

Narrative for Big Snowy Mountains Quadrangle (BSMQ)  
Containing Parts of the Lewis and Clark National Forest (LCNF)

### Introduction

This report discusses the oil and gas occurrence potential and the reasonable foreseeable development potential for three segments of the LCNF: the Big Snowy Mountains (BSM), the Little Snowy Mountains (LSM), and the easternmost 11 miles of the Little Belt Mountains (ELBM).

The southern one-third of the BSMQ is largely obscured by Quaternary terraces, which mask much of the geology. However, 18 oil and gas test wells have been drilled, 7 in the last 15 years in this area.

Despite these 18 oil and gas tests, there remain large untested areas, including 4 entire townships without evaluation in this portion of the BSMQ. There are about 11,000 feet of sediments preserved in the Wheatland syncline overlying the Belt Group (pb), and about 14,000 feet of structural relief on the Belt between the Wheatland syncline and the Belt age outcrop 6 miles to the north, which is about 3000 feet topographically higher.

Physiographic areas include the Alaska Bench and Middle Bench (north of the BSM and the LSM) and the Judith Gap-Hobson area, which separates the BSM and the ELBM. South of the BSM is the Wheatland syncline. Southeast of the BSM and south of the LSM are several southeast trending structures, including Devil's Pocket, which is the lone oil producing area on the BSMQ, the Pole Creek Anticline, which is productive about 10 miles east of the southeast corner of the BSMQ, and Woman's Pocket anticline, which starts in T. 9 N., R. 20 E., and continues southeastward for a distance of 15 miles or more.

The oil production at Devil's Pocket in T. 10 N., R. 21 E., is from the Heath Formation. Wells in T. 9 N., Rs. 20 and 21 E., have reported oil and gas shows in the Amsden. T. 10 N., R. 20 E., is untested. North of the Devil's Pocket field, the LCNF acreage in the LSM in Ts. 11 and 12 N., Rs. 20 and 21 E., have 3,000 to 5,000 feet of sediment overlying the Precambrian Belt. The occurrence potential is considered LOW except for the southeasternmost four sections, which have 4,500 to 5,000 feet of cover. This is about 500 feet less than at Devil's Pocket and is considered MODERATE occurrence potential.

Nearly all of the LCNF lands in the BSM block apparently have less than 3,000 feet of sediments and are considered VERY LOW occurrence potential. About 7 square miles along the northwest and 6 square miles on the southern edges are thicker than 3,000 feet and, therefore, are rated as LOW potential. All of the LCNF lands in the ELBM have less than 3,000 feet of sedimentary section above Precambrian and are classified as VERY LOW occurrence potential. The large area classified MODERATE occurrence potential is entirely outside of the LCNF except the previously-mentioned southeast corner of the LSM block. The seven and one-half + sections rated HIGH occurrence potential surrounds and includes the Devil's Pocket field. Surrounding the LCNF lands, there is a large area of LOW occurrence potential that has from 3,000 to 4,500 feet of sediments above the Precambrian Belt Super Group.

The top of the Proterozoic Precambrian Belt is considered the lower limit of sediments with hydrocarbon occurrence potential. However, a good case can be made for including Proterozoic sediments with the rocks having oil and gas producing potential. The 300 to 400 feet of exposed Belt rocks in sec. 4, T. 11 N., R. 19 E., have been identified as "dark grey limey shales" of the Newland limestone member of the Prichard Formation of the Belt Super Group. These are marine shales that have a total organic carbon content of 3 to 4 percent, several times greater than Cretaceous marine shales which have been considered as source rocks in many areas. The most intriguing part of a postulated hydrocarbon accumulation in the Newland is the large size of the pool that could be under the BSM. This structure could have over 300 square miles within its closing contour, gas reserves in the 10 trillion cubic feet range, or oil reserves of over 1 billion barrels. Two additional uncertainties of Belt age accumulation of oil and gas in the BSM are: unknown lithology and the timing of the uplift. The nearest outcrops, which expose the Newland, are 50 miles to the west in the Little Belt Mountains, 15 to 20 miles west of the BSMQ. Consequently, the lithology below this thin exposure of Newland is conjectural. Also, the time of the uplift appears to have been during the late Eocene-Oligocene. Numerous unconformities precede this uplift and shed doubt about the preservation of any pre-existing traps. The Cambrian and Belt outcrops do not offer encouragement. The possible fracture permeability that may be associated with this large uplift is difficult to investigate. However, the Newland potential for porous reservoir rocks is poorer than the potential for source beds.

Devonian rocks thin, from west to east, from about 500 feet at the southwest corner of the BSMQ to about 100 feet along the east central side of the BSMQ. Devonian stratigraphic traps are possible (as well as structural traps) where the flow of meteoric waters from outcrop areas are interrupted by permeability barriers due to lithology or faulting.

The Mississippian rocks have two intervals of possible reservoir potential, the Kinderhookian (lower Lodgepole) and the Chester age Big Snowy Group (Heath, Otter and Kibbey). The Mission Canyon is strongly discounted here because of its large outcrop area and evidence of large scale permeability features such as caverns. Meteoric water flow has probably displaced the larger accumulations out of this area. However, the lower Lodgepole is known to have Waulsortian type biohermal mounds, documented on outcrop in Swimming Woman Canyon. Well log documentation is noted on a "Type Log" of the Shell 21-19 NP, NENW sec. 19, T. 9 N., R. 21 E., Golden Valley County. Located on the northeast flank of the Woman's Pocket surface anticline, the Lodgepole is picked at 5,937 to 6,577. An interval at 6410-6525 shows an average neutron porosity of about 7 percent. The upper 70 feet of this 115-foot thick interval certainly looks like a reef. The Continental 1 NPRR, sec. 9, T. 9 N., R. 17 E., has a 30-foot thick interval at 7275-7305 with similar neutron porosity and low gamma-ray reading. The CIG 1 BN, sec. 31, T. 10 N., R. 17 E., had only about 6 feet of 6« to 7 percent sonic porosity between 7,450 and 7,465 feet. This latter well is only 3 miles northwest of the Continental well. Another 3 miles to the northwest from the CIG 1 BN is the Anadarko 1 Parker-Thompson A, sec. 27, T. 10 N., R. 16 E. This lower Lodgepole interval is at 7,500 to 7,630. Porosities are all less than 3« percent. The above wells are the only tests of sufficient depth on the south flank of the BSM to examine the lower Lodgepole and they show the possibility for stratigraphic prospects in this interval.

On the north flank, there is only one well of adequate depth to evaluate the lower Lodgepole, the Armour 1 Jackson, SE NE sec. 17, T. 13 N., R. 20 E. It is located on Alaska Bench Dome, a structure with about 500 feet of closure over about 5,000 acres. An old well drilled by Portland Synd. (1925), about one-third mile to the southwest, tested 1 million cubic feet of nitrogen gas from the Madison Group at 990 feet. This interval appears to be in the lower third of the Charles formation and may be indicated on the log of the Armour well at 985 to 995 feet, about 20 (?) feet structurally lower than in the 4

old Portland Synd. well. Only an electric log, with SP and resistivity curves, was run in the Armour well. No porosity or radioactive logs were taken. It should be remembered that the Portland well was drilled with cable tools and the Armour well was a rotary operation with 9.5 pound mud at 52 viscosity reported during logging operations. If drilled with clear water, the hydrostatic pressure differential would be over 400 pounds at 900 feet.

The Big Snowy Group--Heath, Otter and Kibbey--of Mississippian Chester age, is a potential interval for hydrocarbon generation and accumulation. It outcrops largely outside of the LCNF. The Heath is the uppermost formation of the Group and carries source rocks of sufficient quality to be considered as "oil shales." With the exception of a local limestone member, the Van Deuzen, it is principally shale and thin, tight limestones. Fracture zones, especially on the steep flanks of structures, might create areas of reservoir potential. To a lesser degree, the same may be true of the middle formation, the Otter. The Kibbey is the basal formation of the Big Snowy Group and contains no source rocks. It could be productive if faulted against source rocks of other formations.

The Tyler formation may transcend the Mississippian-Pennsylvanian time boundary. The Tyler and the Amsden formations are the principal producing formations in a large area east of the BSM which includes northern Musselshell, northwest Rosebud, and northernmost Yellowstone Counties. Only small fields of one million barrels, or less, are anticipated on the BSMQ in these formations and they would be outside of the LCNF boundary.

The Permian and Triassic ages are not represented on the quadrangle. The Jurassic age is represented by the Morrison formation and the Ellis Group (Swift, Rierdon, Sawtooth). The Ellis Group unconformably onlaps the Amsden, a relationship that can form traps in the Amsden. About 25 miles east of the BSMQ, on Cat Creek anticline, the Ellis and Morrison produce oil. The Jurassic outcrops outside of the LCNF boundary.

The Cat Creek sands--first, second, and third--are lower Cretaceous sandstones of Dakota, Fuson, and Lakota ages. The first Cat Creek is Dakota. The second and third are Kootenai (Fuson-Lakota equivalent). These sands produce at Cat Creek and at Mason Lake on the Pole Creek anticline. The Muddy, Mowry, and Frontier oil and gas potential is limited to the southern one-third and the extreme northwest part of the BSMQ. Upper Cretaceous potential from the 5

Eagle-Virgelle up to the Lance (Hell Creek) is restricted to the Wheatland syncline. The shallowest potential horizons are probably in the Lennep (Fox Hills or Horsethief) sandy beds just below the Hell Creek and overlying about 800 feet of black, marine Bearpaw shale. The Lennep occurs at about 1,600 feet in the Montana Power 3-7 Wegner, sec. 7, T. 10 N., R. 19 E., Golden Valley County.

#### Occurrence Potential

A HIGH occurrence potential classification is given the following described lands surrounding the Devil's Pocket oil field: secs. 1, 2, 11, and 12, T. 10 N., R. 21 E.; secs. 6 and 7, T. 10 N., R. 22 E.; secs. 35 and 36, T. 11 N., R. 21 E.; and sec. 31, T.

11 N., R. 22 E. Total sediment thickness, above Precambrian, is expected to be 5,100 to 6,200 feet with surface exposure of beds from upper Cretaceous Eagle through lower Cretaceous Kootenai ages. Nearly one-half of this area is masked by Quaternary terrace gravels.

A VERY LOW occurrence potential is given to the ELBM, and to most of the BSM where the calculated sediment thickness above Precambrian is 3,000 feet or less. On the BSM there are about 4 square miles abutting the northern LCNF boundary, rated VERY LOW. Likewise at the eastern end of the BSM are 16 sections, so rated, that are outside of the forest. About one-half of these are Bureau of Land Management lands.

A LOW occurrence potential is given all those lands with 3,000 to 4,500 feet of sediments above the Precambrian. This includes all but four sections of the LSM and the remaining Forest lands on the BSM.

The remaining area, about one-half of the quadrangle, is classified as of MODERATE occurrence potential. These lands all have more than 4,500 feet of sedimentary cover above the Precambrian and contain known source and reservoir intervals. Maximum thickness is about 11,000 feet in the Wheatland syncline, about 2 miles northeast of the Montana Power 3-7 Wegner, sec. 7, T. 10 N., R. 19 E.

#### Development Potential

There are no areas considered to be of a HIGH development potential on the BSMQ. The Heath oil production at Devil's Pocket field is only about 2,000 feet deep, but the 2 productive wells initialed at only 30-35 barrels per day with a combined cumulative production of 50,000 barrels. There are probably additional fields in this category to be found on the BSMQ.

Five small areas of MODERATE development potential are shown on the BSMQ, each for a different reason. At Devil's Pocket there may be an additional 3 or 4 wells drilled in the next 10 to 15 years. At the northeastern portion of T. 9 N., R. 21 E., on Pole Creek anticline, a Heath pool similar to Devil's Pocket may be discovered, but at depths of 3,000 to 5,000 feet. Amsden potential also exists at this location at these depths. At least two wells are expected in this area. At the southwestern corner of T. 9 N., R. 21 E., is an area that has had Amsden oil shows at about 4,200 feet and also has Waulsortian mound development in the lower Lodgepole at 6,400 - 6,500 feet. At least two wells are expected in this area. Further west is an undrilled area that extends from T. 9 N., R. 17 E., diagonally NW to SE to T. 9 N., R. 18 E, that is bracketed by oil shows in the Amsden and the Devonian. At least one test of 7,500 feet is expected in this area.

An interesting test was drilled at the intersection of Ts. 8 and 9 N., Rs. 15 and 16 E., just south of the BSMQ. The Dunoco 13-1 NPRR found shows in the Mississippian Kibbey at about 5,130 to 5,220. An attempted drill stem test failed. The operator drilled deeper to 5,558 feet and ran another test covering 460 feet. In 2 hours, 4,708 feet of highly oil and gas cut muddy water was recovered. This well bottomed at 6,390 feet, probably in Lodgepole. Dunoco set 5,900 feet of 4½ inch casing through the Charles and into the top of the Mission Canyon. Completion was attempted in the Kibbey through perforations at 5,208-18, which produced a show of gas. Acidization was then performed and the well swabbed dry. After sitting for 12 hours they recovered 100 feet of oil. One well is expected in this area in the next 15 years. The areas of VERY LOW development potential are on the ELBM and the BSM. The latter is a wilderness study area and, therefore, currently exempt from oil drilling. Adjacent to its southeast end is the Twin Coulee Wilderness Study Area, also exempt. The ELBM is VERY LOW because of the thin (less than 3,000 feet) sediments above Precambrian. No wells are expected in these VERY LOW classification areas in the next 15 years.

The remaining 80 percent of the BSMQ, over 1300 square miles, is classified as LOW development potential. This is about 80 percent of the BSMQ. About five wells are anticipated on these lands of LOW rating in the next 15 years.

A total of 14 to 15 wells are expected to be drilled in the next 15 years compared to 22 wells in the previous 15 years. This means about one well per year on the BSMQ. Only two or three of these are anticipated on LCNF lands. A well to test lower Lodgepole might be located in the SE¼ sec. 25, T. 12 N., R. 21 E. A well to test for Heath fracture permeability in steep dip might be located in the SW¼, sec. 15, T. 11 N., R. 18 E. A well to test the Belt Newland formation might be located in the SW 33, T. 12 N., R. 19 E.

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