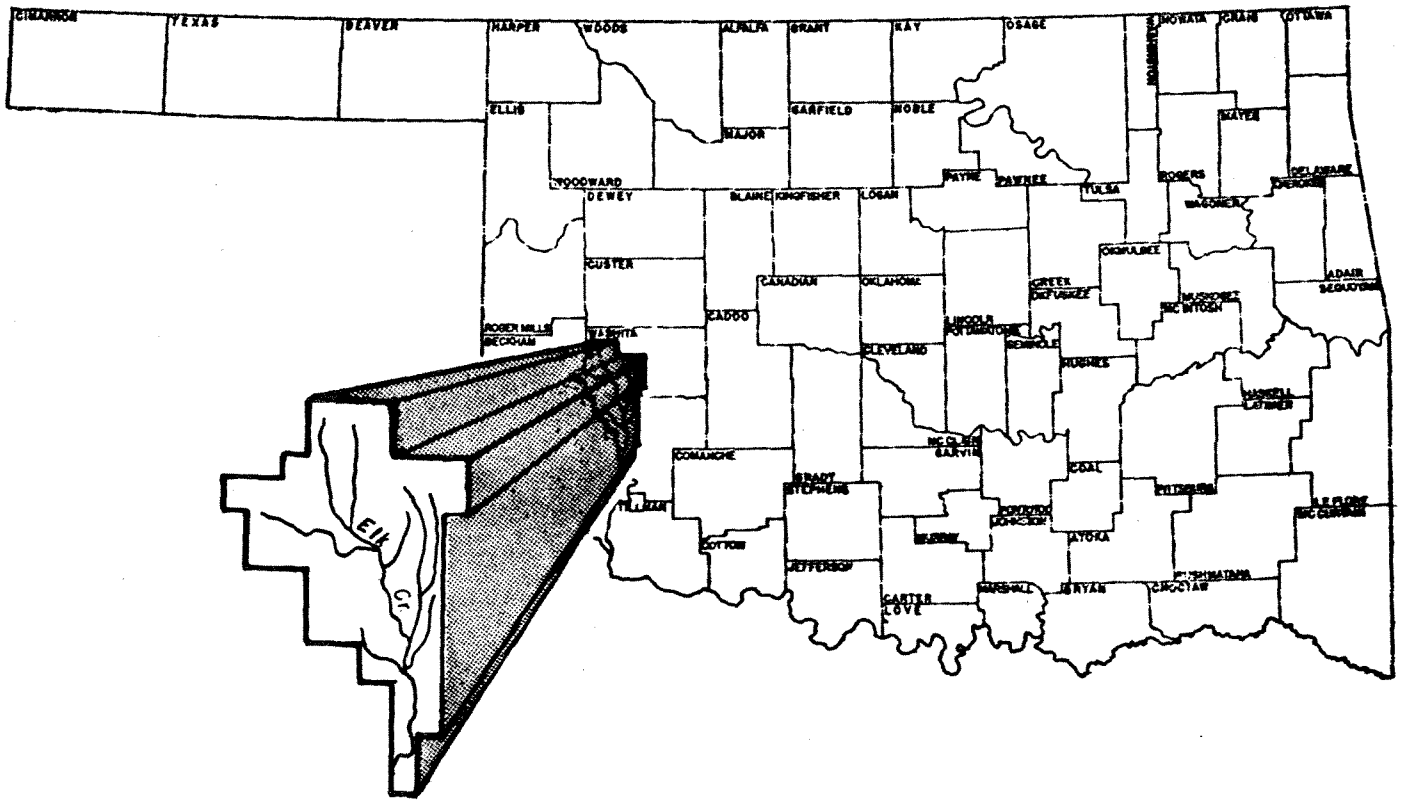
Ground Water In The Alluvium Elk Creek Basin, Oklahoma



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The investigation on which this report is based was made from December 1960 through February 1961 by the U.S. Geological Survey in cooperation with the Oklahoma Water Resources Board. A report that briefly described the ground-water geology and hydrology of the alluvial deposits in the Elk Creek basin was released to the open file in August 1961. The original purpose of the investigation was to provide information for use by the State in establishing water rights in the basin. Because it contains information on the availability of ground water that may be useful in planning and developing the area, the report has been published by the Oklahoma Water Resources Board.

Oklahoma Water Resources Board

GROUND WATER IN THE ALLUVIUM OF ELK CREEK BASIN, OKLAHOMA

By

Jerrald R. Hollowell

Open-File Report
Prepared by the U.S. Geological Survey
in cooperation with
the Oklahoma Water Resources Board

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By Jerrald R. Hollowell

ABSTRACT

The Elk Creek basin comprises 584 square miles in Washita, Beckham, and Kiowa Counties. The basin is typical of southwestern Oklahoma with nearly level plains broken by gentle rolling hills and low escarpments, except for the extreme southern part, where seven granite and gabbroic knobs and ridges of the Wichita Mountains protrude. The alluvium averages 40 feet in thickness and is restricted to the flood plain of Elk Creek and its major tributaries. The upper part of the alluvium is predominantly silt and clay. The lower part is predominantly very fine to medium sand. The flood plain is bounded by bedrock of Permian age except in T. 5 N. where it is bounded also by sporadic knobs and ridges composed of Precambrian rocks. Recharge to the alluvium is prinipally through infiltration of precipitation and surface runoff from adjacent highlands, and through percolation from the Quartermaster Formation in the northern part of the basin. Discharge is principally by seepage into the creek and transpiration by vegetation. Discharge by pumpage is small, principally for domestic and stock supply.

INTRODUCTION

Purpose and Scope

This report illustrates and describes the geology and hydrologic properties of the alluvium in Elk Creek basin. The bedrock geology is illustrated and described briefly. The purpose of this investigation was to map and describe the alluvium in Elk Creek basin and to explain the occurrence, movement, and use of ground water in the alluvium.

Location and General Features of the Basin

Elk Creek drains an area of 584 square miles in Kiowa, Washita, and Beckham Counties (fig. 1). The Elk Creek basin is elongate, trends northwest, and is about 50 miles long and 18 miles wide at its widest part. Altitudes range from about 2,280 feet at the headwaters to about 1,400 feet at the mouth.

Topography of the basin is typical of southwestern Oklahoma and consists of nearly level plains broken by gently rolling hills and low escarpments. However, a few isolated granite knobs and peaks protrude 50 to 200 feet above the plain in T. 5 N. (fig. 3).

Elk Creek heads in Beckham County near Elk City at an altitude of about 2,280 feet. Its course trends southeast about 43 miles to the mouth of Little Elk Creek in sec. 17, T. 6 N., R. 18 W. (fig. 3)., then south 14 miles to its confluence with North Fork Red River. Little Elk Creek heads in central Washita County in the north-central part of the basin at an altitude of about 1,900 feet and flows south to its confluence with Elk Creek.

The population of the basin, according to the 1960 Census, was about 21,700. Principal cities in the basin are Elk City, population, 8,196, in the extreme northern part; Hobart, population, 5,132, in the southern part; and Sentinel, population, 1,154, in the central part. Others are Dill City and Rocky with population of 623 and 343, respectively.

Well and test-hole numbering system

All Wells and test holes referred to in this report are identified by a location number used by the U.S. Geological Survey in Oklahoma. The location number is a description of the geographic location of the well or test hole, based on the Federal system of public-land surveys. It indicates the location of the well or test hole to the nearest 10-acre tract when the well can be located that accurately. The location number consists of a series of numbers and letters corresponding to the township, range, section, and tract within a section, in that order, as illustrated in figure 2. For instance, the number of 6N-18W-20bac refers to a well in T. 6 N., R. 18 W., sec. 20, and located in the $SW\frac{1}{4}NE\frac{1}{4}NW\frac{1}{4}$ of the section.

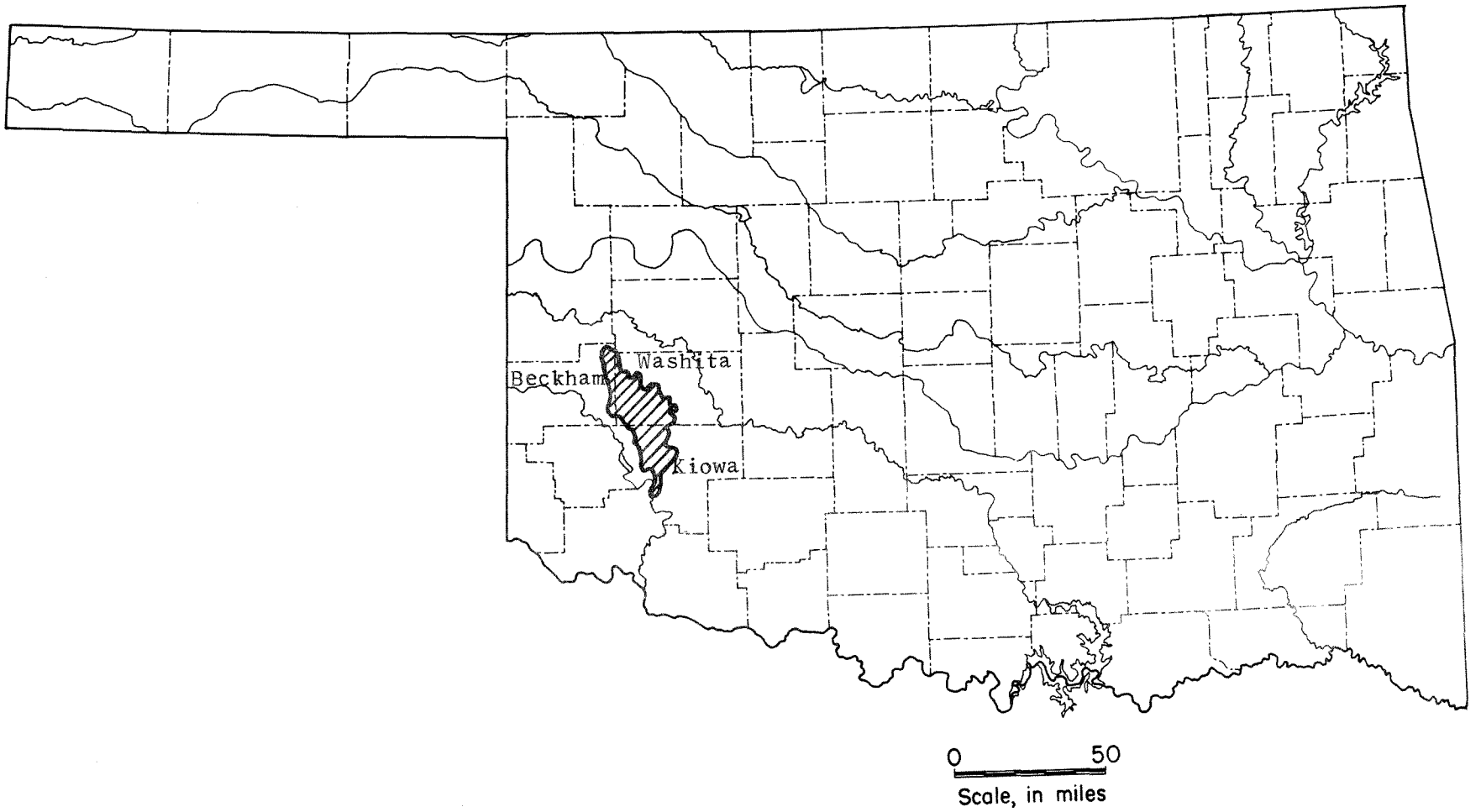

Figure 1.--Index map showing location of Elk Creek basin, Oklahoma

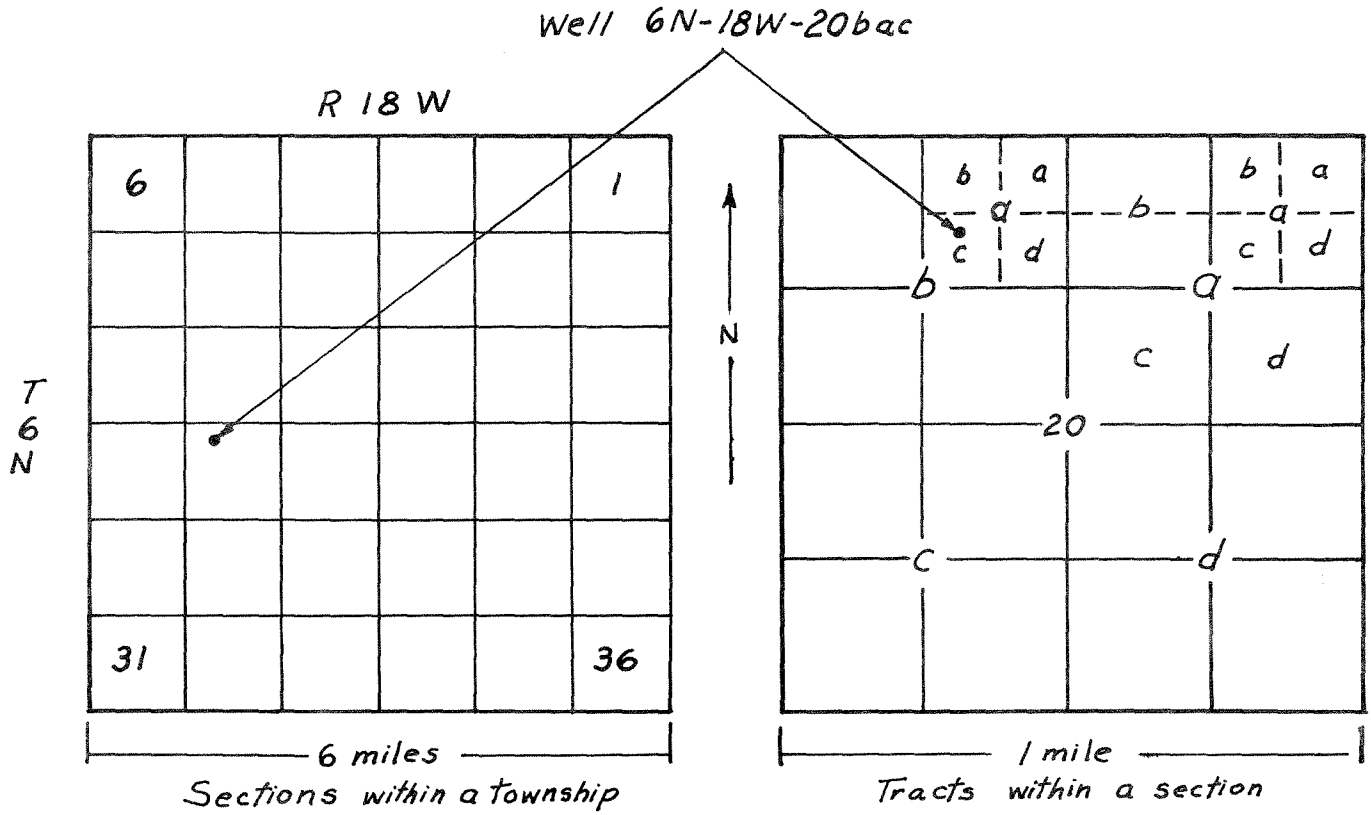

Figure 2.--Diagram illustrating well and test-hole numbering system

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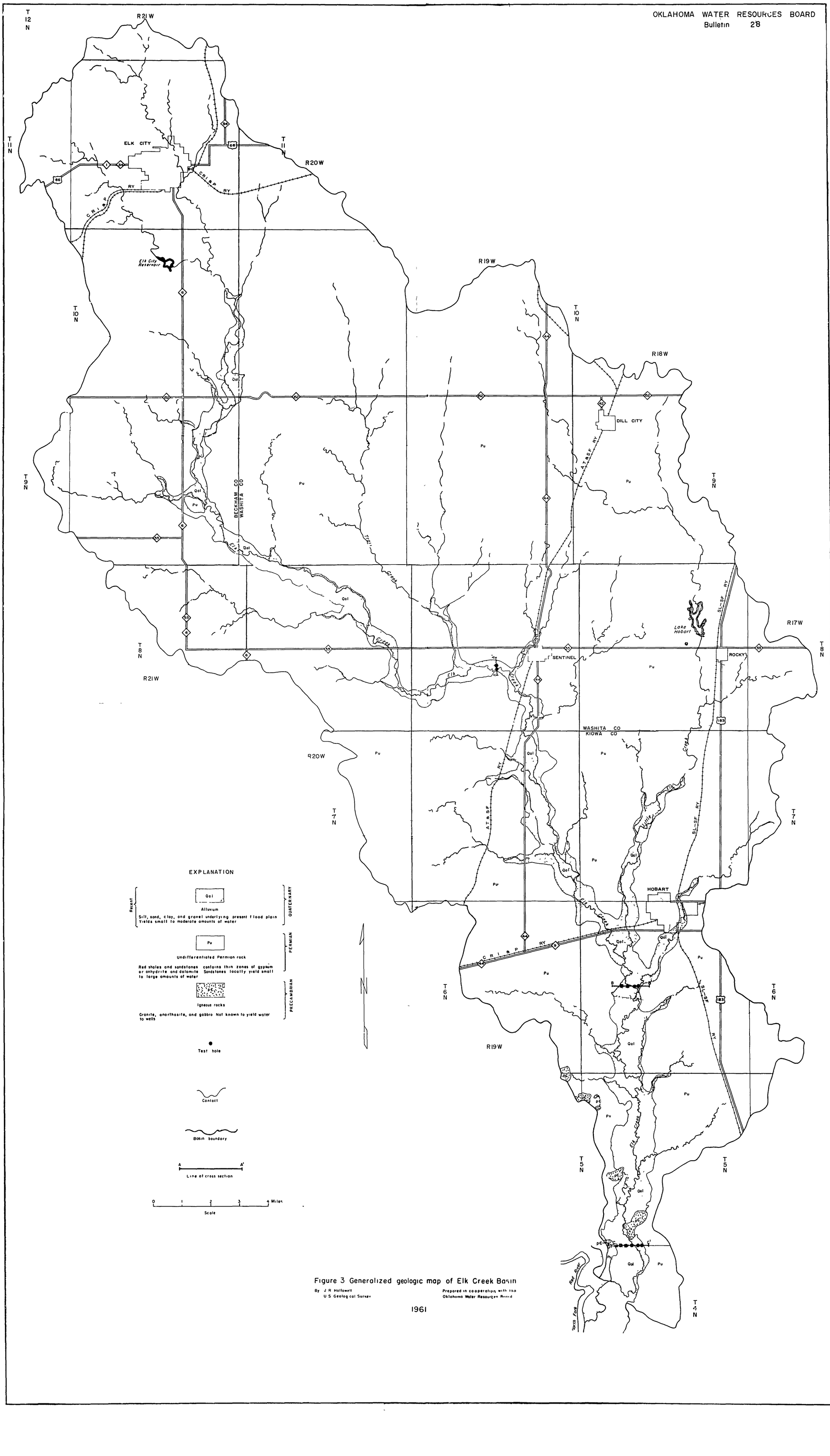


Figure 3 Generalized geologic map of Elk Creek Basin

By J R Hollowell
U S Geological Survey

Prepared in cooperation with the Oklahoma Water Resources Board

1961

GEOLOGY

Precambrian Rocks

The Precambrian outcrops in the basin consist of seven granite and gabbro knobs scattered sporadically in T. 5 N., of Kiowa County (fig. 3). These knobs protrude about 50 to 200 feet above the red-bed plain.

Permian Rocks

The exposed bedrock, with the exception of the Precambrian, is of Permian age. The strata consist predominantly of red shale, sandstone, and beds of gypsum. The outcropping beds traversed by Elk Creek are, oldest to youngest, the Wichita Formation, the Hennessey Shale, the El Reno Group, the Whitehorse Group, the Cloud Chief Formation, and the Quartermaster Formation. The Permian Bedrock is not differentiated on figure 3.

The upper part of the Wichita Formation is composed chiefly of gray-brown and reddish-brown shale and siltstone and light-gray and reddish-brown very fine to medium-grained sandstone which locally is gypsiferous (Adkinson, 1960).

The Hennessey Shale is composed chiefly of reddish-brown shale, some reddish-brown, pale-red and light-gray siltstone, and very fine-grained sandstone. It contains anhydrite, gypsum, and light-gray and reddish-brown limestone and dolomite (Adkinson, 1960).

The El Reno Group consists largely of reddish-brown shale and very fine and fine-grained sandstone containing some gray and greenish-gray shale and siltstone, gypsum, anhydrite, and dolomite (Adkinson, 1960). The lower part contains much lenticular sandstone that, locally, is water bearing and supplies water for stock and domestic use. In this area, the El Reno Group is divisable into the Duncan Sandstone and Flowerpot Shale, the Blaine Gupsum, and Dog Creek Shale.

The lower part of the Whitehorse Group, the Marlow Formation, is composed of reddish-brown gypsiferous very fine and fine-grained sandstone and reddish-brown shale. This is overlain by the Rush Springs Sandstone, which is composed of reddish-brown, limy, very fine and fine-grained sandstone (Adkinson, 1960). The Rush Springs Sandstone is the aquifer from which Sentinel obtains its municipal water supply.

The Cloud Chief Formation is composed principally of pale-red fine-grained sandstone, siltstone, and silty shale interbedded with thin gypsum layers. Near the base there is locally a massive thick gypsum or anhydrite bed (Ham and Jordan, 1961, p. 5).

The lower part of the Quartermaster Formation, the Doxey Member, consists of brownish-red shale interbedded with very thin brownish-red siltstone. The upper member, the Elk City, is composed mainly of fine and medium-grained reddish-brown sandstone that is coarse grained at the base and interstratified throughout with siltstone (Han and Jordan, 1961, p. 6).

Quaternary Deposits

Alluvium

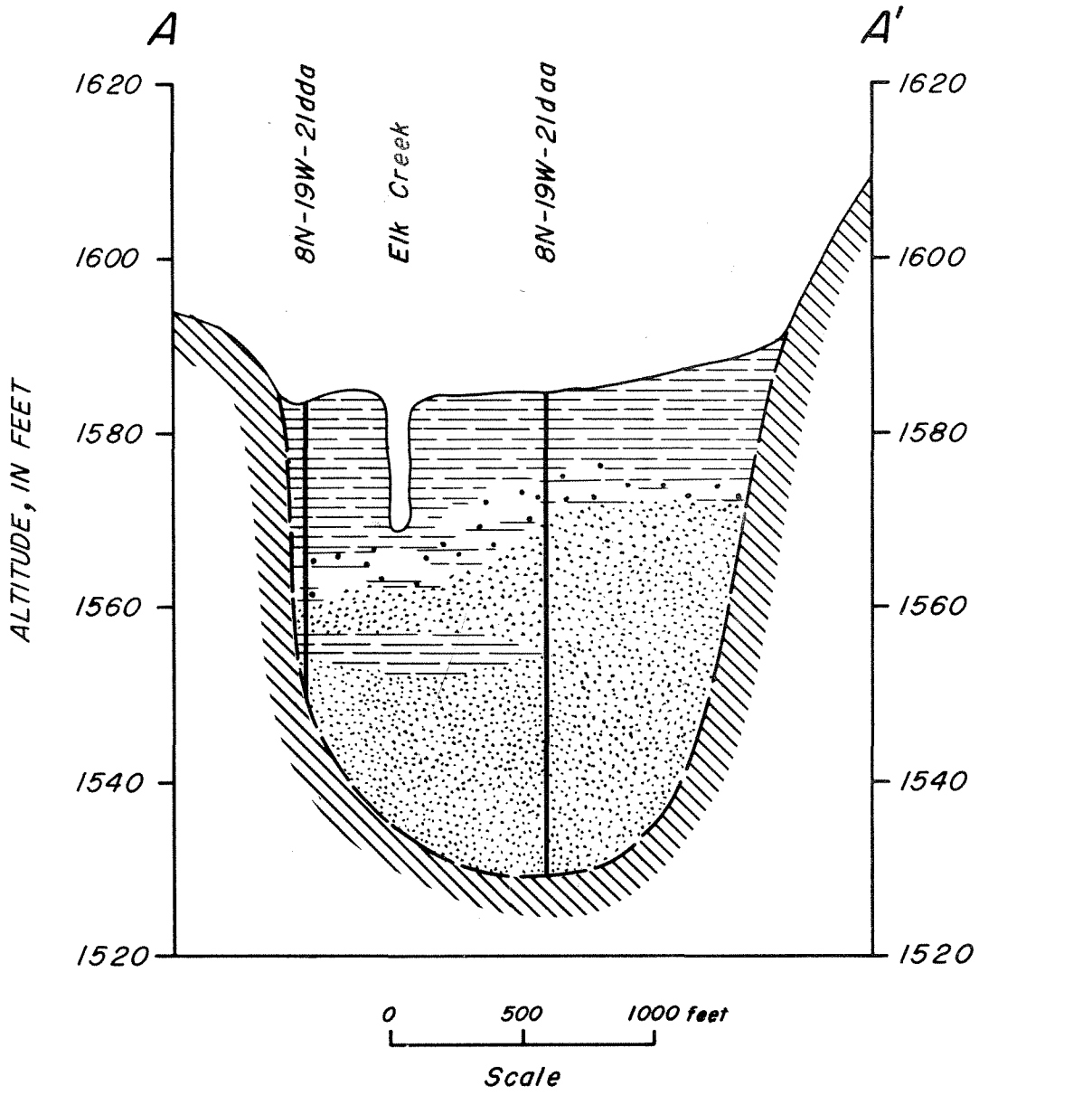
The alluvial deposits of Elk Creek basin are confined primarily to the flood plain of Elk Creek and its tributaries (fig. 3). The upper part of the alluvial deposits consists mostly of silt and clay that range from reddish-brown to dark-brown, is occasionally sandy, and contains invertebrate shells. The lower part of the deposits consists mostly of very fine to medium sand that ranges from reddish-brown to brown. Coarse sand and gravel occur as basal deposits at many places. Silt and clay generally are interbedded with very fine sand in a zone of transition between the upper fine stratum and lower coarse stratum.

The alluvium was derived principally from the fine and medium-grained sandstone, siltstone, and shale beds of the Permian bedrock formations. Coarse sand and gravel were derived from Pleistocene high-terrace deposits and from locally outcropping granite knobs in the extreme southern part of the basin.

The alluvial valley of Elk Creek in Beckham County is about a quarter to half a mile wide narrowing upstream to less than 600 feet. Test-hole 10N-21W-36ab indicates the alluvium has a thickness of 55 feet with 50 feet of sand and gravel in the lower part.

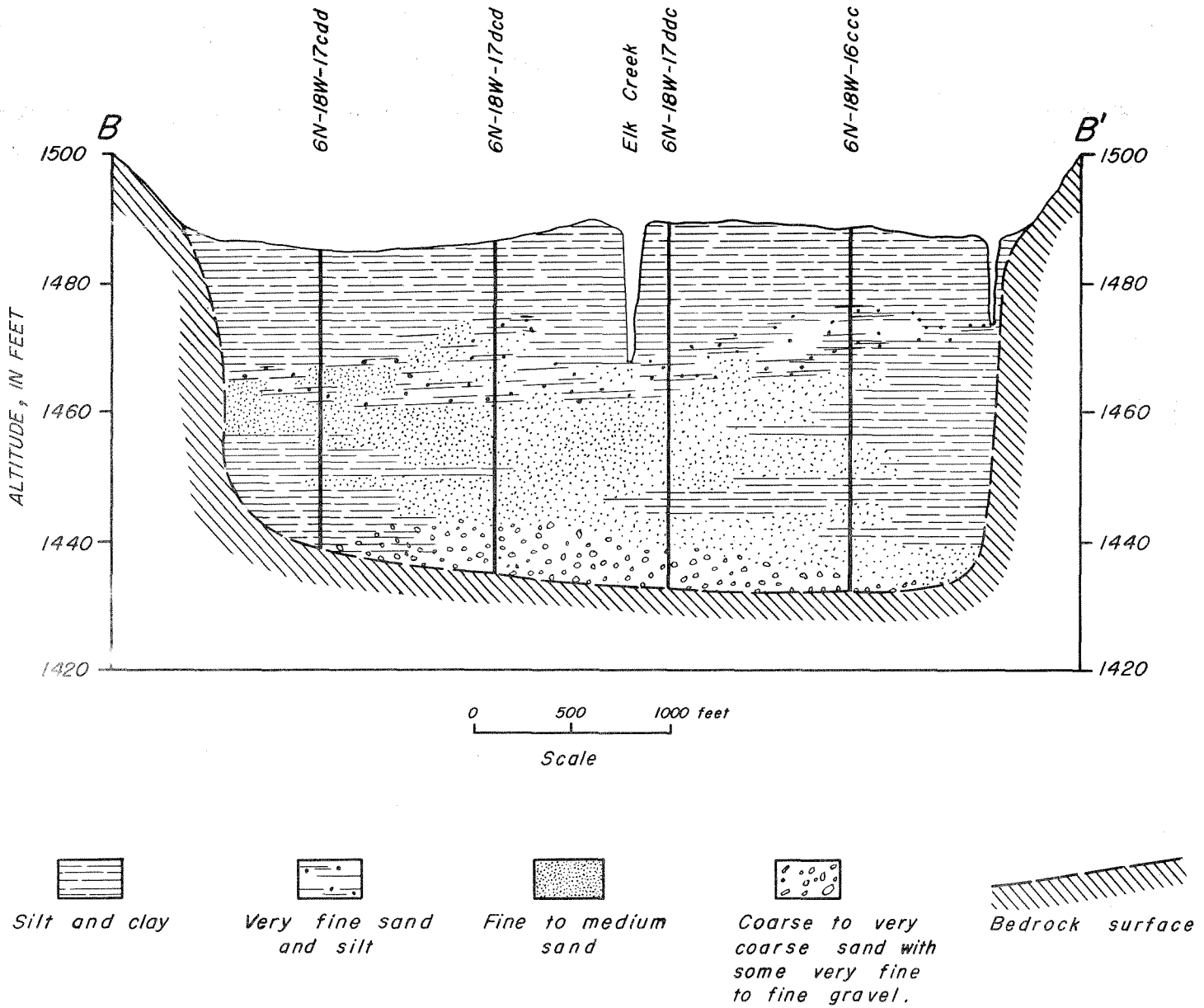
The alluvial valley of Elk Creek in Washita County is about half a mile wide. Near Sentinel, at test-hole 8N-19W-21daa, the thickness of the alluvium is 55 feet with 47 feet of sand in the lower part, as shown in geologic section A-A' (fig. 4).

In Kiowa County, the alluvial valley is about 1 to 2 miles wide. In this wider part of the valley, the alluvium is not as thick as it is near Sentinel (figs. 5 and 6). At the line of section B-B' (fig. 5) the alluvium averages 52 feet in thickness. The upper silt and clay part averages 21 feet in thickness and the lower sandy part averages 31 feet. However, the lower part is silt and interbedded with layers of clayey silt a few inches to more than a foot thick. At the line of section C-C' (fig. 6) the alluvium averages 32 feet in thickness. The upper silt and clay stratum averages 15 feet in thickness and the lower sand and gravel averages 17 feet. The lower sand and gravel are predominantly silty and



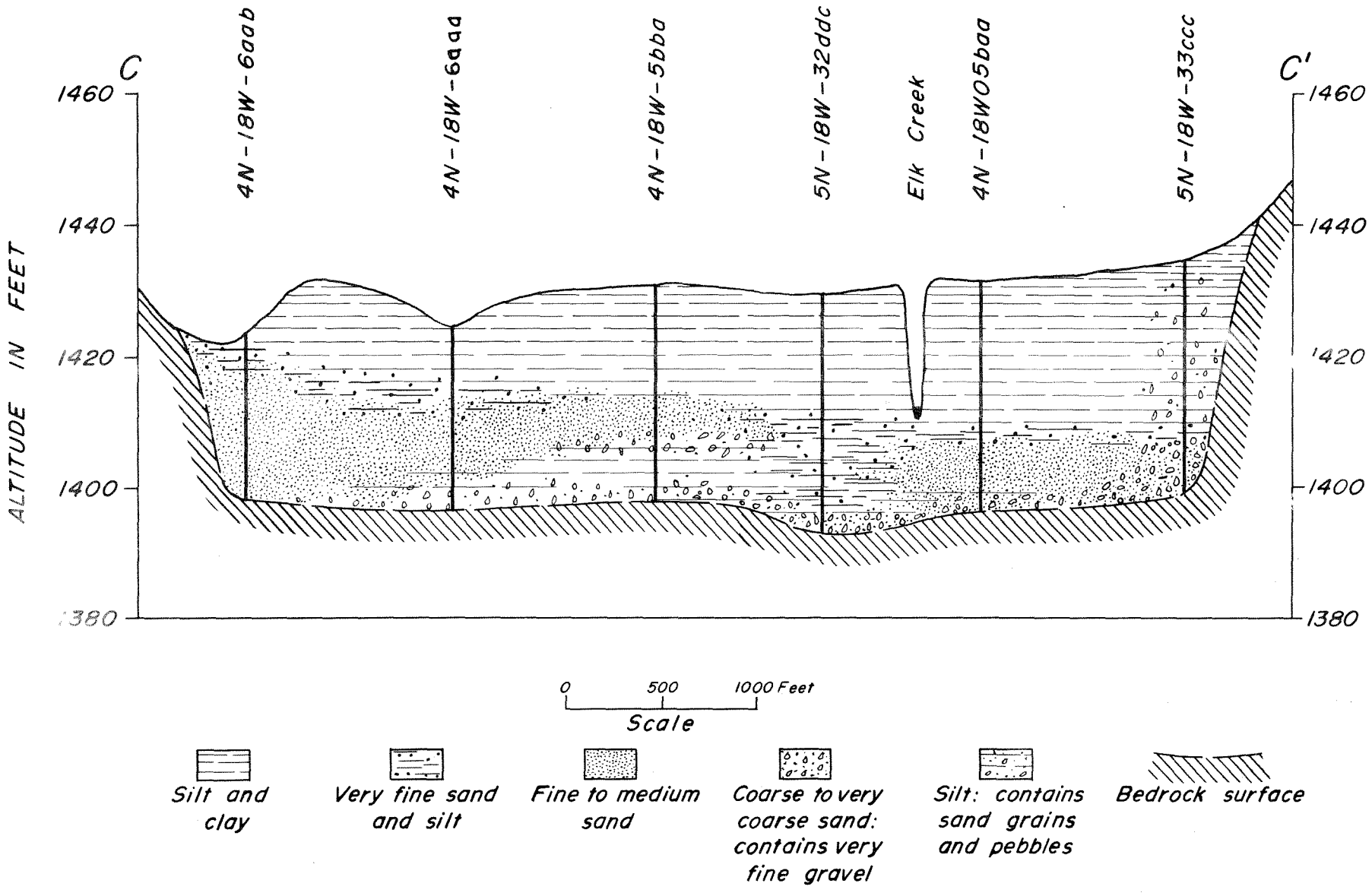
Line of cross section shown on figure 3.

Figure 5. Geologic cross section A-A'



Line of cross section shown on figure 3.

Figure 5. Geologic cross section B-B'



Line of cross section shown on figure 3

Figure 6. Geologic cross section C-C'

interbedded with thin clay and silt layers, however, in test-holes 4N-18W-5baa and 5N-18W-33ccc the sand and gravel were only slightly silty.

The alluvium of Elk Creek is the principal aquifer along its valley, but is inadequate to supply large quantities of water. Although thick sequences of sand may occur, the sand is fine, very silty, and interbedded with lenses of clay. This limits development of large water supplies. Small supplies for domestic and stock use are obtained from locally fine to coarse sand or basal coarse sand and gravel.

Terrace Deposits

Pleistocene terrace deposits in the basin were not mapped. The deposits are topographically high, small in areal extent, and insignificant as aquifers in the basin. No Pleistocene deposits were found in contact with the alluvium.

GROUND WATER IN THE ALLUVIUM

Ground water is water in the zone of saturation beneath the land surface. The water table, the upper surface of the zone of saturation, in the alluvium of Elk Creek generally is 10 to 20 feet below the land surface.

Movement

The ground water is continually moving from points of recharge to points of discharge. The normal movement of ground water in the alluvium is downstream and toward the stream because the greatest recharge into the alluvium is through the land surface and the greatest discharge is into the stream.

Recharge

Recharge, the replenishment of ground water, may be from one or more of several sources. The principal sources are from infiltration of precipitation directly on the flood plain, from surface runoff from adjacent bedrock highlands onto the flood plain, and from overflow of Elk Creek. Another source is from infiltration through the banks of Elk Creek during a higher-than-average stream stage. Recharge takes place continually through lateral percolation from the Quartermaster Formation in the northern part of the basin.

Discharge

Ground water is being discharged continually through one or more of several ways--by seepage into stream channels, percolation into other aquifers, transpiration by plants, evaporation, and pumping by wells.

Discharge takes place as ground water seeps into a stream whose surface is lower than the water table. This occurs at all times except during high-stream stages and when the water table is lower than the stream bed. Seepage from the ground-water body is responsible for stream flow during periods of no surface runoff. In northern Elk Creek basin seepage from the Quartermaster Formation into the alluvium is sufficient to maintain perennial flow in Elk Creek.

Discharge of ground water through percolation into aquifers that form bedrock boundaries for the alluvium occurs principally along the outcrop area of the Whitehorse Group and other sandstones in the Permian rocks.

Heavy growth of trees and brush, lining the banks of Elk Creek and covering other areas of the flood plain, discharge a large amount of ground water through transpiration. Discharge in this manner is particularly great by phreatophytes such as cottonwood, willow, and alfalfa.

Ground water is discharged by evaporation directly from the zone of saturation where the water table is within a few feet of land surface. Discharge in this manner from the alluvium is small because the depth to the water table at most places is too great to permit evaporation.

The discharge of ground water from the alluvium by pumping is small. There are a few irrigation wells in the flood plain near the confluence of Elk Creek with North Fork Red River. Other than water for domestic and stock supply, there is no pumpage from the alluvium north of T. 4 N. The city of Hobart has abandoned wells in the alluvium in sec. 20, T. 6 N., R. 18 W., that once were the source of municipal water. City well 6N-18W-20bac was reported to pump a 6-inch stream with open discharge. Test drilling along section B-B' (fig. 5) did not indicate any material that might supply such a high yield.

REFERENCES

Adkinson, W. L., 1960, Subsurface cross section of Paleozoic rocks from Barber County, Kansas, to Caddo County, Oklahoma: U.S. Geological Survey Oil and Gas Inv. Map OC-61.

Ham, W. E., and Jordan, Louise, 1961, A Permian stratigraphic section in west-central Oklahoma: Okla. Geology Notes, v. 21, no. 1, p. 4-9.

Appendix A.--Logs of test holes in the alluvium of Elk Creek basin, Oklahoma

The logs described below are a record of test holes augered and sampled by the U.S. Geological Survey, except the test holes located in 10N-21W-36ab, which were drilled and logged by George Lutz of Elk City. Altitudes refer to ground level at the edge of the test hole in feet above mean sea level.

Description	Thickness (feet)	Depth (feet)
4N-18W-5baa. 20 feet south and 10 feet west of north quarter cor. sec. 5. Altitude: 1,432.		
Silt, dark-brown	2	2
Silt, reddish-brown, clayey	21	23
Sand, very fine to medium	9	32
Sand, very fine to medium; contains coarse sand	3	35
Shale, red (bedrock)	..	..
4N-18W-5bba. 15 feet south and 1,000 feet east of NW cor. sec. 5. Altitude: 1,431.		
Silt, reddish-brown	18	18
Sand, brown, very fine to medium	5	23
Sand; contains very fine gravel	2	25
Silt, brown, clayey	6	31
Gravel, very fine to fine	2	33
Shale, red (bedrock)	..	..
4N-18W-6aaa. 75 feet south and 20 feet west of NE cor. sec. 6. Altitude: 1,424.		
Silt, dark-brown	2	2
Silt, reddish-brown, and very fine sand	6	8
Sand, reddish-brown, very fine, and silt; water saturated at 11 feet	5	13
Sand, reddish-brown, very fine to medium; contains silt	5	18
Sand, reddish-brown, very fine to coarse	5	23
Silt, reddish-brown; clayey	2	25
Gravel, very fine to medium, and very fine to very coarse sand	3	28
Shale, red (bedrock)	..	..
4N-18W06aab. 15 feet south and 1,100 feet west of NE cor. sec. 6. Altitude: 1,423.		
Sand, very fine to medium; contains coarse sand and silt and shell fragments; water saturated at 9 feet	25	25
Shale, red (bedrock)	..	..
5N-18W-32ddc. 15 feet north and 1,200 feet west of SE cor. sec. 32. Altitude: 1,429.		
Silt, reddish-brown, and very fine sand	4	4
Silt, brown	14	18
Sand, brown, very fine, and silt; water saturated	13	31
Silt	2	33
Sand, very fine to medium; contains coarse sand	3	36
Shale, brown (bedrock)	..	..
5N-18W-33ccc. 15 feet north and 600 feet east of SE cor. sec. 33. Altitude, 1,434.		
Silt, brown	2	2
Silt, brown; contains sand grains and pebbles	23	25
Sand, reddish-brown, very fine; contains silt and coarser sand	3	28
Sand, reddish-brown, very fine to very coarse, and very fine gravel	7	35
Shale, red (bedrock)	..	..
6N-18W-16ccc. 15 feet north and 15 feet east of SW cor. sec. 16. Altitude: 1,489.		
Silt, dark-brown	4	4
Silt, reddish-brown, clayey	3	7
Sand, orangish-brown, very fine, and silt; water saturated from 16 to 18 feet	11	18
Silt, reddish-brown; contains very fine sand	5	23
Sand, reddish-brown, very fine, and silt; water saturated	8	31
Silt, reddish-brown	2	33
Sand, reddish-brown, very fine; interbedded with silt	15	48
Sand, reddish-brown, very fine to fine	7	55
Gravel, very fine to fine and very fine to very coarse sand	1	56
Shale, red (bedrock)	..	..

Description	Thickness (feet)	Depth (feet)
6N-18W-17cdd. 15 feet north and 15 feet west of south quarter cor. sec. 17. Altitude: 1,485.		
Silt, dark-brown	4	4
Silt, reddish-brown	5	9
Silt, reddish-brown, and very fine sand; water saturated at 16 feet	9	18
Sand, reddish-brown, very fine, and silt	5	21
Sand, very fine to fine, and silt; interbedded with clayey silt layers up to a foot thick	8	31
Silt, dark-brown, clayey; contains shell fragments	5	36
Sand	1	37
Silt, grayish-brown, clayey; contains shell fragments	9	46
Shale, red (bedrock)	..	..
6N-18W-17dcd. 15 feet north and 900 feet east of south quarter cor. sec. 17. Altitude: 1,487.		
Silt, dark-brown	5	5
Silt, reddish-brown, and very fine sand	8	13
Sand, reddish-brown, very fine, and silt; water saturated at 15 feet	10	23
Silt, clayey	2	25
Sand, reddish-brown, very fine to fine; and silt; interbedded with layers of silt	20	45
Gravel, very fine to fine	6	51
Shale, blue-gray (bedrock)	..	..
6N-18W-17ddc. 15 feet north and 900 feet west of SE cor. sec. 17. Altitude: 1,490.		
Silt, dark-brown	3	3
Silt, reddish-brown	18	21
Sand, reddish-brown, very fine, and silt; water saturated	4	25
Sand, reddish-brown, very fine to fine, and silt	3	28
Sand, reddish-brown, very fine to coarse, and silt; interbedded with layers of clay	29	57
Shale, red (bedrock)	..	..
8N-18W-21daa. 550 feet south and 15 feet west of east quarter cor. sec. 21. Altitude: 1,585.		
Silt, dark-brown	3	3
Silt, reddish-brown	5	8
Sand, reddish-brown, very fine, and silt; water saturated at 10 feet	5	13
Sand, reddish-brown, very fine to fine; contains medium sand	15	28
Sand, brown, very fine to medium	27	55
Shale, red (bedrock)	..	..
8N-19W-21dda. 1,100 feet north and 15 feet west of SE cor. sec. 21. Altitude: 1,584.		
Silt, dark-brown	2	2
Silt, reddish-brown	13	15
Sand, reddish-brown, very fine, and silt; water saturated	8	23
Sand, reddish-brown, very fine to fine	4	27
Silt, brown	1	28
Sand, reddish-brown, very fine to fine	5	33
Shale, red (bedrock)	..	..
10N-21W-36ab. Driller's log.		
Silt, brown, sandy	5	5
Silt, yellow, sandy	2	7
Silt, brown, clayey	11	18
No sample	20	38
Sand, very fine to medium, silty	3	41
Sand and gravel	7	48
Gravel, fine to medium	3	51
Clay, red (bedrock)	..	..
10N-21W-36ab. Driller's log.		
Silt, brown, sandy	3	3
Clay, red	2	5
Sand, fine to medium, and fine to medium gravel	16	21
Sand, fine to medium; interbedded with clay lenses	30	51
Gravel, medium	10	61
Clay, red (bedrock)	..	..