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RESUME OF OIL EXPLORATION AND POTENTIAL IN IOWA

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GENERAL STATEMENT

The Annual Summaries of Oil and Gas Tests in Iowa are in reality a condensed history of oil drilling in Iowa. The tabulation includes the date each test was drilled, the name of the operator, the geologic section penetrated, and comments concerning presence of oil shows. Even though all of these tests are classified as oil tests, some are really the rankest of "wildcats." In only a small percentage of these tests was the selection of the well site based on geologic or geophysical data.

All counties north of a line from the northwest corner of Harrison County on the west, to the southeast corner of Muscatine County on the east are considered to be largely negative for oil potential (fig. 1). Possibilities where Cambrian oil might be found in this area are limited to the basins which flank the Midcontinent Geophysical High. The aeromagnetic map shows a major "clastic" basin in the area of Hamilton and Boone Counties (Henderson and Vargo 1965). These basins are fairly deep close to the mafic lavas of the "High" and are shallower away from the lavas.

All counties south of the line described above are more attractive for oil prospecting. These counties can be further divided into three broad provinces--the Forest City basin; an unnamed basin north of the Midcontinent Geophysical High in parts of Mills, Pottawattamie, and Cass Counties; and southeastern Iowa. The future potential of these areas lies in the exploration of the Cambrian, post-Lower Ordovician, basal Middle Devonian, and Pennsylvanian rocks.

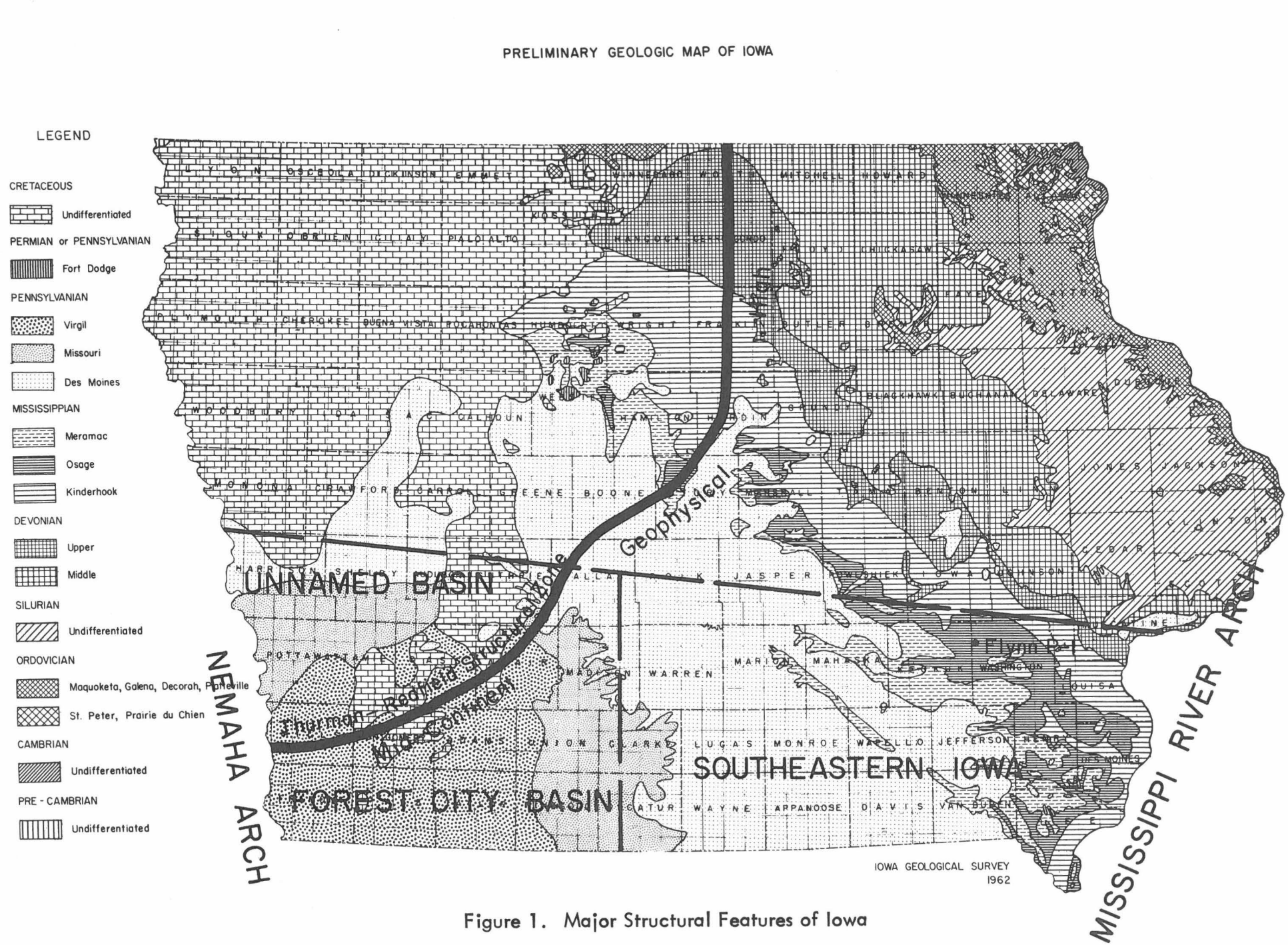


Figure 1. Major Structural Features of Iowa

FOREST CITY BASIN

The Forest City basin is a major structural feature that extends from southwestern Iowa southwestward through parts of Missouri, Nebraska, and Kansas. The northwestern boundary of the Iowa portion of the basin is defined by the Thurman-Redfield Structural Zone. The eastern boundary is undefined by structural features and is arbitrarily placed between the Missouri-Virgil and Missouri-Des Moines Series (Pennsylvanian System) boundaries.

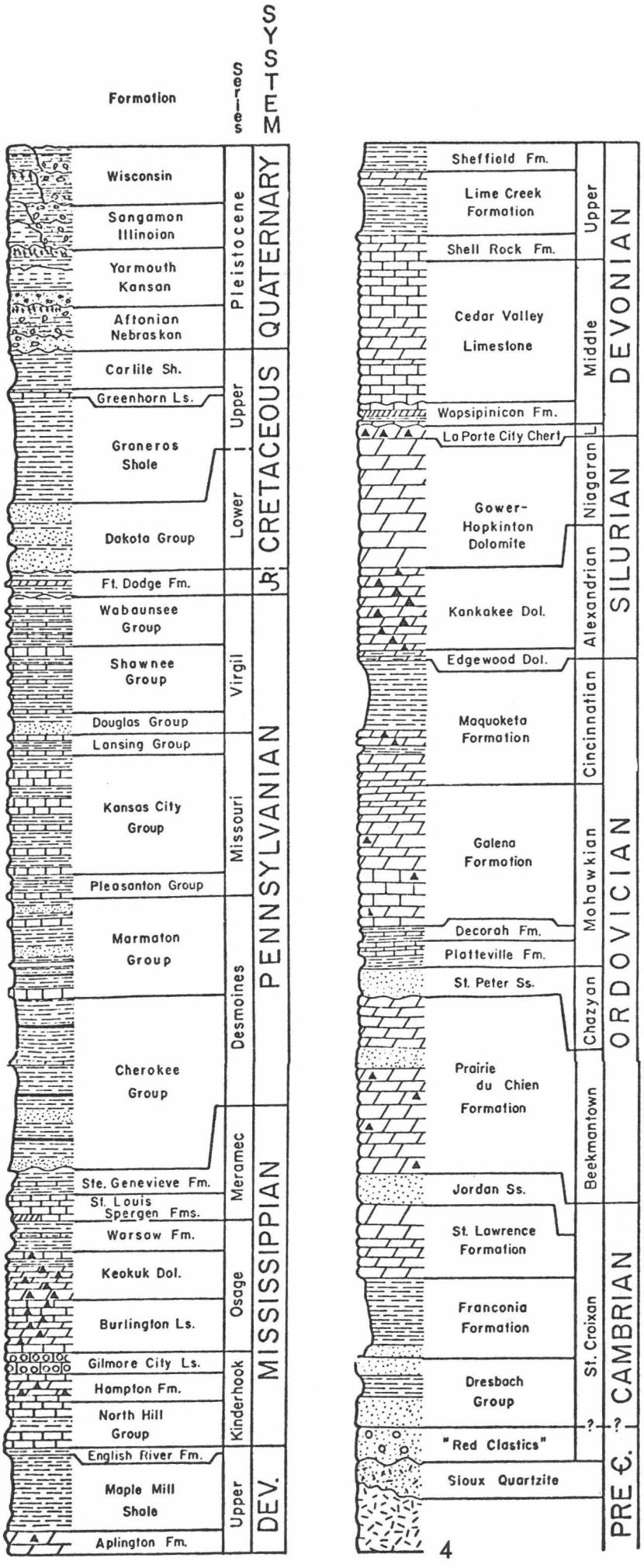
There are two opposing structural trends in the basin which could be important with regard to petroleum production. The older, which is oriented northwest-southeast, developed during the Cambrian and Lower Ordovician whereas the younger northeast-southwest trend formed during and after Mississippian time. Intersection of these trends resulted in a doming effect which is particularly noticeable in Pennsylvanian strata along the basin edge.

Virtually a complete Paleozoic section, except for the Upper Mississippian, Lower Pennsylvanian and Permian, is present in the Iowa portion of the Forest City basin. The deepest well in the basin is the Wilson #1 located in the NE cor. sec. 25, T. 68 N., R. 37 W., Page County. The total depth of the well is 5,305 feet and the crystalline-basement complex was reached at a depth of 5,205 feet. See Stratigraphic Column (fig. 2).

Approximately 80 percent of the oil produced in the Nebraska, Kansas, and Missouri portion of the Forest City basin is from Pennsylvanian rocks with the remainder from Devonian or Middle Ordovician strata.

The Cambrian and Lower Ordovician section essentially is untested as only three wells have been drilled that completely penetrate this section in the Iowa portion of the Forest City basin. Structures in this basin that are the result of basement control are

Figure 2



GENERALIZED GEOLOGIC COLUMN FOR IOWA

Approximate vertical scale in feet

0
50
100
200
300

LEGEND

- Soil zone
- Till
- Shale (clay-silt in Pleistocene)
- Coal
- Sandstone (Sand in Pleistocene)
- Limestone
- Limestone, oolitic
- Dolomite
- Chert
- Gypsum
- Quartzite
- Metamorphic and igneous crystalline rocks

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potential targets. Aeromagnetic maps are the only tool available at present for delineating these areas.

The presence of asphaltic residue and oil stain in the Platteville (Lower Middle Ordovician) rocks in several wells in southwestern Iowa is an indication that oil might occur where structural control is favorable.

The Galena Formation and the lower two members of the Maquoketa Formation, the Elgin and Clermont, are thought to be correlative with the Viola, Fernvale-Viola, or Fernvale-Kimmswick of Oklahoma and Kansas. Intercrystalline and vugular porosity are developed in this sequence of rocks. Facies changes in the upper portion from shale to carbonate and truncation of porosity zones suggest a potential for stratigraphic entrapment of oil. Oil shows and production in the rest of the Forest City basin from this interval make it an attractive objective. Based on exploration history in the remainder of the basin, a combination of some form of structure as well as a facies change is necessary for production.

The Silurian and Lower Devonian rocks are dominantly dolomites and cherts. Although some porosity is encountered in the dolomites, this sequence of rocks is not considered to be prospective.

The Middle Devonian section consists of dense limestones with several zones of fine-to-medium crystalline, porous dolomites. Shows of oil and oil staining have been noted in the sandstone or sandy carbonates that occur at or near the base. Production may be realized in small structural highs or in facies changes and truncation of porosity zones in stratigraphic traps.

Neither the Upper Devonian shales and carbonates nor the Mississippian carbonates are considered to be prospective for hydrocarbons.

Most of the principal oil and gas producing reservoirs in the rest of the Forest City basin are in Des Moines rocks(Pennsylvanian). Most of the producing fields are located in small anticlines or stratigraphic traps formed by lenticular sands, channel sands, or "shoestring" sands. Oil production from the Des Moines rocks will depend on locating small structures or traps which are masked by younger Pennsylvanian strata and a thick cover of glacial drift which makes surface mapping almost impossible and seismic mapping very difficult and expensive. Because of low production (most of the present Pennsylvanian production, either structural or stratigraphic, is in the stripper category) and high cost of exploration these strata are less attractive for test drilling. Thus, as in the past, any drilling will be random and much of the oil that may be present will remain undiscovered.

Production from the younger Pennsylvanian sediments has not been significant in the rest of the Forest City basin and is expected to be insignificant in Iowa.

UNNAMED BASIN

The Thurman-Redfield Structural Zone forms the southern and eastern boundary and the Nemaha Arch the western boundary of this basin. The northern boundary is poorly defined by structural features.

In this basin only five wells penetrate pre-Pennsylvanian rocks and of these, only three penetrate rocks of Cambrian age. At a total depth of 3,185 feet the water well at the Northern Natural Gas Company's compressor station near Oakland, Pottawattamie County(NW cor. sec. 11, T. 75 N., R. 39 W.)is the deepest well within the basin. The well is completed in the St. Lawrence Formation(Upper Trempeleau). With such sparse drilling information the entire Paleozoic section may be considered untested.

The discussion regarding the Paleozoic rocks and oil potential of the Forest City basin is applicable to this untested, unnamed basin.

SOUTHEASTERN IOWA

Southeastern Iowa generally is considered to be a shelf on the eastern periphery of the Forest City basin and forms a part of the Mississippi River arch, a broad structural feature that separates the Illinois basin from the Forest City basin.

The major structural trend in southeastern Iowa is oriented northwest-southeast as indicated by a series of anticlines which parallel the regional strike. An older, opposing trend is evidenced by the alignment of "highs" on the several anticlines which parallel the regional dip.

Only in the northwestern portion of the area is a nearly complete Paleozoic section present and even there the Upper Mississippian, most of the Pennsylvanian, and the Permian are absent. In the southwest portion erosion has removed most of the Pennsylvanian except for the Des Moines Series and outliers of the Missouri Series. The Mississippian-Devonian boundary occurs along the northeastern portion of the area. A major unconformity is present at the top of the Lower Devonian with the result that Middle Devonian rocks rest upon strata ranging in age through Lower Devonian, Silurian, Upper Ordovician (Maquoketa Formation), and Middle Ordovician(Galena Formation). See figure 3.

During exploratory drilling near Keota, Iowa, by Natural Gas Pipeline Company of America for underground storage of natural gas, oil was discovered in the Pecatonica Member of the Platteville Formation (Middle Ordovician). Announcement of the discovery was made March 8, 1963.

The discovery well, W. F. Flynn P-1, is located in the $NE\frac{1}{4}$ $NE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 20, T. 76 N., R. 9 W., Washington County. The well is near the crest of a subsurface anticlinal dome. The dome covers approximately 2,400 surface acres and has 120 feet of structural closure. The original fluid level was 30 feet below land surface and the well

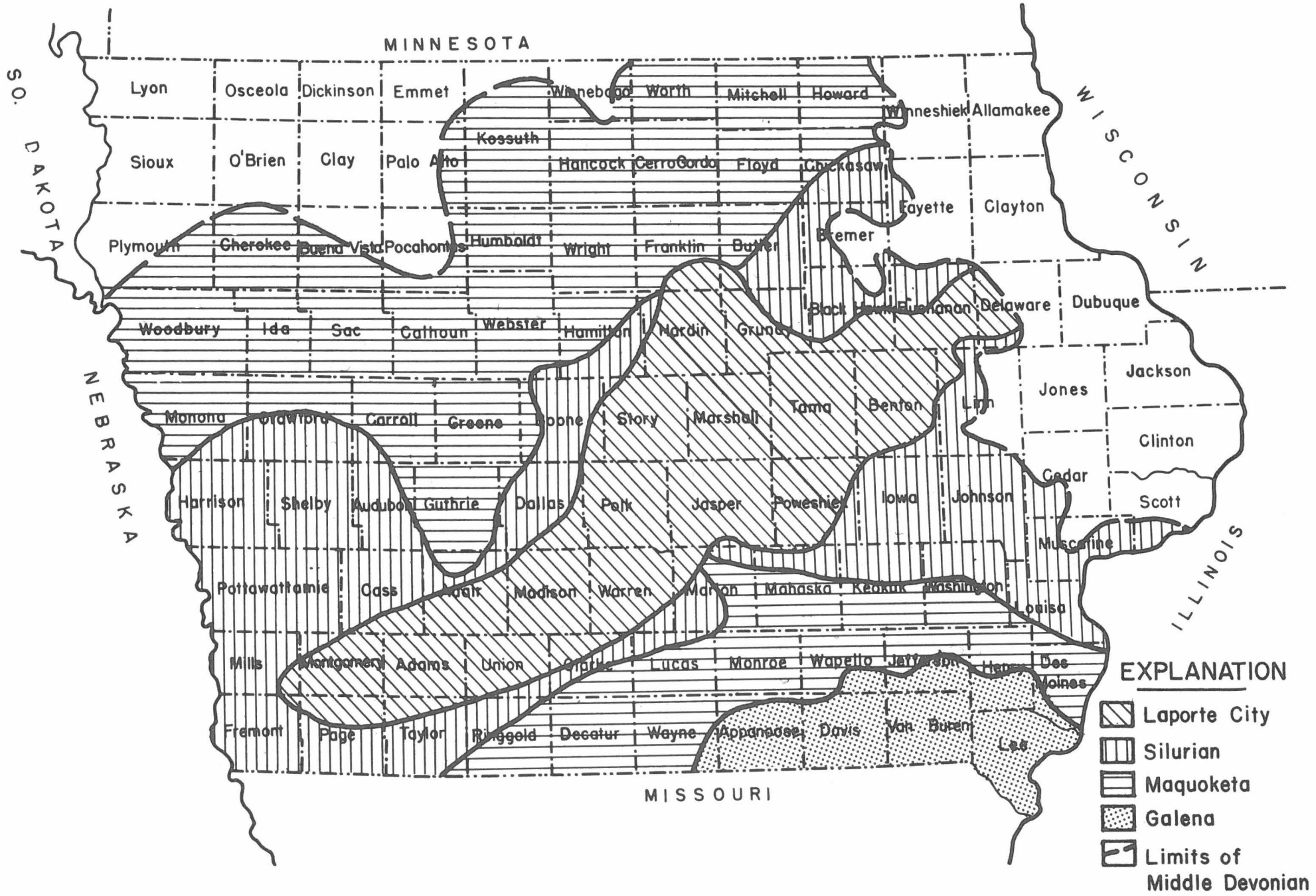

Figure 3. Formations Subjacent to Middle Devonian (Cedar Valley-Wapsipinicon)

produced 15 barrels of oil a day. Total production was about 400 barrels. The well was taken out of production in November 1963 and now is being used as an observation well by Natural Gas Pipeline Company in its utilization of the Keota Dome for the underground storage of natural gas in the St. Peter Sandstone (Middle Ordovician).

Southeastern Iowa has been extensively drilled for water supply wells, gas storage project wells and miscellaneous mineral exploration holes. No well has penetrated into Precambrian crystalline rocks and only three wells, with the exception of the gas storage wells in Louisa County, penetrate the Dresbach Group (Upper Cambrian) and approximately 50 wells penetrate the Jordan Sandstone (Trempeleau Group). Therefore, most of the Cambrian and Lower Ordovician section is untested in southeastern Iowa.

The W. F. Flynn P-1 was the only producing well in the oil history of Iowa. Two to five feet of saturation in the Pecatonica Dolomite and horizontal and vertical oil-filled fractures in the overlying McGregor Limestone (members of the Platteville Formation, lower Middle Ordovician) were encountered in the upper 30 to 40 feet of closure on the Keota Dome. Two test holes located several miles north of the discovery well and 200 feet lower structurally had shows of oil in the McGregor and Pecatonica, but no attempt was made to develop these wells. Although several bailers of oil were removed, the wells were abandoned without production tests. Other test holes in southeastern Iowa have encountered staining and small shows of oil within this stratigraphic interval.

The presence of hydrocarbons is not limited to anticlinal or domal structures. Shows of oil have been found on the flanks and in the synclinal feature adjacent to the Keota Dome in stratigraphic traps formed by facies changes within the Pecatonica from carbonate to sandy carbonate. Thus the sandy facies of the Pecatonica certainly merits further exploration. Detailed stratigraphic studies to determine the facies boundaries are needed and fluid studies may be helpful.

The Pecatonica and the overlying McGregor Limestone should be considered together as the McGregor contains oil-filled fractures and vugs. The source beds for the hydrocarbons may have been the overlying carbonacous dolomites and shales of the Decorah Formation which are called "oil rock" by miners in the lead-zinc district of Iowa, Illinois, and Wisconsin. On distillation the shale gives off hydrocarbons and when dry burns readily. In the subsurface these rocks characteristically contain solid "blobs" of hydrocarbon.

No oil has been reported from the Galena Formation in southeastern Iowa, although in several localities an asphaltic residue is found in the porous dolomite near the top of the formation.

The lower Maquoketa (Elgin Member) is high in organic material. Although no analyses for carbon from drill cuttings of the Maquoketa have been run, samples from the outcrop area of the Maquoketa show a ratio of fixed carbon to volatile material of from 15 to 32. A carbon ratio of less than 45 seems to negate the possibility of oil having been formed from the Maquoketa Shales in the outcrop area of Iowa.

Sandstone at or near the base of the Cedar Valley Limestone (Middle Devonian) has been called "Hoing" in western Illinois since oil was discovered on the Hoing farm in the Colmar-Plymouth oil field in 1941. Hydrocarbon accumulation appears to be controlled by small structures or traps where the Hoing is underlain by the Maquoketa Shales. The Hoing continues into southeastern Iowa as isolated lenses of sandstone which grade into a sandy limestone or dolomite toward the western portion of the area. Oil staining has been noted in this zone in several wells in southeastern Iowa.

The Silurian, Lower Devonian, Upper Devonian, Mississippian, and Pennsylvanian are not considered to be prospective in southeastern Iowa.

Aids in the interpretation and evaluation of oil potential in Iowa:

Geologic Map

Major Structural Features Map

Map of Formations Subjacent to Middle Devonian in Iowa

Stratigraphic Column of Iowa

Summary of Oil and Gas Tests

Highway Research Board Bull. 15 (southwest Iowa)

Iowa Geol. Survey Rpt. Inv. 1 (southeast Iowa)

Iowa Geol. Survey Misc. Map Sr. 1 (Maquoketa Formation)

Aeromagnetic Reports and Maps

Henderson, John R., and Vargo, Joseph L., 1965, Aeromagnetic map of central Iowa: U. S. Geol. Survey, Map GP-476

Preliminary interpretation of an aeromagnetic survey in north-central Iowa

Preliminary interpretation of an aeromagnetic survey in central and southeastern Iowa

Preliminary interpretation report, airborne magnetometer survey of northwestern Iowa

Preliminary interpretation report of an aeromagnetic survey in east-central Iowa

Preliminary interpretation report of an aeromagnetic survey of northeastern Iowa

Preliminary interpretation report of an aeromagnetic survey of southeastern Iowa