Aquifers in Melt-Water Channels Along the Southwest Flank of the Des Moines Lobe Lyon County, Minnesota

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1539–F

Prepared in cooperation with the Division of Waters, Minnesota Department of Conservation, and the Marshall Municipal Utilities, Marshall, Minnesota

MO. GEOL. SURVEY LIBRARY

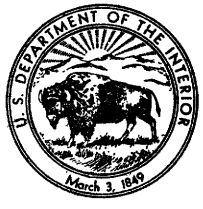
Aquifers in Melt-Water Channels Along the Southwest Flank of the Des Moines Lobe Lyon County, Minnesota

By ROBERT SCHNEIDER *and* HARRY G. RODIS

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1539-F

Prepared in cooperation with the Division of Waters, Minnesota Department of Conservation, and the Marshall Municipal Utilities, Marshall, Minnesota



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1961

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents (paper cover)

CONTENTS

ILLUSTRATIONS

584267—61

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

AQUIFERS IN MELT-WATER CHANNELS ALONG THE SOUTHWEST FLANK OF THE DES MOINES LOBE, LYON COUNTY, MINNESOTA

By ROBERT SCHNEIDER and HARRY G. RODIS

ABSTRACT

During the Cary and Mankato substages of Wisconsin glaciation the Des Moines lobe advanced southeastward through the broad lowland of the Minnesota River valley of southwestern Minnesota, and thence southward to central Iowa.

Among the most prominent topographic features in Lyon County, Minn., are five southeastward-trending end moraines, two of which are associated with and parallel to belts of surficial outwash that are approximately half a mile to a mile wide. Test drilling indicated that one of the belts of outwash is underlain by a complex system of buried melt-water channels. The other is the upper part of a series of deposits in an incised channel. The channels are filled with till, glaciolacustrine deposits, and outwash, which includes permeable deposits of water-bearing sand and gravel.

Associated with the surficial melt-water channels is a pronounced southeastward-trending linear drainage pattern. By studying the lineation of streams and lakes, analyzing the available water-well data, and drilling test holes, several elongate deposits of buried outwash having little or no topographic expression were located. The long axes of the deposits are generally parallel to the lineation of the drainage and the end moraines.

The melt-water channels in Lyon County trend southeastward because the flank of the ice sheet was confined by a landmass that sloped to the northeast. Similar buried channels may be present elsewhere along the southwest flank of the Des Moines lobe. If so, they probably can be located by the methods described.

INTRODUCTION

This paper describes the origin and general occurrence of aquifers in linear melt-water deposits parallel to end moraines along the southwest flank of the Des Moines glacial lobe. The study was part of an investigation of the ground-water resources of Lyon County in cooperation with the Division of Waters, Minnesota Department of Conservation, and the city of Marshall.

Lyon County is about 150 miles southwest of Minneapolis and St. Paul in the drainage basin of the Minnesota River (fig. 1). It is

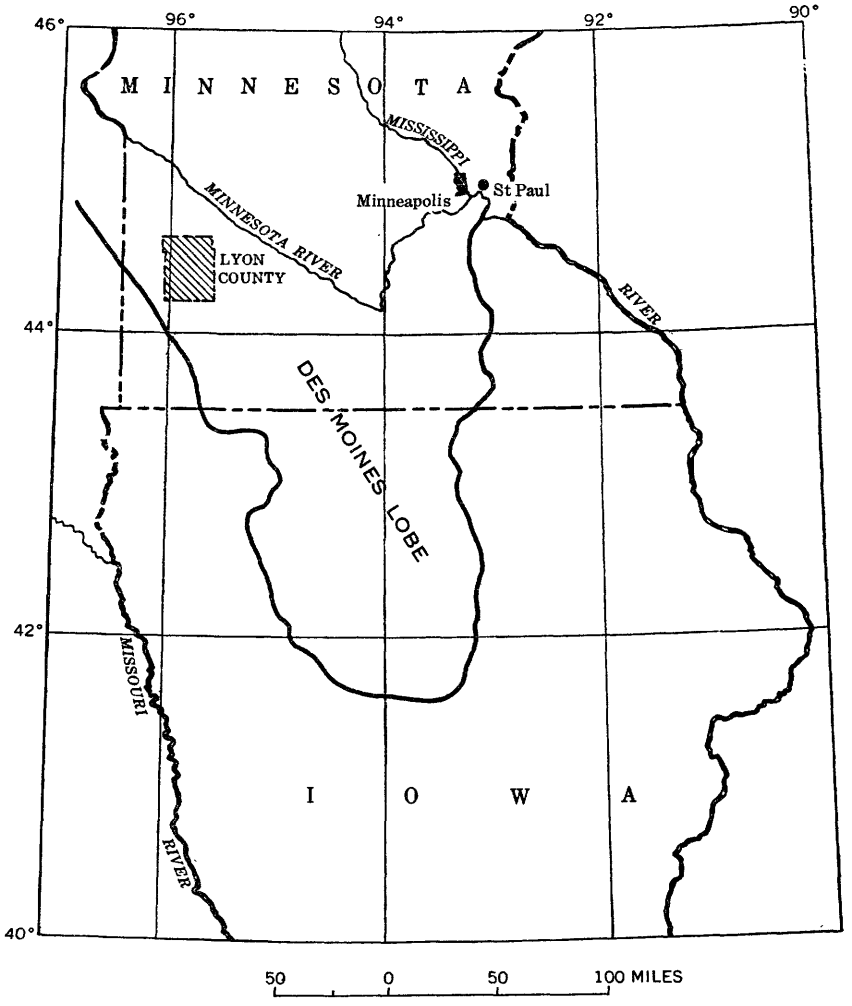


FIGURE 1.—Map of Minnesota and Iowa showing location of Lyon County, Minn., and extent of Des Moines lobe.

within the area covered by the Des Moines ice lobe, about 15 miles from the lobe's southwest flank. The southwestern part of the county is on the northeast slope of the Coteau des Prairies, an elongate highland extending northwestward through South Dakota, Minnesota, and Iowa (Fenneman, 1938, p. 573).

GEOLOGIC CONDITIONS

Geologic conditions are illustrated on a northeast-southwest cross section of the county (fig. 2). The basement rocks consist largely of Precambrian granite; however, quartzite was penetrated by several

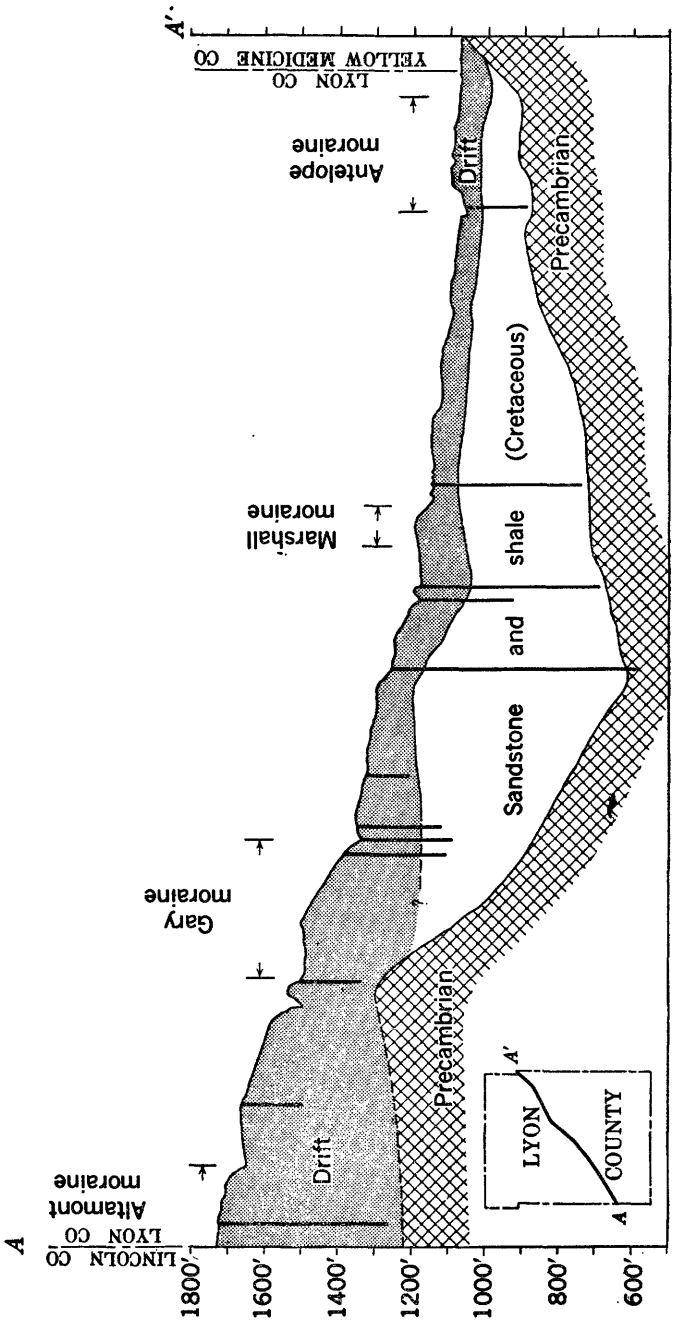


FIGURE 2.—Northeast-southwest geologic section in Lyon County, Minn. Vertical line indicates well or test hole for which log was available.

wells in the southwest. The granite was deeply weathered and is covered by an extensive regolith, consisting in part of weathered materials that were transported and reworked during the Cretaceous period and earlier.

The Cretaceous strata are nearly flat lying and are composed largely of thick beds of soft bluish-gray shale alternating with thin beds of loosely consolidated sandstone. The strata were deposited in a basin whose axis bisects the county from northwest to southeast. The Cretaceous strata are approximately 450 feet thick near the center of the depositional basin and gradually pinch out against its flanks (fig. 2).

The glacial drift ranges in thickness from about 10 feet in the northeastern part of the county to more than 550 feet in the southwest where the Altamont moraine was deposited. Little information is available on the Pre-Wisconsin or early Wisconsin glacial history. However, test holes in the southwestern part of the county penetrated several weathered zones at depth, suggesting that there may be three or even four drift sheets in this area.

During the Cary and Mankato substages of the Wisconsin stage the Des Moines lobe advanced south-southeastward from the Red River valley through the broad lowland of the Minnesota River valley, and thence southward across a low saddle to the vicinity of Des Moines in central Iowa (Leverett, 1932, p. 56–57; Flint, 1955, p. 133). The maximum extent of the lobe is marked by a pronounced series of end moraines which form a broad arc. Within the outermost end moraines are numerous subdued end moraines and extensive areas of ground moraine.

The surficial glacial deposits in Lyon County (fig. 3) consist essentially of five southeastward-trending end moraines. The northeasternmost two of these, the Antelope and Marshall, are flanked on their southwest sides by extensive belts of outwash. The intervening areas are flat to slightly rolling ground moraine.

MELT-WATER DEPOSITS

The surficial melt-water deposits associated with the Antelope and Marshall moraines were studied in considerable detail because of their apparent value as sources of ground water. The belt of outwash in front of the Marshall moraine is about 1 mile wide at the surface and extends almost continuously for about 17 miles. The subsurface extent and nature of the outwash were determined by test drilling. Section *B–B′* (fig. 4), of an area near the city of Marshall, indicates that the belt of outwash is associated with two channels incised in the underlying Cretaceous shale in front of the moraine.

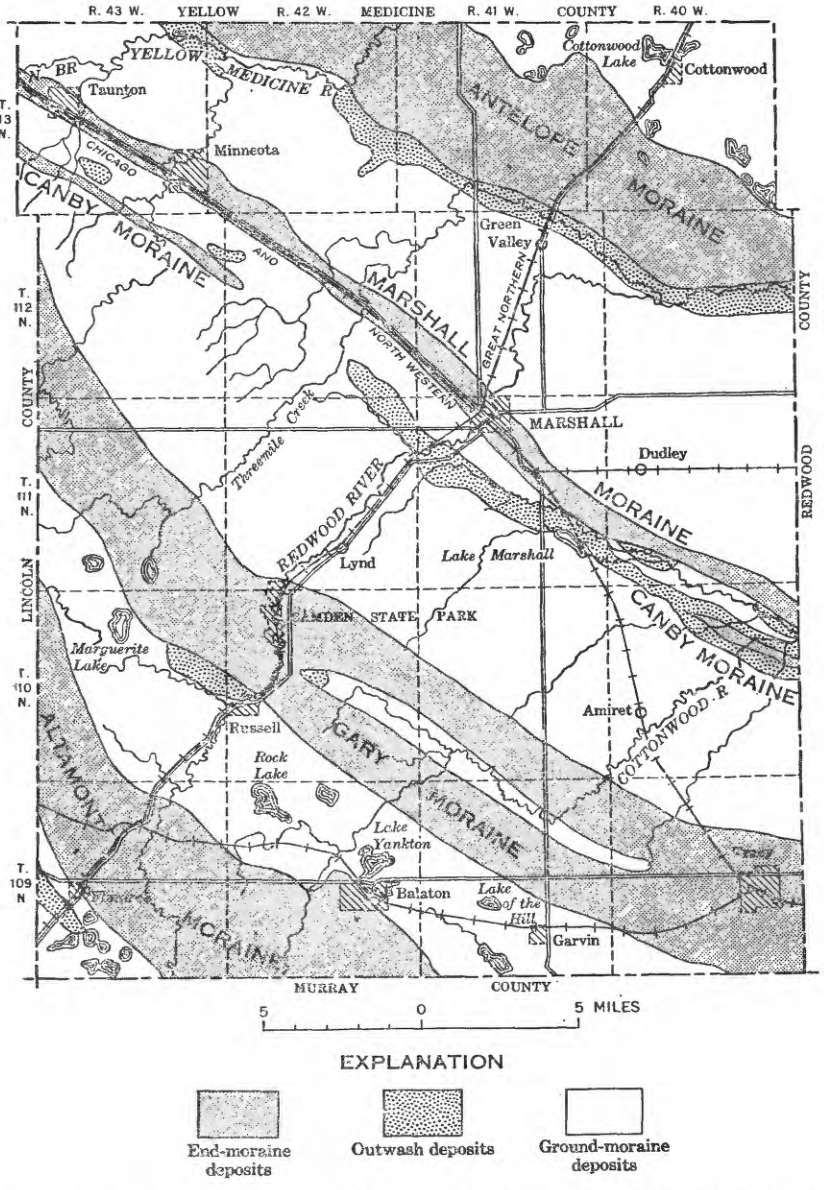


FIGURE 3.—Map of Lyon County showing drainage pattern and surficial glacial deposits.

The shallow channel is filled with till, and the deep one is filled with till at the bottom and outwash at the top. On section *C–C′* (fig. 4) the shallow channel contains outwash at the bottom and the deep one is completely filled with outwash. These two cross sections have been greatly simplified for the sake of clarity. Actually there appears

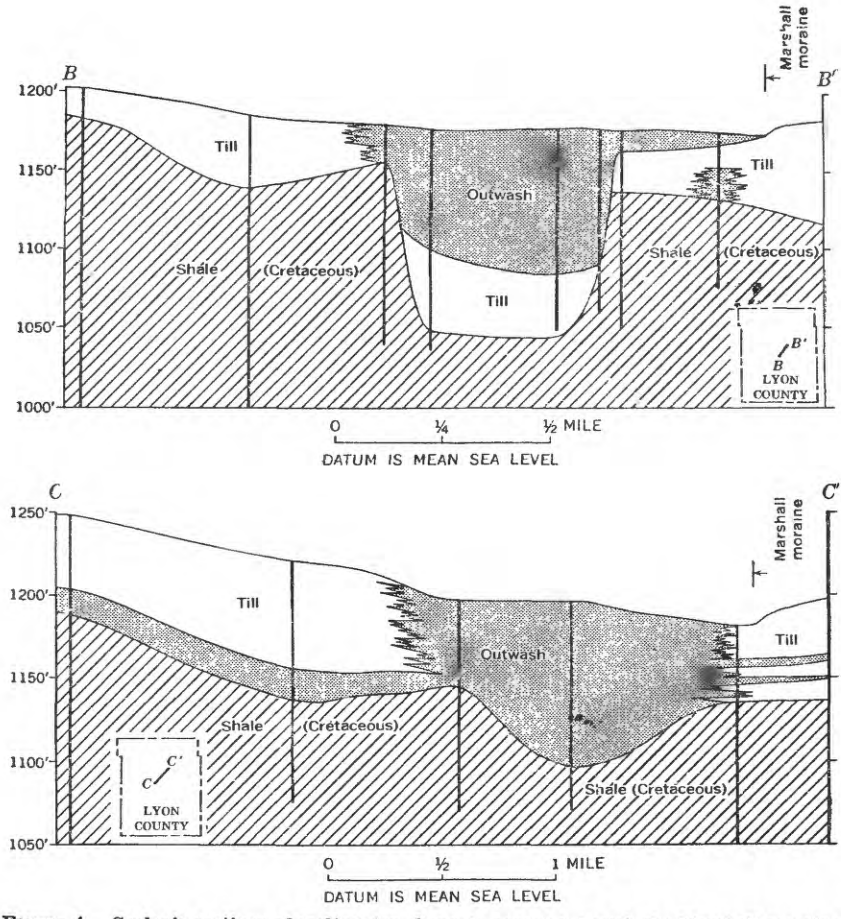


FIGURE 4.—Geologic sections of melt-water channels associated with the Marshall moraine, central Lyon County. Vertical line indicates well or test hole for which log was available.

to be a complex system of channels filled with till, glaciolacustrine deposits, and outwash, which includes thick strata of highly permeable water-bearing sand and gravel. The system of subsurface channel deposits is considerably wider than the associated surficial belt of outwash, and the bottoms of some of the individual channels are about 125 feet below land surface. Two wells were developed in the outwash at Marshall, each of which produced about 500 gpm (gallons per minute) with about 25 to 30 feet of drawdown. The wells were 12 inches in diameter and were completed with 15- and 20-foot screens.

A northeast-southwest section (fig. 5) in front of the Antelope moraine indicates that the surficial belt of outwash, which is about 1 mile wide and 16 miles long, is the upper part of a series of deposits

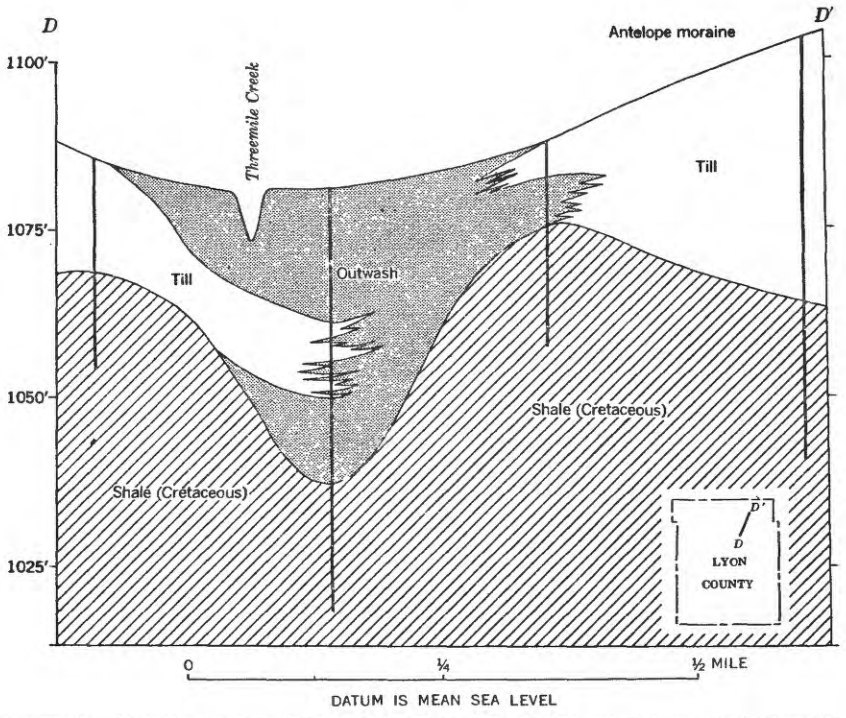


FIGURE 5.—Geologic section of melt-water channel in front of Antelope moraine, northeastern Lyon County. Vertical line indicates well or test hole for which log was available.

filling a channel incised in Cretaceous shale to a depth of about 40 feet. The subsurface extent of the channel appears to coincide with the surface expression. The sediments in the channel are similar to those in front of the Marshall moraine.

It appears that the melt water from the Antelope and Marshall moraines flowed southeastward parallel to the ice front. It seems reasonable to assume that similar melt-water channels are associated with the end moraines throughout the county. Such an assumption, if proved valid, would facilitate location and development of ground water, an important economic objective.

It is evident from figure 3 that, although the present drainage in the county is primarily northeastward toward the Minnesota River, the outwash belts in front of the Antelope and Marshall moraines are associated with southeastward-flowing streams. Elsewhere in the county also, several small tributary streams flow southeastward, and three chains of lakes trend northwest-southeast. One lake chain extends across the northeast corner of the area, another is between the Gary and Altamont moraines, and a third extends across

the southwest corner of the area. In view of the coincidence of the linear drainage pattern with the surficial outwash channels, it was postulated that where the pattern occurred elsewhere it might be associated with buried channels that had little or no surface expression.

By studying the available farm-well data and drilling test holes in the vicinity of the chain of lakes in the northeast corner of the county, a buried melt-water deposit was found to coincide with the lake chain at the Precambrian-Cretaceous contact (fig. 6). The

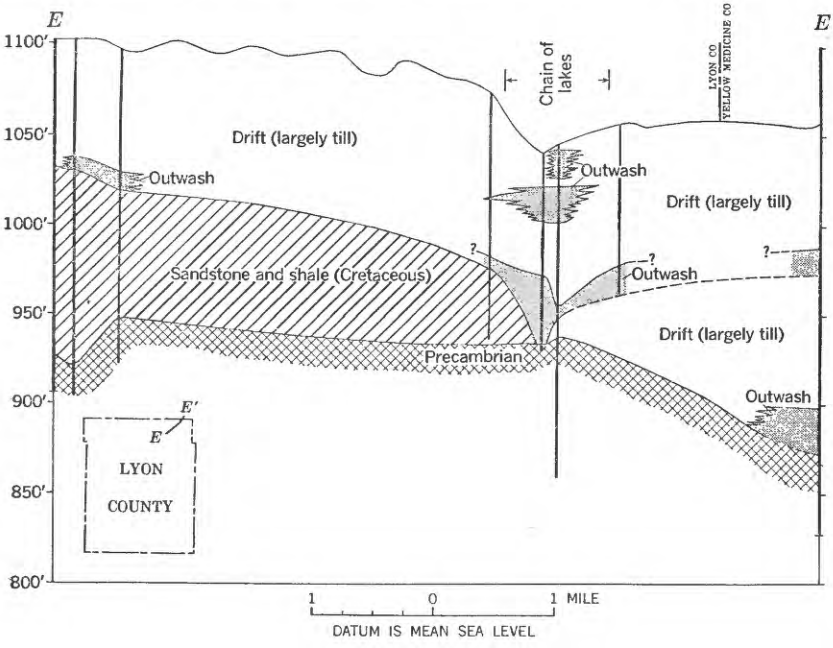


FIGURE 6.—Geologic section in northeastern Lyon County showing buried outwash associated with chain of lakes. Vertical line indicates well or test hole for which log was available.

deposit included permeable water-bearing sand and gravel which yielded about 60 gpm to a well in the village of Cottonwood. It is interesting to note that earlier attempts to develop municipal wells in this area had either failed or resulted in smaller yields.

As was mentioned earlier, several test holes drilled in the southwestern part of the county, where the drift is very thick, indicated the presence of three and possibly four drift sheets. Because of the absence of detailed information on the glacial stratigraphy in this area, the occurrence of aquifers was studied by analyzing the areal and vertical distribution of well-bottom altitudes of numerous farm wells. It is evident from the map (fig. 7) that the areal patterns, which

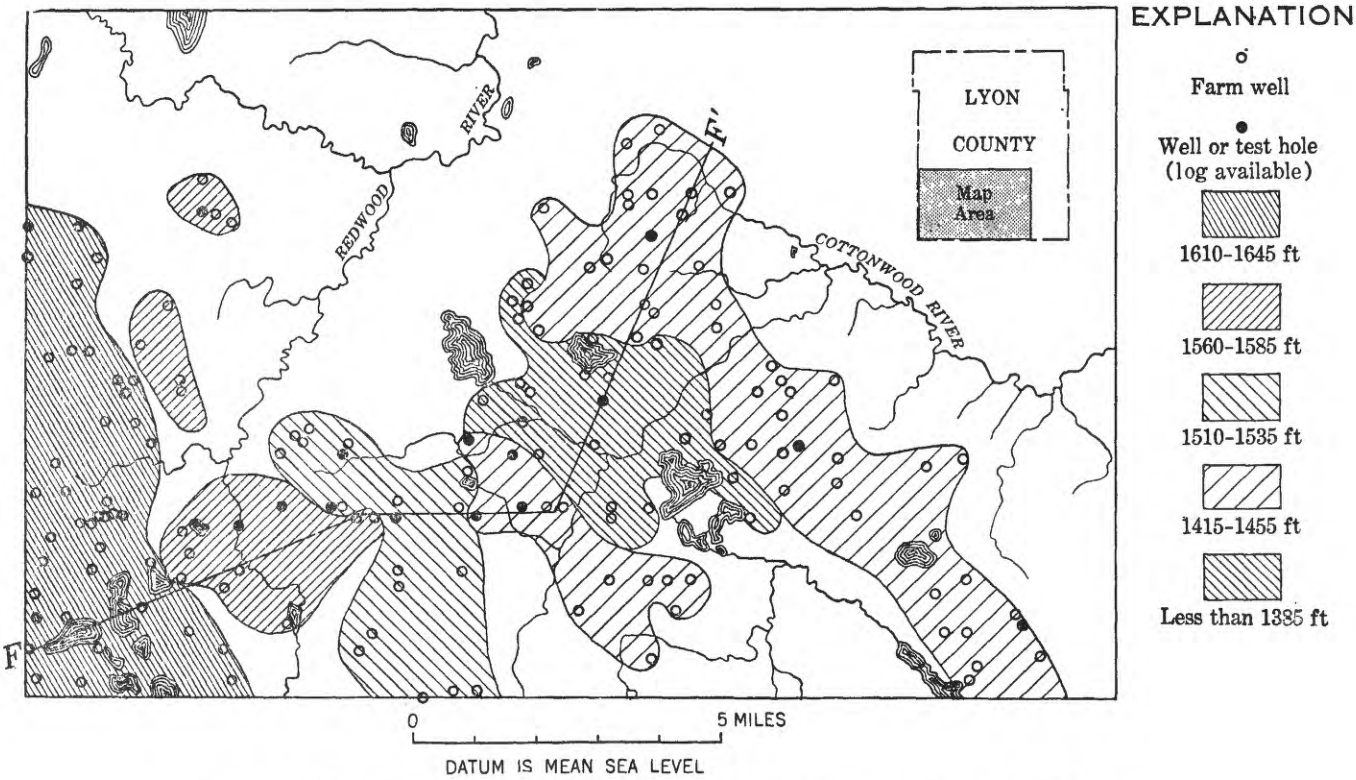


FIGURE 7.—Map of southwestern Lyon County showing areas of correlative well-bottom altitudes.

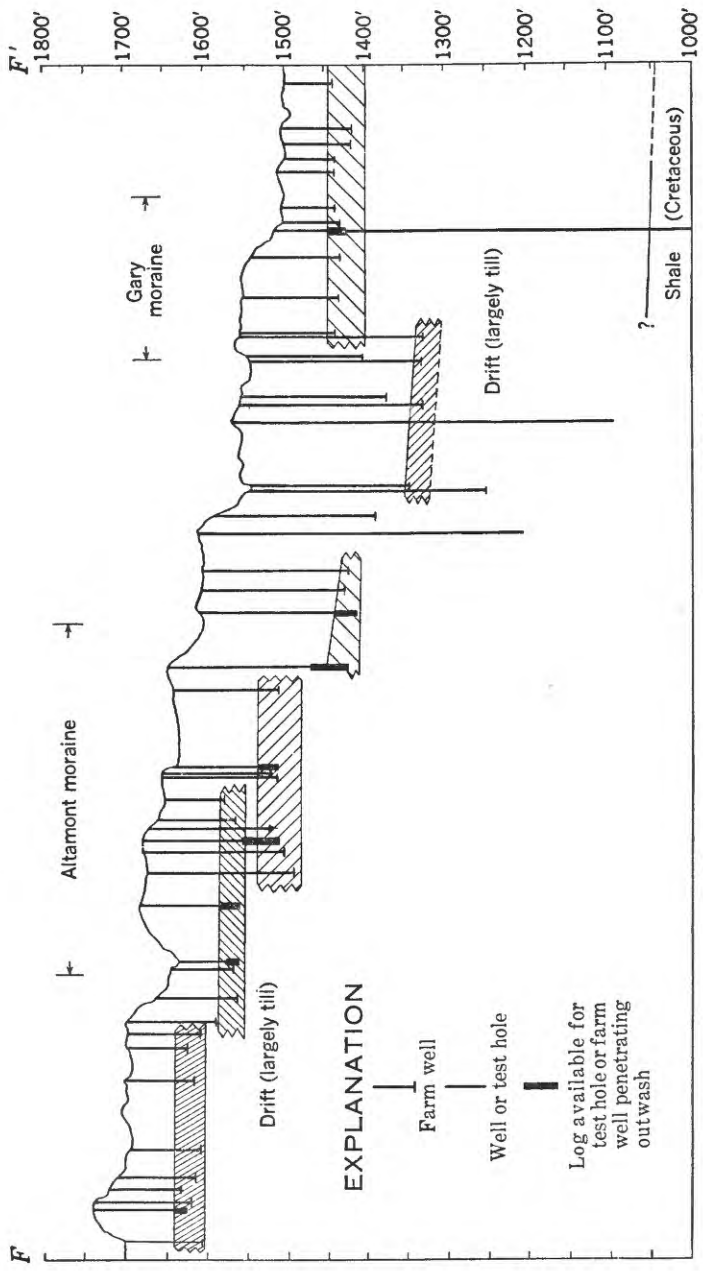


FIGURE 8.—Geologic section in southwestern Lyon County showing correlation of well-bottom altitudes.

were formed by outlining groups of wells having similar ranges of well-bottom altitudes, tend to be elongated northwestward.

A cross section of the area (fig. 8) shows the subsurface correlations of the well-bottom altitudes. Nearly all the zones of correlation have been penetrated by test holes or wells for which logs are available, and these logs substantiate the correlation. The zones of correlation do not necessarily represent extensive aquifers. Rather, it is believed that they suggest groups of elongate outwash deposits that were formed parallel to successive positions of the ice front. Except for the orientation of their long axes which roughly parallels the drainage lines, the zones of correlation have little or no surface expression.

CONCLUSIONS

It is believed that a series of southeastward-trending melt-water channels were formed parallel to the ice front in Lyon County during successive advances and retreats of the Des Moines ice front. Some of these melt-water deposits are exposed; others were buried during readvances of the glacier. The sediments in the channels include permeable water-bearing sand and gravel. In the central and northeastern parts of the county, where the glacial drift is relatively thin, the channels were cut into the Cretaceous bedrock. Where the drift is thick, as in the southwest, the channels were cut into older drift sheets.

A pronounced southeastward-trending linear drainage pattern is generally associated with the surficial outwash channels; and it is probable that, where this drainage pattern is found, outwash channels may occur beneath the surface. Where the glacial drift is very thick as a result of multiple glaciation, elongate deposits of outwash probably occur at depth, although they may not have any topographic expression.

The melt-water channels in Lyon County trend southeastward because the flank of the ice sheet was confined by a landmass that sloped to the northeast. Through application of the methods described in this report, it is probable that other buried channels can be located and additional ground-water supplies developed elsewhere along the southwest flank of the Des Moines lobe.

REFERENCES CITED

Fenneman, N. M., 1938, Physiography of eastern United States: New York, McGraw-Hill, 714 p.

Flint, R. F., 1955, Pleistocene geology of eastern South Dakota: U.S. Geol. Survey Prof. Paper 262, 173 p.

Leverett, Frank, 1932, Quaternary geology of Minnesota and parts of adjacent States: U.S. Geol. Survey Prof. Paper 161, 149 p.

○