shown, of large areas which during long geological periods have been subjected to similar movements—which tracts are, however, separated by lines of weakness—few geologists will now be prepared to dispute. And it is to the efforts of nature to repair these lines of weakness that the formation of mountain chains must be referred. The mass of folded, crumpled and crystallized rocks formed out of the abnormally thickened strata may indeed be compared to the cicatrix produced by the reparative vital actions around a severe wound; and we may perhaps go a step further, and regard the volcanic ejections around it as equivalent to the suppuration and discharge which accompanies the determination of the vital energy towards the injured part. May we not even consider this power of repairing external injuries as not less essential to the continued existence of the globe, than it is to the life of the organized beings which exist upon its surface?

II.—ICE AND ICE-WORK IN NEWFOUNDLAND.

By JOHN MILNE, F.G.S.,

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(Continued from the July Number, p. 308.)

Aspect of Newfoundland.—It has been suggested that the so-called glacial effects which are universally seen in temperate, and even in tropical regions, may in many cases have been due to an ocean on which great icebergs floated. These, as they moved from point to point (like huge pepper-casters), strewed broadcast boulders and detrital matter, such as are now to be seen over an area like that of Russia and parts of North America. The effect of the force of impact of these tremendous masses has also been dwelt on, and the way in which they could grind, smooth down, or rub up the surface of a submerged area, has also often been referred to.

Should the area thus acted on be a rising one, on its emergence it may show definitely the characters that have been impressed upon it, and these perhaps may in some respects be analogous to those produced by land ice. In the explanation of the superficial aspects of a country from some such considerations as these, one man may take his stand upon a glacier, and another upon an iceberg. An iceberg theory has been advanced in the case of Newfoundland as an explanation of the physical features of the island (see Quart. Journ. Geol. Soc., 1874, vol. xxx. p. 722). From the numerous raised beaches containing *Mya arenaria* and other Atlantic species still living in the surrounding seas, Newfoundland appears to have risen in later geological times. The island itself, its principal bays, its mountains, its lakes and rivers, its lines of igneous protrusions, its ice-grooves and scratches, and the general strike of the rocks, which, as was shown by Jukes, may in part account for the tendencies of the other features, have all been shown to trend from about 27° E. of North to 27° W. of South.

These curious coincidences were in part explained by supposing Newfoundland as a rising area submerged 3000 feet beneath its

present level, and some denuding agent like the present Arctic current with its load of icebergs passing over it. This theory, I believe, is looked upon as being considerably strengthened by observations over a large part of North-east America. With regard to the Newfoundland portion of the Western Continent, I wish to show that it is not so clearly to be demonstrated.

After watching several icebergs grounding, it appears to me that they would tend to give anything but a parallelism in their abrading action.

An iceberg aground slowly lurches and rolls, and turns from side to side, as it is differently affected by the wind, the tide, or a current, evidently tearing up and grinding in several directions the strata on which it rests.

To conceive the method in which icebergs acted to form the "parallelism of features," as seen in Newfoundland, a picture must be drawn, which I am afraid will hardly be taken as the true one. As the island rises, the lines of valleys and of the hills have been formed, and along these troughs, and by the ridges, the icebergs pass. This initial direction may, amongst other causes, be due to the configuration of pre-existing land, to the general direction in which detrital matter is strewn by an ocean current. Whilst the land is still beneath the surface of the water, we must imagine these huge islands of ice tripping along from hill-top to hill-top, sometimes just grazing the sides of a submerged valley, and sometimes scouring the surface of a hill, like butterflies before a breeze which try to stop at every tempting flower.

That they may have scattered the boulders which are to be found in most parts covering Newfoundland does not appear to be so great an impossibility as that they were the originators of the parallelisms; but even these, from the observations made by myself and my companion, the late Mr. T. G. B. Lloyd, F.G.S., during the summer of 1874, it appears to me that they might be ascribed to another origin.

Ice-Marks in Newfoundland.—On the eastern coast of Newfoundland, from the extreme South to Kirpon on the North, a distance of 300 miles, boulders and other indications of ice-action are to be seen in most parts: reference to them has been made in the *Quart. Journ. Geol. Soc.*, London, 1874, vol. xxx., p. 725. Near St. John's, ice-grooves and scratches are to be seen up to considerable heights, whilst drift with well-marked stones cover the country. The narrow neck of land that separates the Bays of Trinity and Placentia affords considerable evidence of ice-work. Standing on the water-parting which divides the streams into one of these bays from those entering the other, the contour of the country, which is typical of many other parts of Newfoundland, may easily be viewed. All around is a rough brown surface of berry-bearing bushes and stunted spruce, dotted here and there, over which there are small soft green marshes. These latter generally form the border to many a quiet pool, the dark surface of which seems only to be made as a reflector for a passing cloud or some bare ice-marked hummock, a few of which rise here and there, forming undulations in the surrounding level. In such

places as this the rivers of Newfoundland have their source. Looking down the valley towards one of the bays, your eye wanders over a flat-topped expanse of spruce and other underwood, through which a few scattered pine-trees sometimes lift their heads. To the right and left of this dark mass of stunted underwood there is a line of scarp-faced hills, which look as though they might once have been feeders of moraine to a glacier which, as it slowly pressed itself downwards, ground against their sides. Above the cliffs along the sky-line of the hills, a few large boulders are distinctly visible. On climbing to the top of these hills, you would see beneath your feet a chain of lakes and ponds dotted in amongst the trees. Each of these would have its fringing of green marsh, across which a dark line showing the trampled path of the wandering 'Cariboo' would be well marked. Connecting these lakes in their upper portions are a series of rapids and small waterfalls; whilst lower down, as we approach the tideway, there are often long 'reaches' of steady water. Further north, similar signs are visible,—in Bonavista Bay, in Green Bay, and in many others.

In Green Bay, or, as it is sometimes called, "the Bay of Notre Dame," on the highlands above Belt's Cove, the country, for many miles in extent, is thickly strewn with boulders.

The climb up to this boulder-land (which on the side next the sea forms steep cliffs) is a precipitous one; on reaching the top you are on a brown-looking country in the main undulating as if ice-worn. In the depressions there are either small ponds or marshes, which are bounded by bare hummocks. Sometimes a small cliff-like scarp looks down upon you from still higher ground. The boulders are strewn everywhere, but more particularly upon the highest ground, and often upon extreme points. Several boulders were so perched on two points that they formed an archway beneath, which could be seen at a distance of several miles. In another case one boulder was seen resting upon another. In form they were sub-angular. Fragments were taken from these, and also from boulders in several other districts, and, so far as my examination went, I found that, if not represented by the rock of the surrounding country, they had representatives further west, and this generally in the Laurentian granites. Mr. Alexander Murray, F.G.S., of the Geological Survey, has made the same observation. Now if these boulders had been deposited by Icebergs, this portion of Newfoundland must at the very least have been 1000 feet lower than it stands at present. During the time of its elevation, and especially at the time of its emergence, these boulders must have been subjected to a considerable amount of rough usage, and have received many rolls. If they were protected by a covering of drift, which, to secure them from the action of the sea, must have been many hundreds of feet in thickness, then the surface-configuration of the country might be difficult to be accounted for. Rough treatment, such as boulders receive upon a beach, would hardly have relinquished them in their present subangular condition, nor would it have left them upon the highest ridges, or poised them upon a peak, or perched them one upon another. On the other

hand, I think it would rather have tended to smoothen them down and deposit them in heaped confusion in the valleys, and they would probably, in that case, have been derived from the North-East rather than from the West, as they seem to indicate. Let alone the mechanical forces, which are constantly at work upon a beach, the ordinary processes of disintegration, the result of subaerial conditions must have exercised considerable influence during the ages that have elapsed, whilst the land was rising to its present elevation, and this especially upon such soft rocks as serpentine, of which many of these erratics consist. Such boulders as these seem to point to another origin rather than to that of a sea full of icebergs.

Further to the north the same circumstances are here and there presented. Sailing up the long straight shore of White Bay, a line of hills, whose topmost heights are fringed with boulders, are seen trending away before you to the northward, until their escarpment which faces the Atlantic grows dim, and is lost to view in the distance. After the red cliffs of Conche (which are almost the only fragment of Devonian Shale in Newfoundland) have been passed, Kirpon, the most northern settlement in the island, is reached. Boulders are to be found here, and some of them of immense size.

Western Newfoundland.—After leaving Kirpon, we pass the northern end of the long range of granitic hills, running parallel with the western coast, forming the great backbone of the country, and which give to it, in some respects, a contour not unlike that of Arabia, the slope leading to the eastern coast being flat and long, whilst that to the west is short and steep.

On the eastern side, from what I have already stated, it will be seen that boulders often form a prominent feature in the landscape, but on the west they have hitherto been found to be wanting. Last year (1874), however, I found them at several places, especially in Louis Hills. They all seemed to point to the Laurentian backbone for their origin. Roches moutonnées are not so prominent upon the west as they are upon the east, but scratchings and groovings along the shore (which will be spoken of hereafter under the head of Coast-Ice) are common everywhere.¹

Drift.—In addition to all these evidences of ice-work seen in the shape of boulders and scratched rock surfaces, we have here and there patched over the country large deposits of drift filled with regularly striated rock-fragments.

In the neighbourhood of St. John's the drift-covering is noticeably full of such stones. Similar material covering the country may also be seen in many other parts of the Avalon peninsula, where we

¹ Many of the effects of ice now seen in Nova Scotia are described by Dawson in his "Acadian Geology," p. 64, *et seq.*, as resembling those now produced by frost and floating ice. Blocks of stone are shown to have travelled from elevation to elevation, across valleys which may have been accomplished by ice-floes or bergs. Other blocks again are shown to have travelled from low plains to the summit of hills, which is explained on the supposition that the land at the time of their deposit being slowly subsiding, and the ice-fields of successive years raising them higher and higher.

have good sections of an unstratified clayey base, containing both pebbles and boulders.

Further to the north Mr. Murray has observed these superficial deposits occurring on a much larger scale. In Little Bay, near Terra Nova Mine, he has noted deposits consisting of "probably fifty or sixty feet of stratified clay, gravel, and sand containing modern marine shells at the height of about 40 feet above high-water mark."

In Hall's Bay, up Indian Brook, he also noted stratified deposits of clay, "which is sometimes of a reddish and sometimes of a drab or bluish colour." Although these stratified deposits appear to show a divergence from what has hitherto been observed by Packard and others in the neighbouring mainland of Labrador, they show considerable relation and similarity to observations which have been made further up the valley of the St. Lawrence in Canada. It would seem that at no very remote period Newfoundland has been almost if not entirely subjected to the action of ice. To this fact the rounded hills, the basin-shaped hollows, the scored rocks, the erratic blocks and the immense coverings of drift, all bear testimony; but the mode in which all these phenomena have been brought about is a matter so speculative that I shall refrain from doing more than indicating a possible manner in which they may have occurred, rather than attempting to give any definite solution to such an obscure enigma.

Conclusions. — The general conclusions which might appear naturally to result from a consideration of observations made by myself during two summers travelling in the island, and also those made by other geologists, are as follows:—

If Newfoundland has been steadily rising during past ages, as it now appears to have done at no very remote geological period, it may have been beneath the surface of the ocean. During the period when it was undergoing elevation, no doubt a considerable amount of debris and boulders were dropped by icebergs over its surface when the Laurentian backbone, which would be the first land to emerge, reached the surface, it formed a barrier for the coast-ice which would carry its load of boulders and strew them with those of the bergs. This latter, as will hereafter be shown, might to some degree have been influential in giving a definite character to the rising area. After the final emergence the climate of Newfoundland might still have been a cold one, and the same highlands which gave birth to coast-ice, probably next gave birth to glaciers which scooped and hollowed out a great portion of the remaining marine drift, and left the island with its present contour. After the raising of the great North-East and South-East ranges, first coast-ice flowed East and West, and afterwards the glaciers followed in a similar direction, and thus perhaps the origin of the boulders, those which are so curiously perched being due rather to the latter than to the former. Thus it would seem that icebergs and coast-ice preceded glaciers, but to say what might have come before the former of these agents, would only be diving deeper into the depths of a

sea of speculation. From the scantiness and want of detail in their observations, it is useless attempting definitely to correlate them with those conditions observed in the adjoining continent of America, where it has been shown "that the oldest glacial deposits have yielded evidence of inter-glacial mild conditions" similar to those of the British Isles and Europe (Great Ice-age, Jas. Geikie, p. 428).

(To be continued in our next Number.)

III.—ON SCOTTISH MONOGRAPTIDÆ.

By CHARLES LAPWORTH, F.G.S.

(Continued from page 321.)

(PLATES XII. AND XIII.)

§ IV.

Group 2.—Type, *MONOGRAPTUS HISINGERI*, Carr. sp.

Polypary broad, rigid; bearing overlapping, un-ornamented, linear or cup-like hydrothecæ.

14. *MONOGRAPTUS HISINGERI*, Carruthers. Plate XII. Figs. 1a-f.

Prionotus sagittarius, Hisinger; *Léthea Suecica*, pl. 38, fig. 6.

Monograpsus sagittarius, Geinitz; *Die Graptolithen*, Taf. ii. figs. 2, 3, 4, 6, 21. Richter, *Zeitschrift d. Deutsch. Gesellschaft*. 1853, Taf. xii. fig. 19.

Graptolites Griestonensis, Nicol; *Quart. Journ. Geol. Soc.* vol. vi. p. 64.

Polypary four or five inches in length, straight or very slightly curved, attaining a maximum diameter of one-twelfth of an inch. Hydrothecæ short and broad cups, with subquadrangular section, 20 to 24 to the inch, without overlap, inclined at an angle of about 45°; outer edge convex distally, proximally impressed; apertural margin deep, concave, at right angles to the general direction of the theca; denticle triangular and inornate.

The sicula in this species is short and broad, and the proximal portion of polypary is consequently very abrupt. The polypary itself is usually quite straight throughout the whole of its extent, but sometimes there is a decided ventral curvature. The hydrothecæ afford the best characteristic of the species; they are short and broad cups, sacculate distally and proximally compressed, with a broad concave or straight apertural margin, which as a rule is placed perpendicular to the general direction of the theca. The sharply impressed proximal moiety of the outer edge forms a broad excavation, the deep apertural margin occupying nearly half the transverse diameter of the polypary. This hollow is so strongly marked, that in some views the ventral margin appears as if it were cut into a series of deep notches. An example of this nature seems to have been the original foundation for Nicol's description and figure of his *Graptolites Griestonensis* (*loc. cit. supra*). The denticle is sometimes ornamented with a very minute spine, which is slightly inclined.