farther along b^3. Then taking a course N. E., towards Loch Eck, I passed through b^c and into b^4, going beyond Ben More, at the beginning of Loch Eck my attention was attracted to a rock on the right side of the road. This was furrowed by familiar glaciation, unfortunately I did not have my compass to take the course of the striation. It was apparently towards the S. E. The rock itself is a micaceous schist. We followed the course of the River Echaig, as far as its falls. The water was low at the time and gave an excellent opportunity of examining the magnificent exposure of schist. It is wonderfully worn and excavated by the action of the water, which passes through a narrow gorge. The rock is replete with pot holes, some have had sides worn and the boulders have escaped. Looking at the lofty hill ridges on either side of the valley, and beyond the falls, one is impressed with the adaptation of the position for an Alpine glacier. Of course other geologists have noticed this, although I have failed, on enquiry, of learning the fact.

ART. VII—NOTES OF A POLARISCOPIC AND MICROSCOPIC EXAMINATION OF CRYSTALLINE ROCKS OF NOVA SCOTIA AND CAPE BRETON.

BY REV. D. HONEYMAN, D. C. L., F. R. S. C.

(Read 11th Feb. 1884.)

INTRODUCTION.

1. Basalt.....of Blomidon, N. S.
2. (boulder.).....Weymouth.
3. Basalt.....Jebogue Point, Yarmouth.
4. Diorite.....St. Peter's Canal, Cape Breton.
5. Diorite.....Cranberry Head.
6. Diorite..... Nictaux.
7. Diorite.....Cobequid Mountains.
8. Porphyrite.....Sunday Point, Yarmouth.
9. Porphyritic & Amygdaloidal..Cobequid Mountains.
10. Porphyrite.....Cobequid Mountains.
11. Hornblendic rock.....Yarmouth Harbour.

I have had sections of the preceding rocks carefully prepared by Dr. Alexis S. Julien, New York. Four of them have already been imperfectly examined by an inferior polariscope. I have re-examined these thoroughly by the splendid new Polariscope-Microscope made by Anderson & Sons, London, for our President, and added the other seven to the number; and I propose in these notes to give an account of the interesting results and to illustrate with the instrument.

Dolerites.

1st. I begin with the Blomidon Basalt, as this mountain is well known wherever Nova Scotian mineralogy is an object of study. Its zeolites and other minerals are to be found in all great museums, and it is noted in works on general mineralogy as one of the principal localities where trappean minerals can be collected. The section examined is of a compact basaltic prism which I picked up at the foot of the mountain in 1875, *(a.)* Examined by the Polariscope, with *nicols* crossed, the section is brilliant and striking. Revolving the Polariser or Analyser, as both can be turned, the change in prismatic colours, and their arrangement is kaleidoscopic. The abounding parallel lines with changing and alternating colours (trichoic) indicate combinations of crystals into twins, three lings and four lings, with chroism of labradorite, among these is a constant, unchanging brown colour, this distinguishes augite from hornblende, which is dichroic. We have thus indicated the two minerals which constitute a *dolerite.* When the *nicols* are crossed parts of the section have a vivid chromatic polarisation. This is owing to the presence of quartz. There is also another obvious constitutent which is opaque. All that we can distinguish with the polariscope is the presence of dark forms with acute angles or of irregular shape. (*b.*) Removing the polariser and analyser we then examine them in sunshine with the microscope, the dark forms are seen to be blue-black in colour with metallic lustre. This shows that it is the mineral *magnetite.* Surveying, then, the whole section we find a large number of these. At the same time we detect green specks of olivine. The basalt is therefore dolerite, consisting of labradorite and augite with the accidental minerals, quartz, magnetite

and olivine. 2nd. A boulder of Basalt. When I was surveying parts of the Counties of Digby and Yarmouth, Trans. Inst. 187, I observed at the Weymouth Station of the Railway a large, rough-looking boulder; breaking part of it I found it to be basaltic. It was considerably weathered and easily broken. Examining the pieces macroscopically I found it replete with crystals of olivine of considerable size. These, like the rock, had suffered from decomposition and were very friable. Regarding it as different from the basalt of Blomidon in having olivine, I called it an "Olivine Basalt." The examination of the preceding basalt shews that this is a useless distinction. As fas as I can find this is the first time that olivine has been found in these basalts. (*a.*) Examined with crossed *nicols* the section of this boulder surpasses the other in brilliancy. The crystals are similarly pervaded by parallel lines. Turning the polariser, these are also trichroic. Before the polariser is turned, the vivid chromatic polarisation of the quartz is greater than that of the preceding section. The unchanging greenish brown colour shows the presence of augite, dark forms are also seen but they are small. A crystal of olivine of bright green colour adds to the variety. (*b.*) Examined by the microscope in sunshine, the small dark forms are seen to be of magnetite and to be arranged in groups rather prettily. The crystal of olivine is seen to be surrounded with a decayed crust which has lost its green color. Smaller crystals, (broken,) are seen in different parts of the section. The constituents of the boulder are thus, labradorite, augite, quartz, olivine, magnetite.

2nd. Basaltic dyke at Jebogue Point. I have partially described this already, as peculiar and interesting because penetrating Cambro Silurian rocks. I would now describe the section more particularly. (*a.*) In the polariscope with crossed nicols, it appears dark, with faintish light, excepting when it is surveyed throughout, the crystals of good size are seen divided by a median line. Turning the polariser these crystals are brilliantly trichoic. They are therefore labradorite twins. Numerous small crystals are also seen, which are also trichroic and give considerable brightness to the section when the nicols are parallel. The dark brown colour is constant, indicating a predominance of augite.

Occasional bright spots with quartz polarisation occur. Other sections might shew more of this, as a macroscopic examination of the rock shews amygdules of quartz, and grains in abundance. (*b*) Examined with the microscope, numerous black grains combine with the augite to darken the section. These are seen to be magnetite. Brassy crystals are also of frequent occurrence. These are of pyrite. Olivine is not observed in this section. The minerals in this basalt are thus labradorite, augite, quartz, magnetite, pyrite. This rock has the same essential minerals as the two preceding, and is a dolerite. They differ in proportion. It has the same accidental minerals only *pyrite* takes the place of olivine. Is the third identical with the first and second ? Or is it part of an older rock than these ?

DIORITES.

4. I take as a typical diorite a crystalline rock which occurs in Cape Breton, in that narrow neck of land which separated the waters of the Atlantic and the inland waters of Cape Breton but which have recently been connected by St. Peter's Canal. The specimen which furnished my section is one of a collection made at different depths in the process of excavating the canal, and kindly presented to the Museum by a gentleman residing in the locality. I visited the locality in 1861, after the excavation had been begun and work suspended. I then noticed the rock but did not examine it particularly. The Geological formation of the locality is Carboniferous. I collected *flora* in the vicinity, the precise relation of the rock to the formation may be uncertain, it is likely a pre-carboniferous diorite. (*a.*) Examined with crossed *nicols*, it is more beautiful than any of the sections already described. Seven prismatic colours, violet, blue, orange, yellow, &c., are arranged in four groups and in parallel lines. This is pleochroism in the strictest sense. In an orange colored crystal there are 7 parallel lines. Turning the polariser this becomes trichroic, but without alternation between the parallels. A very beautiful group of colors show the arrangement from left to right, deep blue, violet, yellow, orange. yellow, violet, light blue in parallel lines. Turning the polarizer from left to right about half a revolution the arrangement

changes to yellow, dark blue, light blue, yellow, orange. We have thus a triclinal feldspar, oligoclase. Crossing the nicols, we observe on the right side of the last described, a lovely green, giving the polariser half a turn the green is changed to a bright purple. This is a dichroism indicating hornblende. Surveying the field while turning the polarizer the pleochroism and dichroism is constantly appearing. The rock is thus evidently a diorite, there are also black forms constantly appearing. *(b.)* Examining there with the Microscope they are seen to consist of magnetite and pyrite. The minerals of the rock are oligoclase, hornblende, magnetite, pyrite.

5. This is the section of a rock which I observed at Cranberry Head, Yarmouth County. It is associated with Lower Cambrian rocks, and in close proximity to the auriferous strata of the gold mine. On this account it is singular and interesting. *(Vide paper, Transactions.)* I described it as a diorite. Looking at the section with crossed nicols, we see a pleochrism of pretty much the same character as that of the preceding, but not so brilliant. Turning the polariser, the changes also bear a close resemblance. Parallel lines are equally numerous. There is also a corresponding dichroism throughout the section. We have thus as constituents of the rock oligoclase and hornblende. There is also mica, an accidental mineral, whose presence is readily enough observed macroscopically. Opaque forms are abundant. *(b.)* The microscope shows that the opaque forms are of magnetite and pyrite. The minerals of this rock are oligoclase, hornblende, mica, magnetite and pyrite.

6. Diorite of Nictaux. The rock of our section belongs to a very important series of intrusive rocks which I have pointed out and described in my papers (1) "On the Geology of Kings Counties;" (2) "On the Geology of Annapolis County;" (3) "On the Geology of Digby and Yarmouth Counties." *(Vide Transactions.)*

On geological considerations, and from macroscopical examinations, I have named these diorites. Members of the series have been pointed out as occupying the dividing line between the lower and middle Silurian and the lower Cambrian (auriferous)

formation at Nictaux, Bear's River and Cape Cove, Cape St. Mary's, Bay of Fundy. These diorites have themselves been referred to post-upper Silurian and pre-carboniferous (Devonian) time, with similar rocks of *undoubted* Devonian age, at Arisaig, Antigonish County, and East River, Pictou County. *(Vide papers in Transactions.)* Of these I intend to have sections prepared for subsequent examination.

(a.) One section examined by the polariscope, with crossed nicols and revolving polariser, shew, first, a brilliant dichroism indicating the existence of a large proportion of hornblende. The other chief constituent mineral is a triclinic feldspar albite. That the feldspar is triclinic is evident from the forms of the crystals, medium lines, twining, and other parallels. When the nicols are crossed these are distinctly seen. There are no prismatic colours between the parallels. The colors in this case are purplish, grey and white. Turning the polariser these are seen to change from light to dark, or *vice versa.* (In the Blomidon basalt section there occur, often, crystals having the same character.) There are also opaque forms in considerable number. *(b.)* Examined by the microscope these appear as magnetites and pyrites.

The minerals of this rock are albite, hornblende, magnetite and pyrite.

7. Diorite of the Intercolonial Railway, Cobequid mountains. In the Wentworth cutting I have pointed out the singular association of Lower Silurian claystones, having characteristic fossils with crystalline rocks which have every appearance of being interbedded igneous rocks. I characterized them as *homogeneous* diorites—*(Vide* papers "Geology of the I. C. R.,"—*Trans.* 1873.) —they appeared so *macroscopically.* I have selected one of these as a representative of this series and had a section made. This is far from being *microscopically* homogenous; so that the term "homogeneous" is no longer appplicable to these rocks. *(a.)* Examined by the polariscope it shows much dichroism from the prevalence of hornblende. The predominence of light crystals with median and other parallel lines, indicate the prevalence of triclinic feldspar. The colours within the parallels resemble those

of the preceding (Nictaux) section, and indicate albite. The rock is therefore a diorite. Opaque forms are numerous. *(b.)* These examined by the microscope are seen to be pyrite and magnetite. The pyrite is readily seen in the rock with a pocket magnifier. The minerals are hornblende, albite, pyrite and magnetite.

PORPHYRITES.

8. Sunday Point Porphyrite. Macroscopically this rock consists of a darkish groundmass, with light colored crystals plentifully distributed; hence I have named it porphyrite. Mica is also observed as a prominent mineral. *(a.)* The section examined by the polariscope, with crossed nicols, and the turning of the polarizer, show the crystals with parallels and pleochroism only inferior to that of St. Peter's Canal typical diorite section, and surpassing that of Cranberry Head. The groundmass itself is evidently largely composed of oligoclase. Dichroism shows that another constituent is hornblende. The rock is therefore a diorite-porphyry. The opacity of the groundmass arises, to a large extent, from the abundance of black granules, clouded spots and dark grains. *(b.)* These examined by the microscope are seen to consist of magnetite and pyrite. Mica is also present. The constituent minerals of the porphyrite are thus: oligoclase, hornblende, mica, magnetite and pyrite. Sunday Point is situate at the mouth of Yarmouth Harbour, between the latter and Jebogue Point. It is nearer to the latter than to Cranberry Head. Our polariscopic and microscopic analyses show, however, that the crystalline rock of Sunday Point is more closely related to that of Cranberry Head than it is to that of Jebogue Point, and that they may belong to two different eruptions, ages apart.

9. Porphyrite and amygdaloid diorite of Cobequid mountains, near Wentworth station, I. C. R. In my paper on the I. C. R., I described a very coarse conglomerate, consisting largely of volcanic constituents. This seems to have been the product of a sub-marine volcano of Lower Silurian or Upper Cambrian age. Part of this conglomerate was a singular and rather beautiful rock, having a green groundmass, with amygdules of white calcite and crystals of reddish feldspar.(?) This is the rock of our sec-

tion. The groundmass transmits polarised light with the nicols crossed, and brightens considerably with the turning of the polariser. Its dichroism shows that one constituent is hornblende. Crystals interspersed, having median lines and the general colours, seem to indicate albite as also a constituent. The red crystals which led me to characterize it as porphyrite, are of uncertain character, not having any distinguishing feature. The amygdules which I consider to be calcite, show a varied and beautiful *chroism.* One or two of these are pervaded by fine parallel lines which are sometimes crossed by other parallels. The turning of the polariser does not much affect this striation. It is not, therefore, of the character of the feldspar striation. Some of the amygdules are of a yellow colour; three of these are in the section with the nicols crossed; these are green and black, so arranged as to appear to radiate from the centre. Turning the polariser half a revolution, they become yellow, without the appearance of radiation. The mineral is evidently *dichroic.* I do not know what it is. There are also dark forms in the groundmass. *(b.)* The microscope shows that these are magnetite. The constituents of this rock are therefore hornblende, albite, calcite, magnetite and (?) mineral.

10. In the second of the Whetstone Brook sections which succeed the Wentworth, I. C. R. is porphyrite which is associated with Diorites. The slates which include them have only produced one fossil a large *lingala.* They have been referred doubtfully to the middle silurian period. *(Vide,)* paper already referred to. This porphyrite has a dark ground mass in which are scattered reddish crystals and kernels of hyaline quartz. *(a.)* In section the ground mass transmits light with crossnicols and brightens with rotation of the polariser, hornblende is evidently one constituent.

The sections of the reddish crystals are dichroic, the mineral is therefore monclinic, orthoclase. One has four different shades of color (brown,) irregular dividing lines which deepen in different degrees with the rotation of the polariscope, and after half a rotation or a little more, becomes white (grey.) One of these has a distinct inclusion (mineral.) The hyaline quartz is of a dark blue when the nicols are crossed. The ground mass is unindividualized. (*a.*)

The microscope shows magnetite in grains. The rock is thus composed of hornblende albite (?) quartz and magnetite.

11. At the head of Yarmouth Harbor is a peculiar hornblendic rock. In the paper on the Geology of Digby and Yarmouth, this rock has been pointed out. In my other paper on Polariscopic examination, I have referred to some of the peculiarities of a section of it. I referred to part of its hornblende with a singular, glassy inclusion. I have now ascertained the character of the other chief constitutent of this rock. Comparing it with the section of a typical quartzite, I find it has a similiar dichroism, blue and yellow, only the granulation of the rock is much finer. It requires a higher power to distinguish it, when the polarizer is not used. Glassy portions which do not transmit light, with the crossed nicols occur in the quartz constituent of the rock as well as in the hornblende. *(b.)* The microscope shews these to be magnetite. The constitutents of this rock are therefore, quartz, hornblende, magnetite, glass with or without inclusions. The rock is metamorphic and of Lower Cambrian age.

Inferences.

There are several interesting points that are brought into prominence by these examinations.

1st. The value of the Polariscope and Microscope to the practical geologist. This is evident from the correspondence between observation in the Field and the Polariscope-microscope and from the comparison of observations in my published papers with the observations just submitted. The names given to rocks examined in the Field are in accordance with the names which the Polariscope and Microscope designate, and conclusions arrived at there have been confirmed by the process of examination.

2. In every rock examined magnetite is found. It is thus seen to be distributed far more extensively than we could have ascertained without the aid of the microscope.

4. It reveals to us the origin of some of our magnetic sands, *e.g.*, magnetite was found among the gold and garnet sand at Jegoggin Point. The source of the garnets was obvious and the probable source of the gold was indicated. That of the magnetite only was uncertain. Hornblendic rocks, like these of Yarmouth

Harbour, occur at Jegoggin Point. From these we may have the supply of magnetite.

The magnetite represented by the sections described has also been rendered obvious by reducing pieces of the rocks to a powder in a wedgewood mortar and extracting the magnetite with a magnet.

Art. VIII.—Some Physical Features of Nova Scotia, with Notes on Glacial Action. By M. Murphy, C.E., *Provincial Government Engineer.*

(Read April 14, 1884.)

From the year 1869 to 1872 it was my duty to survey some of the Gold Districts which lie in various directions along the Atlantic slope of the Province; and subsequently it became a no less pleasing one to conduct some railway surveys, the course of which was right across the general direction of the strike of the gold-bearing rocks. During these labours and journeyings my work was entirely confined to surveys and public works. Such observations as I was able to make of a general scientific character, were necessarily incidental, hasty and external; however, these defects of hurried and superficial observation will be found in the details only. I am able to place before you a correct representation of the geological skeleton, the characteristic outlines, and true topographical section on two lines of profile across the province, between the Bay of Fundy and the Atlantic shore. The line of railway in operation from Halifax to Windsor gives a third such profile. All are between the 44th and 46th meridians, and are nearly parallel to one another. These sections or profiles may be said to possess advantages in facilitating the formation of more comprehensive views on the