OVERVIEW

BLACKFEET INDIAN RESERVATION

Blackfeet Nation

Tribal Headquarters: Browning, Montana
Geologic Setting: Southern Alberta Basin

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GENERAL SETTING

The Blackfeet Reservation is located in northwestern 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. The Badger Two Medicine portion of the Lewis and Clark National Forest borders on the southwest. Other natural boundaries include Birch Creek to the southeast and Cut Bank Creek to the east. Elevations vary from a low of 3400' in the southeast to a high of over 9000' at Chief Mountain in the northwest.

Major railroads and highways serving the reservation include the Burlington Northern Railroad's main east/west line. This is paralleled by U.S. Highway #2, which is bisected by U.S. Highway #89 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 are 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 program also assists the Tribe in the evaluation of new leasing, operating and joint venture agreements. New leases, other mineral exploration, and development agreements are designed in accordance with the 1982 Indian Mineral Development Act, and the rules and regulations contained in 25 CFR. Companies are welcome to negotiate with the Blackfeet Tribal Business Council for any type of lease or joint venture agreement which will satisfy both parties.

SEISMIC DATA

Seismic data from past seismic surveys are available from several seismic brokerage firms. The Tribe has purchased seismic data for some portions of the reservation and is in the process of reprocessing the data. Information on conducting new seismic operations can be obtained from the BIA or the Blackfeet Tribe.

Most of the leases and other types of agreements currently in effect on the reservation are in areas now under production. This leaves a large portion of the reservation's minerals available for leasing.

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 present day Sherburne Lake near Many Glaciers Lodge (Douma, 1953). 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 eastern edge of the reservation, along the west flank of the Sweetgrass Arch, random drilling led to the discovery of gas in 1926 and of oil in 1929 (Chickering, 1958; Del Monte, 1958). By 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 265,345,162 barrels of oil through September 2018 (IHS production data, 2018), with annual production at the time exceeding 211,000 barrels of oil, and nearly 465 million cubic feet of gas. Approximately 25 percent of the Cut Bank Field area lies within the reservation borders. When production began to decline in the mid 1940's due to pressure decline of the solution gas drive (Chickering, 1958), secondary recovery operations were initiated. The secondary recovery methods used were chiefly waterfloods, which resulted in an increase of production by the early 1950's. The Montana Oil and Gas Annual Review for 1992 lists 11 secondary recovery projects in the Cut Bank Field. All of these are listed as waterfloods, with six of them listed as being idle. Oil and/or gas production is found in the following formations within the Cut Bank field area: Blackleaf, Bow Island, Dakota, Kootenai (Moulton, Lander, Sunburst, and Cut Bank sands), Ellis and the Madison Group. So far, secondary recovery operations have been limited to the Cut Bank sands, Lander sand and the Madison Formation.

Other oil and/or gas fields on or near the reservation include Big Rock, Blackfoot Shallow Gas, Bradley, Little Rock, Blackfoot, East Glacier, Landslide Butte, and Reagan. Inactive or abandoned fields include Two Medicine Creek, and Blackfoot East. Cumulative production from these fields through 2018 is 13,413,431 barrels of oil (Montana Oil and Gas Conservation Division, 2019 Annual Review). Two of these fields, Blackfoot and Reagan, have active secondary waterfloods. Annual gas production plus associated gas produced from these fields in 2019 was approximately 176 MMCF. Annual oil production for this time period was 61 MBO.
Since 1999, 142 wells were drilled on tribal lands resulting in 37 new oil wells and 8 gas wells. More recent drilling activity involves the use of horizontally drilled wells (14) targeting the Devonian Bakken Shale. The use of lateral drilling technology in conjunction with secondary recovery methods should result in a higher percentage of the original oil in place being recovered.

GEOLOGY

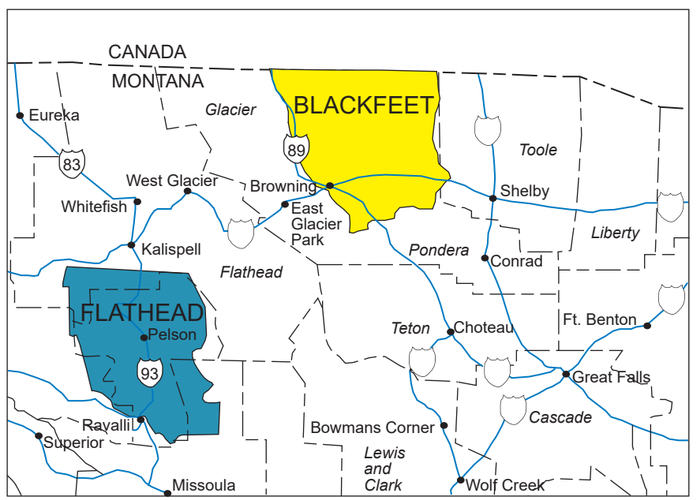
The Blackfeet Indian Reservation occupies a portion of the southern Alberta Basin. Tectonically, the area can be divided into three provinces: the Disturbed/Overthrust Belt on the west, the Foreland Basin in the central portion, and the Sweetgrass Arch on the east. The stratigraphy of the reservation 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. Of these three provinces, only the Sweetgrass Arch has received more than a very limited amount of exploration.

The Disturbed/Overthrust Belt is a zone of north-south trending, 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 older 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. Prolific thrust belt production has also been established in Wyoming and Utah. 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 Blackleaf Canyon Field (Figure BF-2.1). Other potential reservoirs would include the sands of the Cretaceous and the carbonates of the Devonian.

The Foreland Basin is represented by a relatively undeformed wedge of Mesozoic and Paleozoic rocks that vary in thickness from approximately 5,000' 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 is slowly evolving into consideration for 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 sediments that are productive to the north in the Alberta Basin. 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 limited to less than 20 wells.

The Sweetgrass Arch portion of the reservation contains most of the existing production. This production occurs in the clastic sediments of the Cretaceous and Jurassic sections, and in the carbonates of the Mississippian.

In contrast to the structurally complex Disturbed/Overthrust Belt, the eastern part of the reservation is controlled by the structurally uncomplicated 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. Reagan Field is developed on one of these localized structural irregularities. Even in this highly productive area of the Sweetgrass Arch, the full potential of the geologic section has not been adequately tested.



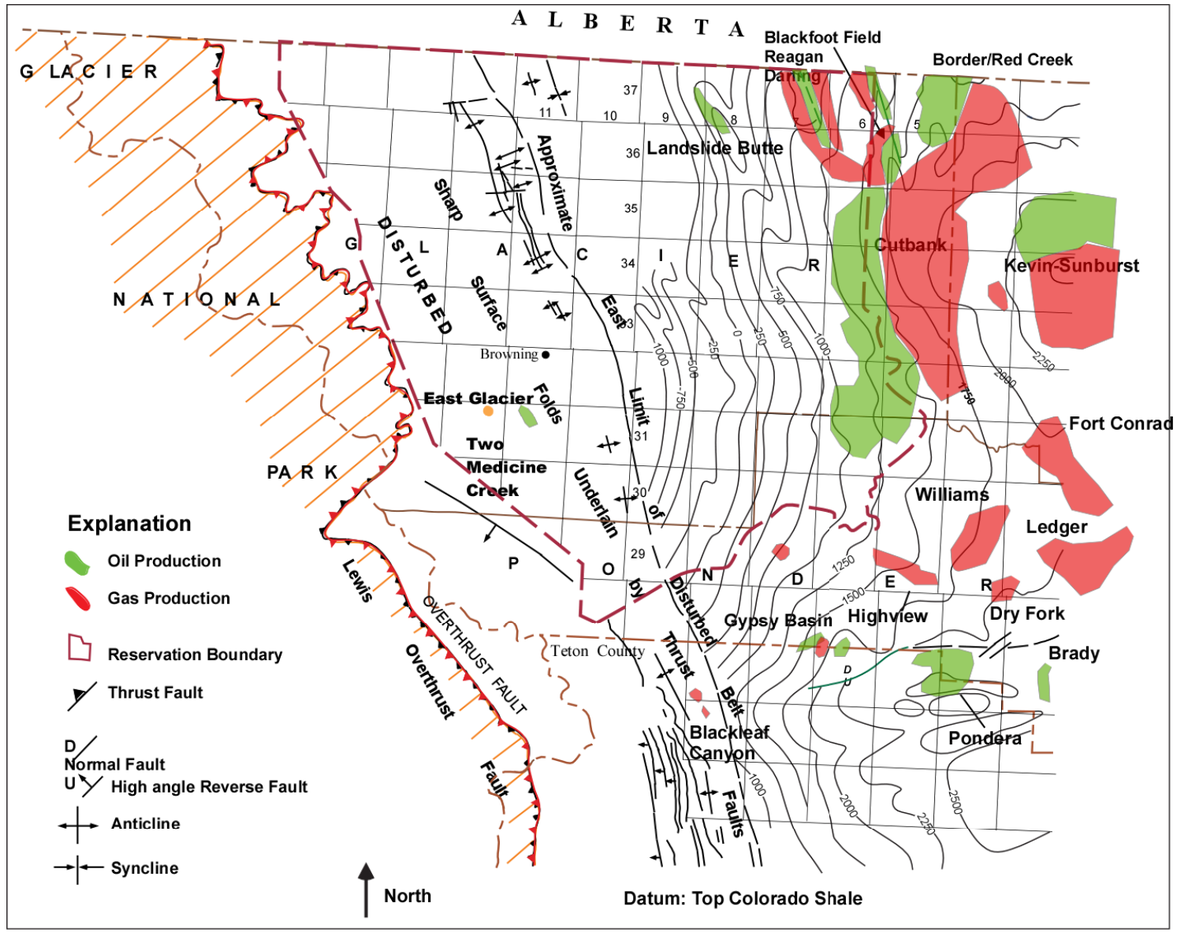


FIGURE BF-2.1. General structure map of reservation and surrounding region.

GENERAL PRODUCTION INFORMATION

U.S.G.S Geologic Province:	North Central Montana
Tectonic Province:	Sweetgrass Arch, Foreland Basin, Montana Disturbed Belt
Overall Production:	571 MMBO and 1.22 TCFG from IHS Production
No. of Fields:	120 discovered fields 60 greater than 1 MMBO or 6 BCFG

Fields Within Reservation Boundaries - (2019 Cumulative Production)

1941 Reagan	11.1 MMBO, 4.2 Bcf, 123 wells
1955 Two Medicine	10.3 MBO, 274 Mcf, 5 wells
1926, 1929 Cutbank	174.2 MMBO, 66.7 Bcf, >3000 oil & gas wells (est. 37% within boundary) 1200 wells
1966, Landslide Butte	980 MBO, 972 MMcf 34 wells

NEARBY FIELDS

1956 Blackfoot - 1.87 MMBO, 1.5 Bcf, 42 wells
1958 Graben Coulee - 2.78 MMBO, 131 wells
1958 Red Creek - 7.5 MMBO, 164 MMcf, 84 wells
1954 Darling - 70 MBO (Abn'd)
1929 Border - 1.52 MMBO, 134 MMcf, 67 wells
1954 Gypsy Basin - 525 MBO, 83 MMcf, 70 wells
1976 Highview - 153 MBO, 33 wells
1958, 1980 Blackleaf Canyon- 33, MBO, 1.05 Bcf, 5 wells (Abn'd)
1979, Fort Conrad - 767Mcf, 21 wells
1943, Brady - 307 MBO, 43 wells
1961 Dry Fork - 536 MMcf, 21 wells
1927 Pondera - 30.5 MMBO, 800 wells

PLAY TYPES ENCOUNTERED

Conventional

1) Fractured/Folded Anticline Mississippian Carbonate Play (2807)
2) Jurassic-Cretaceous Sandstone Play (2808)
3) Mississippian/Devonian Carbonate Play (2805)
4) Montana Disturbed Belt-Imbricate Thrust Play (2701)
5) Fractured Bakken (2804)

Unconventional or Hypothetical

6) Cambrian Sands (2802)
7) Shallow Biogenic Gas (2810, 2811, 2812)

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 (Figure BF- 2.1). The first 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 fields in the Rocky Mountains. Thirty seven percent of this "giant" field is within the reservation boundaries.

Exploration during the late 1920's led to discoveries in the Mississippian Madison with Pondera Field. Other exploration throughout the 1930's and 40's led to additional discoveries in both the Cretaceous and Madison. 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 fields. In 1980, Williams Exploration and Milestone Petroleum tested the "A" Thrust Sheet at Blackleaf Canyon and discovered gas with rates as high as 5.1 MMcfd. Since 1999, an additional 4 MMBO and 38.5 BCF have been produced s a result of new drilling and in some instances, new field discoveries. Additional exploration has involved Denvonian Bakken/Three Forks horizontal drilling within the reservation to limited success (Figure BF - 2.2).

PRODUCING HORIZON LEGEND

= Gas = Oil S = Source Rock

ERA	SYSTEM	SERIES	COLOR CODE	WILLISTON BASIN	POWDER RIVER BASIN	WESTERN WYOMING SOUTHERN MONTANA	WESTERN & NORTHERN MONTANA
CENOZOIC	TERTIARY			Fort Union	White River Wasatch Fort Union	Green River Wind River Wasatch Fort Union	Fort Union
MESOZOIC	CRETACEOUS	UPPER		Fox Hills Judith River Eagle Niobrara Greenhorn	Lance Teckla Mesaverde Teapot Parkman Sussex Shannon Niobrara Frontier	Lance Fox Hills Mesaverde Cody Shannon Niobrara Frontier	Hell Creek Judith River Clagget Eagle Telegraph Creek Niobrara Greenhorn Frontier (S)
		LOWER		Dakota Group	Mowry Muddy Dakota Fall River Lakota	Mowry Muddy Bear River Dakota Cloverly	Blackleaf Bow Island Kootenai Cat Creek Moulton Sunburst Cut Bank (S)
	JURASSIC			Morrison Ellis Group Swift Reirdon Piper Nesson	Morrison Sundance Canyon Springs Gypsum Spring	Gannet Morrison Sundance Stump-Preuss Twin Creek	Morrison Ellis Group Swift Reirdon Sawtooth
	TRIASSIC			Spearfish	Chugwater Spearfish	Nugget Chugwater Ankareh Thaynes Woodside	
PALEOZOIC	PERMIAN			Minnekahta Opeche	Goose Egg	Dinwoody Phosphoria Park City	
	PENNSYLVANIAN			Minnelusa Amsden Tyler	Minnelusa	Weber Tensleep Amsden Darwin	Amsden Tyler
	MISSISSIPPIAN			Big Snowy Group Heath Otter Kibbey Madison Group Charles Mission Canyon Lodgepole	Madison Englewood	Madison Mission Canyon Lodgepole	Big Snowy Group Heath Otter Kibbey Madison Group Sun River Charles Mission Canyon Lodgepole (S)
	DEVONIAN			Bakken Three Forks Nisku Duperow Souris River Dawson Bay Winnipegosis	Jefferson	Jefferson Darby	Three Forks Nisku Duperow Souris River (S)
	SILURIAN			Interlake	Interlake		
	ORDOVICIAN			Stonewall Stony Mountain Red River	Big Horn Winnipeg	Big Horn	Red River
	CAMBRIAN			Winnipeg Deadwood	Deadwood	Gallatin Gros Ventre Flathead	Emerson Flathead

FIGURE BF-2.2. Producing Horizon Legend (modified after Geomap Executive Reference Map, 1983).

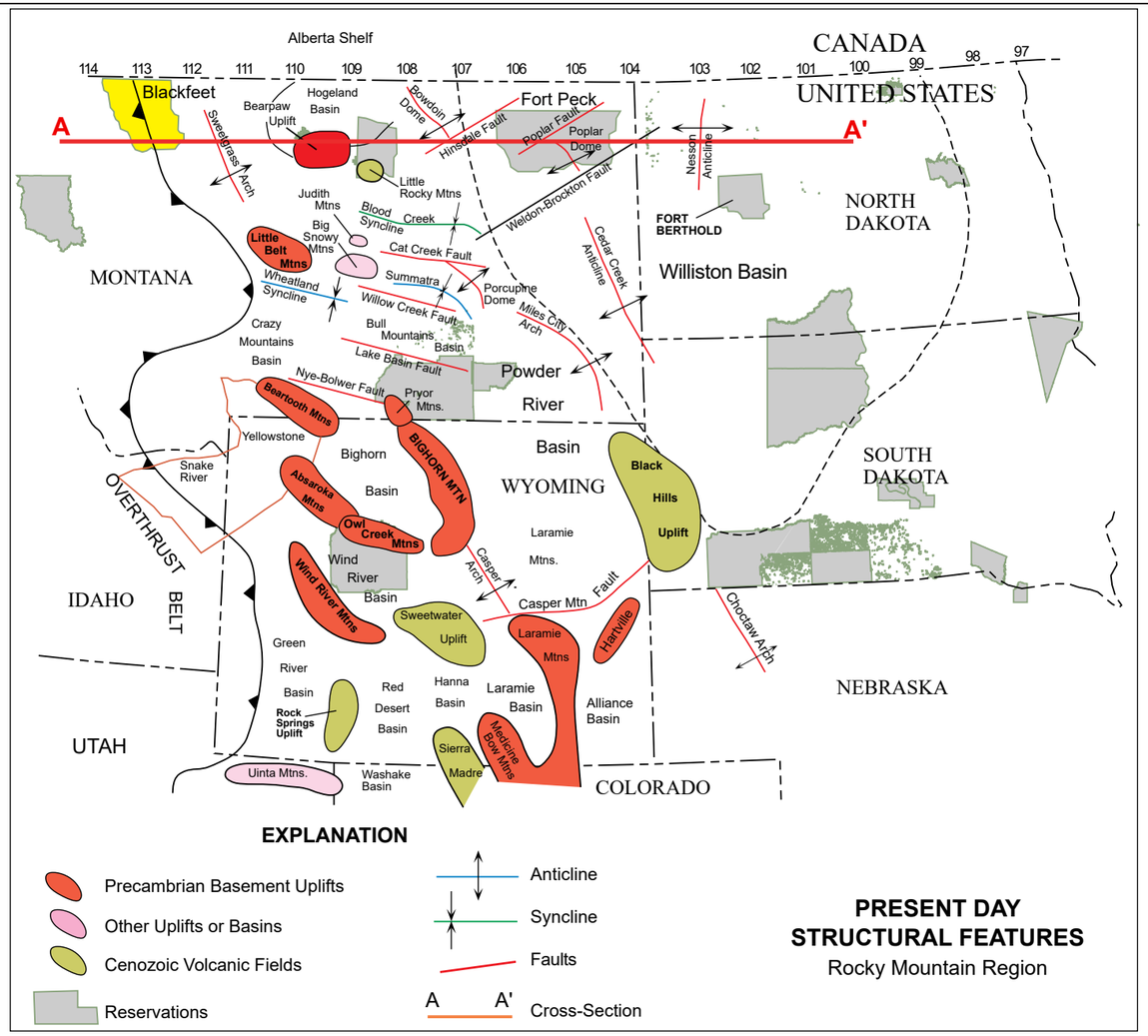


FIGURE BF-3.1. Present day structural uplifts and basins, Blackfeet Indian Reservation and location of regional cross-section A-A' (modified after Peterson, 1987).

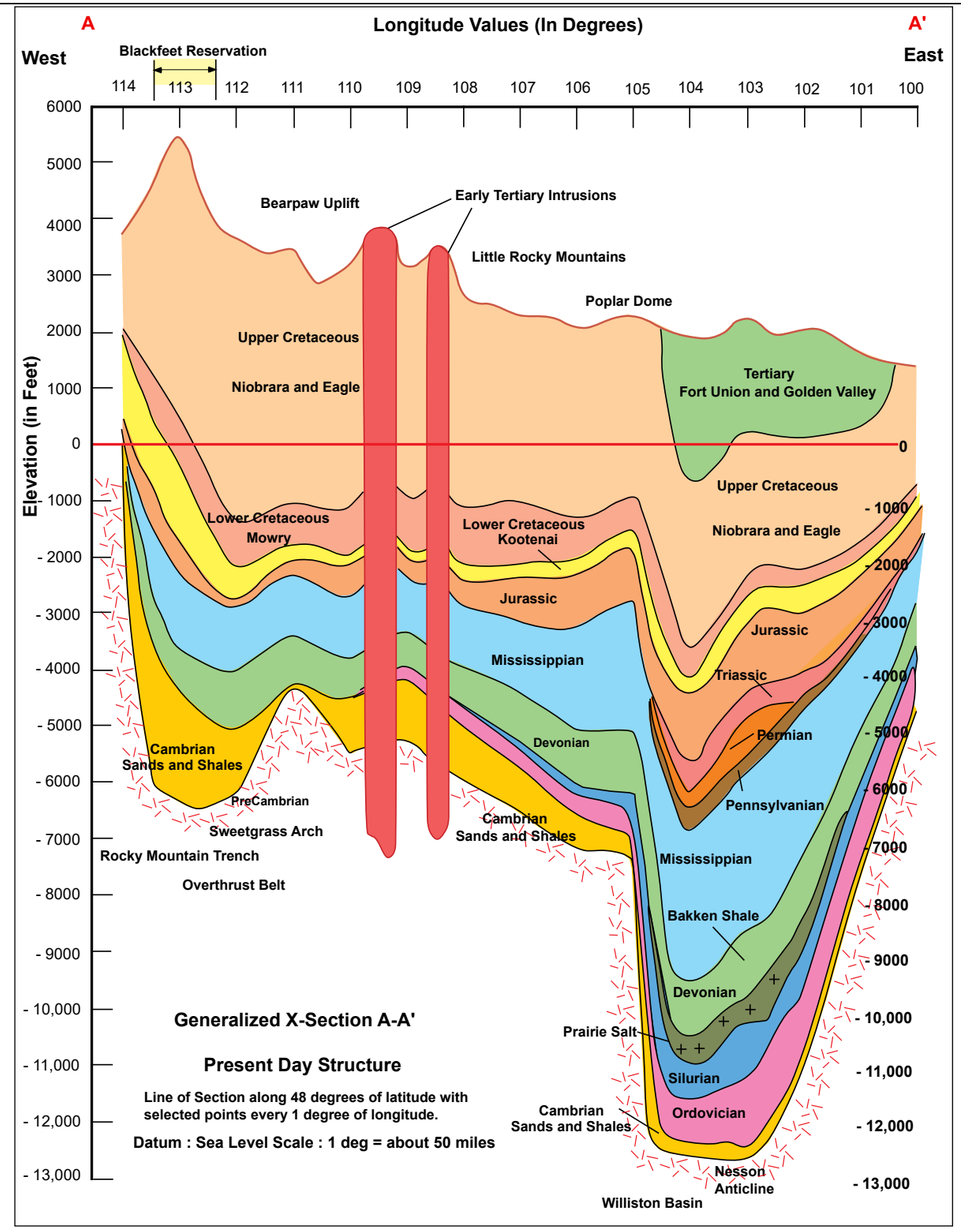


FIGURE BF-3.2. Generalized cross-section A-A', present day structure.

REGIONAL GEOLOGY

The Blackfeet Reservation lies within three distinct geologic provinces, the Montana Disturbed Belt to the west, the Foreland Basin in the center, and the Sweetgrass Arch to the east (see tectonic map and structure cross-section A-A') (Figure BF - 3.1). The Mesozoic section, composed of Cretaceous and Jurassic rocks is predominantly sand and shale. The Paleozoic section is composed of Mississippian and Devonian aged carbonates and Cambrian aged coarse-grained clastics.

Proven hydrocarbon production (see correlation chart and type log), is mainly from the Lower Cretaceous Blackleaf and Kootenai sandstones, although some production is from the Upper Cretaceous Greenhorn. Oil and gas is also produced from the Jurassic Swift and Sawtooth sands. Paleozoic production is from the Madison Sun River Dolomite and the Devonian Nisku.

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 north 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 topographic 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 contains more than 15,000 feet of sediments. The Fort Berthold Reservation is located near the depocenter and is within close proximity to the 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 the Poplar Dome, a Laramide age structure, while Fort Belknap is between Bowdoin Dome and the 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.

CAMBRIAN GEOLOGIC HISTORY

Precambrian age supracrustal sedimentary rocks (Superbelt) are present in the subsurface 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). 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 Sioux 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 areas 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 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.

ORDOVICIAN TO TRIASSIC ROCKS

From late Cambrian through most of the Paleozoic, the Williston Basin located on the east side of cross-section A-A', Figure BF-4.2.

The Williston is a major, stable, cratonic basin, and is characterized by shallow, marine sediments. Ordovician and Silurian rocks were deposited in a tidal flat, cyclic carbonate and evaporite sequence. At the end of Silurian time, a regional unconformity extended across the Williston and to the west. Consequently, there are no Ordovician or Silurian rocks within the reservation boundaries.

Devonian rocks are widespread across the area. The Devonian is characterized by cyclic evaporite and carbonate units including the Prairie Salt sequence in the Williston. The Prairie's western edge was dissolved away during late Devonian time, and caused the formation of several hydrocarbon traps. Deposition of marine shales and limestones continued throughout Devonian time, culminating with the Bakken Shale. The Bakken, and its Alberta equivalent, the Exshaw, is a black, organic-rich shale, which is thought to be the main source rock for the Madison oil throughout the region. Devonian rocks including the Bakken are about 700 feet thick at the reservation. The Bakken/Exshaw varies from 10 feet thick to more than 50 feet thick in this area (Figure BF-5.1).

By Mississippian time, the Williston Basin to the west was continually a site for deposition of limestones and evaporites in a shallow, marine shelf environment. Most of the producing reservoirs in the Williston Basin area are from these cyclic marine shales, limestone/dolomite porosity zones and evaporite seal sequences. Eventually, the Charles Salts would cover the entire basin and part of eastern and central Montana. By late Mississippian time, deposition was mainly shales and mudstones confined to the central Williston and the Big Snowy trough in Central Montana.

A smaller depocenter of Mississippian rocks existed west of the Sweetgrass Arch and Bearpaw uplift each of which were positive features in Mississippian time. Total thickness of Mississippian rocks within reservation boundaries is about 1500 feet.

A major unconformity at the end of Mississippian time led to widespread erosion and karstification. Pennsylvanian sediments are confined to the center of the Williston and in central Montana south of the reservation. Tyler sands and shales are present in the Williston. No Pennsylvanian rocks occur west of longitude 106 degrees along the line of section.

Permian deposits are confined to the central Williston and are predominantly sand/shale and evaporite sequences. A major unconformity at the end of Permian time has removed any evidence of these rocks west of longitude 104 degrees. Triassic rocks are confined to the center of the Williston and are not present on the Blackfeet Reservation.

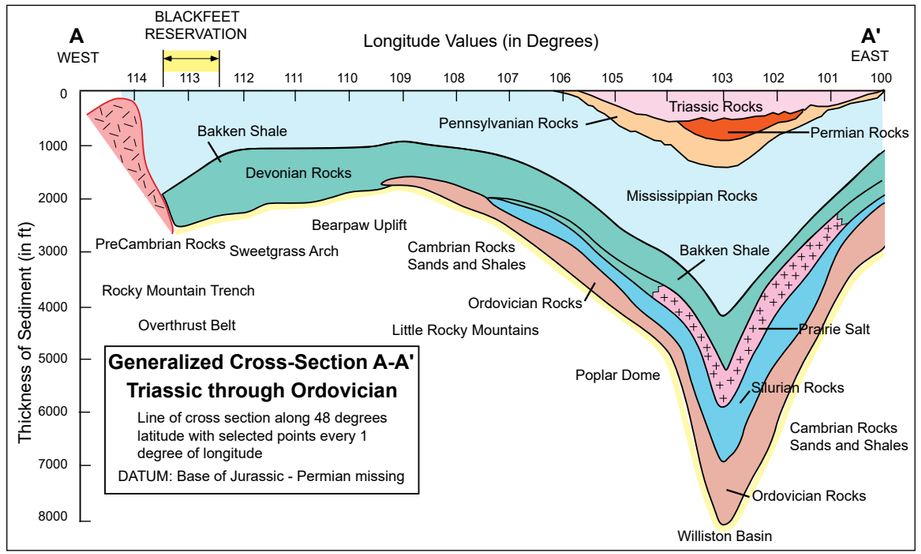


FIGURE BF-4.2. Generalized time-slice cross-section A-A'. Triassic through Ordovician. Line of section along 48 degrees latitude with selected points every 1 degree of longitude. Datum is the base of Jurassic, Permian missing (modified after O'Melveny, 1997).

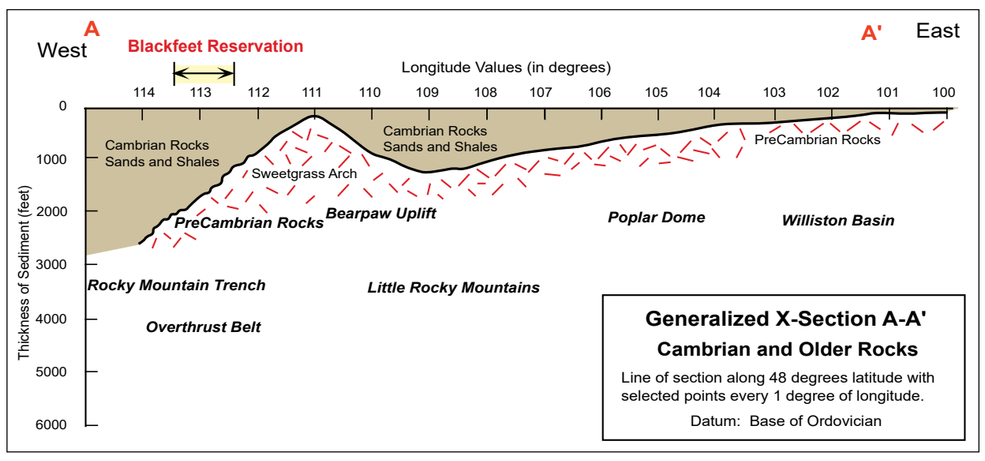


FIGURE BF-4.1. Generalized time slice cross-section of Cambrian paleo-topography along line of section A-A'.

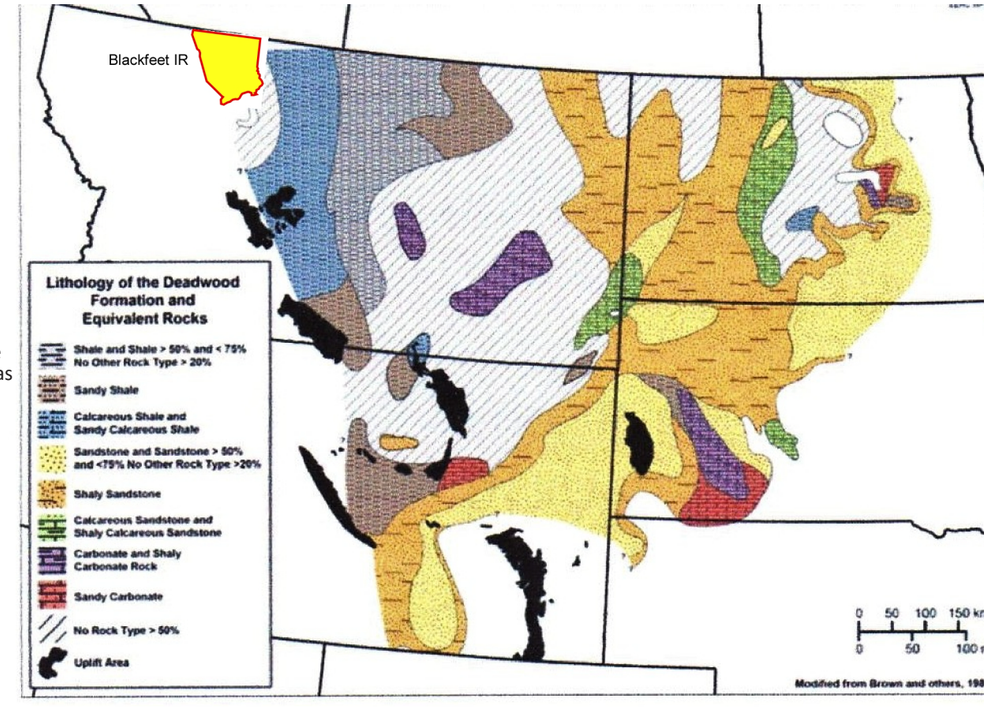


FIGURE BF-4.3. Lithology (facies) distribution map of the Deadwood Formation as interpreted by Brown and others (1984).

JURASSIC TO CRETACEOUS ROCKS

In Jurassic time, the Williston was still the major depocenter for clastic and marine/evaporite sediments. The western portion of the map shows that the Jurassic was fairly thin, implying that the Sweetgrass Arch and Bearpaw Uplift were still positive features. Fluvial sands from the eroding highlands filled paleovalleys cut into the exposed Mississippian rocks. The thickness of Jurassic rocks is estimated to be about 500 feet thick.

Early Cretaceous time saw the development of the Thrust sheets in western Utah and eastern Idaho. The Sevier Orogenic event created a major mountain front which formed an asymmetrical basin with the long axis at the present Idaho-Montana border. Sediments from the western highlands were continually deposited at the foot of the mountain front. Deposits were mainly composed of Mississippian and older rocks, with some Cretaceous aged volcanic rocks. This material was carried by rivers and deposited eastward into the Cretaceous seaway (Lower Cretaceous, Kootenai formation) (Figure BF - 5.2). Deposition continued, becoming more marine (Mowry Shale, Blackleaf Sandstone) (Figure BF - 5.3).

By Upper Cretaceous time, volcanic activity increased. Fluvial deposits continued to carry sediments to the eastern inland seaway. This seaway covered most of eastern Montana, and the great plains from Texas to the Arctic Circle. Extensive chalk (Niobrara Formation) was deposited in the Williston and southeast into South Dakota, Nebraska and Colorado.

By the end of the Upper Cretaceous, mountain building began in western Montana with increasing volcanic activity and thrust faulting. Fluvial deposition increased due to uplift and erosion and resulted in the deposition of nearshore and continental sands (Eagle/Judith River/Foxhills) (Figure BF - 5.2). Cretaceous units are abundant on the reservation. Estimated thickness of Cretaceous rocks is greater than 7200 feet.

TERTIARY AND YOUNGER

Tertiary time saw the erosion of older Cretaceous rocks and subsequent fluvial deposition. Swamps existed in Paleocene and Eocene time in the central Williston Basin, which formed coal deposits at the end of the Eocene. Western Montana apparently had no Tertiary deposition while central and eastern Montana had deposition of some continental sediments.

Quaternary time was a period of major continental ice sheets extending into North Dakota and Montana. Alpine glaciers existed in Montana's western mountains. Extensive glacial lakes were present along the ancestral Missouri River and its tributaries.

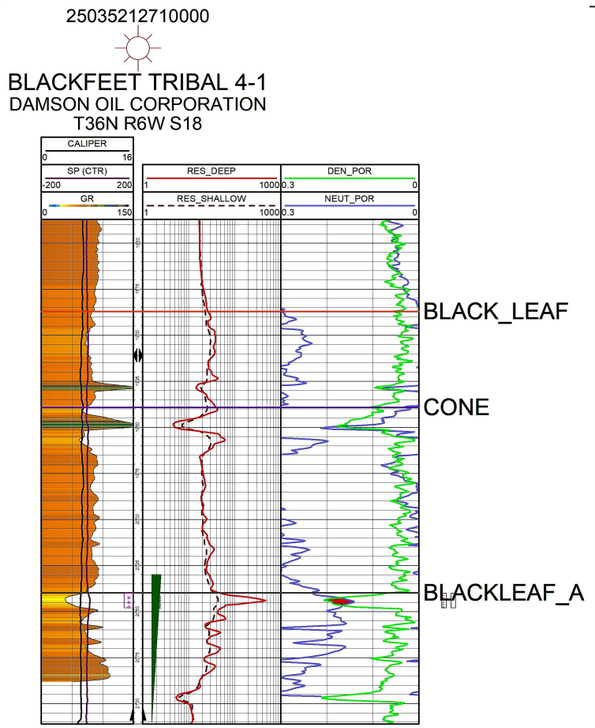


FIGURE BF-5.2. Log example of Cretaceous "Bow Island" production.

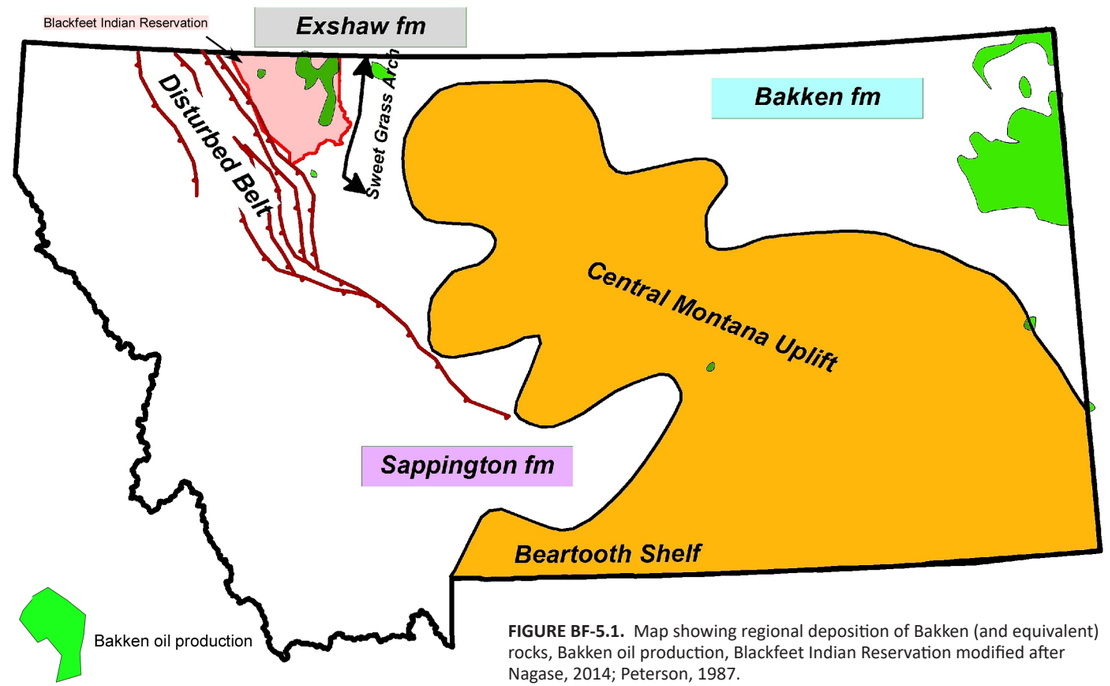


FIGURE BF-5.1. Map showing regional deposition of Bakken (and equivalent) rocks, Bakken oil production, Blackfeet Indian Reservation modified after Nagase, 2014; Peterson, 1987.

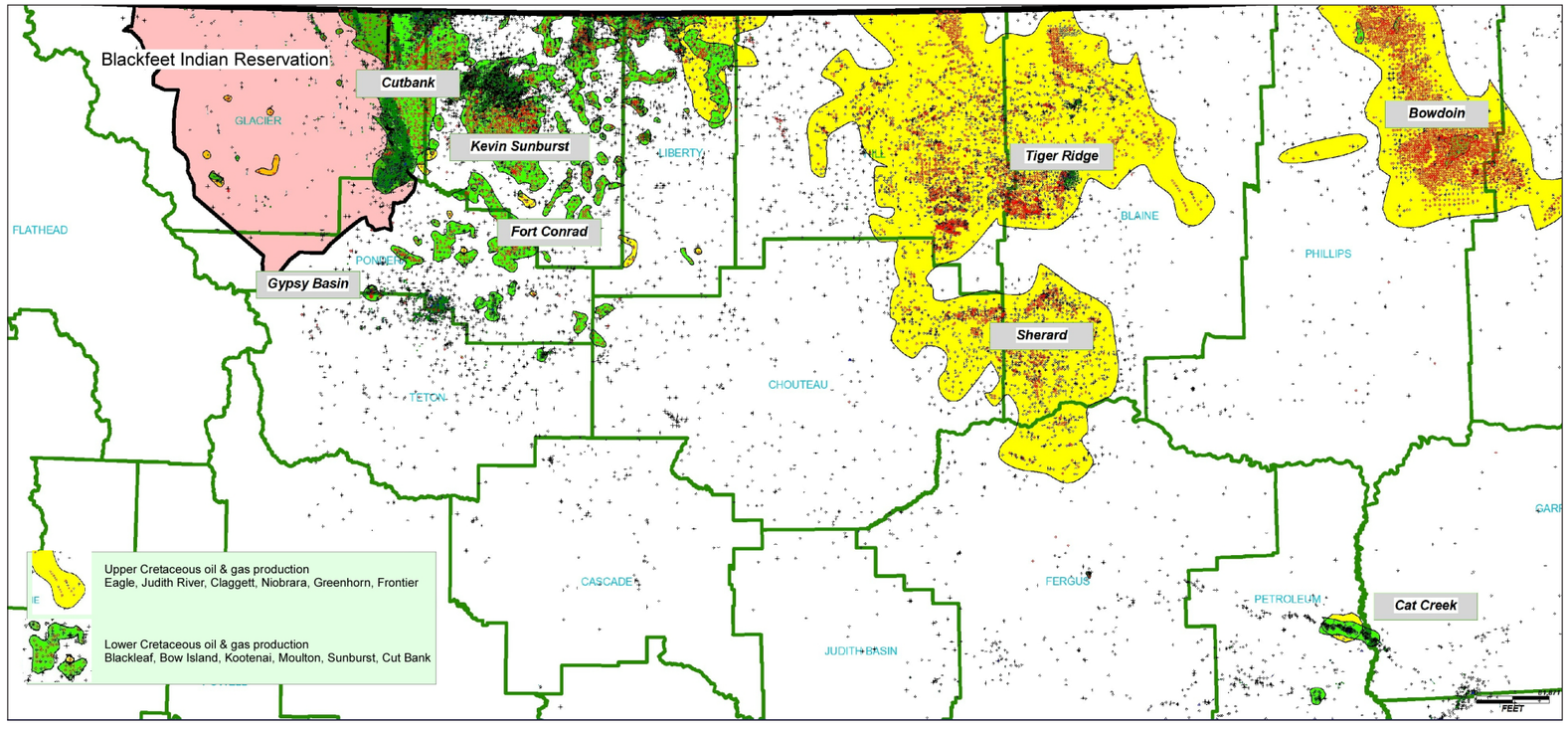


FIGURE BF-5.3. Oil and gas fields producing from Cretaceous sandstones adjacent to Blackfeet Indian Reservation.

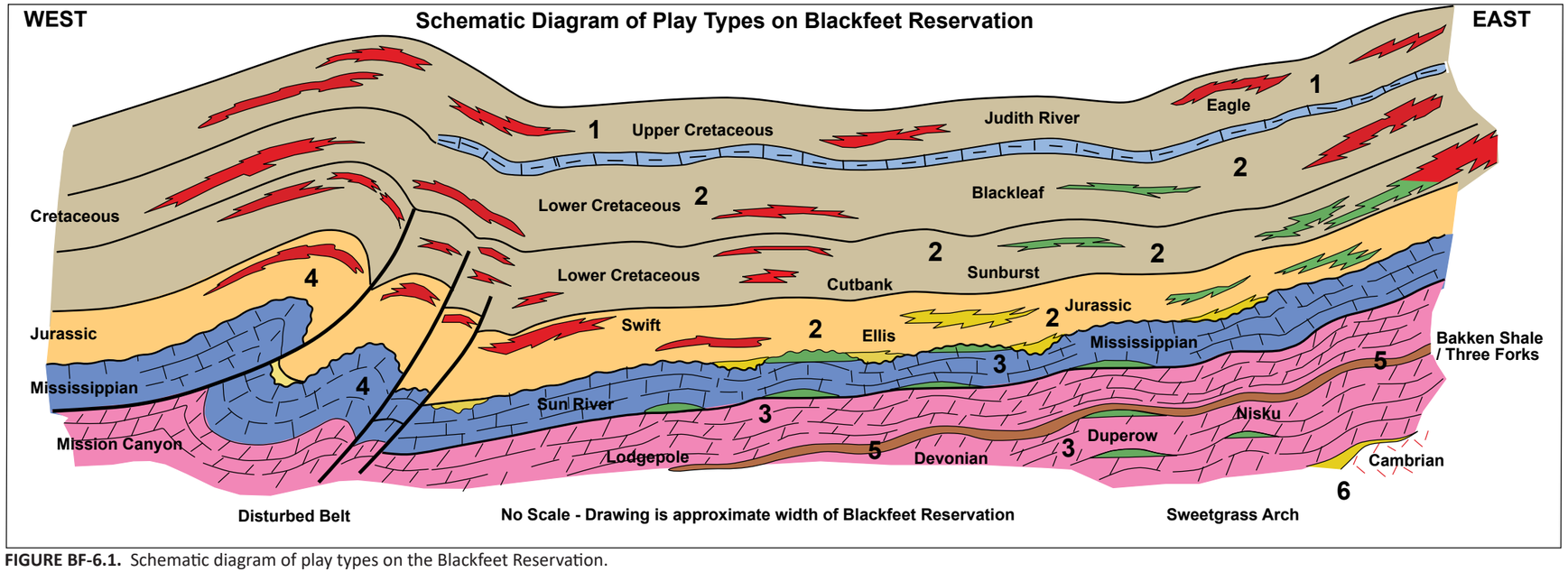


FIGURE BF-6.1. Schematic diagram of play types on the Blackfeet Reservation.

PLAY TYPES - Explanation

1. Shallow Biogenic Gas
2. Jurassic / Cretaceous Sands
3. Mississippian / Devonian Carbonates
4. Imbricate Thrust Sheets
5. Fractured Bakken
6. Cambrian Sands

Sandstone
Shale
Shales, sands, and siltstones
Gas
Oil
Thrust Faults
Chalk
Limestone
Dolomite
Igneous / Metamorphics
Sandstone Lenses
Unconformity

Table BF-6.1. Play summary chart.

Reservation: Blackfeet
Geologic Province: North Central Montana, Sweetgrass Arch, Montana Disturbed Belt
Province Area: North Central Montana (62,500 sq. miles), Thrust Belt (41,400 sq. miles)
Reservation Area: 2385 sq. miles (1,525,712 acres)

Total Production (by province-2019)

	North-Central Montana	Disturbed Belt
Oil:	571 MMBO	2.2 MMBO
Gas:	1.22 TCFG	18 BCFG

No attempt has been made to estimate number of undiscovered fields within the Blackfeet Indian Reservation.

Play Type	USGS Designation	Description of Play	Oil or Gas	Known Accumulations	Drilling depths	Favorable factors	Unfavorable factors
1 Shallow Biogenic Gas* * Hypothetical Play	2811 2812	Accumulation in Upper Cretaceous units; mainly White Specs/Niobrara	Biogenic gas	33 MBO 8.8 BCFG	700-3000 ft.	1) source rock / self source 2) reservoir rock exists 3) shallowing drilling depths 4) occasional gas shows	1) size of accumulation unknown 2) porosity decreases with depth 3) exposed to atmosphere - possible leakage 4) tracking mechanism
2 Jurassic, Cretaceous sandstones	NA	Stratigraphic traps; discontinues sands, updip pinchouts. Fluvial and nearshore sandstones.	Both	344 MMBO 1.1 TCFG	1000-4000 ft	1) confirmed play 2) source / reservoir rock exists 3) thermally mature 4) shallow drilling targets 5) probably many fields	1) lack of well control 2) seismic may not detect strat traps 3) porosity may vary
3 Mississippian and Devonian Carbonates	NA	Folded structures, porosity controlled by matrix or fractures, unconformity traps, Devonian structural traps.	Both	215 MMBO 83.7 BCFG (numbers include Miss. & Dev. Plays)	1000-6700 ft	1) confirmed play 2) structure detected on seismic 3) source / reservoir rocks exists 4) thermally mature	1) lack of well control 2) rough topography 3) porosity may vary 4) Devonian contains N2 gas
4 Montana Disturbed Belt; Imbricate Thrust Sheets	NA	Thrusted units forming shallow and deep anticlines	Mainly gas	2.2 MMBO 18 BCF	3000-19,000 ft.	1) confirmed play 2) source / reservoir rocks exists 3) thermally mature 4) structure detected on seismic	1) small accumulations to date 2) seismic intensive 3) maybe thermally overmature (some Nitrogen Gas)
5 Fractured Bakken	NA	Bakken / Exshaw shale high organic content, thermally mature; fractured reservoir	Oil	41 MBO 279 MMCF	5000-10,000 ft.	1) Bakken exists 2) thermally mature 3) structures and flexures exist	1) thermal maturity unknown in some areas 2) lack of deep well control 3) limited production
6 Cambrian Sands	NA	Coarse sands trapped as pinchouts or on deeper structures	Both	NA	1700-7000 ft.	1) reservoir rock exists 2) structures exist 3) structure detected on seismic	1) no exciting production within province 2) source rock unknown 3) thermal maturity unknown 4) lack of deep well control

SHALLOW 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" are more likely to be found on structural highs (with paleo-thinning). The potential for traps in fine grained reservoir rocks also exists.

A-A' is a regional cross section of Upper Cretaceous formations extending from Blackfeet reservation to the Bowdoin Dome (figures BF-7.1 & 7.2). The diagrammatic section portrays an estimate of depositional extent for each formation. B-B' is a well log cross section of the biogenic gas play potential reservoirs from N-S across the reservation(figures BF 7.3 & 7.4).

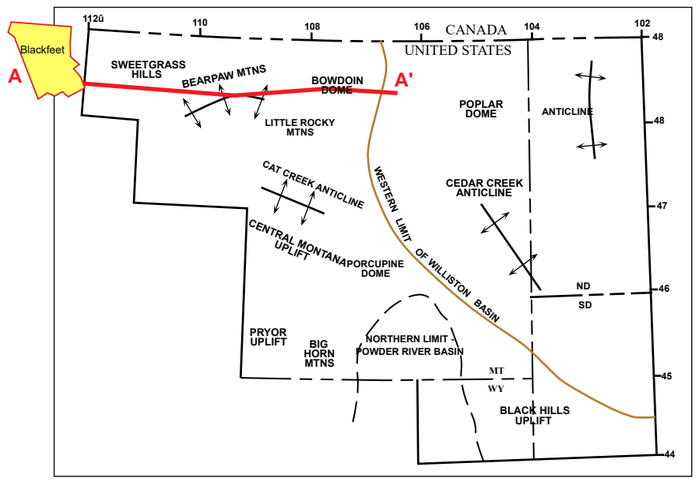


FIGURE BF-7.1. Major structural elements of northern Rocky Mountain Region and location of Cretaceous cross-section (modified after Rice and Shurr, 1980).

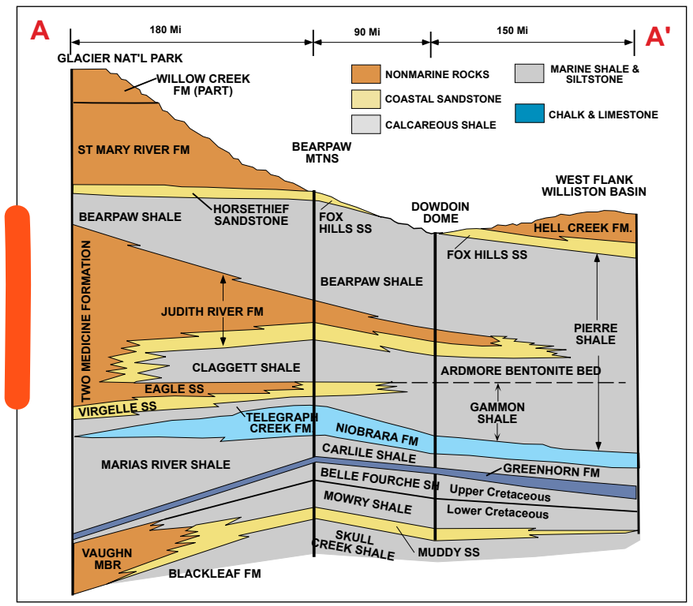


FIGURE BF 7.2. Diagrammatic sequence of selected Cretaceous rocks from Glacier National Park to the west flank of the Williston Basin, Montana (after Rice and Shurr,

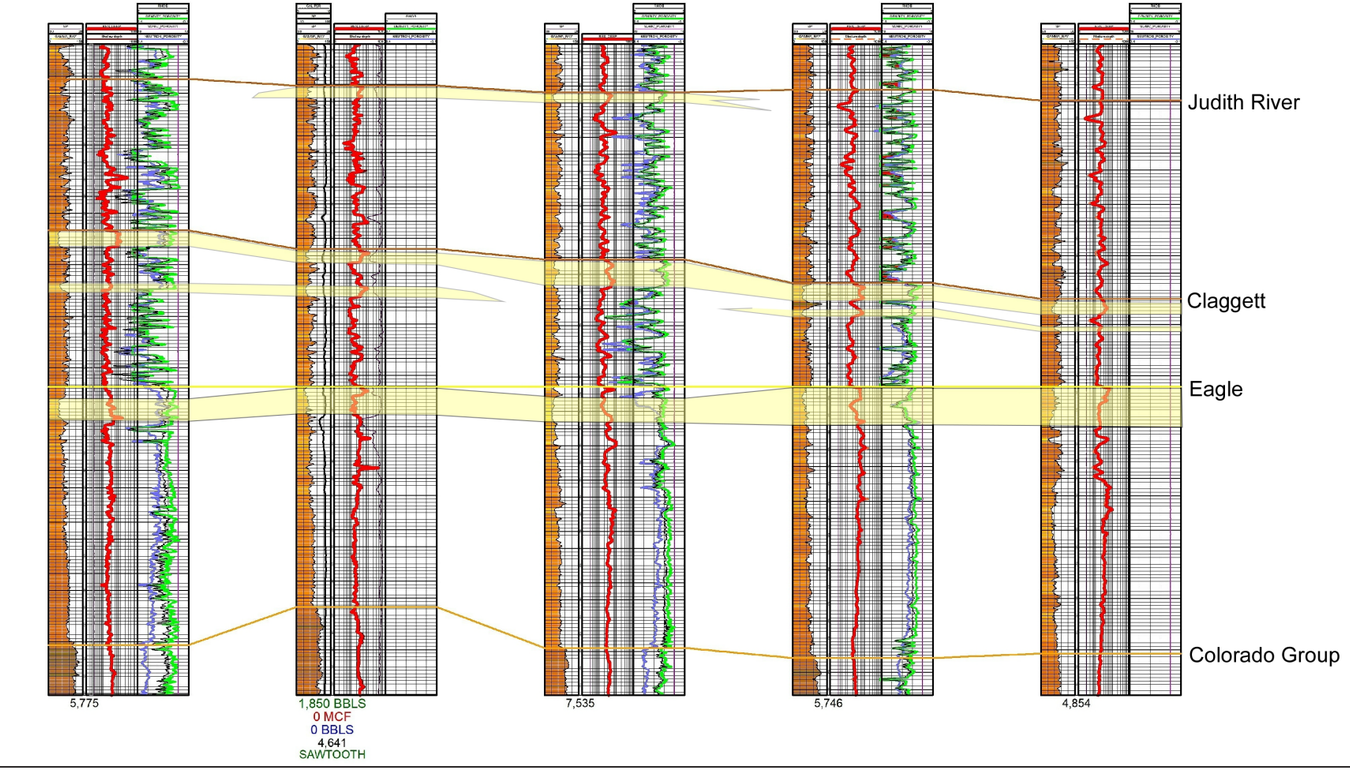


FIGURE BF-7.3. B-B' cross section showing the Upper Cretaceous formations where a possible biogenic gas play may exist within the Blackfeet Reservation. The cross section is flattened on the Eagle Sandstone.

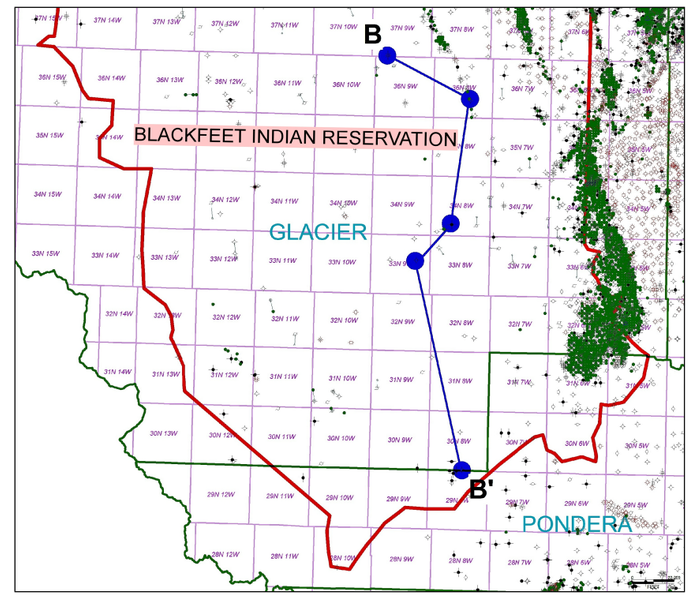


FIGURE BF-7.4. Location of B-B' well log cross section.

Jurracis / 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 pinchout in an updip position along structural trends (Figure BF-8.1, 8.2 & 8.3). 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.

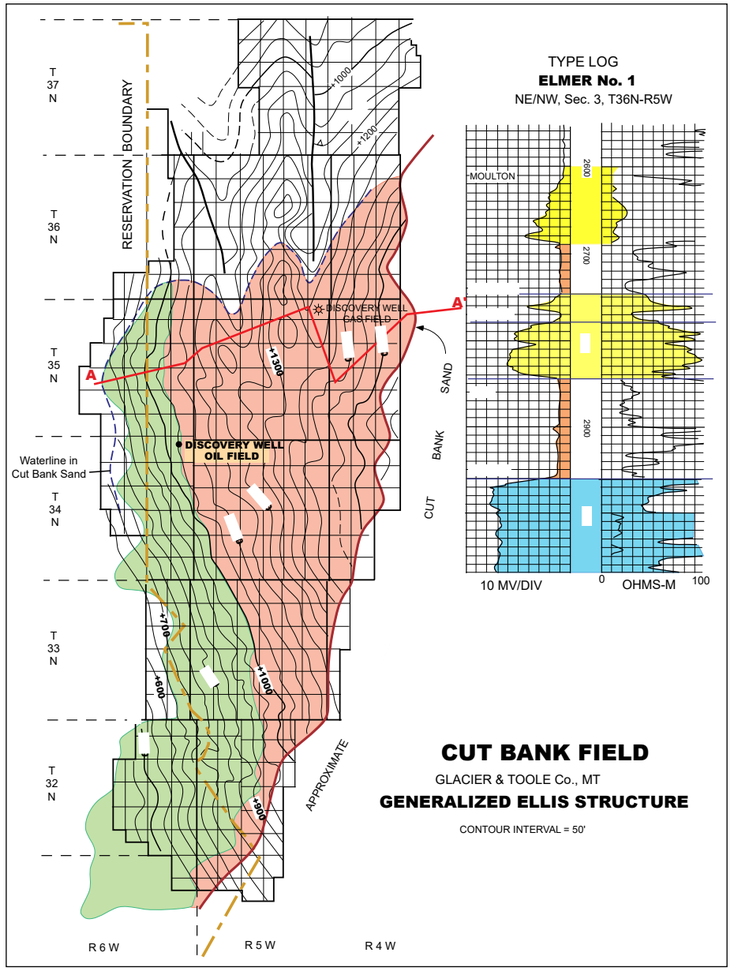


FIGURE BF-8.1. Structure map of the Cut Bank Field, showing the structural and stratigraphic position of Cut Bank sandstone deposits related to underlying Karst development within the Madison carbonates (modified after Cully, Montana Geological Society, 1984).

Cut Bank Field Parameters	
FORMATION:	Cretaceous Cut Bank Sandstone Colorado Group sands (Moulton, Sunburst, Lander) Mississippian Madison
LITHOLOGY:	Cretaceous Cut Bank Sandstone, blanket sand which pinches out updip
AVERAGE DEPTH:	3900 feet (+375)
POROSITY:	Moulton: 19-20%, Sunburst: 14-24% Lander: 18-24%, Cut Bank: 12-19%
PERMEABILITY:	Moulton - 200 md, Sunburst - not known Lander - 827 md, Cut Bank - 110 md Madison - not known
OIL/GAS COLUMN:	52 foot oil column 68 foot gas column (original)
AVERAGE NET PAY THICKNESS: Variable with formation	

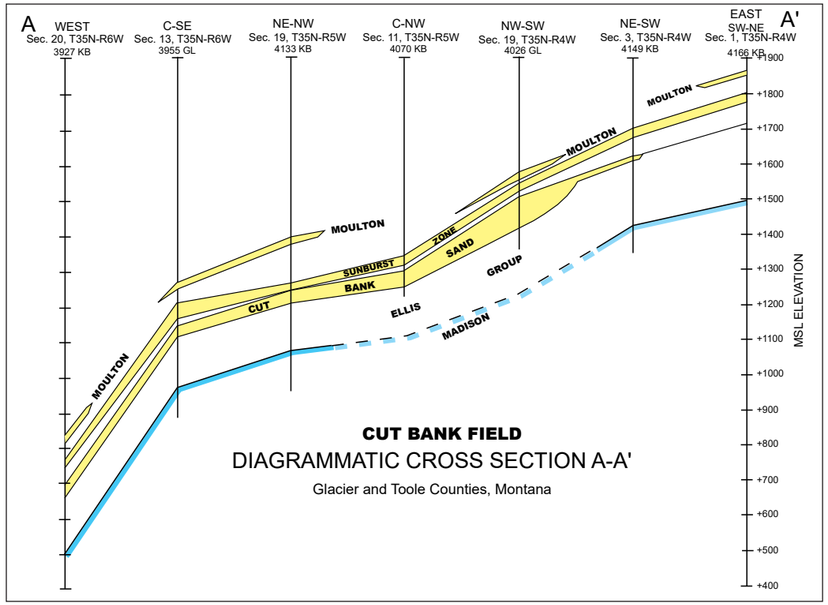


FIGURE BF-8.2. Cut Bank Field diagrammatic cross-section A-A' showing discontinuous nature of sandstone development across structure (modified after Cully, Montana Geological Society, 1984).

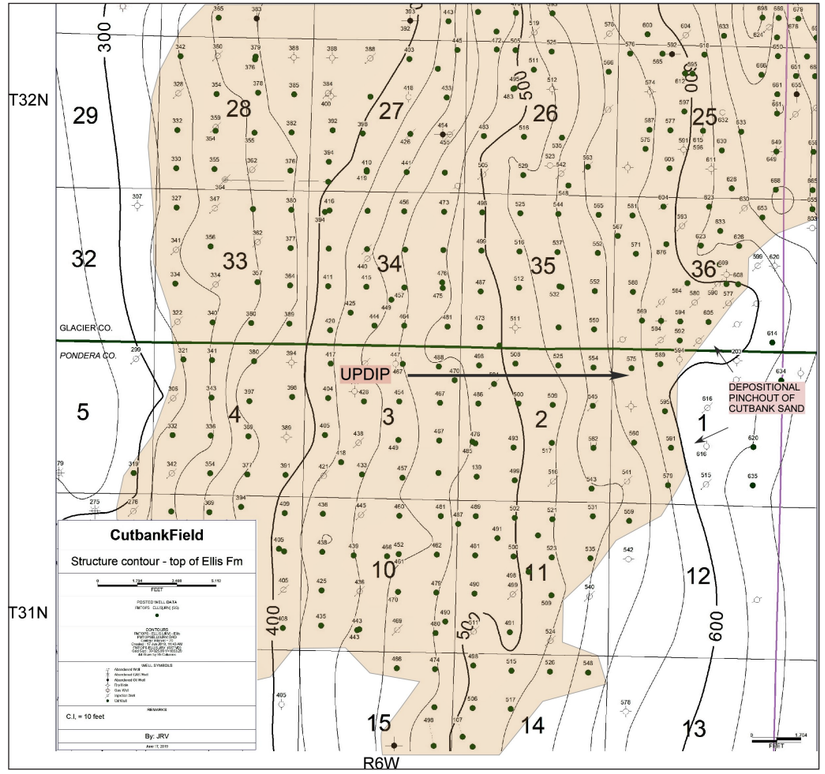
ANALOG FIELDS

(*) denotes fields which lies within the Reservation boundaries)

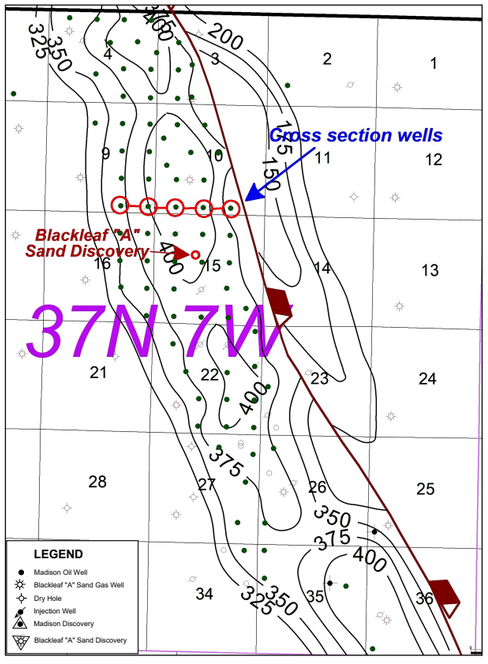
		Cumulative production
Reagan Field *	(Sweetgrass Arch)	232.5 MBO, 16.3 Bcf
Blackfoot Field	(Sweetgrass Arch)	891.5 MBO, 7.9 Bcf
Cut Bank*	(Sweetgrass Arch)	Cut Bank sands 265.3 MMBO, 389.4 Bcf, 1795 wells oil, 394 wells gas
Kevin Sunburst	(Sunburst Dome)	Sunburst sands, 9.1 MMBO, 92.1 Bcf (2019), 278 wells oil, 391 wells gas,
Soberup Coulee	(Sweetgrass Arch)	43.7 MMcf (abn'd)
Gypsy Basin	(Sweetgrass Arch)	22.9 MBO, 2.8 Bcf

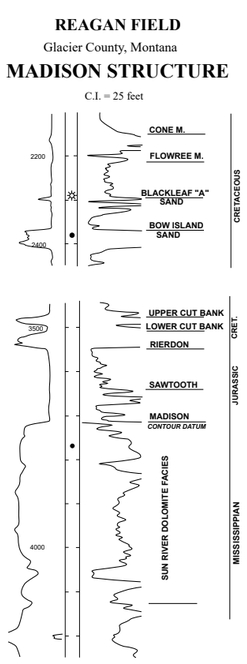
SW Cut Bank Field Parameters	
FORMATION:	Cut Bank
LITHOLOGY:	Cretaceous Cut Bank Sandstone, blanket sand which pinches out updip
AVERAGE DEPTH:	3900 feet (+375)
POROSITY:	Moulton: 19-20%, Sunburst: 14-24% Lander: 18-24%, Cut Bank: 12-19% Madison: 10%
PERMEABILITY:	Cut Bank: 1 to 450 md
OIL/GAS COLUMN:	Information not available
AVERAGE NET PAY THICKNESS:	27 feet

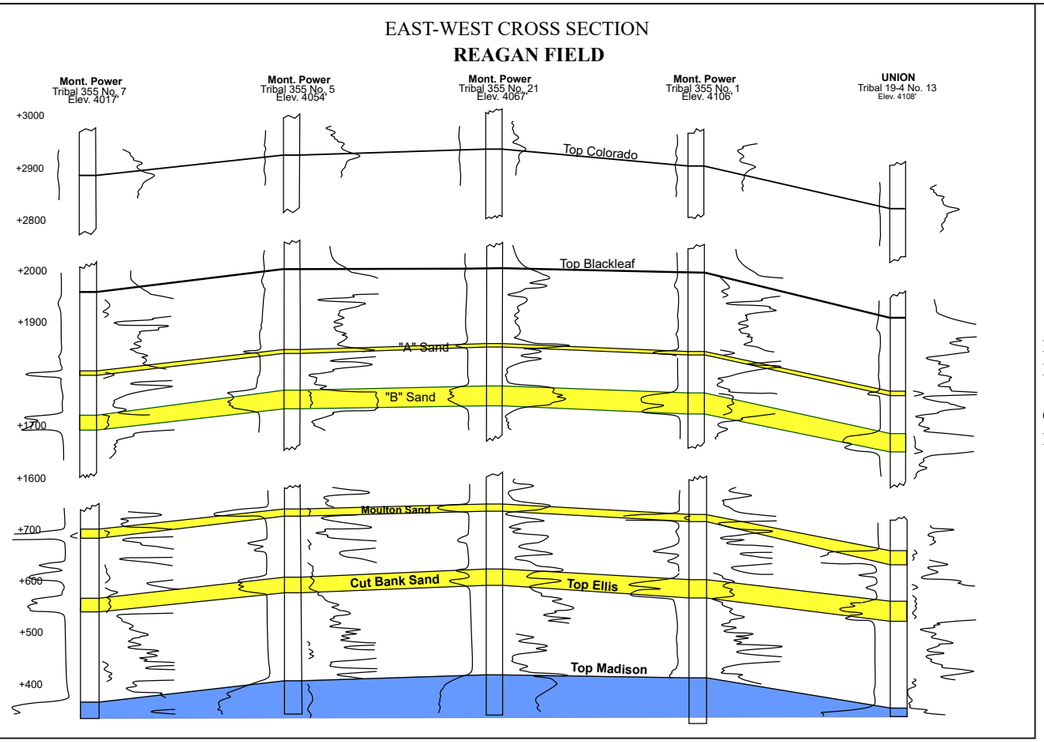
FIGURE BF-8.3. SW Cut Bank Field showing stratigraphic pinch-out in the updip direction which correspond to the distribution of production.



JURASSIC/CRETACEOUS SANDSTONE PLAY (CONT.)







ANALOG FIELDS

(*) denotes fields within the reservation boundaries)

Reagan Field *	(Sweetgrass Arch)	9.3 MMBO, 15 MMcf	54 wells
Blackfoot Field	(Sweetgrass Arch)	1.6 MMBO, 3.0 MMcf	8 wells oil, 7 wells gas
Gypsy Basin	(Sweetgrass Arch)	504,783 BO, 3.1 MMcd	4 wells
Red Creek	(Sweetgrass Arch)	6.5 MMBO, 1.2 MMcd	18 wells oil

FIGURE BF-9.1. Source rock along the Sweetgrass Arch is considered to be the black, organic Bakken/Exshaw 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.

Reagan Field Parameters
Formation: Madison
Lithology: Dolomite
Oil/Gas 52 foot oil column
Column: 68 ft. gas column (original)
Average Net Pay
Thickness: 20 feet
Average Depth: 3900 ft. (+375)
Porosity: 12%
Permeability: 10 md
Other Shows: Blackleaf "A" Sand, Madison

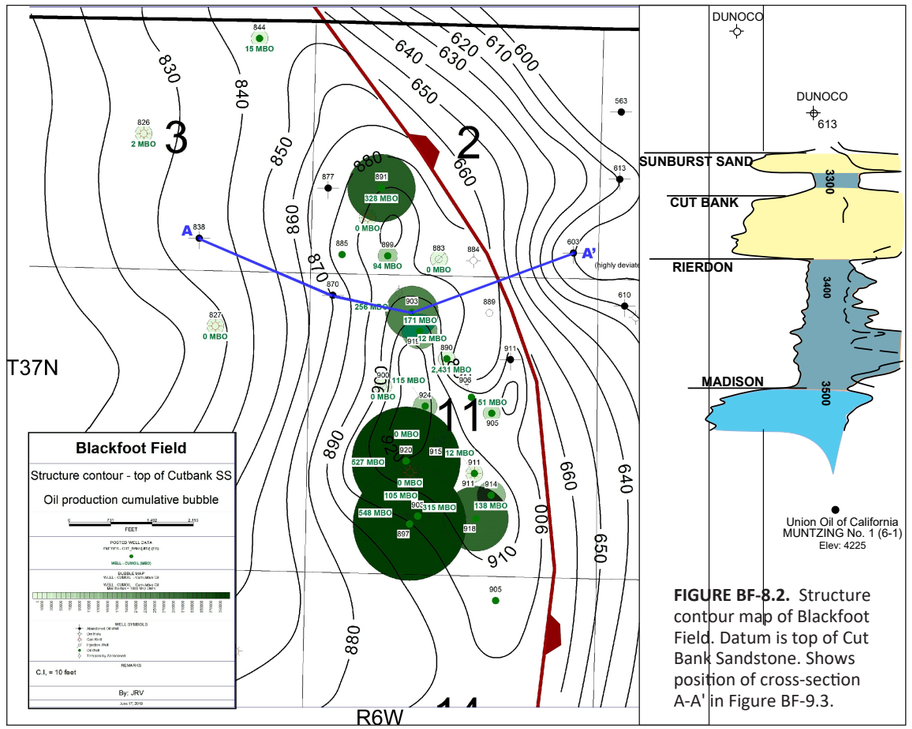


FIGURE BF-8.2. Structure contour map of Blackfoot Field. Datum is top of Cut Bank Sandstone. Shows position of cross-section A-A' in Figure BF-9.3.

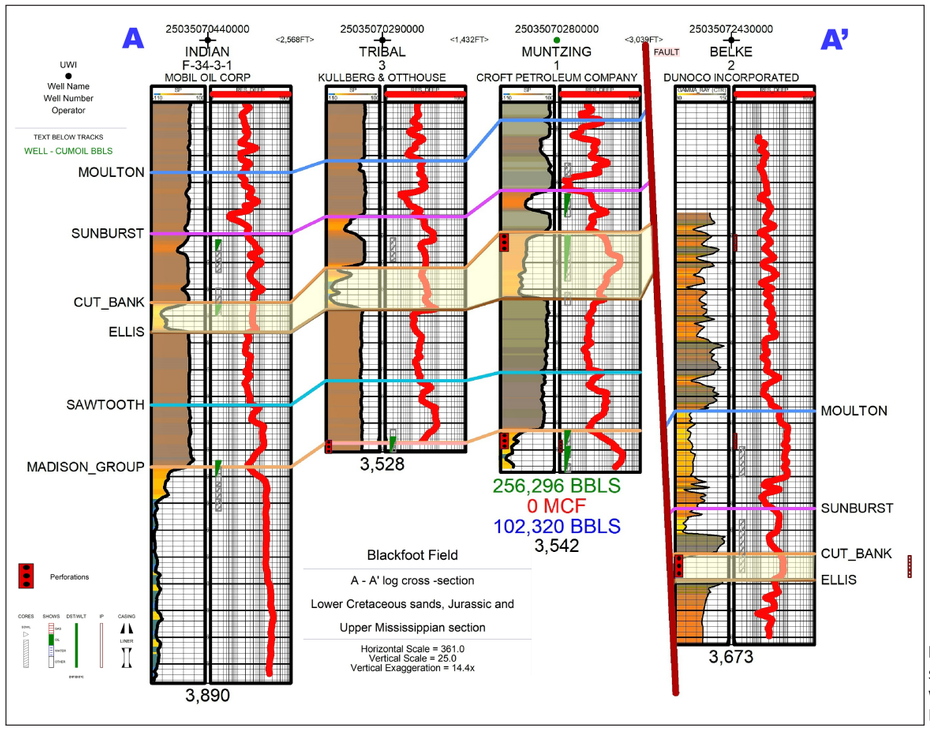


FIGURE BF-9.3. Cross-section A-A' showing the fault-assisted closure within the Blackfoot Field of the Cut Bank Sandstone.

Blackfoot Field Type Log
TYPICAL ELECTRIC LOG
Glacier County, Montana
Cutbank Sandstone
Madison Sun River Dolomite

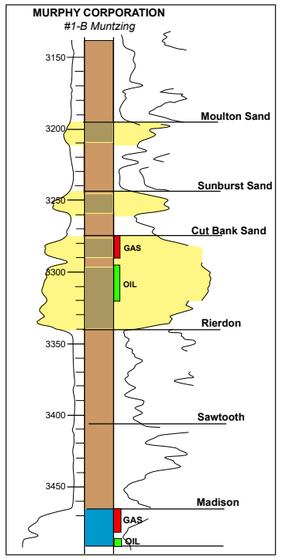
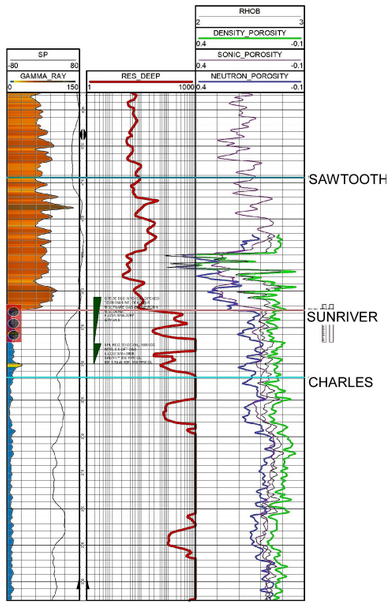


FIGURE BF-9.4. Type log from the Blackfoot Field showing production from both Madison carbonates and from younger karst-related sandstone deposits.

DEVONIAN / MISSISSIPPIAN CARBONATE PLAY

GENERAL CHARACTERISTICS - Very little Devonian production has been found to date. Production will probably be found on structures; numerous shows have been recorded on deep tests at Kevin-Sunburst, Gypsy Basin and Highview Fields (Figure BF-10.4 & 10.5). A Mississippian play on the Madison unconformity surface is also a distinct possibility (Figure BF-10.1, 10.2 & 10.3)

KEVIN EAST	23 Nisku producers, 1.9 MMBO
BLACKLEAF CANYON	1 Souris River producer
PONDERA FIELD (Sweetgrass Arch), 1984	Mainly Madison 54.5 MMBO, 171 MMcf, 462 wells
TWO MEDICINE CREEK*	22 MBO, 2 wells



TYPICAL LOG
REAGAN FIELD

FIGURE BF-10.1. Typical log from the Reagan Field.

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
AVERAGE DEPTH:	1500 feet (+2000 msl)
PERMEABILITY:	variable

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.

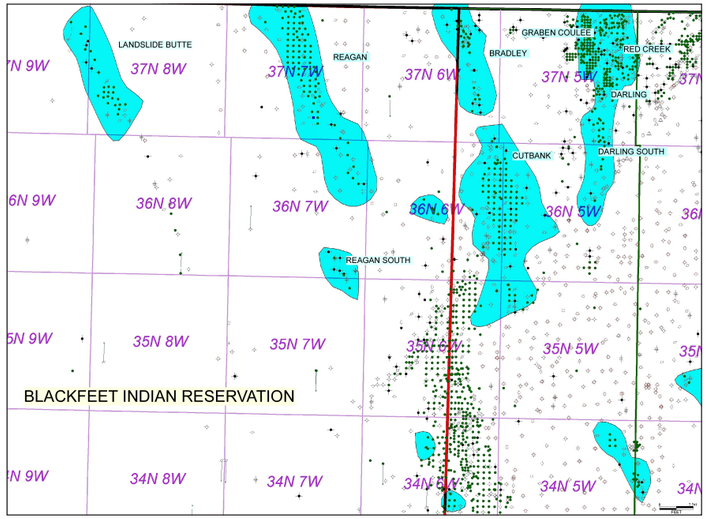


FIGURE BF-10.3. Northeast Blackfeet Indian Reservation showing Mississippian Fields and wells.

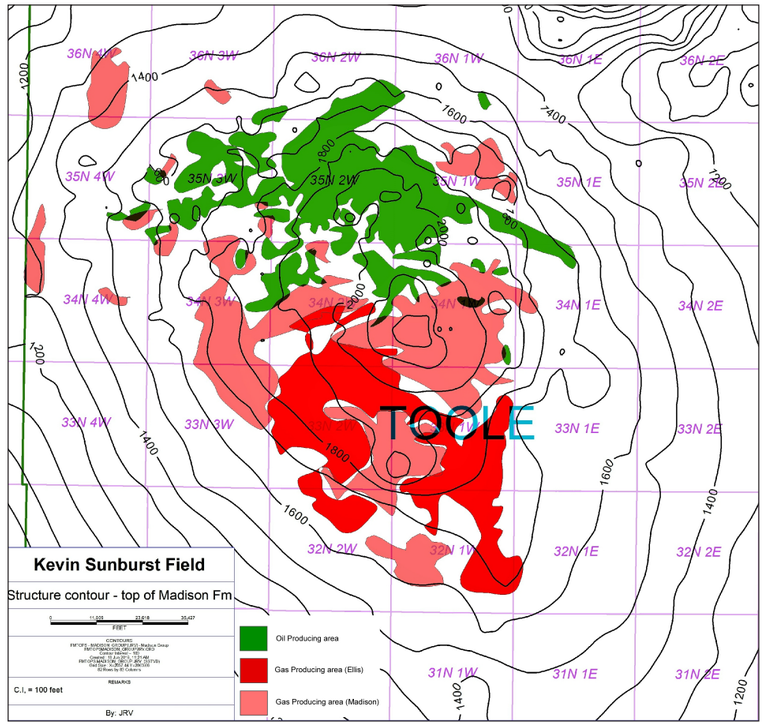


FIGURE BF-10.4. Kevin-Sunburst Dome Structure Datum on top of Madison.

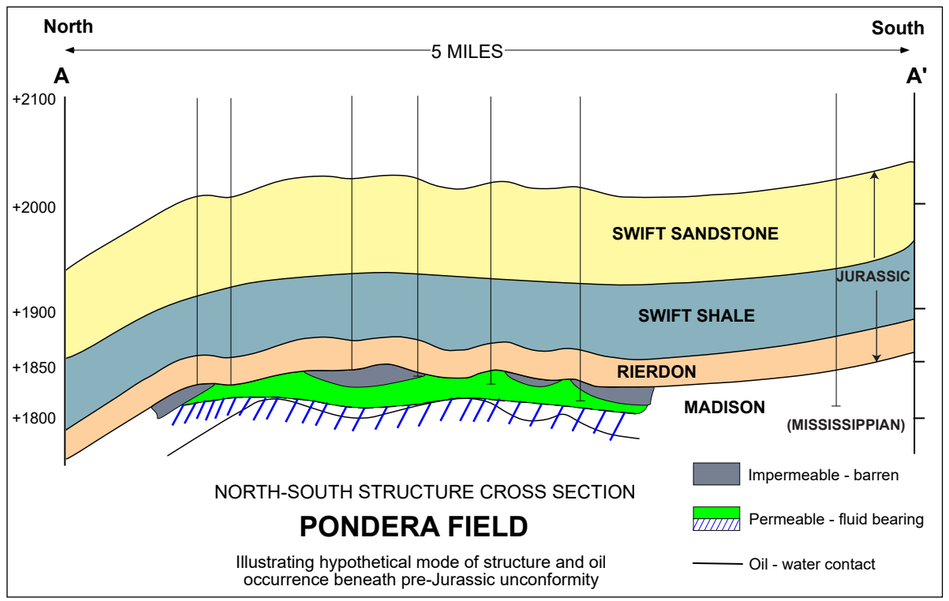


FIGURE BF-10.2. North-south structure cross-section, Pondera Field showing position of permeable, karsted Madison carbonates.

PONDERA FIELD PARAMETERS	
FORMATION:	Mississippian Sun River
LITHOLOGY:	Light gray to buff, finely crystalline to sugary dolomite, 140ft. thick
AVERAGE NET PAY THICKNESS:	10 feet
OTHER SHOWS:	Bow Island Sand Kootenai channel sands, Sun River
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.

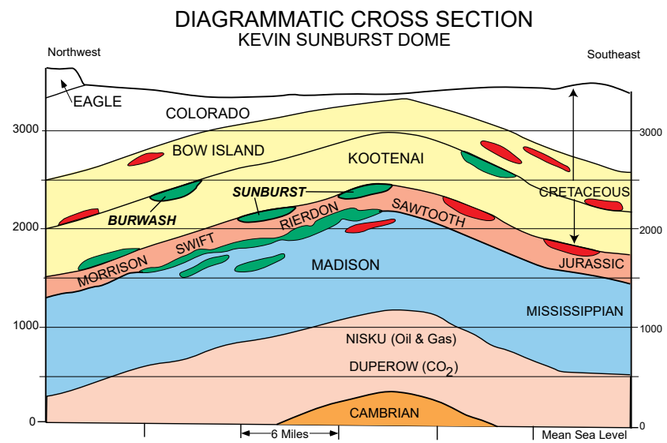


FIGURE BF-10.5. Diagrammatic cross-section showing both the karst-related distribution of sandstone reservoirs (Jurassic sands) and development of channel-related (Cretaceous) sandstone horizons (from Montana Geological Society, 1985).

MONTANA DISTURBED BELT - IMBRICATE THRUST

GENERAL CHARACTERISTICS - This play is characterized by imbricate, or angled thrust sheets and corresponding anticlines between the Lewis Thrust Sheet, and the eastern edge of the Disturbed Belt. Only three known fields exist in this province: the East Glacier and Two Medicine complex (Figure BF-11.1 & 11.2) and Blackleaf Complex (Figure BF-11.3 & 11.4).

Potential reservoir rock is dolomitized Mississippian limestone between 200 and 500 feet thick. Permeability is low which is one explanation for the small accumulations found thus far. Lower Mississippian and Devonian rocks may have fractured reservoirs. Jurassic and Cretaceous sandstones may produce.

Source rocks are thought to be associated with the following: (1) the Flood member of the Cretaceous Blackleaf Formation (43 - 168 feet thick) with 1.1 % total organic carbon (TOC) or (2) the 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 equivalent rocks in Canada. Some carbon dioxide has been found in smaller structures in the Disturbed Belt.

FORMATION:	Mississippian Sun River
AVERAGE DEPTH:	West Sun River "A" thrust sheet: 3900 feet. (+1537 feet MSL) West Sun River "B" thrust sheet: 5700 feet (-200 feet MSL) East Sun River: 5028 feet (-28 feet MSL)
PERMEABILITY:	not known
OIL/GAS COLUMN:	West Sun River "A": (100 feet MSL) West Sun River "B": (350 feet +1450 MSL) East Sun River 350 feet: (-450 feet MSL)
AVERAGE NET PAY:	Sun River: 350 feet thick

ANALOG FIELDS

(*denotes field lies inside Reservation boundaries)

Two Medicine
21.8 MBO 550 MMcf (Abn'd) (Montana Disturbed Belt)
Blackleaf
33,748 BO 7.0 MMcf (Abn'd) (Montana Disturbed Belt)

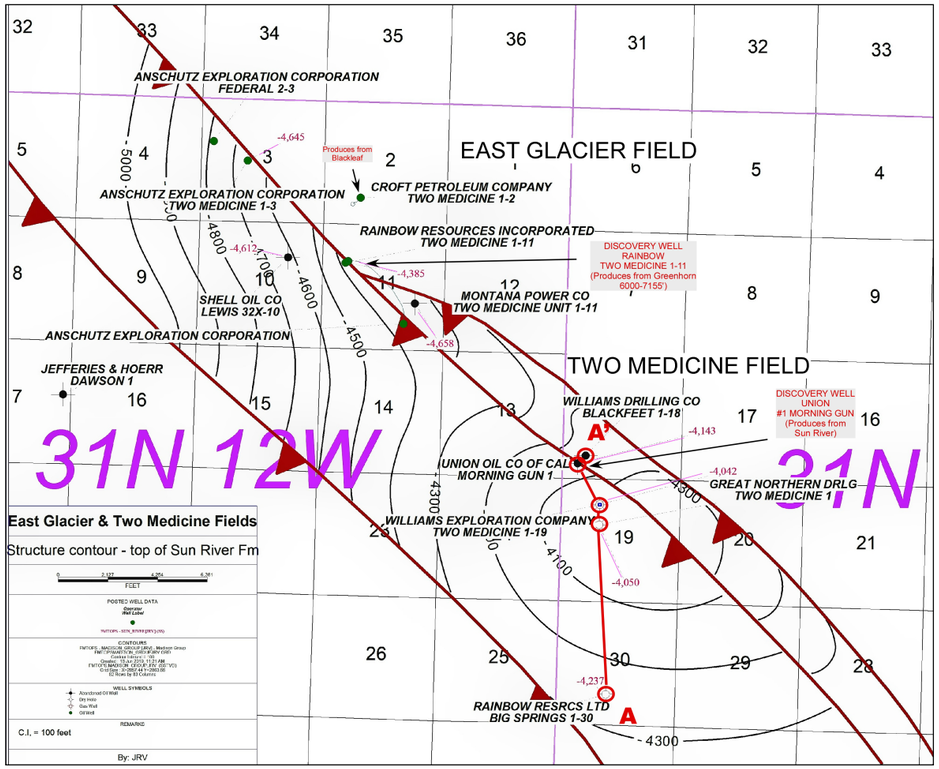


FIGURE BF-11.1. Two Medicine and East Glacier Fields (modified after Garner, Montana Geological Society, 1985).

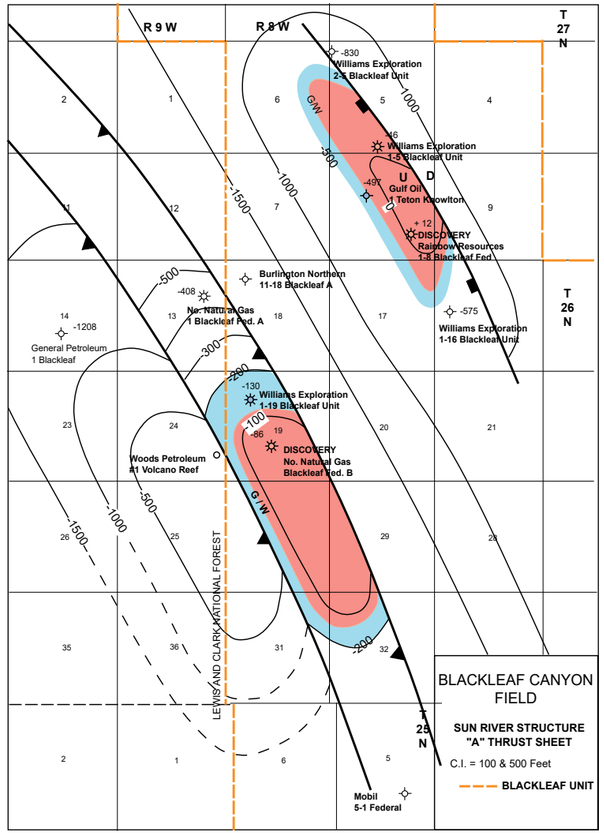


FIGURE BF-11.3. Blackleaf Canyon Field (modified after Garner, Montana Geological Society, 1985).

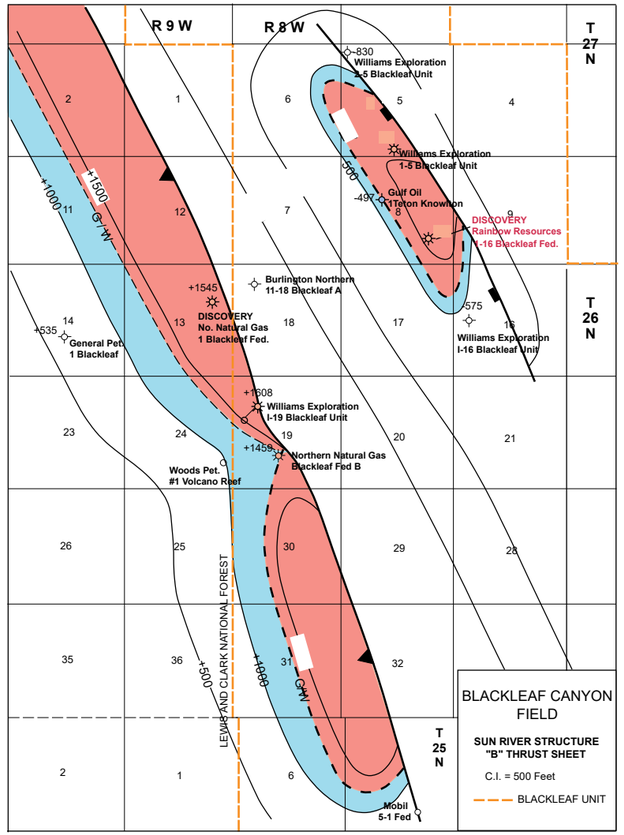


FIGURE BF-11.4. Blackleaf Canyon Field (modified after Garner, Montana Geological Society, 1985).

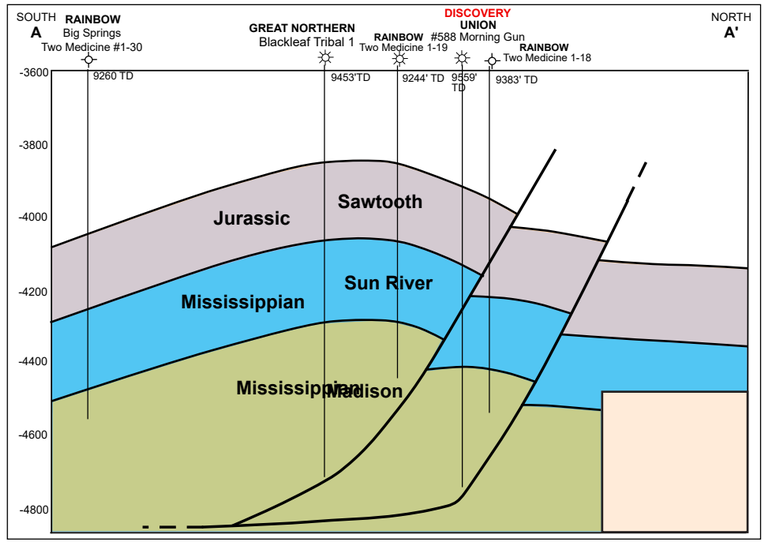


FIGURE BF-11.2. Two Medicine Field (modified after Garner, Montana Geological Society, 1985).

Two Medicine Field Parameters	
FORMATION:	Cretaceous Greenhorn, Mississippian Sun River
LITHOLOGY:	Greenhorn - fractured sandstone and shale, 600 feet, continuous except when faulted Sun River - fractured dolomite, 225 feet, continuous except when faulted
AVERAGE DEPTH:	Greenhorn: 7000 feet (-2000 feet MSL) Sun River: 8800 feet (-4050 MSL)
POROSITY:	Greenhorn: 15% Sun River - 9% average matrix
PERMEABILITY:	not known
OIL/GAS COLUMN:	Greenhorn: 375 feet (water contact not known) Sun River: 125 feet (water contact not known)
AVERAGE NET PAY:	Greenhorn: 100 feet Sun River: 90 feet

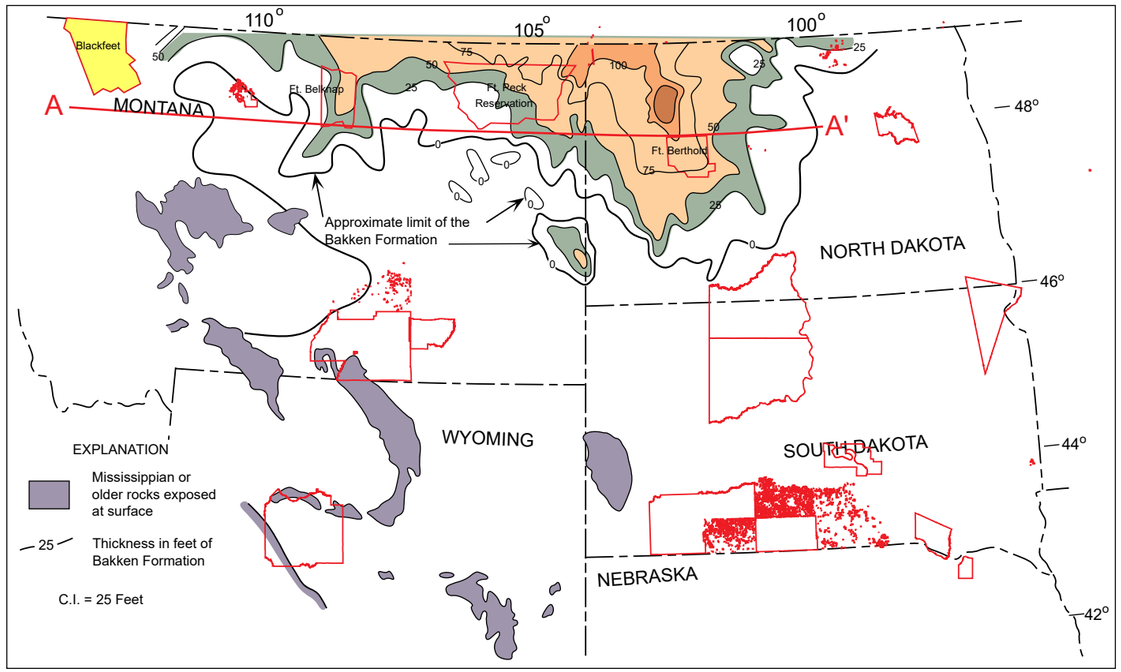


FIGURE BF-12.1. Thickness of Bakken formation (uppermost Devonian and lowermost Mississippian) (modified after Peterson, 1981, 1984).

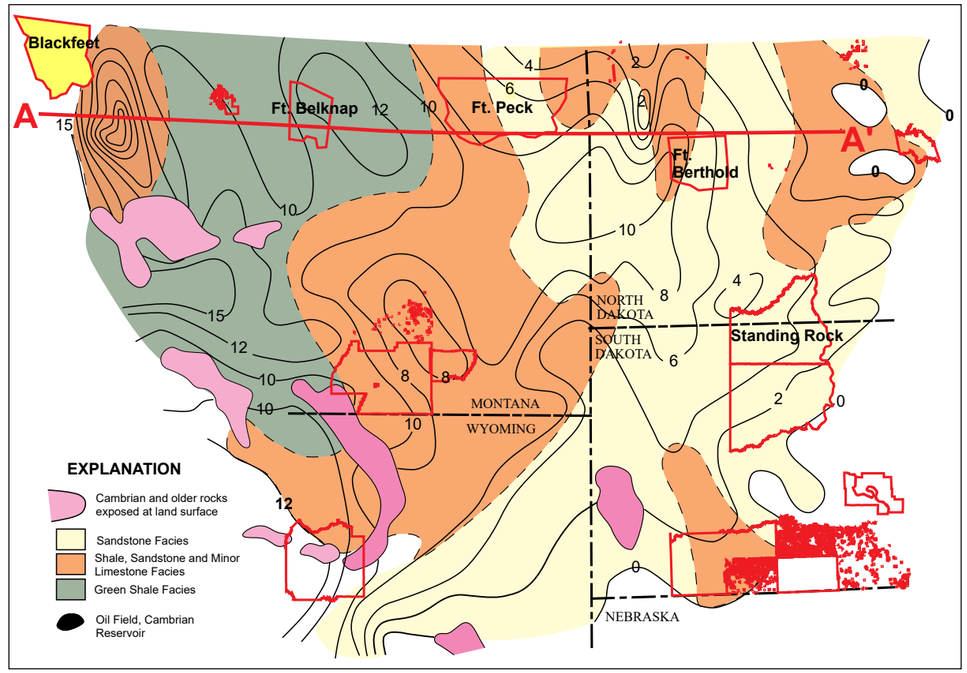


FIGURE BF-12.2. Thickness of Deadwood and equivalent rocks, location of analog fields. Blackfeet Indian Reservation and location of regional cross-section A-A' (modified after Peterson, 1981, 1984).

FRACTURED BAKKEN SHALE

GENERAL CHARACTERISTICS: The Mississippian/Devonian Bakken, one of the probable source rocks for the Madison, is an organic rich marine shale, regionally equivalent to the Exshaw shale in Alberta (Figure BF-12.1, 12.2 and 12.4). 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

GENERAL CHARACTERISTICS: Cambrian sandstones are more than 2000 feet thick in the Disturbed belt part of the reservation (Figure BF-12.2, 12.3 and 12.5). 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 the 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.

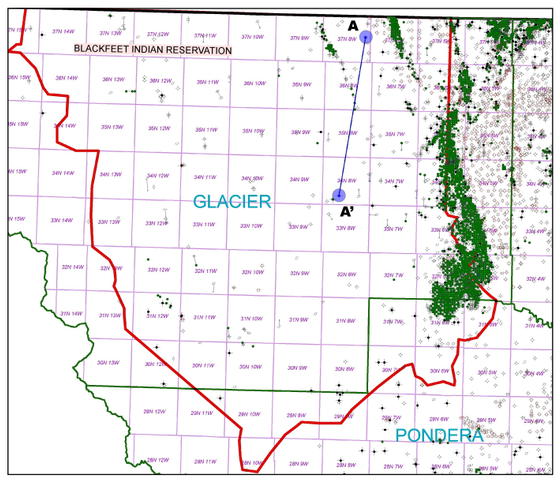


FIGURE BF-12.3. Location of log cross section within Blackfeet Indian Reservation.

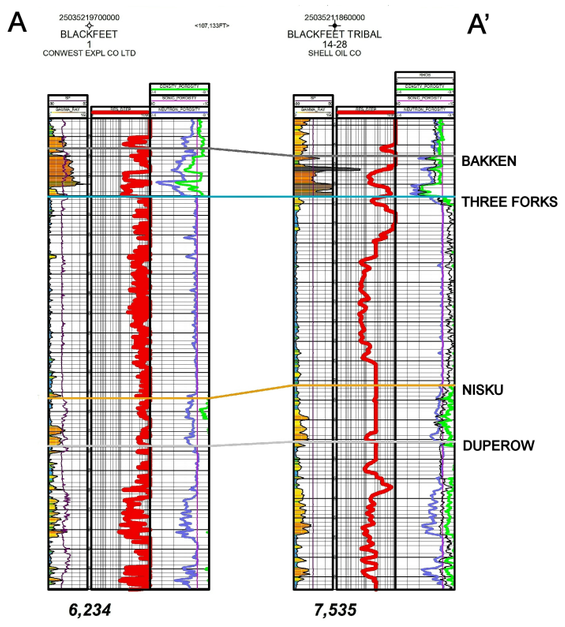


FIGURE BF-12.4. Log cross section of the Devonian section.

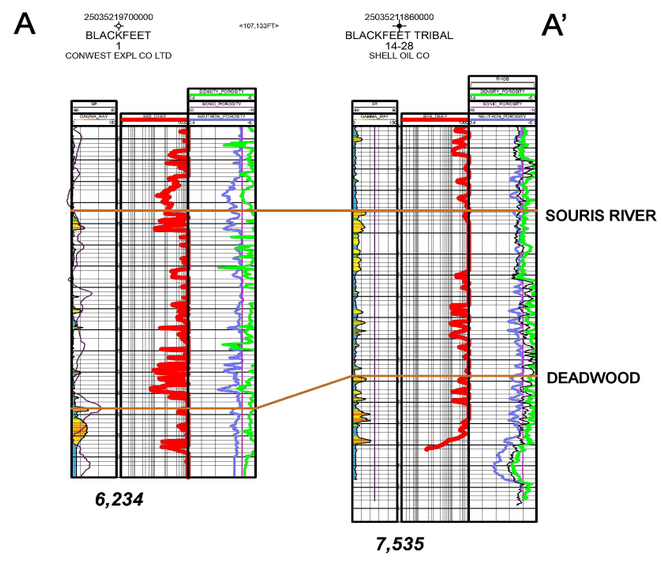


FIGURE BF-12.5. Log cross section of the Ordovician/Cambrian section.

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