BLACKFEET RESERVATION

List of Topics

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Play 2 - Jurassic/Cretaceous Sandstone Play
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Play 4 - Montana Disturbed Belt - Imbricate Thrust

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REFERENCES
Montana
Blackfeet Reservation

OVERVIEW
BLACKFEET INDIAN RESERVATION

Blackfeet Nation

TRIBAL HEADQUARTERS: Browning, Montana
GEORGIC SETTING: Southern Alberta Basin

General Setting

The Blackfeet Reservation is located in northeastern Montana and includes most of Glacier County. On the north it borders the Canadian Province of Alberta. On the west it shares a border with Glacier National Park. Elevations vary from a low of 3400' in the southeast to a high of over 9000' at Chief Mountain on the northwest boundary.

Major railroads and highways serving the Reservation include Burlington Northern Railroad’s main east/west line. This is paralleled by U.S. Highway #2, and is bisected by U.S. Highway #99 at Browning, the administrative center for the Reservation. Great Falls, Montana, an air traffic center, is approximately 125 miles to the southeast, and Calgary, Alberta, Canada is approximately 210 miles to the north.

Mineral Ownership and Leasing

The Blackfeet Reservation contains 1,525,712 acres, with the mineral estates divided as follows. Approximately 41.8% of the minerals is tribally owned. Another 31.3% is owned by allottees, and the remaining 26.9% is owned by fee owners. A Mineral Assessment Program is currently operating under a three-year plan to evaluate and further define the oil and gas potential of the Reservation. This geologic province extends from the Brooks Range in Alaska southward to Central America. In Alberta, Canada this belt contains a number of large fields including Pincher Creek and Waterton Lakes. There is limited production of oil and gas from the Disturbed Belt portion of the Reservation near East Glacier. The primary reservoir rocks in this region would be the Mississippian carbonates - limestones and dolomites - which are productive to the south of the Reservation at the Blackfeet Canyon Field. Other potential reservoirs would include the sands of the Cretaceous and the carbonates of the Devonian.

Four Foreland Basin is represented by a relatively undeformed wedge of Mesozoic and Paleozoic rocks that vary in thickness from approximately 3,000’ on the east to 14,000’ on the west. Although the Cretaceous, Jurassic, and the Mississippian portions of the geological section have a high potential for oil and gas production, the Devonian should also be considered as having significant undiscovered hydrocarbon potential. It is this Foreland Basin broad shelf that, during the Devonian, was the site of the deposition of reef-type rocks and the carbonates of the Mississippian. In contrast to the structurally complex Disturbed/Overthrust Belt, the Sweetgrass Arch area is controlled by the generally westward dipping flank of the Sweetgrass Arch. The largest producing field, the Cut Bank Field, is the result of a stratigraphic trap in the Kootenai Formation. Some localized structural irregularities occurred along the west flank of the Sweetgrass Arch. Regression and erosion has developed on one of these local structural irregularities. Of the three geological provinces, only the Sweetgrass Arch has received more than limited exploration. However, even in this highly productive area of the Sweetgrass Arch the full potential of the geologic section has not been adequately tested.

Petroleum Exploration and Development

The first commercial oil discovery in Montana was made in the spring of 1903 in the Swift Current Valley, just west of the Reservation in what is now Glacier National Park (Darrow, 1955). This discovery was made by a prospector named Sand D. Somes who was looking for copper ore in the Swift Current Valley, now covered by the water of many Glaciers (Darrow, 1955). His interest in oil developed in 1902 when he found pools of oil when cleaning out his workings after blasting. This early production came from a depth of 500’. By 1906, twelve wells had been drilled, six of which produced oil (Darrow, 1955). The best oil well, completed during the spring of 1906, had an initial production of 60 barrels of oil per day. Although production from this oil field was short lived, it marked the beginning of the petroleum industry in Montana.

Just off the Reservation’s eastern edge, along the west flank of the Montana Oil and Gas Conservation Division, 1991, with annual production of oil and gas in 1926 and of oil in 1929. Since the early 1930’s, development drilling had extended the known limits of this field onto the reservation.

The Cut Bank Field, which extends from Townships 31 to 36 North, in Ranges 5 and 6 West, produced 164,499,336 barrels of oil through December 1992 (Montana Oil and Gas Conservation Division, 1993), with annual production of oil still over 740,000 barrels, and nearly 3 million cubic feet of gas. Approximately 25 percent of the Cut Bank Field area lies within the Reservation.

Production from these fields through 1992 was approximately 815,000 mcf. The study of the Mississippian-Devonian. On the Reservation, Production from the Devonian section also occurs in the Kevin-Sunburst area of the Sweetgrass Arch. Although highly productive of oil and gas in Canada, exploration for the Devonian on the Reservation has been insignificant.

The Disturbed/Overthrust Belt is a zone of northwesterly, closely-spaced, sub-parallel thrust faults and folds with some known normal faults. The large scale structural dislocation of these sub-parallel thrust faults may result in oil and gas reservoir rocks overlying younger source rocks, or in the fracturing of source rocks to create a reservoir. This geologic province extends from the Brooks Range in Alaska southward to Central America. In Alberta, Canada this belt contains a number of large fields including Pincher Creek and Waterton Lakes. There is limited production of oil and gas from the Disturbed Belt portion of the Reservation near East Glacier. The primary reservoir rocks in this region would be the Mississippian carbonates - limestones and dolomites - which are productive to the south of the Reservation at the Blackfeet Canyon Field. Other potential reservoirs would include the sands of the Cretaceous and the carbonates of the Devonian.

Only limited exploration and development drilling has taken place within the Disturbed/Overthrust Belt. The Sweetgrass Arch area is controlled by the generally westward dipping flank of the Sweetgrass Arch. The largest producing field, the Cut Bank Field, is the result of a stratigraphic trap in the Kootenai Formation. Some localized structural irregularities occurred along the west flank of the Sweetgrass Arch. Regression and erosion has developed on one of these local structural irregularities. Of the three geological provinces, only the Sweetgrass Arch has received more than limited exploration. However, even in this highly productive area of the Sweetgrass Arch the full potential of the geologic section has not been adequately tested.

Geology

The Blackfeet Indian Reservation occupies a portion of the southern Alberta Basin. Tectonically, the area can be divided into three provinces: the Disturbed/Overthrust Belt on the west, the Foreland Basin in the central portion, and the Sweetgrass Arch on the east. The stratigraphy of the Reservation is generally characterized by the clastic section of the Cretaceous-Jurassic and the carbonates of the Mississippian-Devonian. On the Reservation, production exists in formations within the Cretaceous, Jurassic, and the Mississippian.

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Three provinces, only the Sweetgrass Arch has received more than a very limited amount of exploration.

The Disturbed/Overthrust Belt is a zone of northwesterly, closely-spaced, sub-parallel thrust faults and folds with some known normal faults. The large scale structural dislocation of these sub-parallel thrust faults may result in oil and gas reservoir rocks overlying younger source rocks, or in the fracturing of source rocks to create a reservoir. This geologic province extends from the Brooks Range in Alaska southward to Central America. In Alberta, Canada this belt contains a number of large fields including Pincher Creek and Waterton Lakes. There is limited production of oil and gas from the Disturbed Belt portion of the Reservation near East Glacier. The primary reservoir rocks in this region would be the Mississippian carbonates - limestones and dolomites - which are productive to the south of the Reservation at the Blackfeet Canyon Field. Other potential reservoirs would include the sands of the Cretaceous and the carbonates of the Devonian.

For a more detailed understanding, the following geological provinces are discussed:

1. **Disturbed/Overthrust Belt**
   - Located on the west side of the Reservation.
   - Characterized by northwesterly, closely-spaced, sub-parallel thrust faults and folds.
   - Contains significant potential for oil and gas production.

2. **Sweetgrass Arch**
   - Located on the east side of the Reservation.
   - Characterized by a stratigraphic trap in the Kootenai Formation.
   - Contains productive reservoirs in the Cretaceous and the Mississippian.

3. **Foreland Basin**
   - Located in the central part of the Reservation.
   - Characterized by a broad shelf with significant potential for oil and gas production.

Each of these provinces has been the subject of limited exploration. However, even in this highly productive area of the Sweetgrass Arch the full potential of the geologic section has not been adequately tested.
**EARLY EXPLORATION ON THE BLACKFEET RESERVATION**

Oil and gas was discovered in Montana in the late 19th century as oil seeps, in what is now Glacier National Park. The first Montana well in this area was drilled in October of 1901, and achieved a depth of 1450 feet in 1902. Gas was flared from a "sand unit" at a depth of 720 feet.

Swift Current Valley was the scene of the first commercial oil production in 1902. Early copper prospectors, among them Sand D. Soomes, is credited with the discovery of oil seeps during mining operations. By 1906, the field had six producing wells. With the establishment of Glacier National Park in 1910, oil exploration was suspended.

Early exploration on the Sweetgrass Arch, to the east of the reservation culminated in gas and oil discoveries in the late 1920’s. January 1931, heralded the discovery of Cutbank Field, which is one of the largest in the Rocky Mountains. Twenty percent of this "giant" field is within the reservation boundaries. Exploration during the late 1920’s led to the discoveries in the Mississippian Madison with Pondera Field. Other discoveries throughout the 1930’s and 40’s led to both Cretaceous and Madison production. The 1950’s saw a flurry of activity in the Montana disturbed belt which led to the discoveries of East Glacier/Two Medicine and Blackleaf Canyon. In 1980, William Exploration and Milestone Petroleum tested the "A" Thrust Sheet at Blackleaf Canyon and discovered gas with rates as high as 5.1 MMcf/d.

**NEARBY FIELDS**

- **1956 Blackfoot**: 1.6 MMBO, 3.0 MMcf, 8 wells oil, 7 wells gas
- **1958 Graben Coulee**: 2.4 MMBO, 63 wells oil
- **1956 Red Creek**: 6.5 MMBO, 1.2 MMcf, 18 wells oil
- **1954 Darling**: 70,000 BO (Abn'd)
- **1929 Border**: 497,000 BO, 346,000 Mcf, 1 well oil, 1 well gas
- **1929 Old Border**: 786,450 BO, 7 wells oil
- **1964 Gypsy Basin**: 504,783 BO, 3.1 MMcf, 4 wells total
- **1976 Highview**: 101,477 BO, 741,600 Mcf, 7 wells total
- **1958 Graben Coulee**: 58,000 BO (Abn'd)
- **1956 Blackfoot**: 33,748 BO, 7.5 MMcf (Abn'd)

Other small fields with no current production

**PLAY TYPES ENCOUNTERED**

- **Conventional**
  1. Fractured/Folded Anticline Mississippian Carbonate Play (2007)

- **Unconventional or Hypothetical**
  7. Shallow Biogenic Gas (2810, 2811, 2812)

**GENERAL PRODUCTION INFORMATION**

| U.S.G.S Geologic Province: | North Central Montana |
| Tectonic Province: | Sweetgrass Arch, Foreland Basin, Montana Disturbed Belt |
| Overall Production: | 440 MMBO and 1.1 TCFG |
| No. of Fields: | 170 discovered fields |
| Fields Within Reservation Boundaries: | 58 greater than 1 MMBO or 6 BCFG |

**OVERVIEW**

Oil & Gas Production
Regional Geology

The Blackfeet Reservation lies within three distinct geologic provinces, the Montana Disturbed Belt to the west, the Foredland Basin in the center, and the Sweetgrass Arch to the east (see tectonic map and structure cross-section A-A’). The Mesozoic section, composed of Cretaceous and Jurassic rocks is predominantly sand and shale. The Paleozoic section is Mississippian and Devonian in age and is mainly carbonates. The Cambrian section is mainly composed of coarse-grained clastics. Proven hydrocarbon production (see correlation chart and type log), is mainly from Lower Cretaceous Blackleaf and Kootenai sandstones, although some production is from Upper Cretaceous Greenhorn. Oil and gas is also produced from Jurassic age Swift and Sawtooth sands. Paleozoic production is from the Reservations, Fort Peck is on the western flank of the Williston Basin and is proximal to Nesson Anticline, a major oil producing structure.

Geologic History

A generalized structural cross-section (see cross-section A-A’, Figure BF-3.2) summarizes present day tectonic provinces and older paleostructure. The cross-section uses rock thickness values from each of the geologic periods. The section runs along the 48 degree latitude line and values were selected at one degree longitude intervals. The western end of the section, near the Blackfeet Reservation is dominated by high relief (greater than 5000 feet). The Cretaceous and older Paleozoic section is about 11,000 feet thick. Major basement uplifts, such as the Sweetgrass Arch and Bearpaw Uplift, influenced sedimentation throughout geologic time.

The eastern side of the cross-section is dominated by the Williston Basin, a stable cratonic depocenter which has more than 15,000 feet of sediments. The Fort Berthold Reservation is located near the depocenter and is within close proximity to Nesson Anticline, a major oil producing structure. Between these two tectonic provinces lie the Fort Peck and the Fort Belknap Reservations, Fort Peck is on the western flank of the Williston Basin and is dominated by Poplar Dome, a Laramide age structure, while Fort Belknap is between Bowdoin Dome and Bearpaw Uplift.

A paleo cross-section attempts to show what the subsurface geology may have looked like within that time interval. For the sake of space, only the particular interval is shown; no rocks older than it are illustrated. The rock units above the interval have not yet been deposited; the top of the section is the datum. The datum is flat, representing the paleo ground surface.

Regional Geologic Overview

Introduction

Blackfeet Reservation

Montana

Figure BF-3.1. Present day structural uplifts and basins, Fort Peck Reservation and location of regional cross-section A-A’ (modified after Peterson 1987).

Figure BF-3.2. Generalized cross-section A-A’, present day structure.
Cambrian Geologic History

Precambrian age supracrustal sedimentary rocks (Superbelt) are buried in the western part of the reservation and extend into Glacier National Park. These rocks are estimated to be from 900 to 1400 million years old.

During Cambrian time, a major seaway existed in western Montana and eastern Idaho (see cross-section A-A’ Figure BF-4.1 and map of the Cambrian). This seaway gradually transgressed from west to east across eastern Montana and the Dakotas. The major source of coarse-grained clastics was to the east (from the SiouxC Arch) and graded into shales and limestones to the west. Thickness of the Cambrian varies from over 2000 feet at the reservation to less than 100 feet thick at the eastern edge of the Williston Basin.

Between these two tectonic provinces lie the Fort Peck and the Fort Belknap Reservations. Fork Peck is on the western flank of the Williston Basin and is dominated by Poplar Dome, a Laramide age structure, while Fort Belknap lies between Bowdoin Dome and the Bearpaw Uplift.

To better illustrate the geologic history of the region, which has been influenced by all of these tectonic provinces, a series of paleo cross-sections are shown. Each section summarizes a particular time interval; Cambrian and older rocks, Ordovician to Triassic and Cretaceous to Jurassic. Since Tertiary sediments are present only in the Williston Basin, no paleostructure section is shown.

A paleo cross-section attempts to show what the subsurface geology may have looked like within that time interval. For the sake of space, on the particular interval is shown; no rocks older than it are illustrated. The rock units above the interval have not yet been deposited; the top of the section is the datum. The datum is flat, representing the paleo ground surface.
Blackfeet Reservation in Montana and location of regional cross-section A-A’ (modified after Peterson, 1987).

**Orдовикские скальные вулканы**

Из латерального взаимодействия до большинства среднего Палеозойского периода, Биллинтон-Басин на востоке был стабильным кратоном и характеризовался неглубокой, морской седimentацией.

Наиболее короткий период от позднего Камбрия до большей части Палеозойского периода, Биллинтон-Басин на востоке был стабильным кратоном и характеризовался неглубокой, морской седimentацией.

В ордовикское время, основным источником седиментации было море, что привело к накоплению серых алевритов и сланцев, а также известняков и карбонатных слоев. В верхнем ордовике и нижнем силуриане, осадочное бассейновое море было стабильным и характеризовалось неглубокой седimentацией, включая накопление известковистых слоев и угленосных пород.

По окончании силурианского времени, появился региональный несогласный разрыв, который простирается по всему Биллинтону и дальше на запад. Ордовикские и силурианские слои были накоплены в тихоокеанском море.

В ордовикское время, основным источником седиментации было море, что привело к накоплению серых алевритов и сланцев, а также известняков и карбонатных слоев. В верхнем ордовике и нижнем силуриане, осадочное бассейновое море было стабильным и характеризовалось неглубокой седimentацией, включая накопление известковистых слоев и угленосных пород.

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**Reservation:**
Blackfeet Reservation
North Central Montana, Sweetgrass Arch, Montana Disturbed Belt
North Central Montana (62,500 sq. miles), Thrust Belt (41,400 sq. miles)

**Geologic Province:**
North Central Montana (62,500 sq. miles), Thrust Belt (41,400 sq. miles)

**Total Production (by province-1996):**

**Oil:**
North-Central Montana Disturbed Belt: 440 MMBO

**Gas:**
North-Central Montana Disturbed Belt: 1.1 TCFG

**NGL:**
North-Central Montana Disturbed Belt: 6 BCFG

**Undiscovered resources and numbers of fields are for Province-wide plays. No attempt has been made to estimate number of undiscovered fields within the Fort Berthold Reservation.**

### Play Types - Explanation

1. **Folded and Fractured Mississippian Carbonates (2807)**
- Folded, folded anticlines in Mississippian Carbonates
- Folded structures, parallel developed nearly or horizontally
- Field Size: 2 MMBO (min), 18 MMBO (median), 32 MMBO (max)
- No. of undiscovered fields: 1 (min), 3 (median), 6 (max)
- Median: 7.2 MMBO (9 fields @ 1 MMBO)

2. **Jurassic / Cretaceous Sands (2808)**
- Jurassic / Cretaceous sands
- Thrust sheets, parallel developed nearly or horizontally
- Field Size: 10 MMBO (min), 100 MMBO (median), 250 MMBO (max)
- No. of undiscovered fields: 2 (min), 10 (median), 20 (max)
- Median: 25 MMBO (10 fields @ 2.5 MMBO)

3. **Mississippian and Devonian Carbonates (2805)**
- Mississippian / Devonian Carbonates
- Thrust sheets, parallel developed nearly or horizontally
- Field Size: 1 MMBO (min), 10 MMBO (median), 25 MMBO (max)
- No. of undiscovered fields: 1 (min), 16 (median), 24 (max)
- Median: 3.4 MMBO (10 fields @ 0.3 MMBO)

### Table BF-6.1: Play summary chart.

<table>
<thead>
<tr>
<th>Play Type</th>
<th>USGS Designation</th>
<th>Description of Play</th>
<th>Oil or Gas</th>
<th>Total Accumulations</th>
<th>Undiscovered Resources (MMBOE)</th>
<th>Play Probability (chance of success)</th>
<th>Drilling depths</th>
<th>Favorable factors</th>
<th>Unfavorable factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2807</td>
<td>Folded anticlines, parallel developed nearly or horizontally</td>
<td>Bath</td>
<td>63 MMBO (min) 21 MMBO (median) 150 MMBO (max)</td>
<td>30 MMBO (min) 150 MMBO (median) 500 MMBO (max)</td>
<td>Drill 1,000-2,500 ft</td>
<td>1,000-3,000 ft</td>
<td>1. Folded play</td>
<td>2. Presence of reservoir rock at suitable depth. 3. Thermally mature.</td>
</tr>
<tr>
<td>2</td>
<td>2808</td>
<td>Jurassic-Cretaceous sands, parallel developed nearly or horizontally</td>
<td>Bath</td>
<td>150 MMBO (min) 250 MMBO (median) 500 MMBO (max)</td>
<td>5 MMBO (min) 25 MMBO (median) 50 MMBO (max)</td>
<td>Drill 1,000-2,500 ft</td>
<td>1,000-3,000 ft</td>
<td>1. Folded play</td>
<td>2. Presence of reservoir rock at suitable depth. 3. Thermally mature.</td>
</tr>
<tr>
<td>3</td>
<td>2805</td>
<td>Mississippian / Devonian Carbonates, parallel developed nearly or horizontally</td>
<td>Bath</td>
<td>1 MMBO (min) 10 MMBO (median) 25 MMBO (max)</td>
<td>1 MMBO (min) 10 MMBO (median) 25 MMBO (max)</td>
<td>Drill 1,000-2,500 ft</td>
<td>1,000-3,000 ft</td>
<td>1. Folded play</td>
<td>2. Presence of reservoir rock at suitable depth. 3. Thermally mature.</td>
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</tbody>
</table>
Table BF-7.1. Play summary chart.

<table>
<thead>
<tr>
<th>Play Type</th>
<th>Oil or Gas Description</th>
<th>Field Size</th>
<th>No. of Undiscovered Fields</th>
<th>Play Probability</th>
<th>Drilling depths</th>
<th>Favorable factors</th>
<th>Unfavorable factors</th>
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<tbody>
<tr>
<td>Montana Disturbed Belt Imbricate Thrust Sheets</td>
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<tr>
<td>Fractured Bakken</td>
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<tr>
<td>Cambrian Sands</td>
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<tr>
<td>Shallow Biogenic Gas</td>
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</tr>
</tbody>
</table>

Table BF-7.1: Play summary chart.

Conventional play type

Unconventional/Hypothetical play type
Typical traps are folded Madison rocks, with enhanced fracture porosity. Source rock along the Sweetgrass Arch is thought to be the black, organic rich Bakken/Exchaw shale, or marine Lodgepole limestone. Source rocks on the Arch are considered mature, while those in the Montana disturbed belt are overmature. Typical traps are folded Madison rocks, with enhanced fracture porosity.

**General Characteristics**

- This play consists of folded or fractured Madison limestones or dolomites. Reservoir rock consists of either (1) sub-tidal carbonate beds with enhanced porosity zones due to dolomitization or (2) paleokarst porosity that developed during post-Mississippian erosion. Source rock along the Sweetgrass Arch is thought to be the black, organic rich Bakken/Exchaw shale, or marine Lodgepole limestone.

**ANALOG FIELDS**

<table>
<thead>
<tr>
<th>Field</th>
<th>Depression</th>
<th>Source Rocks</th>
<th>Production Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reagan Field*</td>
<td>(Sweetgrass Arch)</td>
<td>Bakken/Exchaw shale, marine Lodgepole limestone</td>
<td>9.3 MMBO, 15 MMcf, 54 wells</td>
</tr>
<tr>
<td>Blackfeet Field</td>
<td>(Sweetgrass Arch)</td>
<td>Bakken/Exchaw shale, marine Lodgepole limestone</td>
<td>1.6 MMBO, 3.0 MMcf, 8 wells oil, 7 wells gas</td>
</tr>
<tr>
<td>Gypay Basin</td>
<td></td>
<td></td>
<td>504,783 BO, 3.1 MMcf, 4 wells</td>
</tr>
<tr>
<td>Red Creek</td>
<td>(Sweetgrass Arch)</td>
<td></td>
<td>6.5 MMBO, 1.2 MMcf, 18 wells oil</td>
</tr>
</tbody>
</table>

**Cutbank Sandstone Structure**

- Datum is top of Cut Bank sandstone.
- Structure contour map of Blackfeet Field.

**Cross-section A-A’**

- Shows position of cross-section A-A’ in Figure BF-8.4.

**Type Log**

- Type log from the Blackfoot Field showing production from both Madison carbonates and from younger karst-related sandstone deposits.
Cut Bank Field Parameters

<table>
<thead>
<tr>
<th>Formation</th>
<th>Cretaceous Cut Bank Sandstone, Colorado Group sands (Moulton, Sunburst, Lander), Mississippian Madison</th>
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</thead>
<tbody>
<tr>
<td>Lithology</td>
<td>Cretaceous Cut Bank Sandstone, blanket sand which pinches out updip</td>
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<tr>
<td>Average Depth</td>
<td>3900 feet (+375)</td>
</tr>
<tr>
<td>Permeability</td>
<td>Moulton: 200 md, Sunburst: not known, Lander: 827 md, Cut Bank: -110 md, Madison: not known</td>
</tr>
<tr>
<td>Oil/Gas Column</td>
<td>52 foot oil column</td>
</tr>
<tr>
<td>Average Net Pay Thickness</td>
<td>68 foot gas column (original)</td>
</tr>
</tbody>
</table>

SW Cut Bank Field Parameters

<table>
<thead>
<tr>
<th>Formation</th>
<th>Cut Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithology</td>
<td>Cretaceous Cut Bank Sandstone, blanket sand which pinches out updip</td>
</tr>
<tr>
<td>Average Depth</td>
<td>3900 feet (+375)</td>
</tr>
<tr>
<td>Permeability</td>
<td>Cut Bank: 1 to 450 md</td>
</tr>
<tr>
<td>Oil/Gas Column</td>
<td>Information not available</td>
</tr>
<tr>
<td>Average Net Pay Thickness</td>
<td>27 feet</td>
</tr>
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</table>

General Characteristics - This play is the major producing interval on the Sweetgrass Arch. Stratigraphic in nature, typical traps are discontinuous fluvial sandstones in the Jurassic Sawtooth and Swift formations. Sandstones in the Cretaceous Kootenai and Blackleaf intervals are also productive.

Several traps are blanket sandstones that pinch out in an updip position along structural trends. Numerous smaller fields are probably present on the flanks of the Sweetgrass Arch and the Kevin-Sunburst Dome. Source rock is thought to be Cretaceous marine shales which are thermally mature across the region.

Analog Fields (*) denotes fields which lie within the Reservation boundaries:

- **Reagan Field** (Sweetgrass Arch) - Sunburst and Cut Bank Sands
- **Blackfoot Field** (Sweetgrass Arch) - Cut Bank Sandstone
- **Cut Bank** (Sweetgrass Arch) - Cut Bank sands (est 15% with boundary 167.3 MMB, 317 MMcf, 447 wells oil, 235 wells gas)
- **Kevin Sunburst** (Sunburst Dome) - Cumulative production (1985) 74.9 MMB, 79.5 MMcf (1963)
- **Niku** (well) - Madison (795 wells)
  - (well) (Sunburst)
- **Soberup Coulee** (Sweetgrass Arch) - 21,853 Mcf (abn’d)
- **Gypsy Basin** (Sweetgrass Arch) - Sunburst Sand

**Cut Bank Field**

**Generalized Ellis Structure**

**Diagrammatic Cross Section A-A’**

**CONTOUR INTERVAL = 50’**

**Blackfeet Reservation**

**Montana**

**Jurassic/Cretaceous Sandstone Play**

**PLAY TYPE 2**

**Jurassic/Cretaceous Sandstone Play**

- **General Characteristics**
  - This play is the major producing interval on the Sweetgrass Arch. Stratigraphic in nature, typical traps are discontinuous fluvial sandstones in the Jurassic Sawtooth and Swift formations. Sandstones in the Cretaceous Kootenai and Blackleaf intervals are also productive.
  - Several traps are blanket sandstones that pinch out in an updip position along structural trends. Numerous smaller fields are probably present on the flanks of the Sweetgrass Arch and the Kevin-Sunburst Dome. Source rock is thought to be Cretaceous marine shales which are thermally mature across the region.
  - Analog Fields (*) denotes fields which lie within the Reservation boundaries.

- **Reagan Field** (Sweetgrass Arch) - Sunburst and Cut Bank Sands
  - **Blackfoot Field** (Sweetgrass Arch) - Cut Bank Sandstone
  - **Cut Bank** (Sweetgrass Arch) - Cut Bank sands (est 15% with boundary 167.3 MMB, 317 MMcf, 447 wells oil, 235 wells gas)
  - **Kevin Sunburst** (Sunburst Dome) - Cumulative production (1985) 74.9 MMB, 79.5 MMcf (1963)
  - **Niku** (well) - Madison (795 wells)
    - (well) (Sunburst)
  - **Soberup Coulee** (Sweetgrass Arch) - 21,853 Mcf (abn’d)
  - **Gypsy Basin** (Sweetgrass Arch) - Sunburst Sand

**Cut Bank Field**

**Generalized Ellis Structure**

**Diagrammatic Cross Section A-A’**

**CONTOUR INTERVAL = 50’**

**Blackfeet Reservation**

**Montana**

**Jurassic/Cretaceous Sandstone Play**

- **General Characteristics**
  - This play is the major producing interval on the Sweetgrass Arch. Stratigraphic in nature, typical traps are discontinuous fluvial sandstones in the Jurassic Sawtooth and Swift formations. Sandstones in the Cretaceous Kootenai and Blackleaf intervals are also productive.
  - Several traps are blanket sandstones that pinch out in an updip position along structural trends. Numerous smaller fields are probably present on the flanks of the Sweetgrass Arch and the Kevin-Sunburst Dome. Source rock is thought to be Cretaceous marine shales which are thermally mature across the region.
  - Analog Fields (*) denotes fields which lie within the Reservation boundaries.

- **Reagan Field** (Sweetgrass Arch) - Sunburst and Cut Bank Sands
  - **Blackfoot Field** (Sweetgrass Arch) - Cut Bank Sandstone
  - **Cut Bank** (Sweetgrass Arch) - Cut Bank sands (est 15% with boundary 167.3 MMB, 317 MMcf, 447 wells oil, 235 wells gas)
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  - **Niku** (well) - Madison (795 wells)
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  - **Soberup Coulee** (Sweetgrass Arch) - 21,853 Mcf (abn’d)
  - **Gypsy Basin** (Sweetgrass Arch) - Sunburst Sand

**Cut Bank Field**

**Generalized Ellis Structure**

**Diagrammatic Cross Section A-A’**

**CONTOUR INTERVAL = 50’**

**Blackfeet Reservation**

**Montana**

**Jurassic/Cretaceous Sandstone Play**

- **General Characteristics**
  - This play is the major producing interval on the Sweetgrass Arch. Stratigraphic in nature, typical traps are discontinuous fluvial sandstones in the Jurassic Sawtooth and Swift formations. Sandstones in the Cretaceous Kootenai and Blackleaf intervals are also productive.
  - Several traps are blanket sandstones that pinch out in an updip position along structural trends. Numerous smaller fields are probably present on the flanks of the Sweetgrass Arch and the Kevin-Sunburst Dome. Source rock is thought to be Cretaceous marine shales which are thermally mature across the region.
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  - **Niku** (well) - Madison (795 wells)
    - (well) (Sunburst)
  - **Soberup Coulee** (Sweetgrass Arch) - 21,853 Mcf (abn’d)
  - **Gypsy Basin** (Sweetgrass Arch) - Sunburst Sand
PLAY TYPE 3
Devonian / Mississippian Carbonate Play

General Characteristics - Very little Devonian production has been found to date. Probably found on structures, and numerous shows have been recorded on deep tests at Kevin-Sunburst Gypsy Basin and Highview Fields. A Mississippian play on the Madison unconformity surface is also a distinct possibility. Corresponds to the same United States Geological Survey play classification.

Analog Fields (*) denotes fields within Reservation

Gypsy Basin (Sweetgrass Arch) 504,783 BO, 3.1 MMcf, 4 wells
Contains 7 Devonian Nisku producers
Kevin-Sunburst (
Contains 1 Devonian Nisku producer
Pondera Field (Sweetgrass Arch), 1984 22.5 MMBO, 224,702 Mcf, 361 wells

Pondera Field Parameters
Formation: Mississippian Sun River
Lithology: Light gray to buff, finely crystalline dolomite, 140 ft. thick
Average Net Pay Thickness: 10 feet
Other shows: Bow Island Sand, Sunburst
Average Depth: 1950 feet (+1820 msl)
Porosity: 14%
Permeability: 82 md
Oil/Gas Column: 70 to 100 foot oil column

This field is a pre-Jurassic truncation of folded Mississippian rocks, and part of a Laramide structural terrace.

Kevin-Sunburst Field Parameters
Formation: Mississippian Madison
Lithology: Dolomitic limestone, varies from dense, to coarse crystalline to intragranular to vuggy to fracture porosity. Secondary porosity also is important locally
Average Net Pay Thickness: 10 feet porosity
Other shows: Bow Island Sand, Burwash, Sunburst, Swift, Reirdon, Sawtooth, Madison, Nisku, Duperow
Average Depth: 1500 feet (+2000 msl)
Porosity: 20%
Permeability: variable
Oil/Gas Column: from 1400 to 2150 feet in the Madison

This field has numerous pay zones with both a structural and stratigraphic influence. While the Kevin Sunburst Dome does not exist on the reservation, the local variations in reservoir rock make smaller structural and stratigraphic traps likely possible.
General Characteristics
- Imbricate, or angled thrust sheets and corresponding anticlines between the Lewis Thrust Sheet, and the eastern edge of the Disturbed belt summarize this play. Only three known fields exist in this province: the East Glacier and Two Medicine complex and Blackleaf Complex.
- Potential reservoir rock is dolomitized Mississippian limestone between 200 and 500 feet thick. Permeability is low which may explain the small accumulation found. Lower Mississippian and Devonian rocks may have fractured reservoirs; Jurassic and Cretaceous sandstones may produce.
- Source rock is thought to be either (1) the Flood member of the Cretaceous Blackleaf formation (43 - 168 feet thick) with 1.1% total organic carbon (TOC); (2) shale member of the Jurassic Swift formation (6 - 32 feet thick) with 1.1% TOC; or (3) Devonian Bakken/Exshaw organic rich shale (10 - 40 feet thick) averaging 0.97% TOC.
- Depths to potential reservoirs vary from 19,000 feet on the western side to less than 3000 feet on the eastern side. Carbon dioxide gas has been found in the equivalent rocks in Canada. Some carbon dioxide has been found in smaller structures in the Disturbed Belt.

Analog Fields (*denotes field inside Reservation boundaries)

<table>
<thead>
<tr>
<th>Field</th>
<th>Well</th>
<th>Gross BO</th>
<th>NGL BO</th>
<th>Water BO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackleaf</td>
<td>2-5 Blackleaf Unit</td>
<td>275,000</td>
<td>275,000</td>
<td></td>
</tr>
<tr>
<td>Blackleaf</td>
<td>1-5 Blackleaf Unit</td>
<td>100</td>
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<tr>
<td>Blackleaf</td>
<td>1-8 Blackleaf Fed</td>
<td>11,510</td>
<td>11,510</td>
<td></td>
</tr>
<tr>
<td>Blackleaf</td>
<td>#1 Volcano Reef</td>
<td>6900-7155</td>
<td>6900-7155</td>
<td></td>
</tr>
<tr>
<td>Blackleaf</td>
<td>LEWIS AND CLARK NATIONAL FOREST</td>
<td>1985</td>
<td>1985</td>
<td>1985</td>
</tr>
</tbody>
</table>

**Figure BF-11.2.** Two Medicine Field (after James W. Garner, Montana Geological Society, 1985).
Fractured Bakken Shale Play

General Characteristics - The Devonian Bakken, one of the probable source rocks for the Madison, is an organic rich marine shale, regionally equivalent to the Alberta Shale, Exchaw shale. The Bakken is considered to be thermally mature across the Sweetgrass Arch, and varies from less than 10 feet thick to over 75 feet thick in the northern portion of the Blackfeet Reservation. Depths vary from 1500 to 6000 feet deep. Fractures would occur along hinge lines in the basin or on the crests of structures.

Cambrian Sandstone Play

General Characteristics - Cambrian sandstones are more than 2000 feet thick in the Disturbed belt part of the Reservation. Reservoir rocks are quartz and lithic sandstones from the Flathead formation. Depth to Cambrian is between 3000 and 8000 feet. Source rock is thought to be dark gray marine shales in the Cambrian Gordon formation. No information is available on source rock organic content or thermal maturity. Traps could be structural closures or pinch-outs.

Biogenic (Low, Medium, High Potential) Gas Play

General Characteristics - Shallow biogenic (methane rich) gas produces at Bowdoin Dome and Cedar Creek Anticline from the Cretaceous Eagle and Judith River sandstones. Traps are stratigraphic and consist of coarse clastic sands grading to fine sands and silts. Methane is generated soon after burial and is preferentially trapped in the coarse facies. The reservoirs are shallow and tight and look poor on well logs. A pay section may not yield gas shows when drilled. “Sweet spots” on structural highs (with paleothinning) probably localized better reservoirs. This potential for traps in fine grained reservoir rocks also exists.
**BLACKFEET RESERVATION**

**General References**


**REFERENCES**


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Blackfeet - Map References

Executive Reference Map 334, 1985 edition, Extended Area, Northern Rocky Mountains, Geomap Company.


Indian Land Areas, 1992, United States Department of the Interior-Bureau of Indian Affairs.
