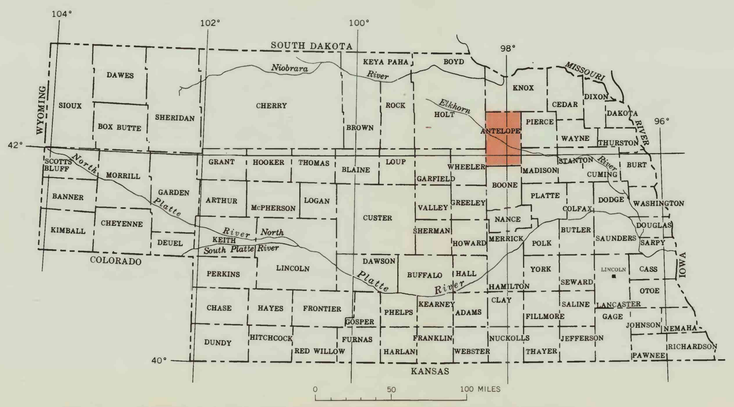
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

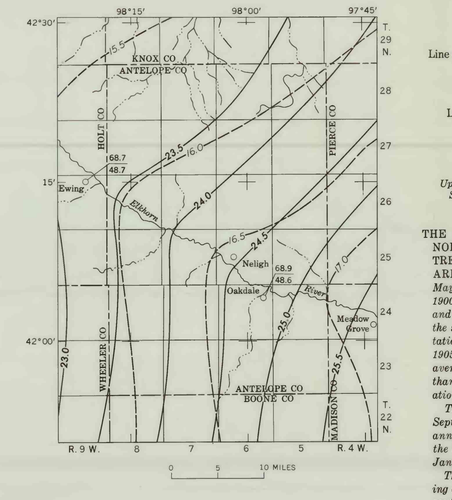
PREPARED IN COOPERATION WITH THE
CONSERVATION AND SURVEY DIVISION
OF THE UNIVERSITY OF NEBRASKA

HYDROLOGIC INVESTIGATIONS
ATLAS HA-316 (SHEET 1 OF 3)

CLIMATE



ANTELOPE COUNTY IS LOCATED IN NORTHEASTERN NEBRASKA



EXPLANATION

Line of equal average precipitation for period May through September
Interval 0.5 inch

24.0

Line of equal average annual precipitation
Interval 0.5 inch

68.9
68.6

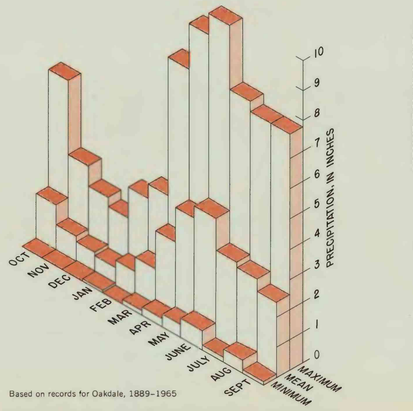
Temperature, in degrees Fahrenheit
Upper number, average for period May through September. Lower number, annual average

THE CLIMATE OF ANTELOPE COUNTY IS NORMALLY DRY SUBHUMID BUT IN EXTREME YEARS HAS BEEN HUMID (1965) OR ARID (1934).—*The average precipitation for the May-through-September months during the period 1906-65 increased southeastward across the county and the annual average precipitation increased in the same direction. The greatest annual precipitation during the same period was 24.40 inches in 1905 and the least was 16.52 inches in 1931. The average annual precipitation is 1 to 2 inches less than the average annual potential evapotranspiration.*

The average temperature for the May-through-September period is about 69° F, and the average annual temperature is about 49° F. At Oakdale the lowest temperature recorded was —38° F in January 1912 and the highest 115° F in July 1936.

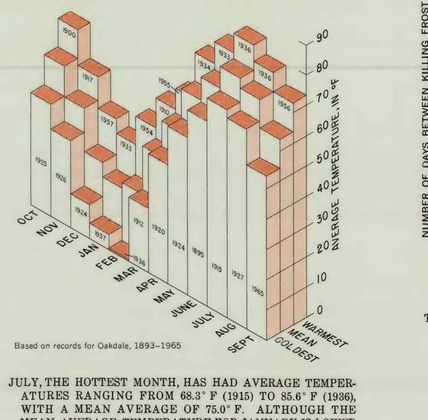
The direction of the wind changes frequently during all seasons; the prevailing direction is from the south or southeast from May through September and from the northeast the remainder of the year. The average wind velocity is 10 miles per hour. In some years, hot dry winds cause extensive damage to crops.

Sunshine for the year averages 63 percent of the possible amount. The average for December and January is 55 percent and for July and August a little more than 70 percent.

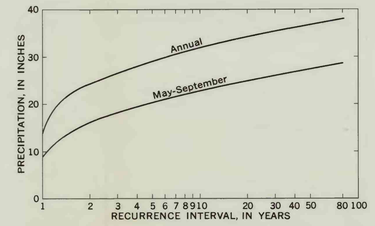


JUNE ORDINARILY IS THE WETTEST MONTH AND JANUARY THE DRIEST; THE AVERAGE PRECIPITATION FOR JUNE IS MORE THAN EIGHT TIMES LARGER THAN THAT FOR JANUARY.—*About half the annual precipitation occurs as thundershowers, and precipitation during May through September generally is about two-thirds the annual total.*

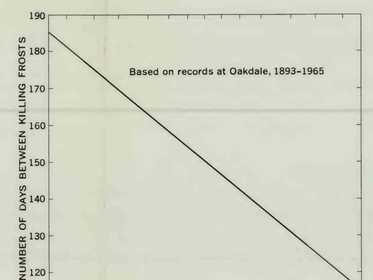
In many years the yields of crops are reduced because soil moisture is insufficient at one or more times during the growing season.



JULY, THE HOTTEST MONTH, HAS HAD AVERAGE TEMPERATURES RANGING FROM 68.3° F (1915) TO 85.6° F (1936), WITH A MEAN AVERAGE OF 75.0° F. ALTHOUGH THE MEAN AVERAGE TEMPERATURE FOR JANUARY IS LOWER THAN THE MEAN AVERAGE TEMPERATURE FOR ANY OTHER MONTH, THE AVERAGE TEMPERATURE FOR FEBRUARY 1936 (0.8° F) WAS LOWER THAN THE AVERAGE TEMPERATURE RECORDED IN ANY JANUARY.—*The winter months are characterized by a considerably greater difference between the lowest and the highest average temperatures than are the summer months. The wide range in monthly average temperatures is typical of the interior of continents in the middle latitudes.*

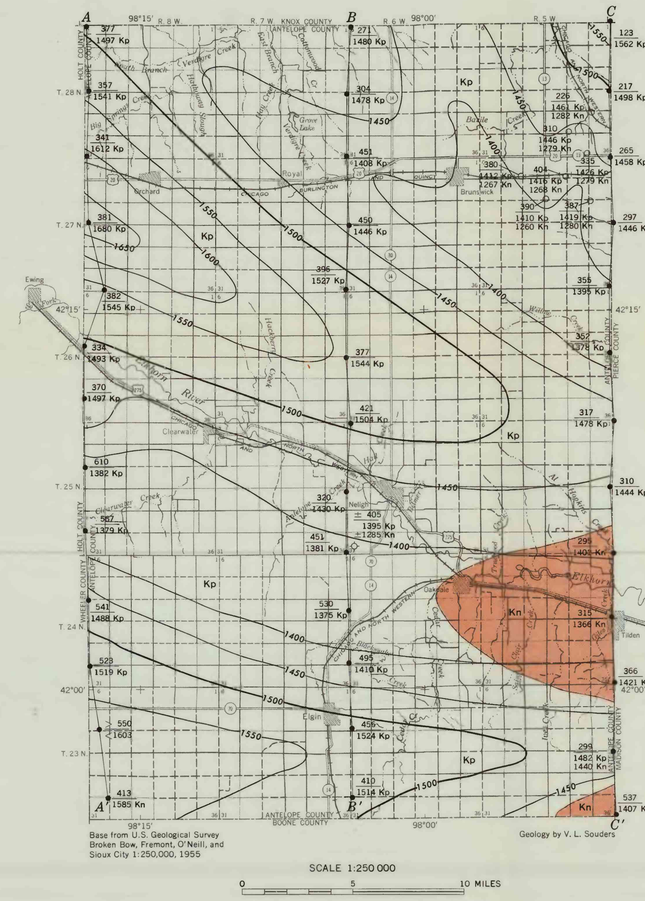


THE CHANCE, THAT A CERTAIN AMOUNT OF PRECIPITATION WILL BE EQUALED OR EXCEEDED DURING ANY YEAR OR ANY MAY-THROUGH-SEPTEMBER PERIOD IS INDICATED BY THE ABOVE RECURRENCE-INTERVAL GRAPH, WHICH IS BASED ON RECORDS COLLECTED AT OAKDALE FROM 1889 TO 1965.—*For example, the recurrence interval for an annual precipitation of 30 inches or more is 6 years and of 25 inches or more is 25 years. Similarly, the recurrence interval for a May-through-September precipitation of 21 inches or more is 6 years and of 25 inches or more is 20 years. A 20-year recurrence interval would have 1 chance in 20, or a 5-percent chance of being equaled or exceeded in any year.*



THE AVERAGE DATE OF THE LAST KILLING FROST IN THE SPRING IS MAY 5 AND OF THE FIRST KILLING FROST IN THE FALL IS OCTOBER 2; THUS, THE AVERAGE NUMBER OF DAYS BETWEEN KILLING FROSTS IS 150.—*The latest killing frost on record was May 29 and the earliest September 11. The graph shows that the frost-free growing season is at least 140 days in 75 percent of the years.*

GEOLOGY



Base from U.S. Geological Survey
Broken Bow, Fremont, O'Neill, and Sioux City 1:250,000, 1955

Geology by V. L. Souders

EXPLANATION

Upper Cretaceous — CRETACEOUS

Kp — Pierre Shale

Kn — Niobrara Formation

1500 — 1400 — Bedrock contours

Show approximate altitude of the surface of Cretaceous rocks. Contour interval 50 feet. Datum is mean sea level

304 — 1478 Kp

Drilled by Conservation and Survey Division, University of Nebraska, in cooperation with the U.S. Geological Survey

Oil company stratigraphic test: 310 — 1446 Kp — 1279 Kn

Oil test: 299 — 1482 Kp — 1440 Kn

Test holes

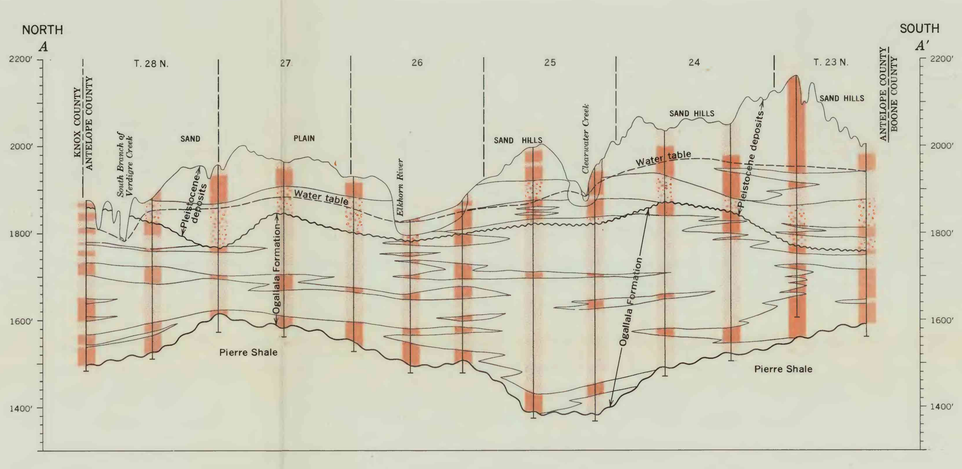
Upper number is depth to Cretaceous rocks, in feet below land surface. Lower numbers are altitude of Pierre Shale (Kp) and Niobrara Formation (Kn), in feet above mean sea level

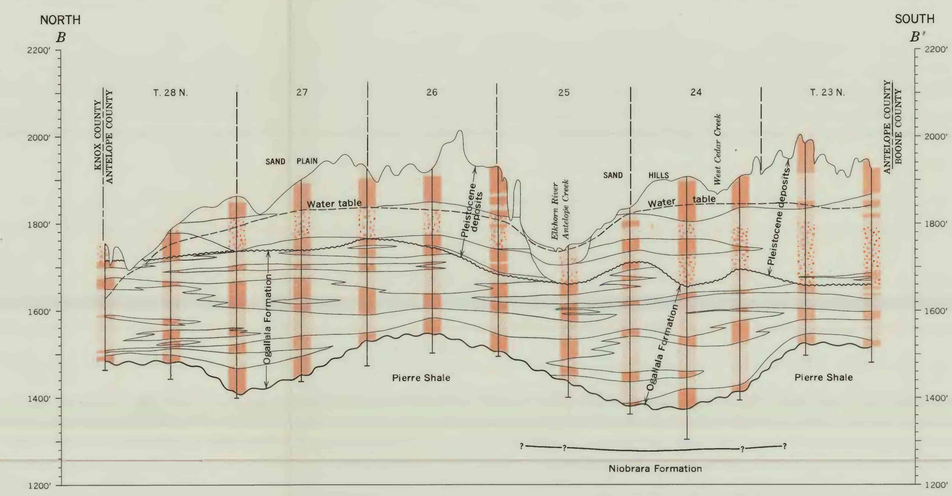
SCALE 1:250 000
0 5 10 MILES
0 5 10 KILOMETERS

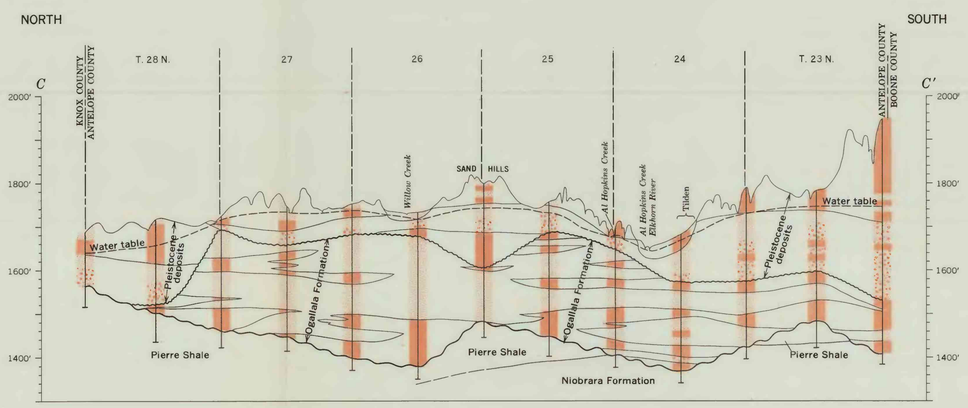
CONFIGURATION OF THE BURIED SURFACE OF CRETACEOUS ROCKS

FINE-GRAINED ROCKS OF LATE CRETACEOUS AGE UNDERLIE THE ENTIRE COUNTY; THEIR UPPER SURFACE IS THE LOWER LIMIT OF PROFITABLE DRILLING FOR SUPPLIES OF FRESH WATER.—*The Pierre Shale is the uppermost Cretaceous formation in all but two areas, one of about 12 square miles and the other of about 2 square miles, in the southeastern part of the county. In those areas the Niobrara Formation, which elsewhere underlies the Pierre, is the uppermost Cretaceous rock unit. Both the Pierre Shale and the Niobrara Formation, together with the older underlying Cretaceous rock units, dip generally eastward at low angles.*

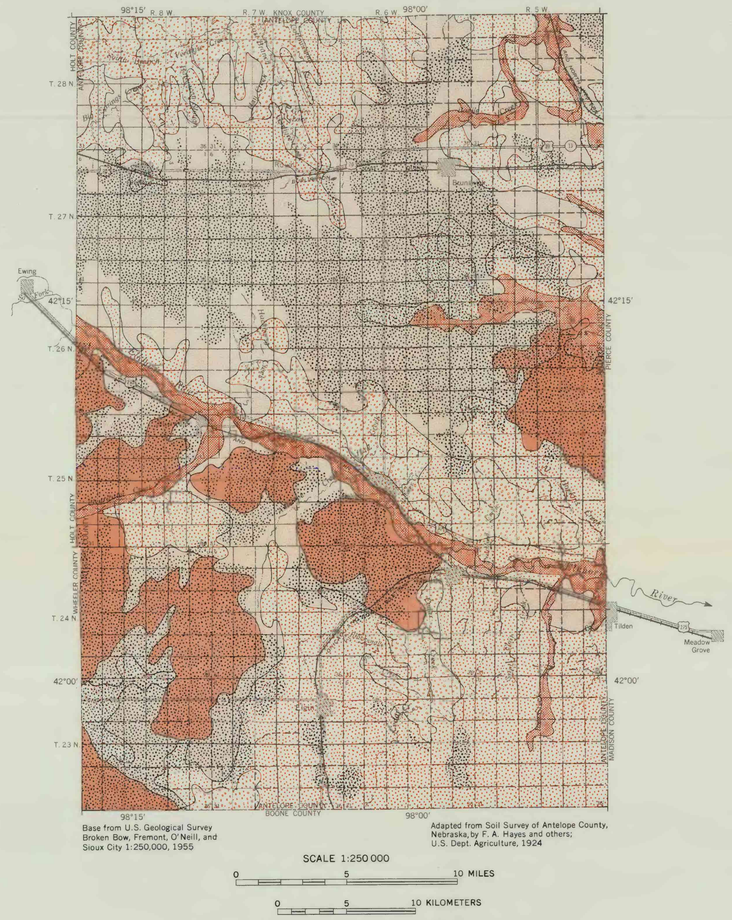
The configuration of the upper surface of Cretaceous rocks is the result of post-Cretaceous stream erosion. The highest and lowest points on that surface, as known from test drilling, are in sec. 18, T. 27 N., R. 8 W., and sec. 13, T. 26 N., R. 5 W., respectively. The difference between their altitudes is about 300 feet, or about 100 feet less than the present-day topographic relief.







SOILS



Base from U.S. Geological Survey
Broken Bow, Fremont, O'Neill, and Sioux City 1:250,000, 1955

Adapted from Soil Survey of Antelope County, Nebraska, by F. A. Hamilton and others, U.S. Dept. Agriculture, 1924

SCALE 1:250 000
0 5 10 MILES
0 5 10 KILOMETERS

AREAL DISTRIBUTION OF SOILS

EXPLANATION AND APPRAISAL OF SOILS

Map symbol	Soil type	Slope	Land use	Relation to water supply
	Sand	Hummocky to rolling	Pasture	Rapidly absorbs most or all the precipitation so rarely produces runoff. Probably transmits 20 to 25 percent of annual precipitation to water table.
	Loamy sand	Level to hummocky	Pasture, hay, small grains and row crops. Some areas suitable for irrigation.	Do.
	Silty and sandy loams	Level to rolling	Pasture, hay, small grains and row crops. Some areas suitable for irrigation.	Absorbs most or all of light precipitation but produces much runoff when precipitation is heavy. Most of absorbed precipitation is retained as soil moisture and is returned to atmosphere by transpiration of vegetation and direct evaporation. Probably transmits 5 to 10 percent of annual precipitation to water table.
	Silty and sandy loams; sandy loams locally gravelly	Steep	Pasture	Absorbs very little of moderately heavy and heavy precipitation and so produces much runoff. Most of the absorbed precipitation is retained as soil moisture and is returned to atmosphere by transpiration of vegetation and direct evaporation. Transmits little or none of the annual precipitation to water table.
	Silty to sandy loams	Level	Pasture, hay, small grains and row crops. Some areas suitable for irrigation.	Absorbs most of the precipitation so produces little runoff. Probably transmits large percent of annual precipitation to shallow water table, but gain to storage is only temporary because uptake by vegetation and direct evaporation return as much or more to the atmosphere.

Boundary of soil type

Area contributing little or no runoff to streams

SAND AND LOAMY SAND ARE THE PRINCIPAL SOIL TYPES IN ANTELOPE COUNTY, COMPRISING NEARLY 70 PERCENT OF THE COUNTY AREA; OTHER SOIL TYPES ARE SANDY LOAMS AND SILTY LOAMS.

Most soils developed on wind-deposited or wind-modified stream-deposited sediments. Neither the sand nor the loamy sand are calcareous, but the other types are mostly somewhat calcareous and their subsoils are lime enriched owing to incomplete leaching.

Throughout much of the upland area, soils are so porous that they absorb all or nearly all the precipitation. Only those soils that have a high silt content or are steeply sloping produce significant runoff. Except for some bottomland areas and land in the vicinity of Willow Creek, the entire county is well drained either internally or by overland runoff.

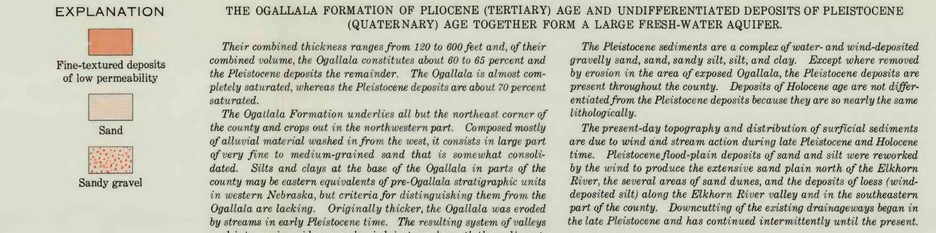
Large parts of the county are nearly level to gently rolling, and several rather extensive areas of grass-covered sand dunes—one north and the others south of the Elkhorn River valley—have a hummocky aspect. The steepest slopes are the sides of canyons in the northwestern part of the county, but moderately sharp relief also characterizes the valley sides of tributaries entering the Elkhorn River from the north, of Cedar Creek and its tributaries south of Oakdale, and of two creeks heading in an area a few miles east of the southwest corner of the county.

About half the county is used for growing crops, and most of the remainder is used as pasture for cattle.

When the county was first settled, trees were restricted to the stream valleys and to canyons in the northeastern part of the county and in the lower Cedar Creek drainage area. The remainder of the county was in prairie grass, which accounts for the present dark color of the loams and loamy sand. Beginning in the 1930's, many shelterbelts were planted and these afford some protection from the wind.

GENERALIZED SECTION OF STRATIGRAPHIC UNITS UNDERLYING ANTELOPE COUNTY

System	Series	Stratigraphic unit	Thickness (feet)	Character and distribution	Water supply
Quaternary	Holocene	Dune sand, loess, and surficial alluvium	0–15±	Wind-deposited sand and silt; flood-plain deposits of clay, silt, sand, and gravel. Widespread soil development.	Differences in slope and texture affect proportions of precipitation that become overland runoff, soil moisture, and recharge to zone of saturation.
	Pleistocene	Unconsolidated eolian and alluvial deposits	0–420	Wind-deposited silt and sand; stream-deposited clay, silt, sand, and sandy gravel. Underlies all but small areas in northwestern part of county.	Upper part generally not saturated; differences in texture affect rate water infiltrates to zone of saturation. Saturated lower part is principal source of water to wells. An important ground-water reservoir.
Tertiary	Pliocene	Ogallala Formation. Includes some thin pre-Ogallala sediments	0–440	Sandstone, silty sandstone, sandy siltstone, and unconsolidated sand, silt, and clay. Underlies all but the northeastern part of the county.	Yields water to a few wells in county. An important ground-water reservoir.
Cretaceous	Upper Cretaceous	Pierre Shale	0–300	Mostly gray to black marine shale. Calcareous in part. Underlies all of Antelope County, except for two areas in southeastern part.	Not a source of water supply in county.
		Niobrara Formation	300±	Yellow and light- to dark-gray marine chalky shale, chalky mudstone, and chalk. Underlies entire county.	Do.
		Carlile Shale	250±	Medium- to dark-gray marine shale. Thin fine-grained sandstone layers in upper part; calcareous in lower part. Underlies entire county.	Do.
		Greenhorn Limestone	20±	Gray fossiliferous limestone interbedded with calcareous shale. Underlies entire county.	Do.
		Graneros Shale	40±	Dark-gray shale. Calcareous in upper part. Underlies entire county.	Do.
	Lower Cretaceous	Dakota Sandstone	500–600	Sandstone interbedded with siltstone and claystone. Underlies entire county.	Sandstone layers slightly to moderately permeable. Water probably too highly mineralized for most uses. Depth to unit more than 1,000 feet below land surface. Not tapped by any wells in county.



EXPLANATION

Fine-textured deposits of low permeability

Sand

Sandy gravel

THE OGALLALA FORMATION OF PLIOCENE (TERTIARY) AGE AND UNDIFFERENTIATED DEPOSITS OF PLEISTOCENE (QUATERNARY) AGE TOGETHER FORM A LARGE FRESH-WATER AQUIFER.

Their combined thickness ranges from 120 to 600 feet and, of their combined volume, the Ogallala constitutes about 60 to 65 percent and the Pleistocene deposits the remainder. The Ogallala is almost completely saturated, whereas the Pleistocene deposits are about 70 percent saturated.

The Ogallala Formation underlies all but the northeast corner of the county and crops out in the northwestern part. Composed mostly of alluvial material washed in from the west, it consists in large part of very fine to medium-grained sand that is somewhat consolidated. Silts and clays at the base of the Ogallala in parts of the county may be eastern equivalents of pre-Ogallala stratigraphic units in western Nebraska, but criteria for distinguishing them from the Ogallala are lacking. Originally thicker, the Ogallala was eroded by streams in early Pleistocene time. The resulting system of valleys and intervening ridges was buried, in turn, beneath the sediments deposited in Pleistocene time.

The Pleistocene sediments are a complex of water- and wind-deposited gravelly sand, sand, sandy silt, silt, and clay. Except where removed by erosion in the area of exposed Ogallala, the Pleistocene deposits are present throughout the county. Deposits of Holocene age are not differentiated from the Pleistocene deposits because they are so nearly the same lithologically.

The present-day topography and distribution of surficial sediments are due to wind and stream action during late Pleistocene and Holocene time. Pleistocene flood-plain deposits of sand and silt were reworked by the wind to produce the extensive sand plain north of the Elkhorn River, the several areas of sand dunes, and the deposits of loess (wind-deposited silt) along the Elkhorn River valley and in the southeastern part of the county. Downcutting of the existing drainageways began in the late Pleistocene and has continued intermittently until the present.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1969—W68252

WATER RESOURCES OF ANTELOPE COUNTY, NEBRASKA

By
V. L. Souders and F. B. Shaffer

1969

For sale by U. S. Geological Survey, price $1.50 per set