Study Reveals...

MISSISSIPPIAN POSSIBILITIES

Report on Upper Madison group facies in northwestern North Dakota may improve correlation tasks.

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**Mississippian possibilities**

Report on Upper Madison group facies in northwestern North Dakota may improve correlation tasks.

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Facies problems of the Upper Madison group of Mississippian age in northwestern North Dakota long have been responsible for the confusion existing in correlation of the Mississippian system.

Names, definitions, correlations, occurrence, lithology and thickness of Madison group formations are offered in an effort to eliminate some of this confusion.

**Description.** Thickness of the Mississippian system is governed by regional thinning and post-Mississippian-pre-Triassic erosion. In the eastern half of the area, the Big Snowy group—which overlies the Madison group deeper in the Williston Basin—is missing; the Madison is unconformably overlain by the Spearfish “red beds” of Triassic or Jurassic age.

A secondary anhydrite cap has been deposited over most of the post-Mis-

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**FIGURE 1**—Facies change in the Upper Madison group discussed extend from the northwestern to the northcentral portion of North Dakota in Townships 156 through 164 to the International Boundary within Ranges 77 through 95.

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**A** LINES OF CROSS SECTION  
**B** WELL NUMBERS

1. NORTH SOURIS
2. NORTHEAST LANDA
3. SCANDIA
4. NORTH WESTHOPE
5. KUROKI
6. WESTHOPE
7. SOUTH WESTHOPE
8. LANDA
9. HAAS
10. BLUELL
11. WAYNE
12. NEWBURG
13. BAUKOL-NOONAN
14. NOONAN
15. COLUMBUS
16. RIVAL
17. ENTRY
18. FLAXTON
19. LIGNITE
20. COTEAU
21. MCGREGOR
22. TIOGA
23. EAST TIOGA
24. WHITE EARTH
25. BEAVER LODGE
26. SOUTHWEST AURELIA

**B** FIELD NUMBERS

1. NORTH SOURIS
2. NORTHEAST LANDA
3. SCANDIA
4. NORTH WESTHOPE
5. KUROKI
6. WESTHOPE
7. SOUTH WESTHOPE
8. LANDA
9. HAAS
10. BLUELL
11. WAYNE
12. NEWBURG
13. BAUKOL-NOONAN
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15. COLUMBUS
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**Legend**

- **A** LINES OF CROSS SECTION
- **B** WELL NUMBERS
- **C** FIELD NUMBERS

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sissipian erosional surface. This anhydrite may form an effective seal over some of the porous beds that have been truncated by erosion, thereby forming excellent stratigraphic traps.

Several facies changes exist in the area under discussion, notably changes from a limestone facies to an anhydrite facies or from porous limestone to dense limestone. The latter also may form excellent stratigraphic traps.

These porous horizons may provide excellent oil and gas reservoirs if they meet one or more combinations of the following conditions:

- If they contain permeability barriers
- If they are associated with structure
- If they are truncated by the Mississippian unconformity and overlain by a secondary anhydrite acting as a seal.

Obviously, the easiest to find are the porous horizons associated with structure. The other conditions are...
FIGURE 3—This cross-section B-B' is a geologic east-west cross-section extending from Phillips Petroleum Company's Braather 1, Sec. 29-162-95, to Cardinal Drilling Company—U.C.L.I. 1, Sec. 1-163-81. Datum for this cross-section is the top...
Several good possibilities for stratigraphic traps are shown along the top of the cross-section at the unconformity—between the Texota-M. Sorum I, Sec. 23-163-91, and the Sohio Petroleum Corporation-Magnuson 2, Sec. 30-163-84.

A secondary anhydrite appears to have been developed over the erosional surface. The secondary anhydrite may form an effective seal over the truncated limestone beds which could create excellent stratigraphic traps.

FIGURES 4 and 5—These illustrations furnish a comparison of the electric-radioactivity log cross-sections for Section A-A'. They show the differences in nomenclature presented by the author (Figure 4) and as presented by Harrison and Flood (Figure 5) in 1957.
FIGURES 6 and 7—These illustrations compare electric-radioactivity log cross-sections for Section B-B'. They show the differences in nomenclature as presented by the author (Figure 4) and as presented by Harrison and Flood (Figure 6) in 1957.
much more difficult to find, and finding them will require detailed subsurface studies.

**Formations considered.** Facies changes in the Upper Madison group discussed lie under an area as shown in Figure 1. Formations included are:

- Englewood formation
- Madison group
- Lodgepole formation
- Mission Canyon formation
- Charles formation

**Data selection.** Control data include sample logs, which were prepared by North Dakota Geological Survey geologists, as well as electrical and radio-activity logs from NDGS files.

For clarification of correlation work of the Mississippian series, the following illustrations have been included:

- Two geologic cross-sections (Figures 2 and 3)
- Four electric and radioactivity log cross-sections (Figures 4, 5, 6, and 7)
- A nomenclature chart (Figure 8)
- A facies diagram (Figure 9)

Lithologies illustrated in Figures 1 and 2 include limestone, dolomite, salt, anhydrite, shales, siltstone and sandstone. Limestone textural terms used on the cross-sections are oolitic, fragmental, granular and dense, as defined in Table 1.

**Englewood formation.** In the portion of the Englewood formation covered by this report, as in a large part of the Williston Basin, the Englewood consists of two thin bedded, carbonaceous, hard, dark gray to black shales, separated by a light gray siltstone, very fine grained sandstone or a thin limestone.

The Englewood in North Dakota rests unconformably on the Devonian Lyelton formation and is conformably overlain by the Mississippian Lodgepole formation.

From outcrops in the Black Hills, Darton in 1901 described outcrops as being composed of a pink slabby limestone, 20 to 30 feet thick, underlying the Pahasapa limestone and overlying the Cambrian Deadwood formation. Later, the formation was described as being composed of varicolored shales with intercalated beds of reddish brown limestone and buff colored dolomite underlying the Pahasapa limestone.

From samples obtained in Amerada Petroleum Corporation’s H. O. Bakken 1, Sec. 12-157, the black shale and sandstone at the base of the Mississippian in North Dakota was named the Bakken formation. However, in the opinion of the NDGS, the Englewood of North Dakota correlates reasonably closely with the Englewood of the Black Hills. Therefore, there is no apparent need to use the term “Bakken,” unless further study indicates the need.

**Madison group.** The NDGS defines the Madison group as consisting of the Lodgepole, Mission Canyon and Charles formations.

The Madison group was described in 1893 by Peale, who divided it into three units: laminated limestones, massive limestones and jaspery limestones. He described laminated limestones as dark, fine-grained, compact limestones occurring in laminated beds; massive limestones as light bluish-gray and massively bedded; and jasper limestones as massively bedded with the upper 300 or 400 feet being generally yellowish white, light colored beds containing jasper and chert.

These formations are time-honored terms which still have some validity in parts of the Williston Basin. However, the facies situation is such that if lithologies only are used, these formations would intergrade with each other, particularly the Mission Canyon and Charles.

The Bakken was included in the Madison group by Fuller (1956), who placed the Lodgepole and Mission Canyon formations in a unit termed Madison limestone. Considerable confusion has existed in the nomenclature in this part of the geologic column, as can be seen in Figure 8.

**Lodgepole formation.** This formation was named for exposures in Lodgepole Canyon in the Little Rocky Mountains of Eastern Montana by Collier and Cathcart (1922), who described it as consisting of fossiliferous thin-beded limestones and shales having a thickness of 800 feet.

Texture of the Lodgepole in the portion of the Williston Basin under discussion varies from fine-grained dense to granular and fragmental limestone. There appears to be more granular and fragmental limestone toward the eastern part of the area. The lower part of the Lodgepole often is argillaceous with a cherty limestone section immediately underlying it. The color varies from medium gray to light gray becoming pale reddish to pale orange toward the edge of the basin.

In the section of North Dakota covered by this report, the Lodgepole conformably overlies the Englewood formation, and is conformably overlain by the Mission Canyon formation. Thickness of the Lodgepole in this area varies from about 560 feet in the east to about 650 feet on the Nesson anticline.

As yet, no production has come from the Lodgepole in North Dakota. However, the formation does produce in the Lulu Lake and Virden areas of Manitoba.

**Mission Canyon formation.** Collier and Cathcart (1922) named this formation for exposures of 500 feet of massively bedded white limestone in Mission Canyon in the Little Rocky Mountains.

The Mission Canyon, in the east and central portions covered by this report, consists largely of pale red to pale orange oolitic and fragmental limestone having a thickness of about 280 feet, grading into yellow gray and yellow brown fine grained, dense limestone about 650 feet thick in the west part.

The Mission Canyon contains sev-
eral excellent zones of porosity, particularly in the central and eastern portion, where the formation becomes largely oolitic [see Anderson and Nelson (1956) and Figures 1 and 2]. In the east part, Mission Canyon contains an anhydrite bed which has been called the Middle Anhydrite by Anderson and Nelson. Others have termed this the M. C. 2 bed (Figure 8), which points to the fact that it is an excellent marker bed. This marker bed ranges from about 10 to 30 feet in thickness and occurs in about the center of the formation. To the west, this anhydrite marker becomes shaly or dolomitic and eventually changes to limestone.

The Mission Canyon rests conformably on the Lodgepole formation, and is overlain conformably by the Mississippian Charles formation, although the typical Charles lithology in the east appears in part to be the time equivalent of the Mission Canyon lithology in the west.

In the easternmost part of the area of this report, the Charles has been eroded and the Spearfish red beds overlie the Mission Canyon unconformably.

Charles formation. Seager (1942) named the Charles formation from the Arro Oil and California Company's 4, NE NW 21-15N-30E, Garfield County, Montana. He described the Charles as a sequence of anhydrite, limestone, brown to red shales, siltstones, and dolomite lying between the Kibbey and Mission Canyon limestone. Seager placed the Charles in the Big Snowy group, but did not designate the interval; however, Nordquist (1955) put the Charles in the Madison group and designated the interval in the type well as being from 3,195 to 3,800 feet. Anderson (1954) also put the Charles in the Madison group. Thickness of the Charles is governed both by regional thinning eastward and pre-Mesozoic erosion.

In the western section of the area under discussion, the Charles consists largely of salt, anhydrite and limestone. In the east part, it consists largely of anhydrite and limestone with only one minor salt which is stratigraphically lower than the salts to the west as shown on Figure 1. Massive salt beds in the west part thin to the east and eventually are replaced by anhydrite.

The limestone of the Charles grades from a pale brown and light gray in the west to a yellowish gray in the east part of the area. The anhydrites vary from a light gray and bluish white to a pale red, becoming more reddish to the east. The formation varies in thickness from about 820 feet in the Amerada H. O. Bakken 1, 12-157-95, to being absent in the east part of the report area, where the formation has been removed by erosion.

From present studies, the contact between the Charles and Mission Canyon apparently is conformable and transitional, and, in part, the two formations are time equivalents. In this area, the Charles is overlain un-
conformably by the Spearfish of Triassic or Jurassic age.

REFERENCES


13 Saskatchewan Geological Society, 1956, Stratigraphic Cross-Sections of Mississippian Rocks (Exclusive of the Bakken formation) in the Northeastern Part of the Williston Basin: Mississippian Names and Correlations Committee, Regina, Saskatchewan, Canada.