

# ELECTRIC-LOG CROSS-SECTIONS OF THE SILURIAN-DEVONIAN FORMATIONS OF A PART OF CENTRAL ILLINOIS

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## REGIONAL SETTING

The area discussed is in the northwestern portion of the western shelf area (Fig. 1) of the Illinois basin (formerly called the Eastern Interior Basin), a large, spoon-shaped, structural basin in central and southern Illinois, southwestern Indiana, and northwestern Kentucky. The basin is surrounded by three major positive areas—the Wisconsin arch on the north, the Cincinnati arch on the east, and the Ozark dome on the southwest.

The three cross-sections presented here are part of a study being made preparatory to a revision of the subsurface structure map (Bell, 1943) of the base of the Kinderhook-New Albany shale in the southern two-thirds of Illinois. The base of the New Albany shale has been used as the datum plane for the cross-sections, and the sea-level and minus-2500-foot contours on this horizon are shown on the index map (Fig. 1).

The area represented on the three cross-sections is on the western shelf area northwest of the deep part of the basin. Cross-sections A-B-C (Fig. 2) and D-E (Fig. 3) run south to north, almost parallel to the strike of the shelf, and the F-G section (Fig. 3) runs west to east at approximately right angles to the strike.

In this area the base of the New Albany shale dips eastward into the basin. Cross-section A-B-C, extending from sec. 1, T. 18 N., R. 1 W., Logan County, to sec. 21, T. 6 N., R. 2 W., Bond County, has an average southward dip of 9 feet per mile for the entire distance of nearly 75 miles. Elevations range from 1040 to 1721 feet below sea-level. Along section F-G the dip eastward averages about 26 feet per mile. This cross-section runs from sec. 16, T. 13 N., R. 8 W., Morgan County, to sec. 9, T. 13 N., R. 1 E., Christian County, and the elevation of the base of the shale ranges from 277 feet below sea-level at the western point to 1665 feet below sea-level in the eastern test, a distance of about 50 miles.

## STRATIGRAPHY AND LITHOLOGY

Rock formations present in this part of Illinois, from late Ordovician to early Mississippian time, are shown in Figure 4.

The Maquoketa shale, the uppermost Ordovician formation, is predominantly grayish green, with some relatively thin olive-gray limestone and dolomite beds in the middle portion of the shale. It is uniformly about 180 to 200 feet thick in the area.

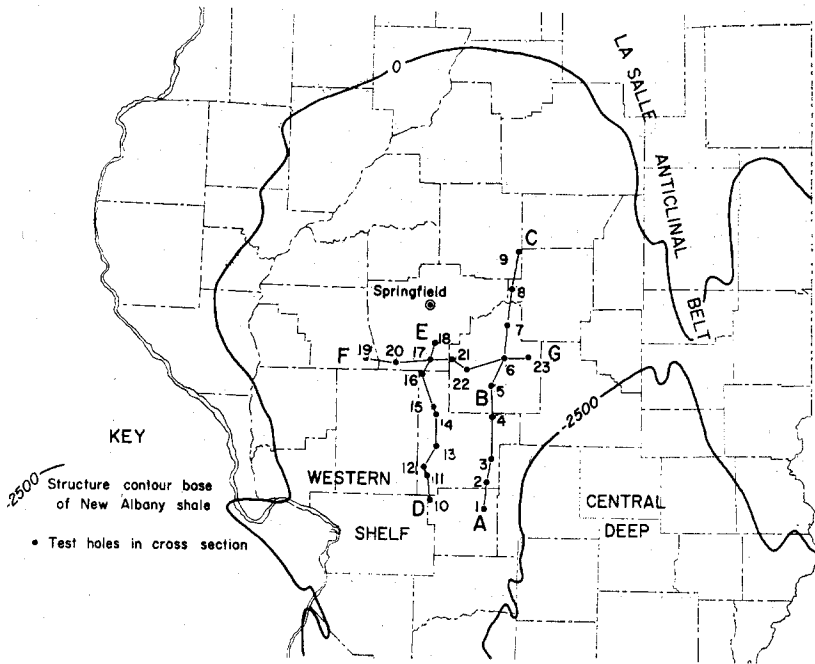


FIG. 1.—Map showing location of stratigraphic cross-sections.

The Alexandrian series, of Lower Silurian age, is about 50 feet thick in this area. The Edgewood formation at the base is commonly a thin, brownish gray, very fine-grained, silty dolomite. The overlying Kankakee formation, about 45 feet thick, is a white to buff, very fine-grained cherty limestone, often containing glauconite.

In northern Illinois the Niagaran series, of Middle Silurian age, consists of four different formations, which in ascending order are the Joliet, Waukesha, Racine, and Port Byron. Southern Illinois correlatives are the St. Clair and Moccasin Springs formations. Both sets of names have been used to designate the formations in the area studied.

A sample study of the Huber No.

1 Kunz test in sec. 11, T. 6 N., R. 5 W., Bond County, made by E. A. Atherton of the Survey staff, shows the Niagaran series to be about 450 feet thick at that place. The lower 175 feet are a red and greenish gray, very finely crystalline limestone and dolomite sequence, argillaceous in the upper 80 to 100 feet and pure limestone with red grains and pink crinoid plates in the lower part. This is the "red" Bainbridge group, composed of the argillaceous Moccasin Springs limestone resting on the purer St. Clair limestone.

Above the red section, another 135 feet of rock is similar except that the limestones contain more dolomite and chert and are not red.

The upper 135 feet consist of grayish or grayish green to brown dolo-

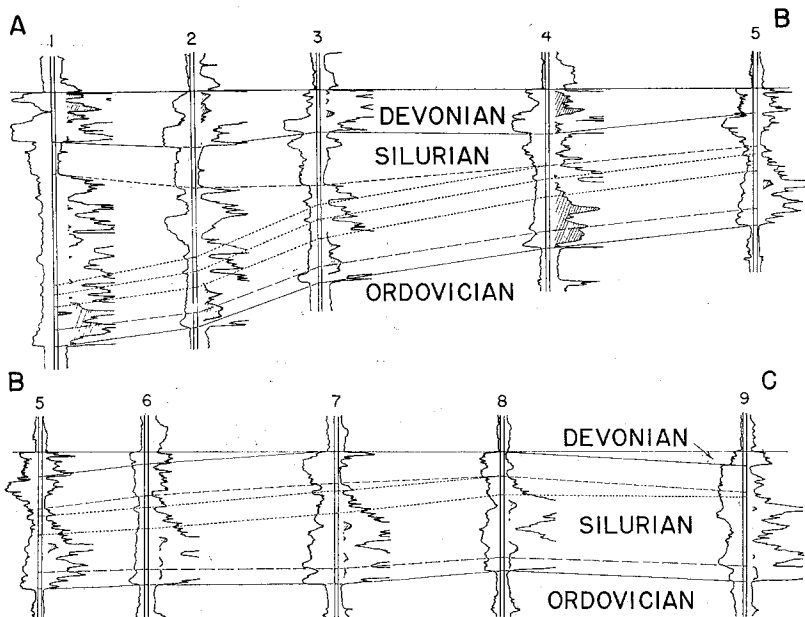


FIG. 2.—Stratigraphic cross-section A-B-C. (Hole 5 is shown on sections A-B and B-C).

mite, quite cherty in the bottom 100 feet. The top 30 feet contain large fissures filled with Devonian sand.

The Devonian rocks range from zero to about 150 feet thick over the area and are represented by the Cedar Valley and Wapsipinicon formations, both of Middle Devonian age. They generally consist of grayish to grayish brown finely crystalline limestone, with coarse fossils in the Cedar Valley portion. In places they are dolomitic. Scattered, fine to coarse, semi-rounded sand grains are common throughout and in some areas thin, local, sandstone lenses are developed.

The Grassy Creek shale is the basal portion of the Kinderhook-New Albany section in this part of Illinois. The shale is chocolate-brown, has a brown streak, and com-

monly a somewhat greasy or waxy appearance. Sporangites are common and helpful for identification. Toward the base the shale may be gritty, and at the base, between the shale and the Devonian limestone, the thin pyritic and quartzitic Sylamore (Hardin) sandstone is almost always present.

#### DISCUSSION OF CROSS-SECTIONS

The stratigraphic cross-sections are not intended to show present structure. We have used the base of the New Albany shale rather than sea-level as the datum plane to illustrate the stratigraphic conditions at the time deposition of the shale began. Correlations are based primarily upon characteristics shown in electric logs, which we believe are consistent with age and lithological correlations.

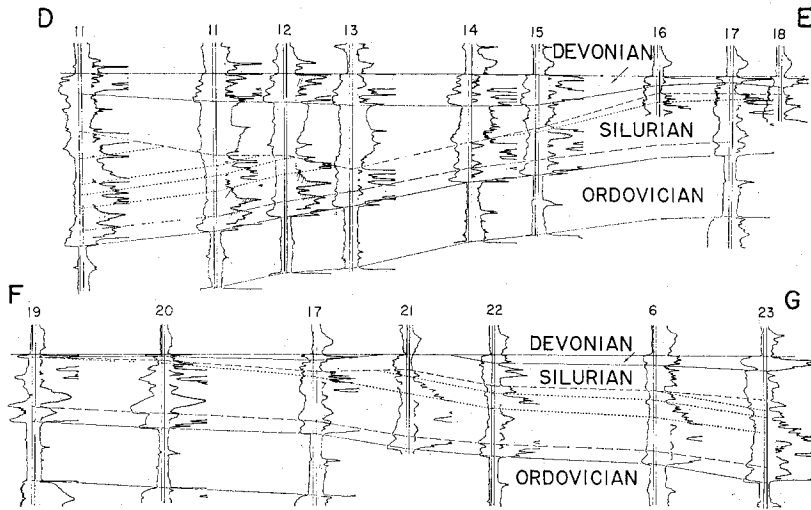


FIG. 3.—Stratigraphic cross-sections D-E and F-G.

The Maquoketa shale and the Lower Silurian (Alexandrian series) are uniform in thickness over the entire area, indicating that conditions were uniform during late Ordovician and early Silurian time.

Middle Silurian (Niagaran) strata above the Alexandrian show not only a variable over-all thickness at different places, but also considerable variation in the lithology and thickness of the several units.

The Niagaran section, as a whole, thickens to the south and east. However, the lower units thicken to the north and west. The lower portion is very characteristically indicated by high electrical resistance, not only here but over the entire basin. A short distance above this lower portion is one of the best electrical markers in the basin, commonly referred to as "3-kick," and directly below it is "2-kick," another recognizable unit (Fig. 2, hole 3).

In cross-section A-B-C, the first unit above the Alexandrian (indi-

cated by the fine dashed line) is more than three times as thick at the north end (hole 9) as it is at the south end (hole 1). All the units in the lower portion of the Niagaran appear to have the same northward thickening, although some are cut out to the north, as shown on our cross sections. In the east-west cross-section F-G these same units thicken toward the west.

The upper part of the Niagaran maintains similar characteristics over a wide area. It is thickest in the middle portion of the north-south sections but, as indicated in cross-section F-G, it thins westward and is absent in Morgan County. Specifically, the thickest section is at hole 13 in T. 9 N., R. 5 W., and thins toward the east, north, and south from this point. We are not certain of conditions farther to the west. Lower Niagaran units approach the upper Niagaran unit with an angular relationship and appear to be truncated at their point of in-

System	Series	Formation
Mississippian	Kinderhook	New Albany (Grassy Creek)
?		
Devonian	Middle	Cedar Valley
		Wapsipinicon
Silurian	Niagaran	Kankakee
	Alexandrian	Edgewood
Ordovician	Cincinnatian	Maquoketa

FIG. 4.—Rock formations present in central Illinois.

tersection with its lower surface. If this surface be an unconformity, there was a period of uplift and erosion within Niagaran time, when several hundred feet of lower Niagaran sediments were removed before the upper unit was deposited. The position of this possible unconformity is indicated by the medium-length dashed line on the cross-sections.

Beds of Wapsipinicon and Cedar Valley limestone rest on the dolomite strata of Niagaran age. Because these Middle Devonian beds overlie Middle Silurian beds, it is obvious that there was an appreciable time interval between deposition of these formations. Devonian carbonate rocks are absent in three of the holes in Christian and Macon counties and the black shales rest directly on Niagaran dolomite.

The New Albany shale with the thin Sylamore (Hardin) sandstone at the base lies unconformably upon the beveled surface of both the Devonian and Silurian formations.

#### CONCLUSIONS

Critical examination of electric logs and assembly of cross-sections presented here furnish new data

concerning the subsurface geology of this part of Illinois. These data also suggest possible new interpretations of stratigraphy and structural history of part of the rocks of the area. Although these suggested interpretations are as yet not sufficiently firm to replace earlier conclusions, it is our opinion that they are strong enough to merit careful consideration as an alternate hypothesis.

A recent report (Ball, 1952: 12-14, 58) on the Carlinville area, which lies just west of our D-E cross-section, stated that there is an unconformity between the Maquoketa shales of Ordovician age and the Alexandrian limestones of lower Silurian age, another unconformity between the Edgewood and Kankakee (Sexton Creek) formations of the Alexandrian series, and a disconformity between the Alexandrian and the overlying rocks of Niagaran age. Evidence from our cross-sections bearing on these matters is inconclusive. The uniform thickness of the Maquoketa formation and Alexandrian series shown on our cross-sections indicates that there was no significant differential erosion accompanying the several periods of emergence.

TABLE 1.—List of Wells in Cross-Sections.

No.	Company	Farm	Sec.	Twp.	Range	County
1.	Ashland & Nash Redwine..	#1 Rasler.....	21	6N	2W	Bond
2.	Calvert Drilling.....	#1 Webb.....	9	7N	2W	Montgomery
3.	Superior Oil.....	#1 Singler.....	3	8N	2W	"
4.	Benedum-Trees.....	#1 Janssen.....	3	10N	2W	"
5.	Rogers & Rogers.....	#1 Johnson.....	27	12N	2W	Christian
6.	Sun Oil.....	#1 Ettinger.....	8	13N	1W	"
7.	Jarvis.....	#1 Butcher.....	21	15N	1W	"
8.	Sun Oil.....	#1 Graves.....	3	16N	1W	Macon
9.	McCue.....	#1 Christensen	1	18N	1W	Logan
10.	Eason.....	#1 Mohme.....	14	6N	5W	Bond
11.	Reznick.....	#1 Monke.....	4	7N	5W	Montgomery
12.	Seaboard Oil.....	#1 Lay.....	20	8N	5W	"
13.	Calvert.....	#1 Hopkins.....	24	9N	5W	"
14.	Gulf.....	#1 Brandon.....	1	10N	5W	"
15.	Texas Co.....	#1 Long.....	27	11N	5W	"
16.	Graeling & Shanahan.....	#1 Guill.....	6	12N	5W	"
17.	Gulf.....	#1 Dambacher	15	13N	5W	Sangamon
18.	Roberts.....	#1 Shepherd.....	25	14N	5W	"
19.	Panhandle Eastern.....	#1 Doolin.....	16	13N	8W	Morgan
20.	V. S. & S. Drilling Co.....	#1 McNaught.	24	13N	7W	Sangamon
21.	Phillips Petroleum.....	#2 Pawnee*....	15	13N	4W	Christian
22.	National Associated.....	#1B Peabody				
		Coal.....	33	13N	3W	"
23.	National Associated.....	#34 Lawrence.	9	13N	1E	"

\*Structure Test.

The over-all thickness of the middle Silurian (Niagaran) is greatest toward the south and east, but beds in the lower portion of the Niagaran series thicken toward the north and west. This relationship suggests that the depositional basin during earliest Niagaran time lay northward rather than southward as one would conclude by considering total Silurian thicknesses.

Workman and Gillette (1956: 10, 12), in their discussion of the Kinderhook series, defined the Petersburg basin as the area lying northwest of the Vandalia arch and north of the Ozark uplift in which the Kinderhook strata are 200 to 225 feet thick. Presumably this basin originated during Kinderhook time and had a connection northwestward

into Iowa. Our sections lie in the area northwest of the Vandalia arch and north of the Ozark uplift, and the northern and western wells are in the basin proper. It seems possible that the thickening of the lower Niagaran strata shown by our sections may indicate an earlier and larger ancestral Petersburg basin.

While not indicated by our electric-log cross-sections, the presence of an unconformity at the top of the Niagaran strata cannot be doubted. The time interval between the deposition of middle Silurian rocks and of the immediately overlying middle Devonian rocks is great and is represented in other areas by thick sedimentary sequences. Because of this known great time-interval, previous workers (Lowenstam, 1949:

9) believed that the over-all thinning of the Silurian rocks northward is due to bevelling during this period. The rocks which we call upper Niagaran have been considered a facies of rocks in the units we place in the lower portion of the Niagaran (Lowenstam, 1949: Fig. 2, and 1950: Fig. 2). It seems logical to assume that, if a sequence of truncated beds occurs below the middle Devonian contact, there should be considerable variation in the lithologic and electrical characteristics of the uppermost Silurian rocks along the line of cross-sections. However, the logs indicate a high degree of uniformity with variation only in total thickness of the Niagaran at any one locality. This uniformity has been attributed (D. H. Swann, pers. comm., 1957) to a weathering change of original lithologic types during the long period of erosion.

An alternate hypothesis that we judge to be worthy of consideration is implied by the cross-sections (Figs. 2 and 3). The medium-length dotted line is indicated as a surface of unconformity resulting from uplift and erosion during Niagaran time with truncation of the older Niagaran beds below this surface. This hypothesis assigns the beds above the unconformity to a younger age within the Niagaran; that is, these rocks were deposited upon previously bevelled earlier Niagaran rocks.

Such an unconformity accounts for the apparently anomalous variations in total thickness as opposed to the individual unit thicknesses. Subsequent deposition on this eroded surface possibly accounts for the

uniform dolomitic character of the upper Niagaran unit.

If this hypothesis should prove to be correct, then the surface of unconformity may offer possibilities for the stratigraphic accumulation of oil at locally favorable places throughout the area.

Middle Devonian (Wapsipinicon and Cedar Valley) limestones rest unconformably upon the Middle Silurian (Niagaran) sequence. There is an area in Christian, Macon, and Sangamon counties where the Devonian and upper portions of the Niagaran rocks are absent (cross-section A-B-C, wells 7 and 8, and cross-section F-G, well 21) because of erosion following deposition of the Wapsipinicon and Cedar Valley formations. Whiting (1956) has shown that oil in the Christian County area is obtained from porous zones developed in the Silurian rocks during this erosional period. The absence of Devonian limestones here is probably due to re-uplift and erosion at the close of Middle Devonian time.

The Wapsipinicon and Cedar Valley limestones are sandy and variable in lithology, which suggests near-shore deposition. The Wapsipinicon is correlated with the Geneva dolomite and the lower part of the Grand Tower limestone, both of which are Middle Devonian in age. Oil production in the Salem Pool is at this horizon.

The New Albany (Grassy Creek) shale lies unconformably over all the area of this study. This shale is considered the most likely source of oil in Devonian and Silurian rocks with which it is in contact.

Publication of this manuscript is authorized by the Chief, Illinois State Geological Survey.

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