Region of Manitoba
& N W Territory

~~3. The Manitoban Region~~

Chapter I. General Description

The North American Continent resembles the other great land masses in being bounded seaward by elevated ridges, the interior forming a broad relatively depressed area. The Elevated eastern border is generally known under the name of the Appalachian Range, the western may be designated the Cordillera region. These two lines of uplift diverge and trend northeastward & northwestward respectively & include a wide triangular area, which, however, does not lie completely open to the north. A third geologically important line of elevation forms a cascade or fore-shore shaped curve convex northward around the basin of Hudson Bay. This, which may be denoted the Laurentian axis becomes nearly parallel to the Appalachian ranges to the east, the valley of the River & gulf of St Lawrence separating the two systems. The Laurentian region is here high & mountainous ~~ragged~~ but to the west & north-west becomes lower, ~~becoming rather a rocky plateau than~~

~~A mountain Spur Range~~. In consequence of the position of the Laurentian axis the wide low interior ~~Region~~ plain of the Continent becomes narrowed near the western end of the Great Lakes & occupies thence to the Arctic ocean a gradually narrowing region between Laurentian plateau & the Rocky Mountains.

This region, to the South, is generally one of plain & prairie a circumstance dependant on the small rainfall ~~Rate~~ which it receives, & other causes. Farther North it becomes lightly & at length densely forested. ~~Where~~ along a line nearly following the N. Saskatchewan River, where it crosses the 49th Parallel, which constitutes the political boundary between the United States & Canada, the interior plain or plateau of the Continent is included in Longitude between the 96th & 114th Meridians, with a width of about 800 miles. Its Eastern boundary is formed by the western slope of the ~~Laurentian axis above referred to~~. old crystalline nucleus of the Continent, which though it doubtless holds throughout most of its extent areas of Horizontal

rocks may be traced as far as the Laurentian hills. ~~His~~ In this direction it is not quite [but is rather an elevated rocky plateau] known as Mountain range. It has an average breadth of about 250 miles, ~~is discussed as there~~ which is increased to about 400 miles? when it terminates at the Arctic ocean. Its average altitude north of Lake Superior & west of Lake Winnipeg is probably between 1500 to 2000 feet, while ~~the~~ further northward it is even less. Nor is it ~~altogether~~ an altogether continuous barrier, for it is crossed by a wide depressed area near the north end of Lake Winnipeg where the Nelson & Churchill Rivers traverse it to reach Hudson Bay. Here is to will depressed region flanked between the two systems draining the Laurentian district, the watershed following a very sinuous course among the innumerable lakes, small & great, which cover a large part of its surface.

3a. The Rocky Mountains to the west of the Interior Continental

Its character is in general extremely barren, its
mammilated rocky surface being in its original
condition generally but thinly covered by pretty dwarf
growth, rooted in a scanty soil, but peat & soil
together have frequently now extensive areas been
covered by fire, The ~~valleys of the~~ Nelson & Churchill
& associated rivers & lakes appear to occupy
a wide transverse depression in the
Laurentian plateau, in which ~~though~~ the granitic
& Gneissic rocks are to a great extent covered
with boulder clay & other deposits referable to the
Glacial period. Quite further to the north the
plateau though broken here & there by ranges of
hills is still low, or spreads widely as the
'barren grounds' which have been so graphically
described by Hearn, Richardson & others.

The most striking feature of the whole Laurentian
plateau is the unaltogether system of rivers &

& though there are
everywhere many spots
of sylvan beauty
with fine mirror lakes
& waterfalls this
region can scarcely
claim any economic
importance except
by the mineral wealth
it may contain, & the
peculiar style of
fur chase & the
fishery

already alluded to
Lakes with which the surface is sometimes covered.

Valley or plateau rise abruptly from the elevated plains at their base; generally to the east, near the 49th parallel almost perpendicular walls of rock. They are composed, not of a single upheaved ridge, but of a number of more or less nearly parallel ranges, which have a general direction a little West of North, & a breadth of over sixty miles, extending from the margin of the great plains to the valleys of the Kootanie, Columbia & upper Fraser Rivers. The geological continuity of the Country is generally as sharply broken & the line of their eastern base as its physical character, & we pass at once from the little altered or disturbed beds of Tertiary or Cretaceous age to scarped mountain sides composed of metamorphosed & folded Palaeozoic rocks. The rocky Mountains near the 49th parallel seldom much exceed 6000 feet in altitude, they appear to culminate Northward between the fifty-first & fifty-

second parallels where peaks which a ~~considerably~~ greater height considerably greater has been assigned are situated. They are comparatively low & narrow in the Peace River country, & become still lower & more depressed toward the arctic ocean, ~~where they are~~ ~~at last represented by ranges of mere hills~~. Northward from the Peace River to the bend of the Mackenzie River near ~~Fort Simpson~~ ~~63 the Sixty~~ 63rd parallel the Eastern base of the Mountains ~~has~~ appears to turn nearly due North, while beyond this point it again ~~takes its~~ resumes its north westward Course.

In intimate connection with the change in Character of the Rocky Mountains to the North West is, the remarkable fact that the rivers flowing Eastward from them have their sources further back among the Mountains as we proceed Northward. Near the 49th parallel the tributaries of the Missouri & South Saskatchewan rise in the abrupt

eastern valleys of the first range. The Kananaskis River, one hundred miles to the north, rises in the first Longitudinal valley, or at the foot of the second component range; Bow River from the third range; the North Saskatchewan from the fourth range; the Athabasca from the fifth; while the Peace & Liard Rivers have their sources quite to the west, & drain both slopes of the Rocky Mountains.

The Interior region of the Continent slopes gradually Eastward from the Elevated plains lying at the foot of the Rocky Mountains, & the foot of the Laurentian highlands; & though the "indications is more abrupt on approaching the Mountains it is not so much so as to attract special attention. In the tract embraced between the forty-ninth & fifty-fourth degrees of latitude, however, along two lines which are in a general way parallel, & hold a north-west & south-east course across the plains, remarkable step-like rises occur. Here escarpments run the eastern edges

of the two higher prairie steppes or plateaux, & the
last taken when includes the lowest prairie level,
or that of the Red River Valley. The three prairie steppes
thus depicted differ much in age & character. They
have been impressed on the soft formations of the plains
by the actions of sub-aërial denudation, of the sea, &
of former great lakes, & though the precise mode of their
formation is more fully discussed elsewhere, they
deserve notice here as being among the great primary
features of the country.

The actual increase of elevation accorded to in the
two escarpments is, however, slight compared with that
due to the uniform northward slope of the plains. The
direction of greatest inclination is in this region toward
the north-east & a line drawn from the extreme city of
the Forty-ninth parallel with the base of the Rocky Mountains,
to a point on the lowest prairie level north of Lake Winnipeg,
will be found to cross the escarpments ~~nearly~~ at ~~right~~
angles nearly a right angle, & to have an average

slope of 5.38 feet to the mile. From the same initial point, in a due East line to the lowest part of the valley of the Red River, the average slope is 4.48 feet per mile.

The first or lowest prairie level is that which the southern part lies along the Red River & which Northward embraces Lake Winnipeg & associated lakes & the flat land surrounding them. A great part of its Eastern border is conterminous with that of Lake Winnipeg, & paved by the rocky fronts of the Laurentian, but East of the Red River it is bounded by the high-lying ~~terraces of~~ drift terraces which surround the Lake of the Woods & form a part of the drift plateau of Northern Minnesota. To the West it is limited by the more abrupt edge of the second prairie level, which though very regular in some parts of its length has been broken through by the broad valleys of the Assiniboine & other rivers. The escarpment in the Southern part of

Manitoba is known as Riverina Mountain, & is continued northward by the Riding, Duck, Porcupine & Barquea Hills. South of the forty-ninth parallel the Valley of the Red River extends, with gradually narrowing dimensions to Traverse Lake, a distance of — miles. The average ~~height~~ elevation above the sea of the lowest part of the inland Continental region, is about 800 feet, the lowest part being that surrounding the Winnipeg group of lakes which stand at about 700 feet. The edges of this great valley are also — notwithstanding its apparent horizontality — considerably more elevated than its Central line which follows the Red River. Its width on the 49th parallel is fifty-two miles. Its area north of that line may be estimated at 55,600 square miles, of which the Great System of lakes in its northern part — including Lakes Winnipeg, Winnipegosis, Manitoba Cedar &

St Martins — occupies over 13,000 Square miles. A great part of this prairie land is wooded more or less densely, ~~& much of the low lying land near the great lakes appears to be swampy & liable to flood.~~ The southern part, extending from the 49th parallel nearly to the south end of Lake Winnipeg, including the exceedingly fertile prairie of the Red River Valley.

The superficial deposits of this stage are chiefly those of a great lake, which ~~Mr Warren Upham proposes to Call Lake~~ Agassiz occupied its area ~~of~~ toward the close of the glacial period, & which Mr Warren Upham proposes to Call Lake Agassiz. This must have united all the Lakes now found in the region into a single sheet of water, which extended with narrowing dimensions about two hundred miles South of the 49th parallel. The Red & Assiniboine Rivers & their tributaries have not yet Cut very deeply into the alluvial deposits of

the plains & its surface is level & little furrowed by denudation.

The second steppe of the plains is bounded to the east as already indicated, & to the west by the Missouri Coteau or edge of the third prairie level. It has a width on the 49th parallel of two hundred & fifty miles but before reaching the 54th parallel the distinction between the second & third steppes appears to be nearly broken down, the edge of the third steppe being scarcely clearly traceable beyond the North Saskatchewan. The southern ~~portion~~ part of the second steppe forms the eastern portion of the great ~~basin~~ western plains. These have an area of 71,300 square miles. On the south the boundaries of this region also appear to become more indefinite, & in the southern part of the County the three principal levels of the country here described are probably scarcely distinguishable. The rivers have acted on this region for a much longer time than on the last, & are now found flowing with sunken, though generally sloped,

Currents in wide trough-like valleys excavated in the soft material of the plains & often depressed from one hundred to three hundred feet below the general surface. In these the comparatively insignificant streams wander from side to side in tortuous channels. The surface of this prairie steppe is also more diversified than the last, being broken into gentle swells & undulations, partly, no doubt, by the action of ordinary denudation but in part also, as would appear, by the original unequal deposition by currents & ice, of the drift material which here constitutes the superficial formation.

The average altitude of this region may be taken at 1600 feet, & the character of its soil & its adaptability for agriculture differ much in its different portions.

The third or highest prairie steppe, may be said to have a general normal altitude of 3000 feet, though its eastern edge is sometimes little over 2000 feet, & it attains a maximum elevation of 4200

at the foot of the Rocky Mountains near the 49th parallel. Owing to the indefinite character of the dividing line between this region & the East, & the North, it is difficult to state its whole area between the 49 & 54th parallels. Of this steppe, however, it is estimated that an area of about 114 000 square miles, ~~is about~~ constituting its entire Southern part, is almost entirely devoid of forest, the wooded region being confined to a small portion of its northern extension ~~on~~ about the North Saskatchewan River & its tributaries. The breadth of this steppe on the 49th parallel is four hundred & sixty-five miles, & its Eastern boundary is well marked, being the broken hilly country known as the Coteau de Missouri or great Coteau, which crosses the 49th parallel near the 104th Meridian, & runs thence north-westward, near the Elbow of the South

Saskatchewan. It is then continued ~~southwards~~ by to the north by a range of high lands, of which the Eagle Hills west of Fort Carleton constitute a part. This portion of the great plains was doubtless the first to emerge from the Submergence which occurred during the glacial period, & has long been subject to the wearing influences of rain & rivers in both pre-glacial & post-glacial times. The portions yet which still remain but little modified, form table-lands, more or less completely ~~isolated~~ separated by lower ground. The immense amount of denudation which has taken place is evidenced by the ~~great~~ size & ~~great~~ depth of the valleys of the rivers & streams, both of pre-glacial & post-glacial age, the great ravines & gullies which have been cut & are still extending themselves among the soft Sandstones & clays of the district, & the isolated plateaux & 'buttes' which now stand far out be-

plains of ~~the~~ lower level, scanned with newer systems of coulées & gorges. Deposits ~~along~~ due to the glacial period are found on this light steppe, but are not spread with the same uniformity as on the lower levels, & a great part of the surface is found almost immediately on Cretaceous or ~~Laramie~~ Laramie beds, & varies in its character with vegetation & appearance according to their composition. The Agricultural value of this region is by no means so great as that of those before described, but is too varied to allow generalization. It embraces some land of unsurpassed fertility along the base of the mountains & also the northern extension of the desert region with its surface of sun-baked clay & sand scarcely supporting a thin growth of Cactus and Stipa.

The region between the 54th & 49th parallels, though

Plain or Steppe & depicts in its Grand features, shows many irregularities & exceptions in detail. The Second Steppe has some Elevations in its surface as high as the Edge of the third, & that part surrounding the Assiniboine River & its tributaries has become abnormally depressed, making some portions of the Eastern Edge of the Prairie Level which overlook Manitoba Lake, more to resemble outliers than integral parts of it. The third Steppe, though so irregular in its details, also shows evidence in the corresponding heights of the portions still remaining of the original surface, of previous uniformity. ~~The total area of that part of the great plains or open treeless country, between the 49th & 54th parallels is about 192,000 square miles~~

North of the 54th parallel the total area of prairie country properly so called is comparatively very small. Between the 54th & 49th parallels it may be estimated at 192,900 square miles. Though much of this vast region is not absolutely treeless like its southern portion, its aggregate tree-clad area is quite insignificant as compared with that of its open plains.

The central portion of British North America, may therefore be regarded as a great shallow trough, of which the western edge is formed of the Rocky Mountains, bordered, the Eastern by the Laurentian plateau, but of which the western portion of the floor is now more elevated than its Eastern rim. There are, however, two other & transverse watersheds in the area in question, which are not marked of any grand physical features, but appear to ~~be caused~~ have been produced merely by low gentle ~~folds~~ flexures in the strata. Of these one, in a general way follows the political boundary of the 49th

parallel. It separates the waters of the Red the Assiniboine & Saskatchewan rivers (which find their way through Winnipeg Lake to Hudson's Bay) from those of the Mississippi & Missouri & their various tributaries. Beginning in that region of Swamp & Lake in Northern Minnesota which feeds the variously destined head-waters of the Winnipeg St Lawrence, Mississippi & Red rivers, it dips Southward between the tributaries of the latter two streams & passes between Lake Traverse & Big Stone Lake with an altitude of 970 feet- only, about 200 miles South of the ~~49th parallel~~ Boundary line. Thence it pursues a general North-westerly course along the high lands formed by the Southern extensions of Cambrian Escarpment & the Missouri Coteau, & becoming identified with the latter crosses the boundary-line three hundred miles west by Red River. Then falling South of the drip-ridge of the Missouri Coteau, it follows the

Summit of the plateau of the Lignite Tertiary for about 300 miles to the Cypress Hills, when it is only 40 miles north of the boundary-line. Thence it trends southward & crosses the line for the last time about 30 miles east of the base of the Rocky Mountains. The average altitude of this watershed region east of the Red River is 1,400 feet. In Northern Dakota it may be estimated at 2000 feet; & from thence it rises the near the mountains it has obtained an elevation of about 4000 feet.

~~The second transverse watershed Crosses from the Rocky Mountains to the Laurentian region near the fifty-fourth parallel - which has consequently been chosen as a Convenient northern boundary for the region now described.~~

The second or northern transverse watershed region is ~~one~~ more complicated. Leaving the Rocky Mountains

near their intersection with ~~them~~ the 55th thro' parallel, the watershed runs North Eastward about two hundred miles, where, west of Edmonton, it is found to rise an elevation of about 2500 feet, & is composed of undulating hills of drift deposits, having to the North the tributaries of the Mackenzie to the South those of the Saskatchewan. At this point it bifurcates, the two arms stretching with Eastward to the Laurentian plateau & including between them a low region filled with lakes which drains toward Hudson's Bay by the Churchill River. The height of the southern watershed, between the Saskatchewan & Churchill is quite small. It is crossed by the Canoe Route at Frog Portage. The northern watershed between the last named rivers & the tributaries of the Mackenzie when crossed by the same route has, according to Sir J. Richardson a height of 1566 feet.

General Geology &c

The Silurian & succeeding deposits of the interior continental region seem to have accumulated on a great submarine plateau, stretching westward from the base of the Laurentian & Huronian ranges under a sea which was probably for a long time ~~land~~ in open communication with the ocean occupying the position of the Pacific of today. At various times the Laurentian & Huronian barrier may have been more or less completely overlapped by the newer newer deposits, which may have been found to the Surrounding Hudson's Bay, While the region now occupied by the western Mountain Ranges though ~~W~~ presenting a continuous land barrier was outlined by islands & areas of shoals & sand-banks at an early date. ~~It~~ It appears to have been most deeply submerged in Devonian & Carboniferous times, while from the Cretaceous onward the Elevation of ~~the~~ mountains was

such as to produce a complete land barrier. From this time the formations accumulating between the Cordilleras & ~~the~~ Laurentian regions, were those of a great interior continental basin or trough, the waters of which, at first in open communication with the ocean to the South & North, were soon, by the gradually increasing elevation of the continent, cut off from it more or less completely; and, after a period of transition became a great fresh water lake or series of lakes. The Lignite or Laramie group is the newest formation (yet known to be) represented north of the 49th parallel, to the south in lakes of constantly decreasing size the sands & clays of the later Tertiaries were laid down, including in some places in great abundance the remains of the various land animals which inhabited the then extensive surface of the continent.

Since the final withdrawal of the sea from this area in the latest Cretaceous or earliest Tertiary time, & probably for the most part at an epoch long subsequent to this, the beds in the vicinity of the forty-ninth parallel near the western margin of the interior continental region have been lifted up almost horizontally to a height of over 4000 feet just above the sea, following the upheaval of the Cordillera region & ~~produce~~ giving rise to the Eocene & North Eocene slope of the plains. It is interesting to observe that while the Cretaceous & Tertiary beds of the interior have been raised en masse by the slow exercise of immense force, these broken remnants on the Pacific coast have in many places scarcely been elevated above the level of the ~~Pacific~~ sea.

The Laurentian & Huronian rocks form the
North Eastern border of the Lakes Cultivated plain
do not differ in any marked way from those of
that portion of the same axis which stretches from
Lake Superior to Labrador, & which have already
been described (?) So far as yet known the Laurentian
is ~~generally~~ characterized by orthoclase gneisses &
granites like those of Logans lower division, & it
occupies by far the greatest area. The Huronian
forms a series of parallel bands which occupy
synclinal troughs in the older formation, &
without standing the general North-East & South-West course of the axis, runs as a rule in
North-East & South-West bearings. In the Lake of
the Woods region, two great series of movements seem
to have conspired to ~~give form to~~ produce the present
complexity of the rocks, both post-Huronian in date

The first of these series of rocks produced folds which are very an abrupt character but involve great breadths of strata & run in a general course a few degrees north of west. The great masses of intrusive granite are probably ~~more or less parallel to~~ closely connected with this series, & are more parallel to the folds, intersecting rocks of Laurentian or Huronian age indifferently. ~~The~~ ~~in the~~ ~~&~~ The subsequent North-East & South-West fracture of the rocks has been very violent in its character, producing vertical or overturned dips in both Laurentian & Huronian rocks, & producing the ~~parallel~~ troughs of the latter ~~above~~ alluded to. Lithologically, the Huronian rocks of the vicinity of the Lake of the Woods which resemble in many respects the typical rocks of that series as described on Lakes Huron & Superior, differ markedly in some points. They consist of black & greenish

foundlandic Schists, which become in many instances paler & almost nacreous in lustre, (?) probably by the development of hydrous micas. These are associated with massive diorites & quartzites, & with great bodies of 'greenstone conglomerates' & allied rocks which are evidently ~~agglom~~ properly speaking agglomerates or volcanic breccias due to contemporaneous volcanic activity.

In the Rocky Mountain region near the fortieth parallel the ~~Series~~ Laramie ~~is described by King as~~ which appears to merely the western development of the Fort Union beds & is probably as strictly synchronous with them as portions of a single formation so widely separated in space usually are, is described by King as consisting of "a series of rather coarse Sandstones, buff & grey, frequently striped with alternating strata of rusty red & carrying repeated intercalations of ~~rusty clays~~ Carbonaceous clays, & a considerable number of Coal-beds". The series is over 5000 feet in thickness in the Green River basin, & is characterized throughout by the salt & brackish-water types of Molluscs & contains several important zones of plant-bearing beds. The line between the Fort Hill & Laramie is drawn where the true pelagic forms of molluscs are found to cease.

The economic importance of this group lies in the occurrence in it of numerous beds of lignite & lignite-coal, on which some details are given ~~on a preceding page~~ below. The eastern edge of the Lignite Tertiary is practically the same with the western of the Pierre group of the Cretaceous, outlined on a preceding page, & they doubtless occupy a great part of the Missouri plateau, stretching ~~on~~ to the forty-ninth parallel & the very base of the Rocky Mountains. Notwithstanding the generally horizontal position of the beds the irregularities of the surface of the highest prairie level, & the excavation of deep river valleys in it has exposed the underlying Cretaceous in many places, & it is as yet impossible to define the limits of the formations on the maps with any accuracy. The Lignite Tertiary however, covers in the aggregate a very great area between the forty-ninth parallel & the Saskatchewan, the edge of the

thru prairie slope & the Rocky Mountains, & is almost ~~throughout~~ everywhere found to yield coal or lignite-coal in greater or less quantity. In the vicinity of Wood Mountain & the Cypress Hills the tributaries of the Missouri & South Saskatchewan have cut down in many places to the clays of the Pierre group, leaving the lignite Tertiary as a more or less depauperate plateau like the ~~main~~ portions of Canada. The lignite Tertiary has been most carefully studied in the vicinity of the forty-ninth parallel, where the lignite beds are probably those occurring the tributaries of the Quaking Ash between the 345 & 385 mile points west of Red River, known as Porcupine & Pyramid Creeks & the Great Valley. In ~~Canada~~ both the sections here explored, numerous & important beds of lignite occur, in association with greyish, yellowish & purplish arenaceous

arenaceous clays, sands & little consolidated sandstones, & beds of limonite. The deposits show no trace of marine conditions & brackish-water conditions, & wherever remains of molluscs are found they are those of fresh-water. The lignites appear to prove the frequent elevation of parts of the area above the surface of the water, & the general prevalence of plant remains in the interven sands & clays, shows that at no time were the land surfaces far removed.

It is probable that the lignite beds seen in the Souris River district are below those just described, but differ little from them. The lower part of the section on the Souris River includes the nodular sandstones which give rise to the fantastically weathered Roches Percées. It was supposed at the time the Souris River sections were examined that the Roche Percée sandstones were

very near the base of the Lignite Tertiary formation, but Subsequent Surveys by the Geological Survey have shown that ~~it~~ this is not the case, & that the Tertiary outcrops, though concealed & drift, probably extends considerably further East than is indicated in my Boundary Commission Report. Numerous beds of lignite, in some cases six to seven feet in thickness, occur in this district, & acquire some importance as being the nearest known to the settled County of Manitoba. Fossils are met in a few places, the commonest form being Ostrea Nebrascensis, with a second species of this genus & of Goniobasis, fragments of Unio & Corbula (Polamonya) Mactrifarmis, which must be considered as a brackish water ~~type~~ form. Further West than any of the localities yet mentioned beds of this age are extensively displayed in the bad lands ~~South of the Woody Mountain~~ on the

Southern edge of the Woody Mountain plateau.
The ~~are~~ have ~~found~~ have a somewhat different appearance, & west of this point a gradual change continues to take place, till in the region round the Three Buttes the formation has assumed an appearance so diverse from that of its Eastern development, that were sections ~~in the~~ from the two Regions directly compared it would be difficult to prove their equivalency. The beds best known in the Bad Lands are at the very base of the formation, & lower than any seen East of this place, but their difference when compared with those of the Series is not very striking. In some of the lowest beds a pale greenish-grey tint, not previously observed, appears, & the occurrence of reptilian bones is a new feature, none having yet been found East of this place in Canadian territory.
On the Milk River, where the next great series of

expanses of this formation occurs, its character has undergone a further change. The pebble gravel strata is now more pronounced, & characteristic of a greater thickness of the beds; & while ~~well marked~~ fresh-water molluscs abound, they are mixed for the first time with the remains of Ostrea a marine form. Lignites still occur, though not abundantly, & reptilian bones are found in certain layers.

In the vicinity of the Three Buttes, while lignites & carbonaceous shales still occur, the beds hold shells of Ostrea in great numbers with a Dentalia (Peritima) & other marine or brackish-water forms. Still further west, near the first & second branches of the Milk River, there is a remarkable reversion to fresh-water conditions, quite at variance with the general tendency to become more strictly

Marks westward, & perhaps indicating the occurrence of a higher portion of the formation. Dinosaurian & other Reptilian bones, however, still occur in connection with Unio near the First Branch, & on the Second Branch the bone-bearing beds appear to overlie a considerable thickness of shale holding Limnaea, Paludina, Planorbis & Sphaerium, from which an identical assemblage of the more typical eastern Fort Union beds. Greenish-grey arenaceous clays now constitute a large part of the series, coarse sandstones occur frequently, & a few beds of Conglomerate are noted. No lignites were found in this part of the formation.

When next met with in force, on the St Mary River twenty-five miles east of the base of the main range of the Rocky Mountains, the beds seem very probably to be considerably below those of the last localities. They still bear much the same general character, & greenish arenaceous

Clays are conspicuous. The are, however, not consolidated, & the coal found here differs considerably from the lignites of the Eocene localities, a circumstance probably connected with the disturbance of the beds, which are here found at high angles. The molluscs include decidedly salt-water forms, & no reptilian remains were found in this neighborhood.

It would thus appear, that though the general tendency of the Lignite Tertiary, is toward salt-water conditions Westward & those of fresh-water lakes to the East, that there are important exceptions, & that while brackish-water forms spread Eastward in the Crow beds as far as the Roche Percée, fresh-water species are scattered Westward nearly to the base of the mountains.

In this latitude a Zone of Sandstones appears to be of very constant occurrence in the formation. It appears on the Souris River at the Roche Percée

? if this Zone is always the same?

In the Bad Lands it is abut 150 feet abm the Country the Sot Hill Group; in the Valley y the Milk River abut 200 fut abm the base y the elevated section, & in the region surrounding the Buttes at Several miles from the base y the Mountains, & there probably several hundred fut up in the Tertiary

In the mount state your knowledge y the region between the 49th ninth parallel & the Saskatchewan, in which as above stated the Upper Tertiary Lies Where distinctly outlined, ~~it is necessary for me to discuss~~ it would be possible to discuss a number y isolated localities merely.

The Cretaceous Rocks y the Peace River Country, being separated from the region contiguous to the 49th ninth parallel & Southern portion y the Cretaceous area in Canadian territory by a wide tract y which comparatively little is known,

it is more convenient to ~~[illegible]~~ describe separately. To the East of the Rocky Mountains, which are very narrow & very high, & rest on the Devonian & Triassic beds quite unconformably are the Cretaceous rocks, which, between the Mountains & the Eastern outcrop

of the Devonian rocks on the lower Peace, occupy a basin with a width of nearly 350 miles, implying a Cretaceous sea of that width.

The Rocky Mountains have here formed a shore-line in Cretaceous times, and the Cretaceous rocks along their eastern base are almost entirely sandstones and conglomerates, the constituent fragments of which can be traced to the cherts and quartzites accompanying the limestones. The mountains are bordered to the east by foot-hills, in which, on the upper part of Pine River, for a distance of fifteen miles from the older rocks, the Cretaceous sandstones are folded and disturbed. The disturbance, however, gradually diminishes on receding from the mountains, and the beds at length become flat, or are affected by very slight and broad undulations only. Shaly materials increase in importance eastward, and the Cretaceous series eventually resolves itself into the following sub-divisions, which are placed opposite their supposed representatives in the Western States:

Upper, or Wapiti River Sandstones	Fox Hill (and Laramie?)	
Upper, or Smoky River Shales.....	Pierre,	Colorado.
Lower, or Dunvegan Sandstones.....	Niobrara,	
Lower, or Fort St. John Shales.....	Benton,	

The correlation as above shown is based partly on
palæontological evidence, partly on lithological
resemblance. The synchronism of the Upper Strata
with the Puerco group is quite clearly shown by the
fossils, which were found in abundance in several
places on Smoky River, & of which a list of
twenty species is given in the Report of Progress
of the Geological Survey for 1879-80 (p. 124 B.)
No fossils have been obtained from the overlying
member, which while its lower part doubtless
represents the Fort Hill group, may pass above
into the Laramie. The fossils of the lower
Sandstone are peculiar, consisting chiefly of
fresh-water & estuarine forms of Mollusca &
land plants. They have not yet been thoroughly
examined but include Inoceramus, Pteria,
Cyrena, Ostrea, Unio, Corbula, Goniobasis &
many the plants Cycadites, Magnolia, Carya

Protophyllum, Salix, Glyptostrobus gracilimus & Sequoia, forms a flora akin to that of the Dakota group, but older than that of the Coal-measures of Vancouver Island or the Laramie of the Plains. Its beds, collectively, are of great extent, forming as a matter of fact the Cretaceous proving almost unexpanded in these respects. Its molluscs closely resemble those of the Lorenzo group & might readily be mistaken for Tertiary forms. They resemble those detected & mark from a series of beds locally developed at Coalville Utah, which must have formed in the edge of the Cretaceous sea at the mouth of a small river, but in the Peace River district we have, instead of a merely local intercalation of this character, a widely extended series of Cretaceous beds persistently holding fresh-water & estuarine types of molluscs & land plants

In the Lower Shales, the most characteristic fossil is a large ammonite, resembling Ammonites (Prionocyclus) Woolgari, but specifically distinct. No trace is known as the Dakota has yet been found to exist in this district.

Lithologically the Upper Sandstones, consist of soft often shaly sandstone, earthy shales & clays generally of yellowish & brownish colours. Seams of lignite are included in the series. The Upper Shales are greyish & almost to nearly black in colour, the latter hue being due to finely divided Carbonaceous matter, which, with disseminated pyrites causes the spontaneous combustion of beds of these shales which has given its name to Smoky River. Concretions occur in abundance in many places in nodules & nodular sheets. The lower Sandstones are often shaly & not frequently cross-bedded giving rise to curiously weathered rocks along the banks of

rivers when they occur. They hold excellent
Coals in the vicinity of Pine River Forks &
the Mountain of Rocks of Peace River. The lower
Strata almost purely resemble the upper clay
group, but — as perhaps somewhat darker in
Several tint & sometimes include sandstones.

The Circumstances of deposit & origin of the material
of the several subdivisions of the Cretaceous
& Lignite Tertiary group is an interesting subject,
& leads us to attempt to ~~mendard~~ realize
the physical Geography of the Western portion
of the Continent in Mesozoic times.
It would appear that the Cretaceous period with a period
of considerable land surface, shallow waters & current-driven
Sand banks, & that these circumstances not only extended from the
Nebraska region westward to the Wahsatch Mountains, but probably
also to the Saskatchewan region & even further north. Similar
Conditions affected the Mississippi region described by Prof. Hilgard,
& probably at the same time the Cretaceous of New Jersey.

This seems to have been followed in the interior Continental region by a general subsidence, during which the Benton shales were formed, the great quantity of fine material required being probably brought into the region owing to the opening by the depression of wide avenues to the north through which currents flowed Southward. The conditions giving rise to the Benton shales are now known to have obtained northward to the Peace River district. During a succeeding period of tranquility, in which but a small amount of detrital material was introduced over the broken floor of the area, the chalk-like limestones of the Nebraska region were formed. Niobrara

~~For~~ In the Rocky Mountain region the Niobrara was a period of elevation, ~~and~~ Calcareous beds are not so important, & it would now appear, if the correlation of the Dunvegan Sandstones with this group is correct, that in the region of the Peace River the elevation gave rise to widely

extended tracts of low land. Here probably we find the [western] land barrier which shut out the sediment-bearing currents

In the Pierre shales, exceedingly fine in texture and of great thickness, we have evidence of a second considerable subsidence, which by again allowing the region to be traversed by marine currents, and perhaps also by bringing neighbouring decayed land surfaces under the action of the sea, supplied the necessary material. During this period, according to Meek and Hayden, a part of the clays and greensands of New Jersey were formed on the Atlantic coast; and in the Mississippi region, according to Hilgard, the Rotten-limestone Group was deposited. The fact that calcareous beds were being formed in the southern portion of the interior continental trough, while deposits so purely argillaceous were produced in the northern, seems to verify the supposition of the entrance of the sediment-bearing waters from the north. On the west coast, the subsidence appears to have allowed the Chico beds to spread to the foot of the Sierra, while land surfaces in Vancouver Island were brought down to the sea-level, and vegetable accumulations formed and covered by marine strata, giving rise to the valuable coal deposits of that region. Here the subsidence must have continued for a long period, while several thousand feet of strata were laid down.

In the interior continental region, either elevation followed the Pierre period, or the increase of sediments proceeded faster than the slow subsidence, for the succeeding Fox Hill period is again characterized by sands and similar shallow-water accumulations; and between the Rocky Mountains and the Wahsatch, near the western margin of the sea, land surfaces, evidenced by the occurrence of coals, existed. That the decreased depth over the interior continental region was due mainly to the filling up of the northern portion of the basin, rather than to elevation, seems to be indicated by the fact that limestones and marlites still continued to be deposited in the Mississippi region.

chalk-like Niobrara limestones of the Nebraska region were formed. These have now been found in several places along the eastern exposures of the Cretaceous north of the 49th parallel. In the Rocky Mountain region the Niobrara was a period of elevation, and calcareous beds

extended tracts of low land. Here probably we find the [nucleus] land barrier which shut out the sediment-bearing currents

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During the deposition of the Upper Cretaceous, Transition or Eocene beds of the Laramie and Fort Union series, depression must have been steadily in progress, for while land surfaces are evidenced at many horizons, the thickness of the formation is very great. The accumulation of material, however, outstripped the slow sinking, for during this period marine conditions came to an end, the salt water being first excluded from the eastern, afterwards from the western part of the area.

Rocks on Richardson

with special ref to phys. geog & geol. of N.W.

Slope of Country Eastward to Hudson Bay
2d Ice mule p. 102.

Spurs of Rocky Mts Across Mackenzie &
Nahany to Bear Lake. Limestone. Fossil Corals
of N and of Rocky Mts. p. 171.

Navigability of the Mackenzie p. 208.

Saskatchewan & Nassumpee in one great
Valley Vol II. p. 199.

Lewis of the Primitive Rocks II. p. 200.

For table upwards see Report. 1879-80

Sketch of Geology of [illegible] Central region

1881

G. M. Dawson

Wants.

Note on possible Economics of Laurentian & Huronian.

Descript & economics (salt, petroleum) of Sil & Dev. rocks along Winnipeg & lakes.

Short note on Age of Laramie.

Review of distribution of Coals

Character of Coals

Ironstones & Economics generally of Cret & Tert.

Drift — (? of certain letters in general acct including counts of W. grants.

Chapter III, The Cretaceous & Tertiary.

By far the greater part of the interior Continental plateau basin between the Laurentian & the Rocky Mountains is covered with rocks of Cretaceous age, or corresponding generally with the great Chalk formations of Europe, though very different from them in mineral character. ~~Except in a few~~ With the exception of a few localities, & a belt ~~following the base of~~ in the vicinity of the Rocky Mountain region of upheaval, they are & have always as perfectly horizontal as when originally deposited. The eastern edge of this formation irregularly overlaps the Silurian & Devonian limestones & runs nearly parallel with the ~~Laurentian~~ Lower Silurian base of the Laurentian plateau at a distance of about one hundred & thirty miles from it, between the fifty-third & fiftieth parallels of latitude. ~~It~~ Further Southward it trends to the East, & probably crosses the forty-ninth parallel East of the Red River

While in South western Minnesota, Cretaceous rocks appear in four places directly on granite which are probably Laurentian. The general course of the Eastern outcrop is Consequently about North north East, & it is marked broadly, by a series of escarpments & elevations, including, — from South to North — Pembina, Riding, Duck, Porcupine & Basquia "Mountains". All these appear to be composed for the most part, of Cretaceous rocks, though the extreme Edge of the formation may often stretch beyond them. These so-called mountains, are, more correctly speaking, as has been already shown — Salient points of the Edge of the Second ~~Plateau~~ prairie plateau; & the generally horizontal position of the beds thus suddenly cut off to the East, attests the immense denudation which

must have taken place in comparatively modern times.
West of the Barquia Mountains, from the very scanty
information we at present possess, the edge of the Cretaceous would
appear to run westward & cross the Saskatchewan near Fort
à la Corne, where at Coles Falls, a dark coloured shale
which has been referred to the lowest member of the Series
occurs. It may probably be nearly coterminous with the edge of
the second plateau, which, according to Mr Selwyn, crosses
the river forty-five miles below the fort. Still trending to
the north-west, the edge of the Cretaceous is next found on
the lower Peace River at a point a short distance above the
Falls, the intervening country between this & the last mentioned
locality being unknown. The western base of the formation
seems in most places to follow close along the base of the

Rocky Mountains, but in some parts of the Range, according to Dr Hector, rocks of this age occur among the mountains where they have been considerably altered. In Montana, Dr Hayden supposes the Cretaceous rocks, including those of the Laramie period to have passed completely across the region of the Rocky Mountains proper so called & to have been removed from them subsequent to their upheaval by denudation. This may also have obtained in the Rocky Mountains immediately north of the forty ninth parallel, but further north, in the Peace River region the mountains have been a land line during the Cretaceous, & it is probable that even in the just mentioned region the Cretaceous seas did not extend far west of the Range. Near the forty ninth parallel the Cretaceous deposits must have a width of over eight hundred miles, while in the Peace River region they still have a breadth of

westward at right angles to the Rocky Mts through a distance of about three hundred & thirty miles; implying in each case a sea of such considerable extent as the above figures. Still further north, the Cretaceous area becomes very much constricted or restricted. Sutherland Cut off near the head of the Mackenzie River in Latitude 63°. There is no reason to suppose, however, that the Cretaceous Sea terminated here, for the break in the continuity of the deposits, if it indeed occurs — is doubtless due to subsequent denudation, for further north in the Mackenzie valley the Cretaceous deposits are known to reoccur, though their area has not yet been defined, & the information concerning them is very imperfect, consisting principally of notes made by Sir J. Richardson during his necessarily hurried journeys through this region. On the Bear Lake River, near its junction with the Mackenzie Sir J.

Richardson discovered an Ammonite ~~which~~ among Sandstones & Shales which he states resemble those of the Coal measures. Prof. Meek has also found fragments of an Ammonite & Inoceramus in Mr Kennicott's collections from the same place, & had previously described two species of Ammonites from specimens obtained in this neighbourhood & submitted to him by Prof. Hind, as A. Barnstoni & A. Billingsii. It indeed seems probable, from Richardsons descriptions, & the information given to Meek by Kennicott that ~~the~~ beds of Cretaceous age, whereby characterize the greater part of the length of Bear Lake River, but occupy a portion of the ~~south~~ western shores of Great Bear Lake & spread pretty widely in the region of the Mackenzie Estuary.

? See vol. 1. p 92 Trans. Chicago Acad. Sci.

South of the forty ninth parallel the Cretaceous ~~forms a ser~~ extends to the Mexican frontier & beyond, but is concealed over wide

beds by Cretaceous & Tertiary deposits. In the region here treated of ~~the~~ with the exception of the deposits due to the period of glaciation, the Laramie & Fort Union beds, which have been variously classed as Upper Cretaceous or Eocene Tertiary are the ~~latest~~ youngest yet discovered, & ~~these~~ they cover a considerable portion of the Cretaceous rocks as ~~they~~ understood ~~in~~ here ~~this~~ defined in this article, they lie entirely within the limits above given for the Cretaceous, & it will be more convenient to speak of their distribution in connection with that of the subdivisions of the Cretaceous.

The Typical Cretaceous Section of the Interior Continental basin ~~region~~ is ~~not~~ established in my Yours ago by Messrs Meek & Hayden in the Nebraska region. This has formed the basis of the investigation of the western Cretaceous, & as it is equally applicable to great districts both south of the Rocky mountains

parallel way to should here. It is also included in the several comparative tables of Subdivisions at the close of this Chapter. The Section is as follows in descending order.—

Later Cretaceous.—

No. 5. Fox Hill Beds.— Grey, ferruginous & yellowish Sandstones & arenaceous clays. Marine shells 500 feet

No. 4. Fort Pierre Group.— Dark grey & 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 grey 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.

2,600 feet

From the Nebraskan region, the Cretaceous beds stretch westward in an unbroken sheet to the base of the Rocky Mountains, though, as above stated, often concealed by newer deposits. The beds originally passed in this latitude completely across the Rocky Mountain range & the base of the Wahsatch Mountains near the Great Salt Lake this range forming the western border of the "Cretaceous Mediterranean" as Clarence King has well designated the sea of the interior Continental ~~region~~ basin. In following the ~~Cretaceous~~ beds westward as they ~~to the dividing~~ they are found to change considerably ~~in character~~, becoming coarser & less regular in ~~the~~ character & thickness, & less perfectly differentiated by their fossils. A similar change is

in travelling westward over the beds of this period
observed ~~such~~ in tracing the beds of this age westward
further to the north, & is more fully discussed in the succeeding
paragraphs.

We may now proceed to trace out in somewhat greater detail the
distribution of the Cretaceous subdivisions so far as these have
been made out in Canadian territory, in so far as our
present ~~separation~~ knowledge allows. The task is a difficult one
owing to the infrequency of exposures over great districts of the
plains, a fact due chiefly to the thick & severely uniform
covering of drift deposits of the glacial period. This has so far
prevented the satisfactory mapping of these subdivisions over
a great part of the area here treated of. What is known for the
region south of the line of the Saskatchewan will first be stated
in brief, & the Cretaceous of the Peace River basin then described.
Of the continuation of these rocks still further to the north no details

Can yet be given.

The beds representing the Dakota, or lowest Cretaceous subdivision, in the typical Missouri River sections, are described as being "yellowish, reddish, & occasionally white Sandstones, with, at places, alternations of various coloured Clays, & beds & seams of impure lignite; also silicified wood, & great numbers of leaves of the higher types of dicotyledonous trees" with "casts of shells referable to the genera Pharella, Alinacea, Mactra & Cyprina" & Unio Nebrascensis. * In the Rocky Mountain region near the fortieth parallel, the Dakota Group is described by King * as consisting of a characteristic ~~remarkably persistent~~ Conglomerate, in which the size of the pebbles increases southward as the old shore line of ancient Wahsatch Range is approached. Over this is a varying series of yellow & grey Sandstones, with,

* Geol Report Yellowstone & Missouri Expedition.

Systematic Geology Hoyt Powell p. 348

in the Uinta region a prominent red clay shale, & a seam of good coal, which is not found further East.

The Beds of Dakota age have not been positively identified west of the forty-ninth parallel, though Dr. Hector supposes that those of his Division E, are referable to this period, & it is probable that at least a portion of them really are so. They consist of Sandstones Shales & soft limestones with beds of lignite coal & are extensively developed on the upper parts of nearly all the rivers flowing from the Rocky Mountains Eastward. In Nebraska three seams of lignite coal are known in the Dakota beds & have been to some extent worked owing to the scarcity of other fuel. Similar lignites are also found in South-western Minnesota, but are not of economic value. It is possible that workable lignite beds may occur in the representatives of the Dakota at the Eastern Edge of the outcrops of the Cretaceous in Manitoba,

see subsequent writings in 1881.

& yet this should prove to be the case, they would yet be
representatives of part of the Red River Valley.
The Benton Group, in Nebraska is described as consisting
of "dark grey laminated Clays, with light colored
arenaceous partings, & layers & beds of sandstone. Towards
the upper part, near its connection with the Niobrara Group
Division above it, it sometimes includes intercalated layers
of grey limestone, in all respects similar to the lower
overlying portions of the overlying rock; while at some other places,
its upper portion passes into a dark shale" *. Further
West, it is very extensively developed at Fort Benton on the
Missouri, from which it takes its name. The beds here
"assume the form of black plastic laminated Clay, with
numerous Calcarious concretions" *. In the Rocky
Mountain Region, in the portion parallel, this division
consists of a dark plastic clay Series, with varying

* G. B. y & m. Rep.

* Ibid.

ferruginous & argillaceous layers, overlain by greyish-blue clays, often inclining to black, & becoming more calcareous toward the top; the entire thickness being from 200 to 450 feet. ✕ ~~The only place~~

✕ Systematic Sect. Look parallel

The only place in which beds of this age ~~have yet appeared~~ have been determined with any certainty in Canadian territory, South of the Peace River region, which is subsequently described — is at Cole's falls on the Saskatchewan. This determination was got from made out in the district bordering on the Rocky Mountains.

See future expl. 1881.

The Niobrara Group in Colorado is described by Dr Hayden as consisting of "Lead-grey calcareous marl, weathering to a yellowish & whitish chalky appearance above, ~~containing~~ containing large scales & other remains of fishes & numerous fragments of Ostrea congesta attached to fragments of Inoceramus, passing down into light-

yellowish & whitish limestone* & blending with the next lowest group, particularly in the Black Hills & ~~Rocky Mountain Region~~ further west X. In the Rocky Mountain region on the forticth parallel the Niobrara state consists for the most part of argillaceous limestones & marls, the series being from 100 to 200 feet thick.

In Manitoba about twenty-five miles north of the boundary line where the Boyne River cuts through the Pembina escarpment, beds clearly separable to the Niobrara group are known to occur, & precisely resemble the latter lithologically & in their included fossils those of the Niobrara region. The rock is a cream-colored limestone chiefly composed of shells of Inoceramus & Ostrea congesta, but frequently in places a white chalky material which under the microscope is resolved into a mass of Foraminiferal shells, Coccoliths & allied minute organisms. Of the

* Geol. Report of U.S. Exploration p. 14

Foraminifera the genera Textularia & Globigerina are the most abundantly represented. Thus exposure ~~of the Niobrara~~ though probably small in extent enables the outcrop of the Niobrara to be defined at a point nearly two hundred miles beyond the farthest ~~previously known localities~~ northern locality previously known. Still further north along this eastern outcrop of the Cretaceous at Swan River & Thunder Hill, Manitoba west of Lake Winnipegosis, limestones & marls ~~of this~~ containing fossils like those of the last mentioned locality & evidently of Niobrara age are again found. In the western portion of the plains between the forty-ninth parallel & Peace River again no deposits of this age have been certainly identified, for though Dr Hector suggests the correlation of Group C. of his Cervical section with the Niobrara, the rocks, consisting of dark clays with Ostrarian nodules are more probably referable to the next overlying division; & with regard

X.R.y.p. 874-75 3.66.

~~to the locality~~ the rocks of other localities which have been doubtfully referred to this group, for much uncertainty still obtains as to render it unnecessary to repeat [illegible] here.

See results of 1884.

Of the Cretaceous strata so-called the Fort Pierre group is by far the most important member in Canadian territory. In the Nebraska section this ~~xxx~~division is described as consisting of a great thickness of "fine, gray, & dark-coloured clays, in moderately distinct layers, but never presenting a laminated or slaty structure, like the Fort Benton group. When wet the clays are soft & plastic, but on drying they often crack & crumble so as to obliterate the marks of deposition in vertical exposures."* Toward the base there occurs in this division, in some places, a local bed of from ten to thirty feet in thickness of fine micaceous clay, with much Carbonaceous matter,

Geol. Rep. of Mr. Sefwd. p. 19.

& crystals of pyrite & selenite. This is worth remark in connection with the similar appearances presented near the base of the same division in the Bear River district subsequently described. The western outcrops of the Pierre on the upper Missouri, & along the Rocky Mountains as far south at least as Colorado, appear to maintain, to a great extent, the characters which it presents in the East. Beginning, in the fortieth parallel region, these beds are described as consisting, in ascending order, of — Greyish black Carbonaceous shales & marls, Nearly black arenaceous clays, & interstratified beds of clay & sand, with a total thickness of 250 to 300 feet. Rocks of the Fort Pierre Group have been examined by Dr Hector, Prof. Hind & ~~Hayden~~ the writer in a number of localities, but owing to their soft nature & the thick drift-covering of the plains it is yet difficult to outline their

area with accuracy. The lithological character of these rocks is somewhat very uniform, & though Dr Hector considers his Group B, alone as representing this part of the series it appears very almost certain that his Group C also may must be included under this head. The Eastern boundary of the Series must be many considered with that of the Cretaceous as a whole in the ~~range~~ Escarpment which overlooks the great Lakes from the west, while the western edge of its main area is formed by the overlap of beds of Laramie or Fort Union age & those of the Cypress Hill group. This western boundary according to the latest information appears to cross the forty-ninth parallel between the 101st & 102nd Meridians, & thence to run ~~west~~ north-westward to the Elbow of the South Saskatchewan, becoming nearly identified with the Edge of the Missouri Coteau, before reaching

that part of it called the Thunder Breeding Hills on Palliser's Map, & probably — according to information obtained by Dr Hector — forming a narrow belt along the valley of the South Saskatchewan at least as far as the Cypress Hills. North of the Elbow the boundary is then probably continued along the edge of the third prairie steppe to the North Saskatchewan; rocks of this age ~~stretching~~ here forming the whole breadth of the second prairie steppe, with the possible exception of outliers of the newer groups. These rocks are characteristically displayed in the escarpment of Pembina Mountain, & have been designated the Pembina Mountain group in the Report on the forty-ninth parallel. In the great scarcity of organic remains, as well as in their lithological character they resemble the typical series as represented at Fort Pierre. Septarian nodules from a prominent

features in a portion of the terrain lies near the base of the escarpment, but the shales are generally exceedingly firm & uniform in texture. Selenite frequently occurs as a secondary product in cracks & veins formed by the action consequent on the decomposition of pyrite.

Following the fork-built parallel westward, many of the streams ~~cross~~ occur south of the woody mountain Tertiary plateau, with an appearance somewhat different from those of Permian limestone being on the whole more crumbling & earthy, though many parts of the series shall so closely resemble the Tertiary developments as to be indistinguishable from it. The septarian nodules are now found at several different levels in the section, characterizing narrow zones, & it is almost exclusively in connection with these that ~~the~~ fossils are found.

In continuing westward, after passing over a great plain based on Tertiary rocks, the Pierre group again appears upturned around the flanks of the Buttes, & still preserving — though now within a hundred miles of the base of the Mountains — its old characters, the only ~~most~~ real change being the introduction of a few arenaceous layers, small in thickness & irregular in extent, but sufficient to vindicate the character maintained through the whole of the Cretaceous period by the Rocky Mountain region — that of deposit in shallower & more rapidly moving waters.

[Margin note: a boring carried to a depth of 570 feet at Fort Pelly, on the Assiniboine River, by the geological survey penetrated rocks of the Pierre group for 250 feet, & then passed through calcareous beds probably of Niobrara age, ending in shales which may be supposed to be Benton.*]

The character impressed on the face of the country, wherever the Pierre beds immediately underlie the surface, is unfavourable in the highest degree. Without the intermixture of foreign material, the débris of these rocks forms an exceedingly poor soil. Their fine unctuous character prevents any

* R. of P. 1875-76 p. 292

drainage from below, & the plains based on them alternate with the Seaton from the Condition of tenacious mud to that of hard Sun-cracked clay. The Saline waters & springs issuing from the strata, impregnate the soil of the low grounds & valleys, & produce conditions favourable to the growth of Salicarnea, Obione, Sarcobatus &c.

These remarks apply, however, in their entirety to the region South of the great transverse watershed, which approximately follows the forty-ninth parallel. Wherever the Causes which have produced the thick drift deposits of the plains have operated in their full intensity, the influence of the underlying beds on the soil, has been greatly modified by the addition of transported material, & this modifying action has perhaps nowhere been more effectual, than over the areas covered by the Pierre group which from its compositing yielding character

has been cut away into hollows & buried under great depths of travelled material. The impoverishment thus effected in the country is especially notable between Pembina Escarpment & the Missouri Coteau, over the second prairie steppe, where exposures of the underlying rocks are very seldom seen.

The Fox Hill Group is the highest of the Cretaceous series of the West, properly so called, & is thus described in the Nebraska region:—"This formation is generally more arenaceous than the Fort Pierre group, & also differs in presenting a more yellowish & ferruginous tinge. Towards the base it consists of sandy clays, but as we ascend to the higher beds we find the arenaceous matter increasing, so that at some places the whole passes into a sandstone. It is not separated by any strongly defined line of demarcation from the formation below, the change from the fine clays of the latter to the more sandy material above being very gradual."* Neither does

*G. R. of & M. Exp. p. 22.

the transition appear to be marked by any great change in life, as indeed this division might almost as well be considered the closing Epoch of the last, but for the ~~persistency of the~~ lithological break & the persistency of these Upper Sandstones over great areas. The representative of the ~~[illegible]~~ Fox Hills group in the fortieth parallel ~~region~~ area of the Rocky Mountain Region is described by King as consisting almost altogether of gray, rusty & buff sandstones, containing a few ~~[illegible]~~ clayey beds. It has a thickness of 1500 feet near the western margin of the Great Plains, but increases further west, near the Wahsatch, to 3000 & 4000 feet. It is known to hold one bed of coal immediately west of the Rocky Mountain range, proper, & several considerable beds to the west.

As indicated in the table on another page, the Benton, Niobrara, & ~~[illegible]~~ Pierre groups here in

the Rocky Mountain region has grouped together by King & Hayden under the single name of the Colorado. ¶ This has been done because of the difficulty found in recognizing & separating the four lowest three subdivisions which are distinct enough in Nebraska. The three subdivisions above mentioned are in the west naturally allied, being the great clayey portion of the Cretaceous, which is underlain by the Dakota Sandstones & overlain by the Sandstones of the Fort Hill group just described.

Though rocks of this age upon the Fort Hill group of Nebraska must border the eastern edge of the Cretaceous formation, they are not exposed near the forty-ninth parallel. But Kind, however, does their occurrence in two places, — at the junction of the Eyebrow Hill stream with the Du Appelle, about 40 miles of Fort Pelly

clays & hard ferruginous Sandstones; & at the Elbow of the South Saskatchewan, as ferruginous & yellowish grey sandstones, with two clays, ~~& two~~ The following fossils were recognized & Mr Meek among those collected from these deposits. — Scaphites Conradi, Nautilus Dekayi, Avicula linguiformis, Avicula Nebrascana, & Portellania Americana.

South of the Woody Mountain Tertiary Plateau, the Cut Hill beds are separated by division No 4 by my "Bad Lands" Section, consisting of yellowish & buff Sandstones in two plains arrangements & with a total thickness of about Eighty feet only. These beds are again seen, further west, on White Mud or Frenchman's River. They were not observed at the junction of the Cretaceous & Tertiary east of Milk River, but their position is marked by sand hills on the flanks of the Three Buttes they are again brought to the surface, & consist of softer sand

Sandstone with some soft & more argillaceous beds near the base. Their outcrop in the vicinity of the Rocky Mountains has not been defined.

The beds overlying those of the Fox Hill series belong to the 'Lignite Tertiary' Fort Union or Laramie series, & the assignment of these to the Cretaceous or Tertiary has given rise to a protracted controversy. As however all are agreed as to the main facts of their character & position, it matters comparatively little whether the line between the Cretaceous & Tertiary, which must always be to some extent arbitrary & local in character be placed above or below them. The earliest portion of this great wide spread formation, as the Missouri near Fort Union is described as assigned a thickness of about 2000 feet, & described

See p. 27 Sup. as thickness.