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Hydrogeology of the Northeast Quarter of Marion County, Iowa

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Abstract. This research was done on a study of the Hydrogeology of the Northeast Quarter of Marion County, Iowa, during the year of 1965-1966.

In the surveys conducted the bedrock topography was found to be an extremely irregular surface; it is composed of both Mississippian and Pennsylvanian rocks. The top of the Mississippian rocks was found to be an irregular erosional surface possibly indicative of Karst topography. The piezometric surface for wells cased in Mississippian strata indicates a ground water divide. North of this divide the water flows into the South Skunk River, and south of the divide the water flows into the Des Moines River.

The quality of the ground water deteriorated with depth, due to the presence of coal and pyrite in the Pennsylvanian strata, and limestone, dolomite, and some gypsum in the Mississippian strata. The principal aquifers as far as the production of wells is concerned are the St. Louis and Ste-Genevieve Formations and the Pleistocene deposits.

The problem concerns the ever-increasing demand for domestic, industrial, and municipal water supply in the state of Iowa. Nearly all supplies are obtained from ground-water resources. The Iowa Geological Survey has been collecting data for years and in 1938 the U.S. Geological Survey began investigating the available water resources in this section of the county. The investigations which provide the data for this report were part of the state-wide program. This report presents the geology of the area, with particular emphasis on the hydrogeology.

METHODS OF INVESTIGATION

Not much hydrologic investigation had been made in the study area before work was commenced on this project in the summer of 1965 and intermittently during 1966. The study area consists of 144 square miles (Fig. 1), and lies partly in the Pella Quadrangle and partly in the Knoxville Quadrangle. Field work consisted of collecting data on geologic formation penetrated, production and use of water, rock exposures in quarries and road cuts, coal mines, and driller's logs. Chemical analyses for selected wells were obtained from the Iowa Geological Survey files. Locations of wells and contact between Mississippian and Pennsylvanian strata are shown in Figure 2.

The bedrock is of Pennsylvanian and Mississippian age, and no wells have been drilled deeper. However, some city wells in other parts of the county and the surrounding counties have penetrated into the Devonian and Silurian Systems and the Jordan

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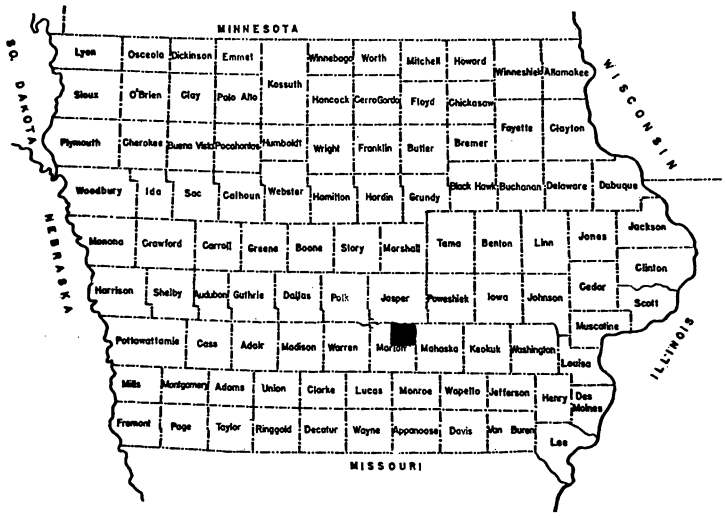


Fig. 1. Map of Iowa. Shaded area represents location of study area.

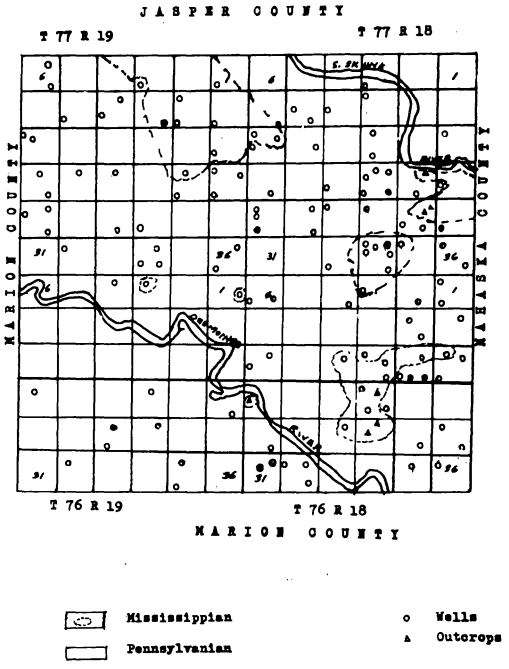


Fig. 2. Location of wells and the contact between Mississippian and Pennsylvanian strata in study area.

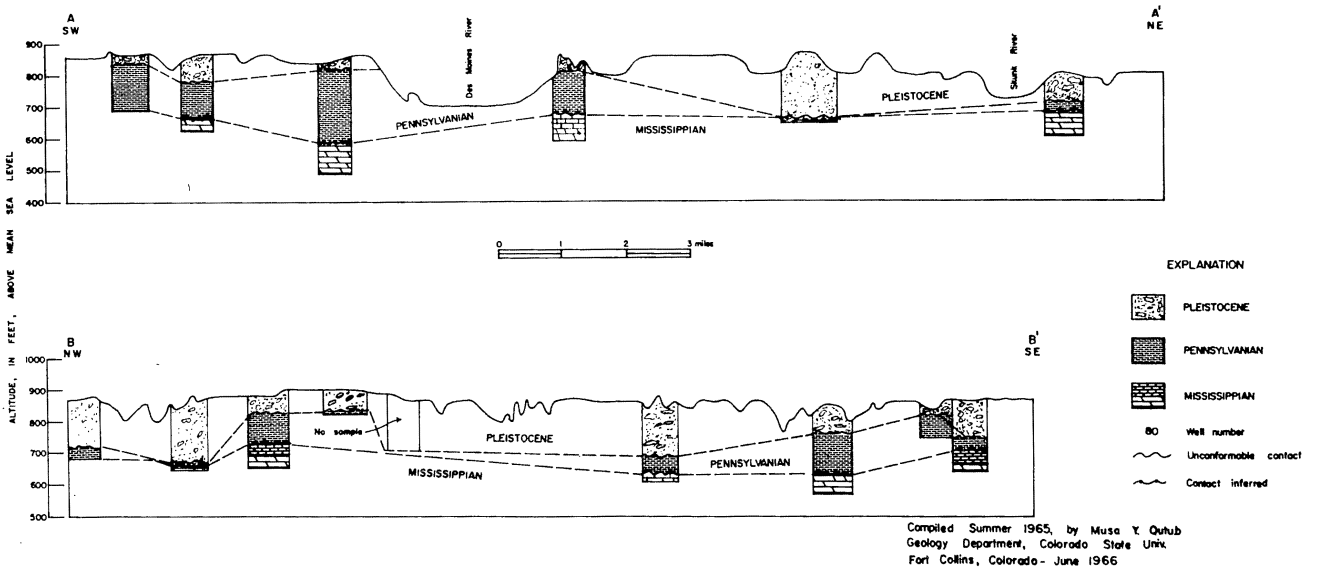


Fig. 3. Geologic cross-sections Northwest through Southeast and Northeast through Southwest.

Formation of the Cambrian System (Twenter and Coble, 1965). Aquifers in these Formations produce both good quality and large quantities of water. The approximate depth to the bedrock and changes in thickness of the Mississippian and Pennsylvanian strata, and of the Pleistocene deposits are shown in Figure 3.

The Mississippian System is represented by the Meramec and Osage Series (Harris & Parker 1964). The top of the Mississippian is an irregular erosional surface possibly indicative of Karst topography, as is evidenced by the closed depressions shown in Figure 4. Drilling reveals the bedrock topography as being relatively flat,

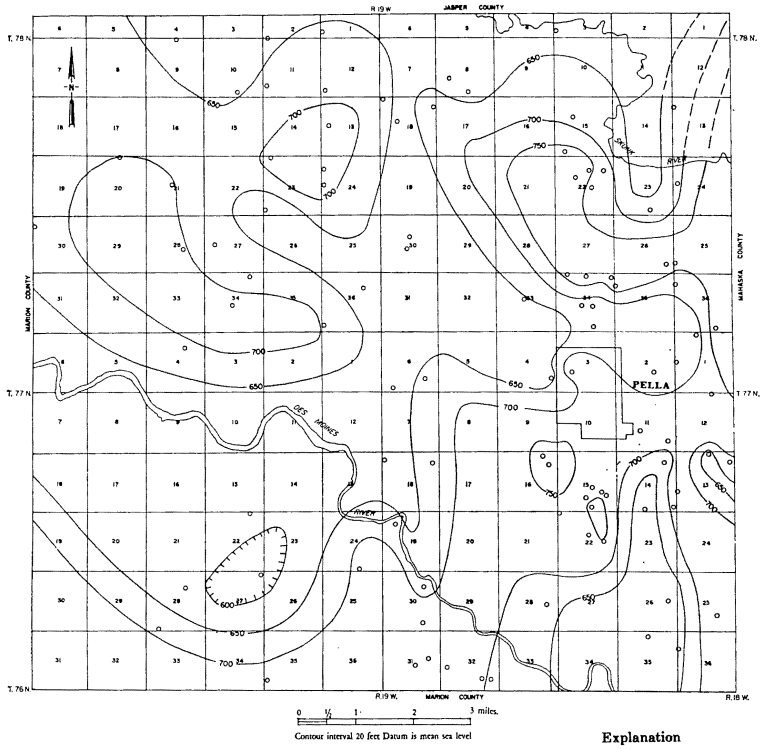


Fig. 4. Contour map of pre-Pennsylvanian topography.

with three highs and a low in the center. The thickness and physical characteristics of the Mississippian strata are shown in Figure 5.

System	Series	Sub-division	Rock Column	Thickness and physical characteristics	Water supply
Quaternary	Pleistocene	Kansan stage		0-225 feet Siltstone, till, gravel, drift, siltstone clay, sand, oxidized loess	sand and gravel yield water from 5-40 gpm for domestic and farm use. 11 wells have been drilled into this formation.
Pennsylvanian	Des-Moines-ian	Undifferentiated beds		0-230 dark carbonaceous shale, clay, sandstone, coal, thin limestone, some dolomite and silt	The sandstone yields water from 4-25 gpm. 25 wells have been drilled into this formation.
Mississippian	Meramec	St. Genevieve		0-40 Predominately limestone and shale - some dolomite	The limestone yields water from 5-20 gpm. 12 wells have been drilled into this formation.
		St.Louis		0-35 Sandy limestone	The sandy limestone yields water from 3.5-25 gpm. 40 wells have been drilled into this formation.
	Osage	Warsaw		0-110 Shale and dolomite	The dolomite yields water from 4-22 gpm. 7 wells have been drilled into this formation.
		Keokuk		0-75 Dolomite and limestone and chert	The dolomite and limestone yield from 3-18 gpm. 17 wells have been drilled into this formation.
		Burlington		0-90 Dolomite and limestone	The dolomite and limestone yield water from 2-5gpm.2 wells have been drilled into this formation.

Fig. 5. Generalized graphic stratigraphic column of study area.

The Pennsylvanian System is represented in the study area by the Cherokee Group which is undifferentiated (Fig. 5). The bedrock contour map (Fig. 6) shows the surface of the bedrock as extremely irregular. The Pleistocene deposits mantle the bedrock except in a few places where outcrops of Mississippian and Pennsylvanian rocks are noted (Fig. 2).

Hydrogeologic Units

Mississippian System

Burlington: The Burlington Formation is not a significant aquifer at the present time. Apparently well drillers in the study area do not find it necessary to drill deeper than the St. Louis Formation to find adequate amounts of water. Two wells were drilled into this formation with a total production of 7 gpm.

Keokuk: The Keokuk Formation is the third major aquifer in the Mississippian System as far as the production of wells is concerned. Data are available for 17 of the wells producing from the Keokuk Formation. It is estimated that the total production of these wells is 140 gpm (Fig. 5).

Warsaw: The Warsaw Formation is approximately 110 feet thick, and due to the abundance of shale, it is an aquiclude. Six wells were drilled into this formation with a total production of 54 gpm and depth ranging from 132 to 225 feet (Fig. 5).

St. Louis: The St. Louis Formation is the major aquifer. Data are available for 38 wells from this formation, and it is estimated that the total production is 391 gpm.

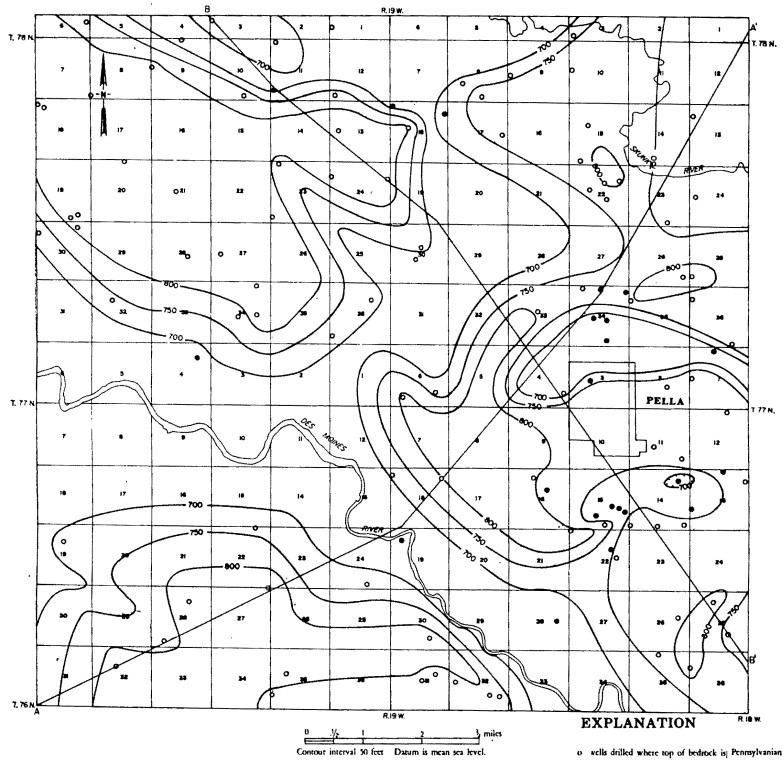


Fig. 6. Bedrock contour map of pre-glacial topography.

Ste-Genevieve: The Ste-Genevieve Formation is considered the second major aquifer in the Mississippian System because it has high porosity and permeability due to the fractures. Well drillers in the study area have noted that the Ste-Genevieve is fractured to a considerable extent, and this fact also is apparent in quarry excavations. Data are available for 11 of the wells producing from the Ste-Genevieve Formation, and it is estimated that the total production of these wells is 163 gpm.

Pennsylvanian System

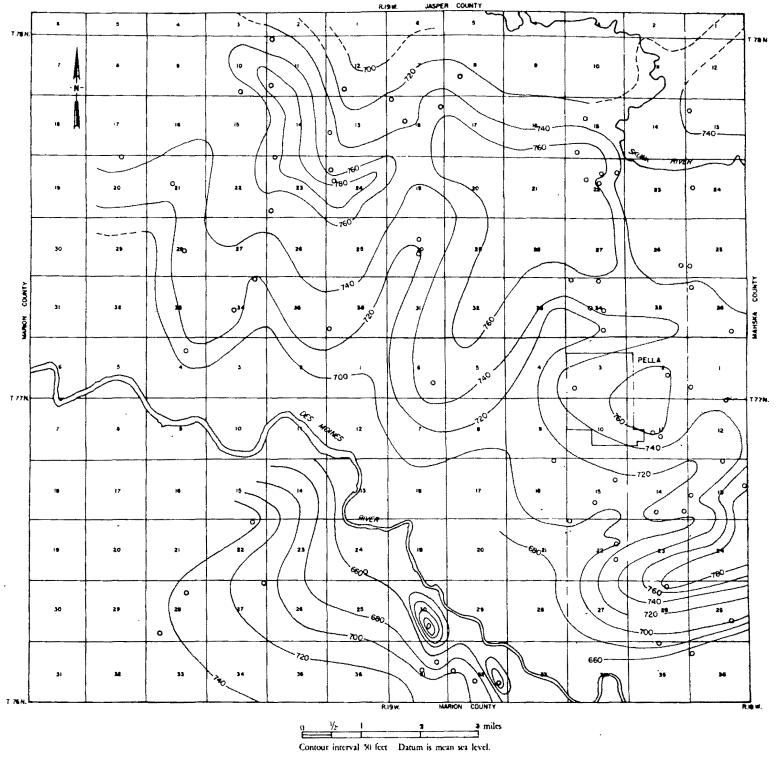
Des Moines series: The main aquifer of this unit is a sandstone, averaging 34 feet in thickness, and occurs at the base of the Cherokee Group. Data are available for 23 of the wells from this aquifer and it is estimated that the total production of these wells is 193 gpm.

Quaternary System

The Pleistocene deposits are considered as the second major source. Data are available for 17 of the wells producing from these deposits, and it is estimated that the total production is 357 gpm.

Ground Water Movement

The static water levels of the wells drilled in the study area were measured when the wells were drilled. Therefore, the piezometric maps prepared cover a period of approximately thirty years.



Compiled by Musa Qubub - Geology Department,

Colorado State University - Fort Collins, Colorado -

August 1966.

Fig. 7. Contour map of piezometric surface for wells cased in Mississippian strata.

Figure 7 shows the piezometric surface of wells cased in the Mississippian strata. Southwest of the South Skunk River the map

shows a NW-SE trending ground-water divide that coincides approximately with the surface drainage divide. In the northeast corner of the study area there is another ground-water divide approximately perpendicular to the first divide. The highest altitudes of the piezometric surface are in the southeast corner. The steepest gradient, approximately 120 feet per mile, is found in the same area, while the gentlest gradient, approximately 30 feet per mile, lies in the northwest portion of the study area. The irregularity in the hydraulic gradient is possibly due to differences in the permeability of the water-bearing materials. This permeability variation may be due to differential fracturing.

Certain salient features of the ground-water surface are shown on Figure 7. North of the ground-water divide the subsurface flows northeast into the South Skunk River, and south of the divide the water flows southwest into the Des Moines River.

Ground-water movement in Pennsylvanian and Pleistocene deposits cannot be discussed because the information was not recorded and made available for this research.

Water Quality

A comparison of the quality of ground-water in the study area to that of the rest of the county is shown in Figure 8.

Water obtained from Pleistocene deposits apparently is quite satisfactory for domestic and industrial use due to the fact that the more active ions such as SO_4 were removed as the sediments were being transported.

The abundance of dissolved solids in water which is obtained from the Pennsylvanian strata presents a problem. The water obtained in the study area from this strata is higher in dissolved solids and SO_4 than in any other part of the county. This is partly due to the presence of pyrite in the Pennsylvanian coal and the fact that the study area has more coal beds than in the rest of Marion County. Therefore, there is a relatively greater abundance of associated minerals; and hence, a greater percentage of dissolved minerals in the ground water obtained from the Pennsylvanian strata.

Water obtained from Mississippian rocks is even higher in mineral content owing to the abundance of limestone, dolomite, and possibly gypsum (Fig. 8).

Conclusions

The main aquifers in the study area are the St. Louis Formation, Ste-Genevieve Formation, and the Pleistocene deposits. The quality of water obtained from deeper aquifers deteriorates due to lithologic factors. Upon completion of the Red Rock Dam this Fall (1969), the water of the lake which will be formed will re-

	Water samples obtained from the Pleistocene drift		Water Samples obtained from Pennsylvanian Rocks		Water Samples obtained from Mississippian Rocks	
Dissolved Constituents	NE quarter of Marion County Average of 2 wells	Marion County Average of 6 wells	NE quarter of Marion County Average of 2 wells	Marion County Average of 11 wells	NE quarter of Marion County Average of 4 wells	Marian County Average of 11 wells
Dissolved Solids	475	401.1	3133	744.72	3596.75	3880.9
Fe	0.35	0.99	0.35	0.97	0.524	3.75
Mn	0.08	0.544	0	0.174	0	0.235
Ca	87	84.33	322.5	138.99	275.25	346.12
Mg	27	26.16	94.5	19.55	83.75	61.45
Na K (as Na)	6.9	20.98	493	51.36	922	728.62
HCO_3	317	388.16	330.5	321.72	343	296.45
SO_4	70	50.16	1778.5	254.18	2380	2213.09
Cl	5	3.58	84	6.63	240.25	123.77
F	0	1.15	0.35	0.427	0.85	1.78
NO_3	1.6	8.71	116	0.81	13.22	5.57
Total Hardness	328	633.43	1194.5	452.18	1285	1119.08
Ph	7.5	7.31	7.2	6.56	7.3	7.21

Fig. 8. Comparison of water quality in NE to rest of county.

charge the aquifers. If this water becomes contaminated by man's misuse of the lake the water quality will deteriorate considerably. Reserve aquifers could be found in the Devonian and Silurian Systems. The Jordan Formation of the Cambrian System can also be considered as a reserved aquifer. In the northeast quarter of Marion County the depth to this formation is estimated to be 1309 feet below sea level.

Acknowledgements

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