Descriptive note on a Section from the Laurentian axis to the Rocky Mountains, north of the 49th parallel

by

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The section in connection with which these notes are presented is a diagrammatic one, intended rather to show the general arrangement of the rocks underlying the Great Plains, than the actual position of the beds on any definite line. The direction of the section is however almost really transverse to that of the ~~st~~ main strike of the rocks & that of the great inland continental valley which ~~intervenes~~ lies between the Laurentian highlands ~~on the east~~ & the Rocky Mountains ~~on the west~~. The section is about eight hundred miles in

length. The profile represented by it is that of a line drawn from the middle of Lake Winnipeg West-South-westward, passing through the Touchwood ~~Hills~~ & Porcupine Hills, & reaching the base of the Rocky Mountains midway between the 49th & 50th parallels. The vertical scale, & thickness of formations is necessarily very much exaggerated.

Lake Winnipeg & the contiguous great lakes ~~so~~ ~~with~~ the low country about them, ~~lie~~ mask the outcrops of Silurian & Devonian rocks, ~~that~~ which rest at very low angles, or are nearly horizontal. These rocks are for the most part magnesian limestones of pale buff colour & resemble those generally ~~and~~ representing these periods in the Mississippi valley. They must originally have spread far up on the Laurentian plateau, &

perhaps soon have coalesced with the similar rocks of the same age which border the basin of Hudson's Bay. The great denudation which they have suffered in times geologically very recent is attested by the immense quantity of these peculiar rocks which together with Silurian & Huronian fragments ~~[illegible]~~ has been ~~scattered~~ spread abroad over the surface of the great Plains in the form of boulders & gravel. Rocks of Devonian age occupy the western portion of this region of the lakes, & Prof. Hind has described observations in several localities a belt of these at least fifty miles in width. It is in connexion with these rocks that the brine springs of the vicinity of Manitoba Lake occur. Salt has been manufactured from these for commercial purposes. North of the Winnipeg Lake, in the arctic slope of the

Continent, the Devonian rocks appear & become more important in regard to the area they cover than the Silurian, & they are found to ~~contain~~ yield petroleum as well as salt. The description of the bitumen & mineral pitch of the Athabasca region by Dr John J. Richardson would seem to indicate that a very important oil region here waits to be developed. The rocks consist of limestones & dark shales & are referred by Meek — who has examined ~~large~~ considerable collections of fossils from them — to the Hamilton & Genesee Epochs. The "Black slate" of the Western & Southern States has been shown to be the equivalent there of the latter, & according to Meek "holds nearly the same position with relation to the Hamilton beds as the Clearwater & Athabasca shales" The resemblance of the rocks in these Northern & Southern localities, & the continued

association of Salt & Petroleum will then to the south ~~leads for~~ renders it not improbable that if penetrated by borings passing through the overlapping Cretaceous rocks, the upper portion of the Devonian in the Manitoba region might prove valuable as an oil-bearing formation. This suggestion was ventured in the Report on the Geology & Resources of the 49th parallel, but remains as yet unexplored.

The unconformable, though nearly horizontal overlap of the Cretaceous on the Devonian, just alluded to, entirely conceals the outcrop of any rocks of Carboniferous age which may exist in this region. It is probable, however, that these rocks consist almost entirely of limestone, & if even if exposed would be found to yield no workable coal seams. The waters of the ocean appear

covered

Here ~~covered~~ this portion of the Continent during the Carboniferous period, & the conditions of accumulation of Coal did not occur till a much later stage in the series.

Rocks of Cretaceous age are, here next found in the Geological series in this region, & they constitute the substratum of by far the greatest area of the plains. The typical section of the Cretaceous of the Missouri Valley & eastern portion of the Interior Continental basin generally, is that ~~which~~ worked out many years ago by Messrs Meek & Hayden in the Nebraska region. It may be summarized as follows, the order being descending. —

Later Cretaceous

No. 5. Fox Hill Beds. — Grey ferruginous & yellowish sandstones & arenaceous clays marine shells 500ft

No. 4. Fort Pierre Group. — Dark gray & bluish plastic Clays. Marine shells & fish remains. . . . . 700 feet

Earlier Cretaceous

No 3. Niobrara Group. — Calcareous marls. Marine shells, foraminifera, fish remains &c . . . . . 200 feet

No 2. Fort Benton Group. — Dark gray laminated clays, with some limestone marine shells. . . . . 800 feet

No. 1. Dakota Group. — Yellowish reddish & whitish Sandstones & Clays with occasional lignite Coals. Marine & some fresh-water shells & Angiospermous leaves. 400 feet

adding together the approximate thicknesses given for the subdivisions above, a total of

2,600 feet is obtained, & it is possible that the Cretaceous system may in some places ~~be~~ attain this thickness. It is probable, however, that in the eastern part of the region traversed by the section now under description ~~that~~ the thickness is not so great, as this must originally have been ~~the~~ near the margin of the Cretaceous Sea. Owing, however, to the thickness of the drift covering & nearly horizontal position of the beds the actual thickness of any of the subdivisions has not been ~~[illegible]~~ ascertained here. It is probable that the lower subdivisions outcrop below the alluvium of the Red River Valley, & toward the base of the Cretaceous escarpment west of the Winnipeg group of lakes, but neither the Dakota or Benton groups have been observed in this region. In Nebraska there seems of

lignite are known in the Dakota beds & here, owing to the scarcity of other fuel, seem to have been worked. Similar lignites are also found in South Western Minnesota at this horizon, but are of no economic value. While it is therefore possible from analogy that workable lignite beds may occur in the representative of the Dakota in Manitoba, it is probable that even if this formation were well exposed & easily accessible the supplies of fuel it might yield would be of little or no economic importance.

The Benton Group though known in the Peace River Country, has been recognized as yet with some certainty in but a single locality in the Saskatchewan basin. The black shales at Coles' Falls on the main Saskatchewan are supposed by Meek who has examined fossils from them, to be of this period.

The Niobrara Subdivision has been recognized in Manitoba when the ~~Boyne~~ Boyne River cuts through the Pembina Escarpment, when it recently resembles lithologically & in its included fossils that of the Nebraska region. The rock is a cream colored limestone chiefly composed of shells of Inoceramus & Ostrea Congesta, but becomes in places a white chalky material which under the microscope is resolved into a mass of ~~forams~~ Foraminiferal shells, Coccoliths & allied minute organisms. Still further north along this western outcrop of the Cretaceous at Swan River & Thunder Hill, west of Lake Winnipegosis & near the line your section limestones & marls containing fossils like those of the last mentioned locality, & evidently of Niobrara age are again found.

The greater part of the Pembina Escarpment, with

its northern continuation, west of the Winnipeg group of lakes is, however, composed of the dark shales & shaly clays of the Pierre group. On the plains west of the escarpment of the Cretaceous the drift covering is so thick that ~~the opportunities for exposures~~ exposures of the Pierre are seldom met with. It is ~~found~~ however found wherever it ~~occurs~~ contains to be nearly horizontal, & it probably immediately & continuously underlies the ~~plains~~ country as far west as the edge of the Coteau.

The Fort Hill ~~beds~~ subdivision of Meek & Hayden's section, ~~are~~ is scarcely known in the eastern part of the plains. ~~They form the top~~ It constitutes the top of the marine beds & ~~are~~ is generally littoral & sandy in character. Rocks containing fossils referable to this subdivision have however been described by Hind at the Elbow of the South Saskatchewan, not far from our line of section.

Still higher in the series are the beds of the Fort's

Rivers region. These are the northern continuation of the Fort Union group of the Missouri, & with their Eastern boundary nearly coinciding with the Colorado or edge of the third prairie steppe, extend still further northward at least as far as the North Saskatchewan. In the Souris region, where they have been much more closely examined than on the line of section, they consist of sandstones, shales & clays, with layers of ironstone concretions & numerous beds of lignite. In the Souris Corbula inactriformis, a shell of brackish or marine water is found near the base, but with this exception all the molluscs are those of fresh water. These deposits have been accumulated in a great lake, a series of lakes with changing outlines, with the frequent local exposure of land surfaces on which conifers & broad-leaved trees grew & the debris of vegetation accumulated to produce beds of lignite. As the Souris region has already been fully reported on elsewhere it will be

unnecessary to dwell at length on them here. The section is however, intended to illustrate one point which has perhaps so far not received sufficient attention. The possible occurrence of outliers of this formation in the Chain of high-lands which begins on the Inkermann boundary-line with Turtle Mountain, is continued north-westward nearly parallel to the edge of the Coleman by Moose Mountain & the Touchwood Hills. So far no exposures have been found in these more elevated tracts which clearly exhibit the character of the underlying rocks, & the drift covering appears to be exceptionally thick & uniform on them. Dr Selwyn has particularly insisted, however, on the possible occurrence of the Souris series in these hilly tracts, & in view of the importance which would attach to the discovery of additional supplies of fuel for settlers of the

main outcrop of this lignite-bearing formation, it will probably before long become desirable to test the question by actual borings ~~[illegible]~~ in properly chosen localities.

So far as the examination of the County west of the Coteau or edge of the Third prairie steppe ~~has yet gone~~ to ~~the~~ about the 110th meridian has yet gone, no new features ~~are found~~ of importance are found in the Cretaceous & Souris beds. The lower parts of the County being usually undulain by Pierre, while the higher are characterized by the Stegomatotheca of the Souris series, & lignites are frequently found in there. The Tot Hill beds have been clearly recognized as an intermediate zone in a few places, ~~the~~ & all the rocks are horizontal.

Slate further west, however, ~~in the Bow & Belly River~~

Where the section traverses the Bow & Belly River region, changes of considerable importance are found to occur. The upper beds, which have so far been referred to as the Souris or Fort Union series, become thicker & more varied in character, & may best be described under the general term Laramie. The base of this division is now as a rule distinctly marine or brackish water in ~~character~~ origin, the beds so characterized often having a great thickness, & representing those of the Judith basin of the upper Missouri. These pass gradually upward into a great fresh-water series, which on lithological grounds I have provisionally divided into the St Mary River, Willow Creek, & Porcupine Hill subdivisions. The Laramie as a whole on approaching the mountains contains much more sandstone ~~& is~~ layers, & these are finer in texture, facts due to the approach to the old shore line, & the superior degree of

alteration which the Rocks have suffered in connection with folding. The Fox Hill beds blend so completely with the Laramie above & the Pierre below, that it is often difficult to ~~[illegible]~~ define them, but they may generally be recognized as a zone of yellowish Sandstones holding strictly marine fossils. The Pierre which probably varies in thickness than before is less homogeneous, containing frequent sandstone intercalations at places for instance the Three Bluffs, & when seen on the ~~[illegible]~~ Bow River containing besides a considerable thickness of whitish or pale coloured sandy & clayey beds which contrast markedly with its usual sombre colours. It appears now certain that the Rocky Mountains have been here born in strictly Cretaceous times as stone line, & that beneath the Cretaceous rocks the ~~[illegible]~~ Laramie beds have passed completely over the mount

position of ~~the~~ the range in this latitude as they are known to have
done further South. The broad undulations by which
the beds are now affected also result in the exposure in
different places of rocks underlying the Pierre, & these
are now found to consist of ~~variously~~ Sandstones, Shales
& Clays, ~~usually of pale colours~~ instead of the
Chalky material of the ~~typical~~ Niobrara of the East.
~~The fossils contained in~~ These are usually of pale colours,
& the fossils contained in them are at last in part
~~fresh~~ distinctly fresh water in character. The subjoined
table shows the provisional arrangement adopted
for the rocks of this region, & the parallel series
described by me in a former report of the Geological Survey
as obtaining in the Peace River Country which though
hundred miles both westward, but ~~bearing a~~ bears
a similar relation to the mountains.

LARAMIE, (including Judith River series.)	Beds of the Porcupine Hills. Massive sandstones, with shales, &c. Willow Creek beds. Reddish and purplish clays, with grey and yellowish sandstones. St. Mary River series. Sandstone shales and clays of general greyish or greyish-green colours. Yellowish sandstones and shaly beds, with a mingling of fresh-water and brackish or marine molluscs.	Upper Sandstones & Shales. (Wapiti River Group)
FOX HILLS.	Yellowish sandstones, with some shales, apparently irregular in thickness and character. Molluscs all marine.	
PIERRE.	Blackish and lead-coloured shales, with occasional sandstone intercalations, especially towards the mountains.	Upper Shales (Smoky Riv. Group)
NIOBRARA ?	Belly River series. Sandstones, shales and sandy clays. Upper part generally greyish ; lower yellowish, and often banded by rapidly alternating beds. Fresh and brackish water molluscs.	Lower Sandstones. (Dunvegan Group)
Benton		Lower Shales (Fort St John Group)

The Laramie & Cretaceous rocks are ~~both~~ sharply corrugated & folded together ~~from their junction with~~ for a distance of ten to twenty miles from their junction with the Palaeozoic rocks of the mountains, a fact probably in connection with the great fault with downthrow eastward which here occurs. East of the belt of corrugation they form a well marked broad shallow synclin the centre of which is occupied by the Porcupine hills, & thence gradually subside to the nearly horizontal attitude which is generally characteristic of the plains.

The ~~fuel~~ lignites & coals are in this western region not confined to the beds overlying the Cretaceous proper, but occur at intervals in the Cretaceous itself ——

Near the base, the Laramie is, ~~in the region now reported on~~, a persistent lignite or coal-bearing formation. A few miles north of the 49th parallel, on the St. Mary River, a coal bed of excellent quality, eighteen inches in thickness, is found, overlain by a bed holding *Corbicula occidentalis* and *Ostrea*. It is described in my Report on the Geology and Resources of the 49th Parallel (pp. 132-172.) Another coal outcrop, possibly on the same seam, and about a foot in thickness, is found on the Upper Belly River. The seam at the Indian farm near Pincher Creek is probably again not far from the same horizon, though perhaps a little higher in the series. Coaly streaks occur in the sandstones at the disturbed locality on the Oldman River, ~~which has already been referred to~~, and a lignite at Scabby Butte may occupy the same position. Further north, ~~the~~ seam on the Bow at Coal Creek, between Morleyville and Calgary, and those in the vicinity of the Blackfoot Crossing, appear to occupy nearly the same horizon. ~~The~~ thin seams near the mouth of the Highwood River may possibly be higher in the Laramie, and from the character of the St. Mary River subdivision throughout, it is not improbable that other coal or lignite-bearing zones may occur locally. The character and surroundings of the more important seams now known are detailed on a subsequent page.

A seam of lignite-coal occurs at the summit of the Pierre on the Bow River at Horse-Shoe Bend, while a persistently coal-bearing horizon characterizes its base, & is well exposed ~~both~~ on both the Bow & Belly Rivers. Lignite-coal also occurs in the beds above described as underlying the Pierre, & it is possible that further

Exploration may bring to light yet other fuel producing horizons.

A further fact of great economic importance is the improvement in quality of these fuels on their approach to the mountains. Two causes operate in this sense. First the greater age of the seams, in the strictly Cretaceous rocks & the consequent superior degree of pressure by overlying beds to which they have been subjected; second, the greater ~~degree of~~ alteration accompanied by flexure, to which the rocks in the vicinity of the mountains have been subjected. The second is, however, found to be much more influential than the first.

The belts of country characterized by different classes of fuels are indicated on the section. The section, over which the word <u>lignite</u> appears yields fuels which

though often containing little ash, & well adapted for local use ~~the~~ hold generally more than 12 per cent. of hygroscopic water. The next, designated as that of Lignite Coals frequently yields fuels containing less than 12 per cent of water, ~~H~~ in some instances not half this amount, & also by their physical character better adapted for transport. The third — ~~a narrow~~ a narrow zone coexclusive with that of great disturbance affords fuels which contain little water, often ~~are~~ give firm cokes on heating, ~~H~~ yield abundance of highly luminous hydrocarbons, & are scarcely distinguishable from ~~Some~~ ~~Coal~~ Coals of the Carboniferous period proper. This change is analogous to that found in passing from the bituminous coals of the Western States to the anthracites of the disturbed Appalachian region to the East.

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