

## CRETACEOUS SECTION IN THE MOOSE MOUNTAINS DISTRICT, SOUTHERN ALBERTA\*

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## INTRODUCTION

The Cretaceous which underlies the Canadian plains is so nearly undisturbed that no great difficulty has been experienced in tracing over large areas the different horizons found. Near approach to the Rocky mountains is, however, accompanied by serious foldings in the strata, so that the foothill region requires detailed study before the formations can be accurately mapped. The discovery of coal at several horizons renders this folded area of interest on account of the many chances that the lower horizons bearing the best grade of coal may there outcrop.

The reported discoveries of petroleum in the southern portion of Alberta were given great publicity and the producing fields of Colorado were cited as examples of what might be expected at almost any point along the front of the Rocky mountains. The desirability of a study of this region is thus quite evident, and last season one party was located in the foothills south of the main line of the Canadian Pacific railway. The work was intrusted to Mr D. D. Cairnes and considerable progress was made in his examination. To correlate the several formations, fossils were collected, but many are of plants which have not been studied yet.

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Two of the greater folds reveal the limestone beneath and several sections were made of the total thickness of Cretaceous strata. As my own

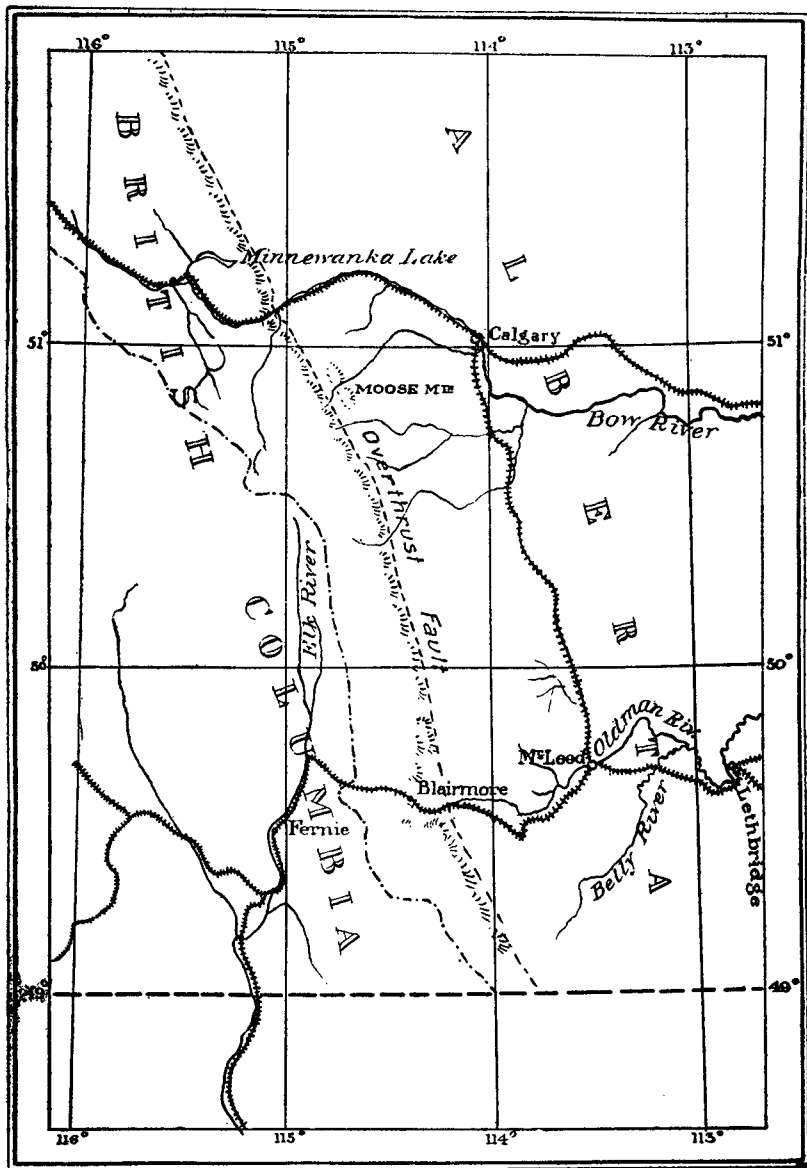


FIGURE 1.—Map of part of Alberta and British Columbia.

work for the last three seasons has been within the mountains on rocks of the Kootanie series, I can with some certainty correlate them with

some of the lower beds found in this section. Previous to this time it seemed doubtful that any exposures of the Kootanie could be found east of the mountains or that the correlation with the Cascade formation of Montana or that in the Black hills called Lakota could be safely assumed. This seems less risky if the Kootanie occurs in the section here discussed.

#### PROVISIONAL SUBDIVISIONS OF THE SECTIONS

As the fossil remains have not been critically studied, the subdivisions I have made are provisional and the succeeding remarks are put forward with the hope that criticism and discussion may reveal errors or misapprehensions on my part which if left unnoticed might prejudice Mr Cairnes in his study of the area :

Provisional.	Dawson's section.	Cairnes' section.	Type of fossils.
Edmonton.	Saint Mary river.	Sandstones with coal seams.	Brackish water and plants.
Bearpaw.	Pierre.	Shale, 250 feet. Sandstone, 50 feet. Shale, 450 feet.	Marine.
Judith river.	Belly river.	Sandstone, 750 feet. Colors—green, blue, yellow, and red.	Fresh water.
Claggett.	Lower dark shales.	Banded sandstone and clays, 250 feet.	
Eagle.		Light colored sandstone, 50 feet.	
Colorado.		Sandy shales grading down to black shales, 750 feet.	
Dakota.		Light colored hard sandstone conglomerate at base, 150 feet.	
Kootanie.	Kootanie.	Dark sandstone and shale, with coal seams.	Plants, conifers, and ferns.
Fernie.		Dark brown to black shale, 225 feet.	

Carboniferous limestone.

#### CARBONIFEROUS LIMESTONE

The lowest member of the above section, the Carboniferous limestone, was by Dr G. M. Dawson\* made to include the black shales resting on

\* Annual Report, Geological Survey of Canada, vol. 1, p. 104B.

them; but the finding by Mr Cairnes of a few Belemnites excludes them from the Paleozoic. The limestone here formed the floor on which the Mesozoic sediments were laid down; but in the many contacts observed at various places throughout Canada the floor evidently consisted of the overlapping edges of several formations. The crustal movements, however, not having been severe, the unconformity is not conspicuous and is indicated mainly by the different age of the beds in contact and the varying amount of the time interval so indicated.

To the west of this locality there are two troughs in the mountains that show Mesozoic rocks resting on a series of red sandy shales and buff quartzites that are above the Carboniferous limestone and seem to occupy a horizon similar to that of the Minnelusa and Opeche formations of the Black hills. These probably represent the top of the Carboniferous or early Permian. East of the mountains the exposures on the Peace and Athabaska rivers and in Manitoba show Cretaceous resting on Devonian. Southward in the Black hills the section is apparently complete.

#### FERNIE SHALE

This formation, which is represented by 225 feet of dark brown to black shale, seems to represent the eastern margin of much thicker deposits of marine origin occupying a similar position in the mountain troughs to the west. The finding of Belemnites of apparently similar species in both helps the correlation. The formation is traced both north and south along the Cascade and Bow River trough for a long distance and varies somewhat in thickness. On the Cascade river, near the outlet of a stream from Minnewanka lake, the section measured 1,600 feet. The top of the formation is here difficult to define, as the Kootanie formation in the lower part consists of brown shales and thin bedded sandstones. Few fossils were found in the exposures, with the exception of the Belemnites above mentioned, but in a shallow trough at the east end of Minnewanka lake (formerly Devils lake) Mr McConnell discovered a bed rich in marine fossils. These have been described by Doctor Whiteaves.\* They show a remarkable similarity to the fauna of the lower part of the Queen Charlotte Island series, the "lower shales" of Dawson. This series was incorporated by him in the Cretaceous, but the general Jurassic aspect of most of the fossils was remarked by Doctor Whiteaves, although he accepted the stratigraphic position assigned by Dawson. The work of Messrs Stanton and Martin† on the Jurassic of Cooks inlet and the Alaska peninsula seems to show conclusively that this fauna belongs well down in the Jurassic. Evidently the fossils from the lower

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\* "Contributions to Canadian Palaeontology," vol. i, part ii.

† Bull. Geol. Soc. Am., vol. 16, p. 402.

shales are from two formations and the Queen Charlotte Island series, if again studied, might allow this subdivision to be made.

Souward the formation has been traced in the mountains through a succession of fault blocks to the Elk River coal field and is the series there called by Mr McEvoy the Fernie shale. Few fossils have been collected from the southern portion, owing probably to the fact that the outcrops of these soft beds are partly concealed, but from near the mining town of Fernie Belemnites and Ammonites were obtained. One of the latter is described by Doctor Whiteaves as *Cardioceras canadense*.\* This would appear to be Jurassic, as the formation is continuous and bears the same relation to the coal-bearing Kootanie series above, the horizons should be but little below that from near Minnewanka lake, which is correlated with the lower shales of the Queen Charlotte islands. These latter, as noted above, are declared to be well down in the Jurassic.

The deposits at Fernie consist of 500 feet of sandy argillites at the base, with 1,060 feet of black and brownish shales above. Eastward through the Crows Nest pass the series decreases, and at Blairmore, near the edge of the mountains, there is only 700 feet. Projecting these beds eastward by assuming a somewhat uniform decrease, it would seem that they may form a small sheet eastward from the mountains, the edge approximating a line southeast from near the Moose Mountain locality.

#### KOOTANIE

Dark, coarse sandstone, with brown shales and coal seams, 375 feet.

This sandstone coal-bearing member of the Kootanie is the representative of thicker measures in the type locality, and all the fossils obtained, on which the discussion of the age of the formation was based, were obtained from within its boundaries. The base of the formation consists of hard sandstones, which are easily traced, making a convenient horizon marker for the base of the formation. Above the coal seams there is a persistent horizon of conglomerate, and in the sandstones succeeding it plants of the Dakota type have been found, so that the conglomerate band for practical purposes is taken as the top of the formation. The thickness on the Elk River escarpment of this formation measures 5,300 feet. Eastward in the Blairmore district, just within the mountains, it has decreased to 740 feet. North, near Banff, it is 3,900 feet, but in the section under discussion there is but 375 feet included between beds bearing characters similar to the limiting members within the mountains. It would thus seem that the formation might not extend much farther to the east in this latitude; but to the south

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\*Ottawa Naturalist, vol. xvii, p. 65.

there is a better chance of some of the beds reaching those of the Cascade formation of Montana, which are correlated by plant remains with it.

This formation is of great economic importance, owing to the rich coal deposits contained within its beds. On Elk river there are 22 seams, aggregating 216 feet of coking and steam coal. At Blairmore 21 seams of a total thickness of 125 feet, and at Moose mountain there are 7, two of which are workable, having 8 and 7 feet of coal respectively. In Montana, where the formation seems thinner, one workable seam is found near the top of the formation. In the Black hills, coal-bearing beds which seem to occupy eroded valleys in the Jurassic are reported.

#### DAKOTA

Light colored, hard sandstones, with conglomerate at base, 150 feet.

As no fossils were here detected, these sandstones are supposed to represent the horizon that is above the conglomerates of the basin within the mountains, and, as the formations originally constituted a continuous sheet, the supposition will probably be borne out by the subsequent finding of fossils. On the north branch of the Oldman river Doctor Dawson observed a bed of ash rock at the top of the formation. This was again more extensively developed near the Crows Nest pass. The Moose Mountain locality seems to be beyond the limits of this volcanic ash and the formation passes to a black shale above, which is probably Benton. In the locality just mentioned Doctor Dawson collected from the sandstones just below the ash bed plant remains similar to the Dakota flora, and on the middle branch of the north fork, Oldman river, from a horizon above the conglomerate beds, a series of plants which have affinity with both the Dakota and Kootanie—that is, of five species recognized a fern and two conifers occur in the Kootanie and one of the two species of dicotyledons was originally described from the Cretaceous of Vancouver island generally placed at about the Dakota horizon.

There is thus in the thicker part of the formation a trace of the change from the flora of the Kootanie to that of the Dakota.

As marine beds, mostly shales, holding Benton fossils are found above the ash beds at the localities just cited, and also occur in the Moose Mountain section, the sandstone series beneath should represent the same deposition, but of greatly diminished thickness in the latter locality. The diminished thickness of the beds in the Moose mountain point to a possible time hiatus between the top of the Kootanie and the base of the Dakota. Attention to this is also drawn by Mr Ward in the Black Hills section. The complete section is probably to be found only in the Rocky mountains. Fresh-water conditions during this period prevailed in Dakota and Montana and probably along the western margin, but northward

on the Athabaska river the Tar sands, representing a period contemporaneous with the Dakota of Manitoba, have a marine fauna.\*

On the Elk River escarpment shore conditions prevailed for a considerable time after the inauguration of the Dakota period, and the formation is represented by a great thickness of conglomerates and sandstones.

#### COLORADO

By eliminating the recognized formations above, there remain some 725 feet of a succession of sandy shales and shale bands grading downward in the section to black shales which can be taken as representatives of the Colorado formation. As it is partly littoral, its thickness does not seem to represent the deposition of the entire period, and thus in the top of the Dakota is probably included the marginal deposits of the advancing shoreline, concealing a probable time hiatus at the top of the Dakota.

#### MONTANA FORMATION

Following the succession as delineated by Messrs Stanton and Hatcher in northern Montana, a conspicuous light colored sandstone, 50 feet in thickness, may be called the Eagle formation. Above this 250 feet of banded clays and sandstones would be the Claggett formation or "lower dark shales" of Dawson's southern Alberta section. A sandstone formation above it, with a thickness of 750 feet, holding the only fresh-water fossils found in the section, would be the Judith River formation. This latter does not contain in this locality an extensive land flora and there are but slight indications of possible coal seams. The shales above the sandstones are very much like those hitherto called Pierre, and the only marine invertebrates, with the exception of those from the Fernie shales, collected during the past season are from these upper shales and are typical Pierre.

On the Bow river, east of Calgary, the Pierre described by Doctor Dawson includes a sandstone series about 50 feet in thickness, which is again found more largely developed on the Red Deer river north. In the foothills this sandstone is 200 feet in thickness along the Bow river and is sometimes conglomeritic, but decreases in thickness toward the south and is only about 50 feet on Sheep creek. It consists of three well marked bands of sandstone, which maintain their character through this range and occupy a position in the upper third of the formation. The Pierre described by Mr J. B. Tyrell on the North Saskatchewan contains intercalated sandstone beds at all horizons from the top to near the base, and all bear marine fossils of Foxhill type; so that as a formation

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\* Ottawa Naturalist, vol. xli, p. 37.

the Foxhill is submerged in the Pierre. As Mr Stanton wishes to call the shales above the Judith river the Bearpaw formation, it is doubtful whether the Saskatchewan deposits should be included, but in the section here discussed the name could be used, as it is quite similar to the formation in Montana.

#### EDMONTON SERIES

The sandstones capping the Bearpaw shales contain a few brackish water shells and many plant remains. The thickness of the brackish water formation as distinguished from the fresh-water beds of the Tertiary was not ascertained. The Edmonton series represents the top of the Cretaceous and includes the lower part of the Saint Mary River series, which is a part of the Laramie.

#### SUMMARY

The Jurassic sea at its latest stage invaded the area of what is now the Rocky mountains in a narrow depression. The transition beds at the base of the Cretaceous were next laid down. The floor over which the Cretaceous was spread consisted of various formations, forming an overlapping series increasing in age toward the northeast. The early Jurassic sea was narrow, or at least extended not far east of what is now the Rocky Mountain area. Land conditions prevailed throughout portions of the Kootanie, and the greatest deposition of detrital matter and remains of an abundant flora occur in the same depression. In the later part of the Kootanie time the deposits extended possibly south-eastward to the Black hills. This period is closed by a depression in the central part of the continent, and the marginal beds of the sea, which then advanced, form the Dakota sandstone on the eastern margin. On the west similar deposits seem to be continued from the Dakota, by way of the Black hills, to the mountains, but both north and south there are evidences of salt-water deposits about this time. The Colorado formations here indicate in the upper members proximity to a western shore. The Montana formations are very similar to those near the Judith river. Land conditions then close the Cretaceous time, but intermittent encroachments of the sea continue to the beginning of the Tertiary.

#### NOTE BY THE AUTHOR

Since the paper was sent to the printer, determinations of the fossils have been received, proving the Kootanie age of the lower member, but bringing the Edmonton of the provisional list down to the Judith river. The revised section will be found in a forthcoming report by Mr D. D. Cairnes.