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ATHABASKA-BARRHEAD MAP-AREA,
ALBERTA
(Summary Account)

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Illustration

Preliminary map — Athabaska-Barrhead, Alberta.

ATHABASKA-BARRHEAD MAP-AREA, ALBERTA

INTRODUCTION

The Athabaska-Barrhead area comprises two 1-degree sheets lying between latitudes 54 and 55 degrees and longitudes 113 and 115 degrees, a total of 5,600 square miles. Only a small part of the western, or Barrhead, map-area northwest of Athabaska River was examined in 1943. This corner includes the east edge of the Swan Hills, from which Sauleux, Coutts, and Allan Rivers flow with steep gradients, and probably contains outcrops of geological importance.

Structurally the combined map-area lies on the east limb of the Alberta syncline. Dips are westerly and seldom exceed 20 feet to the mile. All rocks are sedimentary and of Upper Cretaceous age. The oldest are represented by the upper part of the La Biche formation; the youngest, towards the southwest corner of the map-area, are correlated with the Edmonton formation.

PREVIOUS WORK AND ACKNOWLEDGMENTS

In 1879¹, G. M. Dawson and R. G. McConnell made

¹A list of references is given at the end of this report.

traverses along Athabaska River between the mouths of MacLeod and La Biche Rivers. McConnell again traversed part of the area in 1893. Beginning at Athabaska Landing, he descended Athabaska River as far as Calling River, crossed over to Peace River, and completed his circuit via Lesser Slave Lake, Lesser Slave River, and Athabaska River. In the same year J. B. Tyrrell, on his way to the Northwest Territories, examined some of the rocks and collected fossils on Athabaska River below the Landing. Many years later F. H. McLearn (1916) studied the Cretaceous section on Athabaska River between the Landing and Fort McMurray. More recently, numerous traverses were made over most of the area under present consideration by Drs. J. A. Allan and R. L. Rutherford of the University of Alberta. Their work is compiled in Reports Nos. 13, 14, 15, 22, 24, 26, 28, 29, 30, 32, and 34 of the Research Council of Alberta, and in a geological map of the province.

The writer is indebted to Drs. Allan and Rutherford for information on the location of outcrops and fossiliferous beds in the basal Belly River sandstone. Field work was also facilitated by the assistance of Messrs. J. G. Matthews and A. R. Thompson.

PHYSICAL FEATURES

The map-area is characterized by a glacial topography, more pronounced in some parts than in others. To the west, between Barrhead and Athabaska River, a prominent moraine stretches northward, obviously the northern extension of the Duffield moraine mapped by Rutherford (1941) and J. H. Bretz (1943). The steep morainal hills near Roselea contain numerous boulders and are difficult to farm. An almost continuous range of sand (and silt) hills, probably of fluvioglacial origin and later modified by wind action,

crosses Athabaska River between Chisholm and Hondo, and extends south to southeasterly by way of Rochester, Halfway Lake, Opal, and Redwater.

Post-glacial drainage has not been re-established and shallow undrained lakes and muskegs are consequently numerous. Large swamps are reported on both sides of Athabaska River between Tieland and Smith, on the east side extending as far as Lawrence and Baptiste Lakes. The less glaciated areas, lying south of a line between Barrhead and Clyde, and those east of Athabaska and Colinton, include the best farm lands and are well settled.

The mean elevation of the map-area is approximately 2,250 feet above sea-level, and maximum relief over most of the area is not more than 400 feet. However, the surface rises rather abruptly to about 3,700 feet near the headwaters of Allan River in the Swan Hills. The lowest elevation, about 1,650 feet, is on Athabaska River at the east boundary of the map-area.

The entire area is dissected by one large drainage system, the Athabaska. Its valley is cut down to a maximum depth of 300 feet and a width averaging $1\frac{1}{2}$ to 2 miles. The banks are seldom steep, but descend in gradual, wood-covered slopes or in a series of slump blocks. Cutbanks rarely expose rock formations in this part of the river's course.

Dense brush, and timber stands in various stages of depletion, cover much of the area. Small sawmills operate, most of them seasonally, along Athabaska River and in the more accessible swamp land on either side.

GENERAL GEOLOGY

The Athabaska-Barrhead area is mostly drift-covered. Eighty outcrops, an average of one for each 50 square miles, were observed in those parts examined, and most of these are along Athabaska River and its tributaries. Recent slumping is prevalent along the stream valleys, so that only those outcrops in the cliffs several hundred feet from the channel can be considered in place. In one instance there was rather definite evidence of pre-glacial slumping. Even though the present surface may show no signs of slumping, any local indication of structure must be examined with caution.

Information on the lithological character and thicknesses of various formations is meagre. The thickest section measured is slightly less than 100 feet; most sections are much thinner. Descriptions of all formations below the upper La Biche are based largely on cuttings from wells near Athabaska. Younger formations can be described only generally from observations made in the field. Detailed lithological features of formations penetrated in wells near Athabaska will be brought out in a well log that follows the table of formations.

Table of Formations

| Era | Period | Epoch | Formation or group | Thickness Feet |
|--------------|--------------|------------------------|--------------------------------|-----------------------------|
| Cenozoic | Modern | Pleistocene and Recent | | |
| | Unconformity | | | |
| | Tertiary | ? | Saskatchewan gravels and sands | |
| Unconformity | | | | |
| Mesozoic | Cretaceous | Upper Cretaceous | Edmonton | Lower 400 (approx.) in area |
| | | | Bearpaw | 50- |
| | | | Belly River | 1,150± |
| | | | La Biche | 1,380 |
| | | | Pelican sandstone | 42 - 60 |
| | | Lower Cretaceous | Pelican shale | 90 -135 |
| | | | Grand Rapids | 350 |
| | | | Clearwater | 175 |
| | | | McMurray | 20+ |
| Unconformity | | | | |
| Palaeozoic | Devonian | | | 320+ |

Log of Athadome No. 2 Well

Location: L.s.d. 3, sec. 15, tp. 66, rge. 23, W: 4th mer.
Elevation at ground level: 2,010 feet (Geodetic datum).

Drilling method: Cable.
Date drilled: 1932.

| Formation | Depth in feet | Lithology and remarks |
|------------------------|---------------|---|
| Recent | 0- 36 | Glacial drift. |
| Belly River (36-90) | 36- 90 | Sandstone, light grey to buff, fine- to medium-grained; brown ironstone, thin beds (?) of grey shale and coaly streaks. |

| Formation | Depth in feet | Lithology and remarks |
|------------------------------------|---------------|---|
| La Biche (Continued) (90-1,470) | 90- 150 | Shale, grey, and sandy shale; a few carbonaceous streaks. |
| | 150- 420 | Shale, grey with sandy streaks; upper 70 feet somewhat calcareous; carbonaceous specks. |
| | 420- 600 | Shale, grey with sandy streaks; shell fragment at 450; bentonite 530-550; calcite stringers (?) |
| | 600- 710 | Shale, grey, with trace of bentonite below 630; shell fragments 610-620, 650-660. |
| | 710- 770 | Shale, grey, and <u>speckled shale</u> ; a few sandy streaks; shell and fish fragments; pyrite at 770. |
| | 770-1,000 | Shale, grey and a bit sandy down to 840; trace of <u>speckled shale</u> at 900. |
| | 1,000-1,040 | Shale, grey; |
| | 1,040-1,080 | Shale, grey with sandy streaks, and some <u>speckled shale</u> ; trace of fish scales. |
| | 1,080-1,120 | Shale, dark grey and <u>speckled shale</u> , slightly sandy; fish tooth and fibrous calcite at 1,100. |
| | 1,120-1,220 | Shale, dark grey; fish scales, 1,150-1,160; trace of bentonite. |
| | 1,220-1,230 | As above, with fish remains and shell fragments. |
| | 1,230-1,250 | Missing. |
| | 1,250-1,290 | Shale, dark grey, bit sandy near middle; fish remains. |
| | 1,290-1,300 | Shale, grey, prominently sandy. |
| | 1,300-1,370 | Shale, dark grey, fissile; pyrite and fish remains at 1,310-1,320; chert pebbles (?) and fish remains at 1,370. |

| Formation | Depth in feet | Lithology and remarks |
|--|---------------|--|
| La Biche (Cont'd) | 1,370-1,460 | Shale, dark grey, fissile; some sandy streaks and ironstone, becoming more prominent towards the base. |
| | 1,460-1,470 | Shale, as above, with 60 per cent well-rounded quartz sand, which is probably from bottom of interval; driller reports contact at 1,470. |
| Pelican sandstone (1,470-1,520) | 1,470-1,520 | Sand, medium- to fine-grained, grains rounded and largely quartzose, few chert pebbles; sandstone is finer, probably containing shaly bands, near base. |
| Pelican shale (1,520-1,650) | 1,520-1,570 | Shale, dark grey, trace of rusty concretionary material. |
| | 1,570-1,610 | Shale, dark grey; light brown ironstone; fibrous calcite at 1,600-1,610; chert pebbles at 1,600. |
| | 1,610-1,630 | Shale, dark grey, with coaly and limy specks. |
| | 1,630-1,650 | Shale, dark grey, more silty and sandy. |
| Grand Rapids formation (1,650-1,990) | 1,650-1,670 | Sandstone, medium to coarse, subangular, feldspathic (?); oil stained; thin shale and ironstone beds; heavy oil, 15 bbls. a day reported from this zone. |
| | 1,670-1,720 | Sand, fine- to medium-grained with thin shale beds (partly carbonaceous) and ironstone, especially towards the base; chert pebbles at 1,670-1,680. |
| | 1,720-1,760 | Sand, light grey, with carbonaceous shale interbeds. |
| | 1,760-1,790 | Shale, grey to greenish grey; partly sandy; trace of bentonite and ironstone. |
| | 1,790-1,830 | Sand, salt and pepper appearance, angular. |
| | 1,830-1,880 | Shale, dark grey to grey-black, with carbonaceous specks and some pyrite; slightly sandy towards base. |

| Formation | Depth in feet | Lithology and remarks |
|---------------------------------------|---------------|---|
| Grand Rapids formation (Cont'd) | 1,880-1,940 | Sand, salt and pepper appearance, with ironstone and traces of shale. |
| | 1,940-1,950 | Shale, grey, and well-cemented sandy shale. |
| | 1,950-1,990 | Sand, salt and pepper appearance, with feldspathic (?) grains and shale, especially towards base. |
| Clearwater formation (1,990-2,165) | 1,990-2,030 | Shale, grey, somewhat sandy near top. |
| | 2,030-2,050 | Sand, (oil stained in part), fine-grained to silty, with glauconite and carbonaceous specks. |
| | 2,050-2,165 | Shale, grey with lighter sandy shale; glauconite at 2,100-2,110 and 2,150-2,160. |
| McMurray formation (2,165-2,185) | 2,165-2,185 | Sand, very fine-grained; coal fragments and trace of shale. |
| Devonian (2,185-2,500) | 2,185-2,195 | Chert, buff and grey, with some quartz crystals and pale green shale. |
| | 2,195-2,210 | Limestone, buff, oil stained near top. |
| | 2,210-2,230 | Missing. |
| | 2,230-2,290 | Limestone, dolomitic; traces of shale; oil stained at 2,265 and 2,270-2,280. |
| | 2,290-2,320 | Limestone, dolomitic, buff to grey, with abundant grey shale and shaly sandstone; some whitish chert. |
| | 2,320-2,360 | Limestone, dolomitic, buff to grey, and shale; oil stained at intervals. |
| | 2,360-2,440 | Limestone, light buff-grey; some chert at 2,430-2,440. |
| | 2,440-2,470 | Limestone, light grey, with some greenish shale; pyrite at 2,460-2,470. |
| | 2,470-2,500 | Limestone, dolomitic, light grey, with some greenish shale, pyrite, and chert. |

Devonian

Devonian beds were penetrated for 320 feet at Athadome No. 2 well and for 110 feet at Athadome No. 1 well (l.s.d. 12, sec. 21, tp. 72, rge. 24, W. 4th mer.) near Smith. No subdivision of the Devonian has been attempted along Athabaska River, where it consists mostly of buff and grey limestone, partly dolomitic, with shale interbeds. Chert occurs at the top and is, in part at least, detrital. Where penetrated, the limestone shows no good porous zones in the first 320 feet.

McMurray Formation

The McMurray formation consists largely of fine-grained, brownish sand with, especially towards the base, thin coaly seams and shale bands. It is only 20 feet thick at Athadome No. 2 well. At Athadome No. 1 it is 65 feet thick; is oil stained; and has provided a good flow of gas. These thicknesses represent considerable thinning between McMurray and Athabaska. Where it is exposed on Athabaska River, McLearn (1916) has recorded a thickness of 110 to 180+ feet.

Clearwater Formation

The Clearwater formation, like the McMurray, seems to thin toward the south. Thicknesses have been measured as follows: on Athabaska River, 275 feet; at Athadome No. 1 well, 230 feet; and at Athadome No. 2 well, 175 feet. The formation consists mainly of dark grey shale. Thin interbeds of slightly carbonaceous sandy shale and fine-grained sandstone containing glauconite occur at intervals.

Grand Rapids Formation

The Grand Rapids formation is 350 feet thick in both Athadome wells. On Athabaska River, McLearn (1916) found it to be 280 feet thick. It consists largely of sandstone, especially towards the top and bottom, but at intervals between includes some shale and shaly sandstone containing coaly bands. Athadome No. 2 and Deca No. 4 wells are reported to have struck small quantities of heavy crude oil in the upper sandstone beds, and Deca No. 2 encountered a strong gas flow in the same rocks.

Pelican Shale

Pelican shale has been penetrated by four drill holes south of Athabaska. Thicknesses were found to vary between 90 and 125 feet within a radius of 4 miles. The formation is 95 feet thick in Athadome No. 1 well and 90 feet thick on Athabaska River where it was measured by McLearn (1916). It consists largely of dark grey, fissile shale with fine-grained, lenticular sandstone beds near the base. One such bed, 6 feet thick, lies 8 feet above the base in Deca No. 2 well and a somewhat thicker bed, 20 feet above the base, was penetrated in Deca No. 1 well. No corresponding sand bed is present in Athadome No. 2. An oyster fragment was observed 30 feet below the top of the formation in Deca No. 2 well, and chert pebbles occur at the base.

A micro-faunal zone, assigned to the Lower Cretaceous, was recognized by Wickenden (1944) within the Pelican shale at depths from 1,310-15 in Deca No. 1 well, and from 1,570-90 feet in Deca No. 2 well. Species present in this zone include Haplophragmoides gigas Cushman, Ammobaculites fragmentaria? Cushman, Verneuillina canadensis Cushman, and Gaudryina canadensis Cushman. These were also identified in British Petroleum No. 3 well, Wainwright, from depths of 2,044-54 feet and 2,080-86 feet (Hume and Hage, 1941), near the base of the Alberta shale. Wickenden (1944) further reports that the same micro-faunal zone occurring in the Pelican Rapids well, and earlier recorded (Wickenden, 1930) as coming from the Clearwater shale, is actually within the Pelican shale.

Pelican Sandstone

The thickness of the Pelican sandstone varies between 42 and 60 feet in wells near Athabaska. McLearn (1916) found it to be 35 feet thick on Athabaska River, and well samples from Athadome No. 1 well indicate its thickness there as 50 feet. The formation consists of fine- to medium-grained sandstone. The sand grains are clear, well-rounded, and largely quartz. Glauconite grains are present towards the base, and a few chert grains are scattered throughout.

La Biche Formation

The upper 400 feet of the La Biche formation is exposed along Athabaska River below township 69. These shales also outcrop along tributary streams of the Athabaska over the same interval, particularly along Muskeg Creek, Tawatinaw River, Deep Creek, and Sawdy Creek.

Complete sections of La Biche formation were penetrated in Athadome No. 2 and Deca No. 2 wells. Both wells indicate a thickness of 1,380 feet, consisting largely of grey to dark grey shales, with lighter sandy streaks, particularly in the upper part. Fish scales and other fish remains are common. The thickest measured section is on the east bank of the Athabaska River near the southeast corner of sec. 28, tp. 67, rge. 23, W. 4th mer.; it is 98 feet thick. Outcrops of La Biche shales showed very little variety except in the uppermost beds. Along Muskeg Creek, in l.s.d. 2, sec. 1, tp. 66, rge. 23, W. 4th mer.; these upper beds were described and measured as follows:

| | Thickness feet |
|--|-------------------|
| Sandstone (Belly River), thin-bedded, medium-grained, buff to grey, with coaly streaks and thin ironstone bands. A partly eroded concretionary band occurs at the top of the exposure..... | 17.4 |
| (The plane-table elevation at the base of this sandstone is 1,911 feet). | |
| Shale (La Biche), grey, sandy, crumbly, with coaly fragments..... | 3.0 |
| Sandstone, bluish grey, thin-bedded, a bit shaly, with thin coaly streaks..... | 5.4 |

| | Thickness feet |
|---|-------------------|
| Shale, sandy, thinly bedded, and interbedded grey shale and lighter grey sandstone, gypsum on the weathered surface..... | 26.4 |
| Sandstone, mouse grey, fine-grained, thin-bedded, with a few shaly partings:..... | 2.2 |
| Clay ironstone band with a 1-inch cone-in-cone band at its base..... | 0.5 |
| Shale, grey, sandy, thin-bedded..... | 0.6 |
| Sandstone, medium grey, thin-bedded, with shaly partings, minutely crossbedded..... | 2.0 |
| Shale, grey, sandy, with rusty partings..... | 0.5 |
| Sandstone, medium grey, thin-bedded as above..... | 1.7 |
| Sandstone, medium grey, interbedded with darker grey shale and sandy shale; all thin-bedded..... | 9.2 |
| Shale, dark grey, crumbly, containing fragments of mother-of-pearl and of pelecypod shells; to water level in Muskeg Creek..... | 4.0 |
| Total La Biche measured..... | 55.5 |

Faunal zones in the La Biche along Athabaska River were established by McLearn (1937), who recognized the following: (a) zone containing "Acanthoceras" n. sp. ? and Inoceramus athabaskensis McLearn in the basal part of the La Biche. This zone belongs to the Cenomanian or very early Turonian (early Upper Cretaceous) age of Europe. A similar zone is reported by Warren at the base of the Blackstone shale near Luscar; (b) Scaphites ventricosus zone "possibly" about 600 feet above the base of the La Biche; and (c) Baculites ovatus zone, occupying a rather wide stratigraphic range and apparently comprising three local subdivisions:

(1) Baculites cf. ovatus Say, Inoceramus lundbreckensis McLearn, and Ostrea cf. congesta Conrad, occurring in shales of townships 71 and 72, approximately 640 feet above the base of La Biche; (2) somewhat higher in the section Baculites cf. ovatus and small species of Scaphites; and (3) some 300 feet below the top of the La Biche shale, only a few miles below Athabaska Landing, both McLearn and the writer collected fossils from a zone that contains Baculites cf. ovatus, Lucina occidentalis, and Thyasira n. sp. McLearn. The last species is found in the Lea Park of east-central Alberta, suggesting correlation of at least the upper 300 feet of the La Biche with post-Albertan horizons.

In east-central Alberta the top of the uppermost speckled shale horizon has been placed by Hume and Hage (1941) arbitrarily at the top of the Alberta formation. Speckled shale horizons have been recognized in drill hole samples at Athabaska, and if similar criteria are used, the Lea Park equivalent would then be 780 feet thick. In this area the

inclusive formational name "La Biche", however, is more appropriate, as outcrop and drill information is scarce and mapping of two separate shale formations would be most difficult.

Belly River Formation

Beds of the Belly River formation underlie the greater part of Athabaska-Barrhead map-area. From the few outcrops present the writer found it impossible to subdivide the formation as in east-central Alberta. Further, the nearest region in which members of the Belly River have been recognized is along North Saskatchewan River, to the southeast. All but the Grizzly Bear shale are of brackish or freshwater origin. Lateral variation in lithology is characteristic of such beds, even in a single outcrop. It is possible that subdivisions as defined in east-central Alberta are not represented in the Athabaska-Barrhead map-area, but in any case the subdivision of the formation would require much detailed field work, aided by suitably located drill hole information and topographic maps.

The base of the Belly River is represented by a thick, massive sandstone bed that was found most useful in mapping the Belly River-La Biche contact. This sandstone has a minimum thickness of 97 feet on Muskeg Creek. Fossils were not found there, but farther east the following were collected from near the base of the bed and have been identified by F. H. McLearn of the Geological Survey:

Thracia prouti var.
Clisocolus ? sp.
Liopistha montanensis Henderson
Tellina scitula Meek and Hayden ?
Oxytoma nebrascensis Evans and Shumard
Mactra? sp.
Tanoreidia americana Meek and Hayden

This fauna is indicative of a transitional phase from the underlying marine La Biche formation to the overlying predominantly freshwater beds of the Belly River. The sandstone permits fairly accurate mapping of the Belly River-La Biche contact between longitude 113 degrees and Baptiste Lake. Farther west it disappears beneath swamps and a thick mantle of drift. A similar sandstone, at or near the base of the Belly River, outcrops on Athabaska River at intervals above the mouth of Pembina River, and on Pembina River itself near its mouth. This sandstone is an approximate equivalent of the lower Ribstone Creek member in east-central Alberta, but it seems to be somewhat thicker. Neither the top of the sandstone member nor beds immediately overlying it are exposed. Not far above the sandstone the following outcrop was measured on the east bank of Athabaska River, in sec. 25, tp. 64, rge. 3, W. 5th mer:

| Top of section | Feet |
|--|------|
| Coal, partly eroded, and coaly shale..... | 1.2 |
| Shale, brownish grey, crumbly, carbonaceous..... | 2.1 |
| Shale, olive-brown, crumbly, somewhat sandy..... | 9.9 |

| Top of Section (Cont'd) | Feet |
|--|------|
| Ironstone band..... | 1.0 |
| Shale, brownish grey, plastic..... | 1.7 |
| Sandstone, medium-grained, buff, greyish weathering | 5.6 |
| Sandstone, well cemented; buff, conglomeratic and partly crossbedded; contains coaly fragments.. | 3.0 |
| Sandstone, medium-grained, buff, greyish weathering with few coaly streaks..... | 8.4 |
| Coal and coaly shale..... | 0.7 |
| Shale, brown, carbonaceous..... | 0.4 |
| Shale, light grey, containing volcanic ash (?) grading downward into light brown, crumbly shale..... | 4.5 |
| Shale, grey, crumbly, a bit sandy near the top..... | 8.5 |
| Sandstone, fine-grained, buff to grey..... | 3.6 |
| Sandstone, brownish grey, shaly and sandy shale, poorly exposed..... | 9.4 |
| Shale, dark grey, crumbly, with coaly and carbonaceous streaks..... | 1.5 |
| Shale, light brown, a bit sandy to river level..... | 4.2 |
| Total | 65.7 |

This section may represent the middle part of the Ribstone Creek formation of east-central Alberta. Coal seams prospected along Tawatinaw River near Perryvale, on Little Pine Creek (tp. 65, rge. 21, W. 4th mer.), and on Pine Creek in township 63, probably all occur in sections correlative with the above.

On the east bank of Athabaska River, in the north-east corner of sec. 2, tp. 64, rge. 3, W. 5th mer., 16 feet of coarse- to medium-grained, buff, crossbedded sandstone is exposed. It contains coaly streaks, concretionary lenses, and fossil wood, and is in places conglomeratic. The sandstone looks much like that at the base of the Belly River, but stratigraphically overlies both it and the section in tp. 64, rge. 3, referred to above. It may correspond, approximately, to the upper Ribstone Creek member of east-central Alberta. Higher in the section along Athabaska River, on the east bank, in the northeast quarter of section 12, tp. 63, rge. 4, W. 5th mer., another sandstone bed is exposed in a section that measures as follows:

| Pleistocene | Feet |
|--|------|
| Silty (?) clay, light grey with few pebbles, to top of valley..... | 40± |
| Dark grey boulder clay, containing numerous pebbles | 45± |

| Belly River | Feet |
|--|------|
| Sandstone, massive, buff, greyish weathering, containing chert and coaly specks; medium- to coarse-grained with some large concretionary lenses..... | 49.7 |
| Shale, brownish grey, carbonaceous, with some olive brown shale..... | 4.0 |
| Sandstone, loose, fine-grained, buff..... | 2.5 |
| Shale, brownish grey as above, but more carbonaceous to base of exposure..... | 7.5 |
| Covered, to river-level (21.5 feet) | |
| Total | 63.7 |

The stratigraphic position of the thick sandstone bed suggests that it may correspond to the Birch Lake (Victoria) sandstone on North Saskatchewan River. However, the beds underlying it and which should correspond to the Grizzly Bear shale, do not appear to be marine. There is, of course, no good reason to believe that such shales persist so far west and north.

Higher in the section along Athabaska River, in the southeast quarter of sec. 36, tp. 61, rge. 5, W. 5th mer., the following section was measured:

| Top of section | Feet |
|---|------|
| Covered to terrace level in river valley | |
| Shale, grey to dark grey, with coaly streaks..... | 10.0 |
| Coal..... | 0.6 |
| Shale, dark brown clay, somewhat carbonaceous..... | 1.6 |
| Bentonite..... | 0.9 |
| Shale, dark brown, sticky, grading downward into light buff sticky shale; bentonitic..... | 5.4 |
| Shale, brownish grey, sandy..... | 1.1 |
| Sandstone, light grey, fine-grained and shaly, (bentonitic?)..... | 2.6 |
| Shale, greenish grey to medium grey..... | 8.2 |
| Shale, brownish grey, crumbly, with some carbonaceous fragments..... | 3.7 |
| Shale, light brown, crumbly..... | 3.9 |
| Shale, grey, crumbly, with carbonaceous fragments.. | 5.0 |
| Shale, coaly, carbonaceous shale (0.4 ft.) at base. | 2.0 |

| | Feet |
|---|------|
| Bentonite and bentonitic shale, light buff and very soapy..... | 2.3 |
| Shale, brownish grey and grey, crumbly, with coaly streaks and carbonaceous material..... | 7.2 |
| Sandstone, loose, light grey, fine-grained, and a bit shaly..... | 3.0 |
| Sandstone, ledge-forming, concretionary, grey..... | 1.1 |
| Sandstone, loose, light grey, fine-grained..... | 3.6 |
| Shale, light brown, grading downward into dark brown, sticky, with coaly fragments..... | 10.4 |
| Covered to river level (19.6 feet) | |
| Total | 72.6 |

This section probably represents a part of the Pale and Variegated beds of Alberta, and is fairly characteristic of these beds.

Near the top of the Belly River, probably extending into Edmonton beds, the following section was measured on Athabaska River at its junction with Goose Creek:

| | Feet |
|--|------|
| Grass covered and traces of loose gravel to top of valley | |
| Edmonton (including Bearpaw equivalents) | |
| Coal and coaly shale, powdery and weathered..... | 1.5 |
| Shale, brownish grey, light grey weathering..... | 7.1 |
| Bentonite, yellowish..... | 0.9 |
| Shale, grey, crumbly, with thin ironstone bands and sandy streaks..... | 14.6 |
| Shale, light grey weathering, buff..... | 2.6 |
| Top of Belly River (Pale Beds) ? | |
| Sandstone, medium-grained, light grey weathering.. | 12.0 |
| Shale, grey, sandy..... | 1.4 |
| Sandstone, fine-grained, light grey..... | 4.3 |
| Shale, carbonaceous, dark grey, sandy..... | 0.4 |
| Sandstone, light grey, shaly..... | 4.4 |
| Shale, dark brown, plastic..... | 1.8 |
| Shale, buff, plastic, bentonitic (?)..... | 0.6 |

| | Feet |
|---|-------|
| Shale, light grey, sandy..... | 14.7 |
| Sandstone, light grey weathering, shaly, contains ironstone bands and coaly streaks near base... | 12.9 |
| Shale, brownish black, carbonaceous, fissile..... | 1.0 |
| Shale, buff to medium brown, plastic..... | 7.3 |
| Sandstone, light grey to buff, shaly; poorly exposed | 6.9 |
| Shale, brownish grey, crumbly, with carbonaceous fragments, to base of exposure..... | 4.0 |
| Covered to water level in Athabaska River (33 feet) | _____ |
| Total | 88.4 |

The position of the upper Belly River contact is suggested only by the general lithological similarity of underlying beds to the Pale beds in southern Alberta.

The small outcrops of Belly River that occur east of Athabaska River Valley cannot be correlated with sections along the river, and are of little value in building up a complete section for the Belly River formation. The best outcrop is along a railway cut north of Opal, in sec. 15, tp. 58, rge. 22, W. 4th mer., where the following measurements were taken:

| | Thickness Feet |
|--|-------------------|
| Loam and boulder clay | |
| Shale, grey to brownish grey, crumbly, with some carbonaceous fragments and ironstone streaks; sandy towards the base..... | 10.0 |
| Sandstone, tough, fine-grained, light grey..... | 3.5 |
| Shale, grey, sandy, with some iron stains..... | 1.8 |
| Sandstone, lensy and concretionary, ironstone.. | 1.2 |
| Sandstone, light grey crossbedded near top..... | 9.0 |
| Sandstone, hard, concretionary, crossbedded.... | 1.0 |
| Shale, grey, crumbly, carbonaceous fragments... | 4.3 |
| Coal, lignitic..... | 3.0 |
| Shale, grey, crumbly, to base of exposure..... | 6.1 |
| Total | 39.9 |

These beds are equivalent to the Variegated and Pale beds along North Saskatchewan River.

Bearpaw Formation

No outcrops of marine Bearpaw occur in the Athabaska-Barrhead map-area, and whether the formation is present or not is a matter of conjecture. No marine shales are exposed along Athabaska River where the Bearpaw might be expected to occur. However, topographic features on the basis of which Rutherford (1939) mapped the Bearpaw in the Edmonton map-area continue into Athabaska map-area and the formation was projected across the map-area on the basis of this topography and on the assumption that it is continuous and maintains the same regional strike. Farther west, however, within the Barrhead map-area, the Bearpaw is represented as pinching out, and any equivalents beyond that point are mapped with the beds of the Edmonton formation.

Edmonton Formation

Mineable coal seams in the vicinity of Pickardville are placed in the Edmonton formation, somewhere near the base. The southwest corner of the map-area is underlain by approximately 400 feet of Edmonton beds. From what can be seen, these do not differ in general from Edmonton beds elsewhere, nor do they differ to any great extent from upper Belly River strata exposed along Athabaska River. The best section of beds believed to be Edmonton is along Athabaska River in the northwest quarter of sec. 27, tp. 61, rge. 7, W. 5th mer. It was measured, and may be tabulated as follows:

| | Thickness Feet |
|--|-------------------|
| Pleistocene | |
| Boulder clay, partly stratiform to top of valley (45 feet) | |
| Tertiary | |
| Coarse gravel, springs at base (20 feet Saskatchewan gravels?) | |
| Edmonton | |
| Clay shale, dark grey, sticky..... | 0.5 |
| Sandstone, buff, medium-grained, loose..... | 8.6 |
| Shale, dark grey crumbly..... | 2.2 |
| Shale, olive-brown, crumbly..... | 3.0 |
| Sandstone, medium-grained, buff..... | 1.5 |
| Sandstone, fine-grained, bluish grey with some carbonaceous streaks..... | 30.0 |
| Sandstone, light grey and sandy shale; poorly exposed..... | 5.4 |
| Shale, brownish, crumbly..... | 1.7 |
| Bentonite and bentonitic shale..... | 0.6 |

| | Feet |
|---|------|
| Shale, buff, crumbly..... | 6.1 |
| Shale, dark greyish brown..... | 3.4 |
| Sand, grey, shaly..... | 0.4 |
| Shale, grey, grading downward into brownish grey, crumbly shale; thin ironstone band near the middle..... | 7.7 |
| Sandstone, fine-grained, light grey weathering, and shaly sandstone, thin ironstone band at base... | 3.8 |
| Shale, grey, grading downward into darker grey, crumbly shale..... | 3.8 |
| Ironstone band with vertebrate bones..... | 0.2 |
| Shale, dark grey, sandy and carbonaceous, irregular concretionary sandstone band at the base..... | 1.8 |
| Sandstone, salt and pepper appearance, tough, light grey weathering..... | 7.8 |
| Shale, sandy, brownish grey..... | 0.5 |
| Sandstone, medium-grained, grey..... | 1.6 |
| Shale, chocolate-brown, carbonaceous fragments..... | 2.9 |
| Shale, dark grey, carbonaceous..... | 1.1 |
| Shale, brown, carbonaceous..... | 0.5 |
| Shale, buff clay..... | 0.4 |
| Covered to water level in Athabaska River (114.5 feet) | |
| Total | 95.5 |

Saskatchewan Gravels and Sands

Gravels and sands similar to those named by Rutherford (1936) as "Saskatchewan Gravels and Sands", and considered by him to be Tertiary in age, were noticed immediately overlying bedrock along Athabaska and Pembina Rivers. Details of their nature and continuity were not studied.

STRUCTURE

Structurally the Athabaska-Barrhead map-area lies along the east limb of the Alberta syncline. Successively younger beds occur to the south and west, suggesting a homoclinal regional dip. Local determinations of dip are scarce and were made at widely separate localities. However, the few determinations suggest a steepening of dip to the southwest, as illustrated by the following:

Pickardville, in the northeast part of tp. 58, rge. 27, W. 4th mer. Strike north 80 degrees west; dip south-southwest at 34 feet a mile.

Athabaska River, in the northeast corner of tp. 61, rge. 5, W. 5th mer. Strike, northwesterly; dip southwest at 20 $\frac{1}{2}$ feet a mile; partly due to slump?

Kilsyth, in the southeast corner of tp. 65, rge. 11, W. 5th mer. Strike westerly; dip slightly west of south marked, but may be due to slumping?

Dapp Creek, in the west middle of tp. 61, rge. 21, W. 4th mer. Strike, northwesterly; dip, southwest at 15 $\frac{1}{2}$ feet a mile.

Opal, near the middle of tp. 58, rge. 22, W. 4th mer. Strike, north 52 degrees west (approx.); dip southwest at 18 feet a mile.

Thorhild, in the southeast part of tp. 60, rge. 21, W. 4th mer. Strike, north 76 degrees west (approx.); dip, south-southwest at 3 feet a mile.

Pine River, in the northwest part of tp. 63, rge. 21, W. 4th mer. The beds here are horizontal.

Drill samples from Athabaska wells do not provide very satisfactory information for the study of local structure. Elevations on the base of the La Biche shale suggest a gentle anticline or anticlinal nose between Deca Nos. 1 and 2 wells, but lower samples indicate that this is not reflected on top of the Grand Rapids sandstone. It has already been mentioned that sand lenses occur in the Pelican shale near the base. Continuation of such lensing, between adjacent wells, into the Grand Rapids formation is suggested. The resultant thickening and thinning of the Pelican shale complicates structural interpretations at this horizon.

In the following table the elevations at the base of several formations are given with reference to sea-level, and are all above this level:

| Well | Location | Belly River | La Biche | Pelican Sandstone | Pelican Shale |
|----------------|-----------------------|--------------------|----------|-------------------|------------------|
| | | Feet | Feet | Feet | Feet |
| Athadome No. 2 | Lsd. 3 of 15-66-23 W4 | 1,920 | 540 | 495 | 360 |
| Deca No. 1 | Lsd. 1 of 4-66-22 W4 | | 519 | 477 | 389 |
| Deca No. 2 | Lsd. 3 of 16-66-23 W4 | 1,910 ² | 530 | 468 | 360 |
| Deca No. 4 | Lsd. 2 of 15-66-23 W4 | | | | 374 ² |
| Dom. Gov't. | Lsd. 6 of 20-66-22 W4 | | 589 | 549 | 446 |

¹All elevations in the Dominion Government well are approximate only, as data are incomplete and somewhat doubtful.

²Reported.

ECONOMIC GEOLOGY

Oil Possibilities

Oil possibilities in the Athabaska-Barrhead map-area are not known. The meagre geological information does not permit generalizations and no locality can be considered either particularly favourable or unfavourable. Only one well (Athadome No. 2) was drilled into the Palaeozoic. It revealed oil stains at several horizons but very limited porosity. The McMurray sandstone, which is oil saturated downstream at Fort McMurray, contains only a faint trace of oil in Athadome No. 2 well. Near Athabaska the Grand Rapids sandstone offers the best possibility as a reservoir bed. All recent wells have encountered fairly good flows of gas at the top of this sand, and two wells (Athadome No. 2 and Deca No. 4) are reported to have encountered small flows of heavy oil from the same beds. Results to date have not been very encouraging, but not enough information is at hand to indicate the possibilities of developing a commercial field near Athabaska.

Coal

All coal in the map-area is of lignitic or sub-bituminous rank. Seams from 4 to 6 feet thick have been mined at Pickardville, Thorhild, and Naples (sec. 17, tp. 60, rge. 2, W. 5th mer.). Thinner seams have been prospected and mined for short periods north of Opal (sec. 15, tp. 58, rge. 22, W. 4th mer.); along Pine Creek (tp. 63, rge. 21); along Dapp Creek (sec. 29, tp. 61, rge. 25, W. 4th mer.); and along Tawatinaw River (sec. 12, tp. 64, rge. 23, W. 4th mer.).

At present two small mines are operating 5 miles northeast of Thorhild. At the North Point coal mine, in sec. 11, tp. 60, rge. 21, W. 4th mer., an average of 11 feet of cover is being removed to expose a 5½-foot seam for open-pit mining. The same seam, a mile farther north, is being mined by underground methods. The combined annual production of the two mines is approximately 12,000 tons, all of which is consumed locally. Other mines are not producing at present, largely due to shortage of labour.

Bituminous Sand

Bituminous sand is exposed near Mosside, in secs. 9 and 10, tp. 59, rge. 4, W. 5th mer. It was also reported in two wells and numerous test holes in the vicinity. A suitable auger was obtained and holes bored, first at some distance from the main exposure, then continuously closer to it. The last hole was bored in glacial drift to a depth of 6 feet, only 4 feet from the exposure. None of the holes penetrated bituminous sand. It is evident that the deposit occurs as isolated blocks or boulders in drift, and must have been carried south from the Fort McMurray region by glacial ice. Bituminous sands were found in drift southeast of Jarvie and are also reported near Hondo and Vega. A concretionary block of glacial origin, containing bitumen in cracks, was found a few miles northwest of Boyle.

SUMMARY AND CONCLUSIONS

Outcrops are scarce and are confined mainly to Athabaska River Valley. None exposes more than 100 feet of rock section, and most of them less than 20 feet. Formations above the La Biche have not been penetrated by drill holes so that thicknesses of these formations are inferred and detailed lithological information is lacking.

The general surface structure appears to be a simple homocline, dipping southwesterly and flattening somewhat in the northeastern part of the area. The regional dip is less than 20 feet a mile, and the few scattered dip determinations show only one dip in excess of this figure. Structural details are unknown except within a small area near Athabaska. Local structures, if present, must be determined by geophysical methods or, in suitable localities, by drilling closely spaced test holes on some of the thicker coal seams.

The first oil test of Palaeozoic limestone was not encouraging. The McMurray sandstone is thinned to approximately 20 feet near Athabaska and contains only a faint trace of oil. The upper Grand Rapids sandstone appears to be the most promising reservoir. Recent drilling tests near Athabaska, however, have to date proved very little oil from this horizon. Well samples, although poor, indicate lateral variation in lithology at the top of the Grand Rapids sandstone. It is, therefore, probable that at this horizon stratigraphic traps and porosity are as important as structure in the accumulation of oil. From what is now known no one locality may be said to be more favourable than another, but the northeastern part has the advantage of shallower drilling.

Coal seams of mineable thickness occur in the map-area, but their rank and location with respect to markets lend them only local present economic significance.

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