale Member. In most places the upper surface of the Dakota is an erosional surface. The thickness of the Dakota ranges from zero to a maximum of about 150 feet. In well samples the Dakota is a light-gray to brown sandstone. Sand grains are fine to medium size and subangular to rounded.

The Colorado Group consists of the Graneros Shale and the Greenhorn Limestone and ranges in thickness from zero to approximately 175 feet. The lower unit, the Graneros Shale, is predominantly a gray to black shale interbedded with thin layers of gray fossiliferous limestone; in places it is sandy. The upper unit, the Greenhorn Limestone is a gray, crystalline, fossiliferous limestone interbedded with almost equal amounts of gray shale.

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See sheet 2 for cross sections

PRELIMINARY INVESTIGATIONS OF THE HYDROGEOLOGY OF THE PERMIAN TO TERTIARY ROCKS OF THE OKLAHOMA PANHANDLE

5 0 5 10 15 20 MILES
5 0 5 10 15 20 KILOMETERS

1970 MAGNETIC DECLINATION AT SOUTH EDGE OF MAP VARIES FROM 10° TO 11°30' EAST

By
Robert B. Morton
1973

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W72260

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