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N. D. Geological Survey

NORTH DAKOTA GEOLOGICAL SURVEY

Wilson M. Laird, State Geologist

Miscellaneous Series Number 17

SELECTED DEVONIAN POSSIBILITIES IN NORTH DAKOTA

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Reprinted from
The Oil and Gas Journal, August 12, 1963

GRAND FORKS, NORTH DAKOTA, 1963

THESE three areas in North Dakota do not now have any Devonian production but appear to have excellent possibilities. Fig. 1.

Look again at North Dakota's Devonian

The author . . .

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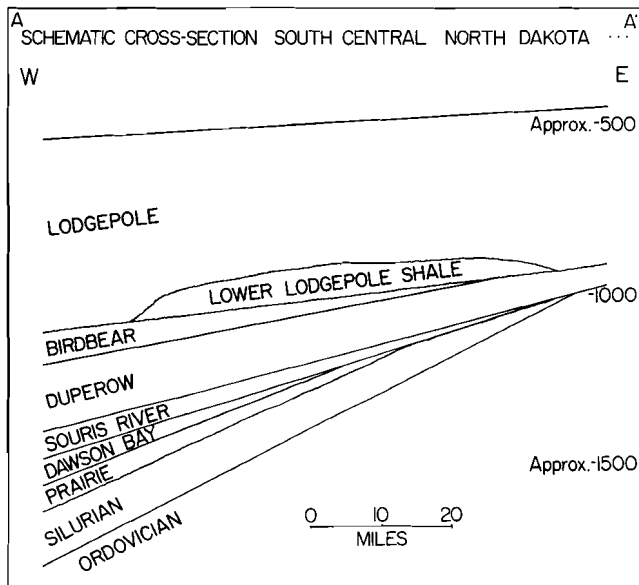
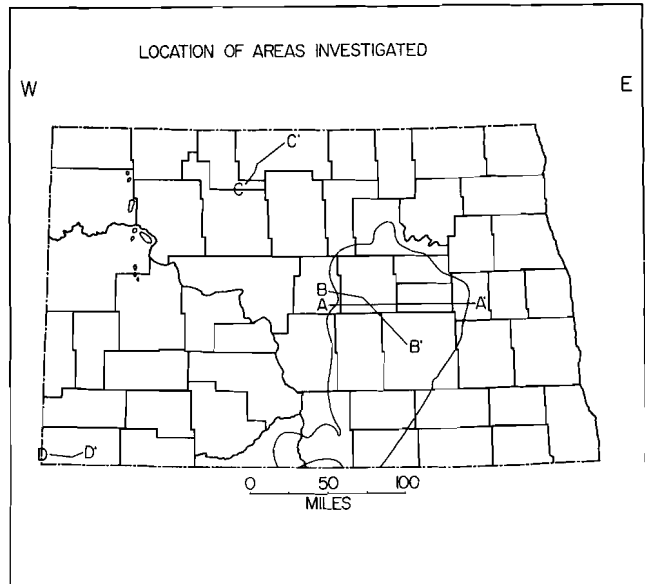
TO FOCUS more interest on petroleum possibilities of the Devonian in North Dakota, let's look at three quite widely separated areas, but which have excellent possibilities. Fig. 1.

The Devonian system of North Dakota consists of rocks of Middle and Upper Devonian age. Fig. 2. The Middle Devonian is represented in ascending order by the Winnipegosis, Prairie, and Dawson Bay formations and the lower part of the Souris River formation. The Upper Devonian is represented by the upper portion of Souris River formation, Duperow, the Birdbear, and Three Forks formations. These formations represent a total Devonian thickness of about 650 ft in South Central North Dakota, ap-

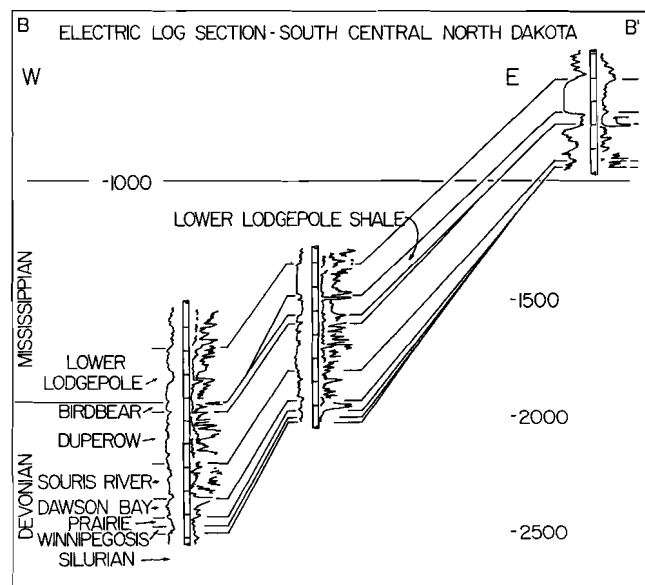
proximately 1,400 ft in North Central North Dakota and about 800 ft in the southwestern part of the state. These units are dominantly carbonates, the principle exceptions being the Three Forks shale and the evaporites of the Prairie formation.

Devonian oil locale. While there is no Devonian production in these areas, the conditions necessary for accumulation are present in the Devonian formations that produce elsewhere in the Williston basin.

Devonian production in North Dakota now comes only from fields located on the Nesson anticline. The production in these fields is from the Duperow, Birdbear, and "Sanish" sand of the Three Forks. Most production is from Duperow.



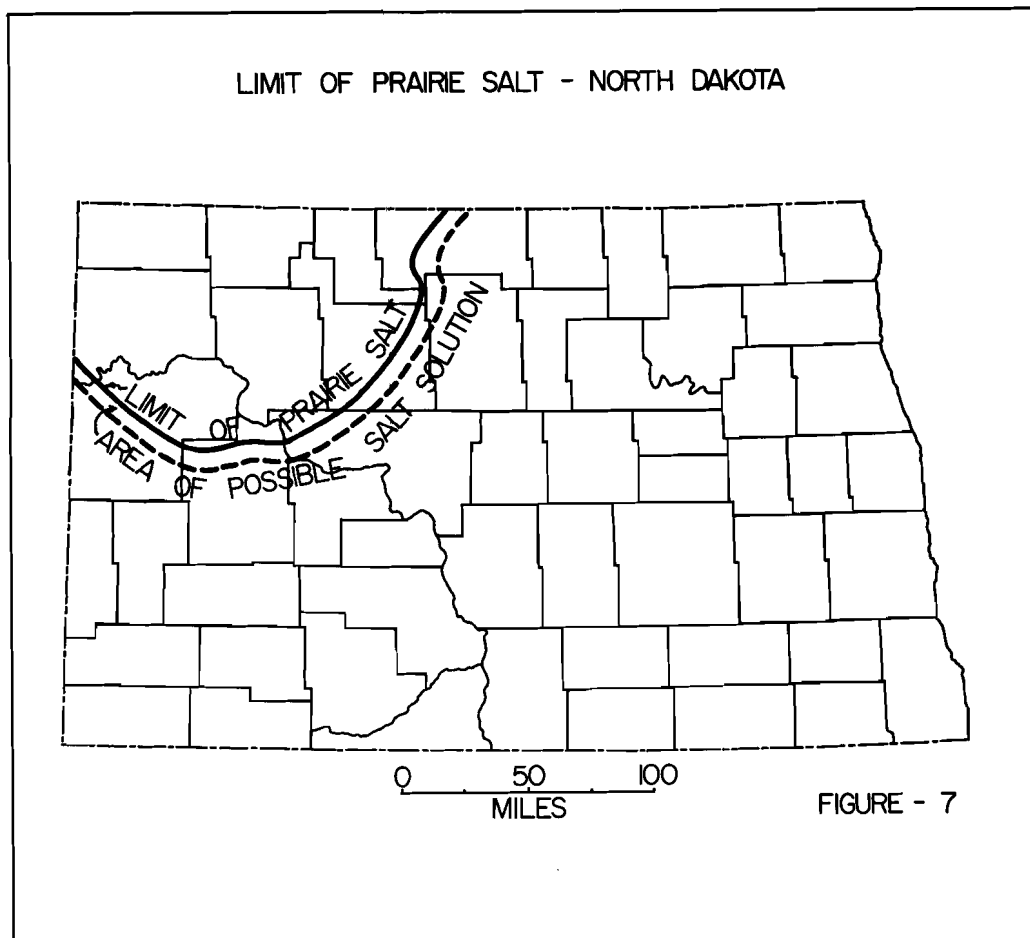
IN A NORMAL sedimentary sequence, this portion of the stratigraphic section, in ascending order, consists of the Devonian Duperow, Birdbear, and Three Forks, the Mississippian Bakken and Lodgepole. Fig. 4.



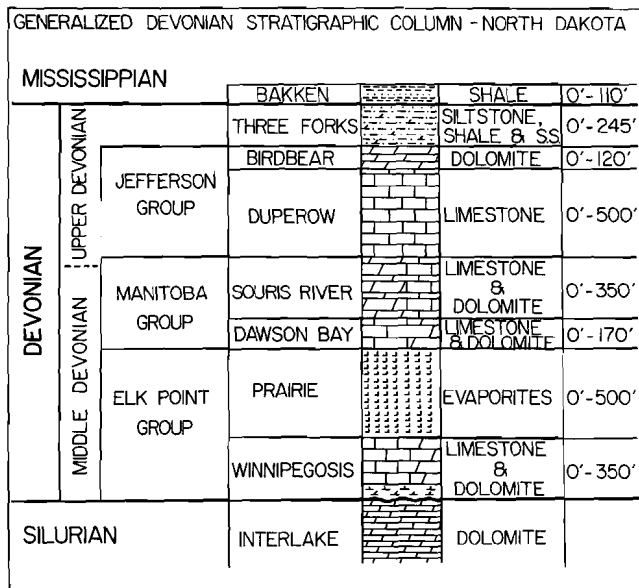
THE SCHEMATIC CROSS-SECTION and the electric log section show that the Birdbear and the upper portion of the Duperow have been truncated, with the overlying shale forming an updip seal. Fig. 5.

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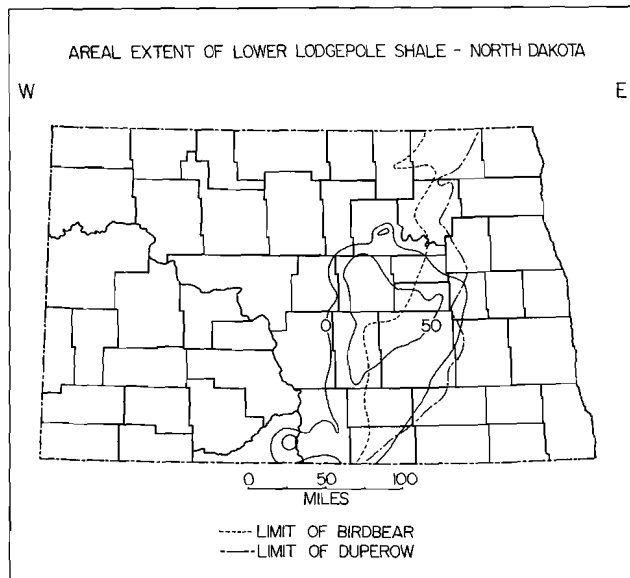
ERRATA



1. Figure 7 "Limit of Prairie Salt in North Dakota" was omitted.
2. Figure 7 lower right corner of page 179 is misnumbered and should be listed as Figure 8.
3. Page 180 first column under heading "North Central" second paragraph, second line indip should be in dip.
4. Page 180 second column under heading "Southwest Corner" the first sentence refers to "Cross Section B - B ft. (Fig. 8)" and should refer to Cross Section D - D' (Fig. 8).
5. Page 180 column two 4th paragraph under heading "Southwest corner," second sentence should read --- which wedge out on the east and west flanks of the anticline by non deposition --



THE DEVONIAN SYSTEM of North Dakota consists of rocks of Middle and Upper Devonian age. Fig. 2.



IN THIS AREA of south-central North Dakota, a facies change occurs at the base of the Mississippian Lodgepole formation. Fig. 3.

Migration time. The areas with which this report is concerned are all located updip from the Nesson anticline, toward the edges of the basin, and it seems reasonable to assume that hydrocarbons could have migrated into these areas. The time of migration is a critical factor. If migration occurred following the formation of the traps or at least continued after the formation of the traps, the possibility of extensive oil fields being developed in these areas is excellent.

The first area is in South Central North Dakota (Fig. 3). In this area a facies change occurs at the base

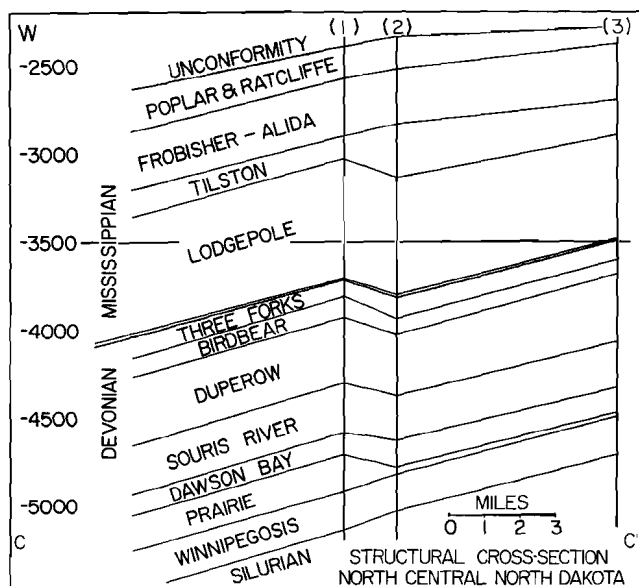
of the Mississippian Lodgepole formation. The section, up to 94 ft thick, changes from limestone to a bentonitic shale and then back to limestone. Thus providing possibilities for the accumulation of hydrocarbons.

Fig. 4 is a schematic cross-section of the area. In a normal sedimentary sequence this portion of the stratigraphic section in ascending order consists of the Devonian Duperow, Birdbear, and Three Forks, the Mississippian Bakken, and Lodgepole. The Three Forks and Bakken formations are not present in this

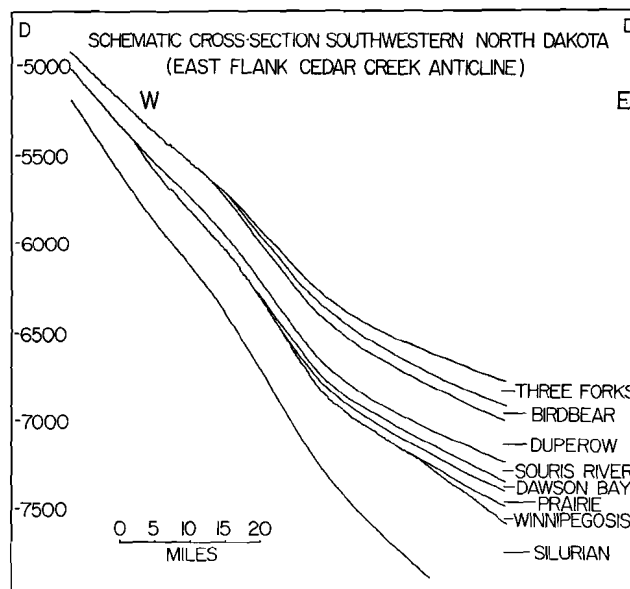
area, indicating an unconformity between the Birdbear and the Lodgepole shale facies, and farther east between the Duperow and the Lodgepole shale facies.

The schematic cross-section and the electric-log section (Fig. 5) show that the Birdbear and the upper portion of the Duperow have been truncated, with the overlying shale forming an updip seal and there is a good possibility for the accumulation of hydrocarbons downdip from the truncated edges. The Lodgepole shale would form an excellent seal over any structure that might occur in the area.

Depths in this area are favorable, ranging from less than 3,000 to about 4,000 ft to the base of the



THE SECOND AREA under study is located in North-Central North Dakota, cross-section C-C', on the location map. This east-west section shows the sediments dipping to the west into the deeper part of the Williston basin. Fig. 6.



SOUTHWESTERN NORTH DAKOTA has had few wells drilled except on the Cedar Creek anticline. Fig. 7.

Devonian, and depths encountered in drilling to Birdbear or Duperow objectives are considerably less.

Lodgepole production is also a possibility in this area. West of the shale facies, a zone of porosity is developed in the basal Lodgepole carbonates and the shale facies developed updip provide the conditions essential for stratigraphic traps.

North Central

The second area is in North Central North Dakota, cross-section C-C', on the location map. This is an east-west cross-section (Fig. 6) showing the sediments dipping to the west into the deeper part of the basin.

As shown on the cross-section, there is a reversal in dip between well 1 and 2 from Dawson Bay to the Mississippian Lodgepole. This reversal is due to solution of salt in the Prairie formation and collapse of the overlying section. Well 1 has 160 ft of salt and well 2 has none. The collapse apparently occurred during late Lodgepole and Tilston time since the increased thickening of this section appears to have compensated for the collapse.

Although this section shows the only known area where solution of the Devonian salt has occurred in North Dakota, the well control along the edge of the salt is very meager. Fig. 7 shows the extent of the Devonian Prairie salt. However, Walker (1957) indicates that in Saskatchewan apparent solution of the Prairie salt and subsequent collapse has occurred in sections ranging from the Middle Devonian to Recent.

It is interesting to note that well 1, the Cardinal Keeler, had shows reported from the Birdbear, Duperow, Souris River, and Winnipegosis. While these were classed as poor shows, they are at least encouraging and possibly significant in that no shows were reported in the California-Thompson or in well

3, the Phillips-Glenn 1 Brandt. This indicates the possibility that there is oil trapped on the edge of the collapsed area. The depths to Devonian objectives in this area are moderate, being less than 7,000 ft to the top of the Silurian.

It is possible that solution of the salt and the resulting collapse of the overlying beds has occurred along much of the margin of the salt, creating extensive traps.

Southwest corner

The third area is located in the southwestern corner of the state and is designated as cross-section B-B ft. (Fig. 8).

This area has had few wells with the exception of those drilled on the Cedar Creek anticline in Little Missouri and Cedar Creek fields. These fields are currently producing oil from the Ordovician Red River and gas from the Cretaceous Eagle sandstone.

The Cedar Creek anticline is a prominent northwest-southeast structure with the major portion located in Montana, extending through southwestern North Dakota and into South Dakota.

Devonian sedimentation in this area was greatly influenced by this structure. This influence is noted especially in the formations of the Elk Point and Manitoba groups, which wedge out east and west of the anticline by nondisposition indicating that the structure was a positive feature during Devonian time.

The cross-section shows the Devonian extending from the deeper part of the basin to the crest of the anticline. In this area the Devonian loses section from the base by nondeposition.

The Winnipegosis wedges out first followed by the Prairie, Dawson Bay and Souris River. The Duperow is the most extensive but thins greatly both by nondeposition and by erosion. In fact, there are some places in Montana on the Cedar Creek anticline where there is no Devonian.

The uppermost formations of the Devonian, the Birdbear, and the Three Forks have been truncated east of the anticline. The Birdbear and Duperow west of the limit of the Three Forks are overlain by a shale section thought to be Mississippian in age. This shale should form an effective barrier against further movement of any hydrocarbons that may have accumulated following the truncation of these formations. The depths in this area are somewhat greater than in the other two areas, but are still not overly deep, ranging from under 8,000 ft-10,000 ft to the top of the Silurian.

The previously mentioned pinch-outs of the lower formations, particularly the Winnipegosis, Dawson Bay, and Souris River, together with the truncation of the Duperow and Birdbear suggests that Devonian production from stratigraphic traps may be found along the northeastern flanks of the Cedar Creek anticline in North Dakota.

Devonian is barely touched

While no Devonian production has yet been found in these areas they are relatively untested. The depths are, of course, greater than the more commonly sought Mississippian objectives, but they are not overly deep.

In the southwestern area the depths to the base of the Devonian range from something less than 10,000 ft to under 8,000 ft. In the north-central area the depths to the base of the Devonian are less than 7,000 ft, and in the south-central area the depths to the base of the Devonian are extremely shallow, ranging from less than 4,000 ft to under 3,000 ft.

The Devonian in North Dakota has barely been scratched, but the potentials are great.

Bibliography

Walker, C. T., 1957, "Correlation of Middle Devonian Rocks in Western Saskatchewan": Sask. Dept. of Mineral Resources, Report 25.