

# **THE COTEAU LIGNITE BED IN NORTH-CENTRAL NORTH DAKOTA**

by

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## Table of Contents

Introduction	
The Coteau Bed	2
The Coteau Aquifer	2
Water Quality . .	9
Methane Potential of the Coteau Bed	9
References	1

## Illustrations

### Figure

	Approximate extent of Coteau bed in north-central North Dakota . . . . .	1
2.	An isopach of the Coteau bed in north-central North Dakota . . . . .	3
3.	Contour map on top of the Coteau bed in north-central North Dakota . . . . .	4
4.	The depth to the top of the Coteau bed in north-central North Dakota . . . . .	4
5.	Northwest-southeast geologic cross-section in southeastern Ward and southwestern McHenry counties . . . . .	6
6.	North-south geologic cross-section in southeastern Ward and northeastern McLean counties . . . . .	7
7.	Locations of farm wells believed to be screened in the Coteau bed . . . . .	8

### Table

	Farm Wells Believed to be Screened in the Coteau Bed . . . . .	10
2.	Groundwater Quality in the Coteau Lignite at the Velva Mine, North Dakota	10

## Introduction

The Coteau bed is a thick, extensive bed of lignite that occurs in north-central North Dakota (Figure 1). The Coteau bed is located in the Bullion Creek (Paleocene) Formation and was mined in eastern Ward and western McHenry counties from the 1920s up through the 1980s. Although it is typically buried several hundred feet beneath the surface throughout most of the area, it is exposed along the upper reaches of several coulees (Bonnes and Oak) in the Sawyer area. These exposures of the Coteau bed made it accessible to the early settlers which is why numerous truck and wagon mines were established along the edges of these coulees around the turn of the century. Underground mining of the Coteau bed in this area began in the early 1900s and continued up to the early 1940s. Surface strip-mining took place in this area from 1927 up to the 1980s at the Velva Mine (Oihus, 1983).

Subsurface data in the form of electric and drillers logs were compiled for a 720-square-mile area bounded by Tps. 148 - 154N. and Rs. 79 - 84W. in Ward, McHenry, and McLean counties. A total of 151 electric and drillers logs, obtained from coal company exploration programs and seven water well and monitoring well logs from the files of the North Dakota State Water Commission were used as data points during the construction of maps and cross-sections of the area.

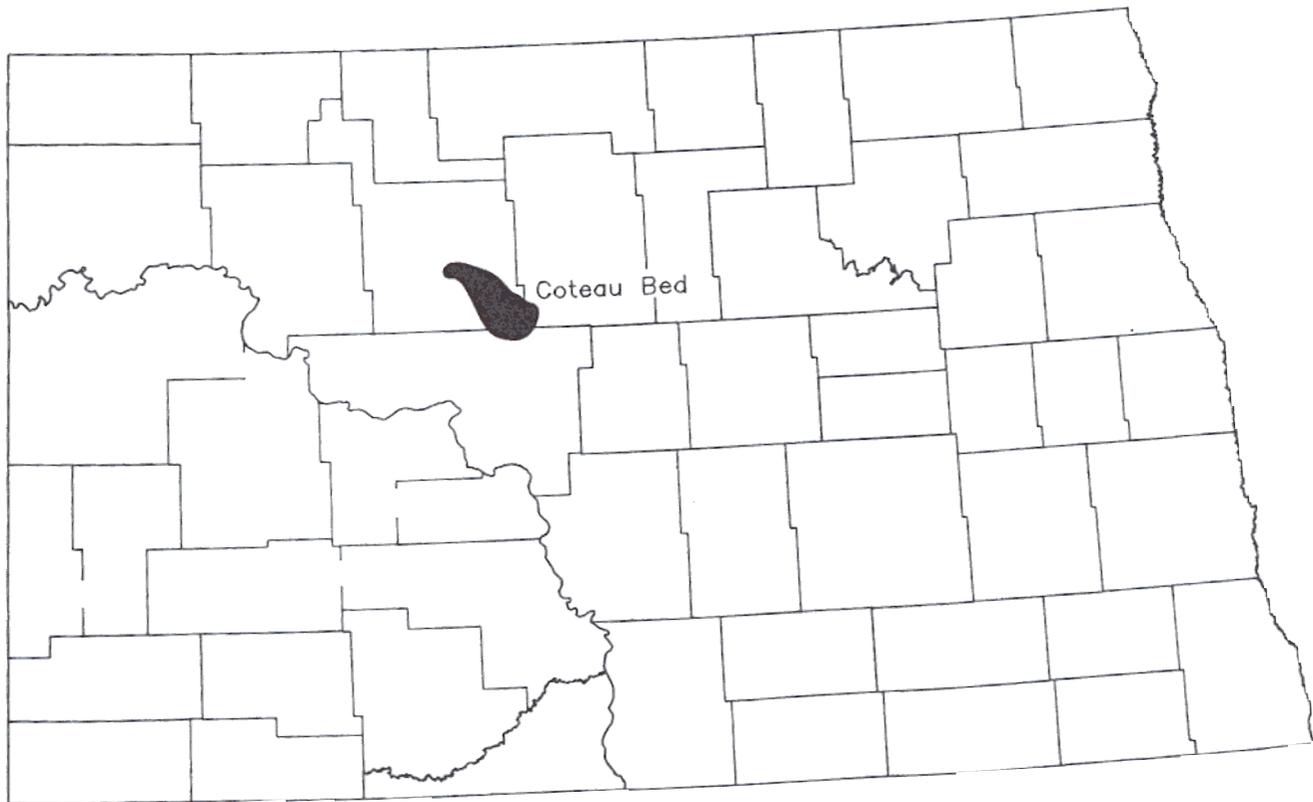


Figure 1. Approximate extent of Coteau bed in north-central North Dakota.

## The Coteau Bed

The Coteau bed can be traced in the subsurface over an area of at least 162 square miles in eastern Ward, southwestern McHenry, and north-central McLean counties (Figure 1). The total extent of this bed may actually be 300 to 400 square miles. Poor data control to the west of R.82W. and to the south of T.151N., coupled with the thinning nature and numerous splits of the Coteau bed in the southern half of the area, make an exact determination of the extent of the Coteau bed impossible. The Coteau bed can be traced, with reasonable accuracy, as far to the northwest as section 13, T.153N., R.83W., approximately nine miles south of Minot.

The lignite bed averages 10 to 12 feet in thickness throughout the three-county area and obtains its maximum known thickness of 22 feet in southeastern Ward County (T.152N., R.81W., section 18) (Figure 2). In general, the Coteau bed dips to the west-northwest with a gradient of 13.6 feet per mile (Figure 3). Locally, the gradient of the coal bed may be much less or much steeper than the average gradient. This is in part a reflection of the original conditions during deposition and also a result of differential compaction by overlying rocks and glacial unloading. In some cases, the local gradient of the lignite bed might not be in the same direction as the regional gradient. This local reversal of the regional gradient has been observed in numerous subsurface correlations of North Dakota lignites.

As previously mentioned, the Coteau bed is exposed at the surface in the upper reaches of Bonnes and Oak coulees. The Coteau bed is present at an average depth of 150 feet throughout the three-county area but, is present at a depth of 300 feet in southeastern Ward County (T.151N., R.81W., sec. 17) (Figure 4). Due to erosion, the Coteau bed is absent north and east of a northwest-southeast trending line which extends from section 31, T.152N., R.80W. to section 31, T.153N., R.81W. (Figure 3).

As demonstrated by the cross-sections (Figures 5 and 6), the Coteau bed thins, thickens, and splits as it is traced through the subsurface in the three-county area. This is in general accordance with the nature of North Dakota lignites. The Coteau bed appears to be present as two seams in T.149N., R.83W., section 23 (between the elevations of 1720 and 1750) (Figure 6). However, poor data control and the splitting nature of the coal in this area made correlation, with any degree of certainty, impossible.

A 24-foot thick lignite bed exists at a depth of 300 feet beneath the surface (1471 feet above sea level), one mile northwest of Minot (T.155N., R.83W., section 3) (Pettyjohn, 1968). A series of three to four, five-foot-thick lignite beds are also present in this area at a depth of approximately 150 feet (1575 feet above sea level, T.155N., R.83W., sec. 1). There is not sufficient data available to determine whether this thick coal bed, or the series of coal beds, correlates with the Coteau bed 13 miles to the south.

## The Coteau Aquifer

The Coteau bed is saturated throughout most of its extent and is an important regional aquifer. A minimum of 30 farm wells are screened in the Coteau Aquifer (Figure 7). This determination was made by comparing the attitude of the Coteau bed with the screen elevations of area farm wells known to be screened in lignites (Table 1). The data base was compiled in 1968 and I did not determine how many of these wells are still in service.

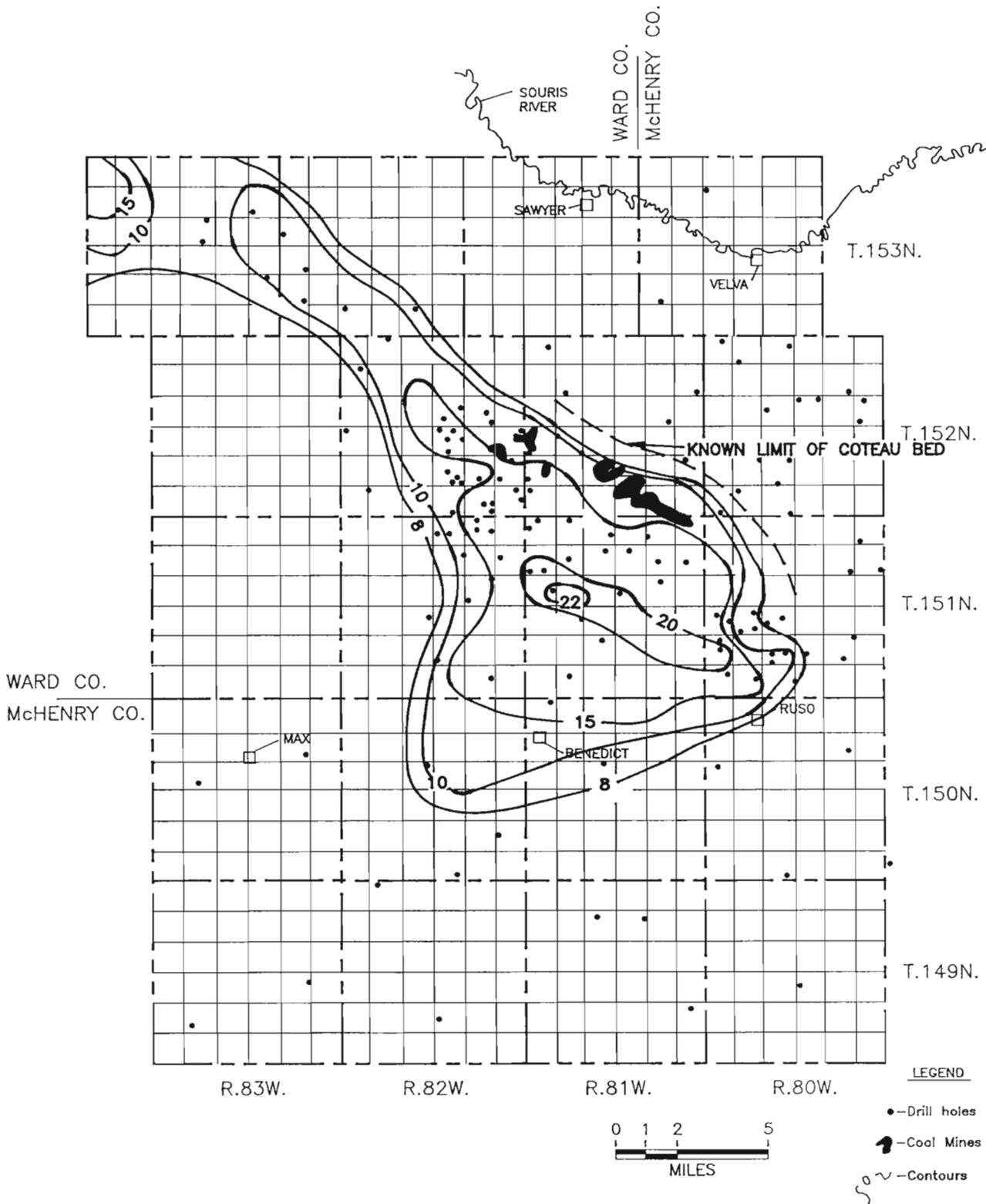


Figure 2. An isopach of the Coteau bed in north-central North Dakota.

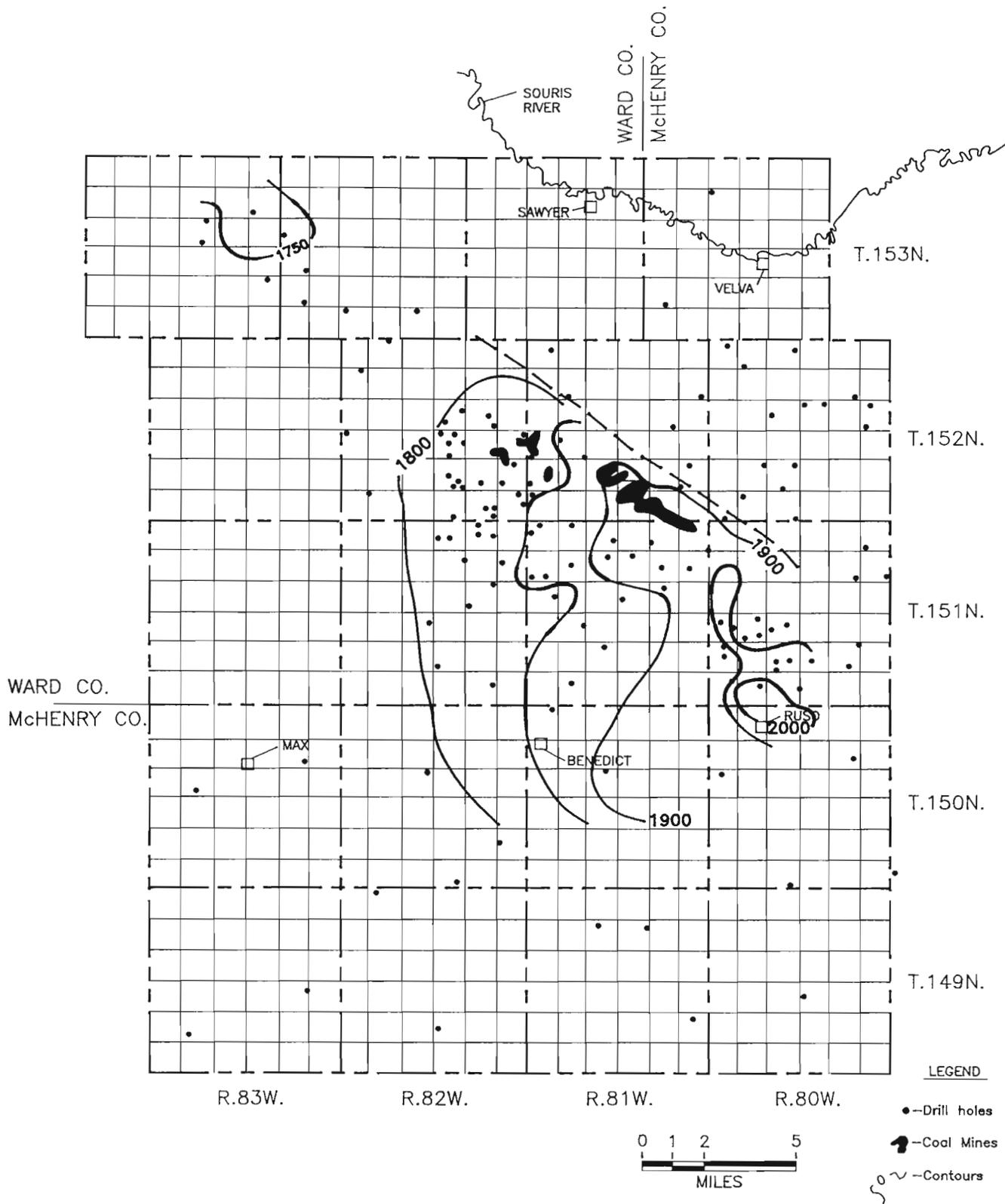


Figure 3. Contour map on top of the Coteau bed in north-central North Dakota.

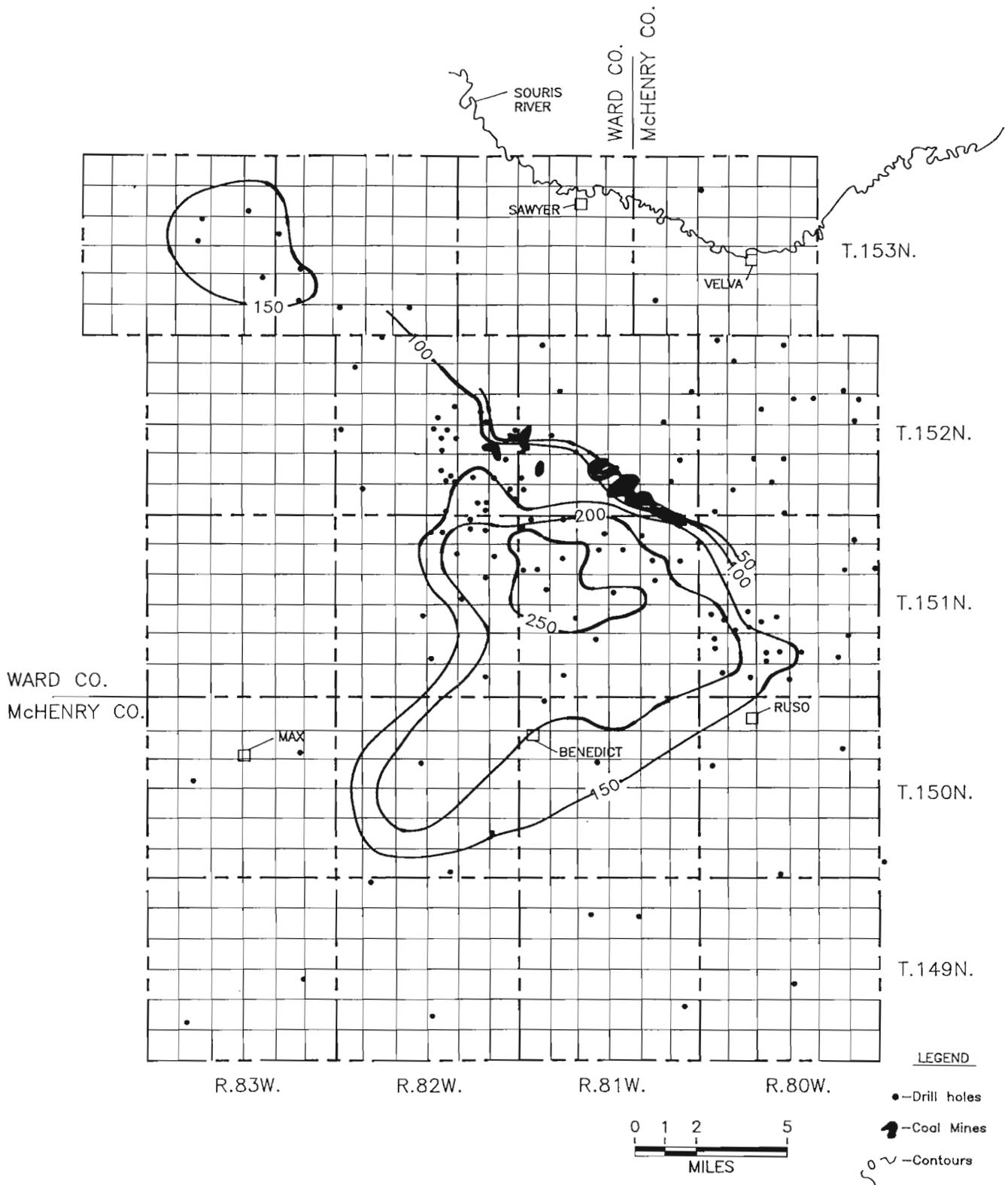


Figure 4. The depth to the top of the Coteau bed in north-central North Dakota.

NORTHWEST  
A

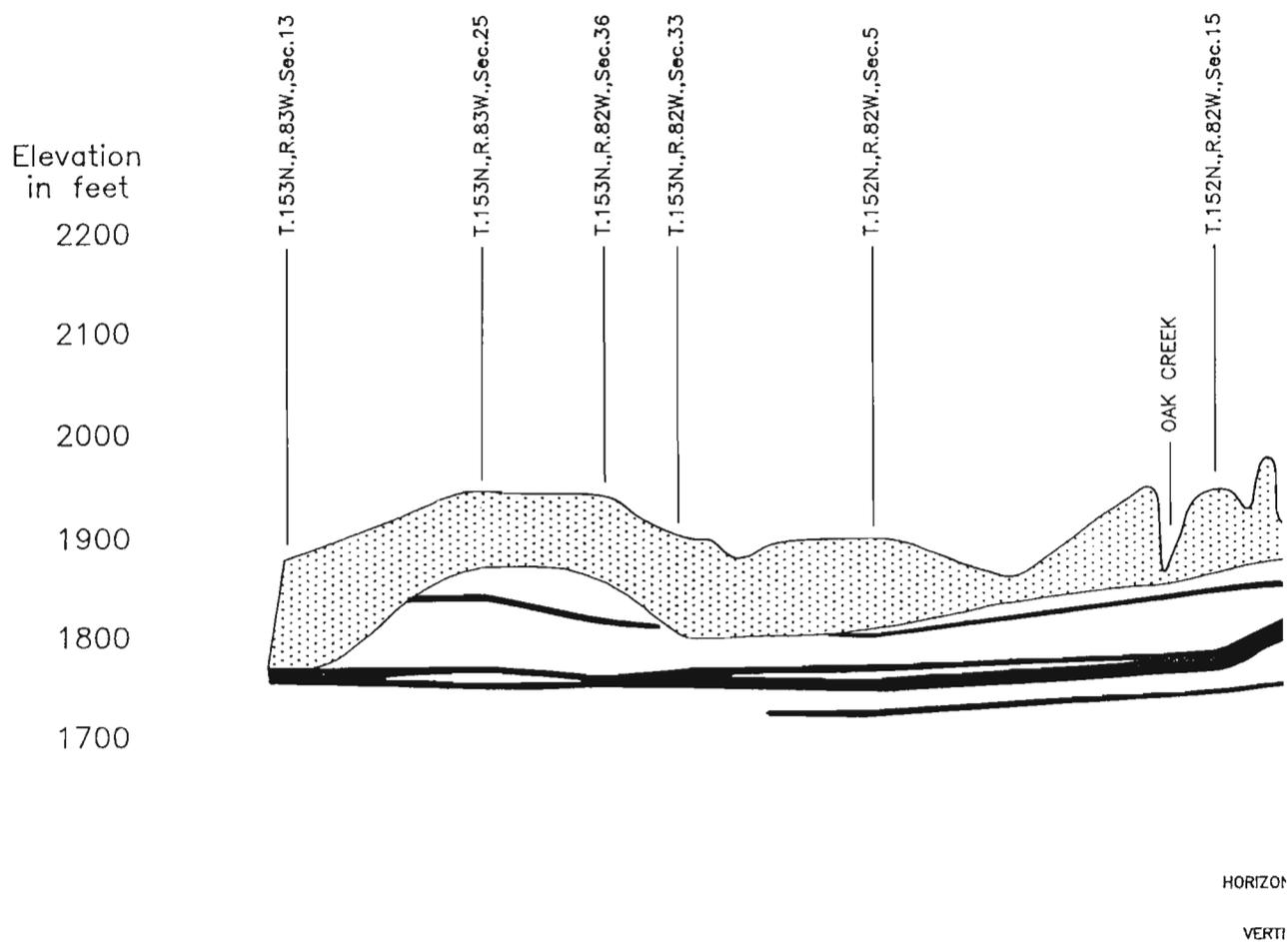
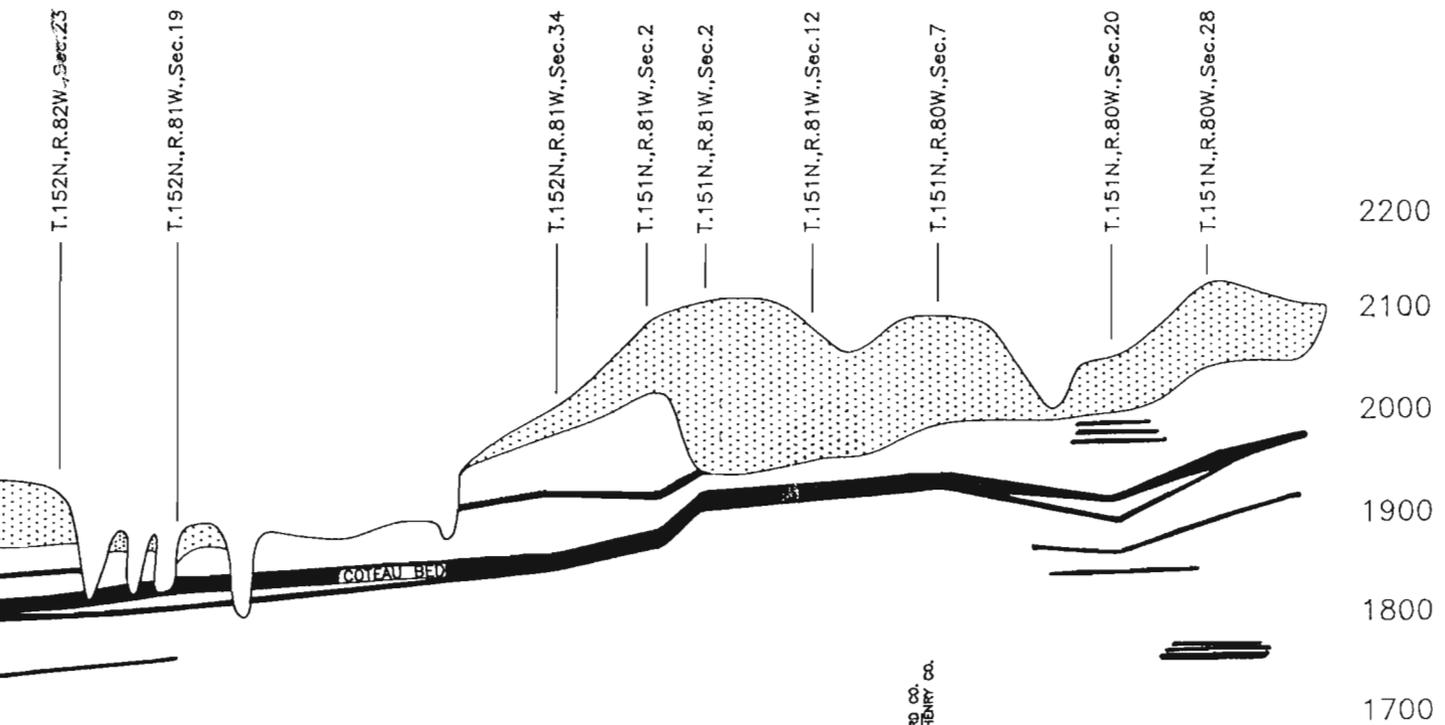


Figure 5. Northwest-southeast geologic cross-section in southeastern Ward and southwestern McHenry c

WARD Co. | McHENRY Co.

SOUTHEAST  
A'



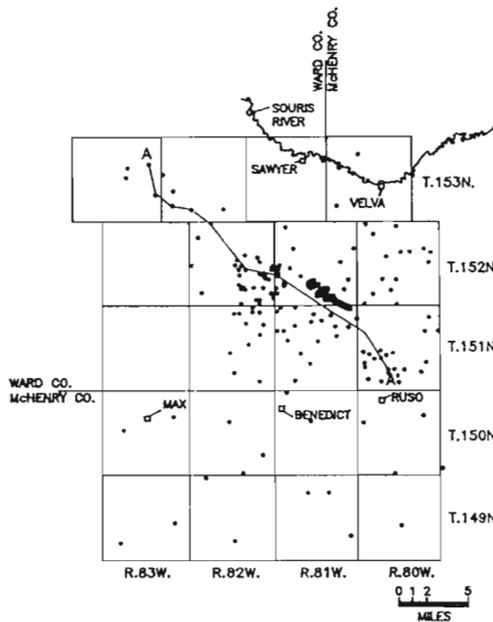
SCALE  
1 Mile

LEGEND

-  -GLACIAL
-  -LIGNITE
-  -SAND, SILT and CLAY

100 feet

PS.



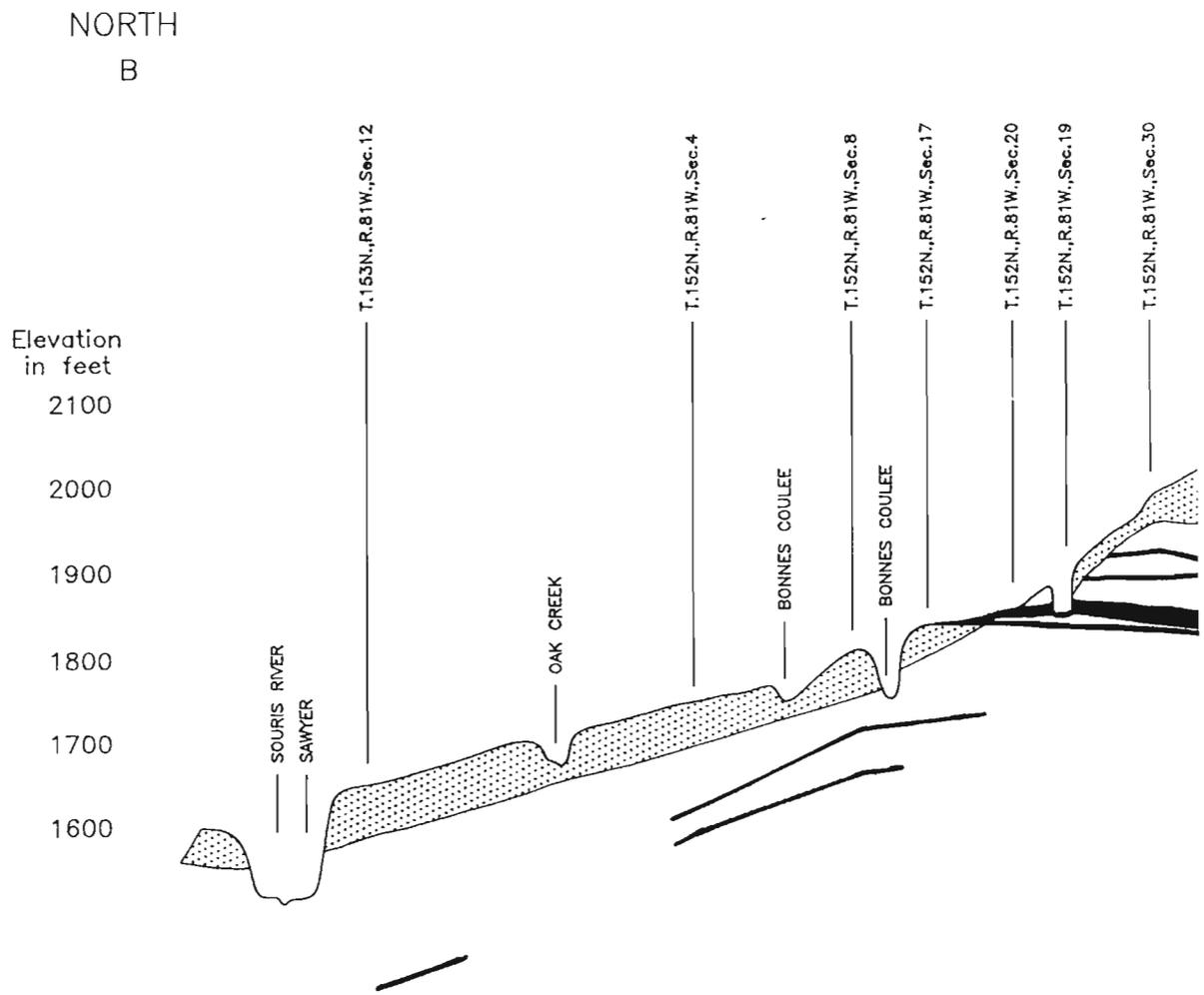
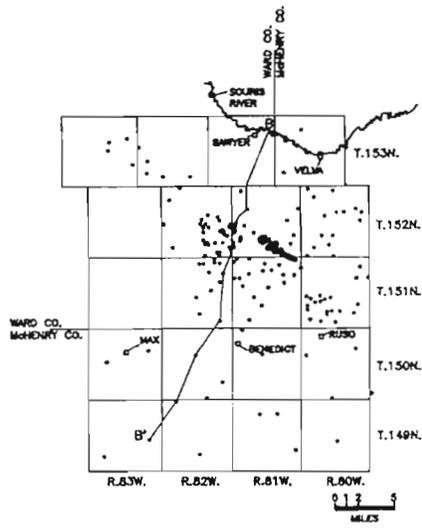
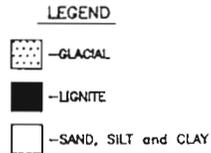
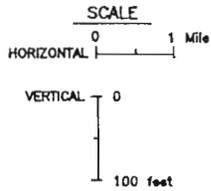
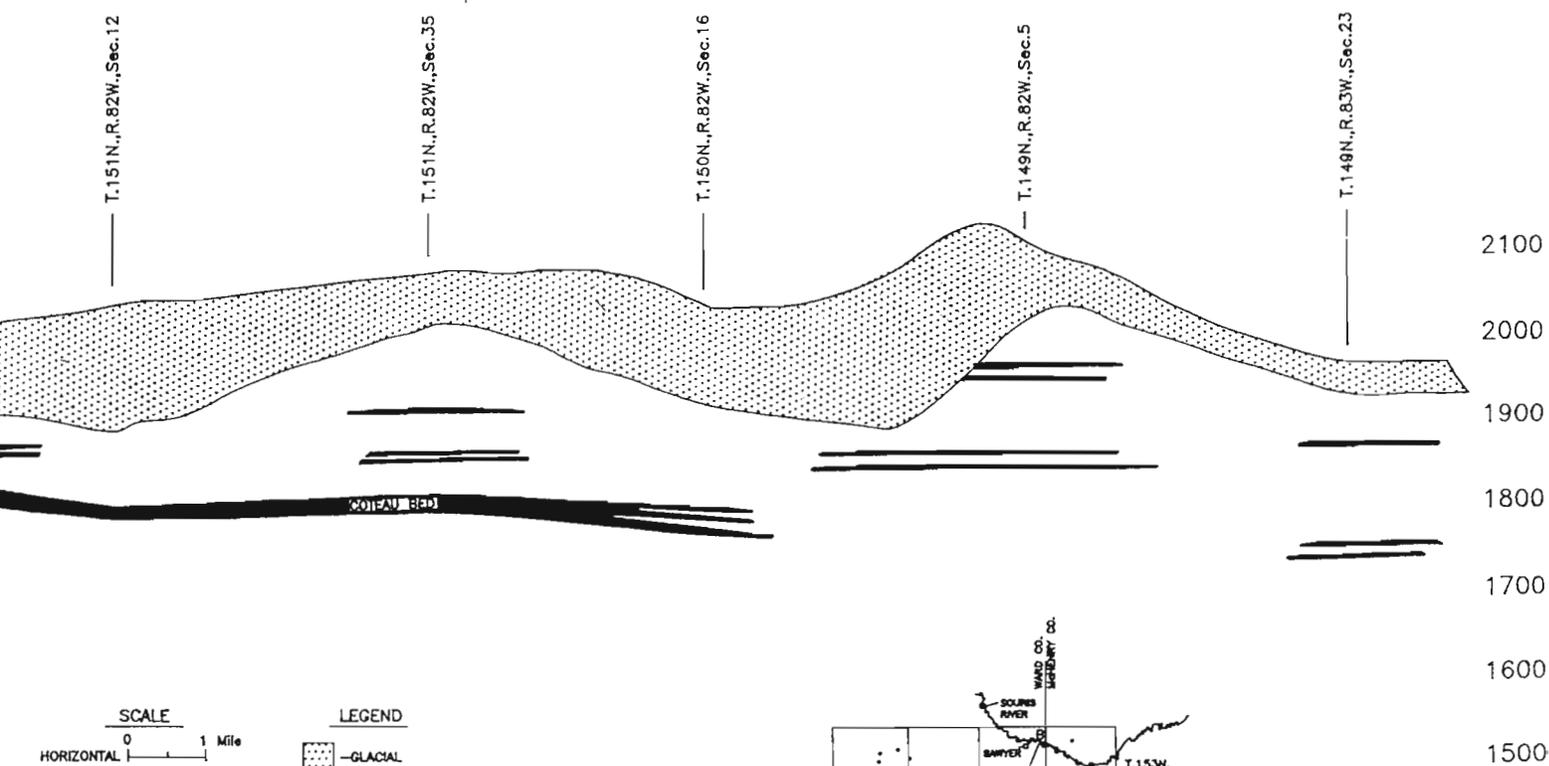


Figure 6. North-south geologic cross-section in southeastern Ward and northeastern McHenry counties.

WARD Co. | McHENRY Co.

SOUTH  
B'



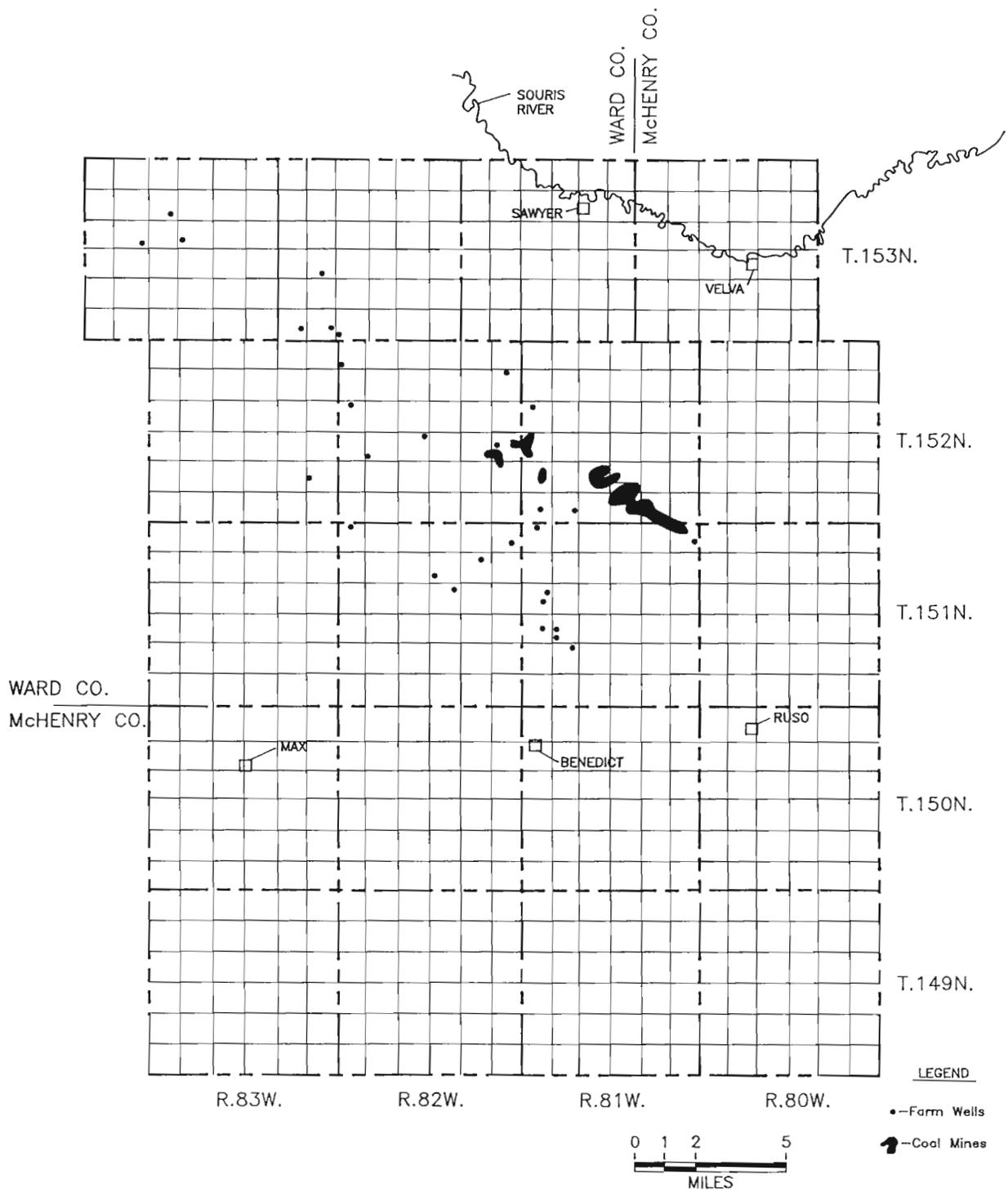


Figure 7. Locations of farm wells believed to be screened in the Coteau bed.

It appears likely that the groundwater flow direction within the Coteau Aquifer is probably to the west-northwest, parallel to the dip of the coal seam. This was confirmed by a study of groundwater flow in the Coteau bed within the Velva mine, in southwest McHenry County (Groenewold et al., 1983). There may be local portions of the upper reaches of Bonnes and Oak coulees which are discharge areas for the Coteau bed, as may be the case in a spring in T.152N., R.82W., section 24.

#### Water Quality

Some scientists have theorized that groundwater chemistry can be used to identify areas within coals that are favorable for methane generation. Chemical analyses of the groundwater within farm wells screened in the Coteau lignite area are not available. However, groundwater analyzes from the Coteau bed were reported in a study done at the Velva mine (Groenewold et al., 1983). This study determined that groundwater within the Coteau bed contains moderate to high concentrations of total dissolved solids and is generally characterized as a sodium sulfate/bicarbonate type water (Table 2).

#### **Methane Potential of the Coteau Bed**

A search of various records failed to find any mention of gas encountered in the Coteau bed. It apparently was not a problem for the various underground mines that operated in the early part of this century in eastern Ward and western McHenry counties. One method of determining the gas potential of the Coteau bed would require gas analysis of groundwater samples obtained from existing wells screened in this coal. In addition to the thirty or so farm wells listed in Table 1, several monitoring wells were also screened in the Coteau bed in and around the Velva mine (Groenewold et al., 1983).

The most promising site for exploration drilling appears to be along a northwest-southeast trend in the central portion of township T.151N., R.81W. An area of approximately 5100 acres is underlain by at least 20 feet of coal at depths of 200 to 300 feet. Additional drilling may expand this area and the Coteau bed may prove to be even thicker in the southwestern portion of this township.

**Table 1. Farm Wells Believed to be Screened in the Coteau Bed.**

LOCATION	OWNER	DEPTH (ft)	DIAMETER (in )	DATE DRILLED	DEPTH TO WATER	USE OF WATER	LIFT AND POWER	ELEV Land Surface	ELEVATION top of water
151-81-6 ab	Bohlender	250	2		175	stock	windmill	2125	1950
151-81-	Berg	315	3	1942	20	domestic	electric	2145	2125
151-81-	Berg	298	4	1962	90	stock	windmill	2145	2055
151-81-	Violets	300	2		80	dom & stock	windmill	2155	2075
151-81-	Berg	290				dom & stock	windmill	2155	
151-81-	Berg	300	5	1955	100	dom & stock	electric	2155	2055
151-81-	Schoenberg	300	5		131	dom & stock	windmill	2161	2030
151-82-1da	Hauf	250	4		250	unused	none	2118	1868
151-82-6ba	Hankel	297	2		235		windmill	2210	1975
151-82-	Schoenwald	290	5		156	stock	electric	2105	1949
151-82-	Aplass	253	3		170	domestic	windmill	2080	1910
153-82-	Bivins	125	2		55	stock	windmill	1863	1808
153-82-	Soum	178	2		118	dom & stock	windmill	1940	1822
153-82-	McCubben	190	2	1910	120	dom & stock	windmill	1922	1802
153-82-	Buechler	185	2		120	dom & stock	electric	1941	1821
153-83-9dd	Pietsch	220	6		28	dom & stock	windmill	1945	1917
153-83-		200	3		20	stock	windmill	1948	1928
153-83-	Jylen	292	3		108	stock	windmill	2028	1920
152-81-	Batke	200	4		100	stock	windmill	2085	1985
152-81-	Brevig	41	12		13	domestic	hand	1962	1949
152-82-6cc	Newman	180	2			stock	windmill	1960	
152-82-	Selzer	57	24		36	dom & stock	windmill	1830	1794
152-82-	Dahl	200	3		78	stock	windmill	1982	1904
152-82-	Kalamaha	330	4	1961	260	stock	hand	2110	1850
152-82-	Buechler	175	2			dom & stock	windmill	1968	
152-82-	Bechtold	38	8		21	unused	hand	1925	1904
152-83-	Samulenok	467	6	1949	350	dom & stock	turbine	2230	1880
152-81-	Schmidt	68			30	dom & stock	electric	1855	1825

Source: Pettyjohn, 1968.

**Table 2. Groundwater Quality in the Coteau Lignite at the Velva Mine, North Dakota (in mg/l).**

pH	H	7.2	Mg	H	229	HCO <sub>3</sub>	H	923.5
	L	6.9		L	71.0		L	657.6
	n	3		n	3		n	3
	x	7.03		x	171.3		x	832.5
TDS	H	3580	Na	H	711	SO <sub>4</sub>	H	1856
	L	2100		L	156		L	1212
	n	3		n	3		n	3
	x	2913.3		x	455.3		x	1513.7
Ca	H	284	K	H	17.0	Cl	H	12.2
	L	96		L	14.0		L	0.1
	n	3		n	3		n	3
	x	184.3		x	15.6		x	4.1

H = high; L = low; n = number of samples; and x = mean  
(modified from Groenewold et al., 1983)

## References

- Groenewold, G.H., Hemish, L.A., Cherry, J.A., Rehm, B.W., Meyer, G.N., and Winczewski, L.M., 1979, Geology and geohydrology of the Knife River Basin and adjacent areas of west-central North Dakota: N.D. Geological Survey Report of Investigation No. 64, 402 p.
- Groenewold, G.H., Murphy, E.C., Koob, R.D., and Schmit, C.R., 1983, Hydrogeological and hydrochemical data base for abandoned surface-mined lands, Phase I, Final report to the N.D. Public Service Commission: Bull. No. 83-10-MMRRI-02, October, 282 p.
- Moran, S.R., Cherry, J.A., Fritz, Peter, Peterson W.M., Sommerville M.H., Stancel, S.A., and Ulmer, J.H., 1978, Geology groundwater hydrology, and hydrogeochemistry of a proposed surface mine and lignite gasification plant site near Dunn Center, North Dakota: N.D. Geological Survey Report of Investigation No. 61, 263 p.
- Oihus, C.A., 1983, A history of coal mining in North Dakota, 1873-1982: North Dakota Geological Survey Educational Series No. 15, 100 p.
- Pettyjohn, W.A., 1968, The Geology and Groundwater Resources of Renville and Ward Counties, Part 2, N.D. Geological Survey Bulletin No. 50, 302 p.