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Overview of Nebraska and the Regional Aquifer from Proceedings of the 1985 Water Resources Seminar Series

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ASPECTS OF GROUNDWATER QUALITY

PROCEEDINGS

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Sponsored by

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June 1985

FOREWORD

During each spring semester, the Nebraska Water Resources Center sponsors a Water Resources Seminar Series at the University of Nebraska-Lincoln. The 1985 seminar series was entitled "Aspects of Groundwater Quality."

Groundwater quality continues to be a concern in Nebraska and the Nation. This is emphasized by the preparation of a groundwater protection strategy by both the U. S. Environmental Protection Agency and the Nebraska Department of Environmental Control. The need for these strategies is becoming more apparent as agricultural production increases its reliance on chemicals for fertilization and pest control. This increased use, coupled with more instances of organic and inorganic chemicals being detected in groundwater supplies, makes groundwater quality protection doubly important in Nebraska. This seminar series examined various aspects of groundwater quality including sources of pollution, regulation and management, and ongoing research.

These proceedings were transcribed from the taped lectures presented by the seminar speakers. It is hoped that the proceedings will serve as a useful reference on groundwater quality in Nebraska.

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OVERVIEW OF NEBRASKA'S AND THE REGIONAL AQUIFER - PART I

by

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As part of my presentation today, I would like to show how the Conservation and Survey Division works out the geologic framework in Nebraska. We are going to be looking primarily at units from the surface down several hundred feet that are part of the regional aquifer.

The Conservation and Survey Division is interested in a number of things in the state, such as: (a) the occurrence of petroleum, natural gas and minerals, (b) the occurrence of bulk materials like sand and gravel for use in roads and buildings, and (c) certain aspects of agriculture. Particularly with respect to the topic of this seminar, we are interested in groundwater, its occurrence, and the sorts of materials which are in that groundwater. Ultimately, we work to produce geologic maps showing the distribution of rock units at the surface of the state, and other types of maps, cross sections and reports on aspects of the topics listed above.

We attack the study of geology of the state and the distribution of rock units from two directions. First, the rock units are physically examined where they are exposed along sides of valleys in Nebraska. Secondly, test drilling is used to determine where these units occur buried beneath the surface of the state.

A geologist will first locate surface formations. Formations are three-dimensional masses of sediment or rock that have some characteristics that can be used to separate them from one another. For example, there are two rock units exposed in Chimney Rock, the first of which constitutes the grey spire of the rock and second a tan material beneath it (Figure 1). Some beds in this particular area are traceable for great distances and are key beds. Two of them are units you can pick out on Chimney Rock and in the Wildcat Hills area. These are volcanic ash beds which are traceable on the surface and in the subsurface for thousands of square miles across western Nebraska. As a geologist, I first study these outcrops, try to pick out such key beds, and try to find out where formations start and stop in the sequence of rocks. I then describe the rocks and plot their distribution on maps.

The Conservation and Survey Division is interested in fossils that occur in the rocks because they can be used to date the rocks. If we locate fossils, we tell paleontologists where the fossils are so they can dig them out and identify them for us. In some cases the fossils are complete skeletons of animals or leaves of plants. Some are more easily identified than others.

While we are looking at exposures of rocks, we also try to locate earthquake faults where rocks have moved with respect to one another producing displacements in the rock sequence. These faults may have something to do with location of subsurface water.

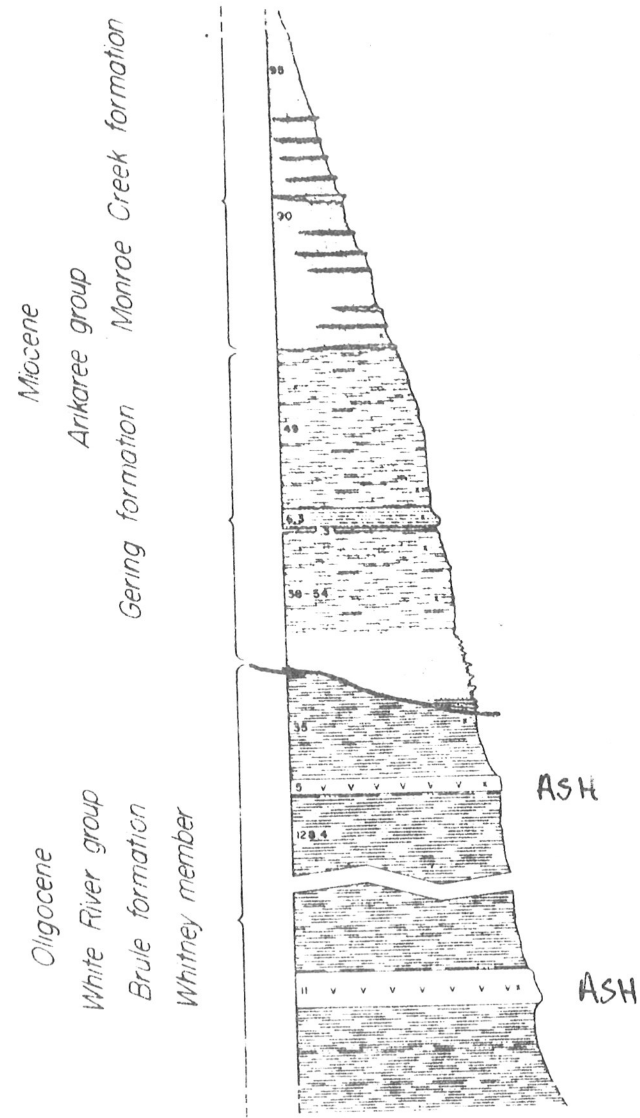

Miocene
Arkaree group
Gering formation
Monroe Creek formation
Oligocene
White River group
Brule formation
Whitney member
ASH
ASH

FIGURE 1

We will locate all of these things on aerial photographs and/or on maps. We will then design a program of test drilling to locate some of the key beds we have observed in outcrops. When we are working on the drilling rig we have at least a staff including a driller, a driller's helper, a catcher, and a geologist. The catcher uses a sieve to catch the samples brought to the surface by water circulated by the rig during drilling. He will wash the samples and lay them on a table for the geologist to describe in detail. Samples are ultimately brought back to Lincoln. Sometimes instead of collecting just chips or cuttings of rock during drilling activity we will obtain pieces of solid rock or core. After drilling is completed we lower probes down the drill hole and determine electrical properties and radioactive properties of the rocks penetrated so that we can pick out the formation changes and match them up with what formations on the surface. We log these formation changes in a logging van beside the drill rig and bring the logs and samples back to Lincoln. We break the sample cuttings up, lay them on a table and examine the changes in texture, color and mineralogy of them. We can also take a sample of core and mount it on a glass slide and observe the mineralogy of the grains in the rock, their distribution, and the distribution of openings or pore spaces in the rock. We can also measure water levels after we drill a well and take water samples.

Once we have collected all the data from outcrops and from subsurface information, we plot those data on maps and then produce a product.

Geologic Framework and Aquifers

The popular notion of the nature of aquifers was expressed well in the Sunday, January 13 Lincoln Journal-Star in an editorial opinion feature called "Groundwater Contamination Becomes Major National Issue." An interesting aspect of this article was the statement, "Through all of this comes a revelation, across much of America, land is simply the surface of subterranean lakes." Some years ago a colleague of mine talked to someone on the Daily Nebraskan staff about the Ogallala Group. Out of his talk on the Ogallala Group the student wrote up a report on the "Aqualla Lake," which she claimed was a vast underground lake beneath the state of Nebraska. When you talk to people about what groundwater reservoirs are like in Nebraska often times this is the idea they have (Figure 2). They believe that there is a vast underground lake and that wells tap this underground lake. We are pumping water out to irrigate, and for stock and domestic use.

You can see, if you travel around the country, why people get notions that all aquifers are underground lakes. There are underground lakes in places like Green Lake at Carlsbad Caverns. In Missouri and Arkansas there are places where huge springs issue from cavern systems and have discharges great enough to supply cities the size of St. Louis.

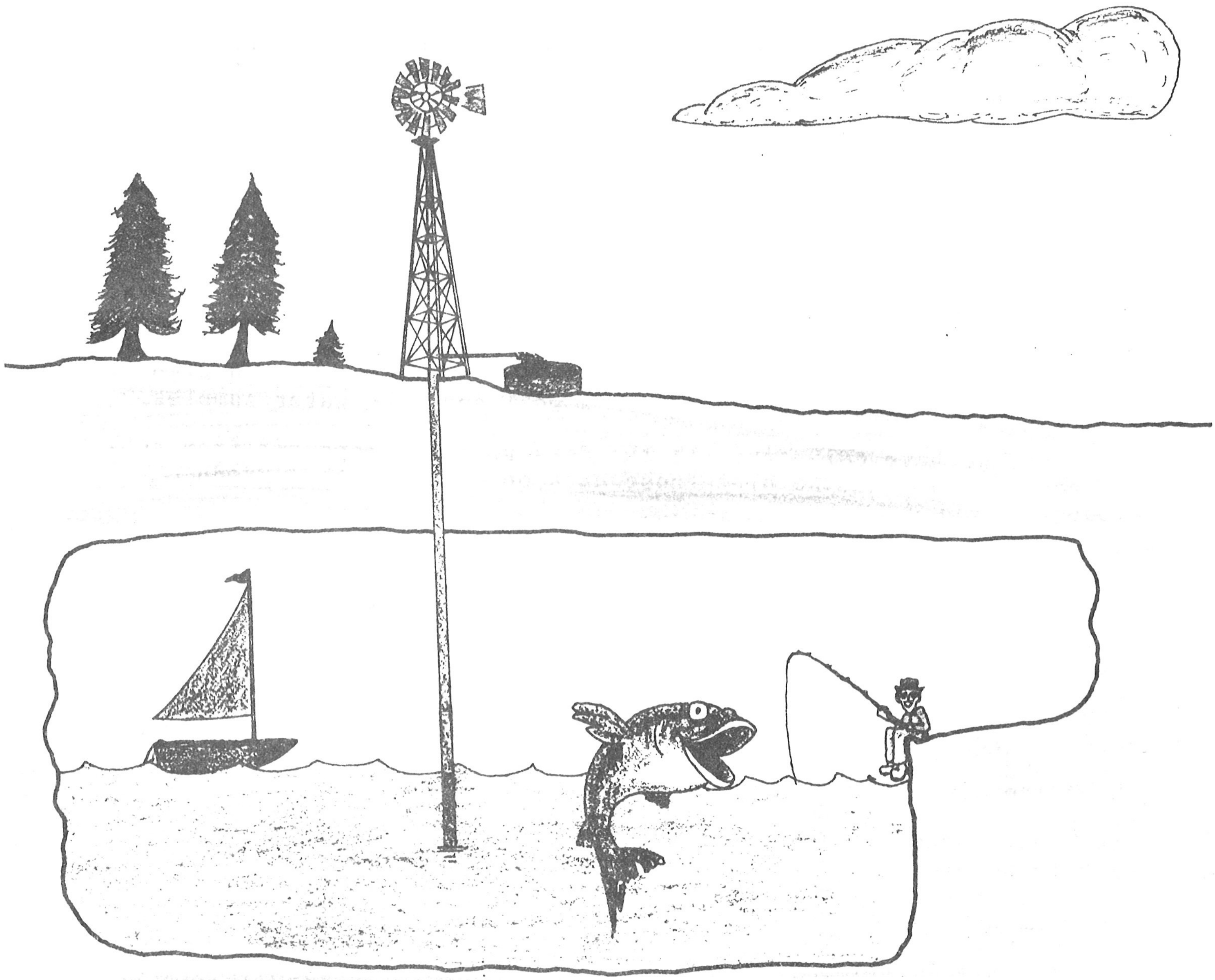


FIGURE 2

In Nebraska, in contrast to these other areas, our aquifers may consist of rather impermeable rocks that are fractured. Water that is in this rock, if there is any, moves along these fractures. In some cases, we have observed that in some of the sediments and sedimentary rocks, large interconnected openings or pipes develop and water will move along those. These openings can be more than several feet in diameter.

At most places in Nebraska water issues from silts, sands, and/or gravels in the form of either seeps or springs. In many cases are aquifers are simply porous sediments. Water fills the pores between grains (Figure 3). When we talk about the regional aquifer in western Nebraska, this sediment with water filling spaces between grains is the reality. Aquifers in Nebraska are <u>not</u> subterranean caverns containing lakes.

<u>Geology of the Southern Panhandle</u>

The geologic framework of the Cheyenne Tablelands, the southern part of the Panhandle, along the North Platte Valley and along Pumpkin Creek Valley (Figure 4) differs from other places. Most of the deposits in this part of the Panhandle are derived from erosion of rocks in the Rocky Mountains to the west or are parts of big volcanic ash falls from eruptions of volcanoes in Colorado, Wyoming and states to the west. The Ogallala Group in this area is not uniform in thickness or distribution (Figure 5).

What we have discovered in looking at the Ogallala and other units in western Nebraska is that basically we are dealing with sediments deposited on the floors and on the sides of ancient valleys (Figure 6). The valleys have been filled up with sediments carried by streams, and then new streams have eroded out new valleys and in turn have filled those up to make a complicated kind of geology.

Some major valleys in western Nebraska are U-shaped in a cross-section. Tributaries to these main valleys often have nearly vertical side slopes, or even slopes over-steepened to the point where overhangs occur. My particular bias is that if you can see these valley shapes today, then they should also have occurred in the past. The Ogallala valleys that the Ogallala sediments were deposited in should have been similar in shape, either having smooth concave-up sides or very steep sides with nearly vertical slopes.

On the North Platte River between Broadwater and Lisco, intermittent streams drain an upland to the north. The geology of the area is shown on Figure 7. Some features cross the present drainages. These features are remnants of an ancient river valley cut filled with sand and gravel (Figure 8). Three hundred feet vertically below the base of this ancient valley is the North Platte River. At one time before the North Platte Valley was formed, there was a river of comparable size flowing across this area. We can pick out the deposits carried by that river because they are typically without any ledge development, form a hummocky terrain, and have a

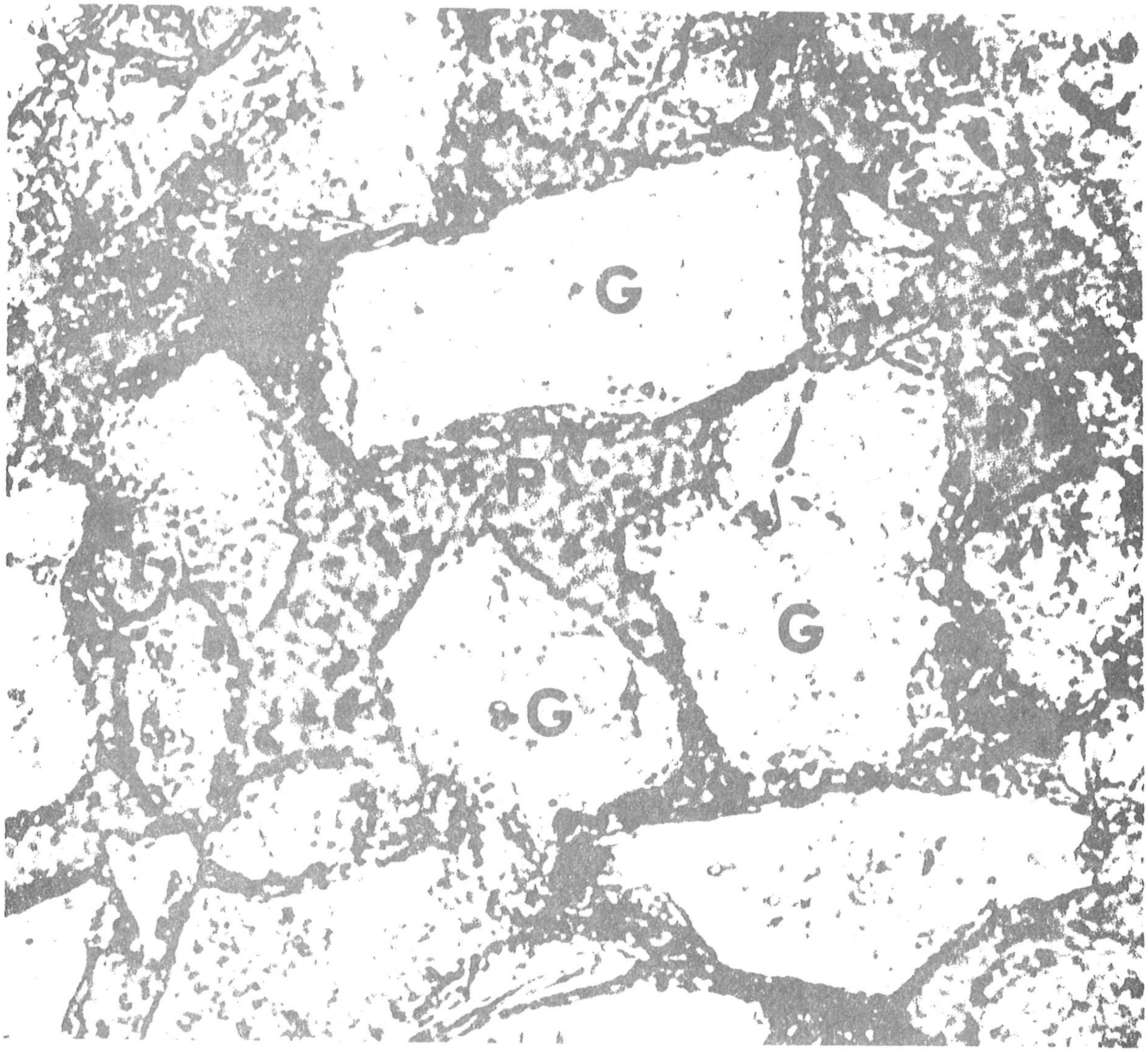


FIGURE 3

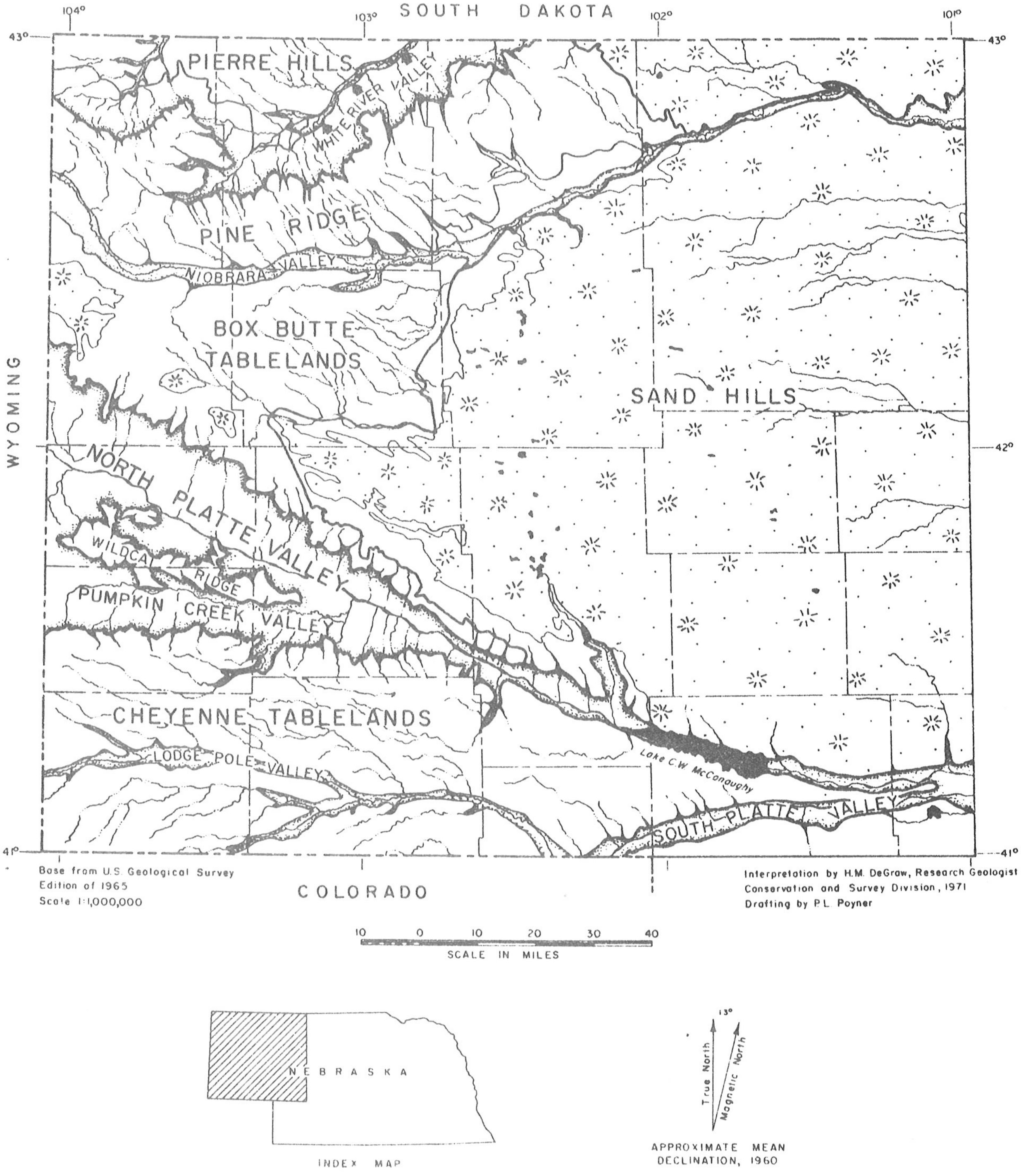
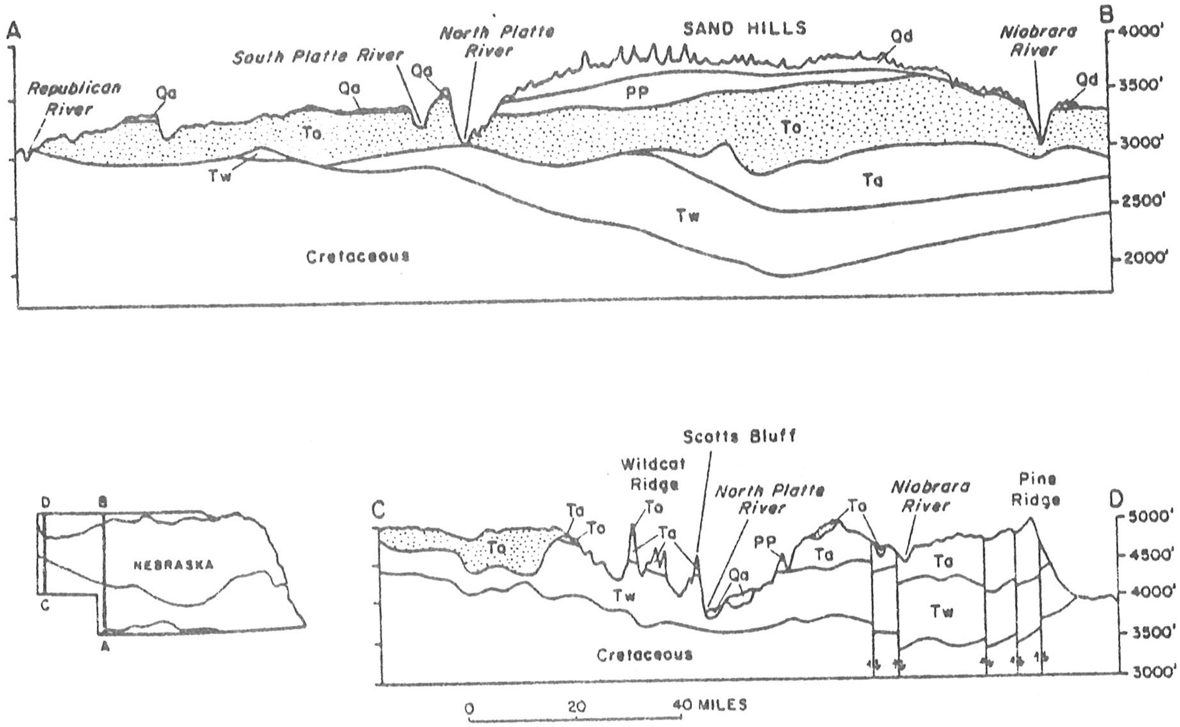

SOUTH DAKOTA
WYOMING
COLORADO
104°
103°
102°
101°
43°
42°
41°
PIERRE HILLS
WHITE RIVER VALLEY
PINE RIDGE
NIOBRARA VALLEY
BOX BUTTE TABLELANDS
SAND HILLS
NORTH PLATTE VALLEY
WILDCAT RIDGE
PUMPKIN CREEK VALLEY
CHEYENNE TABLELANDS
LODGE POLE VALLEY
Lake C.W. McConaughy
SOUTH PLATTE VALLEY
Base from U.S. Geological Survey
Edition of 1965
Scale 1:1,000,000
Interpretation by H.M. DeGraw, Research Geologist
Conservation and Survey Division, 1971
Drafting by P.L. Poyner
10 0 10 20 30 40
SCALE IN MILES
NEBRASKA
INDEX MAP
13°
True North
Magnetic North
APPROXIMATE MEAN
DECLINATION, 1960

FIGURE 4



. South-North cross-sections across western Nebraska. Modified after Swinehart, 1980, p. 126. Ogallala is stippled. Reproduced with permission of Heldref Publications.

FIGURE 5

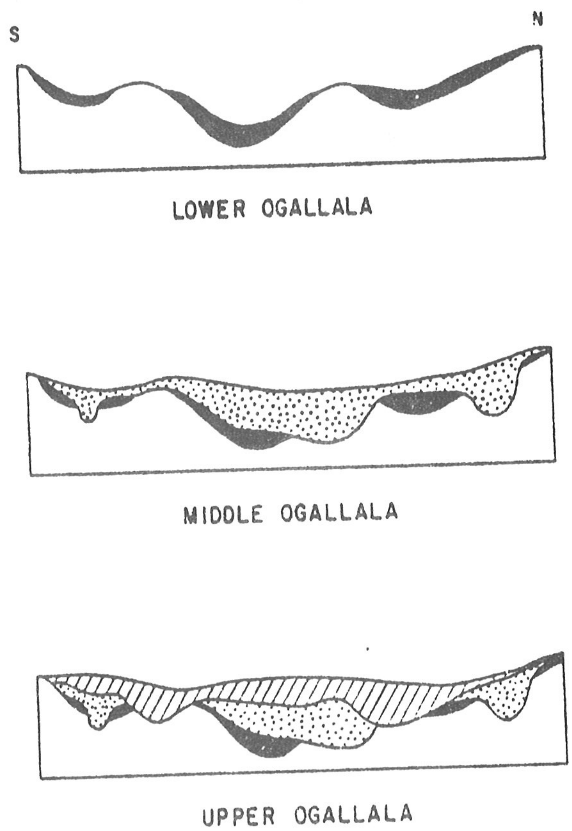
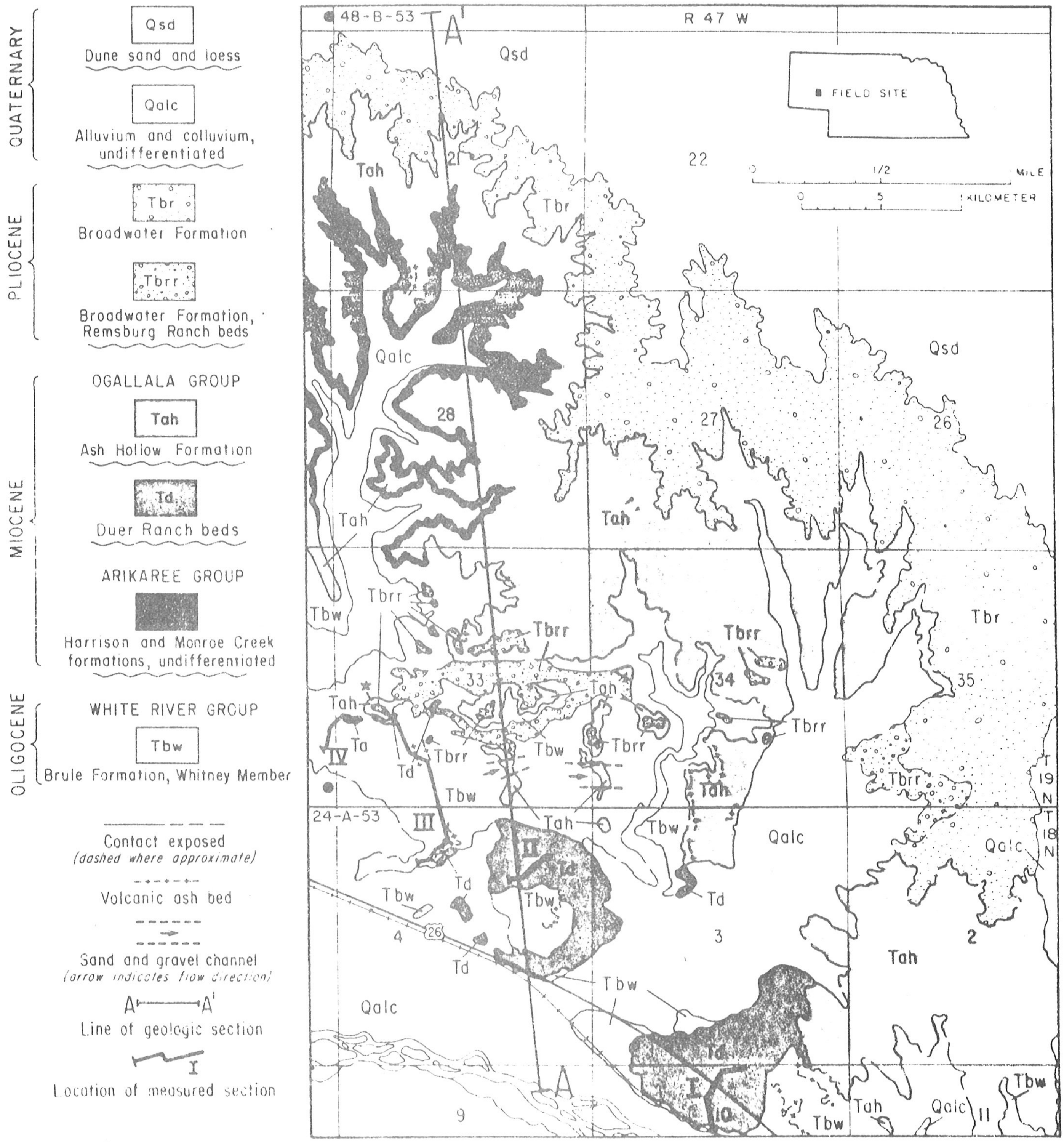
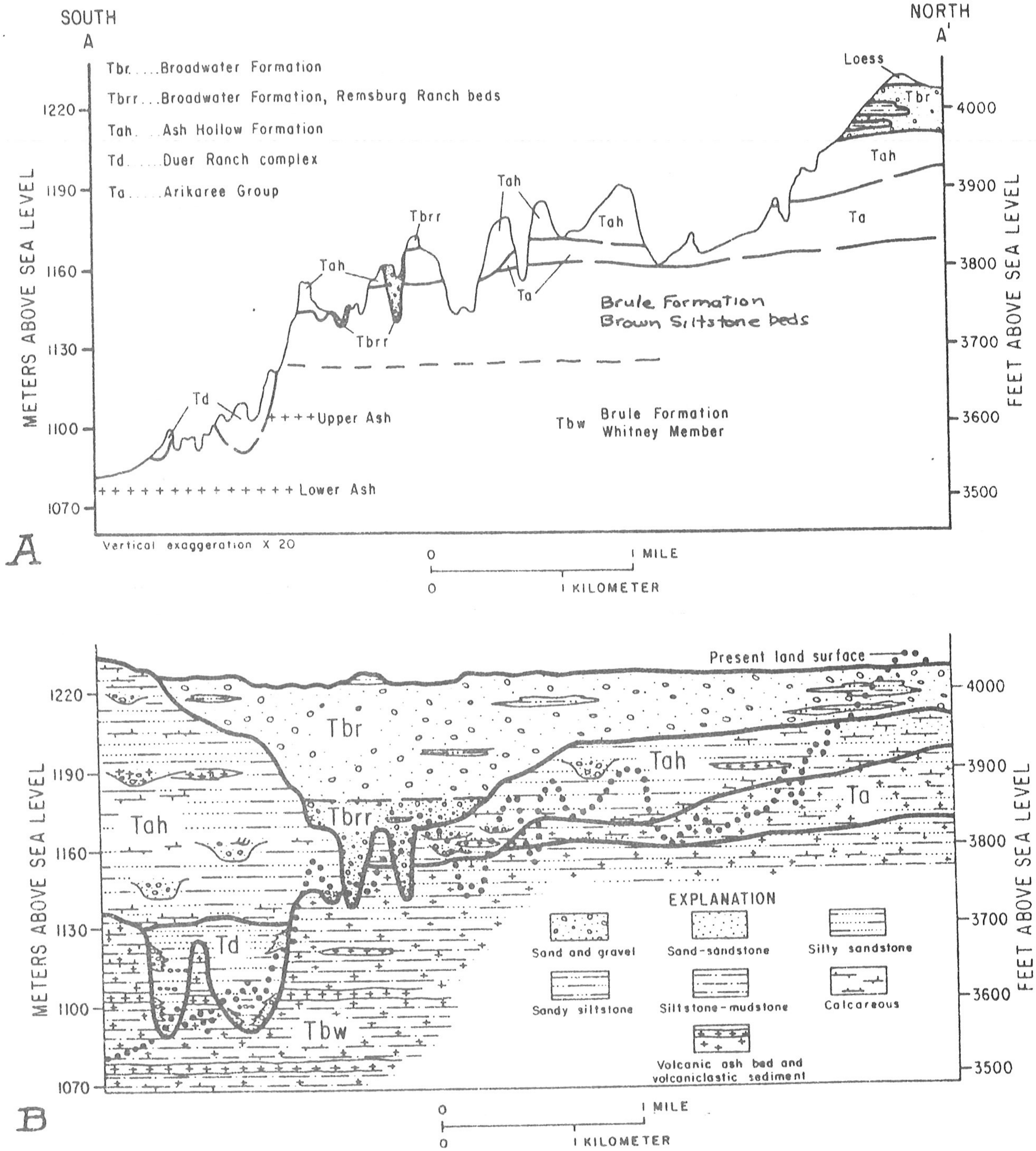


FIGURE 6



Geologic map of the Duer Ranch locality.

FIGURE 7



A. Geologic section along line A-A'. Lower Ash of Whitney projected from Conservation and Survey Division test hole 24-A-53, 1.2 kilometers west of section;
B. Restored geologic section.

FIGURE 8

characteristic pinkish undercast. We have discovered similar narrow and deep ancient sediment-filled valleys during test drilling. These contain porous, permeable sand and gravel that holds a tremendous amount of water.

Almost all of the older rocks beneath the Ogallala Group in western Nebraska are siltstones and sandstones. If these rocks were eroded and the eroded material was carried down ancient stream valleys, it would have a different color and different appearance from those deposits carried out of the Rockies by rivers. It should reflect the nearby source. These rocks, in contrast to those in the main parts of filled Ogallala valleys, are gray or tan. There are no pinkish colored granites derived from great distances.

There are volcanic ash falls preserved in the Ogallala. The ash fills up old gullies cut into older Ogallala deposits, or fills other spots that generally were low areas on an ancient land surface.

There are calcium carbonate cemented layers in the Ogallala and an older strata in western Nebraska that are fairly tight and don't readily allow water to percolate through them. Their presence has an effect on water movements.

We can see a complicated geometry to Ogallala and other deposits in many places in western Nebraska when we go out and look at outcrops. If we can see this complicated picture on the surface, then the geology buried beneath the surface must be every bit as complicated. This complex sediment and rock sequence forms the regional aquifer.