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I.—NOTES ON THE SURFACE GEOLOGY OF SOUTH-WESTERN NOVA SCOTIA.—BY PROF. L. W. BAILEY, M. A., Ph. D.

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IN all regions the features which distinguish their surface geology necessarily have an interest from the intimate connection which they hold with their topography, drainage, agricultural and commercial capacity, as well as from the fact that they mark the last phases or series of events by which these features have attained their present form. In the Province of Nova Scotia all these relations find ample illustration, and are well deserving of careful study; but here, as will presently appear, the subject has an added interest from the relation which these geological features bear, in some instances at least, to the distribution and development of our mineral wealth.

Having, during the past summer, in connection with the work of the Dominion Geological Survey, had an opportunity of making a somewhat careful examination of certain portions of the Province, and more particularly the counties of Queen's and Shelburne, the author proposes to state here a few of the results of his observations, as bearing upon the topics referred to. He would be glad to know that they are in accordance with those of other observers in portions of the Province with which he is not familiar.

In looking, for the first time, at a map of South-Western Nova Scotia, there are two features in its topography which at once attract attention, viz., (1) the broken and indented character of the coast, and (2) the abundance of inland lakes. A closer examination of these features, in connection with the character of the surface, will reveal, in important particulars, a community of origin.

(1.) The extent to which the coast is marked by a broken and indented shore line will perhaps be better appreciated when it is stated that, taking only the two counties to which these remarks more particularly relate, the distance in a straight line, from the eastern boundary of Queens to the western boundary of Shelburne, parallel to the general trend of the coast, is only about sixty-five miles, while if the bays and indentations be followed, even if all minor regularities be omitted, this distance is more than two hundred and forty miles. If with this we take into account the innumerable islands, large and small, with which the coast abounds, the bearing of this feature upon the commercial relations, the fishing industries and the navigation of the latter, as well as upon the habits and character of its people, will be at once apparent.

The majority of the indentations referred to are at right angles to the coast line and therefore approximately north and south. Taking only the most important harbors, those of Port Medway, Liverpool Bay, Port Mouton, Port Juli, Port L'Herbert, Sable River, Jordan Bay, Shelburne Harbor, Negro Harbor, Port La Tour and Barrington Bay, it will be found that the majority have a trend which varies but little from N. and S. (magnetic), the length of the indentations varying from two or three to ten miles and their width from one to two miles. A similar conformity to a general north and south trend is equally evident in the long narrow promontories by which these inlets are separated, as it not unfrequently is also in the position and form of the associated islands.

Such uniformity of arrangement, as also of contour, in each case quite different from that which the underlying rock formations would be calculated to produce, is explicable only upon one

supposition, viz., that of ice excavation. The indentations referred to are veritable fiords, and even were there no other evidence than that of position, form and depth, they would at once be recognized as marking a former period of excessive glaciation. Additional evidence, if needed, is, however, everywhere to be found in grooved and polished rock surfaces, in innumerable boulders of every size and shape, together with the arrangement of the latter in some instances in parallel bands or trains, corresponding in direction to that of the bays and headlands.

The material of the larger boulders varies to some extent with that of the nearest exposed rock-ledges, and in most instances they would seem not to have been transported to any great distance from their parent-beds. Granite boulders, usually well rounded and sometimes of large size, are however often met with widely removed from any known outcrops of similar rock. Some considerable islands seem to be almost entirely made up of granite boulders, while in the vicinity of granite outcrops, as in Port Mouton and about Barrington Passage, they are so thickly strewn, and are often of such huge dimensions, as greatly to increase the dangers of navigation. Much of the granite quarried at Shelburne is from huge boulders, some of them thirty or forty feet in diameter.

(2.) If now we pass from the coast to the interior, the evidences of glacial action as having been chiefly concerned in the determination of the surface features are equally evident. Within the area of the two counties under discussion, no prominent hill range is to be found, but the great central granite axis of Nova Scotia is but little removed from their northern boundaries, sending a spur into north-eastern Queens, and traversing the western part of Shelburne quite to the coast. South of this axis the surface is that of a moderately elevated plateau, diversified by innumerable low hills, none of which probably exceed an elevation of 400 feet. Many of these hills are of a rounded hummocky character, but many also are in the form of long narrow ridges. It is remarkable that these latter have very generally an approximately north or south course, irrespective of the underly-

ing rocks, and that their steeper sides are turned to the west. They are wholly composed of drift, in some instances made up to a large extent of boulders, and presenting the aspect of lateral moraines; in others, largely composed of gravel and sand, forming veritable kames or horsebacks. Apart from these ridges, which rise somewhat prominently above the general level of the country, and which are often of very considerable length, there are also some remarkable contrasts in the ordinary depth and distribution of the drift covering. Over certain belts, having an east and west course, the boulders, often of enormous size, are so thickly and so widely scattered that little else is seen; in other and parallel belts, on the other hand, the underlying rocks are barely covered with soil or are wholly denuded. The former feature is most common in connection with the so-called "whin" belts, and is well exhibited about Ponhook and Molega Lakes; the latter when the underlying rocks are slates. It is however over the slate belts that the best soils and farming lands are to be found, the whin and granite country being for the most part indescribably barren.

The character and distribution of the drift, partly in north and south hills and partly in east and west belts, some of which may have been terminal or frontal moraines, have been the chief determining causes in the formation of the remarkable system of lakes to which reference has already been made. Within the two counties under consideration the number of these lakes is certainly not less than one hundred, besides innumerable lakelets and ponds. Though not confined to any particular region they are most abundant, as well as of the largest size, in connection with the belts of whin and granite, Lake Ponhook, Molega Lake, the Christopher Lakes and Lake Rossignol being all situated in the former, while Pleasant Lake, Tupper Lake and others, either border or are included within areas of the latter. They are often also in groups or belts, as well illustrated in the Christopher Lakes, occupying east and west depressions. In most cases the lakes contain numerous islands which are often only piles of boulders, and scattered blocks, often of huge dimensions, help to make their navigation somewhat difficult and danger-

ous. In several instances the contents of these lakes were distinctly seen to be held up by drift dams across their natural outlets, and their whole grouping and configuration is strongly suggestive of a region resulting from a long continued and intensely powerful glacial erosion, followed by a slow melting of the ice cap and the very imperfect removal of the resulting waters. In some instances, as along Tupper Lake, where the rocks are partly granite and partly whin, the effects of striation, polishing, distribution of erratics and the formation of *roches moutonnees*, are very remarkable, and could hardly be better illustrated in the Alpine valleys of Switzerland.

From a comparison of numerous observations upon the glacial striae in the interior of Queens County, (chiefly north of Ponhook and Molega Lakes) these were found to vary from S. 10 E. to S. 20 E., being in a few instances S. 30-35 E., and in one case having an easting of as much as 60°. In two instances striae having a course S. and S. 10 E. were accompanied by other and apparently later striae showing a course S. 30 W. On the coast of this county the striae are more nearly north and south, being frequently S. or S. 5 E., rarely S. 18-20 E. Going westward into Shelburne the striae along the coast become more variable, those between Jordan Ferry and Negro Harbor often exhibiting a westerly tendency (S. 10 W.), while between Port LaTour and Baccaro they again become a little easterly. In the interior of Shelburne, between Clyde and Ohio, a course of S. 70 W. was observed at one point.

It has been stated in the introductory remarks that apart from the relations which the features above described must obviously have to the agricultural and industrial aspects of the regions in which they occur, they have also an interest in being directly connected with the distribution and development of mineral wealth. There are three ways in which the importance of a knowledge of the superficial deposits will be readily seen, viz.: (1), as tending to hide from view metalliferous lodes beneath a covering of drift, as well as tending to obscure the study of the associated rock structures; (2), as helping to guide the miner or prospector in his search for productive lodes; (3), as bearing

upon the possible existence of "placer" deposits or alluvial diggings along the course of old channels of drainage. A few words may be added upon each of these points.

(1). Over very considerable areas the covering of drift is such as to completely conceal from view the underlying strata. As already remarked, this is particularly true of the whin belts along or in the vicinity of which the principal auriferous lodes occur. This covering is often composed largely of boulders which may be piled up in great heaps and often attain immense proportions, but when these are less frequent, (for they are seldom wholly absent), there are commonly thick beds of coarse gravel or, in the numerous depressions, extensive peat bogs and barrens. The thickness of the superficial deposits is, in the absence of kames, ordinarily about seven or eight feet, but may be twenty feet or more, while the height of local drift ridges or kames may be as much as one hundred feet.

(2). While these superficial deposits thus hide from view the underlying rocks, and thus greatly enhance the difficulties of the explorer and prospector, they may, nevertheless, be so employed by him as to lead the way to the discovery of lodes of which otherwise he might never suspect the existence. I have been informed that in the case of several of the most important mines at Molega and Whiteburne, the first discoveries of gold were made in quartz-bearing boulders, which were then carefully traced back to their parent source. From the nature and origin of the drift these are naturally sought to the north of the localities in which the boulders occur, and the distance travelled has apparently usually been but slight, commonly not over half a mile. In trenching or costeeing the surface, the quartz boulders are found to increase in number as well as in size as the lode is approached, and when this is passed, to suddenly cease. They are also said to be invariably sharp and angular, not rounded, and to be more deeply buried near the lode than at points more remote from the latter. Intelligent and practical prospectors even maintain that they can recognize from hand specimens of gold quartz the lead from which they were derived.

(3.) The larger parts of the superficial deposits of South-

Western Nova Scotia being clearly attributable to the agency of moving ice, and the search for auriferous deposits having been shown to be ultimately connected with the direction and amount of boulder transport by this agency, one is naturally led to enquire what relations, if any, may be traced between such transfer and the position of existing valley depressions, as also whether or not any evidences can be obtained of former river channels, post-glacial or pre-glacial, different from those which now mark the surface. Regarding the former point it may be remarked that in the case of both Queens and Shelburne, the more considerable rivers, such as the Port Medway, Liverpool, Broad, Sable Jordan and Roseway, reach salt water at the head of corresponding indentations of the coast, and for long distances inland have very nearly the same course as the latter—a course (S. 10-20 E.) which corresponds also with the average direction of the drift. It is noticeable also that these streams, though large and rapid, occupy, as a rule, valleys of inconsiderable depth, the bed of the stream being often but a few feet below the level of the surrounding country. It may perhaps be inferred from these facts that the existing drainage is comparatively recent, and the circumstance already referred to that many of the lakes upon which these streams are so largely dependant are drift-dammed lakes, helps to give probability to this conclusion. If such is the case it may be presumed that most of the existing streams, originating in the melting ice of the glacial era, were directed in their flow by the local circumstances of the time, and to a large extent irrespective of previously existing channels, many of which may have been at the same time obliterated. As to whether or not any old and now abandoned channels of drainage exist or are to be recognized, almost nothing of a reliable nature is known. As, however, has been pointed out by Dr. Selwyn and others, the subject is a very important one, for in all gold regions such ancient river beds are found to be rich repositories of gold, and there is no reason to suppose that in this respect Nova Scotia is any exception. To determine this point very careful and minute studies both of the character and distribution of the superficial deposits of the Province are required, but these have not as yet been made.

In the present article the author has merely brought together a few facts, the results of observations incidental to other work. It may be hoped that the more systematic survey referred to may ere long be undertaken, and that it may be amply justified by its results.