THE GEOLOGY AND DISTRIBUTION OF AQUIFERS IN THE SOUTHEASTERN PART OF SAN JUAN COUNTY, UTAH

By

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Illustrations

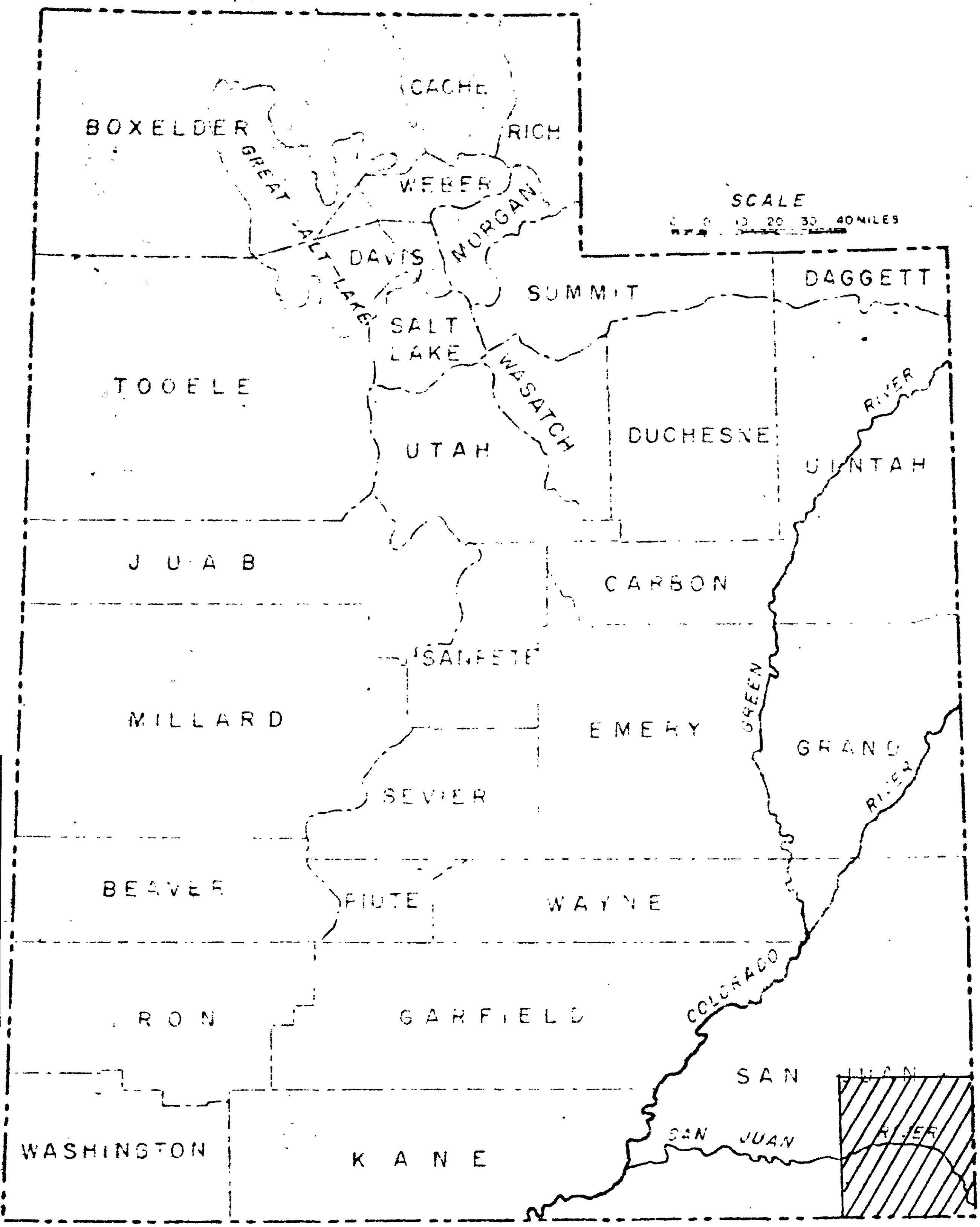

Figure I.- INDEX MAP OF UTAH, SHOWING AREA DISCUSSED IN THIS REPORT

The geology and distribution of aquifers in the southeastern part of San Juan County, Utah

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Purpose of the Investigation

The structural geology and the distribution of aquifers in the southeastern part of San Juan County were studied to establish the relationships of fresh-water aquifers to the oil- and gas-bearing rocks in that area.

Area studied, method of work, and results of the study

The area investigated includes about 1,800 square miles in southeastern San Juan County, Utah (fig. 1). It is a rectangle about 45 miles from north to south and 40 miles from east to west. Its eastern boundary is the Colorado State line and its southern boundary is the Arizona State line.

Published geologic maps, water-well logs, and oil-well logs were studied to determine the surface and subsurface geology and the distribution of aquifers in the area. The writer spent three days in the area observing oil-well-drilling practices and making a reconnaissance of the surface geology.

The principal results of the study are a stratigraphic chart (fig. 6), a series of maps that show surface and subsurface geology (figs. 5, 7, 8, and 9), and maps showing the location of oil and water wells in the area (figs. 2, 3, and 4). In addition, this report discusses the problems of possible contamination of fresh-water aquifers in oil wells, and an appendix briefly describes the maps and chart.

Discussion of the problem

Salt and salt water occur in the oil- and gas-bearing unit of the Hermosa formation and are commonly reported in the logs of oil wells drilled in southeastern San Juan County (fig. 2). Salt water in these oil wells could contaminate fresh water in aquifers overlying the Hermosa formation (fig. 6) in either or both of two ways. Salt water that is brought to the surface and is disposed of by surface spreading could contaminate any aquifer onto which it is spread. Salt water that remains in an oil well could contaminate overlying aquifers during drilling, during flow or pumping, or after abandonment. Both surface and subsurface contamination can be prevented by following aquifer-protection practices. Such practices would prevent disposal of salt water onto outcrops of fresh-water aquifers and would insure that aquifers were adequately sealed off during drilling and that wells were properly plugged before abandonment.

Protection against contamination of aquifers by drilling operations on Federal and Indian lands is afforded by the regulations (contained in Title 30, Code of Federal Regulations 221.28), which are being administered in this active oil field by the petroleum engineers of the Conservation Division, United States Geological Survey. The study for the present report has attempted to determine which formations are valuable aquifers, and where those aquifers occur at and beneath the surface; it does not attempt to recommend which aquifers should be protected, or how the aquifers should be protected.

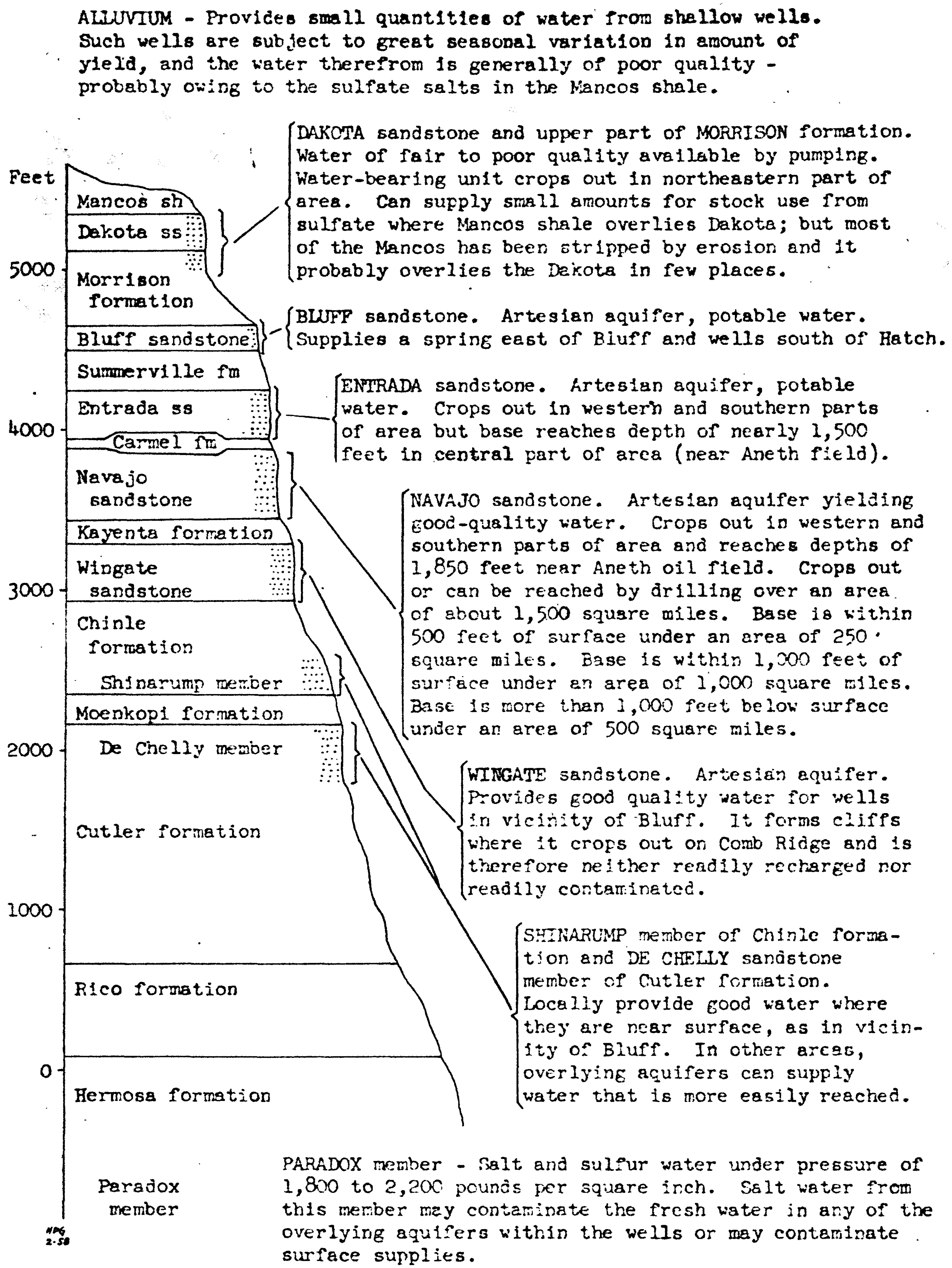

Figure 6. Generalized section of stratigraphic units, including water-bearing units, in southeastern Utah

In this area, the fresh-water-bearing Dakota, Bluff, Entrada, Navajo, and Wingate sandstones, the Shinarump member of the Chinle formation, and the De Chelly sandstone member of the Cutler formation (fig. 6) overlie the Hermosa formation, and most of these are penetrated by oil wells drilled to the Hermosa. Of these water-bearing units, the Wingate, Shinarump, and De Chelly can supply good water in the western part of the area where they are at or near the surface. Thus in the western part of the area the Wingate, Shinarump, and De Chelly should not be subjected to surface contamination; but in the central part of the area they lie below more easily reached aquifers so subsurface contamination in that area may not be as serious a problem. The Dakota sandstone (with the upper part of the Morrison formation) supplies water for shallow wells in the northern part of the area. It is at or near the surface over an area of about 600 square miles (fig. 5) and could be subject to both surface and subsurface contaminations. The Bluff sandstone supplies a spring 2 miles east of Bluff and wells south of Hatch in T. 39 S., R. 24 E. The other and deeper aquifers, the Entrada and Navajo sandstones, are probably the most important because they underlie the largest areas and can probably supply the greatest amounts of artesian water. Although the Entrada and Navajo are more than 750 and 1,000 feet, respectively, below the surface in much of the area, both can supply good quality water under sufficient pressure to bring it to or near the surface. The Navajo crops out or is immediately overlain by porous dune sand over an area of about 160 square miles in the western part of the area (fig. 8), and it underlies another 1,400 square miles. In the center of the area the base of the Navajo is about 1,800 feet below the surface. The Entrada sandstone crops out over an area of only about 35 square miles in a north-south band east of the Navajo outcrop area (fig. 9), but it underlies about 1,300 square miles. The base of the Entrada sandstone is 200 to 450 feet nearer the surface than is the base of the Navajo sandstone under most of the area so that it is more readily reached than is the base of the Navajo.

All oil wells that have been drilled east of the Axis of the Comb monocline penetrate the Entrada or Navajo sandstone, or both.

Discussion of the findings of this study

The maps compiled during this study show the surface geology (fig. 5) and delineate the structure of the Entrada and Navajo sandstones (figs. 8 and 9) and the structure of the principal oil-bearing unit, the Hermosa formation (fig. 7).

The principal structure of the area is the northwest-trending Blanding Basin (Kelley, 1955, p. 174), which has a probable closure of 1,200 to 1,400 feet. The Colorado State line cuts across the basin, and the extension of the basin into Colorado has not been studied; thus the closure in the basin as a whole is not known. In Utah, the maximum basin closure in the Hermosa formation and in the Navajo sandstone is about 100 feet. Three domes having 150 to 300 feet of closure are present in the Hermosa formation within the Blanding Basin. These domes and other structural noses that may have closures of less than 100 feet are oil or gas bearing and have been the targets for petroleum exploration.

The main oil- and gas-bearing unit is within and about 800 to 1,000 feet below the top of the Hermosa formation. Salt and salt water occur below the oil- and gas-bearing unit and thus are commonly penetrated both by dry wells and by wells that reach oil and gas. The oil and gas are under pressures of 1,800 to 2,200 pounds per square inch, and in some wells salt water is brought to the surface with the oil.

Acknowledgments

The writer is grateful to his colleagues in the office of the Utah State Engineer and in the office of the Utah Oil & Gas Conservation Commission for aid in supplying well data and other information from San Juan County. He is especially grateful to Seymour Subitzky of the U. S. Geological Survey for turning over the preliminary work he had done on the problem and to J. G. Richman for his assistance in compiling well data and in preparing most of the maps.

Most of the logs used in this study were published by Petroleum Information. Many others were obtained from the drillers and oil companies through direct reports to the U. S. Geological Survey or to the Oil and Gas Conservation Commission.

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Appendix

Description of maps and chart resulting from the study

Figure

1. Index map of Utah, showing area discussed in this report.

   Scale: 1:1,000,000

2. Map showing location of oil wells in southeastern Utah.

   Scale: 1:125,000

   In the center of the Aneth oil field, T. 40 S., R. 24 E., only selected wells are shown. The other wells in T. 40 S., R. 24 E., are shown on figure 3.

   The logs of the wells shown on this map and on figure 3 provided the information about geologic tops from which the structure maps (figs. 7, 8, and 9) were constructed. Also shown on this map are the wells reporting salt or sulfur water and the shut-in pressure where known.

3. Map showing locations and names of oil wells in T. 40 S., R. 24 E.

   Scale: 1:24,000

   This map shows wells that could not be plotted at the smaller scale of figure 2.

4. Map showing location of water wells in southeastern Utah

   Scale: 1:125,000

   This map includes not only water wells but also oil wells that reported fresh water. The map shows the quality of water in some wells.

Figure

5. Geologic map of the southeast corner of Utah

Scale: 1:125,000

This map was compiled from geologic and photogeologic maps at scales of 1:24,000 and 1:31,680. It has not been field checked.

The map also shows drainage and the altitudes of a few topographic features of the area.

6. Generalized stratigraphic section showing rocks and water-bearing formations in southeastern Utah.

The references listed in the Selected Bibliography were consulted for stratigraphic names, and the thicknesses shown graphically were computed from well logs.

7. Map showing structure at the top of the Hermosa formation in southeastern Utah.

Scale: 1:125,000

The top of the Hermosa has been contoured at an interval of 100 feet with sea level as datum. The map shows the location of oil wells that provided the stratigraphic data and shows the relation of oil and gas fields to structural highs within the Blanding Basin.

8. Map showing structure at the base of the Navajo sandstone in southeastern Utah.

Scale: 1:125,000; contour interval 100 feet; datum is mean sea level.

Figure

The map shows location of oil wells that supplied the stratigraphic data, the depth to the base of the Navajo sandstone, its thickness, and the area of outcrop.

9. Map showing structure at the base of the Entrada sandstone in southeastern Utah.

Scale: 1:125,000; contour interval 100 feet; datum is mean sea level.

The map shows the location of oil wells that supplied the stratigraphic data, the depth to the base of the Entrada sandstone, its thickness, and the area of outcrop.