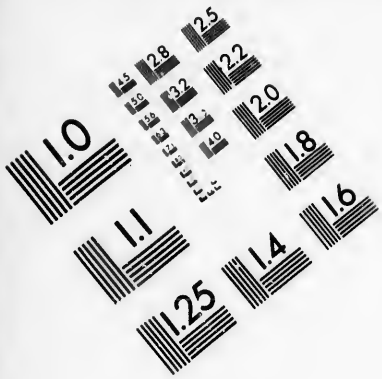

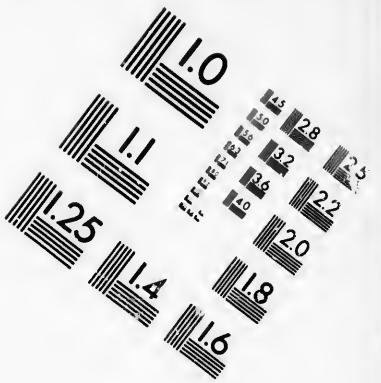

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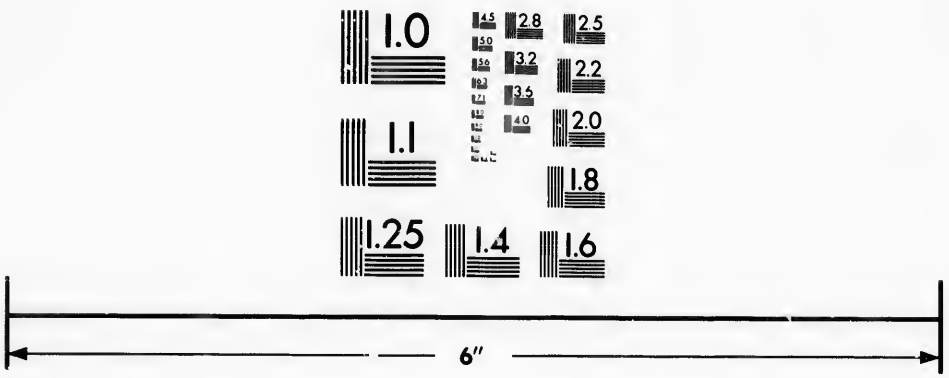

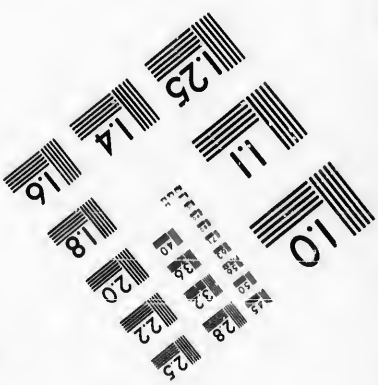

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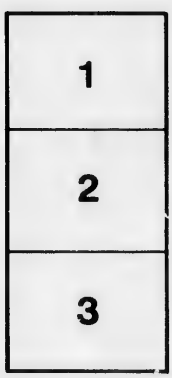
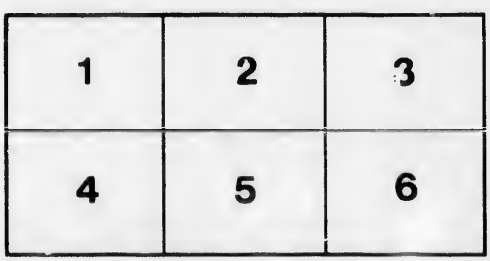




1866

NOTES ON A FEW DYKES CUTTING LAURENTIAN ROCKS, MORE ESPECIALLY WITH REFERENCE TO THEIR MICROSCOPIC STRUCTURE.

By B. J. Harrington,

Of the Geological Survey of Canada.

B. J. H del.

Fig. 1

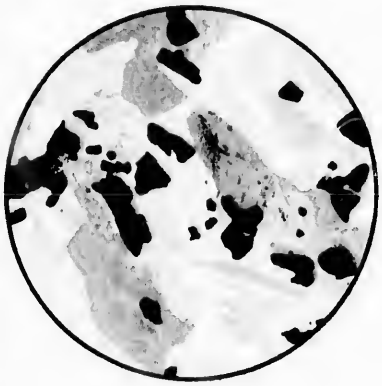


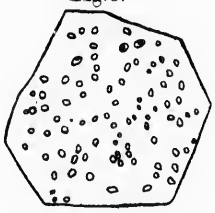
Fig. 2.

Fig. 3

Fig. 4.

Fig. 5.

Fig. 6.



a.

b.

c.

(*From the "Canadian Naturalist, Vol. VIII, No. 6.*")

NOTES ON A FEW DYKES CUTTING LAURENTIAN ROCKS, MORE ESPECIALLY WITH REFERENCE TO THEIR MICROSCOPIC STRUCTURE.

By B. J. Harrington,

Of the Geological Survey of Canada.

The fact that rocks of Laurentian age are frequently cut by trap dykes, was many years ago noticed by Sir William Logan, who traced out and mapped a number of those found in Grenville and some of the neighbouring townships. Since then other observers have noted their occurrence in widely distant Laurentian areas. Mr. Vennor, for example, observed dykes in Madoc and North Burgess. Mr Macfarlane in his report on Lake Superior* describes dykes which cut the Laurentian rocks at Goulais Bay, Gros Cap, and other localities, and from his descriptions some of them appear to resemble those found in Grenville. At Goulais Bay they are from nine to seventy feet thick, strike N. 72° to 75° W., and are probably doleritic. Others at Gros Cap and the mouth of the Montreal River Macfarlane also considers to be dolerites, but states that near Michipicoten Harbour, and in Bachewahnung Bay, there are dykes of diorite. He further states that at two different points in the Laurentian area examined by him, he observed intrusive rocks of the character of the "newer traps or melaphyres which characterise the upper copper-bearing series."

* Geology of Canada, 1866, p. 120.

Professor Bell, of the Geological Survey, has repeatedly noticed the occurrence of dykes in the regions explored by him north of Lakes Superior and Huron, and states that in some parts of the country they form a conspicuous feature in the geology, and have probably played an important part in producing the present geographical features. One described by him as a diorite in the report of the Survey for 1875–76 (p. 314) is said to be from 300 to 400 feet in width. Its course is N. 12° W., and it cuts a thinly bedded micaceous gneiss nearly at right angles to the strike of the latter.

Mr. G. M. Dawson has also given us a number of facts concerning dykes at the Lake of the Woods, where they are said to be both granitic and dioritic. Some of the latter, which are coarse-grained and apparently have general east and west courses, "may very probably be among the oldest of the intrusions." There are others, however, which are very hard and compact, and have a general bearing of north-east and south-west. These cut not only the intrusive granites of the region, but also the altered Laurentian strata.*

The late Mr. Walter McOuat has mentioned the occurrence of dykes of "diorite" from fifty to one hundred feet thick at several localities between lakes Temiscamang and Abbitibbe, and states that the apparent direction of two large ones on Lac des Quinze (on the Upper Ottawa) is north by-east and south-by-west. †

It is therefore evident that in almost all parts of the country where the Laurentian rocks have been examined, they have been found to be cut by dykes of various intrusive rocks, few of which have, however, been critically studied as yet.

The intrusive rocks of the Grenville region are of special interest, inasmuch as most of them were shown by Sir William Logan to belong to a date anterior to the deposition of the Lower Silurian. According to the descriptions given in the Geology of Canada, they consist of dolerite, syenite and felsite porphyry. Of these the oldest "are a set of dykes of a rather fine-grained dark greenish-grey greenstone or dolerite, which weathers greyish white." * * * "Their width varies from a few feet to

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* See Report on the Geology and Resources of the Region in the vicinity of the Forty-ninth Parallel. 1875. pp. 25, 53.

† Report of Progress, Geol. Survey, 1872-73, pp. 120, 122 and 130.

a hundred yards, and they possess a well marked columnar structure. Their general bearing appears to approach east and west, but the main dykes occasionally divide, a branch striking off at an angle of from twenty to forty degrees." Some of them have been traced for many miles, cutting both the limestones and gneisses, and sometimes forming a ridge across the limestone and a hollow in the gneiss. Whenever they are seen to come into contact with the syenite they are interrupted or cut off by it, being therefore more ancient; and "the relations" Sir William states "of the base of the Lower Silurian group along the foot of the hills composed of the syenite are such as to make it evident that the Silurian beds in some places overlie eroded portions of the intrusive rock." All the intrusive rocks of this region are, however, cut by a set of dykes the relations of which to the Silurian series is not known. They were described in Sir William's original report under the name of melaphyre, but were afterwards designated by Hunt as dolerites, though differing considerably in characters from the older rocks of that name.

The writer regrets that he has not had an opportunity of visiting any of the places mentioned above, or even of seeing authentic specimens of any of the dykes, with the exception of a few from Grenville and two or three other localities. These specimens have, however, been sliced and studied microscopically, and a few notes on their microscopic characters may be of interest.

MICROSCOPIC CHARACTERS.

I. *Grenville, Lot 9, Range IV.* (Plate, fig. 1) The examination of a specimen from this locality shows it to consist of plagioclase feldspar, augite, magnetite, viridite,* apatite, and a little mica and iron pyrites. The plagioclase forms a very considerable proportion of the rock, and although much of it has undergone alteration and lost its transparency, it still shows in places, with polarised light, the banded appearance common in plagioclastic feldspars. It has evidently crystallised before the augite, as blades of it are frequently seen to penetrate the latter mineral. The augite is pale brown or in places pinkish in colour. Its form has, for the most part, been impressed upon it by the

* This useful name is applied to a number of green substances which often result from the decomposition of augite, hornblende and olivine, and which cannot always be "individualised."

other minerals, but here and there a rude crystal may be observed. The mica is present in small quantity, and is brown and strongly dichroic. Magnetite (possibly titano-ferrite) is abundant, occurring chiefly in irregularly shaped grains, but sometimes showing rude octahedral form. Sometimes it is seen in innumerable small grains imbedded in the augite. The viridite is abundant and very bright green. It occurs largely in fibrous or sheaf-like aggregations showing faint dichroism, and with the polariscope changing, on rotation of the analyser, from blue to brown. In all probability it is chlorite. The apatite is found in sharply defined acicular crystals which are hexagonal when seen in cross section. It is most abundant in the feldspar, but is also seen to penetrate the mica, augite, and even the magnetite.

II. *Grenville, Lot 9, Range V.* When examined with the microscope the section of this rock is, like that last described, seen to consist of plagioclase, augite, magnetite, viridite, pyrite and apatite? The feldspar forms a network of blades, and has in places undergone some alteration, although for the most part it appears to be unaltered and with the polariscope becomes beautifully banded. It is distinctly seen to penetrate the magnetite in a number of instances, and must therefore have solidified before, or at least simultaneously with the magnetite. It also contains a good many of what appear to be glass- and stone-cavities. The augite is brownish grey in colour, traversed by numerous fissures and penetrated in all directions by blades of feldspar. The rock contains a good deal of magnetite, mostly in grains of irregular form, but occasionally in octahedral crystals. When cut across the grains are often seen to contain numerous irregular cavities, and in one case an octahedral crystal was observed which was hollow, or nothing more than a shell. Viridite is present in considerable quantity. It is much duller green than that in the rock last described, and looks more like an alteration product of the augite. It is mostly amorphous, but occasionally occurs in sheaf-like aggregates. Pyrites is present in small irregular grains scattered here and there through the rock.*

* Specimens I and II were many years ago analysed by Dr. Hunt, who described them as follows: "The dykes of this most ancient dolerite or greenstone in Grenville have a well-marked columnar structure at right angles to the plane of the dyke. They are fine-grained, dark greenish-gray in color, and weather grayish-white.

III. *River St. Simon.* (Plate, fig. 2.) This specimen is from a fine-grained, greyish-black dyke which cuts the Green Lake band of crystalline limestone on the St. Simon, a small tributary of the North River, in Terrebonne County east of Grenville. I am indebted for it to the Director of the Geological Survey. The dyke probably belongs to the same set as the Grenville ones just described, its general structure being the same, but it has apparently undergone very little alteration, the section being beautifully clear and transparent. With the microscope it is seen to consist of a network of plagioclase feldspar, with augite, magnetite and apatite (?) and a very little viridite. The feldspar as seen in the section is perfectly transparent and colourless, and with the polariscope shows a beautifully banded structure. In places it contains microlites which are possibly apatite, and also a few vapour- or gas-cavities, generally in groups. The augite is pale greyish-brown frequently penetrated by blades of feldspar and often containing groups of minute grains of magnetite. It appears to constitute about half the rock. The magnetite occurs mostly in irregular grains and masses of most fantastic shape, but now and then in rude crystals and rod-like forms. In some cases it is seen to be penetrated by blades of feldspar. (See figures on next page.)

The viridite is not very abundant and looks as if derived from

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Under a lens the rock is seen to consist of a greenish-white feldspar with a scaly fracture, mingled with grains of pyroxene, occasional plates of mica, and grains of pyrites. It contains no carbonates. Two analyses of portions of the dolerite from dykes differing a little in texture gave as follows:

Silica	50.35	50.25
Alumina	17.35 }	32.10
Peroxyd of iron	12.50 }	
Lime	10.19	9.63
Magnesia	4.93	5.04
Potash	.69	.58
Soda	2.28	2.12
Volatile	.75	1.00
	99.04	100.72

"The iron in these analyses, although given above as peroxyd, exists in the form of protoxyd, and in the second specimen, in part as a sulphuret." (Am. Jour. of Sci., 1864, 2nd Ser., Vol. xxxviii, p. 174.) Which of the analyses applies to the specimen from Range IV and which to that from Range V is not stated.

the augite. It is rather dull green and can scarcely be said to exhibit dichroism. In places it shows numerous fine lines running in several directions.

Figures 1 and 2.—Grains of magnetite penetrated by blades of feldspar. (× 78.)

Figure 3.—Group showing a few of the varied forms which the magnetite assumes. (× 78.)

IV. *River Gagnon, Terrebonne County.* (Plate, fig. 3.) The specimen from this locality is coarser in texture than the last, and of a dark grey colour. Its specific gravity is 3.013. The dyke where observed by Mr. Selwyn (to whom I am indebted for the specimen) cuts a band of gneiss, and is in all probability of the same age as the Grenville ones, though it has not been traced out. The examination of a thin section of the rock shows it to be composed of plagioclase feldspar, augite, magnetite, apatite and a little mica and viridite. The plagioclase shows evidence of but little alteration, and much of it is striated as in the case of the River St. Simon rock, and with polarised light beautifully banded. The blades run in all directions, but do not constitute as continuous a network as in the last specimen, since the augite is much more abundant. Blades of the feldspar frequently penetrate the augite, and occasionally also the magnetite. The augite is pale brown in colour, perfectly fresh, and often dotted with what appear to be gas-or vapour-cavities. Its cleavage is often well-marked and it occasionally shows twinning (see figure). The magnetite is not very abundant and occurs in irregular and often fantastic forms. The apatite and mica are present in very small quantity, as is also the viridite. The latter chiefly accompanies a brown somewhat decomposed mineral which has not been determined. With polarised light the section forms a beautiful object.

V. *Grenville, Lot 4, Range VI.* The specimen from this locality is from one of the newer dykes which, as already stated, cut all the other rocks of the region. It consists of a dark grey fine-grained base (sp. gr. 2.83) with occasional porphyritically imbedded masses of hornblende, which are often accompanied by a plagioclase feldspar. Calcite is also present in white cleavable masses, mostly filling cavities.*

Microscopically this rock is very different from those already described, but it requires much further study. The ground-mass appears to consist of a mixture of plagioclase, biotite (very abundant), and magnetite or titano-ferrite, with a good deal of a green mineral which is probably an alteration product, and is not at all dichroic. Here and there also there are almost colourless crystals, which may prove to be olivine, very much cracked, and often converted along the cracks into a pale green mineral. As stated above, the rock is porphyritic, and a section cut across one of the porphyritic masses shows it to consist of beautifully striated plagioclase with embedded crystals of hornblende and a little pyrite, while all these three minerals contain numerous crystals of apatite, the largest cross sections of which measure about 0.25 mm. Some of the cross sections are perfect hexagons, but none of the crystals when viewed longitudinally show perfect pyramidal terminations, but are generally rounded as seen in figure 6 e of the accompanying plate. When examined with a high power, most of them are seen to contain numerous cavities, which in a few instances have been observed to contain bubbles, although most of them appear to be empty. Almost without exception, too, they contain black globular and sub-globular bodies (see plate), which possibly take the place of the thin nail-like bodies often found in the apatite of basalt. Some of the crystals contain

* An analysis of this rock was published by Dr. Hunt in the Geology of Canada and also in the American Journal of Science (Second Series, Vol. XXXVIII., p. 174) from which the following is extracted: "When in powder the rock effervesces freely in the cold with dilute nitric acid, and the solution evolves red fumes on heating. In this way there were dissolved, lime, equal to 8.70 per cent. of carbonate, 0.50 of magnesia, and 6.50 of alumina and oxyd of iron = 15.70 per cent. The residue dried at 212° F., equalled 83.80 per cent. A portion of aluminous silicate had evidently been attacked by the acid. The dried residue gave on analysis, silica 52.20, alumina 18.50, peroxyd of iron, with some titanic acid, 10.00, lime 7.34 magnesia 4·17, potash 2.14, soda 2.41, volatile 2.50 = 99.26."

only only one or two of these, but as many as nine have been observed in one case. The rude crystals of apatite which are associated with pyrite are cracked across, and the cracks filled with pyrite as shown in figure 5.

The amygdules have a lining of a green structureless mineral (green earth) while the interior is filled with a colorless mineral which appears in most cases to be calcite. In some cases also the cavities contain pyrites, mostly at the junction of the calcite and green earth.

VI. *Madoc, Ontario, lot* 24, *Range VI.* (Plate, fig. 4.) This rock may be noticed here as a good example of a diorite. It was given to me by Mr. Vennor of the Geological Survey, and stated to have been broken from an undoubted dyke. It was supposed to be a pyroxenic rock, but the microscopic study of a thin section shows it to be a diorite, consisting chiefly of feldspar, hornblende and magnetite, but also containing cubical crystals of iron pyrites and small quantities of a transparent mineral which is probably quartz. The feldspar is a good deal altered, but apparently all plagioclase in the sections examined. The hornblende is of a rich green colour, and much of it shows cleavage lines very distinctly. It is dichroic and polarises beautifully. In places it appears to have undergone some alteration, though not to the same extent as the feldspar.

Conclusions. The first of the rocks just described, on account of the large proportion of viridite which it contains, and the altered state of the feldspar, would be called by German petrographers a diabase. One would also expect to find a larger proportion of water than is indicated by the analysis. In many respects it agrees with Senfter's descriptions of diabase from the Duchy of Nassau in Germany. The alteration which it has undergone, however, is not nearly as marked as in many diabases from much younger formations, as, for example, the Cretaceous of British Columbia. Much of the viridite looks as if it had been one of the original constituents of the rock, but in other places it is pretty evident that it has been derived from the augite.

No. II may perhaps also be called a diabase, although very little removed from such rocks as III and IV. Its general structure is the same, the only important difference being the development of a good deal of viridite. Nos. III and IV are true dolerites or "feldspar basalts," indistinguishable from many

of Tertiary age. They are highly crystalline and do not appear to contain any glassy base. As yet no olivine has been observed either in them or the diabases, but very few sections have been examined, and possibly it will be found on further study. In No. I, a mineral has been observed with the characters of sanidin, and no doubt other minerals will yet be detected.

The order in which the different minerals have solidified is a matter of interest, apparently not being that of the fusibilities of the constituent minerals before the blowpipe. In the diabase and dolerite it is evident that the apatite has been the first to solidify; the plagioclase appears to have come next, then the magnetite, and last of all the augite. Mr. J. Clifton Ward gives an interesting example of the apparent order in which the minerals constituting a leucitic basalt near Naples have solidified, which may be noticed in this connection. The minerals are leucite, magnetite, magnesia-mica, feldspar and augite. Of these five minerals the only infusible one is the leucite, and yet Mr. Ward thinks that the last four "were held in solution by leucite in a state of fusion; and that instead of this mineral crystallising out first, it deposited in succession the magnetite, the mica, the feldspar and the augite, and last of all probably solidified quickly, enclosing within its crystals glass- and stone-cavities, and magnetite and feldspar crystals."

It is evident that No. V is a very different rock from any of the others described. In some respects it resembles the so-called melaphyres, but contains much more mica than is found in any of which I have seen descriptions. No. VI is as already stated a diorite and needs no further remark here.

The slight amount of alteration exhibited by some of the ancient dolerites in the Grenville region would no doubt be surprising to some, but is not so much to be wondered at when we consider that they occur in highly crystalline rocks, which would serve to a great extent to protect them from the agencies which have brought about decomposition in dykes cutting the unaltered strata of some more recent formations.

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* Quart. Jour. Geol. Soc. 1875, p. 396.

DESCRIPTION OF PLATE III.

FIG. 1. Diabase from Grenville, lot 9, range IV, showing augite plagioclase, magnetite and viridite (magnified 28 diameters).

FIG. 2. Dolerite (Feldspar Basalt) from River St. Simon, showing augite, plagioclase, magnetite and a little viridite. The cruciform group in the right hand upper corner is plagioclase. (x 78).

FIG. 3. Dolerite from River Gagnon, showing augite (a twin on the left) plagioclase and magnetite. (x 14).

FIG. 4. Diorite from Madoc, Ontario, showing bluish-green hornblende, plagioclase, magnetite, and pyrite (the square crystal in the lower right hand corner). (x 78).

FIG. 5. Apatite in rock from Grenville, lot 4, range VI. The portion of the drawing shaded black, excepting the spots in the apatite crystals, consists of magnetite and pyrite, chiefly the latter. (x 78)

FIG. 6. (*a*). Cross section of apatite crystal with numerous cavities a few of which show bubbles, and are perhaps liquid cavities. (*b*). Cross section of apatite crystal, showing the black bodies referred to in the text. (*c*). Longitudinal section of rounded apatite crystal with black bodies similar to those in *b*. (All x 78.)