DESCRIPTION OF THE PLATE.

Nos. 1, 2, 3. Arrow heads, full size, barbed, unbarbed.
4. Knife blade, half size. } Restored to modern handles as the Indians now make them, substituting a piece of iron.
5. Axe, half size. }
6. Unmistakable lance head, half size.
7. Pipe, upper part bowl, half inch.
8. Small wedge or hand axe, half size.
9. Serpent stone, half size.
10. Round plummet stone, half size, use unknown.

ART. V. ON THE METAMORPHISM OF ROCKS IN NOVA SCOTIA AND CAPE BRETON. BY REV. D. HONEYMAN, D. C. L., F. G. S., &c.

(*Read Feb.* 10, 1873.)

ALL the pre-carboniferous rocks of Nova Scotia and Cape Breton are metamorphic; all in some degree have been subjected to regional metamorphism of greater or less intensity. Some in addition have been subjected to local metamorphism. From extensive observation I have been led to this conclusion. I find the Middle and Upper Silurian having metamorphic characters of a certain kind, which as a whole may be termed metamorphism of the third degree. I find the Lower Silurian having different characteristics, which dispose me to rank this metamorphism as of the second degree; and I find Cambrian or Laurentian as having other characteristics which give their metamorphism the first rank. I also find a local metamorphism of rocks in the third degree, which elevates them from the third degree to the second, leading to the inference that the virtual cause of this local metamorphism has, under certain conditions, effected all metamorphism, whether of the first, second, or third degree.

In my last paper I noted as the western boundary of the Lower Arisaig Series of crystalline rocks, the trap and conglomerate of Malignant Cove and Brook. Here the trap from north to south has a breadth of about half a mile, as shown by its outcrops in the brook, on the road, and in the adjoining fields. Isolated by this

igneous rock is a patch of Lower Carboniferous conglomerate. This is divided in all directions by the trap which sometimes passes into it like veins. This arrangement is well seen below the mill dam. The consequence of this conjunction is that, conglomerate, generally loose in structure and yielding, is made intensely hard and resisting, forming a very rugged passage for the water below the mill dam, and a very great obstruction to the road maker. Here we have metamorphism of conglomerate by igneous action. Following the exposures of this trap westward we reach it where it comes in contact with the Upper Arisaig Series. This series is rendered metamorphic generally in the third degree, by what we call regional metamorphism. Here the trap forms a great dyke, dark and rugged; it is continued for about a mile, and for about half a mile it is interrupted, or passes under the sea; it reappears on the shore and continues until it nearly reaches the Frenchman's barn; it disappears and rises in the sea immediately north of the barn; it disappears, reappears to the east of Arisaig Pier, is interrupted, and then largely exposed, forming a great proportion of the break water of Arisaig Pier and Harbour.

This trap is generally homogeneous, sometimes porphyritic, frequently amygdaloidal, where decomposed vesicular. The crystals of the porphyritic are felspar,—the amygdala are calcite,—one cavity is filled with an agate. I found this in the trap at Doctor's Brook, some years ago, when dwelling among these rocks for the purpose of studying them. It thus appears that this trap is poor in minerals and very dissimilar to the traps of later age, *e.g.*, of Blomidon and Five Islands. On the north this trap is bounded by the sea; on the south of the trap we have the Arisaig Middle and Upper Silurian Series. Passing along the line of junction of the trap and overlying sedimentary rocks, which form the lowest part of the Upper Arisaig Series, or A. the possible equivalent of the Oneida conglomerate, we find on the east side of the Arisaig Pier, opposite the break of the trap already noticed, low banks of the third degree; they are in marked contrast with the other parts of the same band, and the overlying strata. Higher in the series we have the slates, having cleavage and other characteristics of the degree of metamorphism indicated. To the east of the arenaceous shales is

an eminence—red, prominent, and visible at a great distance, forming a land mark. At the north of this, and in contrast with it, is porphyritic and amygdaloidal trap, which have parcellanized the arenaceous strata, but only in such a degree as to render them readily fissile.

On the north-west, the same strata, forming part of the pier, are in contact with the massive trap already referred to, and have consequently been hardened in an extreme measure. The massive rock is jaspideous and uncleavable, being generally uniform, sometimes beautifully banded, and reticulated with veins of quartz and sulphate of baryta. The boulders of this rock rolling on the shore, when washed by the sea, are beautiful and varied; they are as hard as quartz, and susceptible of a high polish. The Frenchman's barn is another part of the same band. I have observed that the trap lies in the sea on the north of this rock. The north side of the rock is a wall washed by the sea. This is an enormous mass of jaspideous rock metamorphosed by the action of the trap. It is also pervaded by quartz and sulphate of baryta veins.

At Black Rock where the trap from the east first meets with the Upper Arisaig strata, we have also the same lower band metamorphosed and converted into a very hard brown jaspideous rock. When broken this shows in cells, iron and copper pyrites, and malachite. Connected with this I discovered in 1869 a soft rock easily cut with a knife, and having a greasy touch. This rock is of brown and variegated colour, and is susceptible of a fine polish. When I found it, I believed it to be saponite, var. renssellaerite. It is now believed to be a silicate of alumina, somewhat resembling agalmatolite. The rock appears to be about twelve feet wide; it has the hard jaspideous rock below and above. The stratum appears to be lenticular. Its next appearance is a little to the east of the Frenchman's barn: here it comes out of the sea. Its colours are yellow, orange, and red; specimens are very beautiful when polished. It passes on the south side of the Frenchman's barn, where it appears as a shaly rock, having singularly granular nodules, which give it the appearance of conglomerate. Farther west from the barn, the rock under notice has its maximum thickness. Here it consists of mahogany coloured states, having the

general characteristics, viz: softness and greasiness; it is also susceptible of polish, but it soon tarnishes on account of the presence of abundance of minute crystals of sulphuret of iron? It has slaty cleavage. There is also a considerable thickness of rock, which is more compact. This has been quarried to some extent, with the expectation of obtaining a solid and ornamental stone. In this are transparent veins which have all the appearance of true *agalmatolite*. Its next occurrence is at Arisaig Pier, where the finest variety is found. This takes a fine polish and retains it. The only other noticeable rock of the band is on the south of the Frenchman's barn. It has all the appearance of a serpentine, but it is a green and brown jaspideous rock.

Overlying this band of metamorphic rocks, is, first of all, fossiliferous strata of Mayhill Sandstone age—according to Mr. Salter. I regard them as the probable equivalent of the Medina Sandstone of the United States: these are partly arenaceous, sandy, and in the usual condition of strata of this horizon holding fossils; the only peculiarity is that in the lower parts there is abundance of cubical crystals of iron pyrites. The only obvious consequence of Trappean interference is the tilting of the shale. The Lower Clinton shales overlie; there argillaceous strata have also been disturbed but not hardened, and this is also the case with the other overlying formations. All show the effects of regional metamorphism, but local metamorphism is confined, to all appearance, to the lowest strata which I have described. By volcanic heat and the presence of the trap which communicated it, aided by the moisture necessarily contained in the strata, rocks have been produced, and minerals which correspond very closely with the crystalline rocks of George's River, Cape Breton. In both there are jaspideous rocks and a mineral not distinguishable from agalmalotite; the other hydrosilicate of alumina *strata*, show metamorphism equally or nearly so with the hydrosilicates of magnesia, *serpentines;* and the want of marble may be in consequence of the absence of fossiliferous limestone in the original limestone strata.

In the case of the metamorphic strata of Cape Breton, the metamorphism is regional, as at Arisaig, this metamorphism being prior to the eruption which produced the trap there observed. This

metamorphism was the effect of hydrothermal action under pressure — the heat being derived from the source of internal heat,— the pressure being that of superincumbent strata, or of the waters of the ocean. This is the origin of the general metamorphism which I referred to at the outset, to which all the precarboniferous rocks of Nova Scotia and Cape Breton have been more or less subjected.

I have thus illustrated the subject of my paper, but I have still some observations to make in connection with the trap which has occupied so much of our attention. Passing from the Arisaig Pier in a south-west direction, we reach the junction of the Upper Arisaig Series, with the Lower Carboniferous — to the east of McAra's Brook. All the interval is covered by the sea, and consequently any underlying exposure of trap is obscured. At the junction is the base, and a small part of a great mass of amygdaloid trap, which a few years ago formed a prominent and picturesque feature. This was then overlying and obscuring the point of junction which is now exposed. The prominent effect of this intrusion is the change of the general direction of the dip of the Upper Silurian strata, and elevation of the overlying and unconformable Lower Carboniferous conglomerate. There is a distinct slaty cleavage in the disturbed Silurian strata which is at right angles to the plane of stratification. (*Vide* specimen with fossil.) Onward we find it occurring at the mouth of McAra's Brook, and then at intervals in connection with the Lower Carboniferous strata, appearing as if interbedded. At McAra's Brook, at the junction of the Silurian and Lower Carboniferous grits, there is another outcrop of the same trap. We shall leave it here, and return to the trap at Malignant Cove and Brook.

We have followed the course of the trap dykes on the north of the Upper Arisaig Series. We find another series of outcrops passing along on the south. This first meets the Silurian strata— south from the mouth of Doctor's Brook where the East Branch turns to the south. This brings up the strata of Upper Clinton age with its characteristic fossils; these have a northerly dip. It passes an insulated patch of Lower Carboniferous strata, consisting of conglomerate and limestone dipping in the same direction with

the Silurian strata; outcropping on the southern bend of West Branch of Doctor's Brook in several places, bringing up in its course the same strata, with the addition of overlying Upper Silurian strata, giving them all a northerly dip. It outcrops on the elevated ground where the track turns to the north; this is nearly south of Arisaig Pier. From this onward its course is obscured. Its influence is manifest from the continuation of the elevated ground —south of the ravine in which Arisaig Brook flows, which is evidently the effect of the elevation of the Silurian obscured strata. When we reach the end of the ravine from which a branch of Mill Brook now flows, the trap is seen to outcrop to the south of MacAra's Brook, the eastern extremity of the Upper Arisaig Series. This series is thus bounded on all sides by trap.

Returning to Malignant Brook, we find the trap of the Sugar Loaf Series, the red metamorphosed strata of the Upper Silurian of the Mountain Series on the south. This is the southern part of a band which is found undivided, south of the Upper Arisaig Series, but is divided into three parts by the trap, on the east side of the mountain part of the East Branch of Doctor's Brook. On the west side of this part of the tract this trap is largely exposed; here it is associated with a dark brown porphyritic rock which underlies the Lower Carboniferous patch already referred to. It then runs to the south of the red band, being often exposed in its course, and then appears to terminate in a fine exposure on the side of the West Branch of Doctor's Brook, south of Arisaig Pier.

The lower part of this mountain series or Middle Silurian metamorphic, is bounded by and underlaid by the syenite of McNeal's mountain, which rises to 1010 feet above the sea level. The diorite of Mackintosh's on the top of East Branch Doctor's Brook, and the syenites which lie in the rear of McDonald's mountain, south of the Frenchman's barn, and in the table land south of Arisaig Pier.

You will have observed that the trap besides being the agent in local metamorphism, has also been a great intruder and disturber of the Upper Silurian and Lower Carboniferous rocks of this locality. These have been tilted and altered and elevated by its force in a manner singular and perplexing. The two insulated patches of

Carboniferous strata, the position of the red stratum, and the isolation of the Upper Arisaig fossiliferous strata, attest this. Yet I believe that it has been a benefactor to our geology, as I consider that without it this interesting and typical series which is of so much service in the illustration of Nova Scotian Geology, would still have been hidden in the depths.

Art. VI. On the Vegetation of the Bermudas. By J. Matthew Jones, F. L. S.

The Bermudas, sometimes known under the almost obsolete name of The Somers' Isles, are situate in 32° 15′ north latitude, and 64° 51′ west longitude, being distant from the nearest land, Cape Hatteras in North Carolina, about 600 nautical miles.

The general features of the group present no remarkable attractions; merely an elongated strip of land about 25 miles in length, somewhat in shape like the letter J without its horizontal summit, slightly elevated above the surrounding ocean, and broken more or less into a series of disconnected patches, which, although in reality islets, are only slightly separated from the principal body of land which may be called "Bermuda proper." On its northern side, this strip of land as seen from sea, presents a rugged coast outline, composed alternately of cliffs of slight elevation and lowlands faced seaward with a strip of shelving sand beach, or masses of wave worn rock channelled and fretted by the ceaseless action of the waves. The whole is surrounded by a barrier reef formed of the same calcareous limestone as the islands, coated with serpulæ; which, although originally the coast line of the Bermuda land is now wholly submerged at high water, save at one point to the north, where on the line of this barrier reef stand four pinnacles of rock about ten feet above high water.

The surface of the land, which is nowhere higher than 250 feet, appears on trivial inspection to be composed of sand and soil interspersed with rock, and clothed over its whole extent with stunted cedars. In certain places where the land lies nearly on a level