STANDING ROCK RESERVATION

List of Topics

OVERVIEW

STANDING ROCK RESERVATION

Standing Rock Sioux Tribe

TRIBAL HEADQUARTERS: Fort Yates, South Dakota
GEOLOGIC SETTING: Williston Basin

Land Status

The Standing Rock Reservation is one of seven created for the Sioux Indians by Congress. It was established on March 2, 1889. It covers 3,625 square miles in North Dakota and South Dakota, with a total area of 2,320,274.67 acres. The reservation is located in Sioux County, N.D. and Corson County, S.D., with minor portions in Dewey and Ziebach Counties, S.D. Surface ownership of 1,482,733.6 acres is in State, Federal, and non-Indian lands, comprising 63.90 percent. Of this amount, tribal land consists of 294,840.41 acres (12.71 percent), and allotted lands number 542,700.66 (23.39 percent). Tribal ownership of surface and minerals is 143,751.50 acres (6.20 percent) ; tribal ownership of the minerals, but not the surface is 49.566.88 acres (2.14 percent) ; non-tribal ownership of surface and minerals (including allotted lands) is 2,055,144.04 acres (88.57 percent) and the status is uncertain on 71,812.25 acres (3.09 percent). Tribal trust acreage administered by the Aberdeen, S.D. Area office of the Bureau of Indian Affairs (B.I.A.) amounts to 849,989 acres, which includes tribal and allotted lands located off the Reservation.

There are three types of land ownership on the Reservation; allotted lands, tribal lands, and other lands. Allotted land tracts were allotted to the Indians after the establishment of the Standing Rock Reservation. These are subject to trust restrictions by the United States Government, but the restrictions can be ended by the Secretary of the Interior if the individual can manage or sell his land without assistance, or if it is in the best interest of the individual and his family for the land to be sold. Tribal lands are owned by the Standing Rock Sioux Tribe and come under the management of the Tribal Council. Other lands consist of fee patent lands, which are acquired through homesteading or by the ending or trust restrictions on allotted lands; also included in this category is Bureau of Indian Affairs agencies, town sites, and cemeteries.

On the Standing Rock Reservation, mineral and surface ownership have been severed. The categories of mineral ownership include:

a. Surface and mineral ownership reside with allottees (or non-Indians, including government agencies)
b. Surface and mineral ownership reside with the Standing Rock Sioux Tribe
c. Tribal ownership of the mineral estate, but not the surface
d. Lands where the tribe may own the minerals but the status is uncertain

Persons desiring to secure oil and gas or other mineral leases should direct their inquiries to the Director of Natural Resources Development for the Tribe.

Culture, Geography, and Physiography

The Standing Rock Reservation is divided into seven principal political districts names for the geographical areas they represent. These consist of the Cannonball, Kenel, Porcupine, Fort Yates, Bullhead, Little Eagle, and Wakpala Districts. Each district has a representative. In addition there is a representative for the McLaughlin subdistrict of the Little Eagle District. There are 15 members in the Tribal Council and 9 members constitute a quorum. Seven councilmen are elected at large annually for two year terms. The Tribal Chairman is elected at large for a two year term. The Vice-Chairman, Secretary and/or Treasurer is elected for a one year term from within the council membership.

Of the fourteen Councilmen to be elected at large, four must be residents of the North Dakota portion of the reservation without regard to residence in the districts and two must be residents of South Dakota portion of the reservation without regard to residence in the districts. Each of the remaining eight councilmen must be a resident of the district from which he is elected at large by the electors of the entire Reservation, except that two councilmen must be residents of the South Dakota portion of the Little Eagle District.

The Tribal Council is the governing body and it has a regular meeting held the first Wednesday of each month. Special meetings are held upon the written request of 7 council members to the Chairman or the Secretary. Various committees of the tribe can be found in session every week, usually on Thursdays and these meetings may often lst for several days. The Standing Rock Sioux Tribal Government is probably one of the most democratic political institutions in America today. Many other Indian tribes have a similar organization.

The Standing Rock Reservation is bounded on the north by Cedar Creek and the Cannonball River and on the south by the Cheyenne River Indian Reservation. Lake Oahe and the waters of the Missouri River form the boundary on the east and the county lines of Adams and Perkins counties form the west boundary, along the 102nd meridian.

The headquarters for the Standing Rock Sioux Tribe is at Fort Yates, which is also the county seat of Sioux County. McIntosh is the county seat of Corson County, in South Dakota. The total population of these two counties is 8,626 (1970 census). An estimated 4,700 Indians live on or near the Reservation. Total Tribal membership is 8,052.

Bismarck, the State Capital of North Dakota is 64 road miles north of Fort Yates and 24 miles from the north boundary of the Reservation. Commercial jet and other types of air transportation can be obtained at the Bismarck Airport. Several landing strips are located on the Reservation near some of the small cities and towns. Hard-surfaced roads cross the Reservation in east-to-west and north-to-south directions. There are several dirt and graveled roads, which allow access to most of the Reservation. Bus and train transportation meet other requirements.

The topography ranges from badlands type, particularly in the northern and central part of the Reservation, to smooth rounded hills and shallow flat-floored valleys of the Pierre Hills part of the Reservation in South Dakota and in part of the North Dakota portion of the Reservation. Scattered boulders, which generally are igneous or metamorphic rock types are present in the eastern half or the Reservation. They are not indigenous to the Reservation and constitute evidence that glaciers have moved across the land toward the south and west. They are believed to have been transported from far north in Canada where these rock types crop out.

Streams adjoining the Reservation that flow throughout the year, in addition to the Missouri River, consist of Cedar Creek and the Cannonball River along the northern boundary and the Grand River in the southern part of the Reservation, which also flows easterly to meet the Missouri River in the Oahe Reservoir. The streams have meandered back and forth across their valley floors and by erosion have created steep valley walls; in many places the valley floors range from less than a mile across to as much as 1,000 feet above the valley floors with a few buttes in the eastern and other parts of the Reservation rising an additional several hundred feet above the general upland surface. Benches are prominent along the valleys of the larger streams and represent terraces left by the streams during their down cutting.

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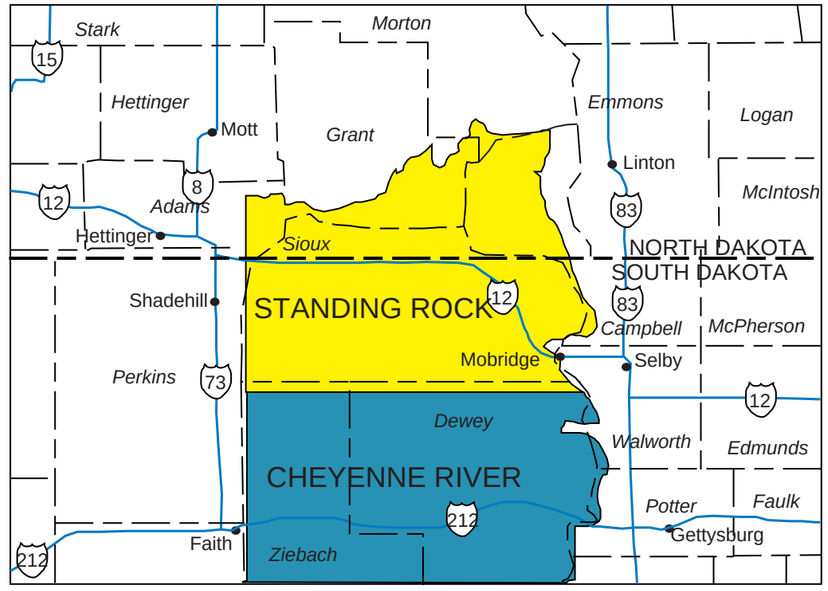

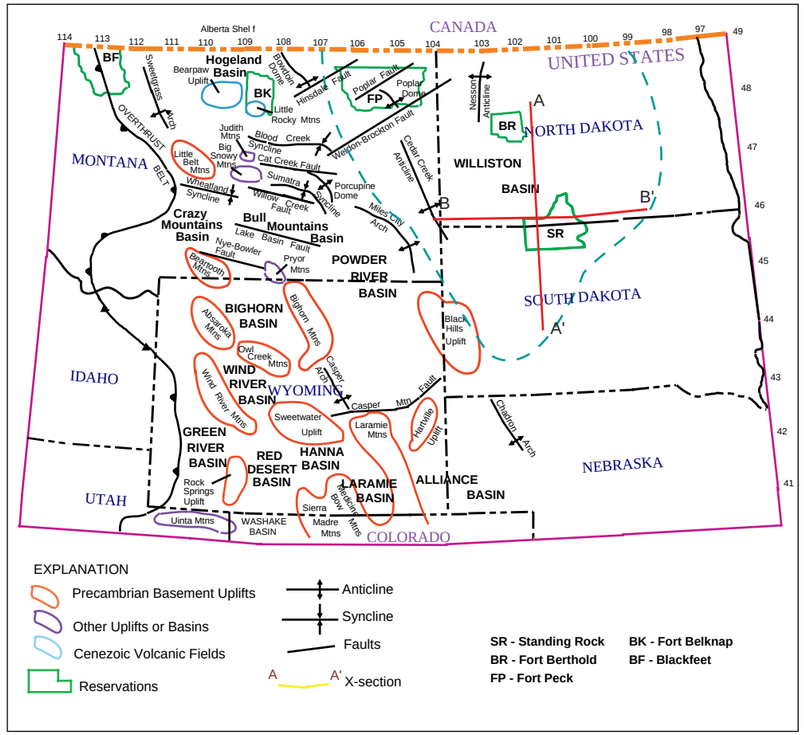

Figure SR-1.1. Present day structural features of the northern Rocky Mountain region. Includes major fault zones, uplifts, basins, and reservation areas (modified after Peterson and MacCary, 1987).

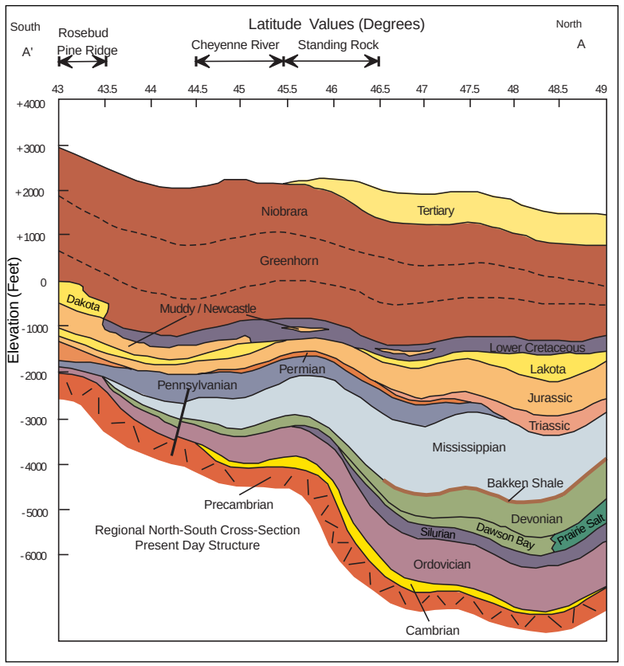

Figure SR-1.2. Regional North-South cross-section - present day structure - cross-section oriented along 101 degrees longitude with points every half-degree latitude.

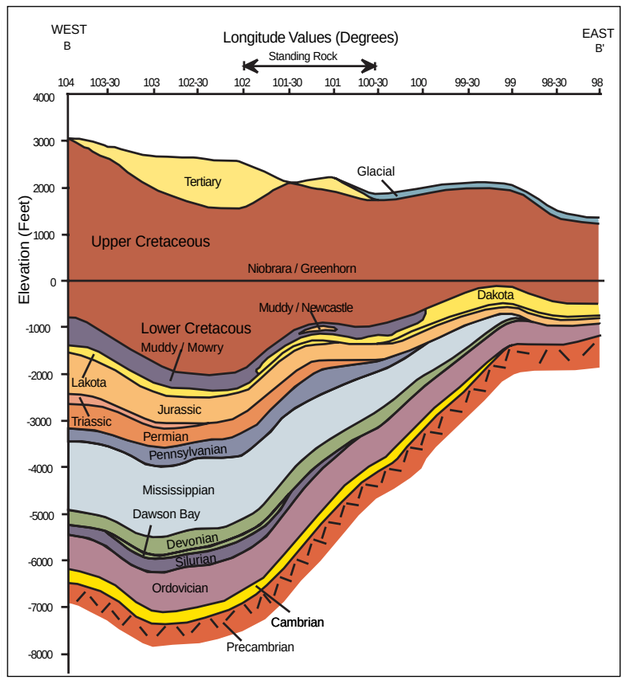

Figure SR-1.3. Present Day Structure - Structural cross-section B-B' - cross-section along the 46 Degree latitude line with selected points every half degree of longitude.

Regional Geology

The Standing Rock Indian Reservation is located on the southern flank of the Williston Basin, a major intercratonic basin (see Tectonic Map and North-South Cross-Section A-A'). The Reservation is northeast of the Black Hills Uplift and is located in the Missouri River Badlands. It is north of the Sioux Arch. The geologic section is represented by Precambrian metamorphics, Paleozoic carbonates and Jurassic and Cretaceous sandstones. The Paleozoic rocks are mainly dolomites and limestones deposited within the Williston Basin depocenter. Jurassic and Cretaceous Rocks vary from continental to marine sands and shales. Most of the surface units on the Reservation are Cretaceous marine shales and some Tertiary fluvial and swamp deposits. The area has been heavily dissected by erosion in classic "badlands topography" by the Missouri River and its tributaries, the Grand River and the Cannonball River.

Structural Geology

The Standing Rock Indian Reservation is characterized by gently dipping Tertiary and upper Cretaceous units which dip to the northwest at about 10 feet/mile. Due to the lack of well control, only regional dip of units can be implied. A shallow map on the Muddy/Newcastle sandstone shows a structural flexure on the North Dakota state line. Regional geology (see north-south Cross-Section A-A') shows a regional "hinge-line" centered on the Standing Rock / Cheyenne River Reservation boundary. This "flexure" separates the Sioux Arch province from the deep Williston depocenter. The east-west Cross-Section (B-B') shows a high structural ridge at Standing Rock which separates the deeper Williston and Cedar Creek Anticline from the thin, eastern flank of the basin.

A structural high is present east of the Reservation and may correspond to the "Pierre Gas Field". The play summary diagram shows a generalized west to east cross-section through the Reservation, and generalized trap types and lithologies that should be present. The rollover of Cretaceous rocks is based on generalized isopach thicknesses and present day structure.

Geologic History

Two generalized structural cross-sections (see north-south Cross-Section A-A' and east-west Cross-Section B-B') have been constructed to summarize present day structure and older paleostructure. The cross-section uses rock thickness values from each of the geologic periods. The north-south section runs along the 46 degree latitude line and values were selected at intervals of one-half degree longitude. Section B runs along the 101 degree longitude line, with selected values at intervals of 30 minute latitude. The western end of section B-B', near the Montana State Line, is about 3000 feet in elevation. This area is the southern end of the Williston Basin near the Canadian Border and is near the deepest part of the Williston (greater than 10,000 feet). Bakken Shale and Prairie evaporite which are present in the deepest part of the basin, are absent at Standing Rock. 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, Mississippian to Precambrian, and Upper Cretaceous to Precambrian. A paleo cross-section attempts to show what the subsurface geology may have looked like within that time interval. 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.

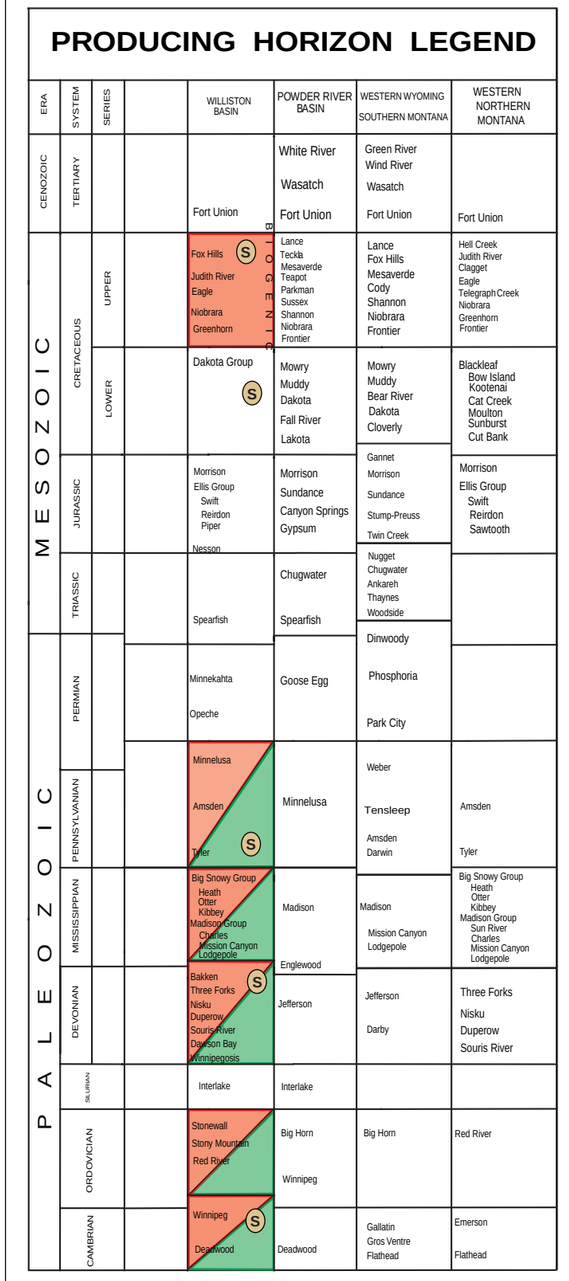

Figure SR-1.4. Producing horizon legend (from Seventh International Williston Basin Symposium Guidebook, 1995).

Most Likely Hydrocarbon Zones

Based on current gas shows and regional hydrocarbon production, regional cross-sections and depositional maps, the most likely plays to develop on the Standing Rock Reservation are:

1) Cretaceous Muddy / Dakota: numerous gas shows in water wells south and east of the Reservation. Pierre Gas Field. Stratigraphic nature of sand bodies; thermal maturity of the area.
2) Mississippian Shorelines: numerous gas and oil shows north of the "hinge-line" where shoreline cycles could develop. Near the Bakken source rock boundary.
3) Ordovician Red River: numerous gas shows in adjacent countries. Red River production south of Reservation. Stratigraphic traps within Red River, likely, due to regional position of Reservation.
4) Upper Cretaceous Niobrara Chalk: biogenic gas.
5) Greenhorn Limestone: biogenic gas.
6) Pennsylvanian Leo sands: gas shows adjacent to Reservation from "Minnelusa / Leo" equivalent rocks. Probably a long shot.
7) Turner sandstone: biogenic gas.
8) Shannon (Eagle) sandstone: biogenic gas.

Cambrian and Older

No Cambrian or Precambrian rocks are exposed on the Standing Rock Indian Reservation. Several wells have penetrated granite and other "Precambrian" units in counties east and south of the Reservation.

During Cambrian time, a major seaway existed in western Montana and eastern Idaho (see 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 Sioux Arch) and graded into shales and limestones to the west. Cambrian rocks are of uniform thickness (about 200 feet) within Reservation boundaries.

Cambrian to Mississippian

The Williston Basin was a stable, shallow marine shelf through most of the Paleozoic Era. (Figure SR-2.3) Ordovician and Silurian Rocks were deposited in a tidal flat environment with alternating cycles of limestone / dolomite, marine shales, and evaporites. At the end of Silurian time, a regional unconformity extended across the Williston and to the west. Present thickness of the Ordovician units on the Reservation are from 600 to 800 feet. Ordovician Red River porosity cycles formed large stratigraphic traps west of the Reservation in Harding County, South Dakota. The Silurian is present but thins rapidly both to the south and east of the Reservation. Silurian rocks are estimated to be about 200 feet thick or less.

Devonian deposition was similar to that during Ordovician time. Within the Reservation boundaries, these rocks are about 200 to 400 feet thick and thin southward and eastward. Bakken Shale (Madison Source Rock) apparently is not present, although well logs show a thick shale and silt unit known as the Englewood. The Bakken Shale exists north of the Reservation. The Sioux Arch, south of the Cheyenne River Reservation, became active during this time, with major faulting.

By Mississippian time, thick carbonate and evaporite units were deposited north and west of the Reservation. A "hinge line" formed possibly related to the Sioux Arch, and separated the deeper Williston from the shallower area southward. This change of gradient in Mississippian time may have influenced shoreline cycles and porosity development. Waulsortian mounds may have developed at this time. A major unconformity at the end of Mississippian time led to widespread erosion and karstification. Mississippian rocks are about 600 to 1500 feet thick.

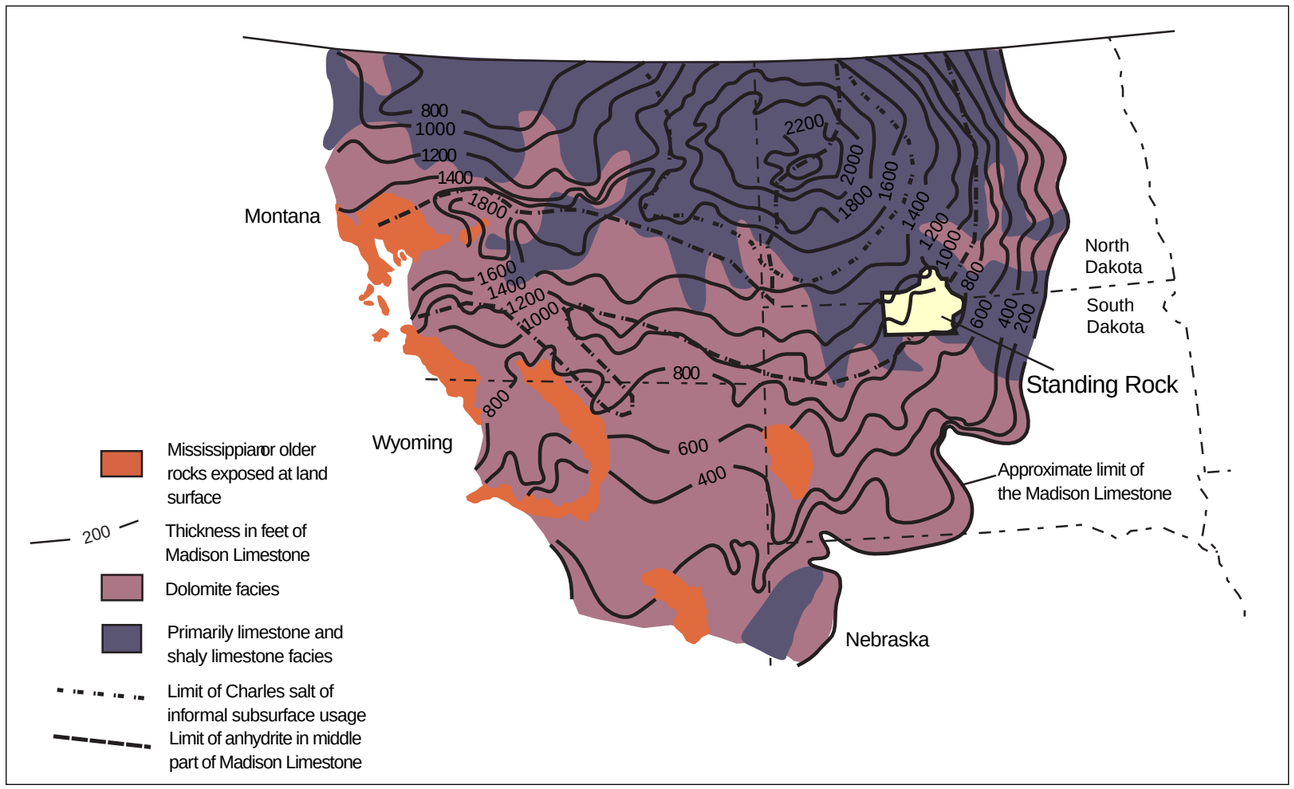

Figure SR-2.2. Thickness in feet and generalized rock facies of the Madison Group (Mississippian) and equivalent rocks (modified after Peterson, 1981, 1984b).

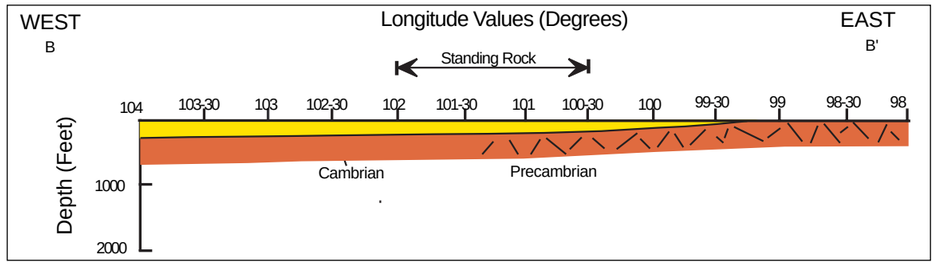

Figure SR-2.1. Paleo Cross-Section B-B' - Cambrian to Basement - Cross-section along the 46 degree latitude line with selected points every half degree of longitude.

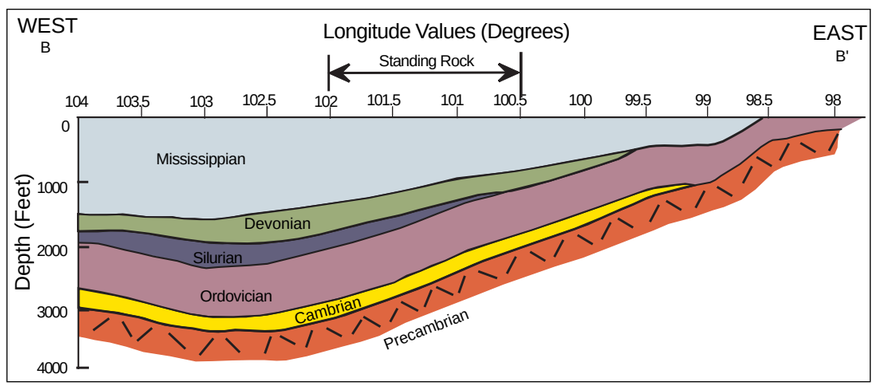

Figure SR-2.3. Paleo Cross-Section B-B' - Precambrian to Mississippian - Cross-section along the 46 degree latitude line with selected points every half degree of longitude.

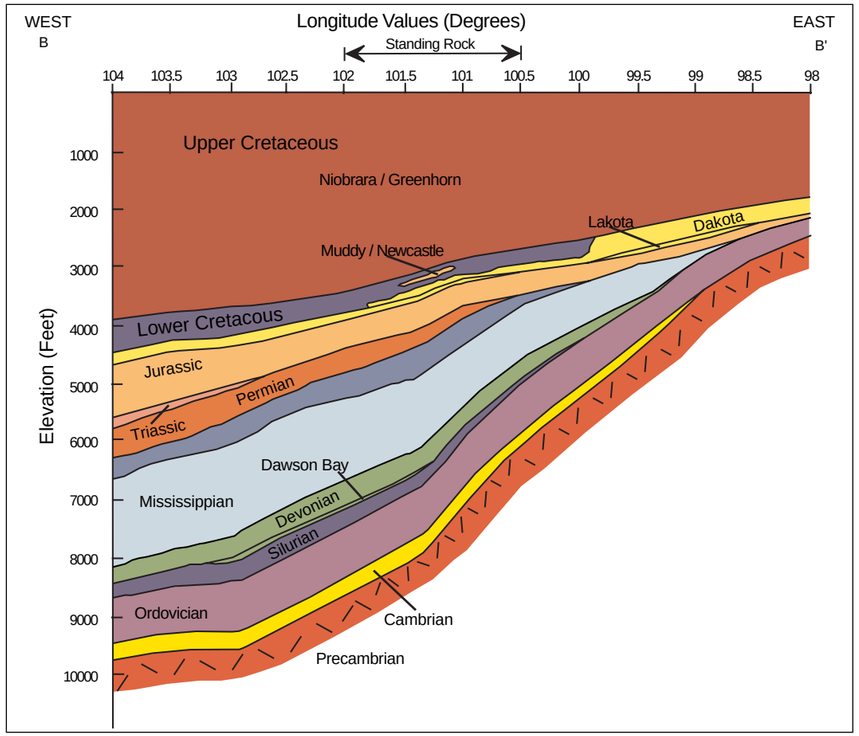

Figure SR-3.1. Paleo cross-section B-B' containing the Precambrian to Upper Cretaceous section. Cross-section is located along the 46 degree latitude line with selected points every half degree of longitude.

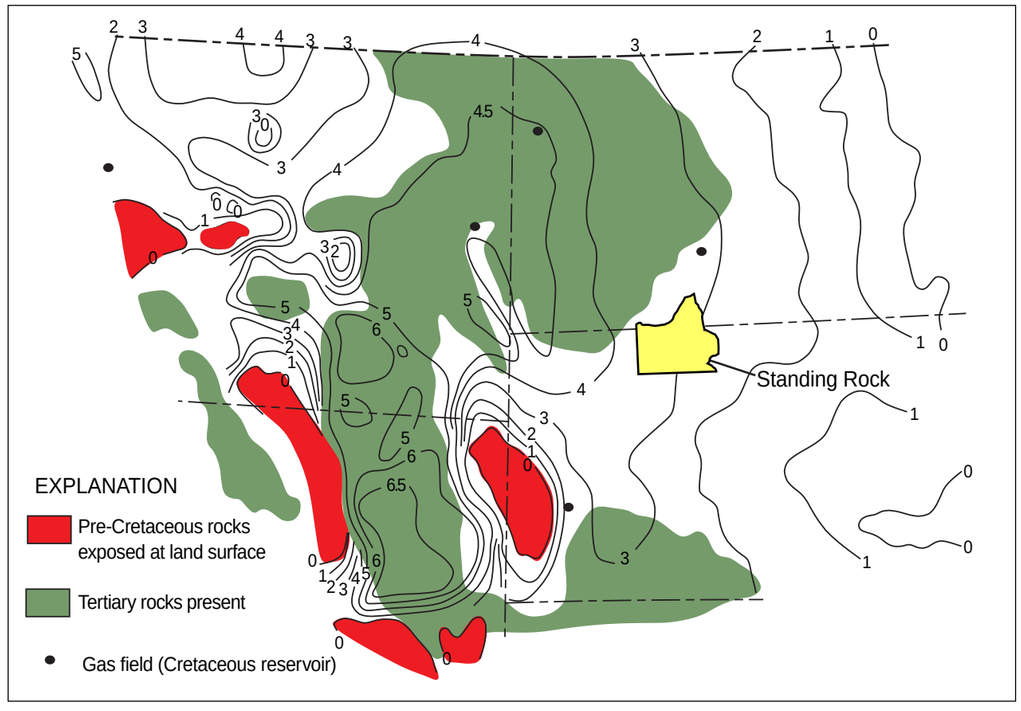

Figure SR-3.2. Thickness of Cretaceous rocks in thousands of feet, showing areas where Tertiary rocks are present. Gas fields producing from Cretaceous sandstones are outlined (modified after McGookey et al. 1972).

Mississippian to Upper Cretaceous

By Pennsylvanian time, the Sioux Arch south and east of the Reservation was continuing to rise. Whether Pennsylvanian units were deposited on the ancestral Sioux Arch is unknown. Units west of Standing Rock thicken. Pennsylvanian production from eolian deposits exist in Fall River County, South Dakota. Pennsylvanian rocks are about 450 feet thick and thin eastward rapidly. Continued uplifting of the Sioux Arch occurred during Precambrian and Triassic time. Units are thin to nonexistent. Depth of burial in the central Williston Basin was sufficient for Ordovician Red River and Silurian Interlake source rocks to mature and oil migration begin.

In Jurassic time, the Williston was still the major depocenter for clastic and marine carbonate / evaporite sediments. Thickness of Jurassic rocks is estimated to be about 300 to 400 feet. Jurassic units thin south and east across the Sioux Arch.

The early Cretaceous saw reactivation of the Sioux Arch and the Standing Rock "hinge line". Most of the Lakota in the Williston and areas south and west are fluvial deposits from highlands in South Dakota. By this time, Devonian age rocks had probably reached thermal maturity in the center of the basin, and oil migration had begun.

During Skull Creek-Mowry time (Lower Cretaceous), the area east of the Reservation was characterized by continued erosion of exposed Precambrian rocks and deposition of very thick sand units. This "Dakota" sandstone thins westward and northward toward the Williston and the Black Hills. The shoreline, continental sands of the "Dakota" gradually become more marine and lenticular "offshore sand bars". The sands are encased in marine shales. The Dakota consists of numerous "tongues" of sandstone. The lowermost "tongue" surrounded by marine shales, and above the "Dakota" is called the "Muddy", and gas is produced from the "Pierre Gas Field", south and east of the Reservation.

By the Early Cretaceous, the Cretaceous Seaway had established itself, and areas west and south of the Reservation were rapidly subsiding. Greenhorn and Niobrara chalks were deposited in the eastern and southern Dakotas, Nebraska, and Colorado. Eagle and Judith River sands (and the equivalent, Shannon / Sussex sandstones) were deposited in western South Dakota, Wyoming, and Montana. Mississippian and Pennsylvanian rocks in the Williston had reached thermal maturity by this time and oil migration had begun

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Tertiary and Younger

In early Tertiary time (Paleocene / Eocene), fluvial and swamp environments were present in the southern Williston. These rocks were deposited and later removed by erosion, and the area was uplifted. The Sioux arch and adjacent "hinge line" were activated. During the Quaternary, the area was glaciated just to the northeast of the Reservation and the ancestral Missouri River began eroding the Badlands.

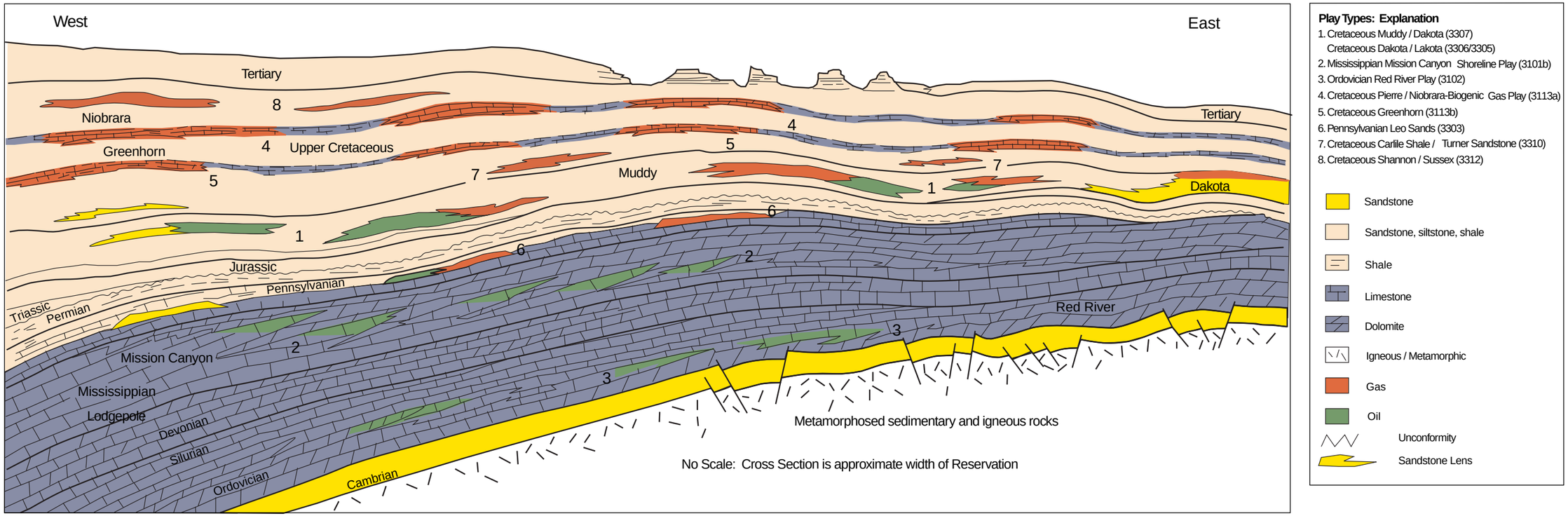


Figure SR-4.1. Schematic Diagram of Play Types - Standing Rock Reservation.

Reservation:	**Standing Rock**	**Total Production (by province-1995)**	**Williston Basin**	**Undiscovered resources and numbers of fields are for Province-wide plays. No attempt has been made to estimate number of undiscovered fields within the Standing Rock Reservation**	
Geologic Province:	**Southern Williston Basin**	**Oil:**	**1435 MMBO**		
Province Area:	**Williston Basin (143,000 sq. miles)**	**Gas:**	**1680 BCFG**		
Reservation Area:	**3852 sq. miles (2,465,280 acres)**	**NGL:**	**186 MBNGL**		

Play Type	USGS Designation	Description of Play	Oil or Gas	Known Accumulations	Undiscovered Resource (MMBOE) Field Size (> 1 MMBOE) min, median, mean	Play Probability (chance of success)	Drilling depths	Favorable factors	Unfavorable factors
Muddy / Dakota Dakota / Lakota **1**	3307 3306 3305	sand bar traps, sands draped across anticlinal structures	Both	New play for this area. No previous production; Pierre Gas Field discovered 1889; Numerous shows from water wells.	New Play; no estimate made of Gas reserves; few records kept. Pierre Gas Field covers several counties.	not estimated	2000 - 4000 ft	1) confirmed play; gas produced outside of reservation 2) thermally mature source rocks 3) source rocks and reservoir present 4) shallow drilling	1) lack of well control 2) rough topography 3) porosity and facies may be highly variable 4) may be all gas and no oil
Madison shoreline/ truncation play **2**	3101b	Cyclic evaporite/ carbonate sequence, structure/stratigraphic updip pinchout, multiple shoreline cycles	Both	878 MMBO 916.5 BCFG 77.9 MMBNGL (numbers include 1, 2,& 3)	**Median:** 600 MMBO (30 fields @ 20MMBO) **Field Size (>1MMBOE)** 2 MMBO(min) 20 MMBO(max) 5.3 MMBO(mean) **No. of undiscovered fields (> 1 MMBOE)** 9 (min) 30 (median) 60 (max) 31.9 (mean) numbers include plays 1, 2, & 3	1 not estimated	4800 - 5900 ft	1) shows in well on reservation 2) thermally mature source rocks 3) source rocks and reservoir present 4) mostly shallow drilling depths	1) lack of well control 2) rough topography 3) porosity and facies may be highly variable 4) seismic may not be able to delineate shoreline trends
Ordovician Red River Play **3**	3102	Cyclic evaporite/ carbonate sequence, structure/stratigraphic updip pinchouts; multiple shoreline cycles	Both	188.3 MMBO 555.7 BCFG 70.5 MMBNGL	**Median:** 250 MMBO (25 fields @ 10 MMBO) **Field Size (>1 MMBOE)** 2 MMBO/10 BCFG(min) 10 MMBO/35 BCFG(max) 2.1 MMBO/11.7 BCFG(mean) **No. of undiscovered fields (> 1 MMBOE)** 5 (min) 25 (median) 50 (max) 26 (mean)	1 not estimated	4000 - 6700 ft	1) shows in well on reservation 2) thermally mature source rocks 3) source rocks and reservoir present 4) seismic useful in locating structures	1) lack of well control 2) rough topography 3) possible small exploration targets
Niobrara Biogenic Gas Play **4**	3113a	Niobrara Limestone self-source; Porosity decreased with increasing depth; Large volume accumulations possible; May be fractured	Biogenic Gas	no Niobrara production in Williston Basin; however, many shows observed	not estimated 180 MMCFG/160 acres (median) 256 MMCFG/160 acres (mean) Area of play = 55,000 sq. miles 20,000 sq. miles untested (median) 29,958 sq. untested (mean)	1 0.5	500 - 2500 ft	1) large volume play 2) shallow drilling depths 3) accumulations in stuctural traps 4) seismic useful in locating structures	1) lack of well control 2) rough topography 3) small exploration targets 4) lack of reservoir

Table SR-1. Summary of Play Types for the Standing Rock Reservation

Reservation:	**Standing Rock**		**Total Production (by province-1996)**	**Williston Basin**	**Undiscovered resources and numbers of fields are for Province-wide plays. No attempt has been made to estimate number of undiscovered fields within the Standing Rock Reservation**				
Geologic Province:	**Southern Williston Basin**		**Oil:**	**1435 MMBO**					
Province Area:	**Williston Basin (143,000 sq. miles)**		**Gas:**	**1680 BCFG**					
Reservation Area:	**3852 sq. miles (2,465,280 acres)**		**:**	**186 MBNGL**					

Play Type	USGS Designation	Description of Play	Oil or Gas	Known Accumulations	Undiscovered Resource (MMBOE) Field Size (> 1 MMBOE) min, median, mean	Play Probability (chance of success)	Drilling depths	Favorable factors	Unfavorable factors
Greenhorn Biogenic Gas Play **5**	3113b	Greenhorn Limestone and other shallow reservoirs self-source; porosity decreases with increasing depth; large volume accumulations possible; may be fractured	Biogenic Gas	No production in Williston Basin; however shows have been observed; log response may be similar to Niobrara	not estimated 180 MMCFG/160 acres (median) 256 MMCFG/160 acres (mean) Area of play = 55,000 sq. miles 20,000 sq. miles untested (median) 29,958 sq. mi untested (mean)	1 0.5	1500 - 2500 ft	1) large volume play 2) shallow drilling depths 3) accumulations in structural traps 4) seismic delineation is useful	1) lack of well control 2) rough topography 3) lack of reservoir 4) small reserves 5) detailed log analysis
Pennsylvanian Leo Sands Play **6**	3303	Eolian (sand dune) deposits with evaporite seals; may have structural component	Gas	No production in Williston Basin; nearest production in Fall River County, South Dakota	not estimated 180 MMCFG/160 acres (median) 256 MMCFG/160 acres (mean) Area of play = 55,000 sq. miles 20,000 sq. miles untested (median) 29,958 sq. mi untested (mean)	not estimated	3000 - 5000 ft	1) source and reservoir 2) thermally mature source rocks 3) shallow drilling depths 4) Minnelusa / Leo shows in adjacent counties	1) lack of well control 2) rough topography 3) no production on Reservation
Carlile / Turner Play **7**	3310	Tight marine sandstone bars; equivalent to 1st Frontier in Wyoming; thickness from 5 to 35 feet; stratigraphic trap	Biogenic Gas	No production in Williston Basin; nearest production in Wyoming; shows in wells south of Reservation	not estimated 180 MMCFG/160 acres (median) 256 MMCFG/160 acres (mean) Area of play = 55,000 sq. miles 20,000 sq. miles untested (median) 29,958 sq. mi untested (mean)	1 0.5	1500 - 2500 ft	1) shows south of Reservation 2) multiple targets; serendipity factor 3) shallow drilling depths	1) lack of good reservoir 2) rough topography 3) lack of well control 4) small targets
Shannon / Sussex Play **8**	3312	Shannon is a marine sandstone; longshore bar; thickness 10-30 feet, width from 0.5 to 3 miles, length from 5 to 20 miles	Biogenic Gas	No production in Williston Basin, except Eagle sand equivalent on Cedar Creek Anticline; Shannon produces at Cady Creek and West Short Pine Hills in Harding County, South Dakota	not estimated 180 MMCFG/160 acres (median) 256 MMCFG/160 acres (mean) Area of play = 55,000 sq. miles 20,000 sq. miles untested (median) 29,958 sq. mi untested (mean)	1 0.5	500 - 2000 ft	1) shows in adjacent counties 2) shallow drilling 3) apparent "sandbar" on logs	1) lack of well control 2) rough topography 3) lack of reservoir 4) small targets

Table SR-5.1. Summary of Play Types (continued).

Conventional play type

Unconventional/Hypothetical play type

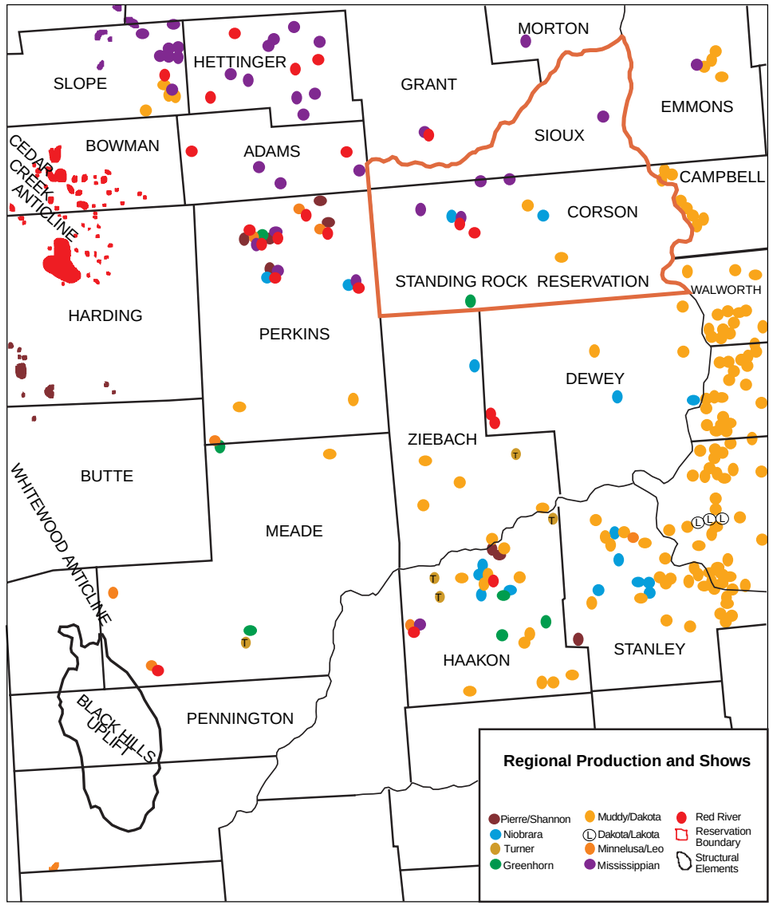


Figure SR-6.1. Regional Production and Shows for Standing Rock Reservation. The regional map shows areas of oil and gas production or areas where hydrocarbon shows were encountered in the vicinity of Standing Rock Reservation (red outline). The colors correspond to the stratigraphic formation or interval in which the production or show is associated (after United States Geological Survey, 1996).

Standing Rock Reservation
General Production Information

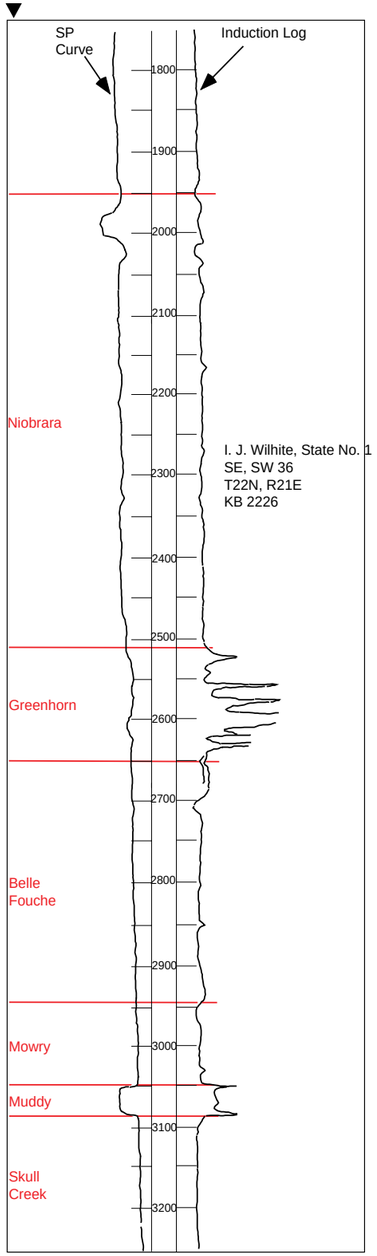
U.S.G.S. Geological Province:	Williston Basin (031)
Tectonic Province:	Southern Edge Williston Basin
Overall Production from U.S.G.S. Play Production Province:	See Individual Play Descriptions

Fields outside reservation boundaries: (1995 Cumulative Production)

(1954) **Buffalo Field**: 19.8 MMBO, 47.2 MMCF, 93 wells (Red River-Harding County)
(1971) **Lantry**: 135 MBO, 1 well (Red River-Dewey County)
(1975) **Jones Creek**: 517 MBO, 3.6 MMCF, 3 wells (Red River-Harding County)
(1959) **Barker Dome**: 217 MBO, 4 wells (Leo sands-Fall River County)
(1981) **Alum Creek**: 2.1 MMBO, 3.3 MMCF, 5 wells (Leo sands-Fall River County)
(1977) **West Short Pine Hills**: 15.2 MMCF, 43 wells (Shannon-Harding County)
(1979) **Cady Creek**: 2.1 MMCF, 10 wells (Shannon-Harding County)
(1989) **Pierre Gas Field**: unknown; supplied gas to the city of Pierre until the mid-1960's; volume produced is unknown (Dakota / Muddy-Hughes, Stanley Counties)

Shows encountered within reservation boundaries: Red River, Mission Canyon, Greenhorn, Dakota / Muddy, Minnelusa (?), Niobrara

Figure SR-6.2. Type log of Lower Cretaceous section in South Dakota (after Howells, 1982).



Standing Rock reservation area is underexplored with numerous exploration possibilities in biogenic gas and stratigraphic pinchout horizons. Further drilling and seismic analysis should delineate exploration targets within this area.

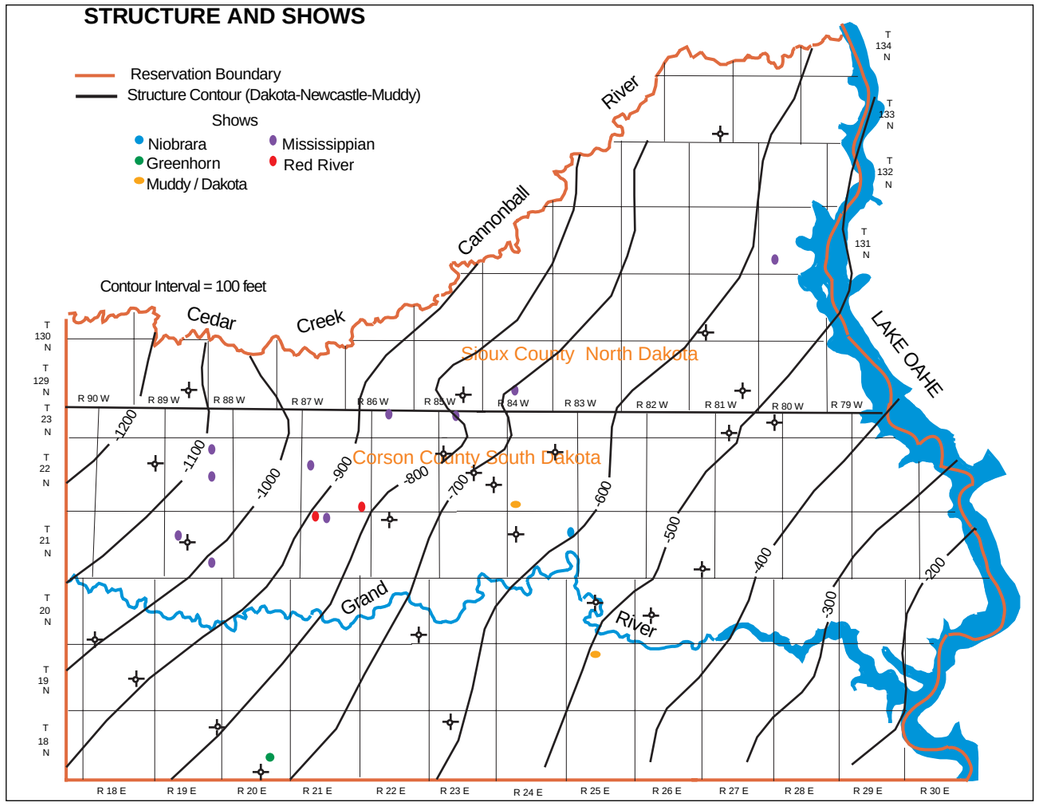


Figure SR-6.3. Structure contour map (top Dakota-Newcastle-Muddy) across reservation. Hydrocarbon shows indicated by formation (after Howells, 1982).

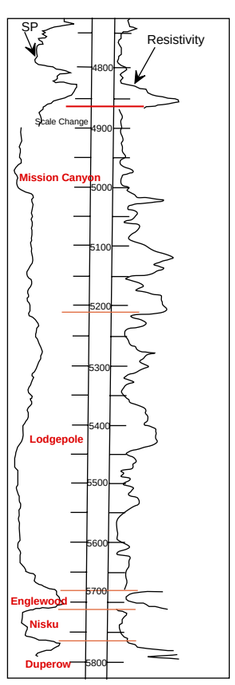


Figure SR-6.4. Type log of Devonian-Mississippian section in central Williston Basin (after Howells, 1982).

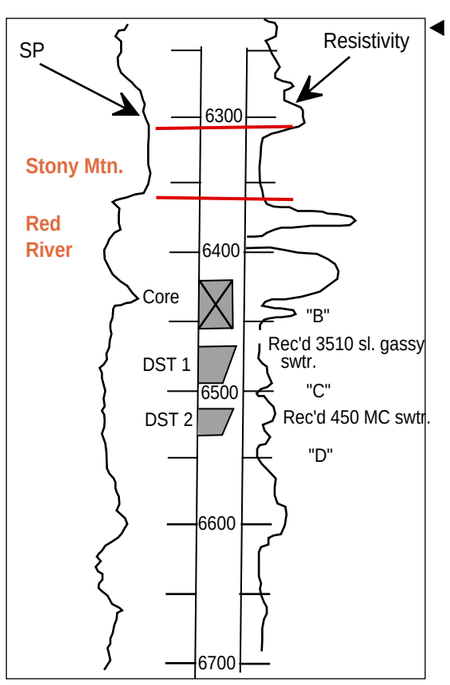


Figure SR-6.5. Type log for Red River hydocarbon show. From well within reservation boundary (after Howells, 1982).

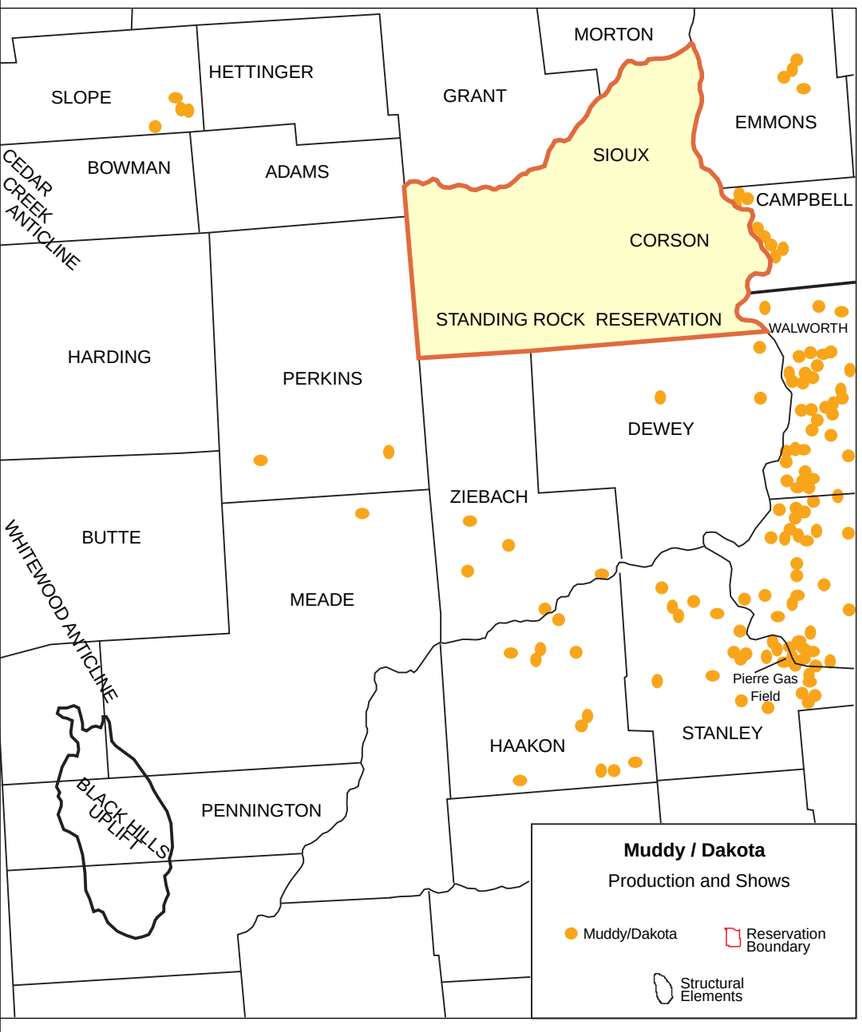
PLAY TYPE 1

Cretaceous Muddy / Dakota Play / Lakota Play

General Characteristics- Normally considered a Powder River Basin Play, the Dakota / Newcastle / Muddy has potential in this part of the Williston Basin. The Pierre Gas Field, located in Hughes and Stanley Counties, supplied gas to the city of Pierre since 1889. The Dakota sandstone is a continental to nearshore fluvial deposit. (see figure SR-7.2) The Dakota is an aquifer near Pierre and to the north and east, however gas has been produced from dozens of water wells, possibly trapped by local structure.

West of Pierre, the Dakota splits into nearshore and marine sandstone lenses. The lowermost, commonly called the Newcastle / Muddy, is equivalent to the Muddy of the Powder River Basin. South of Pierre, the Dakota may have "Lakota" present, which would be Lower Cretaceous and is more continental than the marine Muddy sand lenses.

Source rock would be the Skull Creek and Mowry marine shales. Gas analysis of the Pierre gas is mainly methane with small amounts of ethane and propane. Some of the gas contains significant volumes of carbon dioxide and nitrogen. Shows on the reservation include gas-cut salt water and flammable gas on DST's.



◀ **Figure SR-7.1.** General location map of reservation indicating position of Muddy/Dakota hydrocarbon shows.

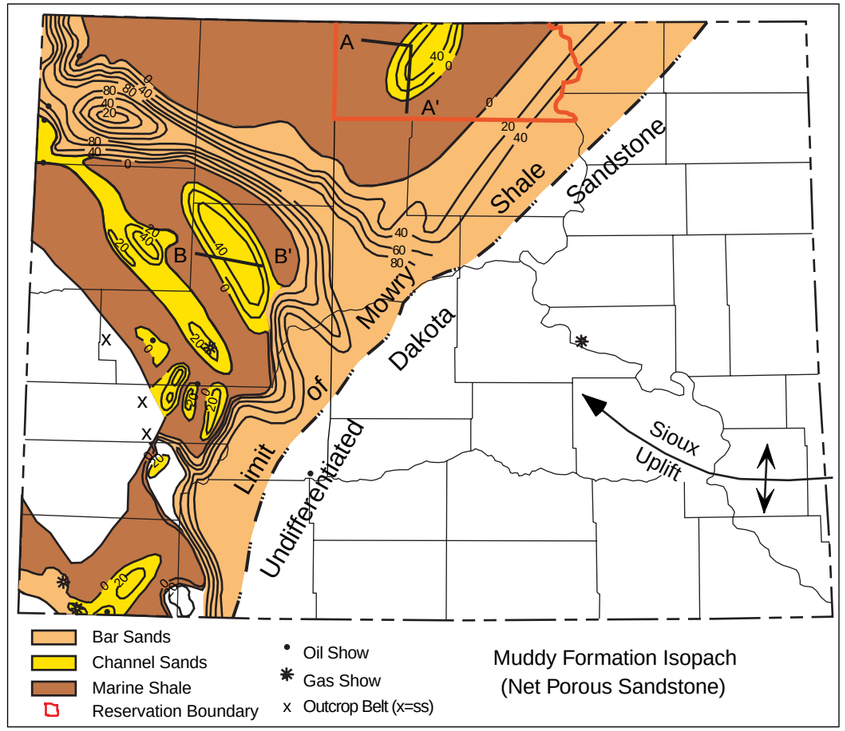


Figure SR-7.2. Distribution of facies and isopach thickness of Muddy Formation. Contour interval is 20 feet. Note the position of channel sands within the reservation boundary. Note location of cross-section A-A' (after Bolyard, 1969).

Pierre Field Parameters

Nearest Muddy Formation hydrocarbon production to reservation

Formation:	Cretaceous Dakota / Muddy / Lakota
Lithology:	sandstone
Average Depth:	1000 to 1500 feet
Porosity:	unknown
Permeability:	unknown; but probably very high
Oil / Gas Column:	unknown
Average Net Pay Thickness:	variable

Other Information: gas was produced from 1889 to mid-1960s; poor records were kept; but numerous wells drilled had flow rates between 25,000 cfpd to 85,000 cfpd; gas is methane with traces of ethane and propane; nitrogen content 3 to 5%

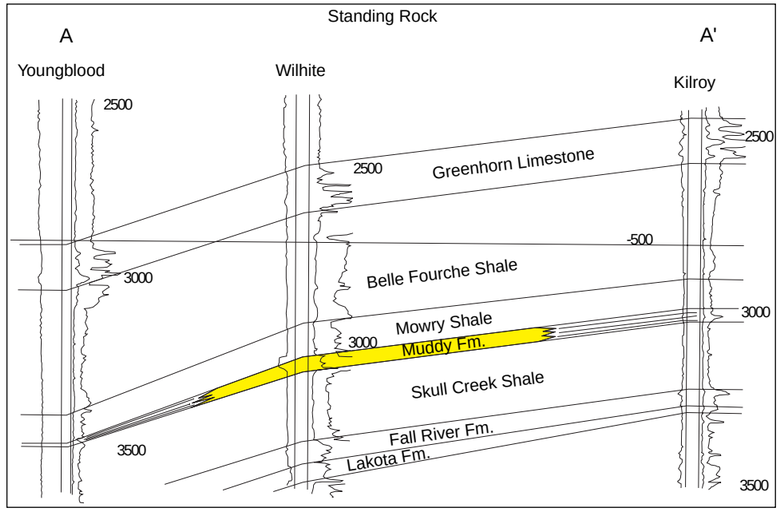


Figure SR-7.3. Cross-section A-A' (see figure SR-7.2. for location of cross-section) across Muddy Formation facies within reservation. Shows the stratigraphic pinch out relationship of the sandstone and shale in this interval (after Bolyard, 1969).

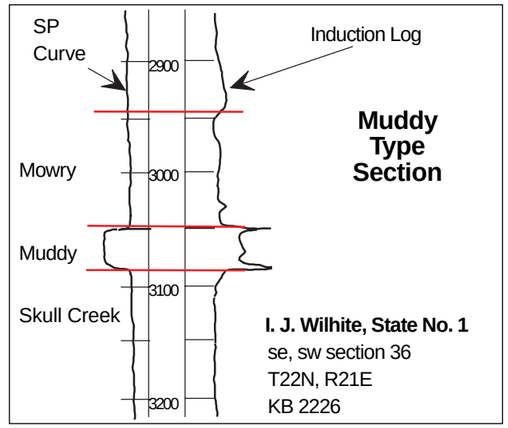


Figure SR-7.4. Type log of Muddy Formation within reservation (after Bolyard, 1969).

Bell Creek Field Parameters

Field parameters from other Muddy Formation production.
This field located in Powder River Basin.

Formation:	Cretaceous Muddy
Lithology:	white, very fine-grained sandstone
Average Depth:	4500 feet
Porosity:	27%
Permeability:	1700 md
Oil / Gas Column:	two separate gas reservoirs
Average Net Pay Thickness:	24 feet
Other Shows:	none reported

Other Information: oil gravity 34 API; discovered 1967; cumulative production (1995) estimated at 100 MMBO; pure stratigraphic trap

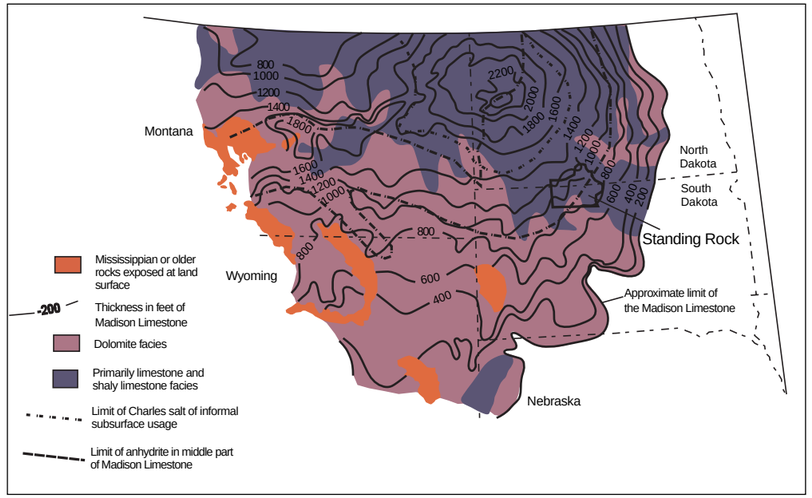


Figure SR-6.1. Thickness in feet and generalized rock facies of the Madison Group (Mississippian) and equivalent rocks (modified (after Peterson, 1981, 1984b).

Analog Fields (outside Reservation)

Plaza: 2.6 MMBO, 1.7 MMCF, from 20 wells, 3-4 MMBO ultimate (Bluell)

Wabek: 5.1 MMBO, 3.6 MMCF, from 18 wells, 6-7 MMBO ultimate (Sherwood)

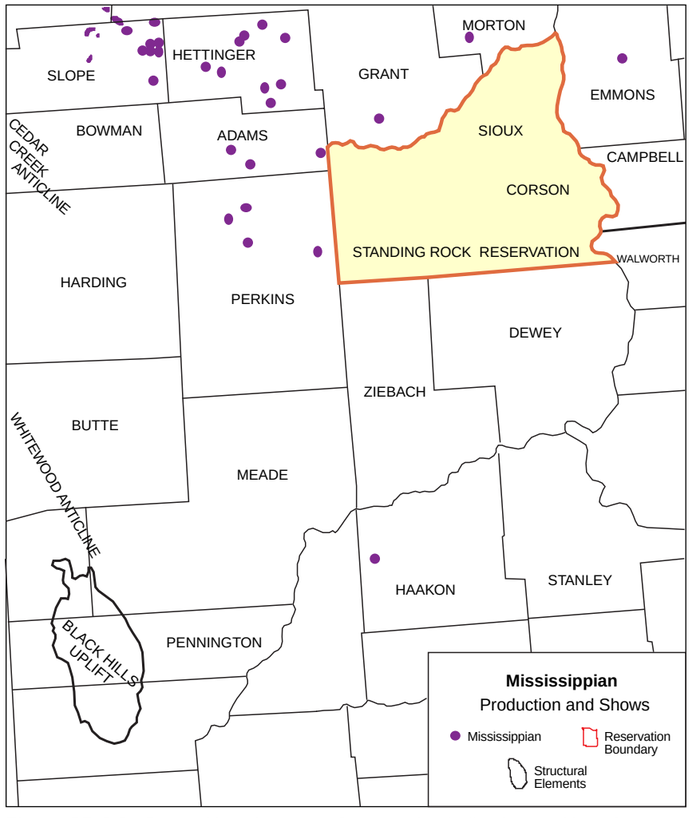


Figure SR-8.2. General location map of reservation indicating position of Mississippian hydrocarbon shows (after Peterson and MacCary, 1987).

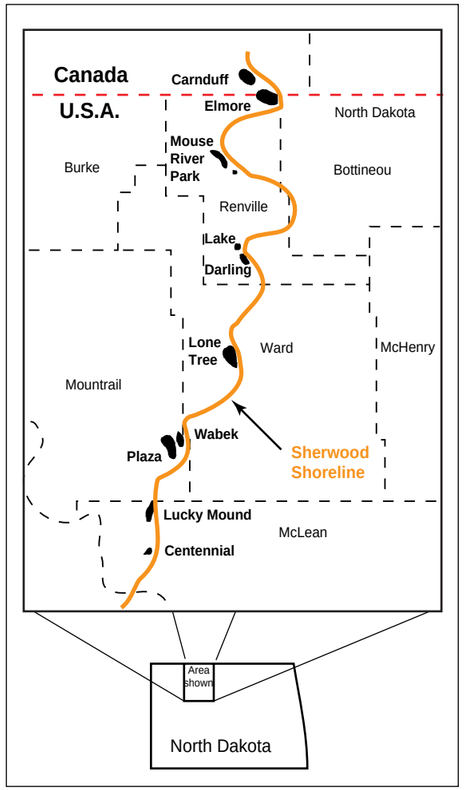


Figure SR-8.3. Sherwood Shoreline trend and position of major oil fields (after Sperr, et al, 1993).

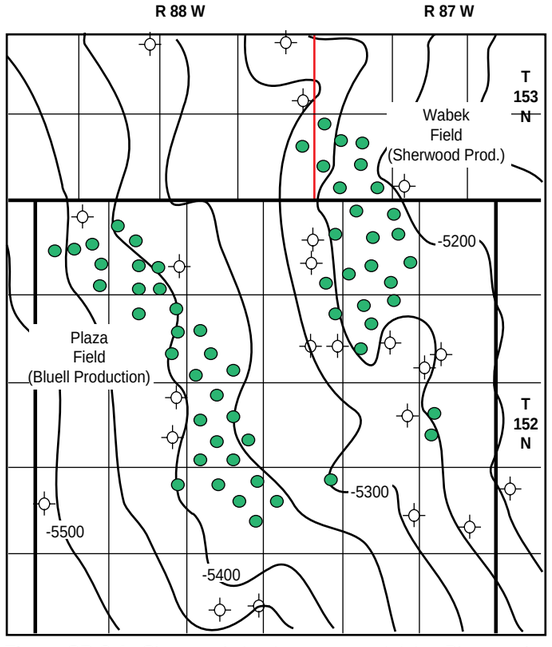


Figure SR-8.4. Sherwood structure map containing Plaza and Wabek fields (after Sperr, et al, 1993).

PLAY TYPE 2

Mississippian Shoreline Play

General Characteristics - This play is an extension of the northeast shelf play which produces from Sherwood and Bluell porosity cycles. The Mississippian subcrops (truncated by Triassic Spearfish), in descending order eastward: Midale, Bluell, Sherwood, Mohall, Glenburn, Landa, Wayne, and finally Lodgepole.

Several of the lower cycles should be present on the reservation. Reservoirs are dolomitized carbonates of either algal, oolitic, or bioherm banks in one or more of the above mentioned intervals. The updip seal can either be an evaporite or a shale. Source rock could be the Bakken Shale or one of the marine shales within the evaporite sequence. Source rocks are thermally mature in the center of the basin and immature on the flanks. Onset of oil generation and migration is thought to have occurred in Late Cretaceous. Time regional cross-sections indicate the presence of a paleoridge and shelf area during Devonian and Mississippian time. Bakken Shale is apparently on the north side of this ridge, just outside the reservation boundaries. Shows in the Mississippian include oil staining in core, oil flecks, gas and mud emulsion, and free gas recovery on DST.

Wabek Field Parameters

Formation:	Mississippian Mission Canyon, Sherwood subinterval
Lithology:	light brown to brown, peloidal, oolitic, pisolitic, intraclastic and composite grain wackestone to grainstone
Average Depth:	7300 to 7350 feet
Porosity:	intergranular, vugular, and interparticle, 6-26%; average of 10%
Permeability:	unknown
Oil / Gas Column:	100 feet
Average Net Pay Thickness:	26 feet
Other Shows:	information not available

Other Information: due to the shoreline sequences, lower cycles may exist at Standing Rock as opposed to the Sherwood / Bluell cycles; detailed log correlation from the center of the basin would be required to determine which cycles are present

Plaza Field Parameters

Formation:	Mississippian Mission Canyon, Bluell subinterval
Lithology:	light brown to brown, peloidal, oolitic, pisolitic, intraclastic and composite grain wackestone to grainstone
Average Depth:	7400 to 7500 feet
Porosity:	intergranular, vugular, and intraparticle, 6-16%
Permeability:	unknown
Oil / Gas Column:	at least 120 feet, oil / water contact is currently unknown
Average Net Pay Thickness:	6 feet
Other Shows:	information not available

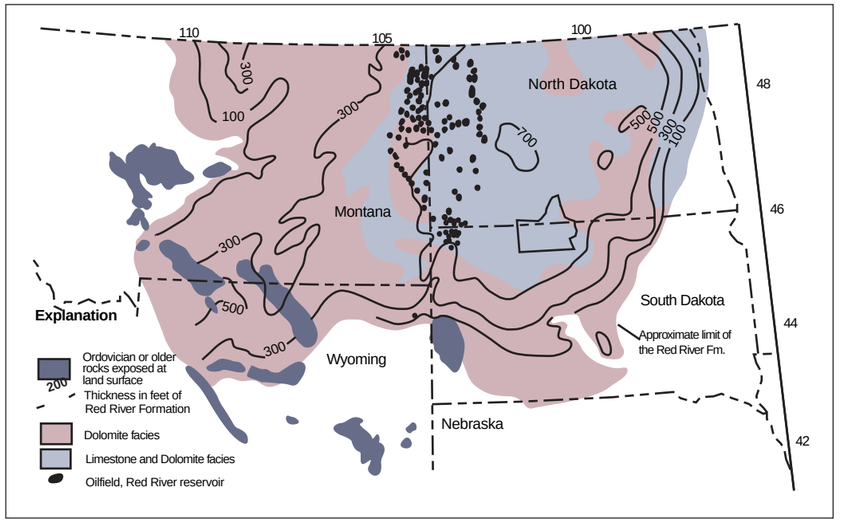
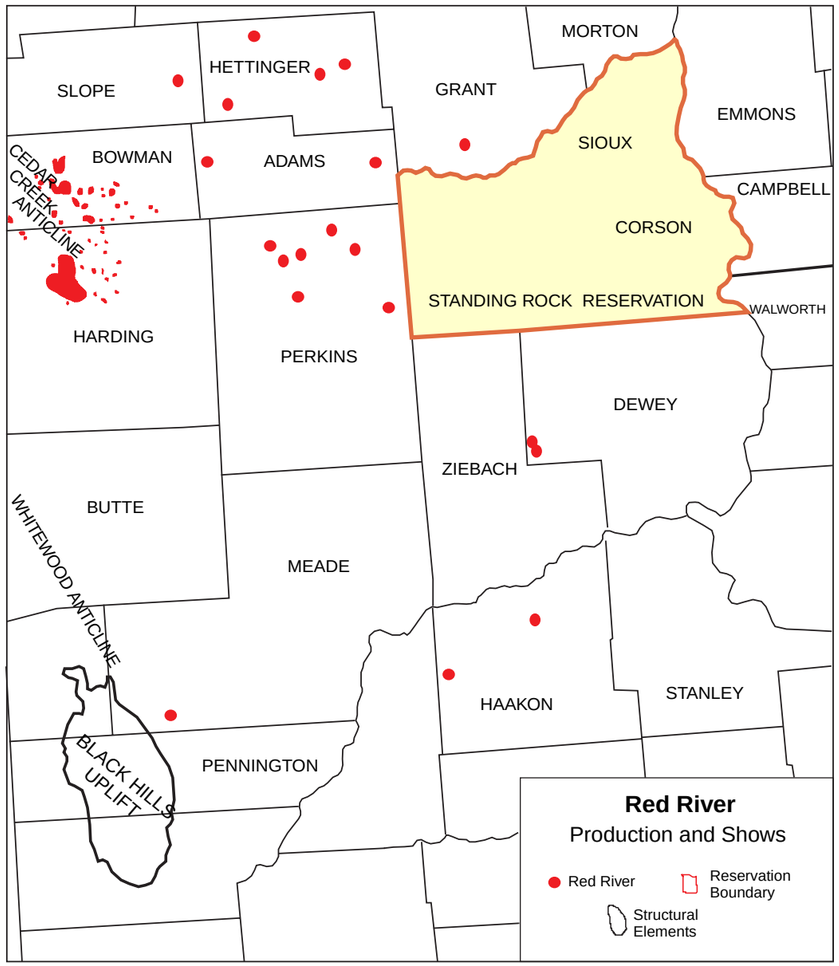


Figure SR-9.1. Thickness in feet and generalized rock facies of the Red River (Ordovician) and equivalent rocks (after Peterson; 1981, 1984b).



◀ **Figure SR-9.2.** General location map of reservation indicating position of Red River hydrocarbon shows.

PLAY TYPE 3

Ordovician Red River Play

General Characteristics - The Red River Formation is the second most productive formation in the Williston Basin. Reservoirs are dolomites and dolomitic limestones formed from bioclastic mounds and tidal flat deposits. Cyclic episodes of carbonate, evaporite, and organic rich shale provide reservoir, source, and seal.

Major accumulations are found on structural noses such as Nesson and Cedar Creek Anticline. Smaller fields are found in fold structures draped over basement fault blocks, or small, carbonate mounds. Accumulations in Harding County are thought to be primarily stratigraphic traps.

Source rock is thermally mature to overmature at the basin center, and pinches out on the basin flanks. Winnipeg shale and marine shale of the Red River Formation are thought to be the primary source rock. Hydrocarbon generation and migration is estimated to have begun in Late Paleozoic time.

The nearest Red River production is thirty miles south of the reservation in Dewey County. Shows are present within the reservation and include oil staining in core, and gas and oil cut mud and water on DST's.

Buffalo Field Parameters

(an example of Cedar Creek Anticline production)

Formation:	Ordovician Red River
Lithology:	limestone / dolomite
Average Depth:	8600 feet
Porosity:	20%
Permeability:	unknown
Oil / Gas Column:	unknown
Average Net Pay Thickness:	15 feet
Other Formations with Shows:	Charles and Red River

Other Information: initial IP 80 BOPD; gravity 30 API; 200 BWPD; cumulative production (1995) 19.8 MMBO, 47.2 MMCF, 93 wells; Harding County; primarily a stratigraphic trap

Lantry Field Parameters

Formation:	Ordovician Red River
Lithology:	limestone / dolomite
Average Depth:	5000 feet
Porosity:	10%
Permeability:	unknown
Oil / Gas Column:	unknown
Average Net Pay Thickness:	30 feet
Other Formations with Shows:	Mission Canyon, Stony Mountain, and Red River

Other Information: initial IP 24 BOPD; gravity 22 API; 62 BWPD; cumulative production (1995) 135 MBO, 5.2 MMBW, 1 well; Dewey County; primarily a structural / stratigraphic trap; also produces large volumes of 140 degree formation water.

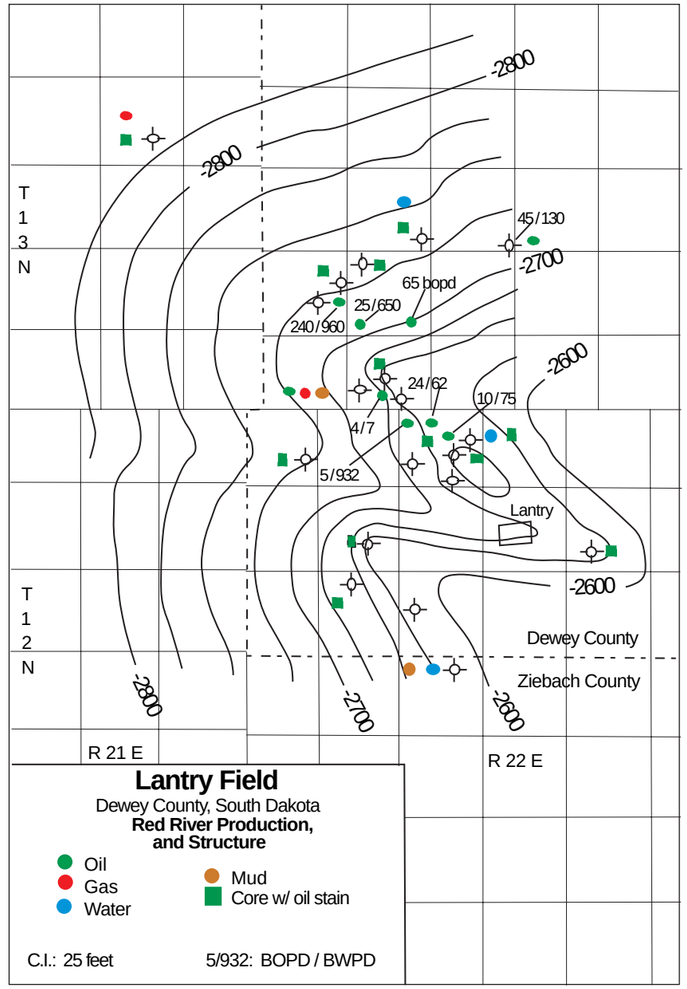


Figure SR-9.3. Structure contour map and production of Red River Fm, Lantry Field.

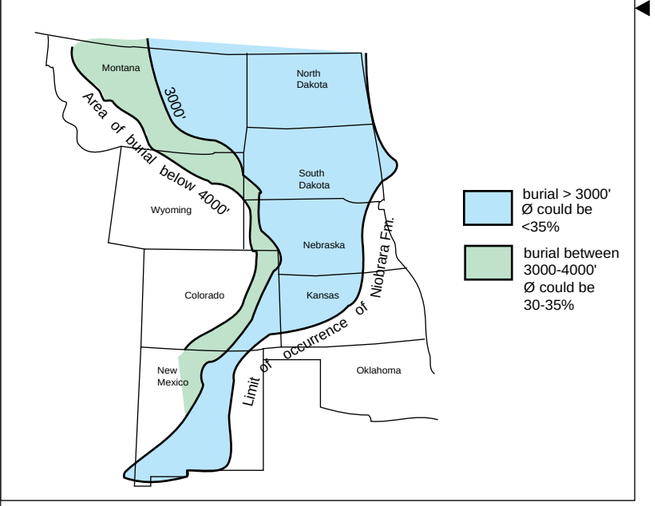
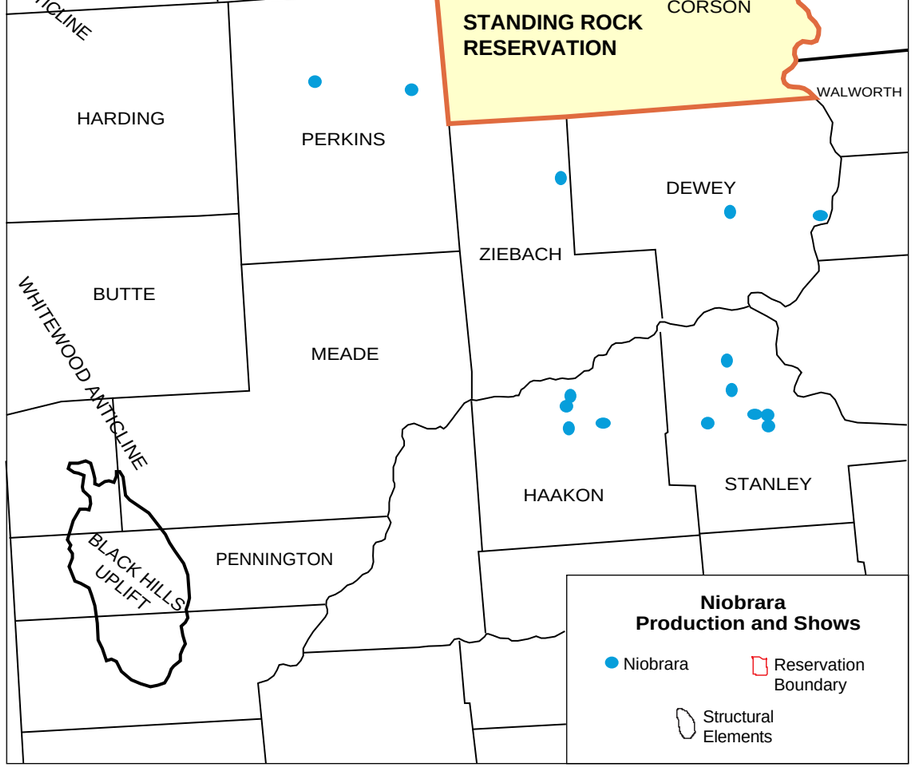


Figure SR-10.1. Regional map indicating burial depth of Niobrara and possible porosity in the area (after Lockridge and Pollastro, 1988).

Figure SR-10.2. General location map of reservation indicating position of Niobrara hydrocarbon shows (after United States Geological Survey, 1996).



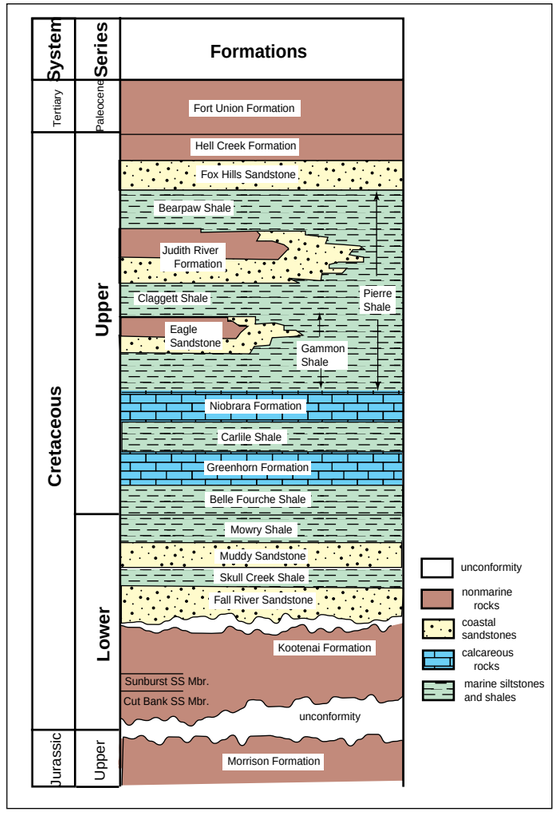


Figure SR-10.3. General correlation chart of Cretaceous rocks in Rice and Shurr's study area (after Rice and Shurr, 1980).

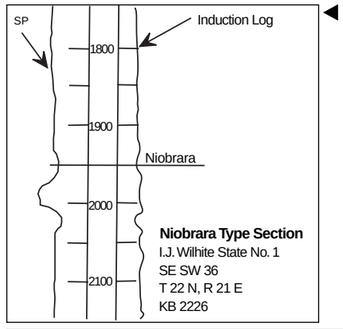


Figure SR-10.4. Niobrara type section (after Lockridge and Pollastro, 1988).

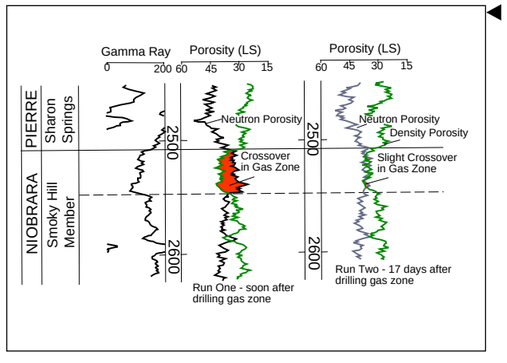


Figure SR-10.5. Example of effect of driling time and invasion on density and neutron porosity logs (FDC and CNL). J-W Operating No. 2 Kitzmiller, NW NW Sec. 4, 4-T3N-R45W, Yuma County, Colorado (after Lockridge and Pollastro, 1988).

PLAY TYPE 4
Cretaceous Pierre / Niobrara Biogenic Gas Play

General Characteristics- Upper Cretaceous Niobrara is a chalk and calcareous shale that covers most of the western interior from Kansas and Eastern Colorado into the Dakotas. It is assumed that a Niobrara gas play similar to the eastern Denver Basin (Beecher Island Field, Goodland Field) exists in the southern Williston Basin. Niobrara production in the Denver Basin is considered a self-sourced, continuous extent gas field.

Estimated thickness of the Niobrara would be greater that 100 feet, and depth of burial is less than 1000 feet. Area of subcrop or outcrop might affect gas generation. Areal extent of production might be as small as 25 square miles.

Shows on the Reservation include gas encountered in the Niobrara section, and bleeding gas from fractures in Niobrara core. Shows are present outside of the Reservation in Dewey County (high background gas in the Niobrara), Perkins County (high background gas in Niobrara) and in Stanley and Haakon Counties (free gas has been encountered, which is mainly methane with trace amounts of ethane and propane, and gas flares).

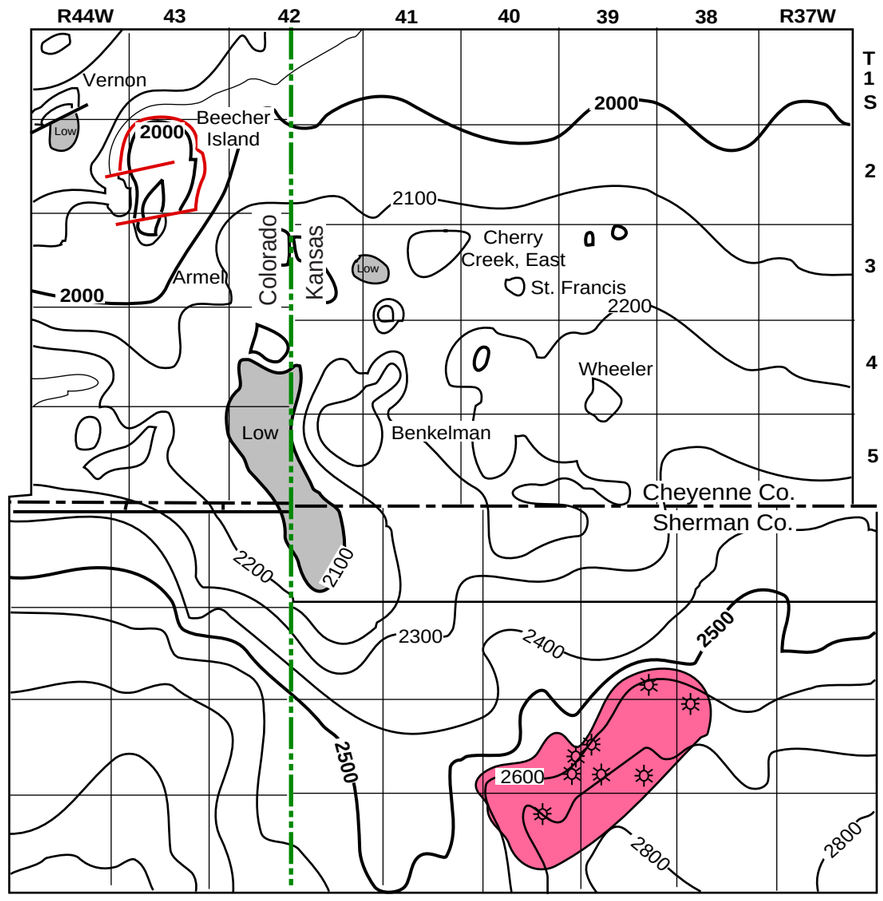


Figure SR-10.6. Structure map on top of the Niobrara Formation, northwestern Kansas showing a Niobrara gas field (in red). Contour interval is 100 feet. Hypothetical or unconventional play analog for Ft. Berthold reservation (after Lockridge and Pollastro, 1988).

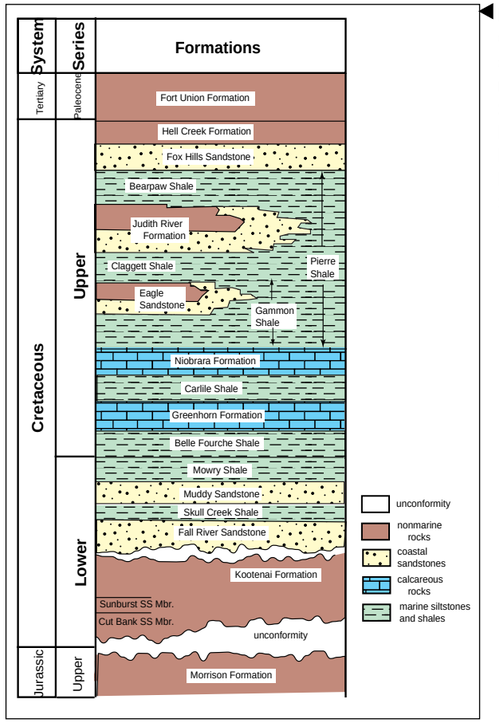


Figure SR-11.1. General correlation chart of Cretaceous rocks in Rice and Shurr's study area - Montana, Wyoming, North and South Dakota (after Rice and Shurr, 1980).

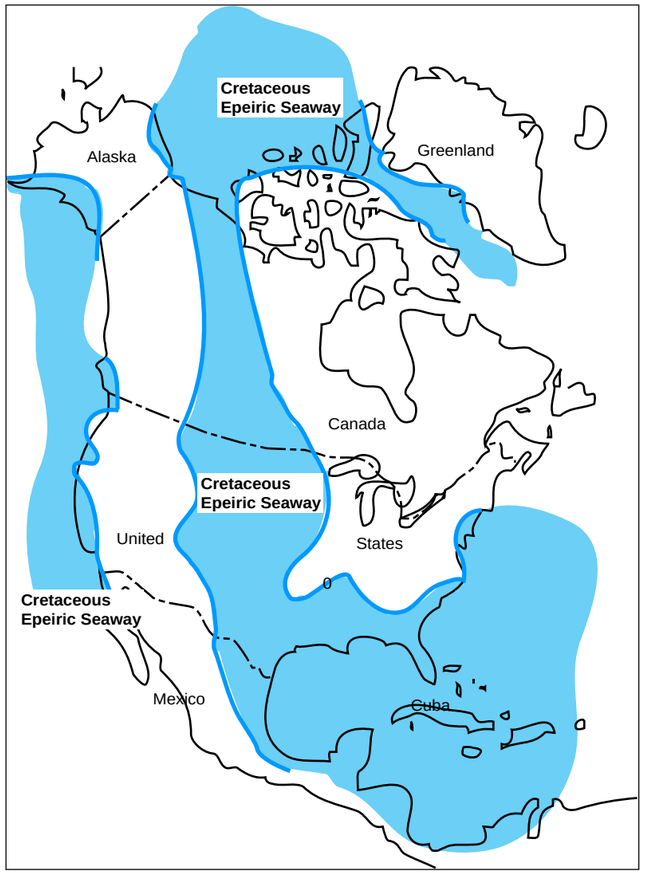


Figure SR-11.3. Paleogeographic map of North America during Late Cretaceous time, showing the extent of the Cretaceous seaway (after Rice and Shurr, 1980).

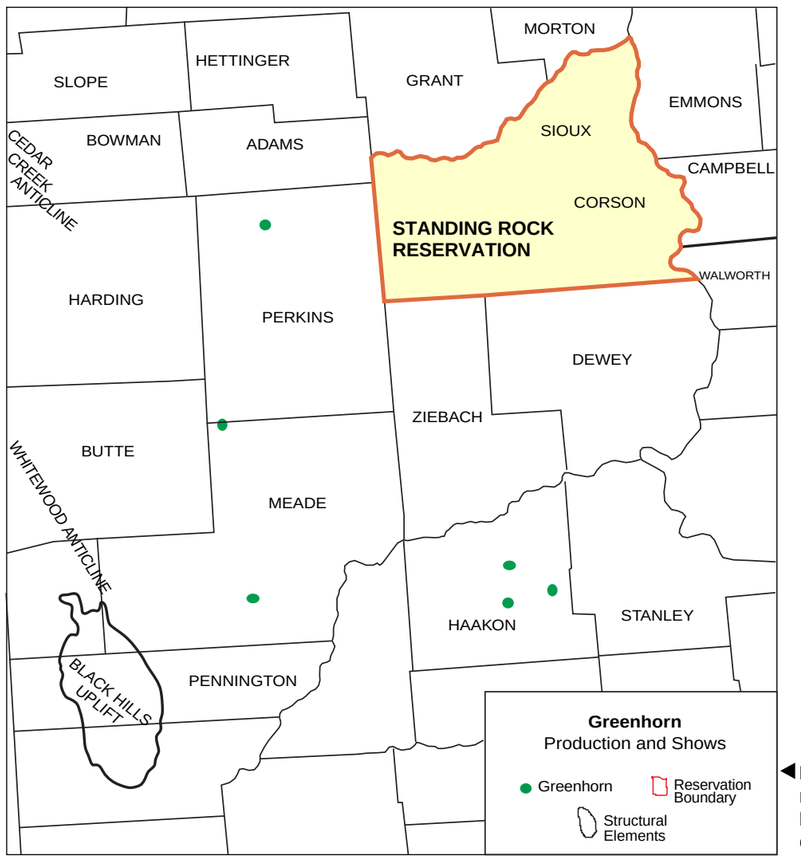


Figure SR-11.2. General location map of reservation indicating position of Greenhorn hydrocarbon shows (after United States Geological Survey,1996).

PLAY TYPE 5

Cretaceous Pierre / Greenhorn Limestone Play

General Characteristics - The Greenhorn limestone is located below the Niobrara chalk member, and is a regional, transgressive limestone and chalk that covers most of the Williston and parts of the Denver basin and Eeast Flank of the Balck Hills. Although not normally considered a hydrocarbon producer, regional studies (Rice and Shurr, 1980) suggest the Greenhorn may have biogenic gas potential.

Greenhorn and Peirre shows have been encountered within reservation boundaries (bleeding gas from Greenhorn samples), and south of the reservation in Haakon County (flares of gas, and gas cut mud of DST).

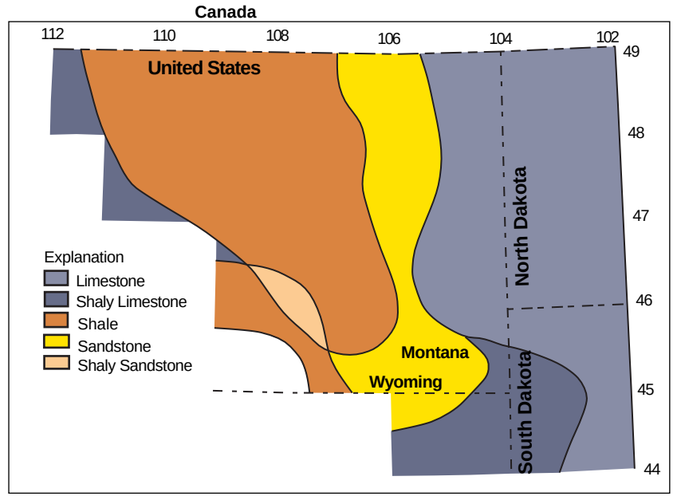


Figure SR-11.5. Facies map for interval 2 (Belle Fourche, Greenhorn, and equivalents) (after Rice and Shurr, 1980).

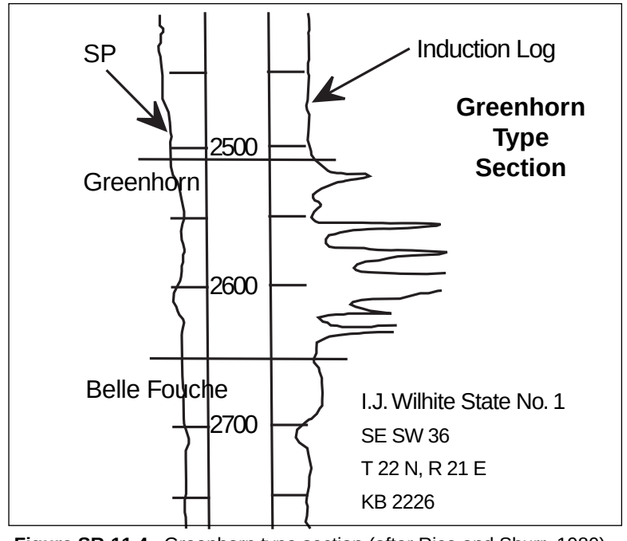


Figure SR-11.4. Greenhorn type section (after Rice and Shurr, 1980).

PLAY TYPE 6

Pennsylvanian Leo Play

General Characteristics - Usually a Powder River Basin Play, the Leo Sand and carbonate units produce on the north flank of the Black Hills at Alum Creek and Barker Dome Fields. (Nebraska) Structural traps are rare, while stratigraphic pinchouts are more common. The Leo is described as an eolian deposit, which is about 18 feet thick at Alum Creek Field reservoir. Sandstone units are sandwiched between layers of dolomite and anhydrite.

Source rock for the Leo is organic rich marine shale. In the Powder River Basin, thermal maturity and migration coincide with Laramide uplift.

A "Minnelusa Age" gas show was encountered at Standing Rock (background gas increase), and shows have been encountered west of the Reservation in Perkins County. Typical shows are gas increases above background with methane through butane being recorded. Shows have been recorded in Haakon County.

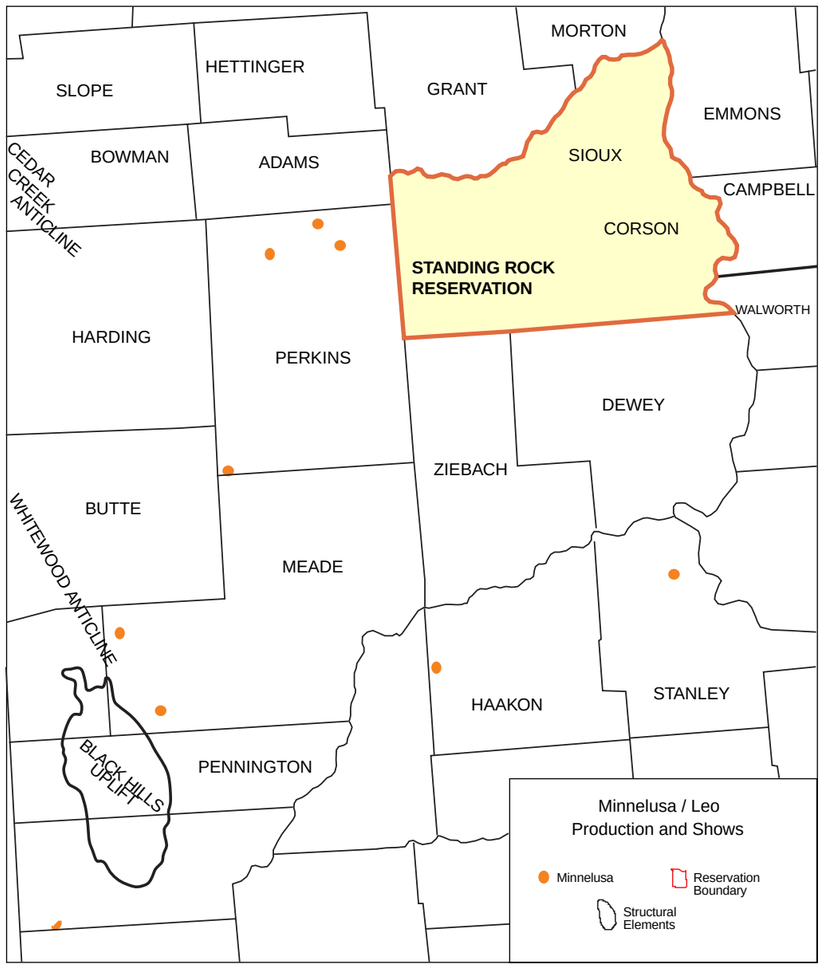


Figure SR-12.1. General location map of reservation indicating position of Minnelusa/Leo hydrocarbon shows.

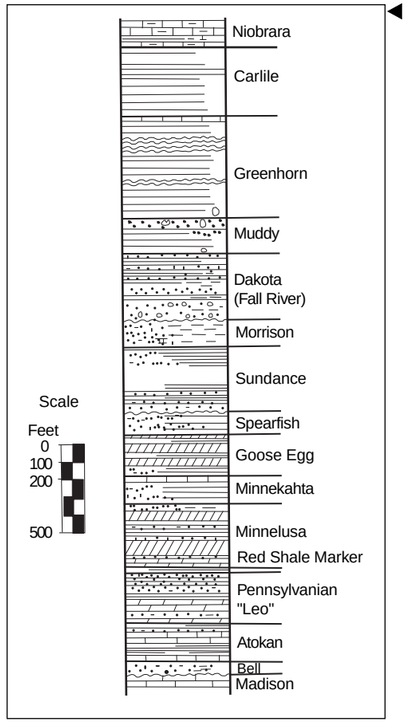


Figure SR-12.2. Generalized stratigraphic section of the Upper Pennsylvanian interval (after Cardinal and Sherer, 1984).

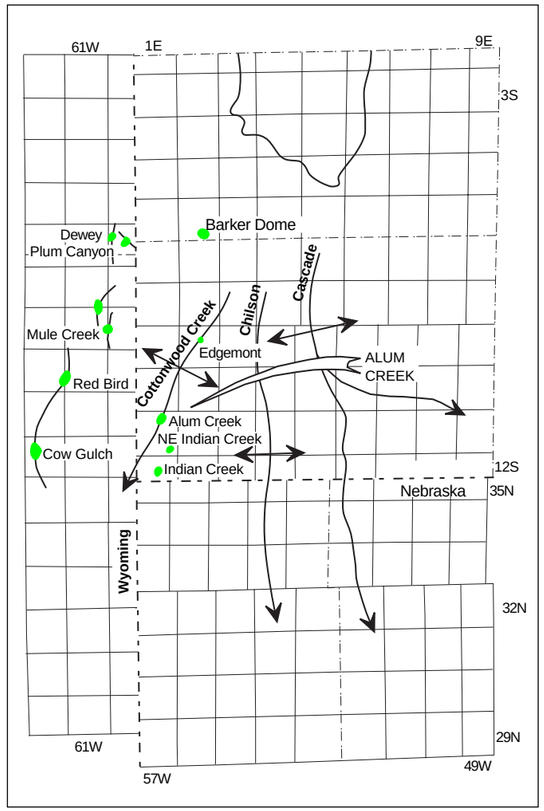
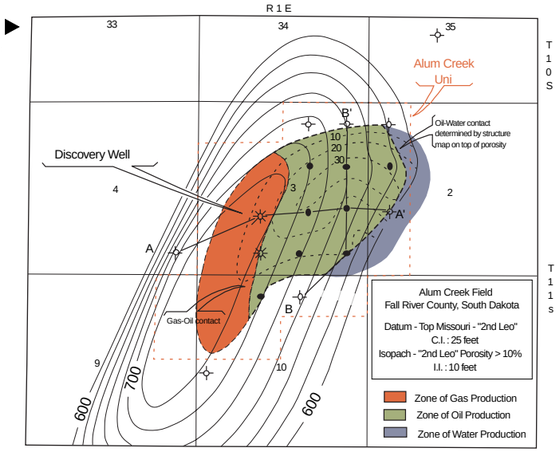


Figure SR-12.3. Index map of Pennsylvanian Leo producing fields (after Cardinal and Sherer, 1984).

Figure SR-12.4. Structure contour map indicating areas of production found in the Alum Creek Field (after Cardinal and Sherer, 1984).



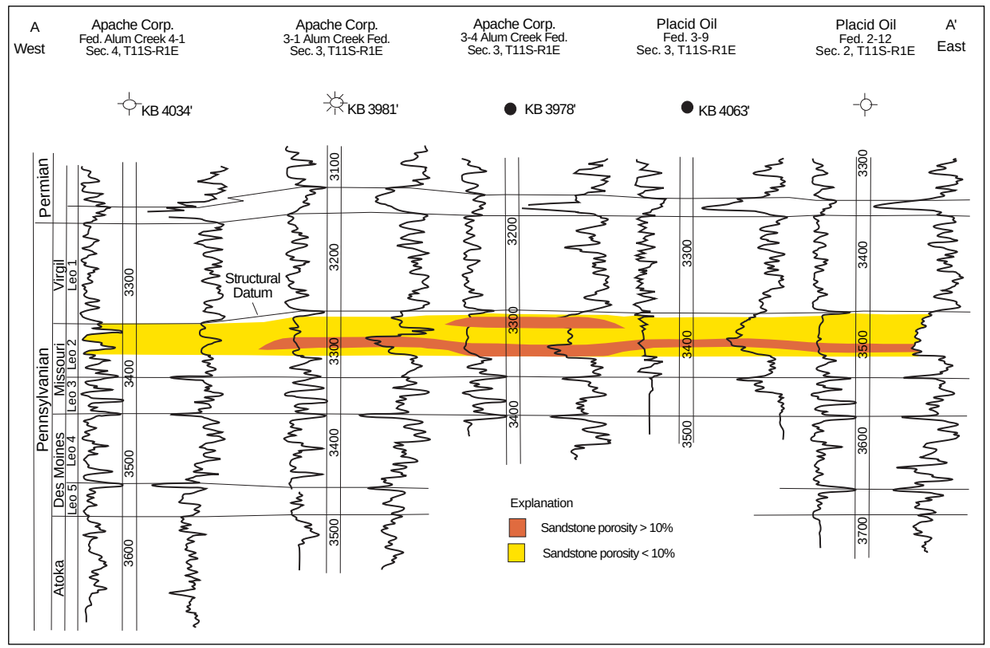


Figure SR-12.5. Cross-section A-A' west to east, Alum Creek field, illustrating the stratigraphic relationship of the 2nd Leo porous interval highlighted (after Cardinal and Sherer, 1984).

Alum Creek Field Parameters

Formation:	Pennsylvanian Leo
Lithology:	fine to medium grained, sub-angular to rounded, quartz-rich sandstone
Average Depth:	3400 feet
Porosity:	17%
Permeability:	2 to 493 md, average 68 md
Oil / Gas Column:	oil 76 feet gas 29 feet
Average Net Pay Thickness:	18 feet
Other Shows:	Upper Minnelusa, 4th Leo Sand

Other Information: stratigraphic-structural; initial discovery 1642 MCFGPD, oil gravity is 33 API; cumulative production is 2.1 MMBO and 3.3 MMCF gas from 5 wells.

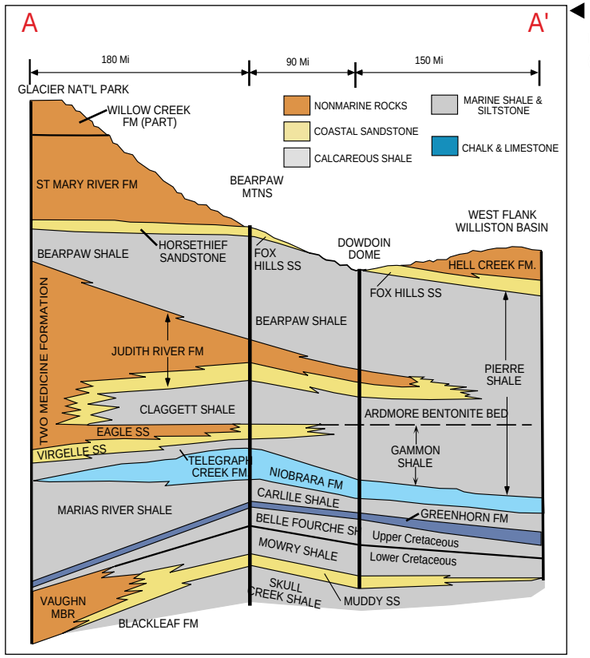


Figure SR-13.1. Regional north- south cross-section (after Rice and Shurr, 1980).

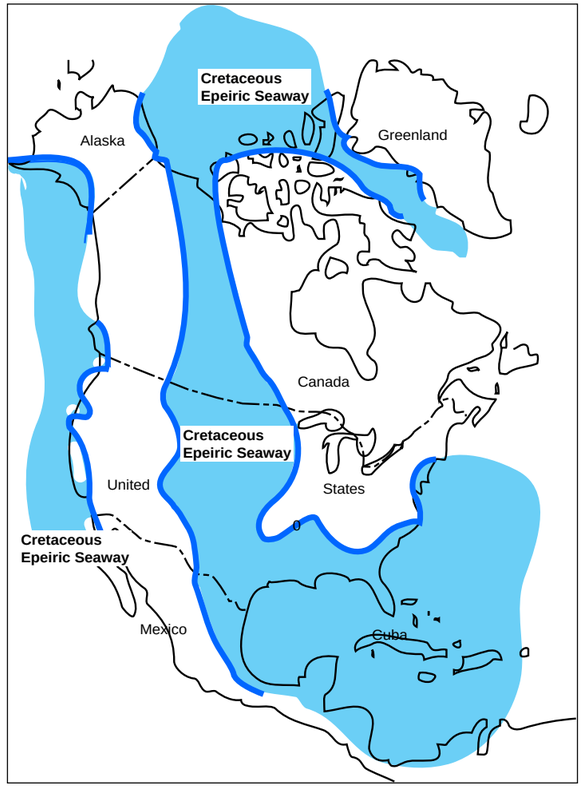


Figure SR-13.3. Paleographic map of North America during Late Cretaceous time, showing the extent of the Cretaceous seaway (after Rice and Shurr, 1980).

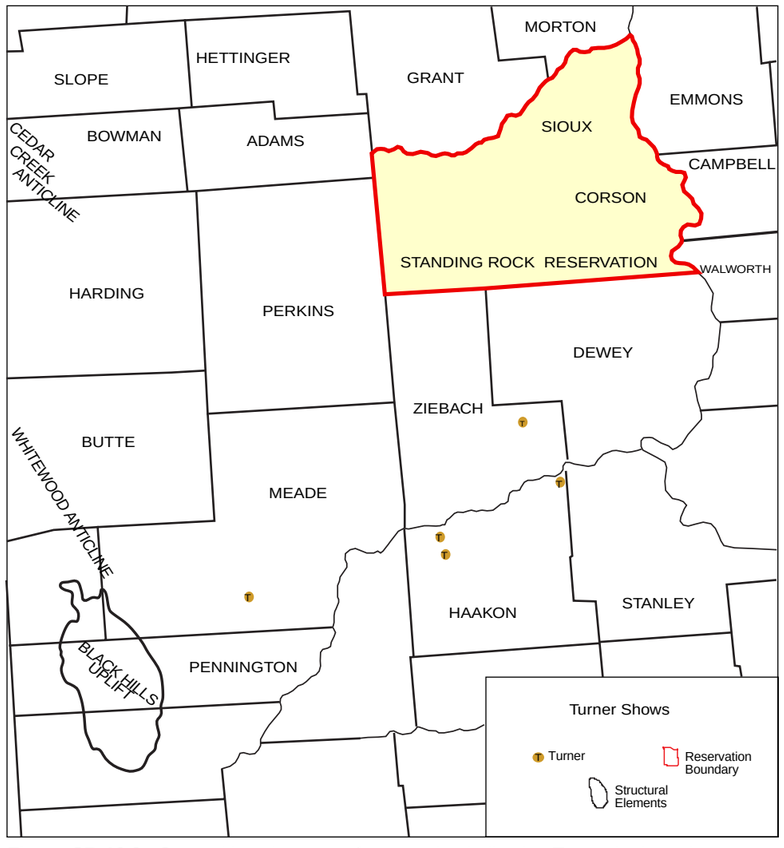


Figure SR-13.2. General location map of reservation indicating Turner hydrocarbon shows (after United States Geological Survey, 1996).

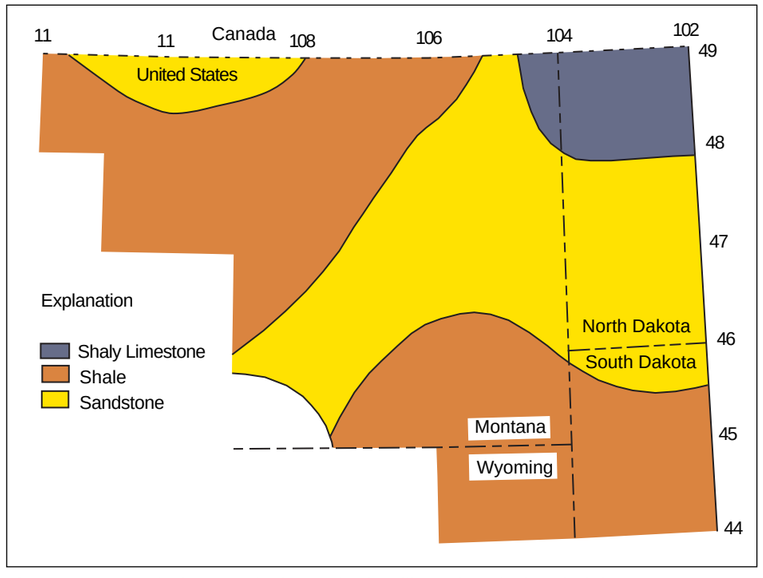


Figure SR-13.5. facies map for interval 3 (Carlile and equivalents). (after Rice and Shurr, 1980).

PLAY TYPE 7
Cretaceous Carlile Shale / Turner Sandstone Play

General Characteristics - Usually considered a Powder River Basin Play, has potential in this part of the Williston Basin. The Turner Sandstone in Wyoming is on the shallow eastern flank of the Powder River Basin. The Turner is marine sandstone, from 5 to 35 feet thick, and is generally a tight reservoir rock, containing chert, interstitial clay and lithic fragments. It is approximately equivalent to the 1st Frontier sands on the west flank of the Powder River Basin.

Although no shows in the Turner have been encountered within the Reservation, many shows have been evaluated in Haakon County (gas increase, gas kicks).

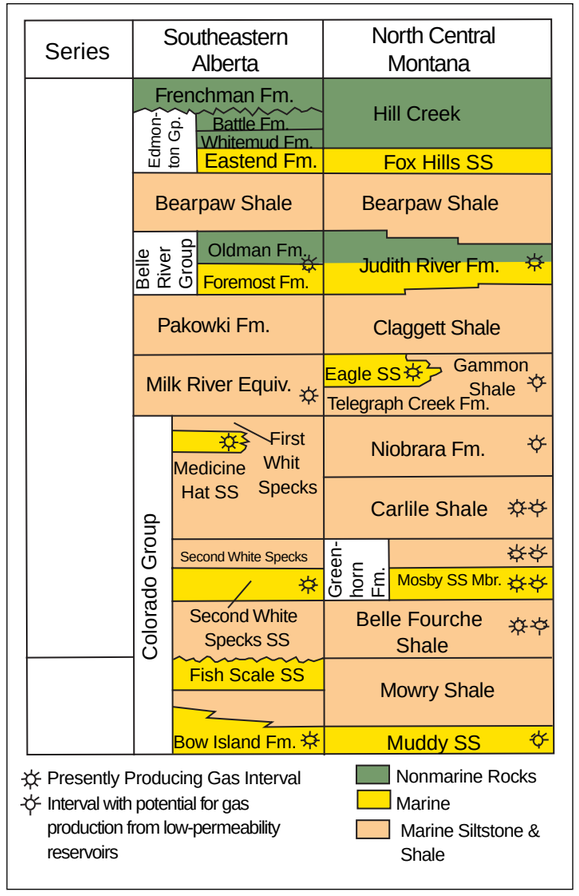


Figure SR-13.4. Correlation chart of selected Cretaceous rocks in north-central Montana and southeastern Alberta showing currently productive intervals and those with potential for gas production from low-permiability reservoirs (after Rice and Shurr, 1980).

PLAY TYPE 8

Cretaceous Shannon / Sussex Sands Play

General Characteristics- Normally a Powder River Basin Play, the Shannon / Sussex sandstone may be productive in this part of the Williston Basin. The Shannon sandstone is Eagle equivalent in Western Montana and produces out of the Eagle Sandstone at Cedar Creek Anticline. Production from the Shannon Sandstone is west of the Reservation at West Short Pine Hills and Cady Creek Fields, in Harding County.

The Shannon occurs above the Niobrara Chalk, within the Pierre Shale and is a fine-grained, well-sorted, marine sandstone. In Wyoming, the Shannon, produces from reservoirs 10 to 30 feet thick in belts 0.5 to 3 miles wide and from 5 to 30 miles long.

Source rock is the Niobrara Formation and Carlile Shales. In this area, maturation and migration are unknown, as is reservoir quality.

Shows are not recorded on the Reservation, however, due to the lenticular nature of the sand bodies, the lack of well control, and the thick Peirre Shale section, some of the recorded Pierre gas shows present in other plays described, may be in Shannon equivalent rocks.

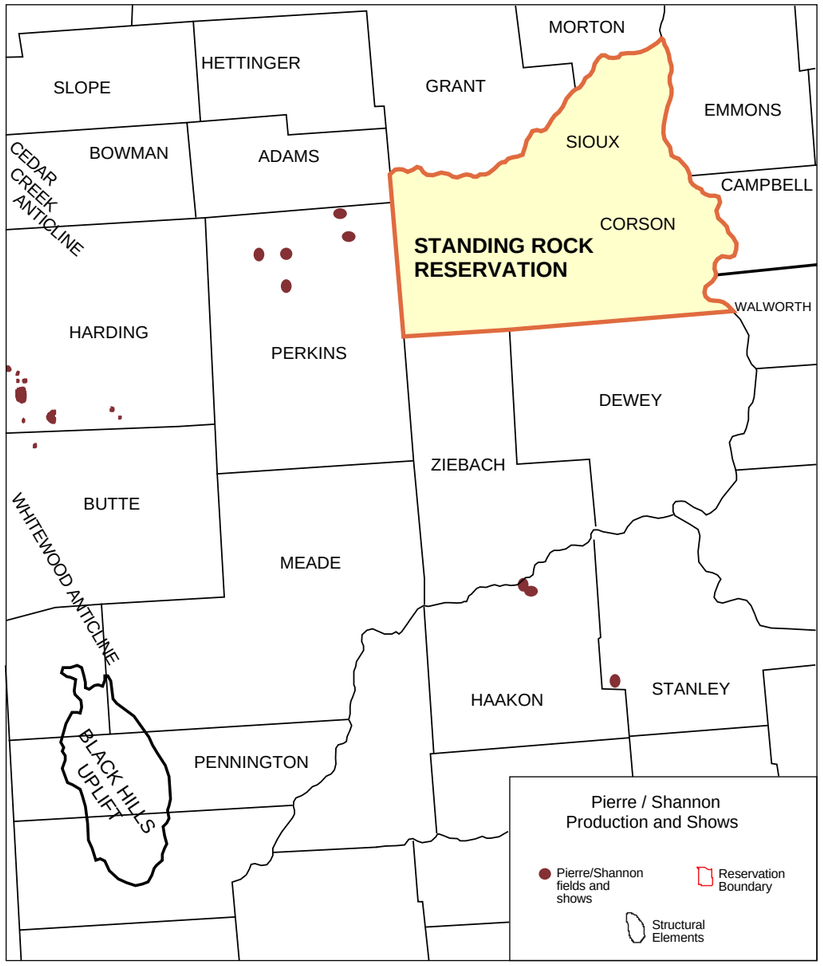


Figure SR-14.1. General location map of reservation indicating Pierre/Shannon hydrocarbon shows (after United States Geological Survey, 1996).

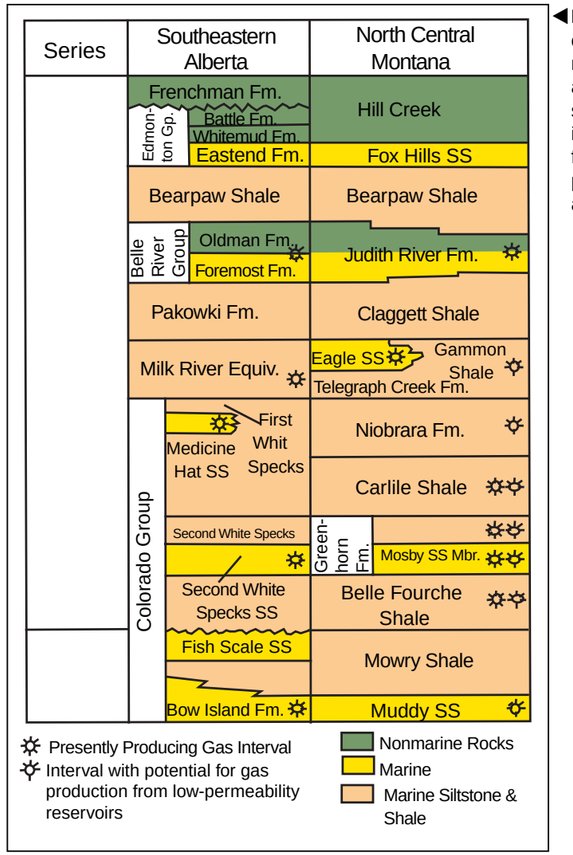


Figure SR-14.2. Correlation chart of selected Cretaceous rocks in north-central Montana and southeastern Alberta showing currently productive intervals and those with potential for gas production from low-permiability reservoirs (after Rice and Shurr, 1980).

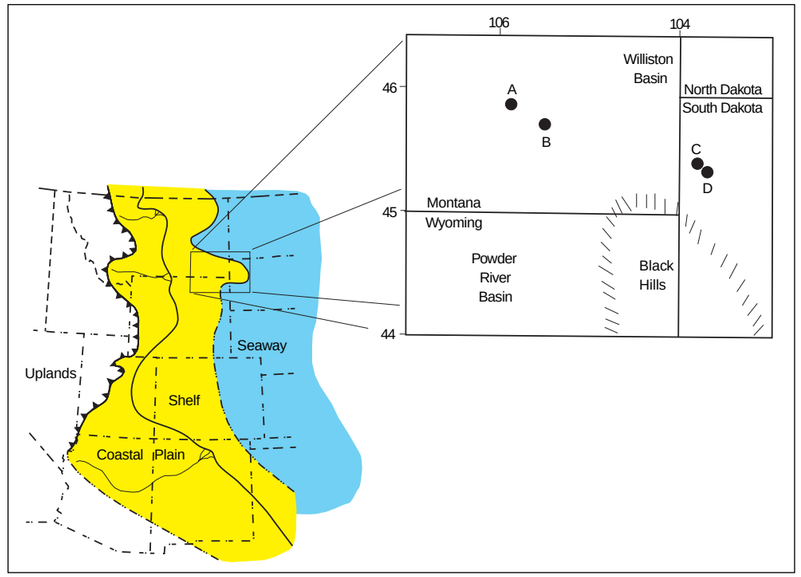


Figure SR-14.2. Regional paleogeography of the western magin of the Westem Interior seaway during the Campanian. Shallow gas fields associated with the Shannon include: (A) Liscom Creek, (B) Pumpkin Creek, (C) West Short Pine HIlls, and (D) Cady Creek (after Shurr et al, 1988).

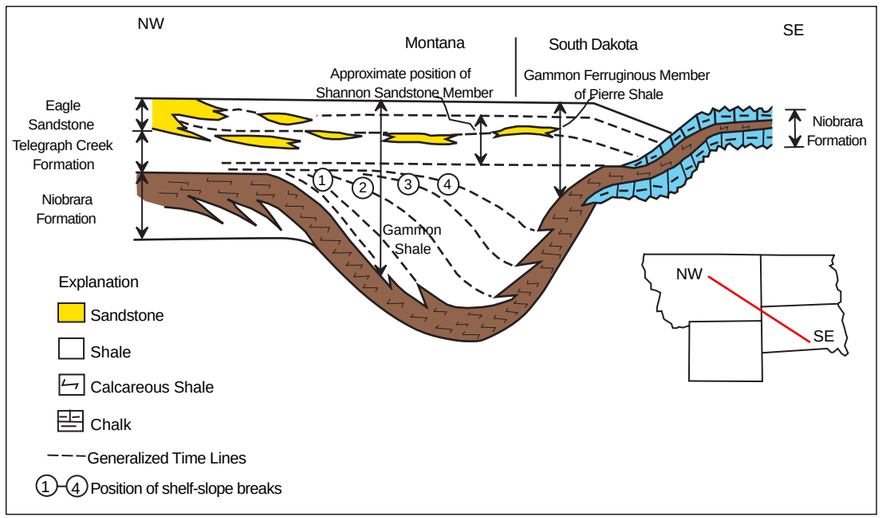


Figure SR-14.4. Regional cross-section summarizing the stratigraphic setting of the Shannon in Montana and South Dakota (after Shurr et al , 1988)

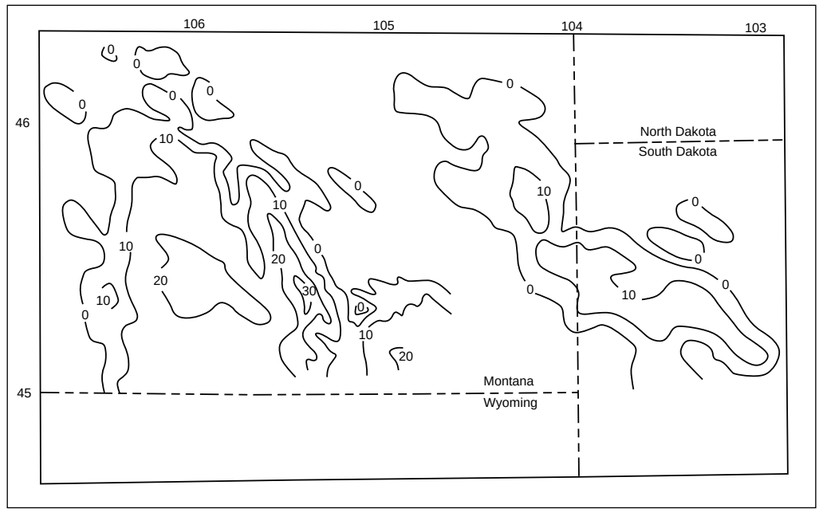


Figure SR-14.5. Generalized map of sandstone thickness in the Shannon interpreted from spontaneous potential (SP) logs. Gross sandstone thickness is based on a 10 or more millivolt deflection from a shale baseline. Contour interval is 10 feet (after Shurr et al, 1988).

Standing Rock Reservation

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