

**Summary Report for the 2002–2003 STATEMAP Project:
Geological Mapping to Support Improved Database
Development and Understanding of Urban Corridors
and Critical Aquifers of Texas**

Final Report

by

Edward W. Collins and Jay A. Raney

prepared for

U.S. Geological Survey
under Cooperative Agreement 02HQAG0012



Bureau of Economic Geology
Scott W. Tinker, Director
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CONTENTS

INTRODUCTION.....	1
GEOLOGY OF THE SEYMOUR AQUIFER DEPOSITS WITHIN THE VERNON, TEXAS, 30 × 60 MINUTE QUADRANGLE.....	4
Geologic Setting.....	4
Geology of the Study Area.....	10
<i>Geologic Map</i>	11
SUMMARY.....	16
ACKNOWLEDGMENTS.....	17
REFERENCES.....	18
GEOLOGIC MAP OF SEYMOUR AQUIFER DEPOSITS, VERNON, TEXAS, 30 × 60 MINUTE QUADRANGLE.....	in pocket

Figures

1. Location of the study area.....	2
2. Location of Seymour aquifer deposits throughout North-Central Texas.....	5
3. Stratigraphic units that compose the Seymour aquifer.....	6
4. Generalized stratigraphic section of Seymour aquifer deposits.....	8
5. Elevation of the base of Seymour aquifer deposits (top of undivided Permian strata).....	9
6. Cross section A–A' illustrating Seymour aquifer deposits.....	12
7. Isopach map illustrating the thickness of the Seymour aquifer deposits.....	13
8. Isopach map illustrating the thickness of the lower gravel- and sand-rich interval of the Seymour aquifer deposits.....	14

INTRODUCTION

This Texas STATEMAP project involves geologic mapping of a portion of the Seymour aquifer of North-Central Texas (fig. 1). *Geologic Map of Seymour Aquifer Deposits, Vernon, Texas, 30 × 60 Minute Quadrangle*, the deliverable for this 2002–2003 contract year, addresses groundwater-resource issues related to the aquifer. The map and related geologic data are intended for a diverse audience—geologists, hydrologists, engineers, students, and laypersons. Uses include (a) identifying aquifer recharge boundaries, (b) characterizing attributes and variations within the aquifer strata, and (c) providing information necessary for land-use activities such as locating landfills and other waste-disposal sites. The map and related geologic data can also be used with Seymour aquifer information to analyze the aquifer's groundwater flow and response for pumpage and recharge for future water-management decisions. The aquifer has been an important source of water for irrigation, municipal pumpage, and industrial and livestock use in the area.

Methods used in the mapping project include standard field techniques, study of aerial photographs, and review of previous work. Base topographic maps having scales of 1:24,000 were used in conjunction with the 1:100,000-scale Vernon, Texas, 30 × 60 minute quadrangle. The study also utilized subsurface data from more than 550 wells and test holes. These data, provided through Texas Water Development Board well and drilling records and published hydrogeologic-related reports, include information on the lithologies and thicknesses of the aquifer deposits (Huggins, 1936; Russell and Huggins, 1936; George and Johnson, 1941; Willis and Knowles, 1953; Baker and others, 1963; Maderak, 1972; Price, 1979). Map data were compiled on the 1:100,000-scale Vernon, Texas, 30 × 60 minute quadrangle, the final map

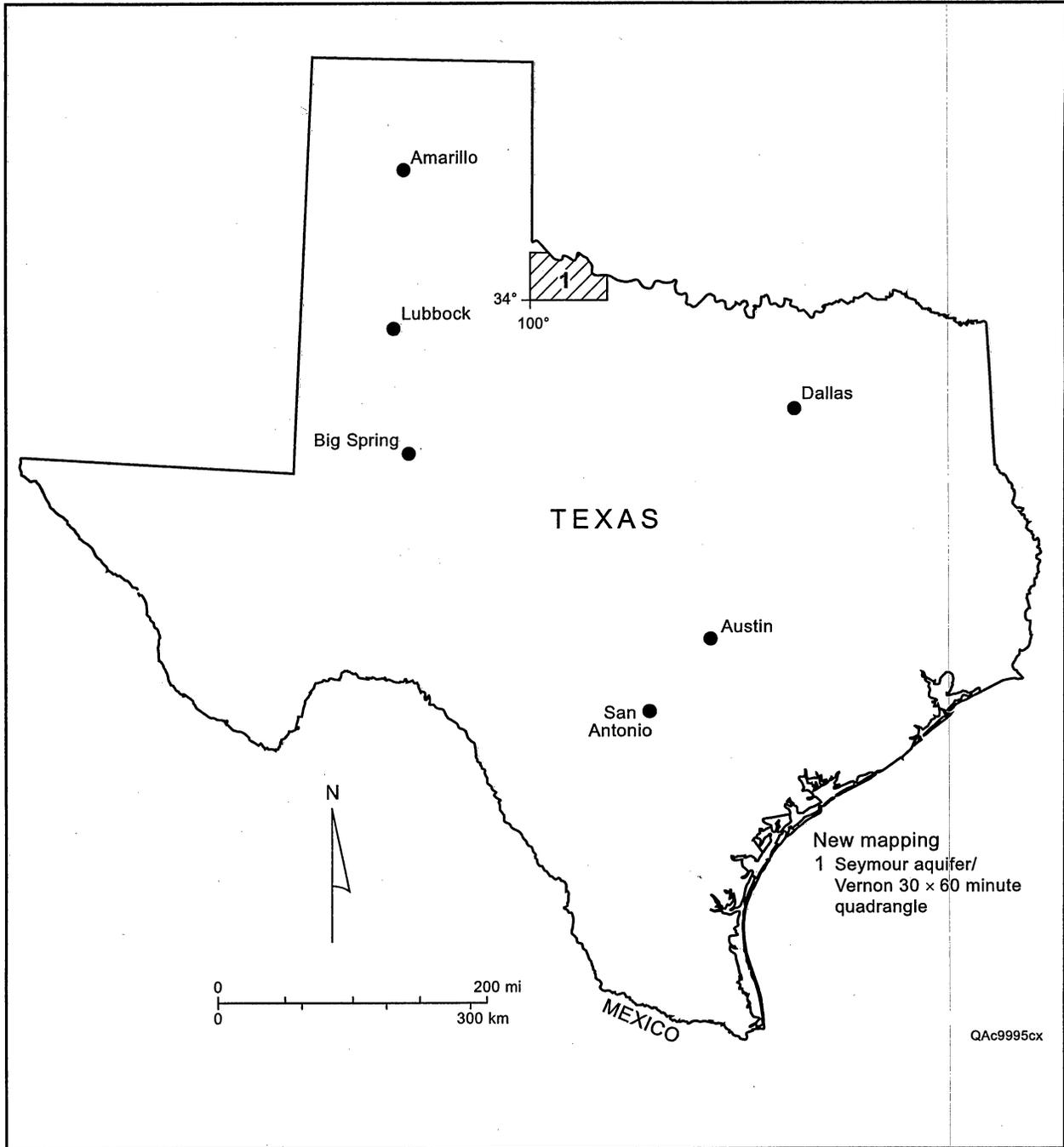


Figure 1. Location of the study area.

product (deliverable). Black-and-white aerial photograph sets used for this study are at scales of 1:40,000 and 1:63,500. Published geologic maps at scales of 1:100,000 and larger do not exist for this new mapping-project study area. An existing regional geologic map that encompasses the area is at a scale of 1:250,000 (Hentz and Brown, 1987). Very generalized page-size maps of Hardeman and Wilbarger Counties are in groundwater reports by Willis and Knowles (1953), Maderak (1972), and Price (1979). Lithology, paleontology, and regional correlation of the water-bearing Paducah Group, which includes Seymour and younger deposits, were discussed by Stricklin (1961), Dalquest (1962; 1965), Hibbard and Dalquest (1966), Simpkins and Baumgardner (1982), Caran (1990), and Caran and Baumgardner (1990), although adequate maps of the study area by these workers do not exist. Useful soil studies of the counties that include the study area, Wilbarger, Foard, and Hardeman Counties, were reported on by Koos and others (1962), Koos and Dixon (1964), and Lofton and others (1972).

GEOLOGY OF THE SEYMOUR AQUIFER DEPOSITS WITHIN THE VERNON, TEXAS, 30 × 60 MINUTE QUADRANGLE

Geologic Setting

The Seymour aquifer is sometimes called “the North-Central Texas alluvial aquifers” because these water-bearing units occur throughout North-Central Texas in more than 15 areas that range in area from about 20 mi² to about 430 mi² (fig. 2). In general, the aquifer strata (fig. 3) include sediments of the Pleistocene Seymour Formation and younger deposits that compose the Pleistocene-Holocene Paducah Group (Caran, 1990; Caran and Baumgardner, 1990). Caran (1990) and Caran and Baumgardner (1990) included Holocene fluvial (channel, floodplain, and terrace), eolian, and lacustrine deposits as upper Paducah Group deposits. The older Paducah Group sediments were deposited as a regionally extending alluvial apron on a Permian bedrock surface by east-flowing streams (R. H. Harden and Associates, 1978; Caran and Baumgardner, 1990; Ryder, 1996). Subsequent erosion of this alluvial sediment package left remnants mostly within interstream areas.

Evidence of Paducah Group fluvial, lacustrine, eolian, and alluvial-fan depositional environments were presented by Caran and Baumgardner (1990). They also proposed that the eastern parts of the Pleistocene sediment package were deposited before the western parts; deposition was thus sequential from east to west and probably related to the westward erosion of the Caprock Escarpment, which marks the boundary between the Rolling Plains of North-Central Texas and the Southern High Plains of western Texas. The Seymour Formation, within the eastern part of North-Central Texas, comprises some of the larger and thicker remnant accumulations of Paducah Group deposits. *Seymour* has therefore been used as the

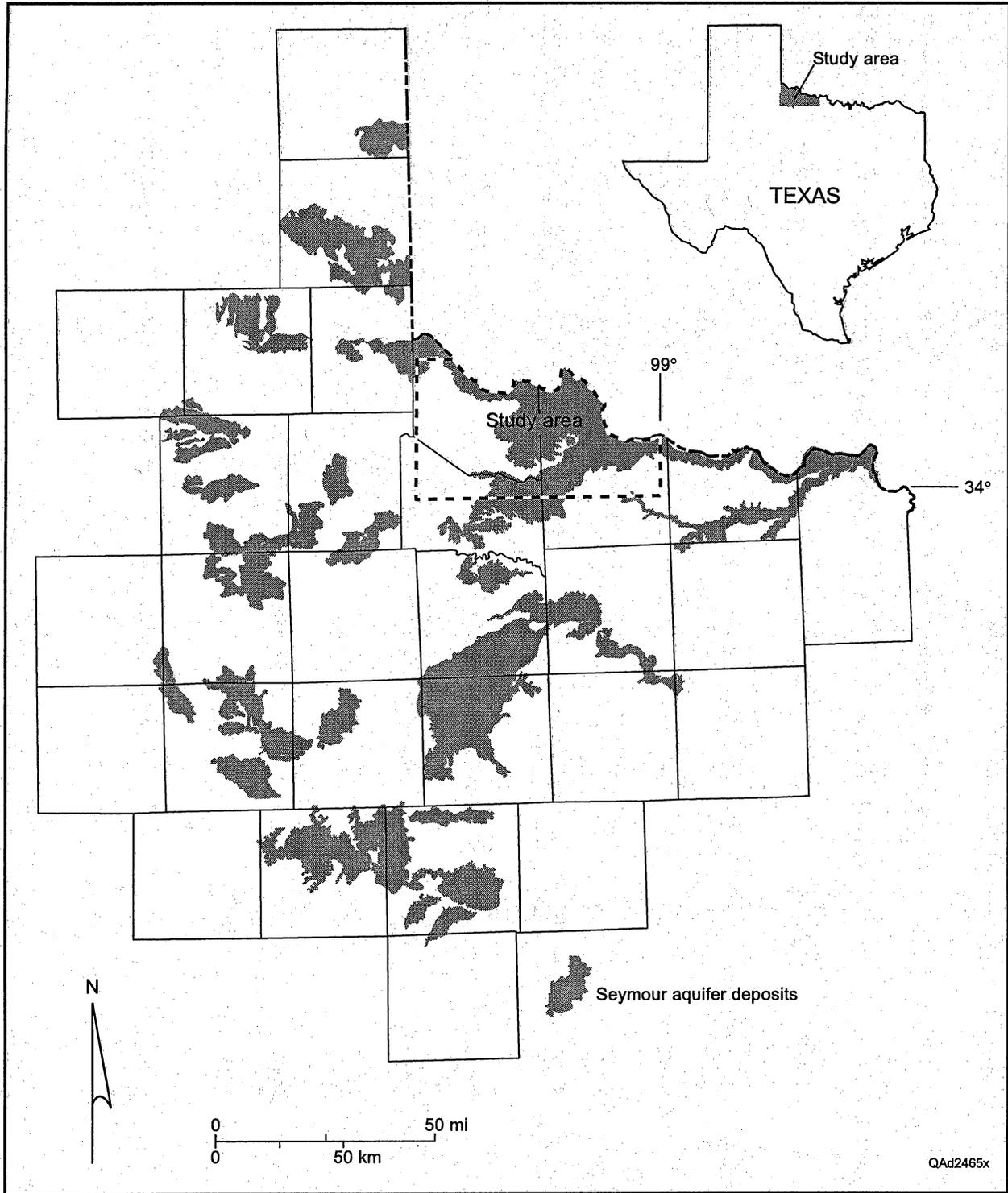


Figure 2. Locations of Seymour aquifer deposits throughout North-Central Texas and study area.

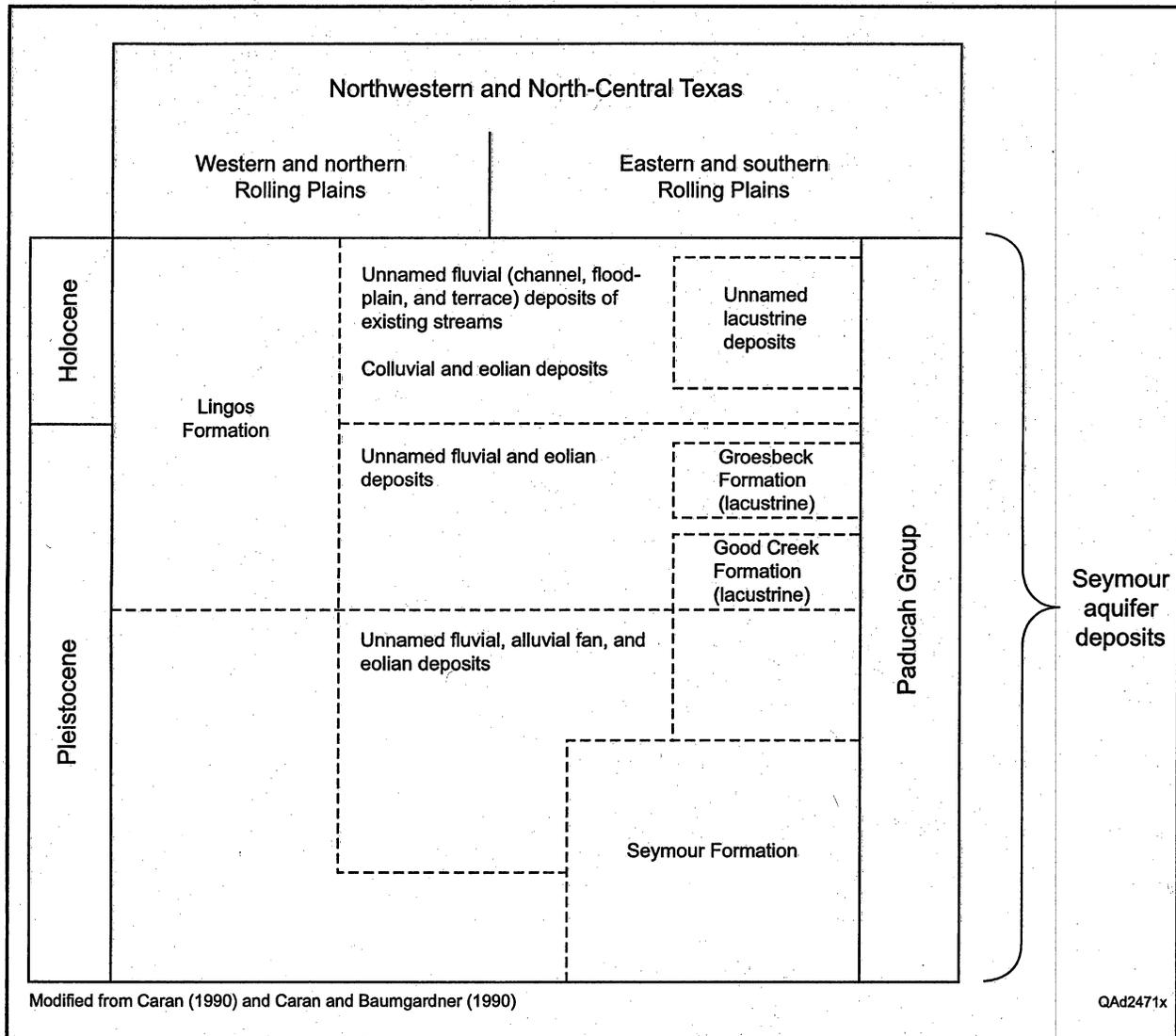


Figure 3. Stratigraphic units that compose the Seymour aquifer. Stratigraphy modified from Caran (1990) and Caran and Baumgardner (1990).

aquifer's name, even though the aquifer is also composed of other Pleistocene-Holocene Paducah Group deposits, including terrace alluvium of recent streams and eolian deposits.

Frye and Leonard (1963) studied the Pleistocene geology of the Red River Basin, which includes the study area, and they noted that repeated episodes of valley incision and subsequent alluviation occurred during the Pleistocene. They reported the occurrence of middle Pleistocene

volcanic ash, as well as middle and upper Pleistocene mollusks within the alluvial deposits of the study area. Dalquest (1965) and Caran (1990) reported that the ash deposits and their location mentioned by Frye and Leonard had been misidentified. However, ash deposits of the 620-ka Lava Creek B ash have been identified within Pleistocene Seymour alluvial deposits elsewhere in North-Central Texas (Stricklin, 1961; Izett, 1981; Izett and Wilcox, 1982; Simpkins and Baumgardner, 1982; and Caran and Baumgardner, 1990).

Seymour aquifer deposits typically consist of basal gravel- and coarse-sand-rich intervals that are overlain by interlayered sand- and clay-rich intervals (fig. 4). In some areas these deposits are overlain by gravel- to clay-rich stream terrace alluvium that is inset into the older deposits. Eolian silt and sand locally cap the alluvial sediments. Seymour aquifer deposits across North-Central Texas unconformably overlie Permian mudstone, sandstone, and some bedded gypsum and dolomite that compose the Clear Fork Group, San Angelo Formation, Blaine Formation, Whitehorse Group, and Quartermaster Formation. Throughout the region, the basal contact of the aquifer is irregular because of erosion before and during early deposition of Seymour deposits by eastward-flowing streams and possibly because of local subsidence that resulted from dissolution of Permian evaporite strata in some areas. Figure 5 is a map showing the elevation of the base of the Seymour aquifer in the study area. This map illustrates the irregular basal contact between Permian and Seymour aquifer contacts and larger paleo-drainageways where relatively coarser grained, channel-related deposits may exist.

The part of the Seymour aquifer that is in Haskell and Knox Counties, between 15 and 55 mi south of the study area, is one of the largest and more prolific water-bearing parts of this aquifer (Ogilbee and Osborne, 1962; R. H. Harden and Associates, 1978). In this area, the

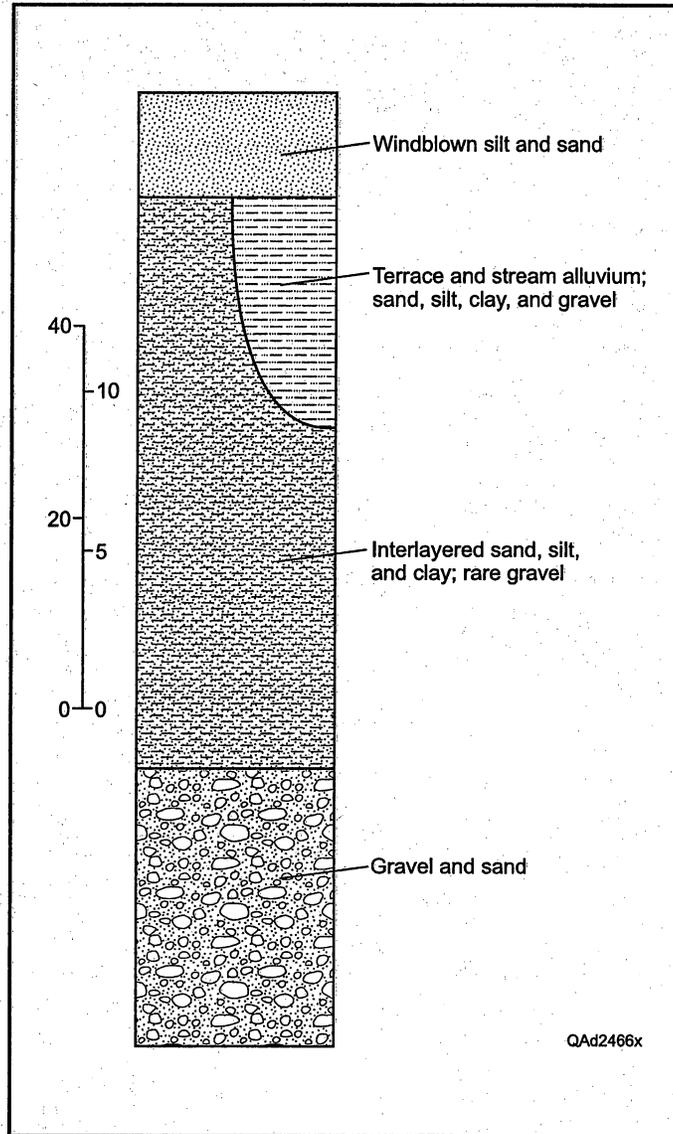


Figure 4. Generalized stratigraphic section of Seymour aquifer deposits.

Seymour, as thick as 94 ft, has an average thickness that is more than 40 ft. Similar to that of the Seymour deposits in the other parts of North-Central Texas, the base of the aquifer deposits represents the buried erosional surface on top of the Permian red beds. Buried channels, where the depth to the aquifer's base is greater than normal, provide the possibility of yielding relatively

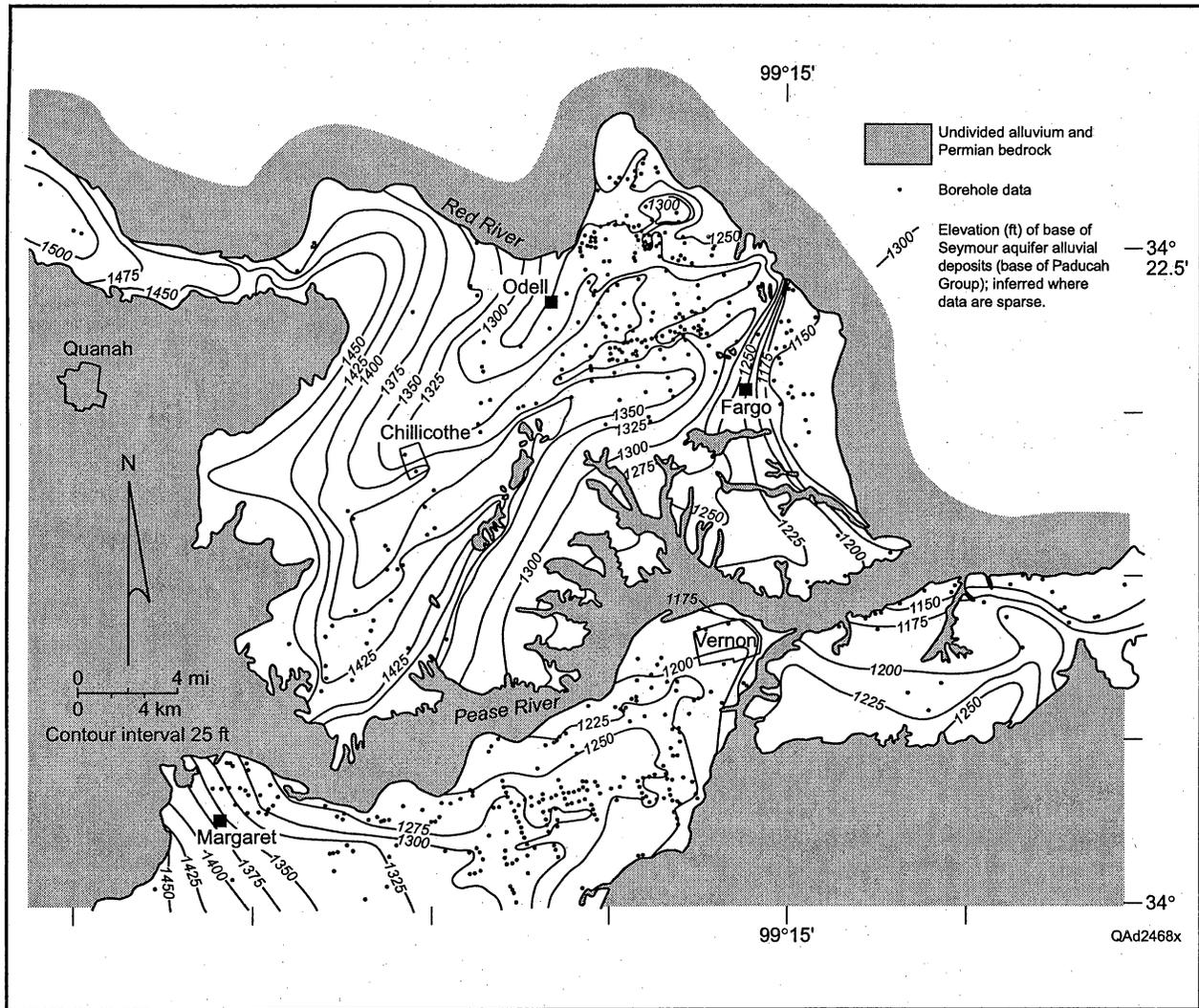


Figure 5. Elevation of the base of Seymour aquifer deposits (top of undivided Permian strata).

greater quantities of well water because of an increased saturated thickness and coarser character of water-bearing materials (R. H. Harden and Associates, 1978). The lower part of the aquifer deposits contain more gravel and coarse-grained sand than the upper part. Holocene windblown sand deposits cover large parts of the Pleistocene Seymour deposits, and previous studies suggest that recharge is greater within the sand-hills area (Ogilbee and Osborne, 1962; R. H. Harden and Associates, 1978).

Seymour aquifer deposits in Fisher and Jones Counties, more than 75 mi south of the study area, compose southern aquifer areas. Here, aquifer deposits are as much as 115 ft thick. Just as in other Seymour aquifer areas, gravel and sand compose the basal part of the unit, whereas interlayered sand, silt, and clay form the upper part of the unit (Price, 1978). The basal gravel and sand interval is as thick as 40 ft but is also locally absent. Aquifer deposits in Hall, Motley, Kent, Stonewall, Collingsworth, and Baylor Counties, spanning the parts of North-Central Texas west and south of the study area, have geologic characteristics similar to those of the Seymour aquifer deposits in other parts of the region. The aquifer deposits in Wichita and Clay Counties are, however, predominantly terrace and stream alluvium of the Red and Wichita Rivers (Baker and others, 1963; Smith, 1970, 1973; Cronin, 1972; Popkin, 1973; Preston, 1978).

Geology of the Study Area

Within the study area and its adjacent areas, in Wilbarger, Hardeman, Foard, and eastern Childress Counties, aquifer deposits compose two relatively large, irregularly shaped areas that are about 360 and 160 mi² in area. Here, the aquifer consists of Paducah Group deposits that include Seymour and possibly younger Pleistocene sediments, Holocene stream and terrace alluvium of the Red River and its tributaries, and Holocene eolian deposits. Paducah Group lithofacies are similar to those of the other aquifer areas of North-Central Texas: a basal gravel- and coarse-sand rich interval and an upper, interlayered sand- and clay-rich interval (fig. 4). The gravel is granule- to some cobble-sized clasts of quartz, chert, igneous and metamorphic rock, limestone, and sandstone. Gravel-rich intervals are sometimes clayey. Individual beds are discontinuous.

Terrace and floodplain alluvium of the Red and Pease Rivers is composed of sand, silt, clay, and gravel. These sediments are inset into the older Paducah Group and Permian deposits.

Geologic Map

The geologic map of the study area (in pocket) and the cross section of the area (fig. 6) illustrate two relatively large, irregularly shaped areas of aquifer deposits that are bound by terrace and floodplain alluvium of the Red and Pease Rivers and undivided Permian strata. The Red River bounds the study area on the north. Some of its terraces underlie eolian sediments that are common along the northern parts of the map. Some terraces are thus not evident in map view. However, a large Red River terrace east of Fargo, at the east side of the study area, is quite distinct and serves as an example of a terrace that is inset into Permian and Paducah Group deposits.

Two areas of Paducah Group deposits are divided in the central map area by Pease River alluvium and Permian strata that are adjacent to the river's floodplain, terraces, and valley (map, in pocket; fig. 6). The northern Paducah Group deposits are further subdivided by an escarpment that consists of slope-wash alluvium, thin Paducah Group deposits, and Permian bedrock. The escarpment probably marks the edge of an ancestral Pease River valley wall. Paducah Group deposits south and southeast of the escarpment appear to represent thin, eroded, remnant deposits that have been inset into relatively older Paducah Group deposits and Permian strata. Deposits that are north and west of the escarpment are at higher elevations within the divide between the Pease and Red Rivers (fig. 6).

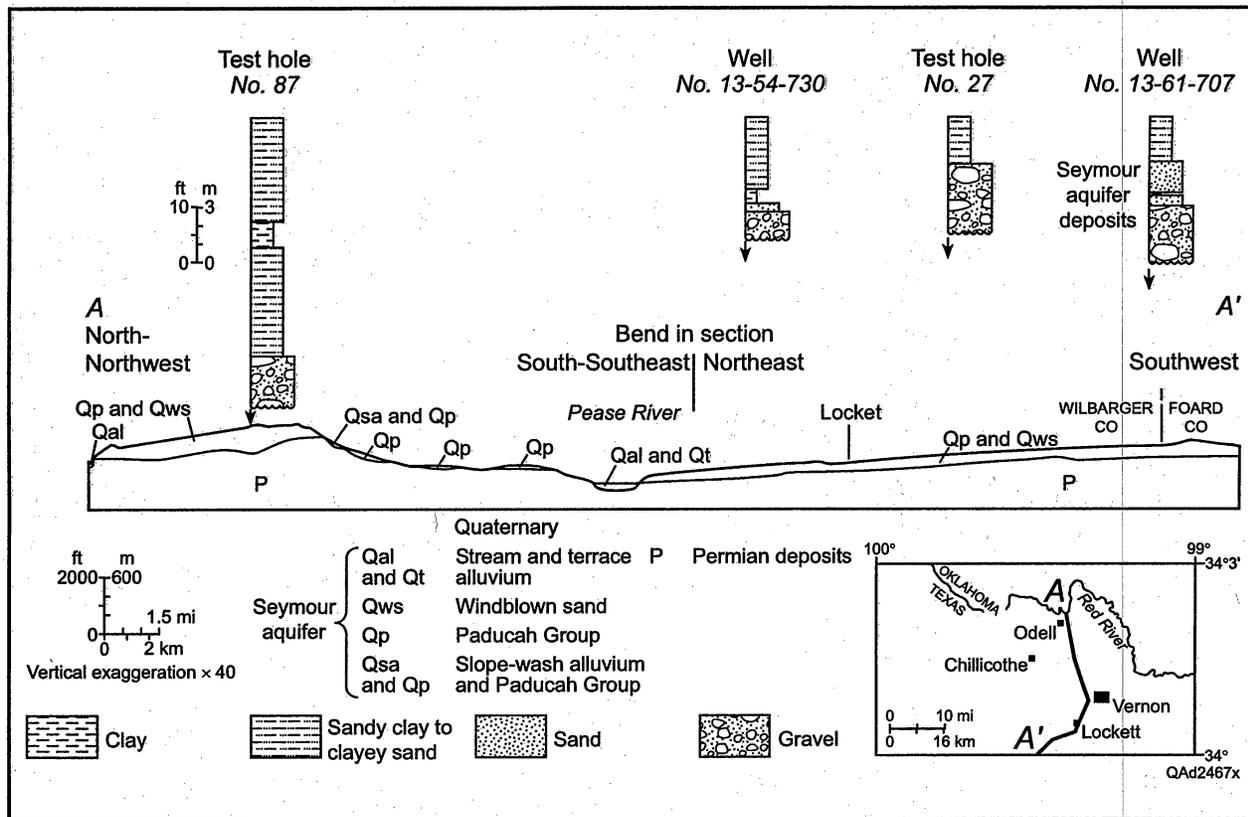


Figure 6. Cross section A-A' illustrating Seymour aquifer deposits.

Eolian deposits are common in the area and are subdivided into three units on the basis of physical attributes: (1) windblown deposits having gently rolling and hilly topography; (2) windblown deposits of partly vegetated, stabilized to partly stabilized dunes that exhibit hummocky to hilly topography; and (3) windblown deposits of active dunes that are partly vegetated (map, in pocket). The eolian deposits are most extensive at the north part of the map near the Red River. Subsurface data from well-drilling records indicate that the windblown accumulations of sand and silt are mostly between several feet and 20 ft thick but locally may exceed 30 ft in thickness.

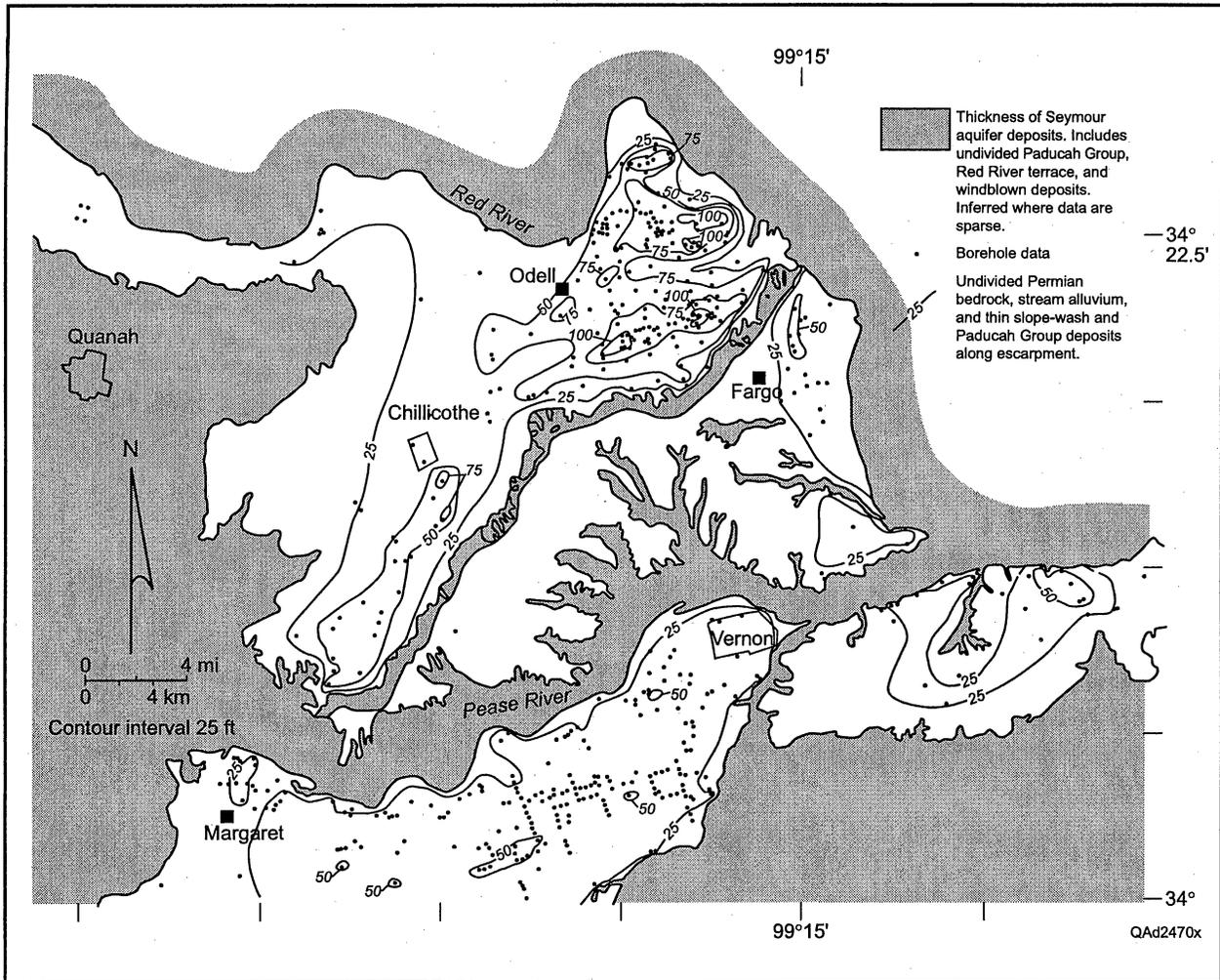


Figure 7. Isopach map illustrating the thickness of the Seymour aquifer deposits.

Thickness variations of the Paducah Group deposits, which are of great importance to aquifer characterization, are illustrated on the geologic map (in pocket) in a generalized manner, the Paducah sediments being subdivided into three map units: (1) thick deposits that are mostly between 25 and 60 ft, (2) thin deposits that are between a few feet and 25 ft, and (3) deposits of unknown thickness. In addition to the geologic map, figures 7 and 8 present isopach interpretations of the total, composite thickness of the Seymour aquifer deposits (fig. 3) and the

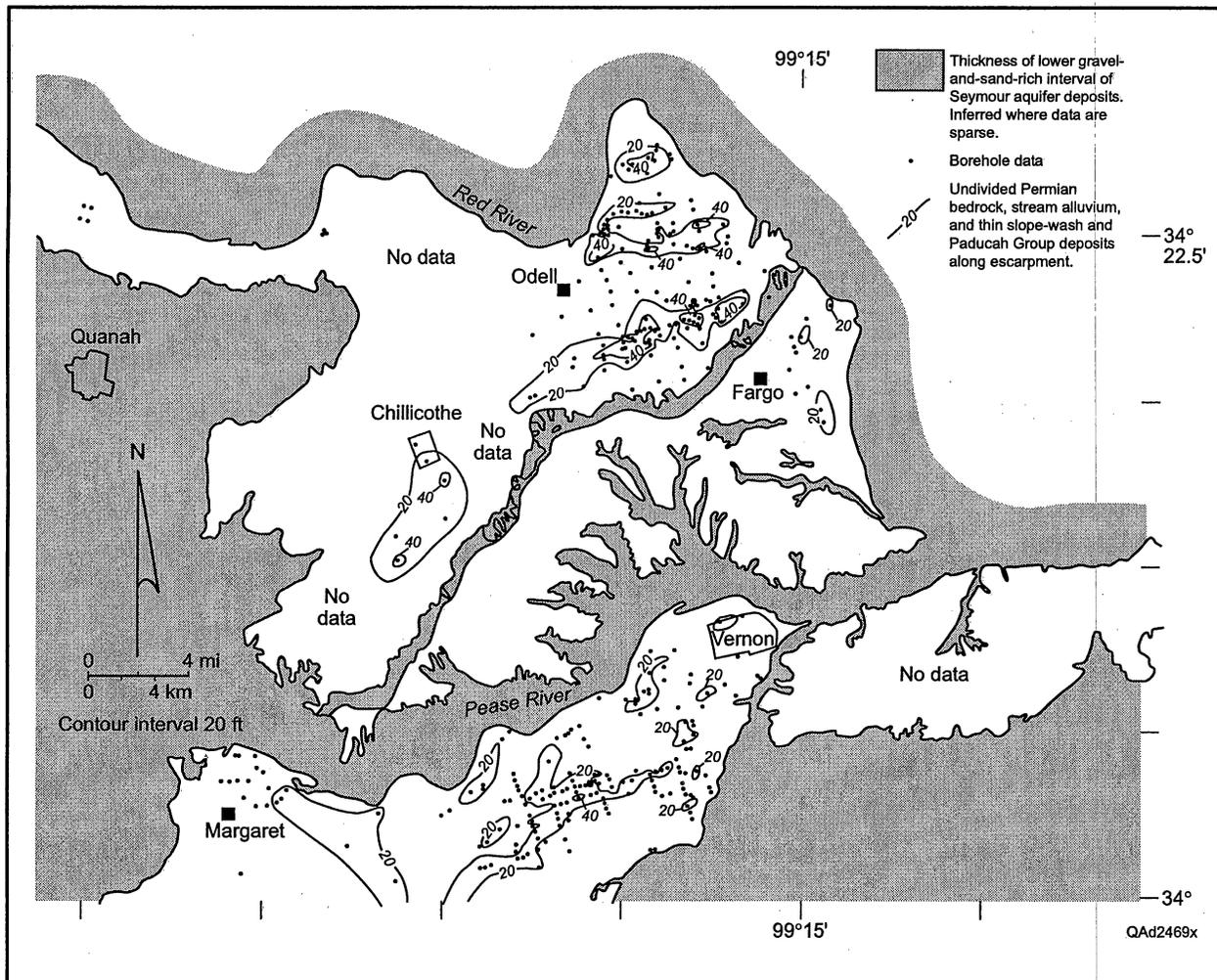


Figure 8. Isopach map illustrating the thickness of the lower gravel- and sand-rich interval of the Seymour aquifer deposits.

thickness of the lower gravel- and sand-rich interval of the Seymour aquifer (basal interval of the Paducah Group). The thickest Seymour aquifer deposits occur in the north part of the study area, east of Odell (fig. 7). In this area the stratigraphic section is composed of older Paducah sediments, probably Seymour Formation, and eolian deposits. Here the unit thickness exceeds 100 ft locally, and several relatively large areas contain deposits that are thicker than 75 ft (fig. 7). South of Chillicothe there is an elongate area where the aquifer sediments are greater than 50 ft thick. Between the Pease River and the escarpment north of the river, Paducah Group

deposits are relatively thin, mostly between a few feet and 25 ft thick. Within the Red River terrace east of Fargo, deposits are commonly between 25 and 50 ft thick. South of the Pease River, between Vernon and Margaret, Seymour aquifer sediments (undivided Paducah Group and eolian deposits) are mostly between 25 and 50 ft thick.

It was beyond the scope of this study to determine the saturated thickness of the aquifer, although figure 8, an isopach interpretation of the basal gravel- and sand-rich aquifer interval (lower Paducah Group interval), illustrates where thicker accumulations of the basal aquifer sediments are located. Higher yield wells in the Seymour aquifer appear to produce from the basal gravel- and sand-rich interval (Price, 1979); thickness variation within this interval is thus an important attribute for future evaluation of the Seymour aquifer. The larger accumulations of relatively thick basal gravel- and sand-rich deposits are elongate and may indicate the locations of paleo-channels. Several areas of thicker basal deposits are east of Odell; one area is south of Chillicothe, and two large elongate areas and several smaller areas are between Margaret and Vernon.

SUMMARY

1. *Geologic Map of the Seymour Aquifer, Vernon, Texas, 30 × 60 Minute Quadrangle* (in pocket) and the geologic cross section of the area, figure 6, illustrate occurrences of the aquifer deposits and some of their general thickness variations. Aquifer strata include sediments of the Pleistocene Seymour Formation, possibly younger Pleistocene deposits of the Paducah Group (fig. 3), and Holocene terrace alluvium and eolian deposits also of the Paducah Group (Caran, 1990; Caran and Baumgardner, 1990).
2. The geologic framework of the Seymour aquifer is provided by (a) *Geologic Map of the Seymour Aquifer Deposits, Vernon, Texas, 30 × 60 Minute Quadrangle* (in pocket); (b) geologic cross section of the area, figure 6; (c) isopach map of the total aquifer thickness, figure 7; (d) isopach map of the lower gravel- and sand-rich interval of the aquifer, figure 8; and (e) map of the elevation of the base of the Seymour aquifer, figure 5. Thick aquifer deposits are mostly in two areas: (a) at the divide between the Red River and the escarpment that marks the edge of an ancestral Pease River valley and (b) within the area between Vernon and Margaret, south of the Pease River. At the divide between the Red River and the escarpment that marks the edge of an ancestral Pease River valley, Seymour deposits east of Odell commonly exceed 75 ft and are thicker than 100 ft locally. South of Chillicothe, also within the drainage divide between the rivers, aquifer deposits are commonly thicker than 50 ft. Within the area between Vernon and Margaret, south of the Pease River, aquifer deposits are mostly between 25 and 50 ft thick. The map of the elevation of the base of the Seymour aquifer illustrates the irregular basal contact of the aquifer deposits and the locations of possible paleo-drainageways

where relatively coarser grained, channel-related deposits may exist. Areas of the thick, lower, gravel- and sand-rich interval of the aquifer east of Odell and south of Chillicothe (fig. 8, isopach map) correlate to paleo-drainageways interpreted in figure 5. In the area between Vernon and Margaret, similarly thick gravel- and sand-rich deposits are also inferred to be within paleo-drainageways, although we are less confident of the interpretation because data are locally sparse. Because an area west of Odell, where another broad paleo-drainageway is interpreted in figure 5, lacks subsurface lithologic data, it is unknown whether thick basal gravel- and sand-rich aquifer deposits exist there.

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The views and conclusions contained in this map are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government. The author disclaims any responsibility or liability for interpretations from this map or digital data or decisions based thereon.

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