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WAPELLA EAST OIL POOL, DE WITT COUNTY, ILLINOIS— A SILURIAN REEF

Richard H. Howard

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John C. Frye, *Chief* URBANA

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ABSTRACT

The discovery well of the Wapella East oil pool, the Lloyd A. Harris No. 1 T. P. Kiley, NE NW NW sec. 28, T. 21 N., R. 3 E., DeWitt County, was completed December 2, 1962, for 154 barrels of oil per day (pump capacity) from Silurian reef dolomite topped at 1112 feet. This discovery is at the northern end of the Illinois Basin, and 25 miles north of Decatur, which previously marked the northern boundary of the major oil producing area of Illinois.

A geologic study of the area shows the Wapella East pool to be situated on a broad, southward-plunging, structural nose. There is about 100 feet of closure in the pool area. How much of this closure can be attributed to the presence of Silurian reef is conjectural and will remain so until a hole that has penetrated the reef is drilled through the entire Silurian. In the pool area, Devonian limestone thins 16 feet over the reef from a thickness of 30 feet to 14 feet.

Eleven wells are producing oil from Silurian dolomite that consists of (1) bluish gray, finely crystalline, vuggy to dense, fractured reef core and (2) lighter gray reef wash having many fossil cavities and apparent bedding dips of 20°.

More exploratory drilling on structural highs in the area may result in the discovery of additional accumulations of oil.

INTRODUCTION

The discovery well of the Wapella East oil pool, the Lloyd A. Harris No. 1 T. P. Kiley, NE NW NW sec. 28, T. 21 N., R. 3 E., DeWitt County, was completed December 2, 1962, for 154 barrels of oil per day (pump capacity) from Silurian reef dolomite topped at 1112 feet. This discovery is located 16 miles southeast of Bloomington and 25 miles north of Decatur, which previously marked the northern boundary of the major oil producing area of Illinois (fig. 1).

A study of the geologic conditions present in the Wapella East area was initiated to aid current petroleum exploration in this portion of Illinois. The report

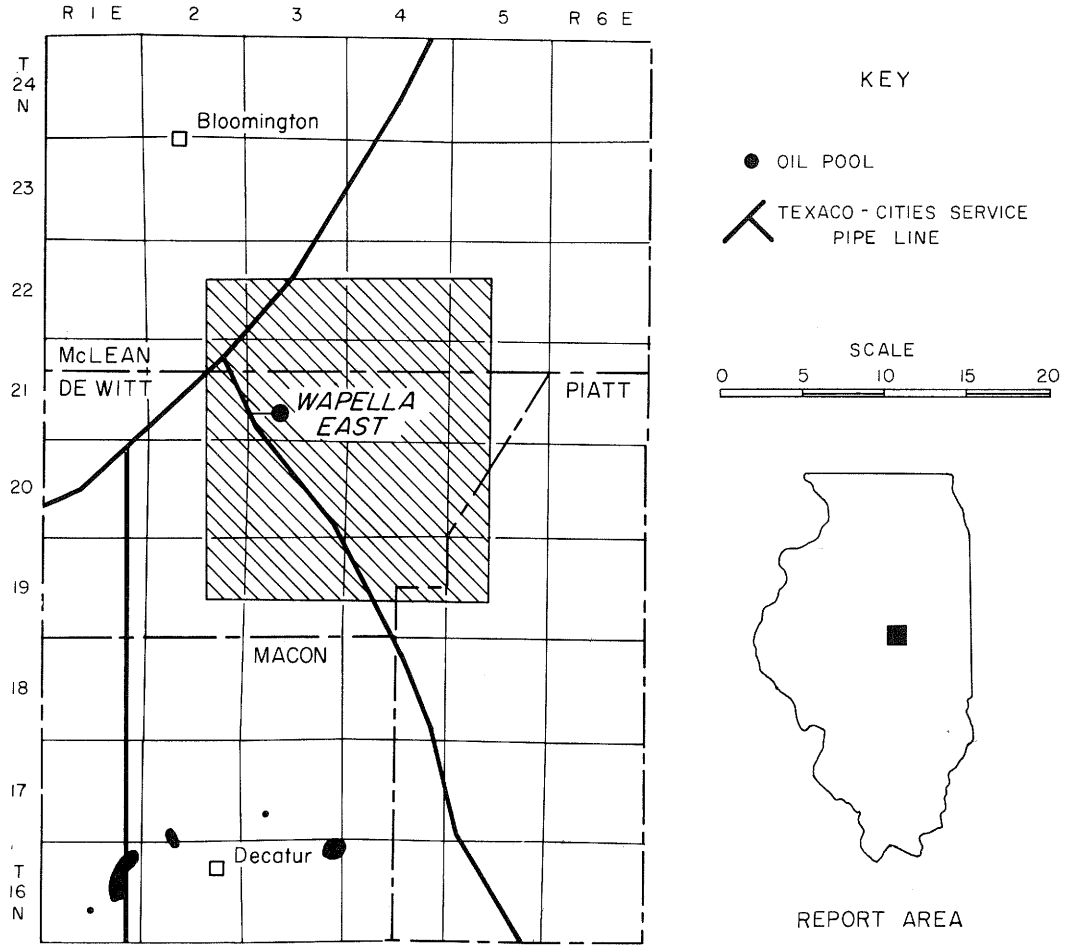

Fig. 1 - Location of the Wapella East area, showing nearest oil production and crude oil pipe lines.

area includes about one-half of DeWitt County and parts of McLean and Piatt Counties. It is 20 miles long from north to south, $17\frac{1}{2}$ miles wide from east to west.

Physiographically the report area is in the southwest part of the Bloomington Ridged Plain of the Till Plains Section of the Central Lowlands Province. The area is drained southwestward by tributaries of the Sangamon River. Topographic elevations range from 640 feet above sea level in the Salt Creek bottom at the southwestern corner of the area to 820 feet above sea level along the northern boundary. Most of the area is relatively flat till plain with local relief of less than 10 feet.

GEOLOGY

General Geologic Setting

The Wapella East pool area is at the northern end of the Illinois Basin about 15 miles west of the steepest dips of the western flank of the LaSalle Anticline. Rock strata dip regionally southeastward at an average rate of approximately 25 feet per mile. The bedrock surface is overlain by 200-400 feet of glacial till, sand, and gravel. Records of oil tests and structure tests for natural gas storage provide geologic data on the deeper strata.

Stratigraphy

In lieu of a discussion of the general stratigraphy in the area, the reader is referred to figures 2 and 3. Figure 2 shows the stratigraphic position, gross lithologies, and approximate thicknesses of strata above the St. Peter Sandstone. The term Hunton Limestone Megagroup (Swann and Willman, 1961) is used for the Devonian-Silurian carbonates. Figure 3 shows the electrical characteristics of the formations encountered in the deepest test hole in the report area. Devonian and Silurian strata in the Wapella East pool area are discussed in more detail under Geologic Occurrence of Oil.

Structure

The structure within the report area is related genetically to that of the LaSalle Anticline, whose steeply dipping western flank is just to the east. Hence, the structural grain of the report area, as contoured on top of the Hunton (fig. 4), is north-northwest to south-southeast, essentially parallel to the LaSalle flexure. Dips on the western flank of the southward-plunging anticlinal nose on which the Wapella East pool is located are four times those on the eastern flank. There are two other important southward-plunging noses in the area: (1) five miles east of the pool; and (2) three miles west of Farmer City. The axis of the major low is just east of Clinton.

Thickness of the New Albany Shale in nearby holes was used in estimating the Hunton top in holes that only reached the New Albany. Figure 5 shows the structure of the Wapella East pool in larger scale.

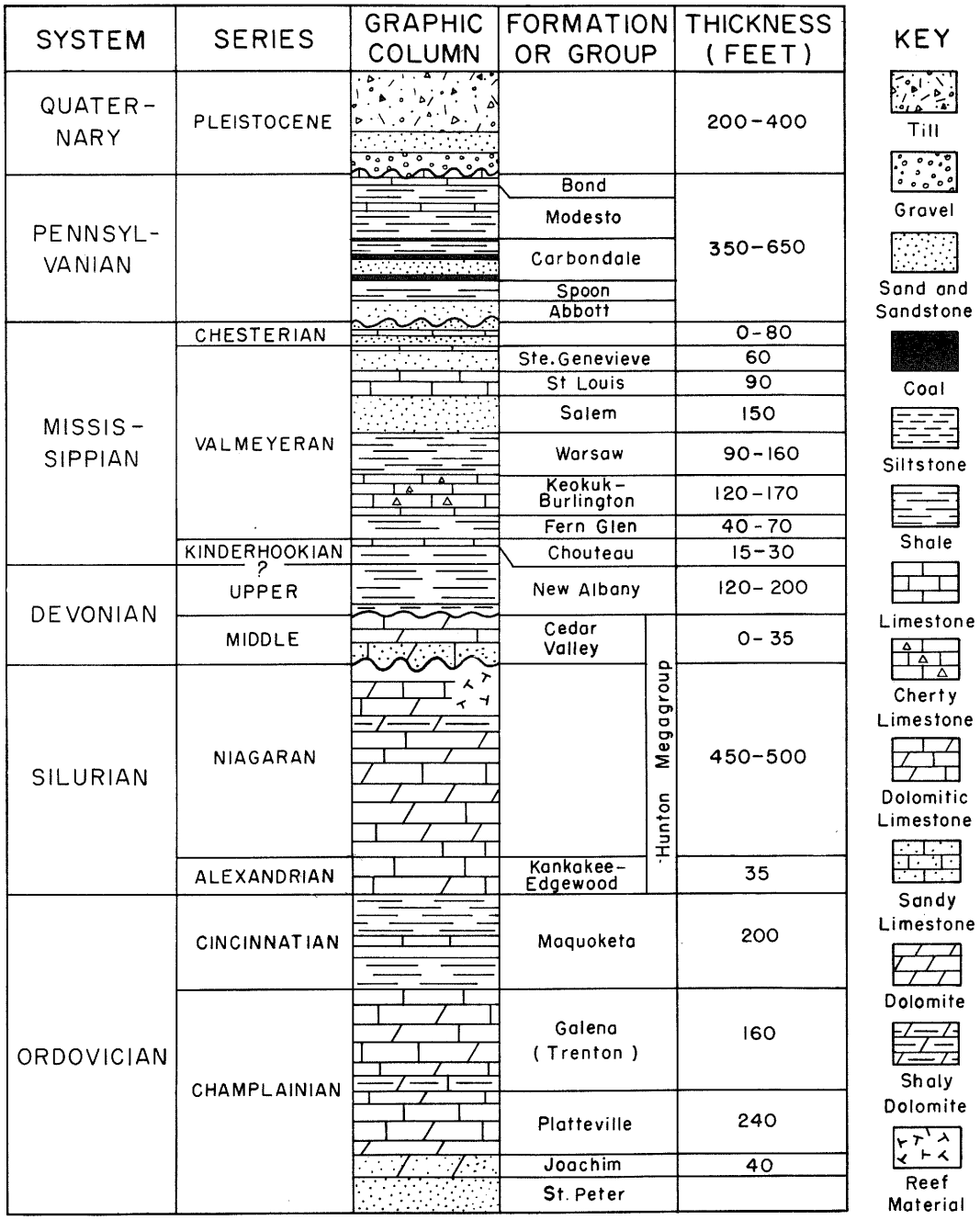

Fig. 2 - Generalized columnar section above the St. Peter Sandstone.

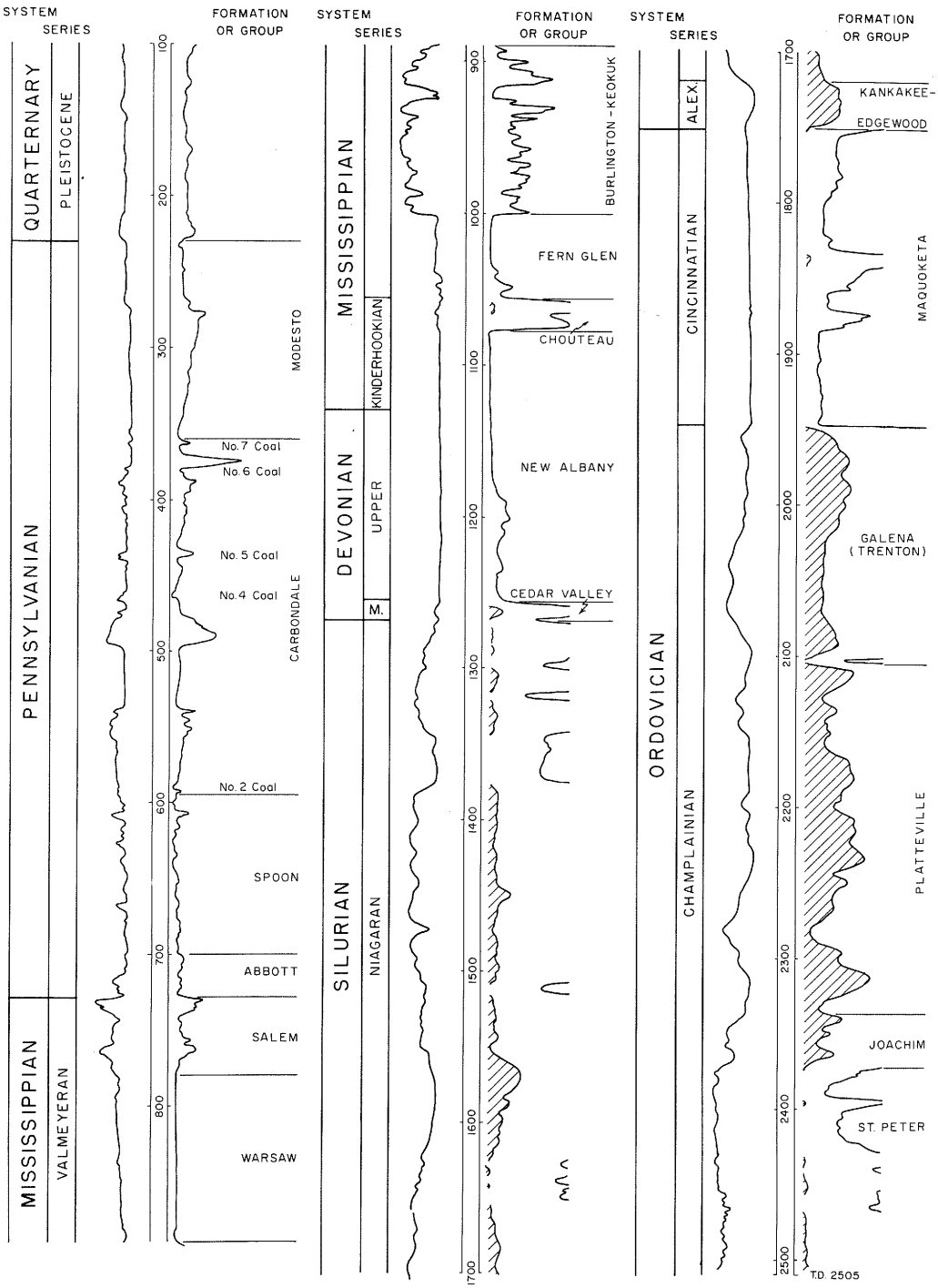

Fig. 3 - Electrical log of the Stensel No. 1 Schwartz, N½ NE NW sec. 30, T. 21 N., R. 4 E., DeWitt County.

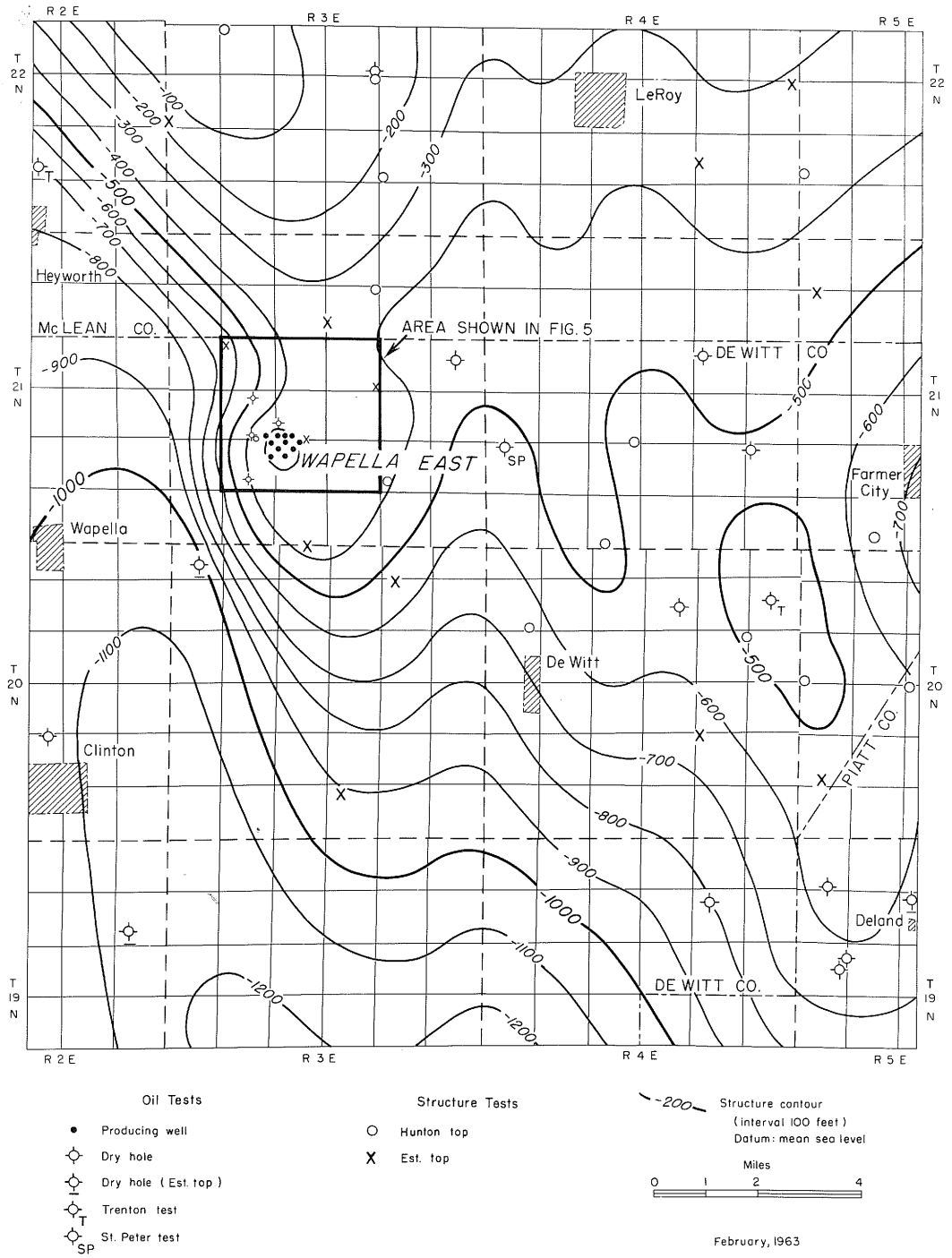

Fig. 4 - Structure map of the report area on top of the Hunton Megagroup (Devonian-Silurian carbonates).

OIL PRODUCTION

Eleven wells are producing oil from Silurian reef dolomite in the Wapella East pool; Devonian production has been minor so far. The crude oil has a greenish cast in a glass bottle, is amber-colored on the hand, and has a gravity of 30.5° A.P.I. The oil is pumped into a 2 7/8-inch branch pipe line that carries it two miles west, into the Texaco-Cities Service pipe line (fig. 1). Virtually no natural gas is produced with the oil. Several of the structually lower wells are producing slightly salty sulphur water. Analyses were made by the Illinois State Geological Survey's Analytical Chemistry Section on brine samples from two wells in sec. 21, T. 21 N., R. 3 E. One sample contained 2724 Ppm chlorides and 5118 Ppm total solids. The other contained 3782 Ppm chlorides and 6907 Ppm total solids. The total solids values conform to the isocon map (Meents, et al., 1952) of Devonian-Silurian brines. Table 1 shows data on the 11 present producing wells in the Wapella East pool.

Discovery and Development

Few oil tests were drilled in this area before 1960. During the latter part of 1960 and early 1961 the Union Hill Gas Storage Company, a subsidiary of Peoples Gas Light and Coke Company of Chicago, drilled 27 structure tests in search

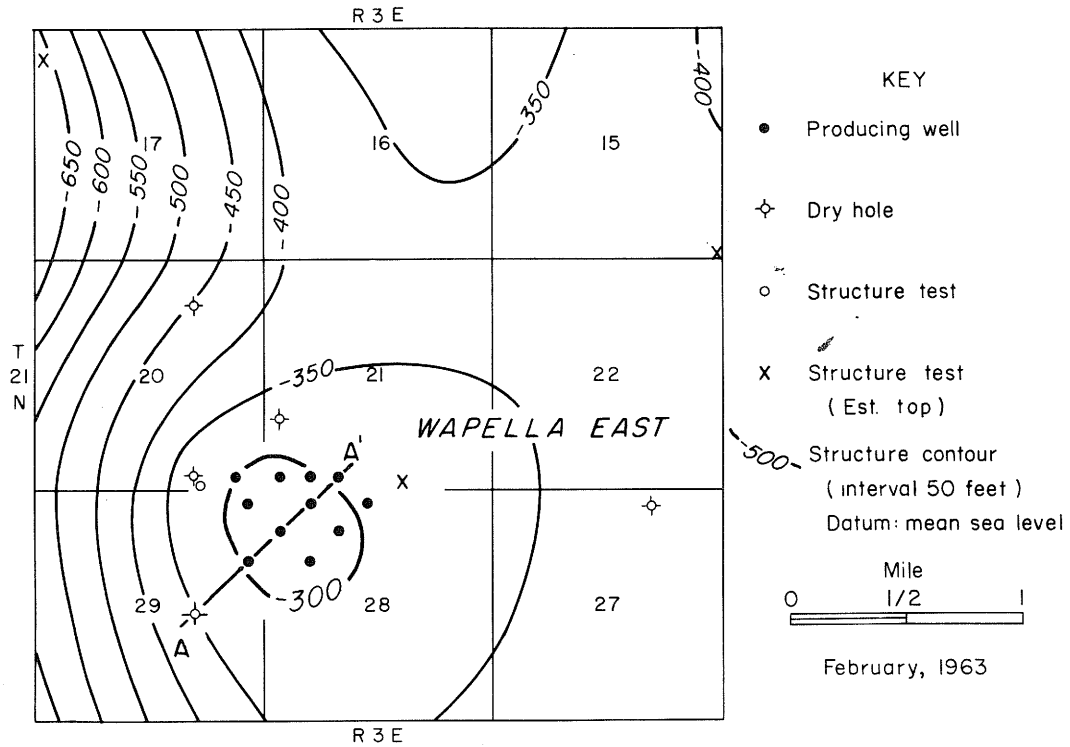

Fig. 5 - Structure map on top of the Hunton Megagroup (Devonian-Silurian carbonates) in the Wapella East pool area.

TABLE 1 – ELEVEN PRODUCING OIL WELLS IN THE WAPELLA EAST POOL

Well	Location	Depth and elevation (in feet)			Initial production in barrels (pump capacity)
		Devonian limestone top	Silurian reef top	Total Depth	
#1 T. P. Kiley	NE NW NW 28–21N–3E	1090 (–285)	1112 (–307)	1117 (–312)	154 oil
#2 T. P. Kiley	SW NW NW 28–21N–3E	1085 (–286)	1101 (–302)	1117 (–318)	148 oil
#3 T. P. Kiley	SW NE NW 28–21N–3E	1097 (–293)	1119 (–315)	1122 (–318)	144 oil
#4 T. P. Kiley	NE NE NW 28–21N–3E	1106 (–302)	1133 (–329)	1139 (–335)	
#5 T. P. Kiley	NE SW NW 28–21N–3E	1090 (–291)	1104 (–305)	1111 (–312)	
#1 Laura Kiley	NE NE NE 29–21N–3E	1090 (–292)	1111 (–313)	1120 (–322)	135 oil
#2 Laura Kiley	NE SE NE 29–21N–3E	1100 (–297)	1117 (–314)	1123 (–320)	
#1 Cora Ryan	SW SW SW 21–21N–3E	1096 (–289)	1120 (–313)	1137 (–330)	146 oil
#2 Cora Ryan	SE SW SW 21–21N–3E	1111 (–297)	1134 (–320)	1139 (–325)	
#3 Cora Ryan	S½ SE SE 20–21N–3E	1106 (–304)	1131 (–329)	1137 (–335)	
#1 Julia Ryan Heirs	SW SE SW 21–21N–3E	1110 (–304)	1134 (–328)	1164 (–358)	152 oil 10 water

of structures with sufficient closure and areal extent to be suitable for underground storage of natural gas. Their Mahomet dome storage project (Bell, 1961) lies 10 miles east of the report area. They did not find the kind of structure for which they were looking and released the structure test electrical logs and drilling samples to the Illinois State Geological Survey, where they were promptly placed on open file.

Mr. Lloyd A. Harris, consulting petroleum geologist from Mattoon, Illinois, while at the Survey office engaged in a subsurface study of the Devonian in this area, found evidence of Devonian porosity down dip on the east flank of an untested structure. Harris' first well drilled on this structure discovered the Wapella East pool. The No. 1 T. P. Kiley topped Devonian limestone at a depth of 1090 feet and Silurian reef dolomite at 1112 feet. It filled up with 950 feet of oil, but could be swabbed down. After being treated with 500 gallons of mud acid, swabbing at the rate of 30 barrels of oil per hour did not lower the fluid level below 900 feet. The well was completed for 154 barrels of oil per day (pump capacity). After being treated with 500 gallons of mud acid, the fluid level in the No. 1 Laura Kiley could not be lowered below 600 feet while being swabbed at the rate of 54 barrels of oil per hour.

Geologic Occurrence of Oil

The present structural configuration of the report area was formed by forces initiated at the close of Mississippian time. The Wapella East pool is situated on a broad, southward-plunging structural nose. There is about 100 feet of closure in the pool area. How much of this closure can be attributed to the presence of Silurian reef is conjectural, and will remain so until holes have been drilled through the entire Silurian. Total Silurian thicknesses in holes that penetrated reef can then be compared with total Silurian thicknesses in holes that did not encounter reef. Four known Silurian thicknesses in the report area, none of which is within 4 miles of the pool, range from 463 feet to 495 feet. In the pool area, Devonian limestone thins 16 feet over the reef, from a thickness of 30 feet in the SW NW SW of section 21 to a thickness of 14 feet in the NE SW NW of section 28. Figure 6 shows 8 feet of this thinning along A-A'.

Devonian limestone in the Wapella East pool consists of three units. The upper unit is tan, commonly finely oolitic, lithographic limestone, which is often chalky and dolomitic. It is usually slightly sandy, contains many thin, black shale partings (fig. 7A), is vertically fractured, and has a strong natural gas odor. The bottom portion of this unit is commonly dolomitic, slightly vuggy and oil stained but usually tight. The lower unit is crinoidal, bryozoan, and frequently coralline limestone (fig. 7B), oil stained, often very sandy, commonly dolomitic and friable. Between these fairly persistent upper and lower units a light to dark brown, silty, shaly limestone with prolific white brachiopod development (fig. 7C) is locally several feet thick. Corals and stromatoporoids (fig. 8A) are locally abundant in the middle and lower units.

The Devonian-Silurian contact (figs. 8B, 8C, 9A) is marked by a sandy Devonian detrital zone that sometimes contains large chert pebbles (fig. 8B). The Silurian surface is fractured and fissured. The fissures, which in some places extend at least 25 feet into the Silurian, vary in width from minute (fig. 9A) to over 3 inches. Figure 9B shows a 1-inch fissure filled with Devonian sand and Silurian reef rock fragments. Figure 9C shows a fissure more than 3-inches wide filled with green clay and sand. The depth 1176 is written on Silurian reef rock.

Silurian strata consist of reef core, reef wash, and interreef rock. The reef core (fig. 10A) is bluish gray, finely crystalline, vuggy to dense, fractured, unbedded dolomite. Reef wash (fig. 10B) is a lighter gray, fine-grained dolomite, vuggy with many fossil cavities, and apparent primary bedding dips of 20 degrees. Figure 10C shows a piece of typical interreef rock that is light green, chalky, pyritic dolomite with isolated large vugs.

Coventional core analysis of 17 feet of reef wash cored in one well indicated an average porosity of 14 to 18 percent and permeabilities of less than 500 millidarcies. Five feet of reef core and 11 feet of reef wash, cored in another well, were subjected to whole core analysis. Average porosities and permeabilities of reef core were 12-13 percent and less than 100 millidarcies, respectively. Average porosities and permeabilities of reef wash were 20-24 percent and more than 500 (up to 11,500) millidarcies, respectively.

The oil-water contact in the pool is believed to be at about 350 feet below sea level.

Drilling and Completion Practices

According to Lloyd A. Harris, principal operator in the Wapella East area, the cost of drilling a well with rotary tools, including coring, drill-stem testing, and logging, is about $5,200. It costs another $7,000 to set pipe and install a pumping unit, and another $2,500 for a tank battery. Some drilling mud is lost regardless of whether heavy or light mud is used. The use of heavy mud results

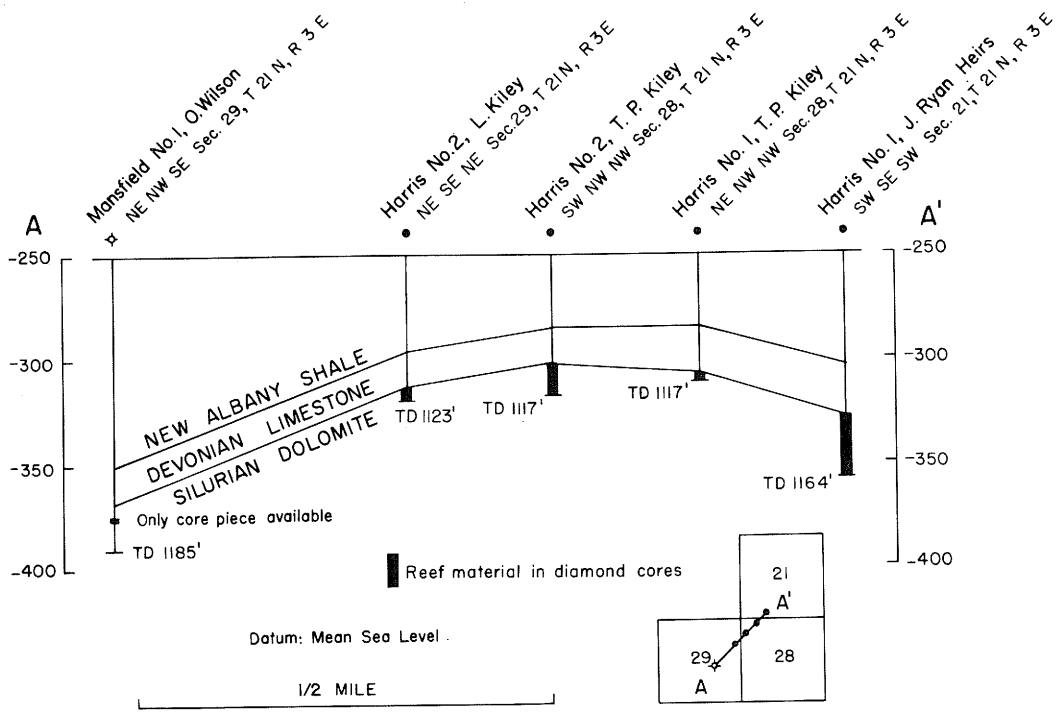

Fig. 6 - Geologic cross section across the Wapella East pool.

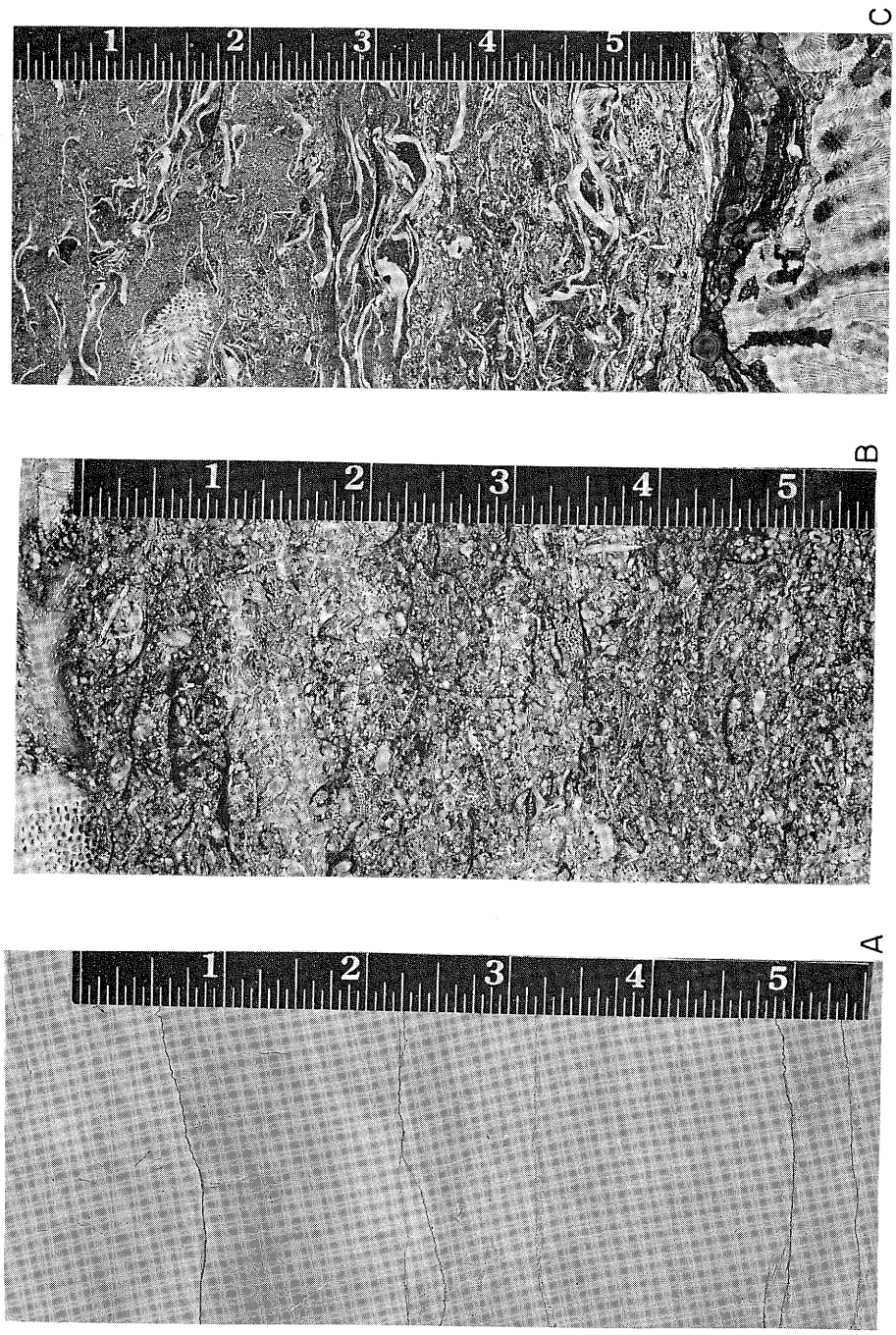

Fig. 7 - (A) Polished core slab of Devonian lithographic limestone with thin, black shale partings. (B) Polished core slab of Devonian crinoidal and bryozoan hash with some corals. Darker areas are oil stained. (C) Polished core slab showing prolific, white brachiopod zone above Devonian coralline, crinoidal zone.

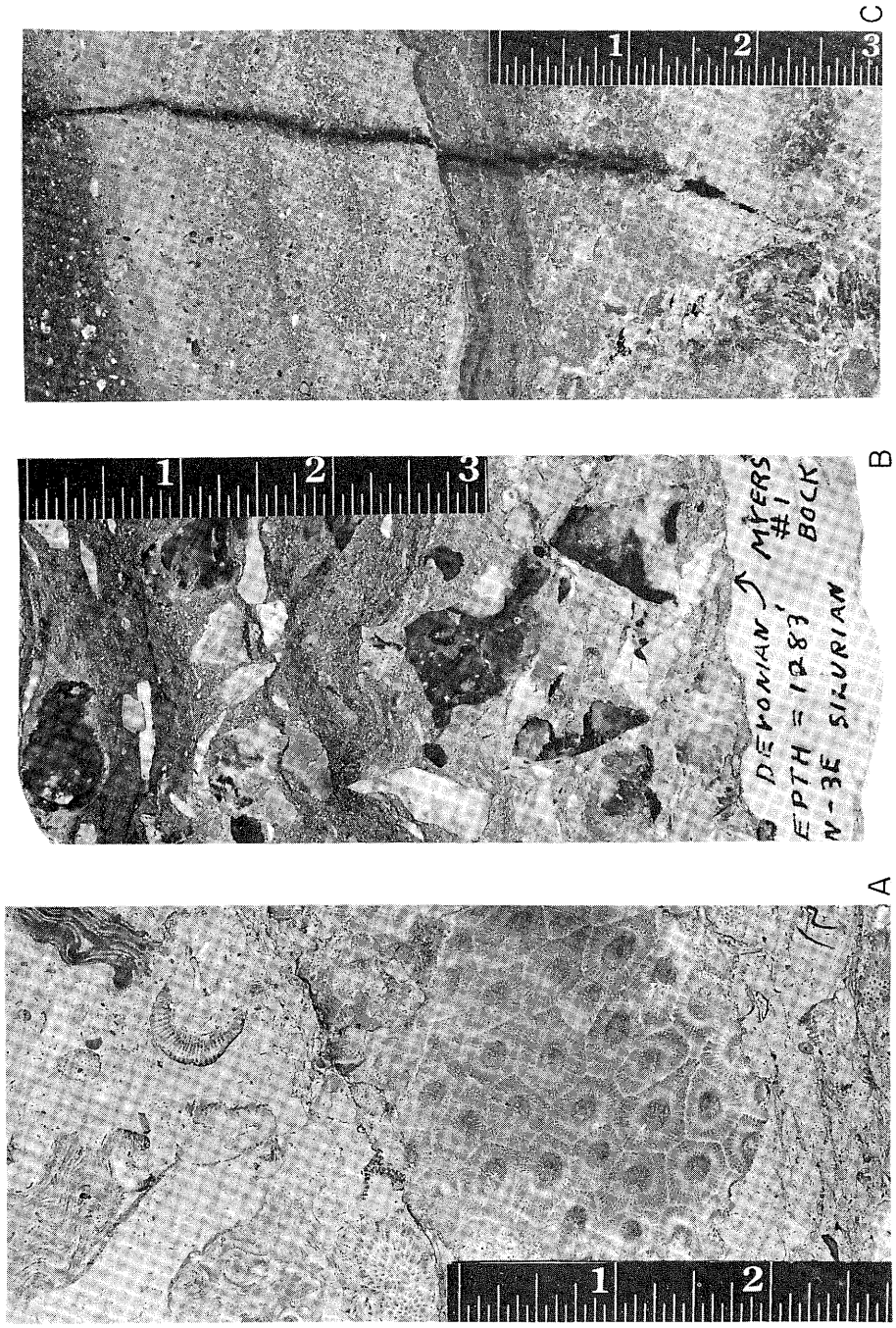

Fig. 8 - (A) Polished core slab of Devonian coralline limestone with a 2-inch coral (Hexagonaria) and three 1-inch stromatoporoids at the top. (B) Sandy Devonian detrital zone containing chert pebbles overlying Silurian interreef rock. (C) Polished core slab showing sandy Devonian overlying fissured and fractured Silurian reef. Lateral displacement of oil-stained vertical fracture pinpoints contact.

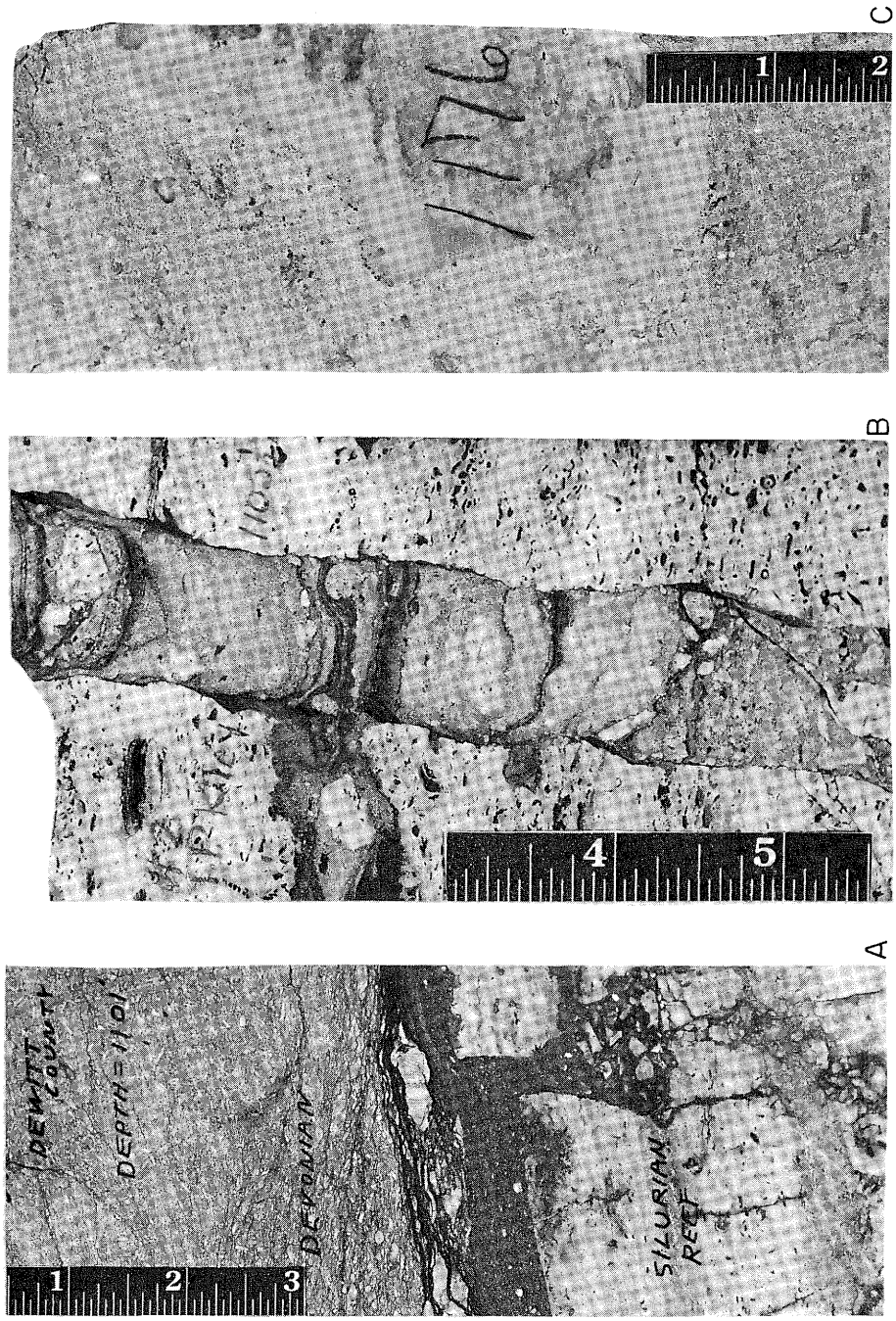

Fig. 9 - (A) Devonian-Silurian contact. (B) One-inch fissure in vuggy Silurian reef wash filled with Devonian sand and Silurian reef rock fragments. Core sample has been retorted during whole core analysis. (C) Devonian clay and sand fissure-filling around Silurian reef rock at right.

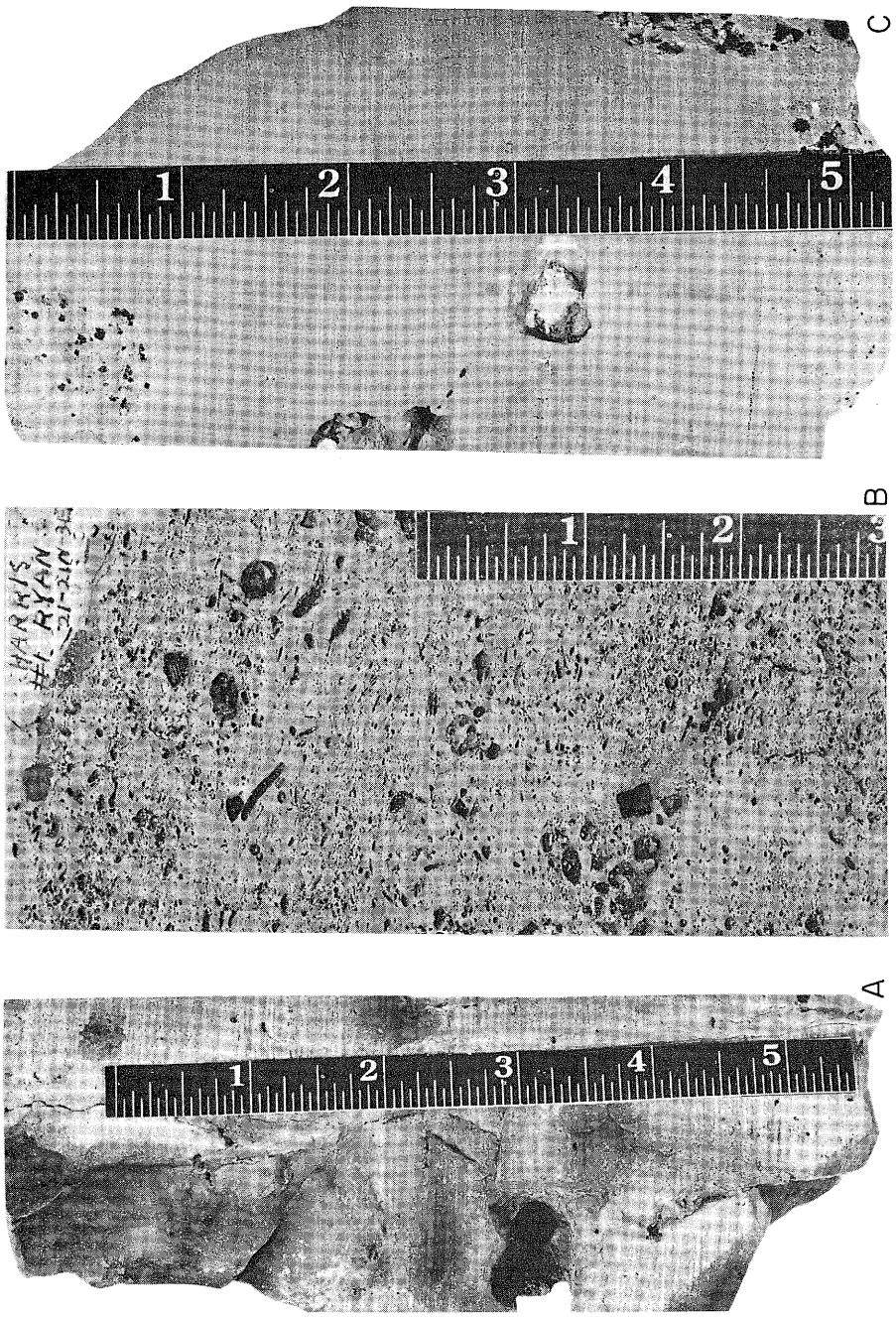

Fig. 10 - (A) Oil-stained, fractured Silurian reef core. (B) Oil-stained, vuggy Silurian reef wash. Note large fossil cavities and apparent 20° bedding dip. (C) Typical Silurian interreef rock.

in more clean-out problems during completion.

The usual casing procedure is to set 100-200 feet of 8 5/8-inch surface casing. Drilling without surface casing also has been tried successfully. The production string of $4\frac{1}{2}$-inch casing is set 3 feet above the pay with the aid of a special casing shoe. All the producers so far have been treated with 500 gallons of mud acid. Rods and 2-inch tubing are run and a 1 3/4-inch pump having a 160-170 barrel per day capacity is installed.

RECOMMENDATIONS FOR FUTURE DRILLING

Water-bearing Silurian reef rock has been penetrated in several off-structure dry holes. Reef rock is probably present in much of the area but must be found structurally high to produce oil. More exploratory drilling along the highs shown in figure 4 may result in the discovery of additional accumulations of oil.

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