

May 16, 1855.

E. H. Hargraves, Esq. was elected a Fellow.

The following Communications were read :—

1. *On the GEOLOGY of the HUDSON'S BAY TERRITORIES, and of portions of the ARCTIC and NORTH-WESTERN REGIONS of AMERICA; with a Coloured Geological Map.*

By A. K. ISBISTER, M.A., M.R.C.P. &c.

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INTRODUCTION.—In submitting to the Society a Geological Map of this extensive region, with a few explanatory remarks, my object has been to recapitulate very concisely the various observations of the geologists and travellers who have explored, and of the naturalists who have examined the organic remains of, this portion of the American Continent, and to present as completely as possible the results which have been hitherto attained in the study of its geological formations. The numberless difficulties inherent in such an undertaking, embracing a range of country so vast and so difficult to explore, or even to obtain access to, must necessarily render any attempt of this nature very imperfect; but I have been induced to undertake it in the belief that, in the absence of any general view of the geological structure of this extensive but interesting region, even the most cursory classification of its formations might be useful to those employed in developing the structure of the crust of the earth,—the more especially as it is not probable that the attention of practical geologists will soon be directed to this distant and almost inaccessible field of investigation.

To render the present attempt as complete as the state of our



knowledge will admit, I have carefully studied all the published documents and the geological collections relating to the subject to which I have been able to obtain access. And I have myself resided for many years in various parts of the territory, which, I may add, I have traversed from one extremity to the other,—from the borders of the United States to the Arctic Ocean in one direction, and from the frontiers of Russian America to Hudson's Bay in the other.

The titles of the publications to which I have referred are indicated below, and may be considered as presenting a bibliographical view of what is known of the geology of this part of America.

LIST OF WORKS RELATING TO THE GEOLOGY OF THE NORTHERN PART OF NORTH AMERICA.

North-West Coast and Russian America.

Geology of the United States Exploring Expedition under the command of Commodore Wilkes. By JAMES D. DANA. New York, 1850.

Geological Appendix to Captain Beechey's Voyage to Behring's Straits in the ship "Blossom." By Dr. BUCKLAND. London, 1839.

Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West Küste Amerika's. Von Dr. C. GREWINGK. St. Petersburg, 1850.

Exploration and Survey of Peel's River; a portion of the chain of the Rocky Mountains and the country west of McKenzie's River. By A. K. ISBISTER. Journal of the Royal Geographical Society for 1846.

Hudson's Bay Territories and Arctic Regions.

Topographical and Geological Appendices to the Narratives of Sir John Franklin's First and Second Journeys to the Shores of the Polar Sea. By Dr. RICHARDSON. And Note on the Fossils. By Prof. JAMESON. London, 1825 & 1828.

Observations on the Rock Specimens collected during the First Polar Voyage of Captain Parry. By CHARLES KÖNIG. London, 1824.

Notes on the Geology of the Countries discovered during Captain Parry's Second and Third Expeditions. By Professor JAMESON. London, 1826.

Geological Appendix to the Narrative of an Attempt to reach the North Pole by Sir Edward Parry, in the year 1827. By Professor JAMESON. London, 1828.

Geological Appendix to Dr. Scoresby's "Journal of a Voyage to the Northern Whale Fishery, including Researches and Discoveries on the East Coast of Greenland." By Professor JAMESON. Edinburgh, 1823.

Discovery and Adventure in the Polar Seas and Regions: Edinburgh Cabinet Library; with a Chapter on Arctic Geology. By Sir JOHN LESLIE, Professor JAMESON, and HUGH MURRAY. 1832.

Voyage of Discovery for Exploring Baffin's Bay. By J. ROSS. 1819. Appendix on the Rock-specimens. By Dr. M'CULLOCH.

Journal of Captain Penny's Voyage to Baffin's Bay and Barrow's Straits, in search of Sir John Franklin. By Dr. P. C. SUTHERLAND. With an Appendix on Geology. By J. W. SALTER. London, 1852.

Arctic Silurian Fossils. By J. W. SALTER. 1853. Quart. Journ. Geol. Soc. vol. ix.

On the Geological and Glacial Phenomena of the Coasts of Davis's Straits and Baffin's Bay. By P. C. SUTHERLAND, M.D. 1853. Quart. Journ. Geol. Soc. vol. ix.

RINK, H. Geology of West Greenland. Trans. Roy. Soc. Denmark, 1852. (Om den geographiske Beskaffenhed af de Danske Handelsdistrikter i Nordgrønland.)

STEINHAUER on the Geology of Labrador. 1814. Trans. Geol. Soc. vol. ii.

BAYFIELD, on the Geology of the N. Coast of the St. Lawrence. 1837. Trans. Geol. Soc. 2nd Series, vol. v.

On the Geology of Lake Huron. By Dr. BIGSBY. 1824. Trans. Geol. Soc. 2nd Series, vol. i.

On the Geology of the Lake of the Woods [and Rainy River]. By Dr. BIGSBY. 1852. Quart. Journ. Geol. Soc. vol. viii.

On the Geology of Rainy Lake, South Hudson's Bay. By Dr. BIGSBY. 1854. Quart. Journ. Geol. Soc. vol. x.

On the Drift of the Lake of the Woods and South Hudson's Bay. By Dr. BIGSBY. 1851. Quart. Journ. Geol. Soc. vol. vii.

Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River. By Captain BACK, R.N. Appendix on Geology. By W. H. FITTON, M.D. London, 1836.

Journal of a Boat Voyage through Rupert's Land and the Arctic Sea, in search of the Discovery Ships under Sir John Franklin. By Sir JOHN RICHARDSON. London, 1851.

On some points of the Physical Geography of North America. By Sir J. RICHARDSON. 1851. Quart. Journ. Geol. Soc. vol. vii.

Report of a Geological Survey of Wisconsin, Iowa, and Minnesota, and incidentally of a portion of Nebraska Territory [including the Red River of Lake Winnipeg]. By DAVID DALE OWEN. Philadelphia, 1852.

The chief sources of information, however, on which I have relied in confirmation of my own observations are the valuable Memoirs of Mr. Salter on Arctic Silurian Fossils, published in the Quarterly Journal of the Geological Society, vol. ix., and in the Appendix to Dr. Sutherland's Journal of Capt. Penny's Voyage, and the extensive researches and the numerous able publications of the great Arctic traveller Sir John Richardson, to whom science is indebted for nearly all that is known of the natural history of the vast region surrounding Hudson's Bay.

The collections of rock-specimens and minerals brought to England by the expeditions of discovery through this territory, to which Sir John Richardson was attached, and the various Arctic expeditions by which its northern shores have been traced, as well as by those recently engaged in the search for Sir John Franklin, are very extensive, and throw much valuable light on the mineral structure of the various formations which prevail in the northern regions of America. It was not, however, until within the last few years that any considerable collection had been made of the *organic remains* belonging to these formations, by which alone their relative ages and their true characters can be determined. Some of the fossil remains alluded to have been described and figured by Mr. Salter in the papers already referred to, others by Dr. Dale Owen, of the U.S. Geological Survey, Dr. Buckland, and others; and some (as will be subsequently noticed) have been described, though only incidentally and in general terms, by Sir John Richardson, Mr. Sowerby, the late Mr. König of the British Museum, and the late Professor Jameson of Edinburgh. A considerable number remain still undescribed in the Museum of the Edinburgh University, the British Museum, the Museum of Practical Geology in Jermyn Street, and the Museum of Haslar Hospital, or are mentioned for the first time in the present paper.

An examination of these specimens leaves no doubt of the existence of a vast development of palæozoic deposits, extending with little intermission (so far as is known) from the northern frontiers of Canada and the United States to the farthest point to which our researches have extended in the Arctic Ocean, and from Hudson's Bay on the east to near the Rocky Mountains on the west,—presenting alto-

gether a geological horizon of a grandeur and extent unequalled probably in any other part of the world, largely as the researches of Sir Roderick Murchison, Sir Charles Lyell, and others have shown such formations to be developed in Russia and the United States.

A slight sketch of the chief physical features of this wide region will demonstrate the remarkable symmetry and unbroken condition of its sedimentary deposits, and to what an unusual degree they have apparently been exempted from those igneous disturbances which have complicated the geological structure of many other countries of far less extent in other parts of the world.

TERRITORIES EAST OF THE ROCKY MOUNTAINS.

Physical Features ; and Range of the Crystalline Rocks.—Separated from Canada by the great granitic range of the Laurentine or Canadian Mountains, which form the division between the hydrographic basins of these northern regions and those of the St. Lawrence and its great lakes, the Hudson's Bay Territories may be considered as forming one vast plain, diversified only by a single low granitic ridge running northwards from the west end and almost the whole north shore of Lake Superior as far as Great Bear Lake, in a direction nearly parallel with the range of the Rocky Mountains. This low belt of crystalline rocks (see Map, Pl. XIV.) averages about 200 miles in breadth, and is evidently the northern continuation of the Laurentine range, which, after extending uninterruptedly along the northern frontiers of Canada until it comes in contact with the northern spurs of the Alleghanies near the mouth of the St. Lawrence, is deflected northwards in a direction again nearly parallel with the Rocky Mountains through Labrador and along the shores of Hudson's Straits and Baffin's Bay until it finally disappears beneath the limestones of Lancaster Sound and Barrow's Straits. The striking correspondence between the direction of this granitic range, as thus traced, and the general contour of Hudson's Bay will be at once obvious from an inspection of the Map (Pl. XIV.), and would appear to point out this vast mass of crystalline rocks as the probable axis of elevation of the great movement by which the Hudson's Bay Territories, as well as Labrador and the lands and islands along the west coast of Baffin's Bay, were first upheaved from the primeval ocean under which they once reposed. The grand chain of the Rocky Mountains may be considered also as forming a new axis of elevation, at nearly an equal distance farther west, upheaving in a similar manner the wide-spread strata which repose on its flanks.

The existence of lines of division, pursuing a parallel course, in a general meridional direction, like those just mentioned, is one of the most prominent general circumstances hitherto ascertained respecting the geology of this part of America. The course of the Rocky Mountain chain, from the Sierra of Mexico in lat. 30° to its termination on the coast of the Arctic Sea in lat. 69° , is about N. by W., with very little deviation anywhere. This is also the general direction

of the rugged and lofty coast-range of Labrador and Baffin's Bay, as well as of the west coast of Greenland.

By carrying the eye over the map from point to point along the western edge of the crystalline belt running through the Hudson's Bay Territories, it will be seen that the average direction is the same; though, as it proceeds northwards it inclines slightly towards the Rocky Mountains, which, it is to be observed however, begin here to lose their continuity; several of the western ranges being found to deviate from the general direction of the chain, and to develop themselves in irregular masses through the interior of Russian America.

We possess little reliable information respecting the structure of the mountain ranges of Labrador (on the east) or of the Rocky Mountains (on the west) north of the forty-seventh parallel, where they were crossed by Lewis and Clarke, in 1805, and no organic remains (so far as I am aware) from either locality. Sir John Richardson, who is in possession of all the information respecting the Rocky Mountain range, collected from the traders of the Hudson's Bay Company and from the botanists Douglas and Drummond, who crossed it between the sources of the Elk and Peace Rivers, describes the eastern slopes as consisting of conglomerate and sandstone, to which succeed limestone and clayslates, probably of Silurian age, and granite. This view is to some extent borne out by the section of this range given by Marcou, at Fort Laramie, in lat. 42° , from the Surveys of the United States' geologists. Farther north, where the chain was explored by myself, near its termination in the Arctic Sea, the prevailing formations were found through their organic remains (as will be subsequently noticed) to be referable to certain members of the Carboniferous series, corresponding probably to the Mountain Limestone of English geologists. From the highest part of the range, near latitude 55° N., where it attains an elevation of 16,000 feet above the sea, the four largest rivers of North America—the Missouri, the Saskatchewan, the Mackenzie, and the Columbia take their rise. It may be added, that these four feeders of opposite oceans not only take their origin from the same range of mountains, but three of them almost from the same hill,—the head-waters of the Columbia and the Mackenzie being only about "two hundred yards" apart, and those of the Columbia and the Saskatchewan, not more than "fourteen paces." It may be mentioned also as a singular fact, that one branch of the Mackenzie, the "Peace River" of Sir Alexander Mackenzie, actually rises on the western side of the Rocky Mountains within 300 yards of another large river flowing into the Pacific, the Tacoutchetsse, or Fraser's River, which discharges itself into the Gulf of Georgia, opposite Vancouver's Island.

Central Plateau of Crystalline Rocks.—Marcou, in his recently published Geological Map of the United States, has traced the crystalline formation of the Laurentine Mountains a considerable distance to the westward of Lake Superior, where it appears to form the chief constituent of the low watershed which separates the waters of the

Missouri from those of the Saskatchewan and other rivers flowing into Hudson's Bay.

The zone of crystalline rocks, chiefly gneiss, with granite and trap, previously alluded to as extending for a very great distance in a north-west direction from Lake Superior, is likewise very little elevated for the greater part of its extent above the surrounding country. Sir John Franklin, on his first overland expedition to the shores of the Polar Sea, crossed this granitic chain nearly at right angles to its line of direction in proceeding from Hudson's Bay to Lake Winnipeg, where it was 220 miles wide; it has been since crossed at various other points, and traced nearly along its entire length to the Arctic Sea. We are thus in possession of the requisite data for mapping its course and extent, and indicating its general features with considerable accuracy. Branching off from the Laurentine ranges, it assumes a north-westerly direction from the Lake of the Woods (where it first comes in contact with the limestones which underlie the prairies on the west), until it reaches Lake Winnipeg, along the eastern side of which it is then continued for about 280 miles in nearly a N.N.W. direction. From Norway Point at the north end of Lake Winnipeg to Isle à la Crosse, a distance of 420 miles in a straight line, the western boundary has, according to Sir John Richardson, a W.N.W. direction. For 240 miles from Isle à la Crosse to Athabasca Lake, its course turns in a somewhat irregular outline northward enclosing the whole of that lake with the exception of its western extremity. Thence it is continued to MacTavish Bay in Great Bear Lake, a distance of 500 miles in a general direction of about N.W. by W., and is marked, according to Sir John Richardson, "by the Slave River, a deep inlet on the north side of Great Slave Lake, and a chain of rivers and lakes, including Great Marten Lake, which discharge themselves into that inlet." From Great Bear Lake to the sea it follows the general course of the Coppermine River, its termination being marked by the mouth of that stream in lat. $71^{\circ} 55'$ N. and long. $120^{\circ} 30'$ W.; or perhaps more correctly by Richardson's River, a little to the west of it. In this part, for the first time, the chain rises to the altitude of hills, marked on the Map as the Copper Mountains, which attain in some parts a height of 800 feet above the bed of the river. The slight elevations composing the main portion of the chain seldom rise, as has been already observed, much above the level of the surrounding country, giving to the entire range the character of a low swampy plateau of crystalline rocks, covered by an immense network of small lakes and swamps, connected by narrow and tortuous channels. The low rugged knolls of granite and gneiss, round which these channels wind, "have mostly," says Sir John Richardson, "rounded summits, and they do not form continuous ridges, but are detached from each other by valleys of various breadth; though generally narrow and very seldom level. When the valleys are of considerable extent, they are almost invariably occupied by a lake, the proportion of water in this district being very great; from the top of the highest hill on the Hill River thirty-six lakes are said to be

visible. The small elevation of the chain may be inferred from an examination of the Map, which shows that it is crossed by several rivers that rise in the Rocky Mountains, the most considerable of which are the Churchill, and the Saskatchewan or Nelson Rivers. These great streams have, for many hundred miles from their origin, the ordinary appearance of rivers in being bounded by continuous parallel banks, but on entering the primitive district, they present chains of lake-like dilatations, which are full of islands and have a very irregular outline. Many of the numerous arms of these expansions wind for miles through the neighbouring country, and the whole district bears a striking resemblance, in the manner in which it is intersected by water, to the coast of Norway and the adjoining part of Sweden. The successive dilatations of the rivers have scarcely any current, but are connected with each other by one or more straits, in which the water-course is more or less obstructed by rocks, and the stream is very turbulent and rapid. The most prevalent rock in the chain is gneiss; but there are also granite and mica-slate, together with numerous beds of amphibolic rocks."

The entire length of this remarkable plateau, from Lake Superior to its termination on the Arctic Sea, may be estimated at somewhat more than 1500 miles. Such an enormous extension of crystalline and eruptive rocks, nowhere assuming the character of a mountain district, is a remarkable example of the tranquil operation of an upheaving force exerted over an immense area, yet with a limited and regulated intensity, and a constancy of direction which render it worthy of attention, not only as a striking geological phenomenon, but as serving, perhaps, to throw some light on the dynamical conditions under which those vast sedimentary deposits which have excited the astonishment of geologists in America from their unparalleled extension have been originally upheaved.

It may be mentioned also as another remarkable circumstance in connexion with this granitic tract, that it is along its western margin, in the line of its junction with the limestones and other secondary deposits which extend between it and the Rocky Mountains, that all the great lakes of America are found. If we regard Lake Erie and Lake Michigan as expansions respectively of Lake Ontario and Lake Huron (being evidently component parts of the same lake-basins), we shall find the following series of great lakes—Lake Ontario, Lake Huron, Lake Superior, Lake Winnipeg, Athabasca Lake, Great Slave Lake, Marten Lake, and Great Bear Lake, succeeding one another in a N.N.W. direction along the line of fracture, and invariably bounded to a greater or less extent on one side (generally the northern or eastern) by crystalline rocks, and on the opposite side by limestones and other secondary formations; the northern coast-line being moreover indented nearly in the same general bearing by Coronation Gulf, where, as already stated, the line of crystalline rocks terminates. It is to be observed, however, that the rivers connecting these lakes run generally wholly in one formation or in the other.

Silurian Basin of Hudson's Bay.—The granitic tract just de-

scribed is bounded to the eastward by a narrow belt of limestone, beyond which there is a flat swampy and partly alluvial district, forming the shores of Hudson's Bay. The west coast of the bay is everywhere extremely low, and the depth of water decreases so gradually on approaching it, that in seven fathoms of water the tops of the trees on the land are just visible from a ship's deck. Large boulder-stones are scattered over the beach, and sometimes form shoals as far as five miles from shore. A low and uniformly swampy aspect characterizes the surrounding country for several miles inland. The upper soil presents a thin stratum of half-decayed mosses, immediately under which we find a thick bed of tenacious and somewhat shaley bluish clay containing boulder-stones. Beyond this occurs an extensive deposit of limestone, completely encircling Hudson's Bay, and following the course of the crystalline rocks to the extreme limit of our researches in the Arctic Sea.

Dr. Conybeare, in his Report on Geology, to the British Association for 1832, had noticed the great similarity between the fossils brought to England by the Arctic Expeditions of Parry and Franklin, and those of the Silurian formations of our own country. The Geological Notices appended to the Narratives of those Expeditions by Professor Jameson, Mr. König, and Sir John Richardson, who had the advantage of Mr. Sowerby's assistance in examining the organic remains, had previously led to the same view; and it may now be considered as finally established by Mr. Salter's examination and description of the extensive collections from the Arctic Regions*, brought to England by the recent expeditions in search of Sir John Franklin. The formation described by Dr. Sutherland as extending along the shores of Wellington Channel and Barrow's Straits, and considered by Mr. Salter to belong to the Upper Silurian group, has since been identified, through its organic remains, at several points along the coasts of Hudson's Bay. Recognized by Mr. Logan at Lake Temiscamang, and at Lakes Abbitibie and St. John, on the northern edge of the Laurentine Mountains, it has been successively identified along the Moose and Albany Rivers flowing into James's Bay, at Marten's Falls†, and along the northern edge of the granitic plateau, thence to York Factory, along the Great Fish River, of Sir George Back‡, at Igloodik§, and along both shores of Prince Regent's Inlet||, to which last-mentioned locality Mr. Salter's investiga-

* Quart. Journ. Geol. Soc. vol. ix. p. 313.

† By Sir John Richardson and Mr. Barnston. "Boat Voyage through Rupert's Land," vol. ii. ‡ Dr. Fitton and Mr. Stokes. § Professor Jameson.

|| Sir Roderick Murchison, 'Siluria,' p. 428. I cannot omit, in this sketch of the geology of so large a portion of the North American Continent, to refer to the very accurate discrimination and description of its leading features contained in the recently published work of Sir Roderick Murchison on 'Siluria.' To this important work, and to the long series of researches of which it is the fruit, the geologists of America must feel under the highest obligation, not only for the clear and comprehensive view it exhibits of the whole phenomena of Palæozoic rocks throughout that continent, but for the important and valuable aid it affords to the explorer and investigator of its organic remains, by the establishment of a definite and perspicuous standard of comparison and reference, by which its geological formations can be identified and described.

tions bring us down. The extreme points here indicated are Lake Temiscamang, in lat. $47^{\circ} 19' N.$, and the shores of Wellington Channel, between 77° and $78^{\circ} N.$, giving the enormous range of 30 degrees of latitude, over which, as far as our present information reaches, the Silurian formation extends uninterruptedly without any important variation, so far as is known, either in its mineralogical constitution or its stratification. The fossils from this district hitherto submitted to Mr. Salter's examination belong exclusively to the Upper Silurian. They are comprised in the following list; and most of them are figured in the Appendix to Dr. Sutherland's Journal of Capt. Penny's Expedition.

Crustacea.

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|---------------------------------------|------------------------------------------------------------------------------|
| 1. Encrinurus lævis, <i>Angelin</i> ? | 3. Leperditia Balthica, <i>Hisinger</i> sp.,
var. <i>arctica</i> , Jones. |
| 2. Proetus, sp. | |

Mollusca.

- | | |
|-------------------------------------------|------------------------------------------|
| 4. Lituites, sp. | 16. Spirifer crispus, <i>Linn.</i> sp.? |
| 5. Orthoceras Ommaneyi, <i>Salter</i> . | 17. —, sp. |
| 6, 7. —, 2 species. | 18. Chonetes lata, <i>Von Buch</i> ? |
| 8, 9. Murchisonia, 2 sp. | 19. Pentamerus conchidium, <i>Dalm.</i> |
| 10. Euomphalus, sp. | 20. Rhynchonella Phoca, <i>Salter</i> . |
| 11. Bellerophon nautarum, <i>Salter</i> . | 21. — Mansonii, <i>Salter</i> . |
| 12. Modiola (or Modiolopsis). | 22. — sublepada, <i>De Vern.</i> |
| 13. Strophomena Donnetti, <i>Salter</i> . | 23, 24. —, 2 sp. |
| 14. —, sp. | 25. Atrypa reticularis, <i>Linn.</i> sp. |
| 15. Orthis. | |

Encrinites.

- | | |
|-----------------------|------------------------|
| 26. Actinocrinus, sp. | 27. Crotalocrinus, sp. |
|-----------------------|------------------------|

Corals.

- | | |
|---------------------------------------------|-----------------------------------------------------|
| 28. Ptychophyllum. | 40. Syringopora, sp. |
| 29. Strophodes Pickthornii, <i>Salter</i> . | 41. Heliolites (Porites). |
| 30. — ? Austini, <i>Salter</i> . | 42. Cystiphyllum, sp. |
| 31. Favistella reticulata, <i>Salter</i> . | 43. Cyathophyllum, sp. |
| 32. — Franklini, <i>Salter</i> . | 44. Clisiophyllum, sp. |
| 33. Fenestella, sp. | 45. Aulopora, sp. |
| 34. Favosites polymorpha, <i>Goldfuss</i> . | 46. Cœnites (Limaria), sp. |
| 35. — Gothlandica, <i>Linn.</i> sp. | 47. Calophyllum phragmoceras,
<i>Salter</i> . |
| 36, 37. —, 2 sp. | 48. Arachnophyllum Richardsonii,
<i>Salter</i> . |
| 38. Columnaria Sutherlandi, <i>Salter</i> . | |
| 39. Halysites catenulatus, <i>Linn.</i> sp. | |

Mr. König describes the limestones from which these remains have been obtained as of an ash-grey or yellowish and grey colour, often foetid, and sometimes crystalline or compact, strongly resembling the Transition limestones of Gothland, and some of the foetid varieties of the Mountain Limestone of Derbyshire. He mentions also that it is filled with zoophytes and shells; and in some parts is quite made up of the detritus of Encrinites, the fragments of which are so comminuted that the rock might readily be mistaken for a granular limestone.

A small collection of fossils * recently procured by the writer from

* The fossils were collected by Dr. Roderick Kennedy, the Medical Officer at Moose Factory.

James's Bay (the southern extremity of Hudson's Bay), which have been submitted to Mr. Salter, but not yet named, exhibit the same general Upper Silurian character with those above quoted. They comprise specimens of the same Corals (*Favosites*, *Cyathophyllum*, *Clisiophyllum*, and *Favistella*), the universal *Atrypa reticularis*, *Pentamerus oblongus*, several Spirifers and *Orthis*, and an *Orthoceras*. Mr. Barnston, of the Hudson's Bay Company's Service, who has resided for upwards of twenty years in various parts of the district under notice, and whose qualifications as an observer are highly spoken of by Sir John Richardson, has traced the Silurian rocks from James's Bay to Marten's Falls, near the source of Albany River, at the eastern edge of the granitic plateau, which would give an average breadth of about 200 miles for the formation in this part. The boat-route from Lake Winnipeg to York Factory crosses the limestone belt at right angles to its course at Rock Portage, and its breadth is there found to diminish to less than 100 miles. The average width of the formation may perhaps be estimated at about 150 miles.

The mineral structure of the rocks forming the northern shores of America has been so fully and minutely investigated and described by Prof. Jameson, Mr. König, Dr. Fitton, and Sir John Richardson, that I shall here, as well as in the notices of the other formations of this territory, confine myself exclusively to the examination of their organic remains, referring the reader for every necessary information on the mineralogical character of the rocks in which they are found to the valuable publications of those authors.

Silurian Basin of Lake Winnipeg.—To the westward of the plateau of crystalline rocks, and following its course for a considerable distance northward, lies an extensive deposit of horizontal limestone, underlying the wide prairie country which extends towards the Rocky Mountains. Lake Winnipeg, which is situated on the line of junction of the two formations, is a long and narrow sheet of water, 230 geographical miles long, and about 40 wide; and, with its associated lakes (Moose Lake, Muddy Lake, Winnepegos, and Manitoba Lakes), receives, through its affluents—the Saskatchewan, the Red River, and other streams—a wide extent of prairie drainage. The commercial route from Lake Superior up to this point lies almost wholly within the granitic tract, touching on Silurian deposits only at the mouth of Rainy River and at one of the south-western arms of the Lake of the Woods, where Dr. Bigsby has detected a few organic remains indicative of the Upper Silurian formation*. The Winnipeg flows wholly within the granitic district, and has the lake-like dilations and other characteristics of the streams which traverse the crystalline tract. When we descend to Lake Winnipeg, we come upon epidotic slates, conglomerates, sandstones, and trap-rocks, which bear a close resemblance to those of the mining district of Pigeon Bay on

* The following list is given by Dr. Bigsby: a small *Phacops*, small *Orthis*—*Orthis*—*Orthis*, minute Encrinural columns, *Favosites Gothlandica*, *Cyathophyllum*, *Murchisonia*, *Pentamerus Knightii*, *Leptæna*, *Avicula*, *Atrypa*, and *Spirifer*. Quart. Journ. Geol. Soc. vol. viii. p. 405.

Lake Superior. After passing the straits of Lake Winnipeg, we have granitic rocks on the east shore and Silurian rocks on the west and north, the basin of the lake being mostly excavated in the limestone. The granite and gneiss which form the east shore of Lake Winnipeg strike off at its N.E. corner, and, passing to the north of Moose Lake, go on to Beaver Lake, where the boat-route again touches upon them. The extension of the limestone in a westerly direction from Lake Winnipeg has not been ascertained; but it has been traced as far up the Saskatchewan as Carlton House, where it is at least 280 miles in breadth. Beyond this it is either succeeded or covered by cliffs of calcareous clay, which bear some resemblance to those found along the banks of the upper portions of the Missouri, together with siliferous marls and beds of gypsum.

Skirting the base of the Rocky Mountains a remarkable lignite formation is met with, which is said to extend through the valley of the Mississippi and of Mackenzie River as far north as the Arctic Sea.

The limestone of Lake Winnipeg, which undoubtedly covers a vast tract of country; may in general be characterized as compact and splintery, and of a yellowish-white colour, passing into buff, and sometimes of an ash-grey, mottled, or banded with patches of light brown. In the district between Lake Winnipeg and the Saskatchewan, more particularly examined by the Arctic Expeditions of Franklin and Back which passed through it on their way to the Arctic Sea, the limestone strata were found to be almost everywhere extensively exposed, and to be remarkably free from intrusive rocks. Professor Jameson enumerates *Terebratulæ*, *Orthocerata*, *Encrinites*, *Caryophyllitæ*, and *Lingulæ*, as the organic remains brought to England by Franklin's First Expedition; Mr. Stokes and Mr. Sowerby examined those fossils which were procured on the Second Expedition, and found amongst them *Terebratulites*, *Spirifers*, *Corallines*, and *Maclurites*. The *Maclurites* were probably the *Maclurea magna* of Le Sueur and Hall. Sir John Richardson has recently brought home from the same quarter a fine specimen of the *Receptaculites neptunii*,—a fossil, which, though it occurs abundantly in some of the Devonian beds of the Eifel, is with the *Maclurite* characteristic in Canada, as in New York, of the Lower Silurian.

Along the southern shores of Lake Winnipeg and in the Valley of the Red River, where the limestone rises in solid ledges from the surrounding prairies, and has been extensively quarried for building purposes, it has been distinctly identified as belonging to that formation by Dr. Dale Owen, Director of the Geological Survey of Wisconsin and Minnesota, who in the course of his explorations visited the small colony settled there by the Hudson's Bay Company. In his recently published Report, Dr. Dale enumerates the following fossils procured by him from the quarries at Red River and from Lake Winnipeg:—

- | | |
|-------------------------|---------------------------|
| 1. Favosites basaltica. | 5. Ormoceras Brongniarti. |
| 2. Coscinopora sulcata. | 6. Leptæna sericea? † |
| 3. Chætetes lycoperdon. | 7. — alternata. |
| 4. Pleurorhynchus, sp. | 8. — planoconvexa? |

9. *Calymene senaria*.
10. *Pleurotomaria lenticularis*?
11. — *muralis* †.
12. *Orthis*, sp. †
13. *Lingula*, sp. †
14. *Terebratula*, sp. †
15. *Cytherina*? †
16. *Syringopora*.
17. *Pleurorhynchus*?
18. Cephalic shield of a *Trilobite* allied to *Ilænus arcturus* †.
19. Pustulated cephalic shield of an *Ilænus* †.
20. *Conularia*, sp.
21. Several specimens of the shield of *Ilænus crassicauda*.

NOTE.—Those marked † are figured in Dr. Owen's Atlas of Illustrations.

Many of these, Dr. Owen states, "are identically the same fossils as occur in the lower part of 'Formation No. 3.' in Wisconsin and Iowa, in the blue limestones of Indiana, Ohio, Kentucky, and also in the Lower Silurian of Europe. The *Coscinopora* is precisely the same as the coral which is particularly characteristic of the lower beds of the Upper Magnesian Limestone of Wisconsin. The specimens of *Favosites basaltica* cannot be distinguished from those which abound in the Upper Magnesian Limestone of Wisconsin and Iowa and the Lower Coralline beds of the Falls of the Ohio."

It has been noticed that the limestones of this formation are distinguished by two different tints of colour. From the following analyses of the two varieties published by Dr. Owen, it would appear that they differ also considerably in their mineralogical character.

Analysis of the Compact Limestone from Red River, containing <i>Leptæna</i> .		Spotted and banded Limestone, containing <i>Coscinopora</i> .	
Carbonate of Lime	53·7	Carbonate of Lime.....	78·1
Carbonate of Magnesia	40·5	Carbonate of Magnesia.....	17·8
Insoluble matter.....	0·8	Insoluble matter.....	1·0
Alumina, Oxide of Iron, and Manganese.....	4·0	Alumina, Oxide of Iron, and Manganese.....	1·4
Water and loss	1·0	Water and loss.....	1·7
	100·0		100·0

It has been stated that none of the fossils from the Hudson's Bay Basin hitherto submitted to Mr. Salter belong to the lower division of the Silurian. It is proper to observe, however, that Mr. Salter has expressed some doubt of the age of the limestone of Igloolik, Melville Peninsula, and Amherst Island, amongst the organic remains of which Professor Jameson and Mr. Stokes detected some *Trilobites*, a *Maclurite*, and a Coral, which last fossil from the description given of it may have been a *Receptaculites*; and it may be added, that Marcou, apparently on the authority of Mr. Logan, classes the limestones of Lakes Abbitibe and St. John as Lower Silurian. The limestones of the Kakabeka Falls were identified by himself as belonging to that division. The insufficiency of geological explorations, and the want of published documents, render it impossible as yet to define with any approach to accuracy the limits of the two great divisions of the formation in this part of America, while it may be safely asserted, however, that under one or other of its forms the Silurian formation attains probably a wider development in the Hudson's Bay Territories than in any other part of the world in which its existence has been hitherto ascertained. Sir John Richard-

son has detected it in the hollows of the granitic plateau, and he expresses a belief that it will be found to occupy all the valleys of that extensive district.

Devonian Formation of the Elk or Mackenzie River.—The extent of the Silurian formation of Lake Winnipeg northward has not been accurately ascertained. Limestones very similar in character have been traced on Beaver River, the most westerly feeder of Churchill River, and situated midway between the Saskatchewan and Elk Rivers. The canoe-route does not touch upon this river, which has its outlets in one of the south-western arms of Lake La Crosse; but it is observed that the country on entering Sandy Lake along the line of communication near this part suddenly changes its aspect. Banks of loam, sand, and rolled blocks of a fine quartzose sandstone are found along the channels of the rivers; and shortly after emerging from the granitic district through which the route lies for the greater part of the distance from Cumberland House to Fort Isle-à-la-Crosse, we come upon a formation of quite another character, occupying the basins of the Elk River and its affluent the Clear-water.

The Elk River, the most southerly feeder of the Mackenzie, originates in the Rocky Mountains, as already stated, near the northern sources of the Saskatchewan; and its bed, which forms with that stream two sides of an equilateral triangle, with its base resting on the western edge of the crystalline plateau, is not separated by any marked ridge from the Saskatchewan prairie country, which appears to extend with little interruption as far as the next great tributary of the Mackenzie, the Unjigah or Peace River. It is separated from the Churchill or Mississippi River system, having its outlet in Hudson's Bay, by the carrying-place of Portage La Loche, a plateau of about ten miles in breadth, which forms the dividing ridge between the waters flowing into Hudson's Bay and those flowing into the Arctic Sea. Portage La Loche has at its highest point an elevation of about 60 feet above the sources of the Churchill River system; but it presents on the side of the Clear-water River a sudden and precipitous descent of 656 feet, disclosing a deep layer of sand, enclosing masses of sandstone, of about 600 feet in depth; the whole reposing upon an extensive formation of limestone which lines the whole bed of the Clear-water as far as its junction with the Elk River. The deposits of sand and sandstone alternate with thick beds of bituminous shale, in some parts more than 150 feet in depth. These bituminous deposits form the distinguishing feature of the formation now under notice, and are developed to an enormous extent, having been traced at intervals along the whole length of Mackenzie River as far as the shores of the Arctic Sea. Springs and pits of fluid bitumen are of common occurrence, and along the banks of Elk River in particular the shale beds are so saturated with this mineral as to be nearly plastic. The whole formation bears a decided resemblance in its lithological character to the lower members of the "Erie Division" of the United States' geologists, which M. de Verneuil considers to

be equivalent to the Devonian formation of Europe *. I have been enabled, through the kindness of Mr. S. P. Woodward, to examine the collection of fossils from this district in the British Museum; and although, from the poverty of organic remains (a circumstance characteristic of the formation also in the United States), the collection is a very small one, there can be no hesitation in assigning the bituminous deposits of the Elk and Mackenzie Rivers to the epoch of the Marcellus shales, and the associated limestones, of the New York Survey.

The most characteristic fossil of the bituminous beds is a small Pteropodous shell, thickly disseminated through the substance of the shale, apparently the *Tentaculites fissurella* of Hall, associated with *Strophomena mucronata*, *S. setigera*, and *Orthis limitaris*, of the same author; at least they cannot be distinguished from his figures of those fossils from the Marcellus shales.

Two Corals from the associated bituminous limestone are, according to Mr. Woodward, characteristic of the same epoch, namely a *Strombodes* (of Hall), having its cysts filled with bitumen, and a *Favosites*, very like the common *F. polymorpha* of the Plymouth marbles. From the underlying limestones of the Elk River, Sir John Richardson collected several specimens of *Productus* (among them *P. subaculeatus*), an *Orthis* resembling *O. resupinata*, *Terebratula reticularis*, a *Posidonomya*, and a *Pleurotomaria*. There is a very fine and well-preserved *Rhynchonella* amongst the collection, remarkable for retaining the original chestnut-coloured bands of the shell.

Other Formations of the Mackenzie River Basin.—*Silurian rocks of Great Slave Lake and River (Onondago Salt Group of Vanuxem and Hall ?).*—After passing through Lake Athabasca, the Elk River is joined by the Unjigah or Peace River, the largest tributary of the Mackenzie, and the united streams, under the name of Slave River, proceed onwards to Slave Lake along the edge of the district of crystalline rocks, flowing sometimes through limestone, at other times over granite, and sometimes between the two. The mouths of Slave River open into Slave Lake between the limestone and granite. The limestones along the banks of this stream are, like those of the Elk River, highly bituminous; but they are chiefly remarkable from their association with extensive beds of compact greyish gypsum, in connexion with extremely copious and rich salt-springs. Where they approach the crystalline rocks, they are found, like those of Lake Winnipeg, to be highly magnesian,—a circumstance which may deserve attention with reference to the hypothesis of *dolomitization*, which regards the introduction or development of magnesia as subsequent to the deposition of the calcareous matter, and as connected with the proximity of masses containing that earth and heated to a very high temperature. Among the fossils collected from this district which are in the British Museum are *Spirifer crispus*, Dalm.?, *Rhynchonella phoca*, Salter, *Atrypa levis*, Vanuxem, *Atrypa reticularis*, an

* Bulletin Soc. Géol. Fr. 2 Sér. vol. iv. p. 646.

Orthis, two small Spirifers, like *S. trapezoidalis*, Dalm. and *S. pisum*, Sow., and fragments of an Encrinital stem like that of *Actinocrinus*. Sir George Back, on his expedition down the Great Fish River, collected some fragments of Corals along the south shore of Slave Lake, which were considered by Mr. Stokes and by Mr. Lonsdale to belong some to *Catenipora escharoides*, and one to the genus *Stromatopora* of Goldfuss, and probably to his species *S. polymorpha*. From the circumstance of these fossils being chiefly Upper Silurian, it has been conjectured, with every appearance of probability, that the salt-springs may belong to the "Onondago Salt Group" of the "Helderberg division" of the New York system.

Carboniferous Series (Mountain Limestone?).—Some of the organic remains procured by Sir John Richardson on a previous expedition from other points along the Mackenzie River would appear to indicate an ascending order in some of the deposits of that district from the Devonian limestones and the shales containing *Tentaculites* into beds of Carboniferous, or perhaps more recent age. In some specimens from the limestone* of the "Ramparts" in the lower part of Mackenzie River, brought to England in 1826, Mr. Sowerby discovered *Terebratula sphaeroidalis*, together with a species common in the carboniferous limestone of Nehou in Normandy, some *Producti*, and a Coral of the genus *Amplexus*. From other parts along the banks of the same river several *Terebratulæ* were procured, one resembling *T. resupinata*, one *Spirifer acutus*, a *Cirrus*, some Crinoidal remains, and Corals,—a somewhat perplexing assemblage, if they were all collected from the same spot. Most probably some of the specimens had been derived from the boulders and transported fragments with which this part of the country is covered.

Lignite Formation.—The difficulty of deciding upon the age of the beds through which the lower part of Mackenzie River flows, is increased by the occurrence among them of a Lignite-formation, covered in parts by deep beds of sand, capped by boulders and gravel. The soft friable shales forming the bank of the river near its termination in the Arctic Sea are also strongly impregnated with alum. These aluminous shales cover a large portion of the delta of Mackenzie River, are continued along the banks of Peel's River to the foot of the Rocky Mountains, and have been traced for a considerable distance along the coast, and also along the shores of Great Bear Lake. The aluminous shale is constantly associated with the bituminous formation, into which it often passes.

The lignite-formation is still more extensively developed; and, as the occurrence of coal in any form in these high latitudes is a

* The limestone of the "Ramparts," which appears again lower down at a spot called the "Narrows," is continued in a westerly direction to the Rocky Mountains, the lower elevations of which are composed of it in that portion of the range through which Peel's River takes its course. It has all the characters of the Mountain Limestone of English geologists,—a formation extensively developed in Russian America, where, as will be subsequently noticed, it has been clearly identified by its organic remains.

question of much interest, I shall here state briefly the results of Sir John Richardson's observations and inquiries on the subject, to which he has given much attention.

The Mackenzie traverses very obliquely the basin in which the lignite-formation is deposited, while Bear Lake River cuts it more directly across; and it is at the junction of these two streams that the formation is best exposed. It there consists of a series of beds, the thickest of which exceeds 3 yards, separated by layers of gravel and sand, alternating with a fine-grained friable sandstone, and sometimes with thick beds of clay, the interposing layers being often dark, from the dissemination of bituminous matter. "The coal, when recently extracted from the bed," says Sir John Richardson, "is massive, and most generally shows the woody structure distinctly; the beds appearing to be composed of pretty large trunks of trees, lying horizontally, and having their woody fibres and layers much twisted and contorted, similar to the White Spruce now growing in exposed situations in the same latitude. Specimens of this coal examined by Mr. Bowerbank were pronounced by him to be decidedly of coniferous origin, and the structure of the wood to be more like that of *Pinus* than *Araucaria*; but on this latter point he was not certain. It is probable that the examination of a greater variety of specimens would detect several kinds of wood in the coal, as a bed of fossil leaves, connected with the formation, reveals the existence at the time of various dicotyledonous trees, probably *Acerineae*, and one of which appears to belong to the Yew tribe." "Different beds, and even different parts of the same bed, when traced to the distance of a few hundred yards, present examples of 'fibrous brown coal,' 'earth-coal,' 'conchoidal brown coal,' and 'trapezoidal brown coal.' Some beds have the external characters of a compact bitumen; but they generally exhibit on the cross fracture concentric layers, although from their jet-like composition the nature of the woody fibres cannot be detected by the microscope. Some pieces have a strong resemblance to charcoal, in structure, colour, and lustre. Very frequently the coal may be named a 'bituminous slate,' of which it has many of the lithological characters; but, on examination with a lens, it is seen to be composed of comminuted woody matter mixed with clay and small imbedded fragments resembling charred wood. From the readiness with which the coal takes fire spontaneously, the beds are destroyed as they become exposed to the atmosphere, and the bank is constantly crumbling down; so that it is only when the debris have been washed away by the river that good sections are exposed *."

* With reference to the southern portion of this coal-field, where it is exposed in the valley of the Saskatchewan, Sir George Simpson, Governor of the Hudson's Bay Territories, has the following remarks, in his 'Narrative of an Overland Journey round the World,' vol. i. p. 162:—

"Near Fort Edmonton a seam of coal, about 10 feet in depth, can be traced for a very considerable distance along both sides of the river. This coal resembles slate in appearance; and, though it requires a stronger draught of air than that of an ordinary chimney, yet it is found to answer tolerably well for the blacksmith's forge. Petrifications are also found here in abundance, and at the Fort there was

Formations similar to that found on Mackenzie River extend southward along the eastern base of the Rocky Mountains, as far as the Saskatchewan River. Sir John Richardson gives a detailed account of the various localities between these two points in which beds of coal have been exposed,—all pointing to the existence of a vast coal-field, skirting the base of the Rocky Mountains for a very great extent, and continued probably far into the Arctic Sea, where, as is well known, lignite, apparently of a similar character, has recently been discovered by Captain M^cClure in the same general line with the localities above mentioned*. In the coal of Jameson Land, lying in north latitude 71° (on the east side of Greenland), and in that of Melville Island, in latitude 75° north, Professor Jameson found plants resembling those of the coal-measures of Britain; and similar remains have been more recently discovered by Mr. Dana in the coal-fields of Oregon and Vancouver's Island. These facts are sufficient of themselves, as is remarked by Sir John Richardson, to raise a world of conjecture respecting the condition of the earth when these ancient fossils were living plants. If the great coal-measures, containing similar vegetable forms, were deposited at the same epoch in distant localities, there must have existed when that deposition took

a pure stone which had once been a log of wood about 6 feet in length and 4 or 5 in girth, the resemblance being so complete as even to deceive the eye."

Sir Alexander M^cKenzie traced the same formation along the upper parts of the Peace River; and it has been found by the traders of the Hudson's Bay Company at several intermediate points along the same general line; leading to the conclusion that the formation in question is continuous and uninterrupted.

* Similar deposits to those discovered by Capt. M^cClure have been found in the New Siberian Islands, and are thus described in Wrangell's Polar Voyages:—"Of these [speaking of the deposits of fossil wood in the New Siberian Islands] Hedenström observes in another place, 'On the southern coast of New Siberia are found the remarkable Wood Hills. They are 30 fathoms high, and consist of horizontal strata of sandstone, alternating with strata of bituminous beams or trunks of trees. On ascending these hills, fossilized charcoal is everywhere met with, covered apparently with ashes; but, on closer examination, this ash is also found to be a petrification, and so hard that it can scarcely be scraped off with a knife. On the summit another curiosity is found, viz. a long row of beams, resembling the former, but fixed perpendicularly in the sandstone. The ends, which project from 7 to 10 inches, are for the greater part broken. The whole has the appearance of a ruinous dyke.' Lieut. Anjou, who likewise examined these Wood Hills, says, 'They are merely a steep declivity, 20 fathoms high, extending about five wersts along the coast. In this bank, which is exposed to the sea, beams or trunks of trees are found, generally in an horizontal position, but with great irregularity, fifty or more of them together,—the largest being about 10 inches in diameter. The wood is not very hard, is friable, has a black colour and a slight gloss. When laid on the fire, it does not burn with a flame, but glimmers, and emits a resinous odour.'"—(Narrative of an Expedition to the Polar Sea, by Admiral F. von Wrangell, of the Russian Imperial Navy, in 1820-23. (Edited by E. Sabine) Introd. p. cxviii.)

The "charcoal" and "ashes" are no doubt the result of the spontaneous combustion of the lignite, as is the case with the lignite deposits at Bear Lake and other parts of the Hudson's Bay Territories, where they take fire on being exposed to the air, and have been observed burning for the last hundred years. The Wood Hills in the New Siberian Islands are in the same general line with the lignite extending along the Rocky Mountains, and with the wood deposits discovered by Capt. M^cClure.

place a similarity of condition of the North American Continent from latitude 75° down to 45° .

Elevatory Movements; and Pleistocene deposits.—Into such questions, however, as the above, or into the discussion of the various hypotheses by which the elevations and depressions of the surface of these vast territories may be accounted for, it is beyond the province of the present paper to enter; nor, in the present state of our knowledge, would a summary of this kind admit of the necessary elucidation. I shall merely say, that, adopting the opinion of Sir John Richardson and the geologists of the United States, that “the eastern portion of the continent was first elevated, and that the older rocks on the west were subsequently overlaid by newer deposits,” I consider that the great mass of the underlying formations surrounding Hudson’s Bay are wholly palæozoic, and that the currents or waves of translation, if such there were, must have had an easterly direction in these latitudes, and gained strength as they rolled towards the Atlantic, when they swept away wholly or partially the fossiliferous deposits that covered the older rocks of Hudson’s Bay, Canada, and the eastern parts of the United States; the former extent of the newer rocks being indicated by the patches which remain. The only recent formations overlying the Silurian rocks, which have been hitherto discovered along the eastern coasts of Arctic America, are patches of pleistocene deposits, with marine shells of existing Arctic species (*Mya truncata*, *Saxicava rugosa*, &c.); the whole crowned by an immense profusion of boulders and erratic blocks. The country forming the Hudson’s Bay Territories is too flat for the immense erratic formation extending over every part of it to be explained by reference to the motion of glaciers; and I think it is more probably due to the action of icebergs and floating masses of ice, still so common along these coasts, and which are without doubt performing at the present day precisely a similar office, in strewing the bed of the ocean in which they are found with the fragments transported from the adjacent shores*.

With reference to the character of the pleistocene or drift formation, it may be mentioned that as we ascend the rivers of this region, especially along the basins of Lake Winipeg and its affluents in the prairie districts, the sandy and clayey deposits are found to abound with land and freshwater shells, such as *Unio*, *Helix*, *Pupa*, &c., of species now living on the borders, or in the beds of the rivers and lakes. The cliffs containing those shells are often raised more than 100 feet above the present levels of the banks of the streams, and appear to be ancient lake- or river-terraces; leading to a belief that, great as is the present extent of freshwater surface in the North

* In the Appendix to Dr. Scoresby’s ‘Journal of a Voyage to the Northern Whale Fishery,’ Professor Jameson enumerates among the specimens found on an iceberg near Cape Brewster the following:—

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| 1. Transition clay-slate. | 4. Hornblende mica-slate. |
| 2. Slaty talcose granite. | 5. Gneiss. |
| 3. Granular felspar. | 6. Basaltic greenstone. |

American Continent, it was at one time still greater, and that the existing series of lakes, from the St. Lawrence northward, were perhaps anciently united in one or more vast freshwater seas, having their western margins indicated, perhaps, by the peculiar elongated strip occupied by the lignite-formation previously described, which presents precisely the appearance which would result from a long line of shelving beach, piled with masses of drift-wood accumulated through long successive periods, similar to what is now found covering the shores of the inland lakes and portions of the coasts of the Arctic Seas.

It has been stated as an exemplification of the wide changes which would result from a comparatively small alteration in the present level, even of such mountainous districts as Canada and the North-eastern States of the Union, that "a subsidence of 400 feet would cause the waters of Lake Ontario to flow through the valleys of the Mohawk and Hudson into the Atlantic, and at the same time convert Lake Champlain into a maritime strait, thereby forming islands of the States of New York, New England, and Maine, and of the British Colonies of New Brunswick and Nova Scotia." A subsidence of one-fourth of that amount in the prairie districts of the Saskatchewan, continued to Great Bear Lake, would carry the waters of the Missouri and the upper portions of Churchill and Mackenzie Rivers into Lake Winnipeg, and convert the plain country bordering on the Rocky Mountains into an inland sea. Even at the present level the Missouri has, twice within the last thirty years, inundated the valley of the Red River, flowing into Lake Winnipeg; while it is a common occurrence for the country through which the lower part of the Saskatchewan flows to be laid under water for a distance of 200 miles above its outlet by an ordinary spring-flood. About forty years ago, in a season remembered especially for the land-floods, a gentleman in the service of the Hudson's Bay Company was drowned on the Frog Portage (the low watershed which separates the Saskatchewan and Churchill Rivers), by his canoe upsetting against a tree in passing from one stream to the other.

The raised beaches of Lake Superior, rising in four or five successive terraces to the height of more than 100 feet above the present surface of the water, and which have attracted the attention of Professor Agassiz and the geologists of the Canadian Survey, appear to point to the existence at some former period of a much greater body of water in this lake, at least, than is at present contained in it, and are to some extent therefore confirmatory of the view now suggested.

The Eocene basin of the Upper Missouri, with its very marked character of freshwater deposition, is stated by Marcou to extend along the upper waters of the Saskatchewan as far as Mackenzie River. I have no knowledge of any such formation myself, although in the unexplored territory west of the Winnipeg basin there is undoubtedly ample room for its development. Its existence, if established, would lend additional probability to the inference deducible from the circumstances previously noticed*.

* The views here suggested are not to be considered as prejudging the question so ingeniously developed by Mr. W. Hopkins, and supported by the late Prof. E.

Territories West of the Rocky Mountains.—Physical Features.—“The great contrast between the east and west sides of the Rocky Mountains has been often mentioned,—the one abounding in sandstone with argillaceous limestones, *without* volcanos or volcanic rocks, while on the other side recent igneous rocks prevail (basalts, basaltic lavas, and trachytes) *, and the sandstones are comparatively of small extent.” This remark, which I quote from the learned and beautiful work of Professor Dana, ‘The Geology of the United States Exploring Expedition under Commodore Wilkes,’ will prepare the reader for the examination of a country of a different character from what has above formed the subject of investigation.

The grand features of the country on the Pacific side of the Rocky Mountains arise from the development of three ranges of mountains, intersecting the country in a direction parallel with the general course of the coast-line. Three of these are north and south ranges,—the Coast Range, the Cascade Range, and the Blue Mountain Range. The first lies near the coast, the second 130 miles inland, and the third 350 miles from the sea.

The Cascade Range is much the most extensive of the three, and even rivals the Rocky Mountains in the height of some of its peaks. It may be traced, according to Professor Dana, far into California, and northward into Russian America; retaining throughout a direction nearly parallel with the coast. It terminates northward, according to Grewingk, in the lofty volcano of Mount Wrangell, in lat. 62° N., where it blends with the lateral volcanic range, forming the remarkable promontory of Aliaska. The main body of the Cascade Range, in Oregon, is seldom over 5000 or 6000 feet in elevation.

The Blue Mountains form the western boundary of the Valley of the Snake River (of Lewis and Clarke), flowing into the Columbia. Immediately to the north of this river, as far as Fort Colville, they are interrupted by an extensive level tract; but to the north of Fort Forbes, respecting the probability of the passage of the Gulf Stream at some former period up the valley of the Mississippi (Quart. Journ. Geol. Soc. vol. viii. p. 89, &c.),—a theory of the highest interest and importance in accounting for the changes of temperature and climate on the surface of our globe, and which, though based by its author upon purely physical considerations, is in harmony with all the geological facts and evidence which have come under the writer's notice.

The age of freshwater accumulations and deposits suggested in the text comes much nearer to our own times.

* Dr. Grewingk, in his Map of Russian America, assigns the localities of fifty-eight active volcanos on the North-west Coast of America. They lie in a line running from the north end of Prince of Wales Island, in lat. 56° N., following the course of the coast through the peninsula of Aliaska and the Aleutian Islands. Many of their summits rise into the region of perpetual snow. The line in which the volcanic peaks of Aliaska lie, when prolonged to the eastward, strikes the Big Beaver Mountains on the Yukon. On the side of the Atlantic, modern volcanic rocks occur in Jan Mayen's Island only, whose principal mountain, Beerenberg, rises 6870 feet above the sea.

I have been recently informed that the Basquiau Hills, which lie to the south of Cumberland House, on the Saskatchewan River, are volcanic, and that an eruption has been observed there within the last year. The report requires confirmation. No other example is known of the existence of a volcano in any part of America east of the Rocky Mountains.

Colville there is a range of heights, which extends along the north branch of the Columbia River, and may be considered a part of the same general chain.

The short western slope of the continent from the Rocky Mountains to the Pacific differs from the eastern in its river-valleys being all more or less transverse,—the rivers flowing through passes or gorges of the intersecting ranges. The peculiar wing-like projection in the north, towards Asia, is evidently due to the volcanic chain of Aliaska, which runs at right angles to the Rocky Mountains. The great transverse valley of the Yukon (the Kwichpack of the Russian geographers) lies to the north of it. The Yukon is a river of great magnitude, probably the largest river in America flowing into the Pacific, not excepting the Columbia. For a considerable part of its course it flows to the north, but afterwards nearly due west, through a country which, as far as can be judged from the descriptive notices of it hitherto collected, closely resembles the valley of the Mackenzie, with some of the affluents of which it is in fact connected; so that here, as in other parts of the Rocky Mountain Chain, the rivers falling into opposite seas interlock at their origin. One or more low chains of mountains, formed by the lateral spurs of the Rocky Mountains, are prolonged along the Arctic Coast, north of the Yukon, giving origin to several small rivers between the mouth of the Mackenzie and Point Barrow.

Oregon Territory.—Our acquaintance with the geology of this district is very limited, and does not extend beyond the portion of country between the Coast Range and the sea, explored by the Expedition of Commodore Wilkes. From Mr. Dana's researches it appears to be occupied chiefly by the tertiary formation, which is found at various places from Puget's Sound to San Francisco along the coast-section of Oregon. The rocks of this formation are soft sandstones, more or less argillaceous and schistose, and clay-shales, either firm or crumbling, together with tufa and conglomerate. The sandstones and shales have been denuded on a vast scale. Although the rocks are nearly or quite horizontal wherever examined, there are no plains on the coast-section excepting those of alluvial origin. Mr. Dana considers that the Coast Range, by which the Pacific coast was elevated, was formed while igneous action was going on in the interior, where the frequent changes of the river-basins and other indications of a similar kind afford evidence of extensive and very recent volcanic disturbance.

The fossils collected by Mr. Dana were examined by the eminent conchologist Mr. T. Conrad, who assigned them to the geological æra of the Miocene. They are comprised in the following list.

Mammal.

1. Vertebra of a Cetacean.

Fishes.

1. Vertebra of a species of Shark.
2. — of a species allied to *Tregla*.
3. —, cast of; species not distinguishable.

Crustacea.

Callianassa Oregonensis.

Balanus.

Mollusca.

Mya abrupta.
Thracia trapezoides.
Solemya ventricosa.
Donax? protecta.
Venus bisecta.
 ——— *angustifrons.*
 ——— *lamellifera.*
 ——— *brevilineata.*
Lucina acutilineata.
Tellina arctata.
 ——— *emacerata.*
 ——— *albaria.*
 ——— *nasuta.*
 ——— *bitruncata.*
Nucula divaricata.
 ——— *impressa.*
Pectunculus patulus.

Pectunculus nitens.
Arca devincta.
Cardita subtenta.
Pecten propatulus.
Terebratula nitens.
Dolium petrosum.
Sigaretus scopulosus.
Natica saxea.
Bulla petrosa.
Crepidula prærupta; and sp.
Rostellaria indurata.
Cerithium modiale.
Buccinum? devinctum.
Fusus geniculus.
 ——— *corpulentus.*
Nautilus angustatus.
Teredo substriata.

Echinoderms.

Galerites Oregonensis (n. sp.).

Foraminifera, 3 sp.

Plants.

Abies? robusta; Leaves of Lycopodium?, Taxodium, Smilax, and others.

The plants were found near the mouth of Fraser's River, and indicate probably the commencement of the deposits of the Carboniferous æra, which are largely developed in the neighbouring island of Vancouver, and along the coasts and islands of Russian America.

The interior of Russian America, like that of Oregon, is unexplored; but, in the work of Grewingk (*Beitrag zur Kenntniss der orographischen und geognostischen Beschaffenheit der Nord-West Kuste Amerika's*), and in the Geological Appendix to Capt. Beechey's Voyage to Behring's Straits, by Dr. Buckland, we have a tolerably complete account of the chief formations occurring along the coast, and on the neighbouring islands, from 52° N. lat. to Behring's Straits.

The only representatives of the palæozoic rocks in this part of America, hitherto discovered, are the Mountain Limestone, and other members of the Carboniferous series, which are found covering the flanks of the mountains here bordering immediately on the sea, and prolonged into a dense archipelago of volcanic islands, several of them containing active volcanos, which skirt the entire coast from the parallel of 50° northward.

Dr. Grewingk has given in the Transactions of the Mineralogical Society of St. Petersburg, for 1848-9, a complete list of the organic remains hitherto discovered in Russian America, including those described in the Appendix to Captain Beechey's Voyage. They afford evidence of the existence of the following formations,—the Carboniferous, Jurassic, Tertiary, and Drift, which have been traced in detached sections along the coast; leaving much still to be desired,

however, before a complete and connected view of the geological structure of this portion of the American Continent can be obtained.

Fossils of the Carboniferous Formation.—The limestones of this formation, which have been traced at several points along the coast (see Map, Pl. XIV.), are most extensively developed in the N.E. extremity of the Continent, where they occupy the greater part of the coast-line from the north side of Kotzebue Sound to within a few miles of Point Barrow, and form the chief constituent of the lofty and conspicuous headlands of Cape Thompson, Cape Lisburn, and Cape Sabine. Near the last-named cape a vein of excellent coal is exposed, which burns with a good heat and a bright flame. The limestone is, according to Dr. Buckland, scarcely distinguishable from the Mountain Limestone of Derbyshire. Some specimens brought to England by Captain Beechey were found to contain *Lithostrotion basaltiforme* (*Cyathophyllum basaltiforme*, Phil. G. Y.), *Flustra*, *Productus Martini*, *Dentalium*, several varieties of *Terebratula*, and a great abundance of Encrinital fragments, with the detritus of which the rock was in many places almost entirely made up. To these Dr. Grewingk adds, from the collections of Russian explorers, *Cyathophyllum flexuosum*, Goldf., *Turbinolia mitrata*, His., *Cyathophyllum dianthum*, Goldf., and *Sarcinula*, together with some *Spiriferi*, *Orthidæ*, and *Terebratulae*.

Remains of Coniferous plants, belonging to the genera *Abies* and *Taxodium*, and of some Ferns, among which is *Neuropteris acutifolia*, have been discovered among the islands along the S. coast of Aliaska.

A specimen of *Catenipora escharoides*, found in a rolled fragment on the island of Sitka, would appear to indicate the existence of Silurian deposits in the neighbourhood; but no organic remains from rocks of this formation *in situ* have hitherto been discovered.

Jurassic Fossils.—Four fossils found in Katmai Bay, on the south coast of the promontory of Aliaska, have been referred by Dr. Grewingk, on the authority of M. Wosnessensky, Curator of the Zoological Museum of the Academy of Sciences of St. Petersburg, to the Jurassic formation. They include a new species of Ammonite, *A. Wosnessenskii*, *Ammonites biplex*?, Sow., and fragments of *Belemnites paxillosus* and *Unio liassinus*. Myer (Nov. Act. Phys. tom. xvii. pl. 47. figs. 1 & 2) figures an *Ammonites biplex* from some Jurassic deposits at the foot of the volcano of Maipu, in the Andes, S. of Valparaiso, which cannot be distinguished from the specimen from Aliaska. It may be doubted, however, whether upon such scanty evidence the existence of deposits of Jurassic age in these high latitudes can be considered as established; no other indication of the existence of this formation having been hitherto discovered in any part of North America north of the United States.

Tertiary Fossils.—Traces of the Tertiary formation have been discovered at various points between Oregon and Aliaska, but not beyond. This striking and well-marked division of the coast may,

therefore, be considered, in the present state of our information, to be the northern limit of the extensive Tertiary formation along the shore of the Pacific. The fossils enumerated by Dr. Grewingk include some well-known species of the Tertiary age in Europe; among which may be mentioned *Cardium Grœnlandicum*, Chemn., *C. multicostratum*, *Venerupis Petittii*, Desh., *Mya arenaria*, *Tellina edentula*, Sow., *Astarte corrugata*, *Mytilus Middendorffi*, and *Ostrea longirostris*, Lamk. Some new species of the same genera are added by Dr. Grewingk, together with some forms of *Saxicava*, *Pectunculus*, *Nucula*, *Pecten*, *Crassatella*, and *Venus*.

Fossils of the Drift.—Organic remains of the Pleistocene or Drift Period appear to be much more numerous on the west than on the east side of the Rocky Mountains. The cliffs and sand-banks, wherever they have been examined along the coast, abound with recent shells of the genera *Cardium*, *Venus*, *Turbo*, *Murex*, *Solen*, *Trochus*, *Mytilus*, *Mya*, and *Tellina*. Fossil remains of *Mammalia*, especially those of the Mammoth, are likewise abundant. Teeth of this animal have been discovered on the banks of several rivers north of Mount St. Elias; and there is a celebrated locality at Escholtz Bay, in Kotzebue Sound, where the thawing and wasting of the frozen cliffs is continually exposing the bones and tusks of Mammoths and other quadrupeds. Dr. Buckland, in his interesting account of the specimens collected at this place during Captain Beechey's Voyage, enumerates fragments of bones of Mammoths and of the *Urus*, the leg-bone of a large Deer, and a cervical vertebra of some unknown animal, different from any that now inhabit Arctic America. Along with these were found also the skull of a Musk-ox and some bones of the Rein-deer, in a more recent condition than the others. Similar remains, including those of the Mammoth, have likewise been discovered, according to Dr. Grewingk, at Cape Nugwuljinuk, at Bristol Bay, and at Norton Sound, as well as in the Pribulon Islands, and lastly at Unalaschka.

The vast profusion of the bones and tusks of the Mammoth in Siberia and the adjacent islands is well known, and it is a somewhat remarkable circumstance that no similar remains have as yet been detected in the corresponding latitudes of America to the east of the Rocky Mountains. None have hitherto been found, according to Sir John Richardson, in the Hudson's Bay Territories, though the annual waste of the banks and the frequent land-slips would have revealed them to the natives or fur-traders had they existed even in small numbers. They are rare also, or altogether wanting, in Canada; but in the Valley of the Mississippi the "bone-licks" are well known as most extensive, and as furnishing the remains of many new species of quadrupeds. In whatever way the circumstance may be accounted for, it seems to confirm the opinion to which most American geologists have arrived, that the countries on the eastern and western sides of the Rocky Mountains have been elevated at different periods and under different geological conditions.
