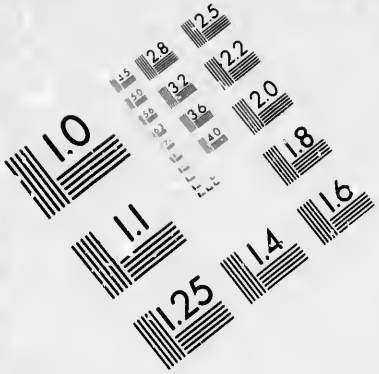

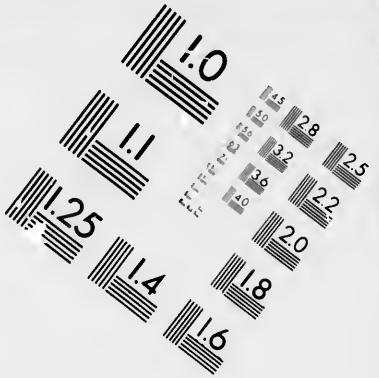

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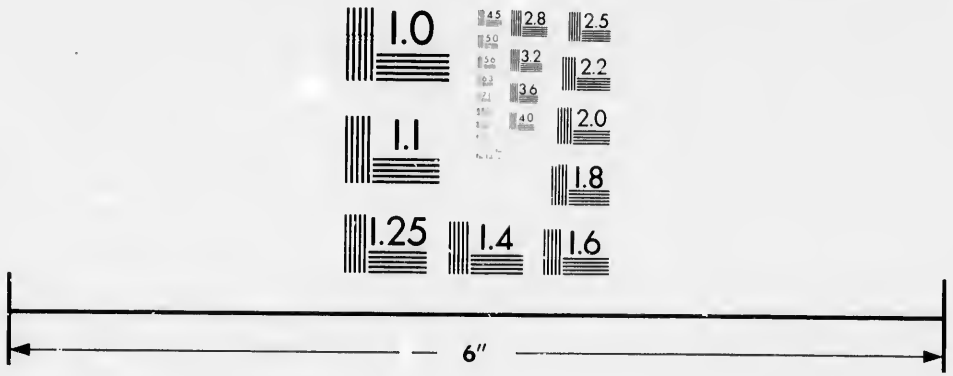

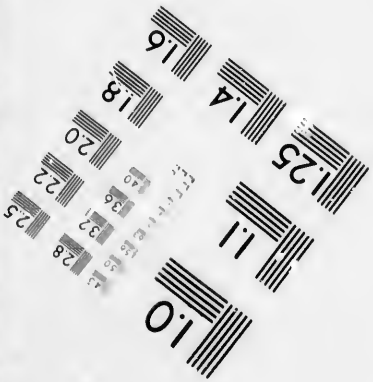

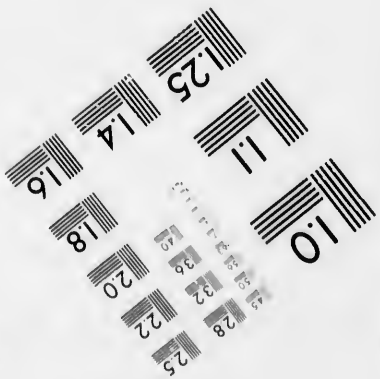

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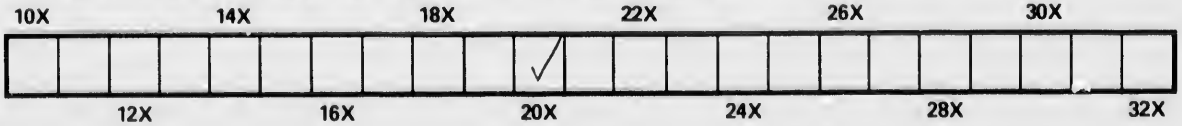

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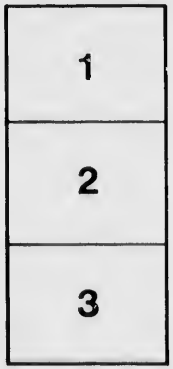

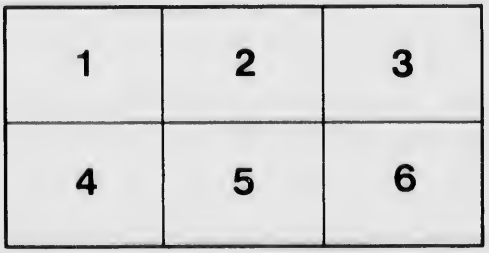

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NOTES

ON THE

GEOLOGY OF SOUTH-WESTERN ONTARIO.

By T. STERRY HUNT, LL.D., F.R.S.

Robert Bell

(Reprinted from the *American Journal of Science* for Nov., 1868.)

NOTES

ON THE

GEOLOGY OF SOUTH-WESTERN ONTARIO.*

By T. Sterry Hunt, LL.D,, F.R.S.

The paleozoic strata of the southwestern portion of the province of Ontario (late Upper Canada), are generally covered by a considerable thickness of clay, which has made their study extremely difficult. During the last few years, however, numerous borings have been made over a wide area in this region, in search of petroleum, and have disclosed many facts of geological interest. By frequently visiting the localities, and carefully preserving the records of these borings, I have been enabled to arrive at some important conclusions as to the thickness and the distribution of the underlying Upper Silurian and Devonian strata, to which I now beg to call the attention of the Association.

The rocks of the New York series, from the Oriskany sandstone to the coal, which are regarded as the equivalents of the Devonian of the old world, were shown by Prof. James Hall, in 1851, to constitute three natural groups. Of these, the first and lowest, sometimes called the Upper Helderberg, and consisting of the Oriskany, with its overlying Corniferous limestone (embracing the local subdivision known as the Onondaga limestone) constitutes what may be provisionally called the Lower Devonian. The second group has for its base the black pyroschists known as the Marcellus shale, followed by the Hamilton shale, with the local Tully

* Read before the meeting of the American Association for the Advancement of Science, at Chicago, August, 1868.

limestone, and terminated by another band of black pyroschist, the Genesee slate; the whole constituting what may be termed the Middle Devonian. The third group, embracing the Portage and the Chemung shales and sandstones, with the local Catskill sandstone, makes the Upper Devonian. *

The black Genesee slate, according to Mr. Hall, is palæontologically related to the Hamilton slates, and by him included as part of the Hamilton group, as recognized in the Geology of Canada. Similar black slates, though thicker, less fissile, and interstratified with greenish arenaceous beds, occur at the base of the Portage formation, marked by the remains of land-plants and of fishes which characterize the Upper Devonian. The black slates of this horizon thus constitute, as it were, beds of passage. The thickness of the lower and more fissile black beds recognized by Mr. Hall as belonging to the Hamilton group, is, according to him, only twenty-four feet at the eastern end of Lake Erie.

There exists in south-western Ontario, along the River St. Clair, an area of several hundred square miles underlaid by black shales, in the counties of Lambton and Kent, of which only the lower part belongs to the Hamilton group. These strata are exposed in very few localities, but the lower beds are seen in Warwick, where they were, many years since, examined by Mr. Hall, in company with Mr. Alexander Murray of the Geological Survey of Canada, and were by the former identified with the Genesee slate forming the summit of the Hamilton group. They are in this place, however, overlaid by more arenaceous beds, in which Prof. Hall at the same time detected the fish-remains of the Portage formation. The thickness of these black strata, as appears from a boring in the immediate vicinity, is fifty feet, beneath which are met the gray Hamilton shales. A similar section occurs at Cape Ipperwash or Kettle Point in Bosanquet, on Lake Huron, where bands of alternating greenish and black arenaceous shales, holding Calamites, are met with. These strata also were recognized by Mr. Hall, who examined them, as belonging to the Portage formation; and abound in the large spherical calcareous concretions which occur at the same horizon in New York. The entire thickness of the black shales at this point has not been determined, but in numerous borings throughout the region under notice, they are easily distinguished

* James Hall, in Foster & Whitney's Geology of Lake Superior, ii, 386.

both by color and hardness, from the soft gray Hamilton shales which underlie them. At Corunna, near Sarnia, a thickness of not less than 213 feet of hard black shales, interstratified towards the top with greenish sandstone, was met with. In the northern part of Enniskillen, near Wyoming, they are about fifty feet in thickness ; at Alvinstone, eighty feet ; in Sombra, on the Sydenham river, 100 feet, and in two borings in Camden, 146 and 200 feet. A little to the north of Bothwell, on the Thames, their thickness was found to be seventy-seven feet, while southward, along the shore of Lake Erie, about sixty feet of the hard black slate overlie the soft gray Hamilton shales.

From these, and a great many similar observations, which are detailed at length in the Report of the Geological Survey of Canada, published in 1866, it has been possible to determine with considerable accuracy the distribution of these black strata beneath the thick covering of clay which conceals them through the greater part of the region. It being impossible, under the circumstances, to distinguish between that lower portion of the black strata which belongs to the Hamilton group or Middle Devonian, and the overlying Portage formation, the whole of these strata, down to the summit of the soft gray shales, are included with the Portage. In Michigan, according to Prof. Winchell, the whole thickness of the Portage (Huron) group, as just defined, including twenty feet of black shale at its base, is only 224 feet, which are represented in Ontario by 200 feet on the Sydenham river, and by 213 feet at Corunna on the St. Clair. Yet, Prof. Winchell, for some reason, doubts the existence of the Portage formation in Ontario.

The Hamilton shale, which in some parts of New York attains a thickness of 1,000 feet, but is reduced to 200 feet in the western part of the state, consists, in Ontario, chiefly of soft gray marls, called soapstone by the well-borers, but includes at its base a few feet of black beds, probably representing the Marcellus shale. It contains, moreover, in some parts, beds of from two to five feet of solid gray limestone, holding silicified fossils, and in one instance impregnated with petroleum, characters which, but for the nature of the organic remains, and for the underlying marls, would lead to the conclusion that the Lower Devonian had been reached. The thickness of the Hamilton shale varies in different parts of the region under consideration. From the record of numerous wells in the south-eastern portion, it

appears that the entire thickness of soft strata between the Corniferous limestone below and the black shale above, varies from 275 to 230 feet, while along the shore of Lake Erie, it is not more than 200 feet. Further north, in Bosanquet, beneath the black shale, 350 feet of soft gray shale were traversed in boring, without reaching the hard rock beneath, while in the adjacent township of Warwick, in a similar boring, the underlying limestone was attained 396 feet from the base of the black shales. It thus appears that the Hamilton shale (including the insignificant representative of the Marcellus shale at its base) augments in volume, from 200 feet on Lake Erie to about 400 feet near to Lake Huron. Such a change in an essentially calcareous formation, is in accordance with the thickening of the Corniferous limestone in the same direction.

The Lower Devonian in Ontario is represented by the Corniferous limestone, for the so-called Onondaga limestone has not been recognized, and the Oriskany sandstone, always thin, is in some places entirely wanting. The thickness of the Corniferous in western New York is about ninety feet, and in south-eastern Michigan is said to be not more than sixty, although it increases in going northward, and attains 275 feet at Mackinac. In the townships of Woodhouse and Townsend, about seventy miles west from Buffalo, its thickness has been found to be 160 feet, but for a great portion of the region in Ontario underlaid by this formation, it is so much concealed that it is not easy to determine its thickness. In the numerous borings which have been sunk through this limestone, there is met with nothing distinctive to mark the separation between it and the limestone beds which form the upper part of the Onondaga Salt-group or Salina formation of Dana, which consists of dolomite, alternating with beds of a pure limestone like that of the Corniferous formation. The saliferous and gypsiferous magnesian marls, which form the lower part of the Salina formation are, however, at once recognized by the borers, and lead to important conclusions regarding this formation in Ontario. In Wayne county, New York, the Salina formation has a thickness of from 700 to 1,000 feet, which, to the westward, is believed to be reduced to less than 300 feet, where the outcrop of this formation, crossing the Niagara river, enters Ontario.

At Tilsonburg, ninety miles west from Buffalo, borings have shown the existence of the Corniferous limestone directly

beneath about forty feet of clay, while two miles to the south-west it is overlaid by a few feet of soft shales, probably marking the base of the Hamilton. From a depth of 100 feet in the limestone, at Tilsonburg, a flowing well was obtained, yielding an abundance of water, and a considerable quantity of petroleum. This boring was subsequently carried 854 feet in the rock, which at that depth was a dolomite. Numerous specimens from the upper 196 feet were of pure non-magnesian limestone ; but below that depth dolomites, alternating with pure limestones, were met with to the depth of 854 feet, from which salt water was raised, marking, it is said, from 35° to 50° of the salometer. The well was then abandoned. We have here a boring traversing 854 feet of solid strata, from what was, probably, near the summit of the Corniferous, without reaching the marls which form the lower part of the Salina formation.

In a boring at London, where the presence of the base of the Hamilton was marked by about twenty feet of gray shales, including a band of black pyroschist, overlying the Corniferous, 600 feet of hard rock were passed through before reaching soft magnesian marls, which were penetrated to the depth of seventy-five feet. Specimens of the borings from this well, and from another near by, carried 300 feet from the top of the Corniferous, show that pure limestones are interstratified with the dolomites to a depth of 400 feet. At Tilsonburg a pure limestone was met with at 524 feet from the top.

At St. Mary's, 700 feet, and at Oil Springs in Enniskillen, 595 feet of limestone and dolomite were penetrated, without encountering shales, while in another well near the last, soft shaly strata were met with at about 600 feet from the top of the Corniferous limestone, there overlaid by the Hamilton shales. It thus appears that the united thickness of the Corniferous formation and the solid limestones which compose the upper part of the Salina formation, is about 600 feet in London and Enniskillen, and farther eastward, in Tilsonburg and St. Mary's, considerably greater, exceeding by an unknown amount, in these localities, 854 and 700 feet. The Corniferous at its outcrop in Woodhouse, twenty-five miles to the east of Tilsonburg, measures only 160 feet thick, so that there is evidently, in the localities just mentioned, a great increase in the volume of the Salina formation from the 300 feet observed in western New York. At Goderich, on Lake Huron, the thickness of this formation is much greater.

Here are found non-fossiliferous strata, having the character of the so-called Water-lime beds, which belong to the summit of the Salina formation, and are immediately overlaid by fossiliferous strata belonging to the Corniferous formation. At this point a boring in search of petroleum penetrated not less than 775 feet of solid white, gray and blue limestones, chiefly magnesian, with occasional thin beds of sandstone. Below this depth the strata consisted chiefly of reddish and bluish shales, with interstratified beds of gypsum sometimes ten feet in thickness. After the 164 feet of these, rock-salt was met with, interstratified with clay, through a distance of forty-one feet, beneath which the boring was carried five feet in a solid white limestone, probably belonging to the underlying Guelph formation. We have thus, for the entire thickness of the Salina formation at Goderich, 980 feet, of which the upper 775 are hard strata, chiefly magnesian limestones, and 205 feet gypsiferous and saliferous shales. Several wells since sunk in this vicinity, one of them twelve miles to the south-westward, have given almost identical results, including the mass of rock-salt at the base. These borings now yield, by pumping, a copious supply of brine, nearly saturated and of great purity, so that this newly discovered saliferous deposit has already attracted the attention of salt manufacturers, both in Ontario and New York. A detailed description of the first well, with an analysis of the brine, will be found in the Geological Report for 1866, already referred to.

Brines are said to have been met with at this horizon in Michigan, where the formation will probably be found to have a much greater thickness than that hitherto assigned to it.

It thus appears that the Salina formation, after being reduced to less than 300 feet at the Niagara river, again assumes, to the north-westward, a thickness of nearly 1,000 feet, and becomes once more salt-bearing, as in the State of New York. The increased thickness of the formation, in these two regions, connected with accumulations of salt at its base, would seem to point to ancient basins, or geographical depressions in the surface of the underlying formation, in which were deposited these thicker portions. The existence of these Upper Silurian salt lakes, whose evaporation gave rise to the rock-salt, gypsum and dolomite of the Salina formation, shows a climate of great dryness to have then prevailed in this region. A similar conclusion is to be drawn from the more or less gypsiferous dolomites of the Calciferous and

Niagara formations, the magnesian limestones at other horizons, and the gypsum and salt deposits of the Carboniferous period,—leading us to infer a very limited rain-fall over the north-eastern portion of this continent, throughout the Paleozoic period.

In this connection, a few remarks with regard to the horizon of the petroleum which issues from the Devonian rocks of Ontario, may not be out of place. In opposition to the generally received view, which supposes the oil to originate from a slow destructive distillation of the black pyroschists belonging to the middle and upper divisions of the Devonian, I have maintained that it exists, *ready formed*, in the limestones below.*—In addition to the well known fact of its frequent occurrence in the Corniferous limestone, I have cited the observations of Eaton, Hall and myself, as to the existence of both solid and liquid bitumen in the Niagara limestone, and even in the massive beds of the Hamilton. A remarkable example is afforded in the oleiferous beds of the Niagara formation in the vicinity of Chicago, † and still another in similar strata belonging to the Lower Helderberg period, in Gaspé. The deep borings already mentioned in Tilsonburg, St. Mary's and Enniskillen, showed in each case small quantities of petroleum in strata of the Salina formation, and the same was observed at considerable depths in the Goderich well already described.

Apart from the chemical objections to the view which supposes the oil to be derived from the pyroschists above the Corniferous limestone, it is to be remarked, that all the oil wells of Ontario have been sunk along denuded anticlinals, where, with the exception of the thin black band sometimes met with at the base of the Hamilton formation, these so-called bituminous shales are entirely wanting. The Hamilton formation, moreover, is never oleiferous, except in the case of the rare limestone beds already referred to, which are occasionally interstratified. Reservoirs of petroleum are met with, both in the overlying quaternary gravels and in the fissures and cavities of the Hamilton shales, but in some cases the borings are carried entirely through these strata, into the Corniferous limestone, before getting oil. Among other instances cited in my Geological Report for 1866, may be mentioned a well at

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* Canadian Naturalist, June, 1861, and Silliman's Journal, March, 1863

† It is proposed to give, in a subsequent communication, the results of an examination of this remarkable limestone.

Oil Springs, in Enniskillen, which was sunk to a depth of 456 feet from the surface, and seventy feet in the solid limestone beneath the Hamilton shales, before meeting oil, while in adjacent wells supplies of petroleum are generally met with at varying depths in the shales. In a well at Bothwell, oil was first met with at 420 feet from the surface, and 120 feet in the Corniferous limestone, while a boring at Thamesville was carried 332 feet, of which the last thirty-two feet were in the Corniferous limestone. This well yielded no oil, until, at a depth of sixteen feet in this rock, a fissure was encountered, from which, at the time of my visit, thirty barrels of petroleum had been extracted. At Chatham, in like manner, after sinking through 294 feet of shales, oil was met with at a depth of fifty-eight feet in the underlying Corniferous limestone.

We also find oil-producing wells sunk in districts where the Hamilton shale is entirely wanting, as in Maidstone, on the shore of Lake St. Clair, where, beneath 109 feet of clay, a boring was carried through 209 feet of limestone, of which the greater part consisted of the Water-lime beds of the Salina formation, overlaid by a portion of the Corniferous. At a distance of six feet in the rock a fissure was struck, yielding several barrels of petroleum. Again at Tilsonburg, where the Corniferous limestone is covered only by quaternary clays, natural oil springs are frequent, and, by boring, fissures yielding petroleum were found at various depths in the limestone, down to 100 feet, at which point a flowing well was obtained, yielding an abundance of water, with some forty gallons of oil daily. The supplies of oil from wells in the Corniferous limestone are less abundant than those in the overlying shales, and even in the quaternary gravels, for the obvious reason that both of these offer conditions favorable to the retention and accumulation of the petroleum escaping from the limestones beneath.

The presence of petroleum in the Lower Silurian limestones, and their probable importance as sources of petroleum, was first pointed out by me in 1861. The conditions under which oil occurs in these limestones in Ontario are worthy of notice, inasmuch as they present grave difficulties to those who maintain that petroleum has been generated by an unexplained process of distillation going on in some underlying hydrocarbonaceous rock. Numerous borings in search of oil on Manitoulin Island, have been carried down through the Utica and Loraine shales, but

petroleum has been found only in fissures at considerable depths in the underlying limestones of the Trenton group. The supplies from this region have not hitherto been abundant, yet from one of the wells just mentioned, 120 barrels of petroleum were obtained. The limestone here rests on the white unfossiliferous Chazy sandstone, beneath which are found only ancient crystalline rocks, so that it is difficult to avoid the conclusion that this limestone of the Trenton group is, like those of Upper Silurian and Devonian age, already noticed, a true oil-bearing rock.

In concluding these observations on the geology of Ontario, it may be remarked that throughout the south-western counties, the distribution of the Middle and Upper Devonian rocks has been determined almost wholly from the results of borings undertaken in search of petroleum. From these it appears that the wide spread of these rocks in this region is connected, first, with a transverse north and south synclinal depression, which traverses the peninsula, and has been noticed in the Geology of Canada, p. 363, and secondly, with several small undulations, running north-east and south-west, on the north west side of the anticlinal of the Thames; which is a prolongation of that passing by Cincinnati, and may be regarded as part of the main anticlinal of the great axis of elevation which divides the coal field of Pennsylvania from that of Michigan.

The Devonian rocks are found, in the region under consideration, at depths not only far beneath the water-level of the adjacent lakes of Erie and St. Clair, but actually below the horizon of the bottom of those shallow lakes. Thus at Vienna, in Bayham, at a point said to be about forty feet above the level of Lake Erie, the underlying rock was met with beneath 240 feet of clay, while at Port Stanley, twenty feet above the lake, the Hamilton shale was struck beneath 172 feet of clay, and at the Rondeau, just above the level of Lake Erie, the clay was 104 feet thick. A similar condition of things exists on the south side of the lake, at Cleveland, where no rock is encountered at a depth of 100 feet below the water-level. Again in Sombra, on the banks of the Sydenham river, which is very little above the level of Lake St. Clair, a well ten feet above the river passed through 100 feet of clay before meeting the black shales of the Portage group, while in Maidstone, on the shore of Lake St. Clair, and a very few feet above its level, 109 feet of clay were found overlying the Corniferous limestone. The greatest depth of Lake St. Clair is

scarcely thirty feet, and that of the south-western half of Lake Erie does not exceed sixty or seventy feet, so that it would seem that these present lake basins have been excavated from the quaternary clays which, in this region, fill a great ancient basin, hollowed out of the paleozoic rocks, and including in its area the south-western part of the peninsula of Ontario.