



PETROLEUM TECHNOLOGY TRANSFER COUNCIL

PETROLEUM POTENTIAL OF THE GREYBULL SANDSTONE IN MONTANA

BOTTOM LINE

The Greybull Sandstone on the Northern Cheyenne and Crow Indian reservations in Montana contains good drilling leads.

KEY WORDS:

Crow Indian Reservation, Montana
Greybull Sandstone
Kootenai Formation
Northern Cheyenne Indian Reservation, Montana
Powder River Basin
Valley-fill sandstones

PROBLEM ADDRESSED

Leads in the Greybull Sandstone (upper Kootenai Formation) on the Northern Cheyenne and Crow Indian Reservations of south-central Montana have been identified where the east-west oriented valley fill channels cross anticlinal structures. Surface geochemical testing has confirmed one of these leads. Oil-stained outcrops of the Greybull Sandstone near the Soap Creek Oil Field indicate that oil migrating through the Greybull did accumulate in favorable structural positions.

TECHNOLOGY OVERVIEW

Stratigraphic traps may be present in Greybull Sandstone valley-fill deposits where it is present above the Lower Cretaceous Kootenai Formation. The area of interest on the Crow and the Northern Cheyenne reservations is located in south-central Montana east of the Pryor and Bighorn mountains on the northwestern flank of the Powder River Basin. The Greybull Sandstone is oil and gas productive in the region.

Exposures of the Greybull Sandstone were measured and described and paleocurrent data were evaluated. Surface and subsurface data were integrated and isopach maps were constructed to define the occurrence of Greybull channels. Isopach maps were used in conjunction with structural contour maps to identify potential exploration leads on the Crow and Northern Cheyenne reservations.

REGIONAL SEQUENCE STRATIGRAPHIC RELATIONSHIPS

Greybull Sandstone is part of the transgressive systems tract that includes the overlying Fall River Sandstone. It was deposited on a major regional unconformity, a low-stand surface of erosion. Where the incised Greybull channels are absent, the low-stand erosional

unconformity is at the base of the Fall River Sandstone and equivalent formations. During pre-Greybull low-stand, sediment bypassed this region. During the subsequent marine transgression, streams began to aggrade and deposit Greybull sands. With continued transgression, the Greybull fluvial sands graded upward into marginal marine (probably estuarine) sands, and finally were capped by marine shale.

CHANNEL OCCURRENCE AND PETROLEUM POTENTIAL

Surface exposures of four separate Greybull channels were identified in the Kootenai-Fall River outcrop belt around the margins of the Pryor and Bighorn mountains on the Crow Reservation. Transport directions in the channel sandstones in the Crow Reservation subsurface are consistently to the west and west-southwest. One outcropping channel has a strong right angle bend to the north, which is matched by the paleocurrent directions. The abrupt change in channel direction coincides with a fault system that splays off from the Nye-Bowler fault zone and suggests that fault activity during channel formation controlled channel trend and location. Similar right angle bends of correlative channel-fill deposits in Saskatchewan are also structurally controlled.

One subsurface channel projects eastward under the Northern Cheyenne Reservation. Potential for oil and gas occur where this channel crosses an anticlinal ridge on the northeastern part of the reservation. Because of limited well control, this lead will probably require confirmation by another technique, such as soil-gas geochemistry or seismic exploration.

In the Crow Reservation subsurface, five major Greybull channels have been interpreted. With the aid of paleocurrent indicators, the subsurface channel-fill occurrences were correlated with the channels identified at the surface. Each of these channels trends east-northeast. The three southern channels come to the

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surface along the margin of the Bighorn Mountains, and no structures appear to have trapped oil east of the outcrop belt. The (fifth) northernmost channel does not appear to cross any significant structural closures; therefore, little petroleum potential exists for this channel.

However, the Crow Agency channel (fourth from the south) appears to have petroleum potential where it crosses three structural features that could potentially provide traps for hydrocarbon accumulation. The three exploration leads along this channel include Little Woody (T3S, R30E), Woody Dome (T3&4S, R31E) and Crow Agency (T3S, R34E). Of these, the Crow Agency lead was confirmed by a significant soil-gas anomaly based on propane and butane data and appears to have the greatest probability of trapped hydrocarbons. The lack of anomalous methane and ethane in the soil-gas survey suggests that the underlying hydrocarbon reservoir may contain relatively heavy crude oil without natural gas.

The Greybull Sandstone is a proven petroleum reservoir in the Crow and Northern Cheyenne reservation region. It produces oil and gas at Mosser Dome, Elk Basin, Golden Dome and several other fields in the northern Bighorn Basin. Regionally, the Greybull Sandstone has excellent reservoir qualities, up to 30% porosity and up to one darcy of permeability.

As can be seen at Elk Basin Field, Mosser Dome and at other fields in the Bighorn Basin, traps in the Greybull are combination traps requiring the presence of channel sandstone and structural closure. In the crest of the dome at Soap Creek Oil Field on the Crow Reservation, the Greybull Sandstone is oil stained and was apparently oil saturated, but has been breached by erosion along Soap Creek. This occurrence of oil saturation is important in evaluating potential of the Greybull on the Northern Cheyenne and Crow Reservations because it establishes that oil was generated and migrated into the Greybull Sandstone and an accumulation of oil is possible in a favorable structural trapping configuration.

LESSONS LEARNED

Stratigraphic traps appear to be present in valley-fill sandstones of the Lower Cretaceous Greybull Sandstone, the upper member of the Kootenai Formation, on the

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Crow and Northern Cheyenne Indian reservations of south-central Montana. These reservations are located on the northwestern flank of the Powder River Basin. The 480,000-acre Northern Cheyenne reservation and the 4,000 square mile Crow Reservation (and ceded area) is under-explored. For example, only sixteen wells have been drilled on the Northern Cheyenne reservation.

Traps in the Greybull are combination traps requiring the presence of channel sandstone and structural closure. Subsurface mapping has identified one potential exploration lead on the Northern Cheyenne Reservation where structural closure coincides with a major Greybull channel. Three exploration leads have been identified on the Northern Cheyenne Reservation where one Greybull channel crosses three structural features that could potentially provide traps for hydrocarbon accumulation. Of these three leads, the Crow Agency lead was confirmed by a significant soil-gas anomaly.

REFERENCES

Workshop and summary based on two reports, which are: (1) Montana Bureau of Mines Report of Investigation 9, Greybull Sandstone Petroleum Potential on the Crow Indian Reservation of South-Central Montana and (2) Montana Bureau of Mines and Geology Open-file Report 416, Petroleum Potential of the Greybull Sandstone on the Northern Cheyenne Reservation, South-Central Montana.

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