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MISSISSIPPIAN SUBSURFACE GEOLOGY IN THE PEMBINA AREA, ALBERTA

(Report and 11 figures)

H. L. Martin

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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

Mississippian rocks in the Pembina map-area are more than 1,000 feet thick in the west but disappear eastward mainly because of erosion in Late Palaeozoic, Triassic, Jurassic, and Cretaceous times. Thus progressively older Mississippian formations underlie the sub-Mesozoic unconformity from west to east. Hydrocarbons are trapped in porous carbonate rocks at the erosional edges of the producing formations in the Brazeau River, Minnehik-Buck Lake, and Wilson Creek gas fields.

Mississippian rocks disconformably overlie Lake Devonian limestones; in ascending order they comprise the Exshaw, Banff, Pekisko, Shunda, and Turner Valley Formations. The black radioactive Exshaw shale is overlain by the Banff which consists of three units: lower argillaceous limestone, medial bioclastic limestone, and upper silty unit. Resistant, light-coloured bioclastic limestones and dolomites of the Pekisko form a low palaeotopographic ridge that separates the relatively recessive Banff and Shunda Formations. Dolomitized Pekisko crinoidal limestones with vuggy and intercrystalline porosity form the reservoir rock of the Minnehik-Buck Lake field. Two facies are recognized within the Shunda Formation: an eastern breccia facies, and a western anhydritic carbonate facies. The uppermost Mississippian beds, the porous dolomites of the Elkton Member of the Turner Valley Formation, form the reservoir rock of the Brazeau River field.

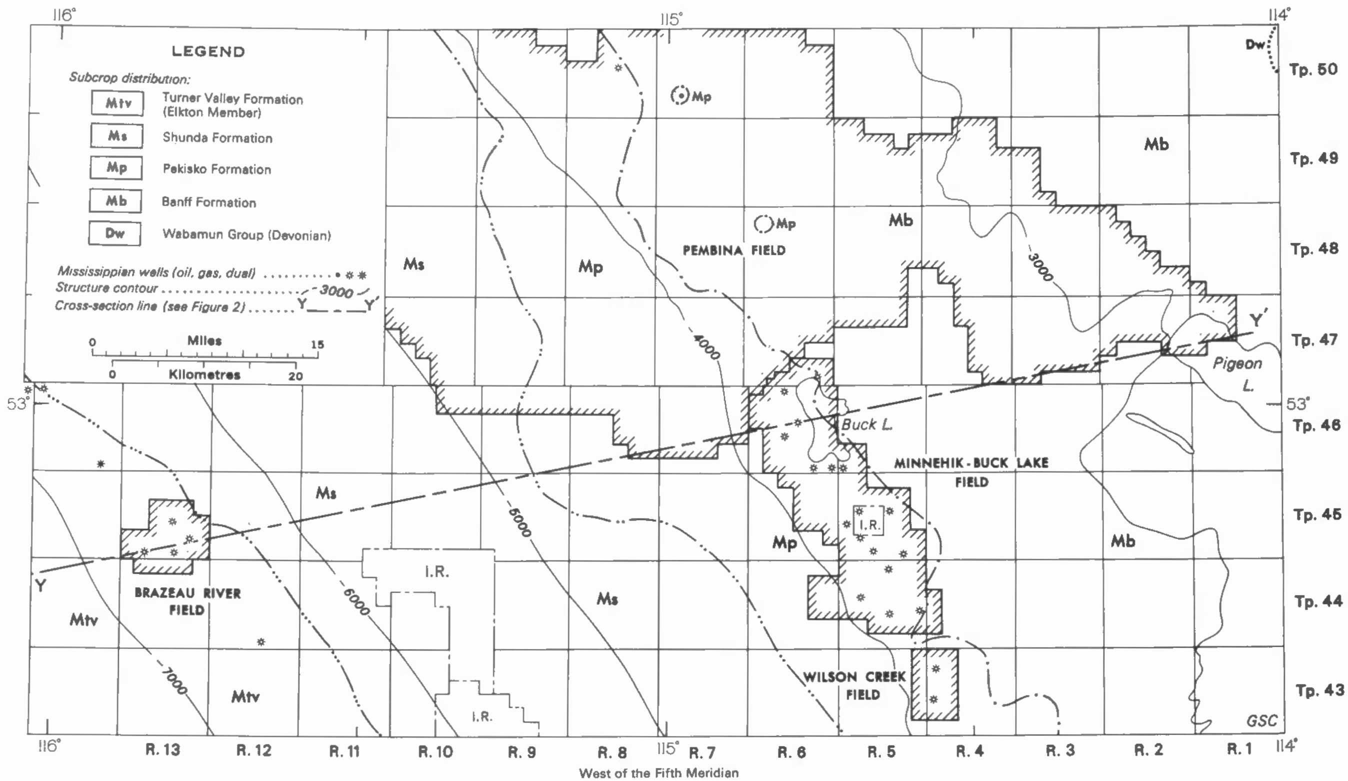

Figure 1. Distribution of Mississippian subcrops and structure contours on top of the Mississippian

MISSISSIPPIAN SUBSURFACE GEOLOGY IN THE PEMBINA AREA, ALBERTA

INTRODUCTION

This report is the second in a continuing study of subsurface Mississippian strata in west-central Alberta. The first (Martin, 1966) discussed the geology immediately south of Pembina area.

The report-area (Fig. 1) comprises ranges 1 to 14 west of the fifth meridian, and townships 43 to 50, inclusive; it is about 4,000 square miles in area.

Gas is produced entirely from Mississippian strata in three fields: Brazeau River, Minnehik-Buck Lake, and Wilson Creek (Fig. 1). The bulk of the hydrocarbon production of the report-area comes from the Upper Cretaceous Cardium and Belly River Formations in the giant Pembina field, which occupies about one third of the area. There are only two Mississippian oil and gas wells in the Pembina field within the report-area.

Mississippian hydrocarbon entrapment is associated with the erosional edges of the producing formations and the distribution of the carbonate lithofacies. To illustrate these relationships, cross-sections, and structure, isopachous, and lithofacies maps have been prepared.

Data, available as of January 4, 1966, from all the 228 wells drilled into and through the Mississippian in the area were used in this study. The formational contacts were determined by examination of samples, cores, and wireline logs.

Well cuttings and cores were examined by stereoscopic microscope. Polished, etched, stained[1] surfaces, and acetate peels[2] were used to supplement the visual sample examination.

In preparing isopachous maps, primary control was obtained from well data, but an attempt was made to minimize the degree of interpretive contouring by developing secondary control points. The method consisted of overlaying transparent copies of structure maps of the upper and lower boundaries of a unit. Where contour lines intersected, a "secondary" isopach value was recorded equal to the difference in elevation of the two contours. This method permitted the structure contour and isopachous maps to be mutually consistent.

Precise delineation of formational erosion edges was difficult because of irregular control. To extend the edges beyond areas of good control, a system of structural map overlays, similar to that used in

1 Alizarin Red S stain was used to differentiate between calcite and dolomite. For a description of its preparation and use, see Warne (1962).

2 For a description of acetate peeling techniques, see Beales (1960).

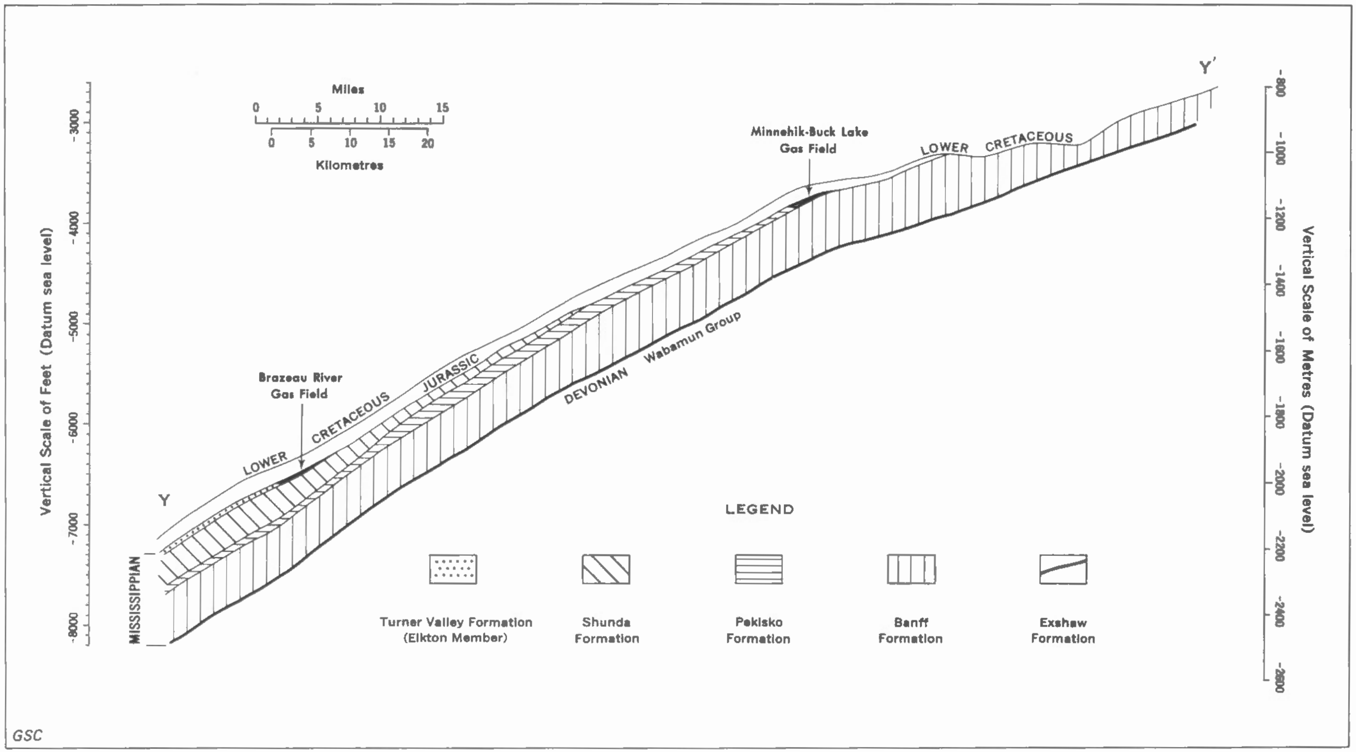

Figure 2. Structural cross-section along line Y-Y′ (for location of cross-section see Figure 1)

"isopaching" was followed. The contours of the formation being mapped were projected until they intersected contours with the same elevation on the structure contour map on top of the Mississippian surface. A line joining points of intersection is by definition the zero edge of a unit. This process has introduced a degree of irregularity on the maps which appears to be beyond the limits of the well control, but is actually no more interpretive than the original structure maps.

The structure contours on top of the Devonian (Fig. 4) show that the strike of the strata is north 40 degrees west; the dip is to the southwest and increases from 40 feet to the mile at the northeastern edge of the mapped area, to 100 feet to the mile at the southwestern edge. A hinge line parallel to the strike passes through the Minnehik-Buck Lake gas field. The changes in rate of dip and position of hinge line are well illustrated on the structural cross-section Y-Y' (Fig. 2).

A weak positive linear feature under Buck Lake extends some distance in a west-southwest direction. This trend, recognized in Devonian and older strata (Dr. Helen Belyea, personal communication), persists through Mississippian formations.

The marked anomaly in the southeastern corner of the area reflects drapage over the underlying Leduc (Late Devonian) reef due to differential compaction. At its maximum development, the top of the reef is about 1,100 feet below the base of the Mississippian sequence. The effects of compaction are still apparent on the structure-isopachous map of the Banff Formation (Fig. 5) as compaction continued in post-Mississippian time (Lill, 1954).

The carbonate classification proposed by R.L. Folk (1959, 1962) was followed in describing the samples and acetate peels. One modification was made, however, in that the upper grain-size boundary of micrite, i.e., lime mud, was raised from 4 to 10 microns. Folk (1959, p.8) mentioned that he "vacillated at different times between grain-size boundaries of 10, 5, and finally 4 microns". The 4 micron boundary is too fine for describing well cuttings under a stereoscopic or binocular microscope. Rock names incorporating Folk's terminology are used throughout this paper but other terms in general use are also indicated.

STRATIGRAPHY

Mississippian strata in the Pembina area are divided into five formations following the usage of Penner (1958a). These are, in ascending order: Exshaw, Banff, Pekisko, Shunda, and Turner Valley Formations. Most of the Turner Valley Formation has been removed by late and post-Palaeozoic erosion, and only the Elkton Member of this formation is present.

Mississippian strata are unconformably overlain by Jurassic rocks in the central and western parts of the area, and Lower Cretaceous rocks in the eastern part. The eroded surface of the Palaeozoic rocks is a peneplain where overlain by Jurassic rocks, but prominent stream valleys and ridges are apparent where it is overlain by Cretaceous rocks (Figs. 2, 10). These erosional features are discussed in Macauley, et al. (1964) as typical of the eroded surface of the Palaeozoic in western Alberta.

Table of Formations

<table>
<tr><th>Period</th><th>Stage</th><th>Formation and thickness (feet)</th><th>Lithology</th></tr>
<tr><td colspan="4">Jurassic and Cretaceous</td></tr>
<tr><td colspan="4">Unconformity</td></tr>
<tr><td rowspan="5">Mississippian</td><td rowspan="3">Osagean</td><td>Turner Valley (Elkton Member)
0 - 48</td><td>Fine- and medium-crystalline dolomite</td></tr>
<tr><td>Shunda
0 - 320</td><td>Silty dolomite, breccia and anhydrite</td></tr>
<tr><td>Pekisko
0 - 130</td><td>Crinoidal limestone and dolomite</td></tr>
<tr><td rowspan="2">Kinder-hookian</td><td>Banff
0 - 620</td><td>Argillaceous cherty limestone, siltstone</td></tr>
<tr><td>Exshaw
0 - 15</td><td>Dark brown and black shale</td></tr>
<tr><td colspan="4">Disconformity?</td></tr>
<tr><td>Devonian</td><td colspan="3"></td></tr>
</table>

The thickest Mississippian section in the area was penetrated in Mobil et al Brazeau 6-15-45-14 where the sequence is 949 feet thick (Fig. 11). In the extreme northeastern corner of the map-area, Mississippian rocks have been removed by erosion, and Cretaceous strata unconformably overlie Upper Devonian rocks of the Wabamun Group. Erosion during the Permian, Triassic, Jurassic and Early Cretaceous periods (Macauley, et al., 1964) bevelled the Mississippian strata and progressively older formations underlie the sub-Mesozoic unconformity from west to east (Figs. 1, 2, 10, 11).

The Exshaw Formation is either Late Devonian or Early Mississippian in age. The Banff Formation is Kinderhookian in age, and the Pekisko, Shunda, and Turner Valley Formations are Osagean (Harker and Raasch, 1958; Penner, 1958a).

Exshaw Formation

The Exshaw Formation was erected by Warren (1937) for a black, fissile shale about 30 feet thick at the base of the Mississippian Banff Formation and overlying the Devonian Palliser Formation near Exshaw, Alberta. Later, Clark (1949) included 30 feet of overlying argillaceous limestone within the Exshaw and Harker and McLaren (1958) and Macauley (1958) included siltstone and silty limestone beds which overlie the black shale in parts of western Alberta. In Pembina area, the Exshaw Formation is a radioactive, dark brown to black non-calcareous shale with a characteristic brown streak generally less than 15 feet thick.

The contact between the Exshaw and the underlying Upper Devonian Wabamun Group is sharply defined due to the abrupt downward change in lithology from shale to limestone. The uppermost Wabamun limestone is commonly a biomicrite (fossil debris 'floating' in a lime mud matrix). This contact is readily defined on gamma ray logs by the highly radioactive character of the Exshaw (Fig. 3). A difference of opinion exists as to the nature of the contact; the Exshaw may disconformably overlie the Devonian system, or deposition may have been continuous from Devonian to Mississippian (see Harker and McLaren, 1958; Macauley, et al., 1964). In this report-area the abrupt change in lithology suggests a disconformity.

The Exshaw is conformably overlain by the Banff Formation. It is necessary to confine the use of the term 'Exshaw' to the original definition otherwise a problem presents itself in drawing a consistent upper contact. The stratigraphic cross-section (Fig. 3) shows the following sequence, in descending order in the three westernmost wells at the base of the Mississippian section:

black shale
argillaceous limestone
siltstone
black shale

This sequence is readily determined both from samples and wireline logs, and is a good illustration of the Exshaw as amended by later workers. However, if the Banff-Exshaw contact is placed at the base of the upper black shale, it can only be traced a short distance eastwards as the upper three units become indistinguishable from Banff lithology. The basal black shale, however, is easily picked in sample studies and on gamma ray logs throughout the area, and for practical purposes is called the Exshaw Formation. This usage of the term was also followed by Moore (1958), and as mentioned by Penner (1958a), it is also used in this manner by industry.

The age of the Exshaw is controversial. It is either earliest Mississippian or latest Devonian age (see Warren, 1937, 1956; Warren and Stelck, 1950; Crickmay, 1952, 1956; Pamenter, 1956; Harker and McLaren, 1958; Folinsbee and Baadsgaard, 1958; Schindewolf, 1959). However, Macauley, et al. (1964, p. 94) stated: "The Bakken[1]Exshaw is generally mapped with the Carboniferous because of lithologic affinity to overlying beds and abrupt dissimilarity to underlying strata". No additional palaeontological evidence was found in this study, and the Banff and Exshaw Formations are dealt with as a single unit for mapping purposes in this report.

Banff Formation

The Banff Formation was originally defined near Banff, Alberta by Kindle (1924) as a predominantly shaly limestone unit grading upwards into massive Rundle crinoidal limestone, and overlying massive Devonian Palliser limestone and dolomite. The Exshaw Formation, as stated above, was designated later for the thin black shale at the base of the Banff.

In this area, the combined Banff-Exshaw, where it has not been truncated by post-Palaeozoic erosion, ranges from 496 to 626 feet in thickness. The thickest combined section is found in Imp Cdn Sup Will 16-9-43-4 and the thinnest full section is in Texaco HB Dismal Creek 6-28-47-14 (Figs. 3, 5). Coincident with the thinning of the Banff in a westward direction, is the development of the previously mentioned distinctive shale, limestone, siltstone, and shale sequence at the base of the Mississippian (Fig. 3). In the thicker eastern sections, only the basal shale of the sequence is discernible; this lowermost shale is the Exshaw Formation of this report.

The Banff Formation may be divided into three broad lithologic units: a lower argillaceous limestone unit; a medial bioclastic limestone unit; and an upper silty unit. Although these units are useful in discussing Banff lithology, they are not practicable for mapping purposes as they vary considerably in thickness and contacts are gradational.

The basal unit, 150-350 feet thick, consists of dark grey-brown argillaceous, cherty limestone grading into or interbedded with dark calcareous shale. The limestone has a grain size of less than 0.010 mm (lime mud or micrite) and commonly contains monaxon siliceous spicules. Where the spicules are not present, it is difficult to differentiate argillaceous limestone from calcareous shale. The argillaceous content of the well cuttings varies in successive 10-foot intervals although rock chips appear much the same. The insoluble residue remaining after boiling a rock fragment in dilute hydrochloric acid is commonly a consolidated dark brown remnant of

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[1] In southern Alberta, Saskatchewan, and Manitoba, the Bakken Formation is the lowermost Mississippian unit and is approximately equivalent to the Exshaw Formation.

very fine silt-sized quartz and lesser clay. For this reason, one symbol is used in Figure 3 to represent argillaceous micrite (lime mud) grading into or interbedded with calcareous shale. Where siliceous spicules are present (fossiliferous or spicular micrite), the brown insoluble residue of silt and clay remaining after treatment with dilute hydrochloric acid is disaggregated and is slight to moderate in quantity. Dark chert inclusions are common in both micrite and fossiliferous micrite. The lower unit includes the shale, limestone, and siltstone sequence at the base of the Banff in the western part of the map-area.

The medial 100-175 feet of Banff consists of dark grey-brown argillaceous fossiliferous limestone termed argillaceous biomicrite. Crinoidal debris and rare ribbed brachiopod fragments are loosely packed in a lime mud matrix; small to moderate amounts of brown insoluble residue are present. Pyrite is abundant, these are light coloured chert inclusions and the zone is often partly silicified. Dolomitization is also a characteristic feature and in many instances a calcareous medium-crystalline dolomite with scattered unreplaced bioclasts, usually crinoids, is the dominant lithology.

The uppermost 100-150 feet of Banff is lithologically variable. It is generally identified by the abundance of dolomitic siltstone interbedded with or gradational into silty dolomite. In places, a very fine sandstone composed of subrounded quartz grains (0.062-0.125 mm) forms the top of the Banff Formation. Pyrite inclusions are abundant and minor beds of green pyritic shale are common. Here and there pelmicrite (pellets, intraclasts, and rare bioclasts in a lime mud matrix), 10-20 feet thick, underlies the silty zone. In the northern half of the map-area, beds of medium-crystalline dolomite with intercrystalline porosity and some pyrobitumin infilling overlie a distinctive dark brown-stained, finely sucrosic dolomite. The approximate outline of the occurrence of this facies is illustrated in Figure 5. In sample examination, the medium-crystalline, porous dolomite can easily be mistaken for similar rock found in the overlying Pekisko Formation, especially where the Pekisko and the uppermost Banff siltstone have been eroded. A silty unit below this dolomite can give a false Pekisko-Banff contact, and careful correlation with wells reaching the Exshaw is required to establish whether the dolomite is Banff or Pekisko.

An anomalous well, Texaco McColl Aurora A-6-27, in l.s. 2-27-49-10 W5, is illustrated in Figure 3. The threefold division is not applicable as the silty and bioclastic zones are interbedded in the uppermost 200 feet. Below this, in descending order, are: 130 feet of siliceous, cherty spicular micrite; 70 feet of pelsparite and biosparite (pelleted and skeletal limestone with spar cement); 60 feet of argillaceous, cherty micrite and cherty calcareous dolomite; 60 feet of cherty dolomitic siltstone and silty dolomite; and 15 feet of calcareous shale. However, this appears to be the only anomalous well, and the three units are recognizable throughout the remainder of the area.

The reservoir rock for the only commercial Banff gas well in the area, Cdn Sup et al Wilson Ck 6-18-43-4, consists of beds of porous, medium-crystalline dolomite interbedded with non-porous finely crystalline silty dolomite in the uppermost 100 feet of Banff section. The secondary origin of the dolomite is apparent as the original skeletal limestone texture is still recognizable. Leaching of crinoids and brachiopods, which were the main components of the rock, has given rise to the vuggy porosity of the dolomite; voids are partly infilled by black pyrobitumin.

Pekisko Formation

The Pekisko Formation (Douglas, 1953; Penner 1958a), a distinctive crinoidal limestone unit is recognizable throughout west-central Alberta. Within Pembina area, the formation ranges from 61 to 130 feet in thickness where not truncated by erosion (Fig. 7). The thinnest areas are in the extreme west and the thickest in the south. In the eastern part of the map-area, the Pekisko has been removed by late and post-Palaeozoic erosion. It is a resistant unit and its subcrop[1] is generally only a few miles in width. The Pekisko is economically the most important Mississippian feature in the area.

Throughout the area, Pekisko limestones, or dolomitized equivalents, rest conformably on the underlying silty dolomites and siltstones of the Banff Formation. This contact is readily determined in sample and wireline log examination (Fig. 3). Lithologically the formation is mainly a medium-crystalline dolomite at and near the subcrop, and a crinoidal spar-cemented limestone at the western edge of the map-area (Fig. 7).

The crinoidal spar-cemented limestone is termed a crinoidal biosparite or biosparrudite; the former name is applied to limestones with crinoidal material between 0.062 and 1 mm in size, and the latter to material greater than 1 mm in size. The crinoidal debris together with minor bryozoan fragments are cemented by clear sparry calcite. The ossicles commonly show pressure welding and the spar is in optic continuity with the adjacent crinoid fragments.

At the western edge of the map-area, the Pekisko consists in descending order, of: pelmicrite (pellets in a lime mud matrix); micritic biosparite (skeletal fragments with both lime mud matrix and spar cement) and biomicrite (skeletal fragments in a lime mud matrix); and biopelsparite (chiefly crinoidal debris with lesser pellets and superficially coated oolites, and minor intraclasts or fragments of lime mud, all cemented by spar) (see Fig. 3). North and east of this limestone sequence, the spar-cemented limestone forms the basal part of the formation, but the upper part is composed of porous, medium-crystalline dolomite with some black pyrobitumin infilling. At the Pekisko subcrop, almost all the rock is medium- to coarse-crystalline dolomite, but in the extreme south, it is all crinoidal biosparrudite with minor bryozoa and superficially coated grains. The rock is not completely infilled by spar and interparticle porosity is present; some voids are partly infilled by black pyrobitumin. This limestone forms a reservoir rock in the Wilson Creek gas field.

Relic textures in the porous dolomite at the subcrop indicate that this rock was originally crinoidal limestone. Black pyrobitumin is present and

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[1] In this report, the term 'subcrop' refers to the area within which a formation occurs directly beneath the sub-Mesozoic unconformity.

partly infills the voids. This lithology is the most important from an economic standpoint as it forms the reservoir rock for the Minnehik-Buck Lake gas field. Both vuggy and intercrystalline porosity are present; the former appears due to the leaching of crinoidal matter, and the latter to incomplete infilling of leached voids by growth of dolomite rhombs. These rhombs are coarser in size than those comprising the main body of the rock and some voids have been completely infilled so that the resultant rock is medium-crystalline with coarse-crystalline patches.

Quartz silt is common in the Pekisko; white chert inclusions are uncommon. In some wells silty, fine-crystalline dolomite occurs in the upper part of the formation.

In the west and northwest parts of the map-area, the upper beds of the Pekisko change to an anhydritic carbonate facies and are mapped with the overlying Shunda Formation, producing an apparent thinning on the Pekisko isopachous map (Fig. 7), and a complementary thickening on the Shunda isopachous map (Fig. 8); see also Figure 2. If the anhydrite is secondary, as seems possible, then these beds would more logically be retained in the Pekisko, but available samples are of insufficient quality to support this interpretation.

Shunda Formation

The Shunda Formation (Stearn, 1956; Penner, 1958a and b) is a heterogeneous sequence of silty dolomites, anhydrite, and breccias. It overlies crinoidal limestone and medium-crystalline dolomite of the Pekisko Formation, and is overlain by medium-crystalline dolomite of the Turner Valley Formation (Elkton Member). At the type section about 13 miles south of the southwest corner of the map-area, the Shunda is a predominantly thin-bedded argillaceous limestone with breccia zones and is 232 feet thick (Penner, 1958b).

In the eastern half of Pembina area, the Shunda Formation has been completely removed by late and post-Palaeozoic erosion, but its subcrop forms the top of the Mississippian section over most of the remainder. The uneroded formation is preserved only in the southwest corner of the area where two wells have penetrated a complete Shunda section. The maximum thickness of 320 feet was found in Mobil et al Brazeau 6-15-45-14 (Fig. 8).

Two main lithofacies are recognized within the Shunda Formation (Figs. 3, 8); an eastern breccia facies and a western anhydrite carbonate facies. The former is a silty, very finely crystalline dolomite, with interbeds of dolomitic siltstone and green pyritic shale, and is characterized by breccia fragments. The anhydritic carbonate facies is dominantly anhydritic, silty, very finely crystalline dolomite with minor beds of dolomitic siltstone in the upper part and contains abundant white crystalline anhydrite in the basal 100 feet. The breccia facies appears to have been formed by the solution of anhydrite at and near the Shunda subcrop. Minor beds of pelmicrite (pellets in a lime mud matrix) occur near the base of both facies in some wells.

The contact between the Shunda and the overlying Turner Valley Formation (Elkton Member) is gradational in some wells (Fig. 3). Medium-crystalline, porous dolomite similar to the overlying Turner Valley is found interbedded with the fine silty dolomite of the Shunda in its uppermost 30 feet. The top of the Shunda is placed at the top of the uppermost fine silty dolomite. The porous beds in the upper Shunda are economic objectives; one capped gas well and one oil well have been completed in this zone.

Turner Valley Formation

Elkton Member

The Elkton Member of the Turner Valley Formation (Douglas, 1953; Penner 1958a) forms the youngest Mississippian rock unit in the area. At the type section (Penner, 1958a) about 70 miles south of the report-area, the Elkton is 140 feet thick and is mostly medium-crystalline dolomite. Throughout most of the map-area (Figs. 1, 9) this member is not present due to removal by late and post-Palaeozoic erosion and it is present only in the extreme southwest corner of the area where a maximum thickness of 48 feet was observed in Mobil et al Brazeau 6-5-45-13.

The Elkton is a light grey and very light brown, medium-crystalline dolomite with very good vuggy porosity. The crystallinity is at the fine end of the medium size range (generally 0.08-0.10 mm). The rock is of high lustre, hard, and composed of euhedral and subhedral rhombs; the vuggy porosity is partly infilled with black pyrobitumin. A secondary origin of the dolomite is apparent as the original skeletal limestone texture is recognizable, and partly leached crinoids and horn corals are responsible for the vuggy porosity. The rock is siliceous in part and a few chips were seen in which quartz had replaced some of the crinoids. Insoluble residues consist of minor silt-sized quartz grains with rare doubly terminated fine quartz crystals. Rarely, quartz crystals were seen in growth position attached to the walls of vugs.

The Elkton Member forms the reservoir rock for the Brazeau River gas field.

ECONOMIC GEOLOGY

Natural gas is currently being produced from the Pekisko Formation in the Minnehik-Buck Lake field. Commercial gas reserves also exist in the Wilson Creek and Brazeau River fields but the wells are capped and not producing at present (Fig. 1). In addition, there are three Elkton and one Shunda potential gas wells outside defined field limits. One of the potential Elkton gas wells is also an oil producer from the Shunda Formation. A second Mississippian oil well produces from an isolated Pekisko outlier in the north-central part of the area.

Banff Formation

Location of the only gas completion in the Banff Formation, and the results of all drillstem tests conducted in the formation are included on the structure-isopachous map (Fig. 5). The Banff gas well, Cdn Sup et al Wilson Creek 6-18-43-4, is actually a potential dual Pekisko-Banff gas producer in the Wilson Creek gas field. In this well, gas occurs in the porous, medium-crystalline dolomite in the uppermost 100 feet of Banff. The Oil and Gas Conservation Board (Alberta) (1965, p. 30) estimated the initial Banff gas in place at 18 BCF (billion cubic feet) as of December 31, 1964, for this field but the gas is "presently considered beyond economic reach".

Oil and gas have been recovered in drillstem tests from the brown sucrosic dolomite facies in the uppermost 100 feet of the Banff Formation (Fig. 5). No commercial production was obtained from this zone, but the significant recoveries indicate a strong possibility that commercial hydrocarbon accumulation may be found in this facies.

Pekisko Formation

Drillstem test intervals and recoveries, and oil and gas wells which produce or are potential producers from the Pekisko Formation, are shown on the structure contour map (Fig. 6). It is apparent that hydrocarbon production from the Pekisko has been discovered only within its subcrop area (Fig. 7). The stratigraphic traps are formed by sealing of the updip edge by impermeable Jurassic strata (Fig. 2). The porosity continues downdip towards the west-southwest but the formation is salt-water bearing in that direction.

The Minnehik-Buck Lake field is the only producing Mississippian gas field in the area. Medium- to coarse- crystalline dolomite with vuggy and intercrystalline porosity forms the reservoir rock. There were 17 Pekisko gas wells, capped or producing, in the field on January 4, 1966. As of December 31, 1964, the Oil and Gas Conservation Board (Alberta) estimated the initial gas in place at 550 BCF, and the initial marketable gas at 420 BCF.

The Wilson Creek gas field contained one dual Pekisko-Banff capped gas well and one Pekisko capped gas well on January 4, 1966. Skeletal limestone with interparticle porosity comprises the reservoir rock. As of December 31, 1964, the Oil and Gas Conservation Board (Alberta) (1965, p. 30) estimated the initial gas in place for the Pekisko at 23 BCF but considered the reserves as "beyond economic reach" at present.

Two Mississippian wells have been completed within the Pembina field boundaries as shown on Figure 1. Both are dual completions; Pan Am Lob E-44 Pem 6-22-50-8 is a dual potential Pekisko gas and producing Cardium (Upper Cretaceous) oil well, and Pan Am Lob L-4 Pem 10-8MU-50-7 is a dual Pekisko oil and Glauconitic (Lower Cretaceous) gas well. The latter is in an isolated Pekisko outlier where only 8 feet of the formation was encountered. Mobil VG 7-6 Pem In 6-7-48-7 was a Pekisko oil well from 1955 to 1956, but the Mississippian was plugged off and the well converted to a water injection well in the Upper Cretaceous Cardium Formation. In all three wells, the Pekisko is a medium-crystalline dolomite with vuggy and intercrystalline porosity.

Shunda Formation

Two wells have indicated commercial reserves in the Shunda Formation (Fig. 8). HB BrazR 10-2-46-14 is a dual capped Elkton gas and Shunda oil well, and UNO-Tex Coalspur 10-31-46-14 is a potential Shunda gas well. In both wells, the Shunda reservoir rock is the topmost part of the section. The core for the oil well was not available for study at the time of writing, but the Coalspur well had 4 1/2 feet of medium-crystalline porous dolomite interbedded with dolomitic siltstone in the uppermost 19 feet of the section. Impermeable Jurassic strata form the updip seal for the trap.

Elkton Member of the Turner Valley Formation

Potential gas wells and drillstem test intervals and recoveries are included on the structure-isopachous map of the Elkton Member of the Turner Valley Formation. This member forms the reservoir rock for the Brazeau River gas field (Fig. 1) and four potential gas wells were within the field limits on January 4, 1966. As of December 31, 1964, the Oil and Gas Conservation Board (Alberta) (1965, p. 10) estimated the initial gas in place at 200 BCF for this field but the gas is "presently considered beyond economic reach". There are also three potential Elkton gas wells outside the field limits in the report area.

The reservoir rock and trap are similar to that of the Pekisko Formation. Fine- to medium-crystalline dolomite with vuggy porosity is sealed at the updip erosional edge by the overlying Jurassic strata (Fig. 2). The member is salt-water bearing downdip (Fig. 9). The erosional edge can be traced northwestward where it forms the eastern limit of the prolific Edson gas field about 8 miles west of the northwest corner of the report-area.

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