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DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

PAPER 44-11

lat. 53°12'30"-53°28'
long. 117°30'-117°52'

DRINNAN to BRÛLÉ LAKE, ATHABASKA VALLEY, ALBERTA

(Report and Map)

West of 5th Meridian
Entrance to C.N.R.
Coal
Not published

BY

A. H. Lang

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DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

Paper 44-11

DRINNAN TO BRÛLÉ LAKE, ATHABASKA VALLEY, ALBERTA

(Summary Account)

By

A. H. Lang

O T T A W A, 1944

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Illustration

Preliminary Map - Drinnan to Brûlé Lake, Alberta.

DRINNAN TO BRÛLÉ LAKE, ATHABASKA VALLEY, ALBERTA

INTRODUCTION

In 1943 the Athabaska Valley was mapped geologically from Obed, which is approximately at the eastern limit of the Foothills, to the first range of the Rocky Mountains. Investigations east of longitude 117°30' revealed nothing of apparent structural signifigance and are not discussed in the present account.

Exclusive of Mount Perdrix, which lies in the mountains proper, the map-area has a maximum relief of about 2,600 feet, ranging from about 3,200 feet at Athabaska River to 5,800 feet on the north ridge of Folding Mountain.

Much of the area was burned over many years ago and is now covered by second-growth jack pine and poplar; some of this is fairly open and visibility and travel are good; elsewhere travel is impeded by muskeg, windfall, and slashing. Dense, virgin spruce forests exist near the headwaters of Maskuta Creek and west of Solomon Creek.

Much of the area is covered by overburden in the form of glacial drift and river gravels, the principal deposits forming wide terraces along Athabaska River and a deep fill along the old course of the Athabaska, now occupied by the lower part of Solomon Creek. East of Brûlé Lake a large, low-lying tract between the highway and the river contains numerous ponds and swamps and is underlain by silts deposited when Brûlé Lake was much larger. Strong winds that blow through the gap at the south end of the lake are re-sorting these silts along the east shore, causing the abandonment of the railway grade there; in places telegraph poles are almost buried.

The map-area is crossed by the main line of the Canadian National Railways and the Edmonton-Jasper highway, from which a branch road leads to Entrance. Automobiles cross the Athabaska on an abandoned railway bridge near Entrance, and from there points in the north half of the area can be reached fairly readily by forestry and ranch roads and trails. Trails and bush roads extend south from Drinnan and Hinton, but the southwest quarter of the area is less accessible because of the dense forest and few trails.

GEOLOGY

The area is underlain by an almost continuous succession of sedimentary strata, ranging in age from Devonian to Paleocene. Rock outcrops are confined mainly to canyons, rocky ridges, and railway and highway cuts, so that only the narrowest formations are anywhere sufficiently exposed to permit close estimates of thickness. Sections of the thicker formations, although representative of the lithology, are too incomplete to allow due cognizance to be taken of various structural complexities, and only rough estimates of total thickness can be made.

Table of Formations

Period or Epoch	Formation and Approximate Thickness (feet)	Subdivision and Approximate Thickness (feet)	Lithology
Paleocene	Paskapoo		Sandstone and shale (non-marine)
Upper Cretaceous	Edmonton 4,000+		Chiefly sandstone and shale (non-marine)
		Entrance conglomerate 20	Coarse pebble-conglomerate
	Brazeau 6,000		Chiefly sandstone, shale, and pebble beds (non-marine)
		Transition zone 122	Sandstone and shale
		Solomon sandstone 87+	Sandstone
	Wapiabi 1,600	Baculites ovatus zone	Chiefly black shale (marine)
		Scaphites ventricosus zone	
	Bighorn 320	Upper zone	Sandstone
		Middle zone	Chiefly black shale
		Lower zone	Sandstone
	Blackstone 1,500+	Prionotropus zone	Chiefly black shale (marine)
Lower Cretaceous	Luscar 2,000		Shale, sandstone, coal (non-marine)
	Cadomin 25		Conglomerate
	Nikanassin 900		Quartzitic sandstone, shale (non-marine and marine?)
Jurassic	Fernie 600		Chiefly siltstone and quartzitic sandstone, (marine and non-marine?)
			Black shale (marine)

Table of Formations (Cont'd)

Triassic	Spray River 500		Black, argillaceous limestone and calcareous shale; arenaceous shale (marine)
Mississippian and (?) Pennsylvanian	Rundle 1,000		Limestone, arenaceous limestone, calcareous shale (marine)
Mississippian	Banff (?)		May be present
Devonian	Minnewanka		Limestone, dolomitic limestone, argillaceous limestone (marine)

Devonian

Minnewanka Formation. The region between Fiddle and Drystone Creeks, including the great massif of Mount Perdrix, is underlain by grey to black limestone, dolomitic limestone, and argillaceous limestone, of Devonian age. These strata were not studied in detail. They have been correlated by earlier workers[1] with the Minnewanka limestone of the Banff area.

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

Carboniferous

Rundle Formation. At the north end of Folding Mountain the erosion of Athabaska Valley has exposed the core of a compressed anticline in which the lowest beds consist of about 1,000 feet of massive, grey and yellowish limestone, arenaceous limestone, and calcareous shale. The limestone is crinoidal in places. Fossils from these beds are too poorly preserved for positive identification, but suggest the Rundle fauna, and the beds agree in lithology and stratigraphic position with the known Rundle west of the area.

A small rock cut on the highway in front of Folding Mountain is in fissile, calcareous sandstone that may be stratigraphically below the Rundle and represent the Banff formation. Otherwise no indication of the Banff was obtained in the area, although it may be present at depth.

Triassic

Spray River Formation. The Rundle formation is overlain by about 500 feet of rusty weathering, calcareous siltstone and argillaceous limestone. Fossils were not found in these strata by the writer, but the beds have been correlated by Allan and Warren (1932) with the Spray River formation on the basis of poorly preserved fish remains, lithology, and stratigraphic position. These beds form the top and west flank of the part of Folding Mountain included in the map-area.

Jurassic

Fernie Formation. The Triassic beds are overlain by about 600 feet of strata from which Jurassic fossils were obtained, but the Jurassic-Triassic contact was not seen. The first beds exposed above those classed as Spray River are fissile, black shales too poorly exposed for measurement. These are overlain by 44 feet of friable, black, organic shale with lenses of buff-weathering siltstone up to 1 foot thick. These in turn are succeeded by 24 feet of buff-, orange-, and grey-weathering siltstone and quartzitic sandstone containing marine Jurassic fossils. Stratigraphically above these are intermittent exposures representing several hundred feet of quartzitic sandstone that may be either of Jurassic or Lower Cretaceous age. The Jurassic strata of the area are correlated with the Fernie formation of southern Alberta, which in their black, shaly members they much resemble.

Lower Cretaceous

The Lower Cretaceous strata of the central Foothills consist essentially of non-marine shale and sandstone, with a prominent conglomerate bed near the centre of the succession. The entire group was originally termed the "Kootenay" group, but MacKay (1930) collected a Kootenay flora from the beds below the conglomerate and a Blairmore flora from the overlying beds, and correlated the conglomerate with the basal Blairmore conglomerate. He termed the conglomerate the "Cadomin formation", the beds below it the "Nikanassin formation", and those above it the "Luscar formation".

Nikanassin Formation. The writer has mapped as "Nikanassin formation" the strata on the east side of Folding Mountain that lie between the known Jurassic strata and the Cadomin conglomerate. The exposures consist of brown-weathering, quartzitic sandstone and siltstone. They are probably interbedded with shale that does not outcrop. No lithological distinction was observed between these strata and the upper Jurassic beds, and, accordingly, an arbitrary boundary was drawn to separate them from the known Jurassic strata, on which basis a thickness of about 900 feet is attributed to the Nikanassin.

Cadomin Formation. The Cadomin formation consists of a 25-foot bed of conglomerate composed of quartzite, chert, and vein-quartz pebbles averaging ½ to 1 inch in diameter. They are closely packed in a hard, siliceous matrix, and many are fractured. The bed forms prominent outcrops and is an excellent horizon marker.

Luscar Formation. The Luscar formation is exposed on the east flank of Folding Mountain, where it is known chiefly from old coal workings and drilling. It consists mostly of brown-weathering, grey and green, arenaceous shale and brown-weathering grey sandstone. A bed of conglomerate 18 feet thick, very similar to the Cadomin conglomerate, occurs about 900 feet stratigraphically above the base. Four coal seams have been found in the formation. In the area mapped, the Luscar is too poorly exposed to permit a measurement of thickness, and is probably much disturbed by minor folding and faulting. In nearby areas MacKay (1928) estimated the thickness at 1,700 feet.

In areas south of Athabaska Valley the Luscar is overlain by a succession of sandstone and shale beds distinguished as the Mountain Park formation, which thins rapidly toward the north. In Brûlé area, where the Luscar is better exposed than on Folding Mountain, MacKay (1928, page 12) considered that the Mountain Park might be missing or that it might be represented only by the uppermost beds mapped as Luscar, in which case they had lost their distinctive ridge-forming character and greenish colour. A similar condition appears to exist in the present map-area.

Upper Cretaceous and Paleocene

The Upper Cretaceous strata consist of a lower, marine group, correlated with the Alberta group of the southern part of the province, overlain by a thick series of non-marine strata. The marine group consists mainly of black shale, with prominent sandstone beds near the centre of the succession. In Bighorn coal basin, Malloch applied the name "Blackstone formation" to the lower beds and named the upper beds the "Wapiabi formation". He grouped the intervening sandstone and associated shale beds as the "Bighorn formation", which has been correlated with the Cardium of southern Alberta. These formations have been traced northward from the Bighorn basin to Athabaska River by MacKay and Rutherford, and the strata mapped by the writer agree fairly closely in lithology and fossil evidence with Malloch's subdivisions.

The marine group is overlain by a great thickness of non-marine strata mapped by Rutherford (1925) as the Saunders group. On recent maps these beds have been separated into a lower unit for which Malloch's (1911, page 37) term "Brazeau formation" is used, whereas the upper beds are grouped as the "Edmonton formation". The boundary between the two is drawn at the base of a prominent bed of coarse pebble-conglomerate, which is 800 to 900 feet below the commercial coal seams of the Edmonton formation. This procedure is followed in the present map-area.

The uppermost beds exposed in the area contain fossil plants of probable Paleocene age, and no means of separating these from the Edmonton beds has been found. The strata overlying the Brazeau formation are, therefore, classed as "Edmonton and Paskapoo formations".

Blackstone Formation. The Blackstone formation is exposed at the head of Maskuta Creek and near the base of Solomon Mountain, and a considerable section was obtained in a bore-hole near the Black Cat ranch. It consists of friable, black and dark green shale, much of which is concretionary, with minor sandstone interbeds. A grit bed about 3 inches thick is exposed at the base of the formation, in the bank of Solomon Creek a few miles north of the area mapped. Inoceramus labiatus and Prionocyclus sp., characteristic of the Prionotropis zone of the Upper Cretaceous, were obtained from the upper part of the formation, and Inoceramus capulus occurs immediately below the base of the Bighorn.

No satisfactory section of the Blackstone is exposed in the area mapped, and Rutherford's (1925) estimate of at least 1,500 feet has been adopted tentatively.

Bighorn Formation. The Bighorn formation is exposed near the headwaters of Maskuta Creek and on Solomon Mountain, and consists of alternating beds of hard, massive, fine-grained, grey sandstone, and black shale. In other areas it is reported to be partly marine and partly non-marine, but no evidence of non-marine deposition was observed in this area. The top and bottom of the formation are marked by prominent, ridge-forming beds of sandstone about 50 feet thick, and the total thickness of the formation as exposed on Maskuta Creek is 320 feet. On Solomon Mountain the stratigraphic interval between the basal and uppermost sandstone members appears to be considerably greater, but this may be due to repetition by faulting. The diagnostic fossils Cardium pauperculum and Inoceramus fragilis prairiensis were found in this formation.

Wapiabi Formation. The principal occurrence of the Wapiabi formation is a belt that is well exposed in the canyon of a small tributary of Maskuta Creek and in two small outcrops between the highway and Athabaska River; the same band outcrops on the west side of Solomon Mountain. The formation is repeated in a syncline on the upper part of Maskuta Creek and by a fault on the ridge south of Seabolt's ranch.

The formation consists chiefly of friable, black, marine shale that does not outcrop well. No satisfactory section was found and the estimate of 1,600 feet is only an approximation. Scaphites ventricosus, Inoceramus inconstans, and I. umbonatus, representing the Scaphites ventricosus zone, were collected from the lower part of the formation. No fossils were found in the upper part.

Brazeau Formation. The Brazeau formation underlies a large part of the map-area and is best exposed in the canyon of the Athabaska near Entrance, in the canyon on the lower part of Maskuta Creek, and on the ridges north of Entrance and south of Seabolt's ranch.

The formation consists essentially of interbedded sandstone, shale, and conglomerate, with minor bentonitic beds and thin coal seams. The sandstone is generally grey, weathers brown and greenish grey, and some of it has a "pepper and salt" appearance due to the inclusion of small, black, lignitic fragments. The shales are grey and greenish grey. The conglomerate contains small pebbles of grey chert. It forms numerous beds in the lower part of the formation and fewer in the upper part. The uppermost bed of the formation is a distinctive, massive bed of grey, buff-weathering sandstone about 70 feet thick.

The lowest bed mapped with the Brazeau in this area is a hard, fine-grained, grey, brown-weathering, quartzitic sandstone, which is a very useful horizon marker and which is known locally as the "Solomon sandstone". The top is not well exposed in the area mapped, the maximum exposed thickness being 87 feet. This bed is repeated by faulting, once

on Solomon Mountain and twice south of Seabolt's ranch. No fossils were found in it. It is succeeded by a transitional zone of sandstone and shale, with plant remains, up to 122 feet thick, and this, in turn, is overlain by the lowest conglomerate bed of the Brazeau formation. The Solomon sandstone and the overlying transitional beds have been included with the Brazeau formation. The Solomon sandstone may be the equivalent of the Highwood sandstone of southern Alberta.

The upper part of the formation contains Upper Cretaceous plant remains at several horizons, and from a bed near Entrance Mr. R. C. Sibley, of Entrance, has collected several dinosaur bones. He sent some of these to Dr. Barnum Brown of the American Museum of Natural History, who reported that they were probably wash accumulation; that a tooth was probably from Gorgosaurus libratus; and that a toe bone was probably from Corythosaurus (casuarius?).

Several thick sections of parts of the Brazeau formation were measured, but these do not approach a complete section, and the estimate of 6,000 feet for the total thickness is indefinite.

Edmonton and Paskapoo Formations. Strata of these formations occupy the eastern part of the area and form a synclinal basin extending southeasterly from Entrance.

The massive sandstone bed at the top of the Brazeau is overlain by a distinctive bed of conglomerate about 20 feet thick that is used to mark the base of the Edmonton in this area. Together, these two beds form a useful and readily recognized horizon marker. The term "Entrance conglomerate" is proposed for the conglomerate. It consists of closely packed pebbles of quartzite and chert averaging 1 to 2 inches in diameter, some being up to 4 inches, in a hard, sandy matrix. It is coarser than the pebble beds seen in the Brazeau and in other parts of the Edmonton, and the underlying massive sandstone aids in distinguishing it.

Overlying the Entrance conglomerate is a thick succession of relatively soft, interbedded sandstone and shale, with minor pebble beds and bentonite beds, at least two commercial coal seams, and several minor seams. The sandstone is rather coarse, and weathers grey, brown, and green; much of it is crossbedded. The shale is generally greenish grey and rather clayey.

No definitely Upper Cretaceous plant remains were found in the Edmonton formation within the map-area. A large collection of fossil leaves was obtained at Fish Creek from an horizon roughly 4,000 feet above the Entrance conglomerate, and another collection was obtained from about the same horizon just east of the map-area. W. A. Bell of the Geological Survey reports that these are probably of Paleocene age. Therefore, the uppermost strata of the area probably represent the Paskapoo formation. These have been mapped with the Edmonton because no change in lithology or break in sedimentation was observed.

STRUCTURE

Lying in the disturbed belt immediately east of the Rocky Mountain front, the strata of the map-area are much distorted by folding and faulting, which diminish in intensity from west to east. The rocks are sufficiently exposed to permit interpretation of the major structures, but it is probable that many minor faults and folds are obscured by drift and their effects not recognized. The folds and faults are discussed separately and the treatment is from west to east.

Folds

Broad folds can be seen in the Devonian strata forming Mount Perdrix, but these lie in the first range of the Rocky Mountains and were not mapped. The Folding Mountain anticline is rather closely compressed and is asymmetrical, the axial plane being tilted to a dip of about 70 degrees southwest. Most of the rocks of Folding Mountain are relatively competent and probably acted as a structural unit that, forced against the less resistant rocks of the Luscar formation immediately to the east of the mountain, caused much minor folding and faulting.

A syncline and an anticline are exposed in a canyon on the upper branches of Maskuta Creek, where their interpretation is aided by the presence of the Bighorn formation. The axial planes of these folds dip about 80 degrees southwest. The anticline appears to be the continuation of one in the valley of Solomon Creek, which may be termed the "Solomon Creek anticline". Minor folds are visible in the incompetent Blackstone shale on Solomon Creek, indicating that the anticlinal structure is complex.

The western belt of the Edmonton formation occupies a broad, gently warped syncline. The fold pitches southeastward at a fairly steep angle, as shown by the curved trace of the Entrance conglomerate and by the fact that no Edmonton strata are found on the hills northwest of Entrance. The dips indicate a slight westward inclination of the axial plane.

A series of small anticlines and synclines occur in the Brazeau formation near the mouth of Maskuta (Prairie) Creek and on the hills to the northwest. These folds appear to represent a composite anticline, which may be termed the "Prairie Creek anticline". The axes of these folds and of the Entrance syncline tend to converge near the Athabaska Lookout. This may be due to greater compression in that vicinity. All these axes have a more westerly trend than is usual in the foothills, indicating a regional bend to the structures that will not be interpreted fully until more mapping is done.

The following aspects of the folding may be emphasized:

(1) The folding is probably more complex than is shown on the structure sections.

(2) The axial planes of the more westerly folds are considerably inclined. Within the map-area they all appear to dip southwest.

(3) The Palaeozoic strata are more massive and resistant than the younger rocks, therefore, folds in the latter may not extend into Palaeozoic strata or may be represented there by more gentle flexures. Where folds originally extended into Palaeozoic strata, the overlying rocks may later have been displaced by thrusting, and folds in them may not contain a Palaeozoic core.

Faults

At the base of the Boule Range, just west of Brûlé Lake, beyond the map-area, the Devonian strata are overthrust onto Lower Cretaceous rocks along a low-angle fault, which MacKay (1930) termed the Nikanassin-Boule overthrust. The southward extension of this fault probably lies in the valley of Drystone Creek, but is obscured by drift in the area mapped.

An assumed thrust fault has been shown in the Luscar formation east of Folding Mountain, but, in reality, this region probably contains several minor faults and folds.

The Solomon sandstone is repeated once on Folding Mountain and twice on the ridge south of Seabolt's ranch. The dips of these faults are unknown. There are probably additional faults in these parts of the area, but they can only be noted where recognizable beds like the Solomon are brought to the surface.

The section measured across the anticline in the Brazeau formation, near the mouth of Prairie Creek, appears to indicate a fault at the position shown on the structure section. The direction of dip of this assumed fault is uncertain.

OIL POSSIBILITIES

The oil possibilities of the area hold considerable interest because oil is produced in the Foothills belt in southern Alberta and because the Athabaska section of the Foothills is readily accessible. No oil has been found in the area or in its vicinity, but a shallow hole drilled in 1924 near Coalspur is reported (Rutherford, 1925, page 60) to have struck gas in the Brazeau formation. Although some gas and oil may occur in the marine Mesozoic beds, interest is directed chiefly to the possibilities of the Rundle and Devonian limestone.

The Folding Mountain anticline offers the shallowest depth to the Rundle limestone, but Athabaska Valley and several creek valleys northwest of the area are eroded into the Rundle, so that the possibilities of this structure are chiefly in the underlying strata. No oil seeps or oil-bearing rocks were noted where the anticline in the Rundle is exposed at the north face of Folding Mountain.

The Prairie Creek anticline is a succession of minor anticlines and synclines in the Brazeau formation and appears to be faulted. It is possible, however, that the more competent underlying limestone formations might not be affected by minor folds and faults, but would have a simpler anticlinal structure. It is, however, difficult to estimate the great depth to the Palaeozoic along this structure as there is no complete section of the Brazeau and as the formations between the Brazeau and the Rundle may thin eastward.

Interest is centred at present on the Solomon Creek anticline because the Luscar and Blackstone formations are exposed along its crest. In 1942, the Shell Oil Company of Canada commenced a well on this structure at a point about 4 miles northwest of the map-area. This hole was spudded in near the top of the Luscar formation and drilling was suspended temporarily at a depth of 4,774 feet pending further geological mapping.

COAL

Coal occurs in the Luscar, Brazeau and Edmonton formations. The abandoned mine at Brûlé, in the Luscar formation immediately west of Brûlé Lake, was one of the principal coal mines in the country, producing 1,836,743 tons between 1914 and 1928, when mining was discontinued because of structural difficulties and dirty coal. At the old Drinnan prospect, at the northeast end of Folding Mountain, four coal seams were uncovered in the Luscar formation during 1910 and 1911. More recently, drilling was done here by Sterling Collieries, Limited.

Coal is being mined at Drinnan by Jasper Collieries, Limited. Here a fairly large operation was conducted on a seam about 1,600 feet above the Entrance conglomerate, but this mine was closed 4 years ago. In 1943 mining was resumed on a small scale on a seam about 800 feet above the conglomerate. The coal is said to be of good quality domestic grade.

Steam coal was mined for several years at Hinton by Hinton Collieries, Limited, but the mine was abandoned in 1941. The workings are flooded and could not be examined, and the few rock exposures in the neighbourhood make it impossible to determine the stratigraphic position and structural relations of this seam. It appears to occur in the upper part of the Brazeau, but may be one of the Edmonton seams that owes its position to a fold or fault now obscured by overburden.

Since the construction of the railway attempts have been made to locate near the main line coal comparable to that mined in the Edmonton formation on the Coal Branch, but the relatively small operations at Drinnan and Hinton have been the only results. The conglomerate designated by MacKay as the base of the Edmonton is a useful guide to the position of the coal seams near the Coal Branch, and the mapping of what is believed to be the same conglomerate in the Drinnan-Brûlé Lake area (namely the Entrance conglomerate) may prove to be a guide for prospecting by trenching or drilling. The position of the two mines at Drinnan with respect to the conglomerate exposure on Hardisty Creek affords a clue to the possible continuation of the seams at both sides of Athabaska Valley, and the fact that dips are steeper in the Entrance syncline suggests that coal should occur there somewhat closer to the conglomerate exposures.

REFERENCES

Allan, J. A., Warren, P.S., and Rutherford, R.L:
A Preliminary Study of the Eastern Ranges of the Rocky Mountains in Jasper Park, Alberta; Trans. Roy. Soc., Canada, vol. XXVI, sec. IV, 1932, pp. 225-248.

MacKay, B.R., Brûlé Mines Coal Area, Alberta; Geol. Surv., Canada, Sum. Rept. 1928, pt. B, pp. 1-29.

_____ Stratigraphy and Structure of Bituminous Coalfields in the Vicinity of Jasper Park, Alberta; Trans. Can. Inst. Min. Met., 1930, pp. 473-509.

Malloch, G.S.: Bighorn Coal Basin; Geol. Surv., Canada, Mem. 9E, 1911.

Rutherford, Ralph L.: Geology of the Foothills Belt Between McLeod and Athabaska Rivers, Alberta; Scientific and Industrial Research Council of Alberta, Report No. 11, 1925.