A CONTRIBUTION TO THE PETROLOGY OF THE GREAT DYKE OF NOVA SCOTIA

by
Dennis Edward Lawrence

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of the degree of
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Frontispiece

The island on the left is Halifax slate and the one on the right is diabase of the Great Dyke of Nova Scotia. Contact rocks have been removed by weathering and active transport. Photo taken from West Ironbound Island, looking west.

ABSTRACT

A large, steeply dipping, quartz-diabase dyke, over 170 miles long and up to 600 feet wide, cuts Paleozoic rocks in southwestern Nova Scotia.

The main minerals are labradorite, pyroxene, quartz, alkali-feldspar and accessory magnetite, ilmenite, biotite and amphibole. The contacts show a chilled margin against relatively unmetamorphosed country rock. Chemical analyses indicate that the rock is derived from a tholeiitic magma slightly deficient in ferro-magnesian constituents.

Indications are that the dyke was intruded in the late Triassic into a tension fissure. Potassium-argon date of the chilled margin of the dyke indicates 194 m.y.

The dyke is correlated with the North Mountain basalts of the Acadian Triassic basin on the basis of age, lithology and chemistry.

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CHAPTER 1

INTRODUCTION

1.1 General Statement

The scope of the investigation is a study of the "Great Dyke of Nova Scotia" and of adjacent country rocks which might yield information concerning this intrusive feature (fig. 1).

The known outcrop of this dyke extends in a southwesterly direction across the mainland of Nova Scotia, from West Ironbound Island, a small island off the coast of Nova Scotia near the mouth of the LaHave River, (latitude 44°14'N, longtitude 66°39'W, approx.). From outcrop indication, the dyke exceeds 75 miles in length; the width of the dyke varies from 200 to 600 feet. Generally the dyke dips steeply to the southeast.

The relief in this area is not pronounced, and in general, the land is low and rolling. Elevations range from sea level to approximately 350 feet.

Glacial features are common and form much of the topography of the area. Features include glacial pavements, rochès moutonnées, boulder fields, erratics,

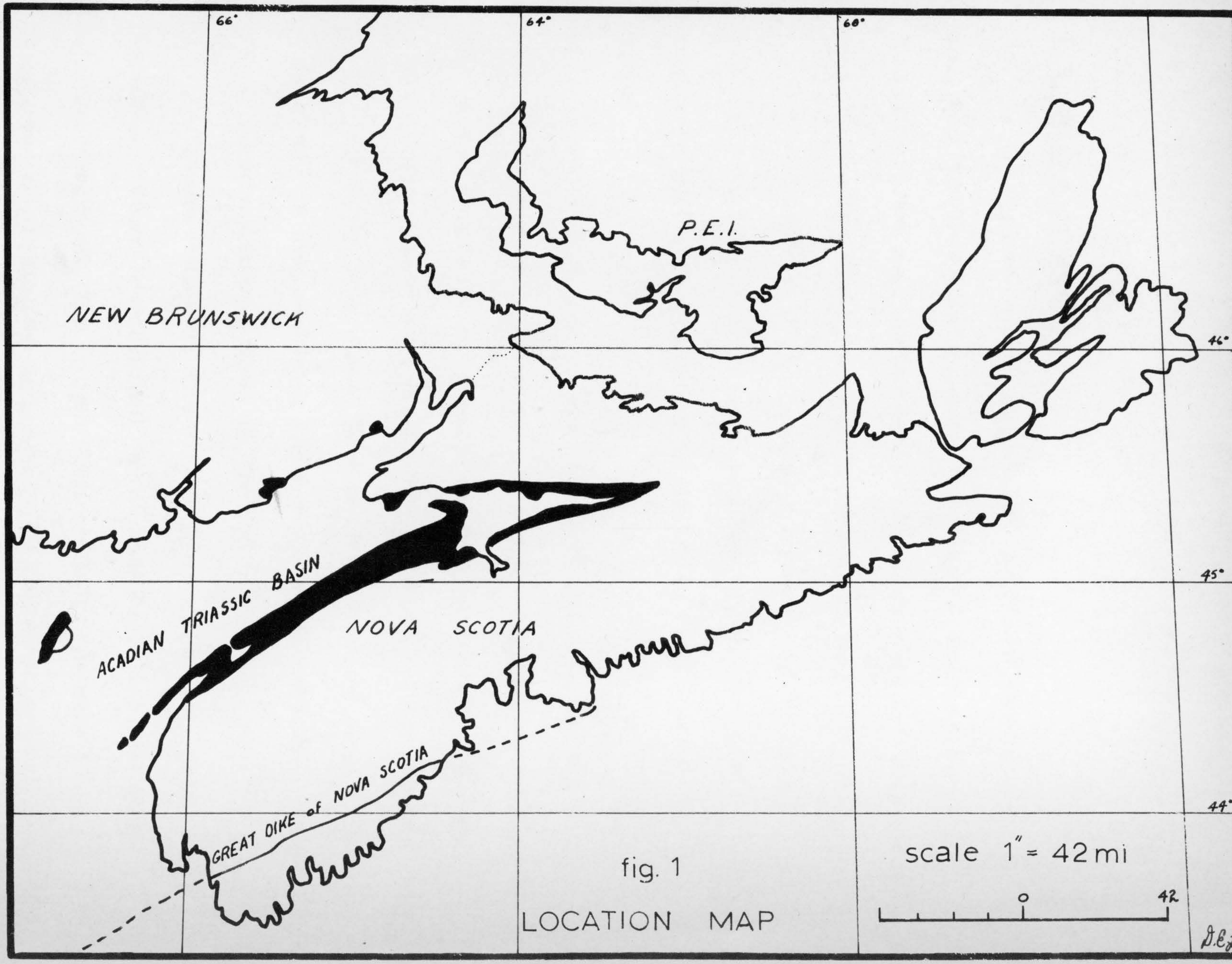

fig. 1

LOCATION MAP

drumlins, eskers, and outwash plains. The area has mixed vegetation with evergreens predominating. There are also extensive areas of swamp.

1.2 Means of access

The provincial highway, number three, from Halifax to Yarmouth, and the Canadian National Railway line run adjacent to the dyke and frequently cross it especially in the northwest part of the area.

A number of secondary roads and logging trails run inland at right angles from the main highway and permit access at intervals along the dyke.

Most rivers in the area run between South and South-southeast and cross the dyke; they may be used for access where no roads or trails exist. In most cases, approach was made by secondary roads and on foot. In only one case was a traverse of more than a few miles necessary, this was in the Pubnico Lake area where access was difficult.

In the case of the off-shore islands, namely Sambro, West Ironbound, and LaHave, a boat was chartered from the local fishermen. Access to smaller near-shore islands was by means of a rubber raft.

TABLE OF FORMATIONS fig. 2

ERA	PERIOD	GROUP	FORMATION	LITHOLOGY
CENOZOIC	PLEISTOCENE			TILL, MORAINE, ESKERS.
PALEOZOIC	POST DEVONIAN			GABBRO
	DEVONIAN			BIOTITE GRANITE, MUSCOVITE-BIOTITE GRANITE, MINOR PEGMATITE.
	LOWER ORDOVICIAN (?)	MEGUMA	HALIFAX	SLATE, MINOR ARGILLITE ALSO STAUROLITE-ANDALUSITE SCHIST, MINOR GARNET-MICA SCHIST, CORDIERITE SCHIST, BIOTITE QUARTZITE.
			GOLDENVILLE	BIOTITE QUARTZITE, MINOR QUARTZITE, CONGLOMERATE, SUBGREYWACKE, MICA SCHIST, ARGILLITE.

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1.3 Geological Setting

The dyke cuts three rock formations. The oldest formation is the Goldenville, the lowest division of the Meguma Group which is possibly Lower Ordovician in age. This formation is composed largely of fine-to medium-grained, thickly-bedded, grey, biotite quartzites. Conglomerate, quartzite, greywacke, mica schist and argillite are present in minor amounts, (fig. 2).

Conformably overlying the Goldenville are coarse-grained, well-bedded, grey, staurolite-andalusite schists. There are also minor amounts of corderite-garnet-mica schists and biotite quartzite. These schists mark the division between the Goldenville and Halifax formations but are assigned to the Halifax.

The upper part of the Halifax consists of well-bedded grey slates interbedded with lighter and darker bands and minor argillite.

The youngest formation of the area is an igneous, medium-grained, grey, biotite granite which is locally porphyritic or gneissic; there are also minor amounts of muscovite-biotite granite and pegmatite. This intrusion is of Devonian age.

The dyke itself is Post-Devonian and thus the youngest rock in the area. It is a fine-to coarse-grained, grey to almost black or dark green gabbro.

1.4 Previous Work

The earliest geological work carried out in the area was by A. Gesner (1849) and J. W. Dawson (1855). These workers were followed by L. W. Bailey (1896) who did more detailed work. None of these investigators made any mention of the dyke.

The first mention of the dyke was made by E. R. Faribault (Summary report of the Geological Survey Branch of the Department of Mines, 1911, (p. 337.)

> The only igneous rock observed in the district is an important dyke of diabase, 200 to 500 feet wide, extending along the sea-shore in a westward direction for at least 25 miles, from West Ironbound island at the mouth of Lahave river to Liverpool, beyond which it was not traced. It outcrops on West Ironbound island immediately north of E. DeWolf's house, crosses Cape Lahave Island along Halibut and Bantam bays, where it shows prominently above the surface, then it strikes the mainland at Cherry cove where it is deflected southerly along Back and Apple coves, then resumes its westerly course along the north side of Conrad beach and crosses Medway between Selig and Great islands, beyond which it is concealed by soil for a few miles but outcrops again on Great hill and on a small knoll one-fourth of a mile north of the railway station at Liverpool.

In the Summary Report for the following year (1912, p. 377) Faribault mentions the dyke again.

> A dyke of coarse diabase, 330 feet wide, outcrops conspicuously on the sea-shore at

Blackpoint. The large dyke of diabase traced previously along the coast for 25 miles, from West Ironbound island to Cowie's Tannery brook, was described in last year's Summary Report.

In the Report of 1913 (p.253-4) Faribault says.

The large and persistent dyke of diabase, previously traced along the coast in a southwest direction for 25 miles from West Ironbound island to Cowie brook, just north of the town of Liverpool, was located across the Port Mouton map-area, where it crosses Five rivers at Jim brook and Broad river at Huphman landing, then follows the north side of the railway to and beyond Wilkins station. This dyke has thus been traced for a length of 42 miles, and its width varies from 200 to 600 feet with a few short spurs in places. The alteration due to the diabase intrusion does not extend more than a few feet from the line of contact. The altered zone is generally impregnated with magnetite weathering to red hematite, which gives the soil a characteristic colour indicating the presence of the dyke where it does not outcrop.

Another dyke of coarse greenish black diabase, 330 feet wide, outcrops conspicuously at Black point, on Liverpool bay, but does not appear to extend any distance west from the shore.

In the Report of 1917 (p. 18F) Faribault traced the dyke farther.

One large and persistent dyke of diabase previously traced along the coast in a westerly direction for 42 miles, from West Ironbound island to Wilkins station, was located across the northwest corner of the map-area where it crosses Jordan river 1 mile, and Roseway river 2 miles, above the head of tide. This dyke has thus been traced for a length of over 60 miles, and its width varies from 200 to 600 feet. The metamorphism due to the diabase intrusion does not extend more than a few feet from the line of contact. Where it crosses Roseway river below Hervey dam, the diabase can be observed to cut both the granite and the schists, and is thus younger than the granite which is of late Devonian age.

In the Summary Report, part F 1919, (p. 5F) Faribault gave further description of the dyke including a list of minerals observed under the microscope.

> The large and persistent dyke of greenish black gabbro which has been traced along the coast in a westerly direction for over 60 miles from West Ironbound island at the mouth of Lahave river to Roseway river 2 miles north of the town of Shelburne, crosses the south-eastern corner of the map-area. It runs westerly a short distance north of the railway from Wilkins station to Tom Tidney river, crosses Sable river at the mouth of Log brook, and the southern limit of the map-area one mile north of S. Huskins' house. Actual outcrops of the dyke have been observed only at two places along this distance, near Wilkins station, but its location can be easily traced by following the debris, which forms a characteristic red soil, and the weathered, red rusty boulders with a rounded pitted surface. The course of the dyke appears to have been affected by two transverse faults converging southerly towards the head of Port Joli. One on Mitchell lake gives to the dyke an horizontal displacement of about one-fifth of a mile to the left; the other on Tom Tidney river, above the "guzzle". a displacement of three-quarters of a mile to the right. The width of the dyke varies from 200 to 400 feet. A microscopic examination of thin sections shows the rock to be gabbro, and not diabase as reported before, nor black granite as it is generally called at Shelburne, where the same rock is quarried and cut for monuments. The minerals present are:
>
> Feldspar: labradorite; most abundant mineral in the rock.
> orthoclase; present
> quartz and orthoclase; fairly abundant in graphic intergrowths.
> Augite: abundant, pale colour.
> Hypersthene: light colour.
> Iron ore: abundant, probably magnetite.
> Biotite: a few small scales.

In 1929, the geological maps of the Bridgewater and Vogler Cove areas (sheets 89 and 90) were published by the Geological Survey of Canada, thus presenting Faribault's findings during the period 1911 to 1919.

The maps of the adjacent Liverpool area (sheets 439A and 440A) compiled the work of Faribault (1911 to 1919), P. Armstrong (1936), and J. T. Wilson (1936); they were published by the Geological Survey of Canada in 1939. The attached text for these map sheets reads in part:

> .....a dike of grabbo cutting Meguma strata has been traced south west to Shelburne county where it cuts granite probably of Devonian age. The dike may be of Triassic age.

G. V. Douglas (1942) says that some of the black granites of the Shelburne area are actually diabase and he mentions the outcrops at Little Rocky Mountain, about two miles north of Shelburne and Moose Hill about two miles north of Birchtown.

E. J. Longard (1947, p.151-152) gives a description of several dyke localities.

> Robert's Mountain stands slightly over 100 feet above the surrounding territory and the major portion of it is believed to be black granite. Eleven outcrops were found near the summit. The weathered surfaces, or "sap" zones, of the outcrops are extremely thin. A thin section study indicates that the rock is diabase.

When polished the rock is quite dark and has a definite bluish case.

The most southerly outcrop of the "black granite" differs from the others. It has a very fine ophitic texture and is a chilled phase of the diabase. Even though it is extremely hard it takes a very poor polish, the surface exhibiting a dull metallic luster. Muscovite granite outcrops at the extreme south side of the hill.

The origin of Robert's Mountain is not understood. It might either be a stock or a "blow" in the course of the diabase dyke which runs from LaHave Island in a westerly direction, and is sometimes believed to cut the Shelburne granite.

Moose Hill rises over 125 feet out of surrounding swamp land and presents a profile very similar to that of Robert's Mountain. A thick mantle of glacial till, containing large "black granite" boulders, obscures any ledge rock. Considering the shape, and the float found on Moose Hill, the future possibilities of that locality seem very good. This locality also lies on the supposed underground dyke line.

This rock is slightly lighter in shade than the rock at Robert's Mountain, and has a greenish brown tinge. From its texture this rock appears to be a diabase.

Situated only two miles north of Shelburne, Little Rocky Mountain is the original source of "black granite" in the county. Some quarrying was carried on shortly after World War 1. The "mountain" is about 25 feet high and 200 feet in diameter.

Monuments made of this rock proved a disappointment. Within ten years the monuments weathered to a yellowish brown colour and took on a pebbly scale. This scale is a vegetable growth feeding on the decaying minerals.

It is believed that the origin, as previously implied, is similar to Robert's Mountain.

Recent work (1962-1964) includes that of W. F. Take of the Nova Scotia Museum of Natural Science, and J. B. Dawson of Dalhousie University, who have investigated the dyke in the field, in hand specimen, and in thin and polished section. These investigations were carried out in the hope of finding rock which would be suitable as a commercial building stone. None of this work has been published.

W. T. Dauphinee, for some time, has been interested in the dyke from an economic view point, especially in the Shelburne and Birchtown areas, where he has carried out quarry operations. At Robert's Mountain, Dauphinee has carried out a ground magnetic survey and has drilled three short diamond drill holes.

In the summer of 1965, the dyke was sampled at various locations by W. F. Fahrig of the Geological Survey of Canada with the intent of doing paleomagnetic and petrographic work. His results have not yet been published.

1.5 Purpose of the Study

The dyke is an interesting, large, conspicuous, virtually unstudied, geological feature and its study will be an addition to Nova Scotian geology. The purpose of the study was two-fold.

1. To study and describe the dyke from a

petrological, mineralogical, and geochemical point of view.

2. To attempt to find the time-space relationship between the dyke and the other rocks of the area.

CHAPTER II

FIELD OBSERVATIONS

2.1 Sampling

During the late summer and fall of 1965 samples of the dyke and adjacent country rocks were taken. Sampling was done in all areas mentioned by previous investigators, in outcrop areas indicated by aerial photos, and in other areas where dyke outcrop might be expected. Special attention was given to the areas on the extension of known portions of the dyke and to anomalous aeromagnetic data which might be indications of the dyke.

An attempt was made to collect representative samples of the dyke along its full length, and where practical, also across the width of the dyke in order to study its variations.

The data collected at different locations were, in most cases, on contact relations, joint directions and weathering.

For convenience, the sample area was divided into sections. Each section is five minutes of longitude in length and contains about four or five miles of dyke. No width restriction was needed because only the dyke and adjacent rocks were studied. The sections were designated by letters of the alphabet. The extreme southwestern section near Pubnico (66°45' to 66°40' longitude) was assigned the letter A. Subsequent sections to the northeast were given letters accordingly. The West Ironbound area in the extreme northeast was lettered S. Individual samples within a section were numerically recorded. (See maps in back cover.)

Where outcrop was absent, boulders were occasionally sampled. Boulders were considered as valid dyke samples only when they were taken at their northernmost limit of occurrence. Glacial movement in the area was from north to south and the dyke is at right angles to this movement; thus, glacial debris is found only to the south of the dyke. In sampling boulders, the procedure was to traverse northward until the last occurrence of dyke boulders in glacial debris was found. This coincided, fairly accurately with the location of the dyke, as indicated by the aeromagnetic information.

In areas where detailed sampling across a specific section of the dyke was possible, hand specimens were taken at various intervals out from the contact: usually closely spaced near the contact (six inches to several feet) and at wider intervals (10 to 30 feet) farther from the contact.

I attempted to have at least one sample location for every five miles of dyke, but in some areas this was not possible.

In many areas the samples were more closely spaced and detailed sections were made at Robert's Mountain, Jordan Falls, LaHave Island and West Ironbound Island.

Further detailed samples were obtained in the Robert's Mountain area which is about three miles north of Birchtown. Through the courtesy of W. T. Dauphinee three diamond drill cores, each 150 to 200 feet long were obtained from Robert's Mountain. Two of these cut the contact with Devonian granite.

2. 2. Distribution and Limits of Occurrence

The limits of the dyke as seen on the geological maps represents the work of earlier investigators (chapter 1). Air photos were used to plan field work and in an unsuccessful attempt to locate additional outcrop. Where the rock exposure is good and the vegetation is sparse, generally only on the islands and near shore areas, the dyke is readily visible. Inland more frequently than not, the dyke is not visible due to vegetation and glacial debris.

The aeromagnetic maps clearly show the dyke as a linear anomaly of about 150 gammas above the background of the relatively non-magnetic granite and quartzites. (See maps in back cover.) Where the dyke cuts slates or metamorphic rocks of higher magnetic susceptibility, the anomaly caused by the dyke is more difficult to follow. From Pubnico Lake to West Ironbound Island, a distance of approximately 75 miles, the dyke can be readily followed on the aeromagnetic maps.

In the area to the southwest of Pubnico Lake there is a large oval anomaly of about 700 gammas. The dyke anomaly merges with the Pubnico anomaly and then emerges from it on its southwestern edge; from there, it seems to continue across the Pubnico peninsula. Interpretation in this area is hampered by the highly metamorphosed country rock.

Magnetic information is not available for the adjacent near-shore submarine area, as the flight lines were usually not continued very far past the shore line, Also, ships doing sea magnatometer work could not navigate in the very shallow coastal areas.

Farther out to sea, magnetic information does exist and a large linear anomaly can be seen running for about 30 miles in a wouthwesterly direction in the area north of Mud Island, until it goes outside the map area. It has been noted that this anomaly is almost exactly in line with known outcrop of the dyke. The anomaly is interpreted (Bower,1962) to indicate the possibility of faulting with an apparent hoizontal displacement to the right. The author is in agreement with this interpretation and believes that the existence of the dyke in this fault is very probable.

The interpretation of the Pubnico anomaly presents a more difficult problem; it will be dealt with under a separate heading.

Magnetic data indicate that the dyke may continue northeastward beyond its present proven limits. To the northeast of West Ironbound Island there is an anomaly indicating the presence of the dyke; it can be traced for a few miles. Between West Ironbound Island and the Sambro Islands, 36 miles to the northeast, there are no data. In the vicinity of Inner Sambro Island, a linear anomaly is once again observed, it passes along the shore to the southwest of the island. It then continues between the shore and Inner Sambro, after which it turns to the north and dies out. More than 35 miles from the last know outcrop, interpretation of this magnetic anomaly is doubtful, but there is a low area, on Inner Sambro, containing numerous boulders of weathered diabase which indicate the presence of the dyke.

2.3 Computation of Magnetic Data

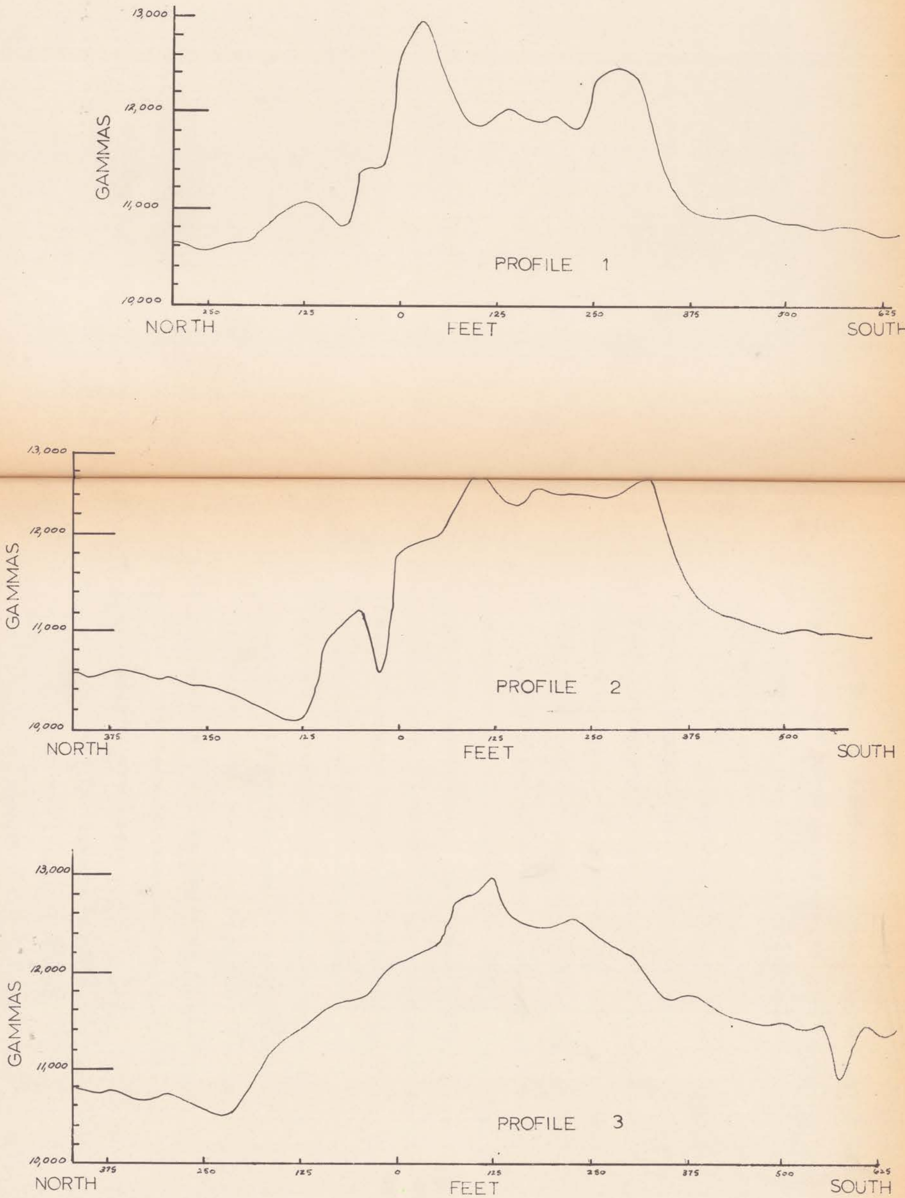
Magnetic methods have yielded new information for interpretation of the Great Dyke.

In addition to the inspection of the magnetic intensity maps, a few more detailed approaches were followed. The first made use of the results of a detailed magnetic survey at Robert's Mountain, done by the Department of Mines of Nova Scotia (1964) for W. T. Dauphinee (fig. 3). These results showed:

1. That the dyke is not uniformly magnetized. In the profiles one and two, there are two high peaks close to the edges of the dyke with a less magnetic area between. In profile three, the most magnetic portion is centrally located.

2. In profiles one and two, the contacts between the dyke and the country rock are more clearly defined than in profile three.

3. At the north contact on profiles one and



MAGNETOMETER SURVEY

ROBERTS MT. N.S. fig. 3

SCALE
1" = 125' (aprox.)

FROM DEPT. of MINES of N.S AUG. 1964.

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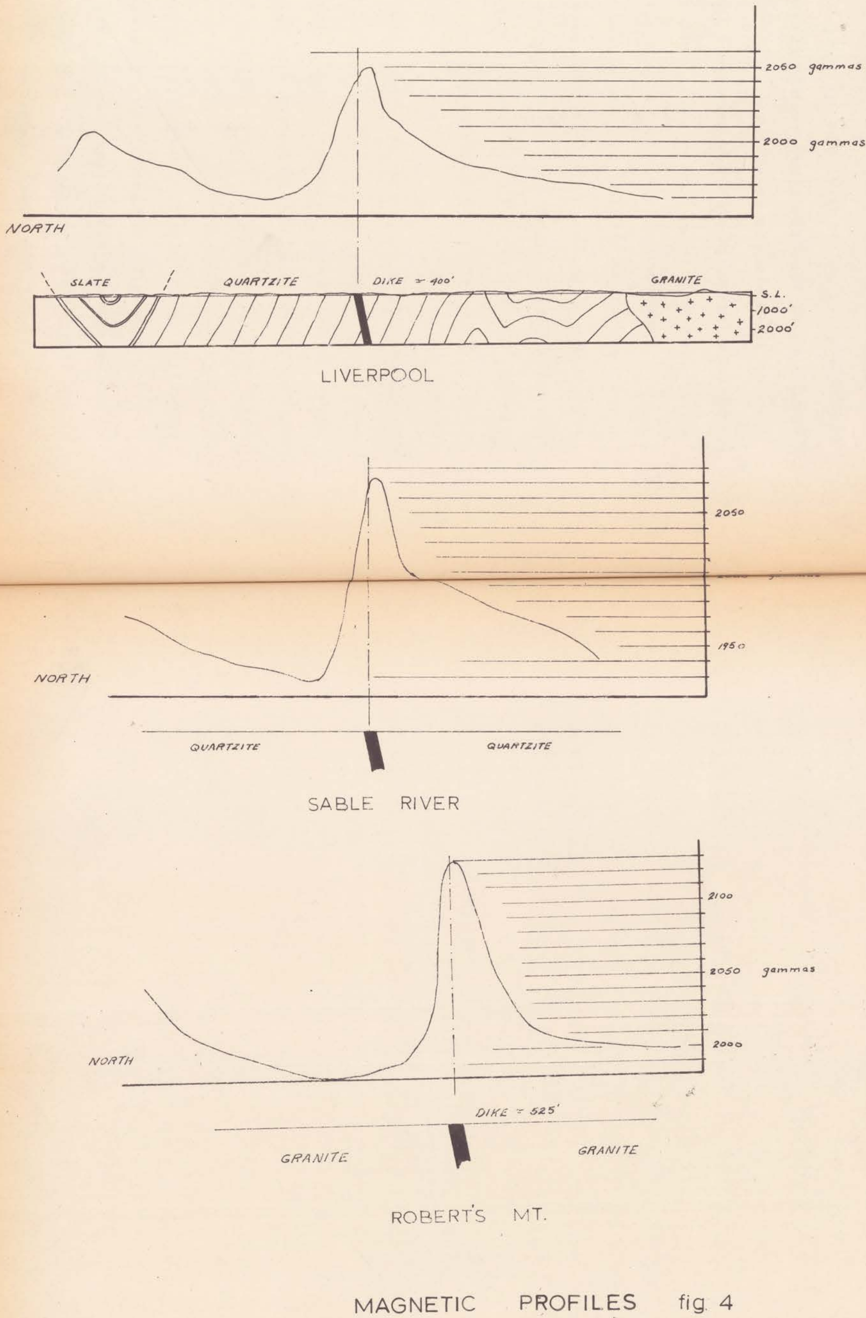
two, there is a small peak separated from the main anomaly. It is believed that this peak represents an offshoot from the main body of the dyke. A similar peak may be seen on the extreme south end of profile three.

4. A comparison of the three profiles shows that the north contact in profile three is about 100 feet further north than in profiles one and two. Based also on outcrop observations it is believed that this indicates an offset of the dyke.

The second method consisted of drawing magnetic profiles across the dyke at localities with minimal interference from other magnetic rocks. (fig. 4). By the method of matching model curves with the actual magnetic profiles of the dyke, the magnetic susceptibility contrast for the dyke was derived. Since the IBM computer at the Bedford Institute of Oceanography and a programme for a two-dimensional magnetic body were available, the matching curves were computed at Bedford.

In these calculations several general assumptions are made:

1. The dyke is uniformly magnetized.
2. The length of the dyke is infinite.
3. The body has parallel sides and a horizontal top.



MAGNETIC PROFILES fig. 4

scale 1" = 1mi

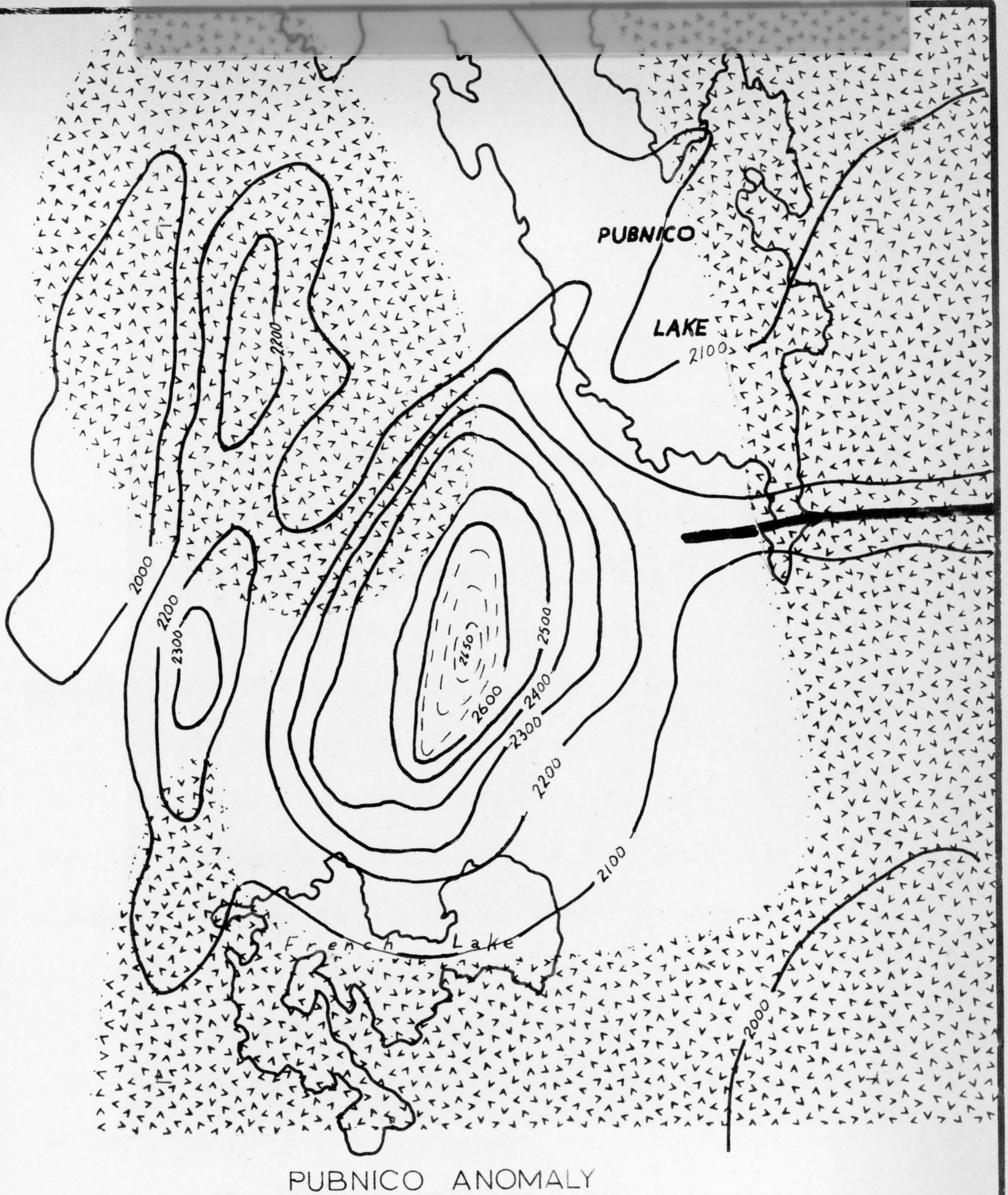
Jan 66

Using a strike of N 90° E due East, magnetic a dip of 75 S and a width of 568 feet, the computed curve giving the best fit to the observed magnetic field indicated a susceptibility contrast of 0.004.

The third approach was to determine the character of the Pubnico anomaly. Ideally, the size of the body should be estimated and then, by assigning to it a magnetic susceptibility, a model may be computed. If the model with the assigned values produces an anomaly of the same size and shape as that observed on the magnetic maps, the values assigned to the model may also apply to the actual body.

The only work done on the Pubnico anomaly was the construction of a second derivative or curvature map. This type of map gives a good idea of the shape of the anomaly by isolating it from interfering magnetics of adjacent rocks.

The method for construction of the second derivative map is to place a grid over the existing magnetic intensity map and calculate the curvature at each intersection point. These points are then contoured to give the final second derivative map. For the detailed method, see Vaquier et al (1951). The zero contour of such a map tends to give the outline of the top surface of the magnetic body.



PUBNICO ANOMALY

AEROMAGNETIC INTENSITY

CONTOUR INTERVAL 100 GAMMAS

DIABASE DIKE

GRANITE

QUARTZITE

SCALE 1" = 1 mi.

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PUBNICO ANOMALY

AEROMAGNETIC INTENSITY

CONTOUR INTERVAL 100 GAMMAS

DIABASE DIKE

GRANITE

QUARTZITE

SCALE 1" = 1 mi

Jan '66 DEL

This procedure was used in the construction of the second derivative map for the Pubnico anomaly. (fig. 5)

2.4 Structural

The examination of the dyke in the field was limited by the extent of outcrop which in many areas is sparse. The best outcrops are on the off-shore islands, (fig. 6) in coastal areas, in railway cuts, and on the shores of lakes and rivers.

The dyke is variable in width, from 200 to 600 feet (Faribault, 1913). In most cases, I was unable to measure the complete width of the dyke because of glacial debris. However, at Robert's Mountain the width is 500 feet; at LaHave Island, 400+feet; at West Ironbound Island, 400 feet; and at Apple Cove, 300+feet.

The dip of the dyke appears to be fairly constant along its whole length. Measurements at various locations range from 75 to 80 degrees to the south although at West Ironbound the dip is only 45 degrees. The magnetic profile is always steeper on the north than on the south. This indicates a southward dipping body, and confirms the consistent southward dip, even where the dyke is obscured.

Figure 6 Panoramic view of the dyke outcrop on the northeast shore of West Ironbound Island. Note the strong jointing in three directions and the equidimensional joint blocks. The dyke-slate contact is shown at the right.

The direction of strike of the dyke is variable (N 45° E to N 60° E) but over its length it may be said to be striking almost magnetic east (N 57° E). It is important to note that the dyke is parallel to the North Mountain basalts of the Acadian basin to the north.

Also noted is the fact that in the south-western parts of both bodies there is evidence of movement. The faults which separate Brier and Long Islands from Digby Neck and the faults farther to the southwest, as shown on the aeromagnetic maps, may be seen in the Acadian Triassic Basin. In the dyke, faults are recorded at Mitchel Brook and at Cowie's Brook (Faribault, 1919). The dyke also seems to be displaced at Bloody Creek and south of Harper Lake, according to magnetic information.

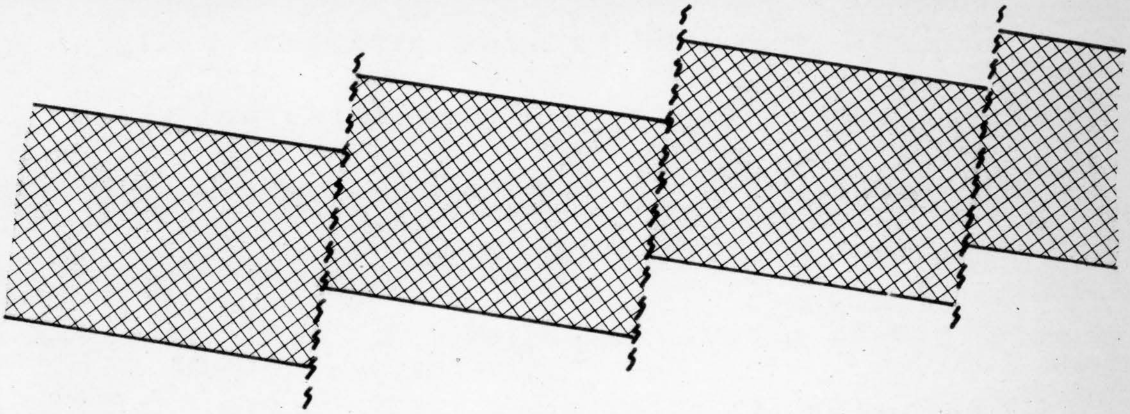
The potassium-argon whole rock age of the dyke is 194 m.y. according to Fahrig, (pers. comm.). This is Upper Triassic, the same age as the North Mountain basalts (Kline, 1957). A study of the remnant magnetism of the dyke indicates a Late Triassic pole position.

It is not too surprising that the dyke is in some way related to the Acadian Triassic Basin, because similar relationships occur between other

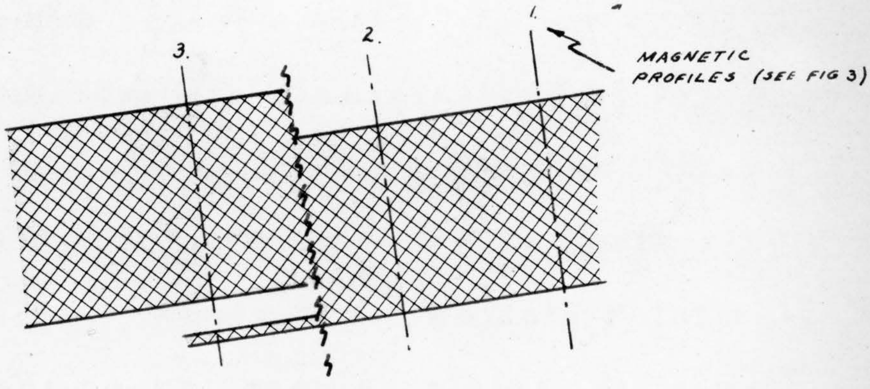
Triassic basins and associated dykes in the Newark System of the Eastern United States. It has been stated (Bain, 1957) that the Triassic basins of the Eastern United States lie in fault zones which gave rise to the basaltic rocks within the basins. It has been mentioned (Russell, 1892, and others) that there are dykes in Paleozoic strata paralleling the Triassic basins. Lithologically the dykes are indistinguishable from the characteristic igneous rocks of the Newark System.

The Great Dyke of Nova Scotia conforms to this general structural picture of Triassic basins and associated dykes, and its age is close to that of the igneous activity in a closely associated basin. If one also finds that there is close similarity lithologically and chemically between the dyke and the igneous rocks of the Fundy Basin, then it would not be unreasonable to assume that there is some association between the Great Dyke of Nova Scotia and the basalts of the North Mountain in the adjacent Acadian Triassic Basin.

The fissure into which the dyke has intruded is, according to Cameron (1956) ". . . . a pre-existing fault fissure which was filled with dyke material," but I have found no evidence for faulting along the dyke fissure. There is evidence that the dyke is not



POSSIBLE
FAULT PATTERN
OF DIKE



DISPLACEMENT
AT ROBERT'S MT.

EN ECHELON FAULTING fig. 7

SCALE 1" = 500'

DCL.

simple but is offset at intervals by cross-cutting fractures. One of these fractures was observed in the detailed magnetic work at Robert's Mountain, (fig. 7); it indicates an offset of about 100 feet. The only observed indication of structural complication is an outlier of diabase at Mersey Point, on Liverpool Bay, 2.5 miles southeast of the main body of the dyke. This rock is in all respects similar to the dyke.

2.5 Appearance

Where the dyke cuts rocks more resistant to weathering, it outcrops only occasionally on river banks and on some hills. In low areas the position of the dyke is characterized by low swampy areas with country rock outcropping on either side, giving evidence of the more rapidly weathering dyke in the low area. Where the dyke cuts relatively less resistant rocks, such as slates, it is well exposed and often stands out above the surrounding country rock; the dyke may be best studied in these outcrops.

The fresh dyke rock is coarse and gabbroidal in appearance, with either single crystals or groups of dark or black pyroxene prisms appearing

Fig. 8 Black and white spotted appearance of the coarse-grained, fresh, diabase. 1/3 natural size.

Fig. 9 Slightly weathered sample of the coarse-grained diabase. Note that there is less contrast between the light and dark areas than in the fresh sample above. 1/3 natural size.

Fig. 10 Sample from the chilled margin of the Great Dyke The rock is dark and massive. The plagioclase crystals show as light colored flecks. 1/3 natural size.

conspicuous against a background of lighter-colored felspar. This texture gives the rock a black and white or "salt and pepper" appearance. (fig. 8). Where the rock has been weathered it has a brown color which tends to soften the striking black and white appearance. (fig. 9). The only minerals identified during field examination were feldspar, pyroxene, and ore minerals. The feldspar appears to be about 50 per cent of the rock.

Rock close to the contact is darker in color and is finer grained than that in the central portions of the dyke, while the rock within a few feet of the contact is very dark or black in color and, when struck with a hammer, gives a metallic ring. (fig. 10). Hand specimens broken from outcrop are very angular, sharp and often with shards. The gradation from the contact material, through the chilled margins, to the coarse, well-crystallized material is gradual, usually over a distance of 10 to 15 feet.

2.6 Contact Effects

The effect of the intrusion on the country rock is noticeable but not extensive. In the granite, the alteration extends only an inch or so and probably

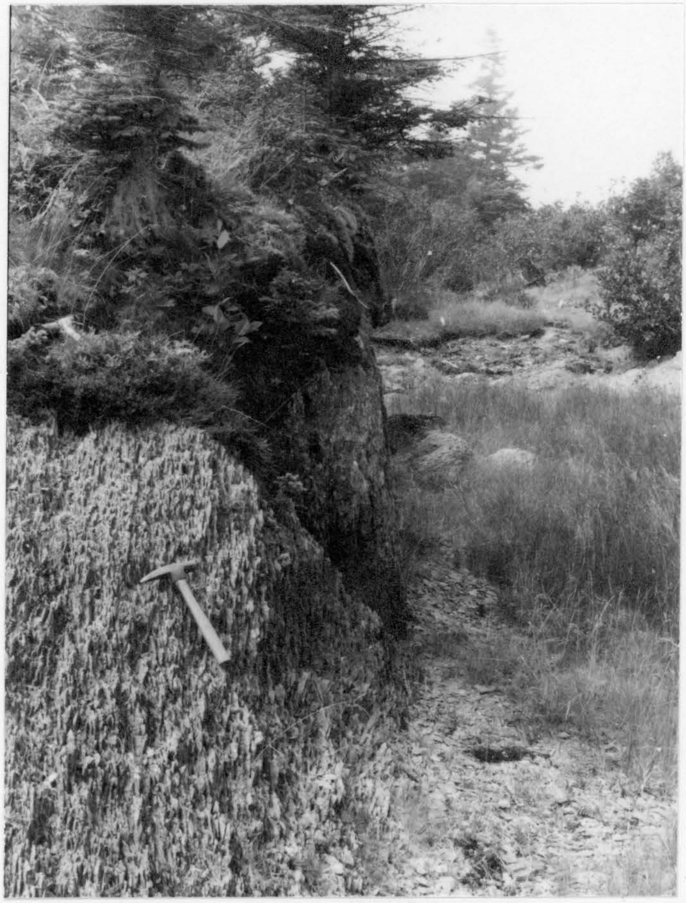


Figure 11 Cleavage in slate parallel to the dyke. This cleavage is caused by the emplacement of the dyke. Normally, in this area, the cleavage is at right angles to the dyke.

Figure 12. Contact rocks are often easily weathered as shown between the two islands. The left island is slate and the right island is diabase. Photograph taken from West Ironbound Island looking west.

affects only the micas. The quartzite also seem relatively unaltered but the slates show more readily the effects of the intrusion. At West Ironbound Island, it was noted that the slates in contact with the dyke appeared baked and discolored. The slates in the narrow zone next to the contact are more massive than usual and the baking effect due to the heat of the intrusion has oxidized the iron-bearing minerals. When weathered, these give a yellow to reddish-brown stain to the rock otherwise grey or black in color.

At LaHave Island the intrusion has imparted a strong cleavage to the slates in a direction parallel to the dyke; the normal cleavage in this rock is at right angles to the dyke. This new cleavage is very closely spaced, causing the rock to be more friable than usual. (fig.11).

Observations in the contact areas were restricted because these zones are more easily weathered due to their fractured nature. In some areas the contact is characterized by a weathered-out channel (fig.12).

2.7 Jointing

The joints within the dyke were measured at various locations; they were found to be of the same types. In all locations there is a main or master joint system which usually parallels the dyke wall and is steeply dipping, generally in the same direction as the dip of the dyke. This joint system is very conspicuous at all locations because of its close regular spacing and continuous nature (fig.13). Other joints in the same general direction dip steeply, 60 to 90 degrees, usually 80 to 90 degrees. The second most conspicuous joint is horizontal or nearly so and is found at all locations. The third set of joints may be said to be roughly at right angles to the other two joint sets. These joints strike across the dyke at right angles to its length and have dips which very from about 25 to 90 degrees. These joints are usually not as well defined, nor as continuous, as the previously mentioned joints. Other minor joints have been observed but could not be assigned to any of the above groups. Due to the concentration of the joints into three major directions there is a tendency for the formation of roughly equidimensional blocks which may be removed from outcrop by mechanical weathering. (fig.14 and 16).

The observed joints are interpreted as tension joints formed while the dyke was cooling. Ideally,

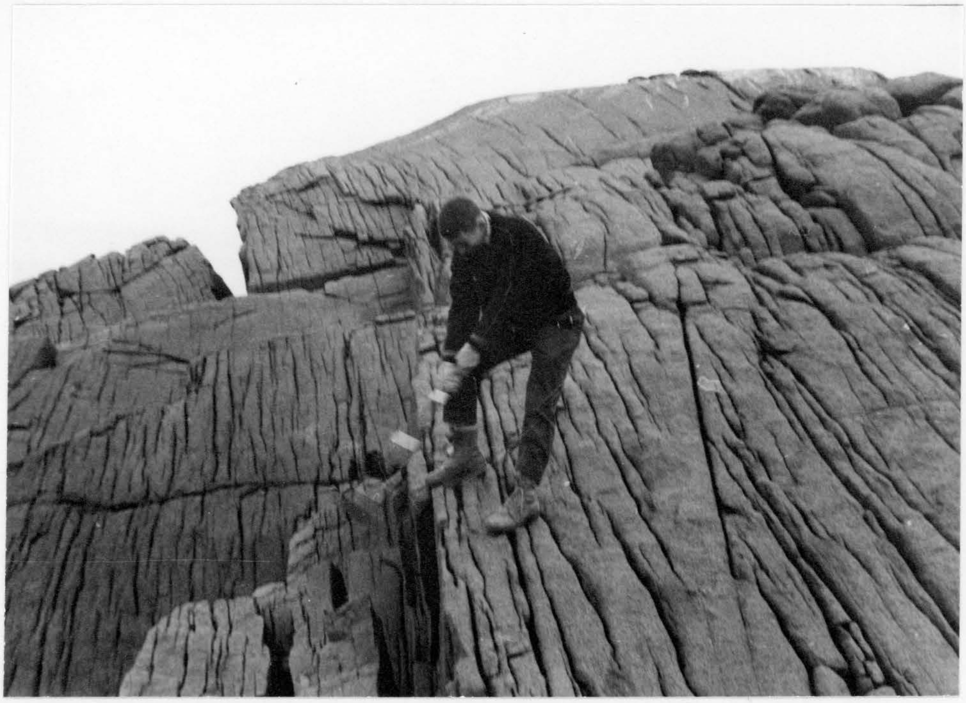


Figure 13 Master joints parallel to the dyke walls at West Ironbound Island.

Figure 14 Large equidimensional joint blocks at West Ironbound Island. The dark colored rock in the background is Halifax slate.

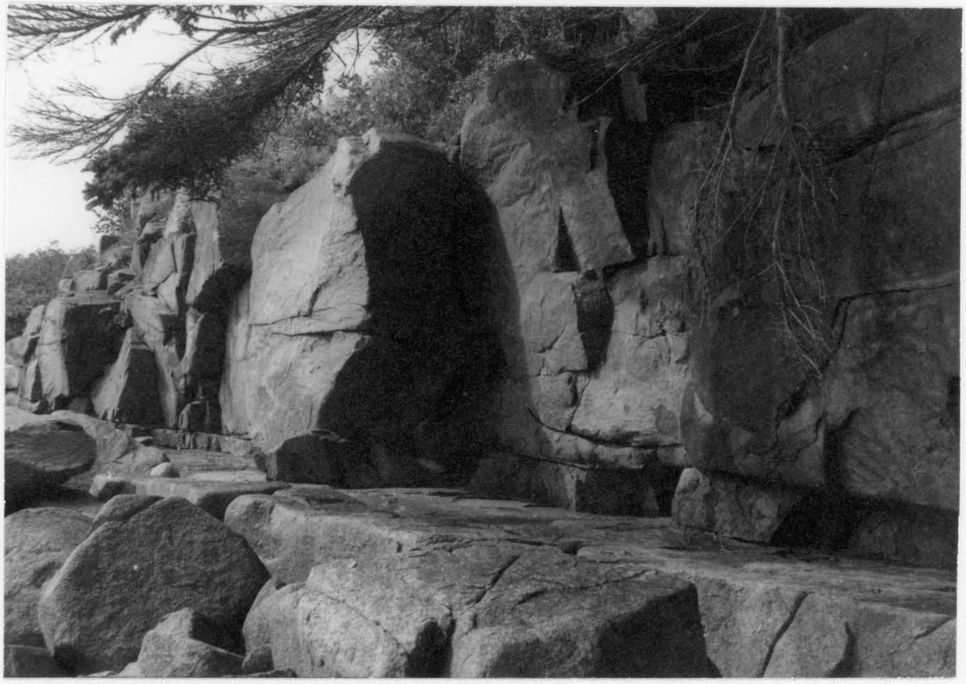


Figure 15 Jointing in the dyke at LaHave Island.

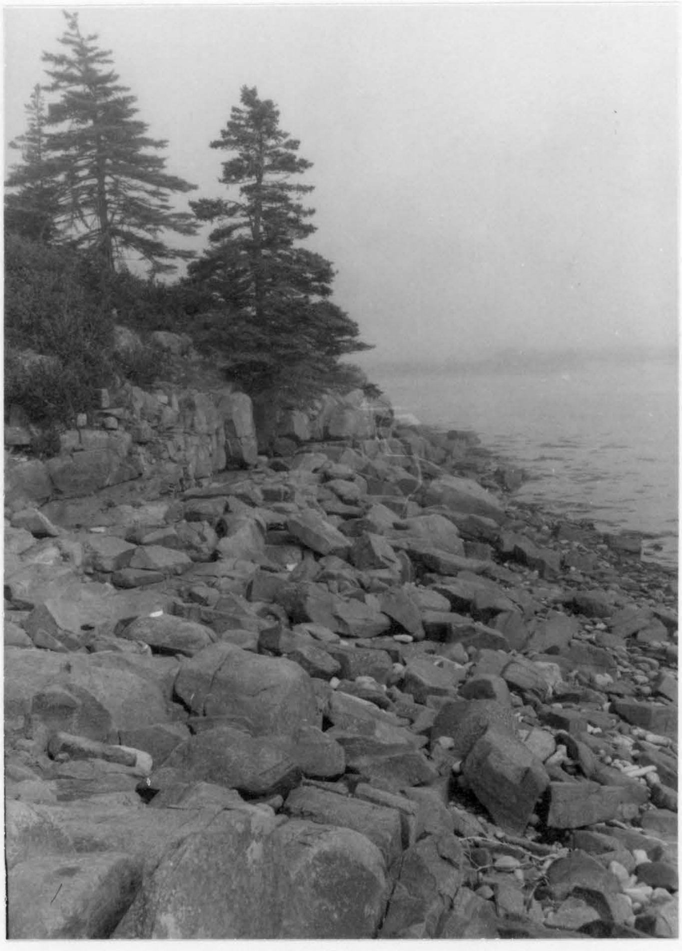


Figure 16 Equidimensional joint blocks at LaHave Island

hexagonal columns are formed on the cooling of basaltic material but conditions within the dyke were not favourable and these columns were not formed. Jointing within the dyke tends to form blocks which show polygonal outlines. (fig.15).

2.8 Weathering

The weathering of the dyke tends to give it a reddish brown color due to the oxidation of iron minerals. The depth and extent of this weathering is variable. In outcrops exposed to active transport, eg. headlands and islands, the weathering is found to be only a few millimeters thick, while in other areas it may extend over a foot into the rock.

Weathering starts along crack and joints, and extends downward and outward from these centers. This process may be observed in various stages. (fig.17 and 18). The first stage is the formation of thin friable weathered zones along the joints, which appear like small dykes; these very in thickness from one to several inches. These zones widen in time to a maximum of several feet. Because of their cross-cutting nature, large blocks or boulders are weathered out from the main mass of the dyke. These pieces continue to weather on their surfaces and they are

Figure 17 Weathering of joints at Apple Cove.

Figure 18 Weathered material has been removed from this joint by active transport. Photo taken at LaHave Island.

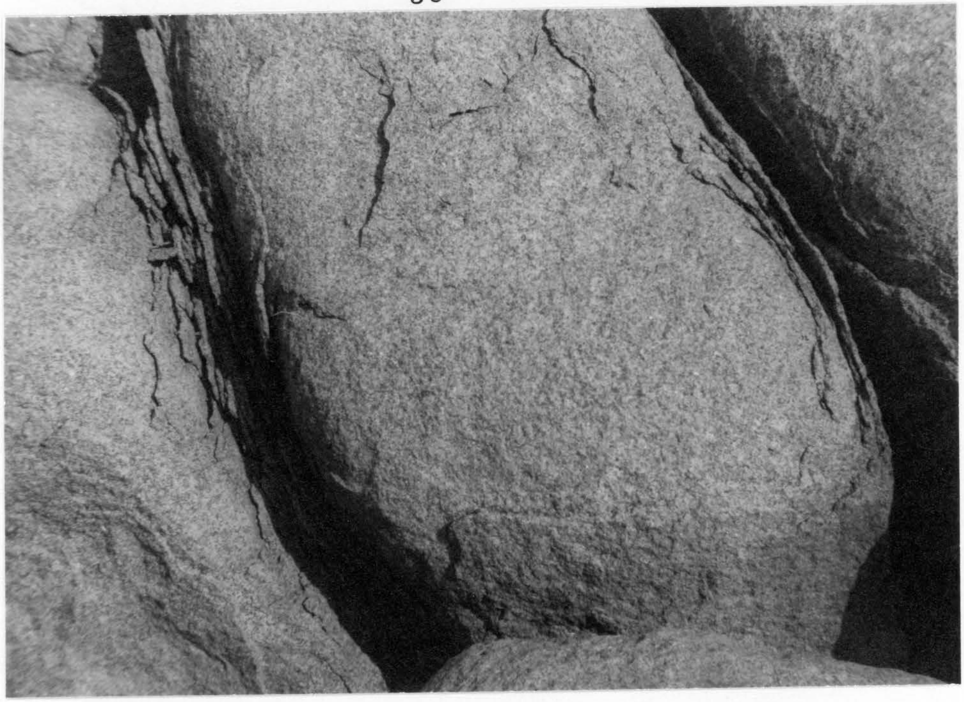


Figure 19 Exfoliation of diabase at LaHave Island. 1/5 natural size.

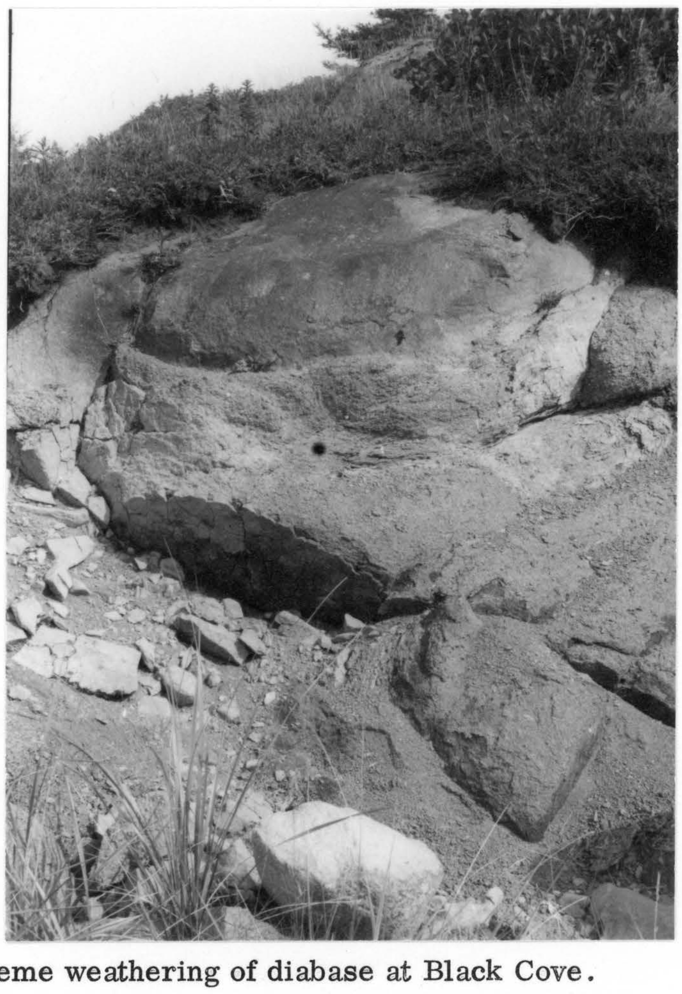


Figure 20 Extreme weathering of diabase at Black Cove.

reduced in size by a process of exfoliation. (fig. 19 and 20). This process appears to be a combination of mechanical and chemical weathering.

Mechanical weathering is observed in exposures where ice wedging and the physical action of the sea have acted along joints and fractures, resulting in the removal of relatively large and unweathered blocks of material from the face of the outcrop, (fig. 15).

CHAPTER III

PETROLOGY

3.1 Methods

Thin sections were made from a representative set of samples taken along the length of the dyke and from across the width of the dyke at Robert's Mountain, Little Rocky Mountain, Jordan Falls, LaHave Island and West Ironbound Island.

The microscopic investigantion was divided into three phases; 1. general observations 2. modal analysis 3. detailed examination of minerals.

General Observations

Thin sections of 72 samples were observed under low and medium power to ascertain the various mineral phases present. Where necessary more detailed observations were carried out in order to identify the minerals.

Modal Analysis

Modal analysis was done by the point count method, using 1000 points per section. It was found that a count of less than about 750 did not give reproducible results. A count of 1000 points was used for convenience and it is estimated that the reproducibility is in the order of one or two percent. It must be realized that there are possibilities for error: statistical error, identification mistakes, gross blunders such as recording mistakes, and incorrect traverses. There is also the possibility that the slide counted is not representative of the rock or that the traverse grid is not of suitable size.

In the counting procedure a Zeiss mechanical stage was mounted on a Zeiss Junior Microscope and observations were made on medium power (80X or 128X).

In the coarse-grained thin sections the minerals were tabulated under the following headings: plagioclase, clinopyroxene, orthopyroxene, graphic intergrowth, ore minerals, calcite, amphibole and biotite, apatite, and calcite. In the chilled margins of the dyke, where the groundmass was fine-grained or glassy, the tabulation was: plagioclase, clinopyroxene, and orthopyroxene phenocrysts, and groundmass. For detailed tabulations see appendix 1.

Detailed Examination

Minerals and their relations were determined by standard methods. Optical orientation of feldspars and pyroxenes and measurement of 2V were made on a Leitz 5-axis universal stage.

Plagioclase compositions were determined by the Michel-Levy and Carlsbad-Albite extinction methods; occasional checks were made using the Rittmann zone method.

For the pyroxenes, the values of 2V were measured in ordinary white light and comparison to graphs (Hess, 1949) was made in order to estimate their composition.

In the determination of the type of feldspar associated with quartz in the granophyric intergrowths, the sodium-cobaltinitrite staining technique was used because optical methods were hindered by the small size of the grains and their close interrelationships.

Photomicrographs were taken with an Asahi Pentax Spotmatic 35mm camera mounted on a Zeiss Junior Microscope. The optics used were the microscope objectives in conjunction with an 8X kpl eyepiece.

Chemical

Two sets of samples were prepared for chemical analysis. The first set consisted of ten three-inch blocks trimmed on a diamond saw so as to have only clean unaltered material. These samples represent a cross section of the dyke at West Ironbound Island. These samples were sent to the Geological Survey of Canada to be analysed.

A second set of samples was prepared in anticipation that they would be analysed within the Geology Department at Dalhousie University. However, only a partial analysis of six samples was completed at the time of writing.

3.2 General Character

Composition

The Great Dyke of Nova Scotia is of variable composition. The most abundant minerals are a grey or white plagioclase and a dark green or black pyroxene. The pyroxene is of two types, orthopyroxene and clinopyroxene; the total percentage is always less than the plagioclase. A granophyric intergrowth of quartz and potassium-feldspar is common throughout the rock, with the exception of the chilled margins where it is not found. The minerals magnetite, ilmenite and pyrite are usually found as small grains throughout the rock; larger skeletal grains of magnetite and ilmenite are also observed. Olivine was observed in a few samples as altered resorbed grains; inclusions in later formed minerals. Apatite is ubiquitous. The major minerals give rise to secondary minerals: the most common are epidote and sericite from the plagioclase; and hornblende, and sericite from the plagioclase; and hornblende, biotite and chlorite from the pyroxenes. The average mineral composition of the dyke, based on the modal analyses (appendix 1), is as follows:

Plagioclase	55%
Pyroxene	30%
Granophyric Intergrowth	10%
Other	5%
Total	100%

Of course, this tabulation is simplified and variations from this are common. The rock may be classified as a quartz-diabase or quartz-dolerite, but the term quartz-gabbro is more fitting for the coarse-grained phases. The composition is compared with that of Triassic diabases (table 1) from other localities and with that of some British quartz-diabases (fig. 38). The modal analyses of the dyke thin sections are given in appendix 1.

Although no definite trends were observed along the length of the dyke, there were some local pecularities. Robert's Mountain is characterized by the presence of amygdules, and at West Ironbound Island orthopyroxene is found in greater abundance than at any other location.

Trends observed in cross sections of the dyke were; an increase in the grain size away from the contacts, the absence of granophyric intergrowth in the chilled margins of the dyke, the relative scarcity of orthopyroxene in the coarse phases of the dyke and the relative abundance of the same mineral in the chilled margins.

Texture

The size and mutual relationships of the mineral grains are most variable, and it is according to these criteria that the main phases of the dyke may be recognized. Most of the dyke is holocrystalline with the exception of the immediate contact zone which has a glassy or cryptocrystalline groundmass. Simplifying it may be said that the chilled margins of the dyke exhibit a diabasic texture, while the coarse phases show sub-ophitic to diabasic texture. The range in the size of crystals is great, from less than 0.1mm to 5mm. In the well-crystallized phases of the dyke the normal size of the crystals is from 0.5 to 2mm, while in the chilled margins the grain size is usually 0.1 to 0.5mm.

There are also two important mineral textures. One is a granophyric intergrowth of quartz and alkali-feldspar which have crystallized as a eutectic, filling the spaces between the earlier crystallized substances. The second is reaction rims which are common on the pyroxenes. Alteration of the pyroxenes gives rise to brown uralitic hornblende, which in turn alters to chlorite. Both minerals mantle the original pyroxene, which is often bleached.

Order of Crystallization

The diabasic texture, the better formed crystals of plagioclase, and the appearance of small, well-formed crystals of plagioclse as inclusions in pyroxene, indicate that the plagioclase has in part crystallized before the pyroxene. Orthopyroxene was contemporaneous with plagioclase crystallization while the clinopyroxene was in part contemporaneous with plagioclase and in part later than the plagioclase. Partly resorbed and altered remains of olivine indicate the earlier crystallization of this mineral. Euhedral apatite needles and small grains of magnetite, ilmenite, and pyrite which are ubiquitous, were among the first minerals to crystallize out from the magma. The sequence of crystallization is believed to be as follows: apatite and ore minerals, olivine, plagioclase, pyroxene, (in part contemporaneous with plagioclase) with the orthopyroxene before the clinopyroxene, and then the alkali feldspar and the quartz as a eutectic. The other minerals found are alteration products.

3.3 Rock Types

Glassy Contacts

The name glassy contacts applies only to the dyke rock which is immediately adjacent to the country rock and which extends inward for about 1/4-inch from the contact. This may be considered as a glassy skin which formed by the very rapid cooling of the magma as it was injected into the dyke fissure. Because of this rapid cooling the glassy contacts represent the composition of the original magma, (assuming that there has been no assimilation of the country rock into the magma).

The groundmass of this rock is brown to black glass with crystallites of apatite, magnetite, plagioclase and pyroxene. Farther from the contact the groundmass quickly becomes more definitely crystallized. Throughout, there are many fine cracks; some of which contain calcite, hematite, and chlorite. These cracks run, in many cases, across the contact into the country rock. The rock consists of 75 percent groundmass (fig. 21). The remaining 25 percent of the rock is made up of microphenocrysts

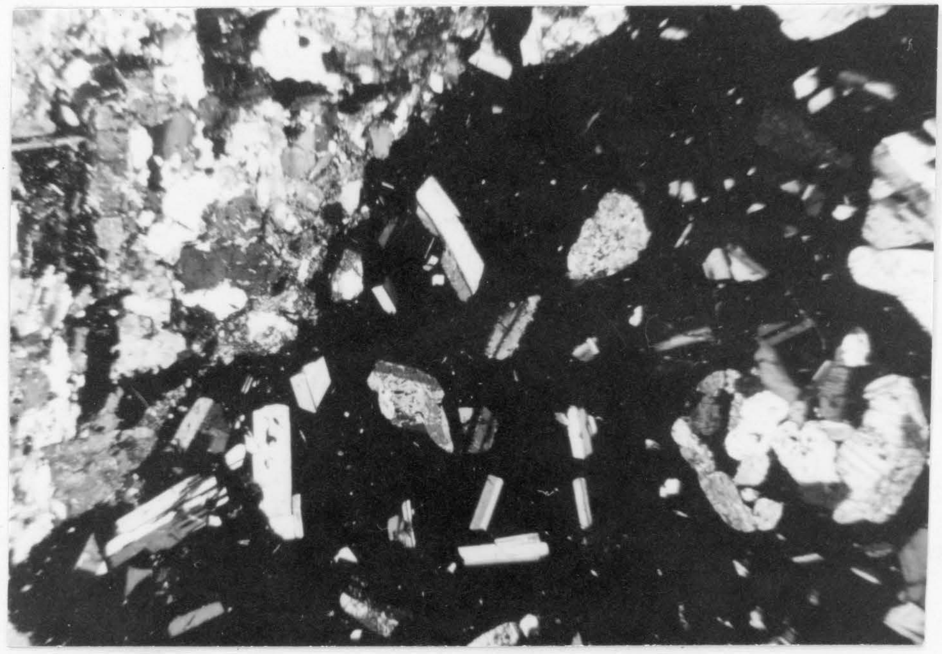


Figure 21 Contact of the dyke with Devonian granite. Note the phenocrysts of plagioclase and pyroxene in the glassy groundmass. Photo taken under crossed nicols. Magnification 20X

Figure 22 Chilled margin of the dyke about two inches from the contact with the slate. Sample from La Have Island. Note the phenocrysts of plagioclase as individuals and the pyroxene as groups. Photo taken under crossed nicols. Magnification 20X.

of several minerals which range in size from 0.1 to 1mm. The most abundant phenocrysts are plagioclase feldspar; they constitute about 12 to 15 percent of the rock. Determinations on these grains indicate a composition of up to 75 percent anorthite. Zoning is observed in many crystals. The feldspars are usually observed as separate discrete phenocrysts and are often surrounded by, or included in, later-crystallizing groups of pyroxene. Extinction on many crystals is wavy.

Both orthopyroxene and clinopyroxene are observed. The orthopyroxene forms as large euhedral phenocrysts up to 1mm in length. They are characterized by their size and by parallel extinction. Plagioclase is a common inclusion in the orthopyroxenes. Orthopyroxenes frequently show an alteration along cleavages and, more intensely, along fractures parallel or nearly parallel to (001). The alteration appears green and chloritic and is believed to be antigorite. Orthopyroxene is generally well crystallized; in many cases the (010) and (100) faces are better formed than the terminations, which tend to be ragged and ill-formed. All orthopyroxene have a weak birefringence and a large 2V. According to their 2V, these pyroxenes would be called enstatite.

The clinopyroxene is not as well formed nor as large as the orthopyroxenes. It is common to find these anhedral crystals in groups, though individuals are observed. These clusters of clinopyroxene often surround laths of earlier-formed plagioclase but the opposite condition was not observed. The clinopyroxenes contain numerous small inclusions of mostly dark, and often opaque, crystallites. These pyroxenes are colorless but may show a slight tint of purplish brown color; they are not pleochroic. They have a stronger birefringence than the orthopyroxenes and a larger extinction angle; twinning along (100) twin plane is frequent. These pyroxenes are identified as augite.

Chilled Margins

The chilled margins are the material which has crystallized more quickly than the main mass of the dyke due to its more rapid cooling. This rock occurs in the zone between the glassy contacts and the coarse-grained phase of the dyke. This zone extends from 1/4-inch to 15 or 20 feet from the contact with the country rock. Within this zone there is a gradational change from a rock which is 70 per cent fine-grained groundmass to a rock in which all the crystals approach the same size (fig. 23).

At about one inch from the contact it was found that the rock was 70 per cent groundmass and the grain size was less than 0.01mm. The remainder of the rock was phenocrysts of plagioclase and pyroxene with grain sizes from less than 0.25 up to 2mm. Farther from the contact the proportion of groundmass decreases and that of the phenocrysts increases. Also, the grain size in the groundmass increases. At a distance of three or four inches from the contact, the groundmass has dropped to 68 per cent and the grain size has increased to 0.05 or 0.1mm (fig. 22). At about eight inches from the contact the groundmass has been reduced to about 60 per cent and the crystals are 0.1 to 0.2 mm. Four feet from the contact, the groundmass is only 40 per cent and the grain size has increased to about 0.5mm. Fifteen to twenty feet from the contacts, all the crystals have reached the same size and no distinct groundmass is found any more. The texture in most cases is microporphyritic. In the coarse parts, farthest from the contacts, the groundmass has an ophitic to sub-ophitic texture; the subhedral plagioclase laths form a network and the other minerals occupy the spaces between the plagioclase laths. Even if the groundmass is ophitic, the over-all texture would be considered porphyritic because of the phenocrysts of plagioclase and pyroxene. It is noted that the plagioclase and the orthopyroxene phenocrysts are euhedral individuals, while the clinopyroxene is usually found as clusters of anhedral crystals.

The groundmass is composed essentially of plagioclase and pyroxene and lesser amounts of magnetite and minor minerals. The plagioclase is seen as slender laths and is relatively unaltered. The pyroxene is characteristically altered and, in most cases, has a green color due to its alteration to chlorite. Brown hornblende and biotite are often present. The magnetite is observed as anhedral and euhedral grains, disseminated throughout the groundmass. Close to the contact the ore minerals appear to be more plentiful and better formed; farther away from the contacts the crystals tend to more diverse shapes and sizes. Examination under reflected light reveals an intergrowth between magnetite and ilmenite in the larger irregular crystals.

The phenocrysts in this rock amount to about 25 per cent in areas close to the contact and increase away from the contacts as the groundmass decreases; farther away, there will be no phenocrysts whatever. Plagioclase forms 50 to 65 per cent of the phenocrysts, while, the pyroxenes amount to 30 to 50 per cent. Usually the orthopyroxene is less than half that of the clinopyroxene.

The plagioclase is similar to that described in the glassy contacts but the composition may be slightly more sodic (about An_{70}). Twinning is conspicuous; Albite, Carlsbad, and combinations of the two types are common. Pericline twinning is less common. Many crystals are zoned.

The orthopyroxenes 2mm in length are the largest crystals. They are more severely corroded and altered than the plagioclase or the clinopyroxene. The alteration in many cases completely replaces the entire crystal. These alteration products are brown, yellow, or often colorless; they have weak birefringence. Where the alteration is less marked it has a green color. These alteration products are believed to be calcite and antigorite. Common inclusions are small well-formed crystals of plagioclase. These pyroxenes are identified as enstatite.

The clinopyroxenes, similar to those in the glassy contacts, are found in groups or clusters of anhedral crystals, often surrounding larger laths of plagioclase. These pyroxenes are more birefringent, less altered, and are smaller than the orthopyroxenes. Twinningis also very common. Detailed examination indicated that these are augite. Pigeonite was not identified as a phenocryst but it is probable that this mineral exists in the groundmass. Clinopyroxenes are altered to uralitic or brown pleochroic hornblende, biotite, and chlorite, all of which are observed as reaction rims surrounding the pyroxenes.

Normal Diabase

Normal diabase constitutes the bulk of the dyke rock; over 95 per cent. This material is found in the central portion of the dyke; it is bounded on either side by the chilled margins. The rock differs from those previously mentioned in that it has cooled more slowly and thus there is a marked difference in the grain size, texture, and the amounts of the various minerals (fig. 24).

The texture is variable but in most cases subophitic or diabasic. All minerals have approximately the same size (about 1 to 3mm). The feldspars are equidimensional to lath shaped, with euhedral to subhedral forms predominating;

Figure 23 Chilled margin of the dyke about 12 feet from the contact The ratio of groundmass to phenocrysts is about 1:1. Photo taken under crossed nicols. Magnification 20X.

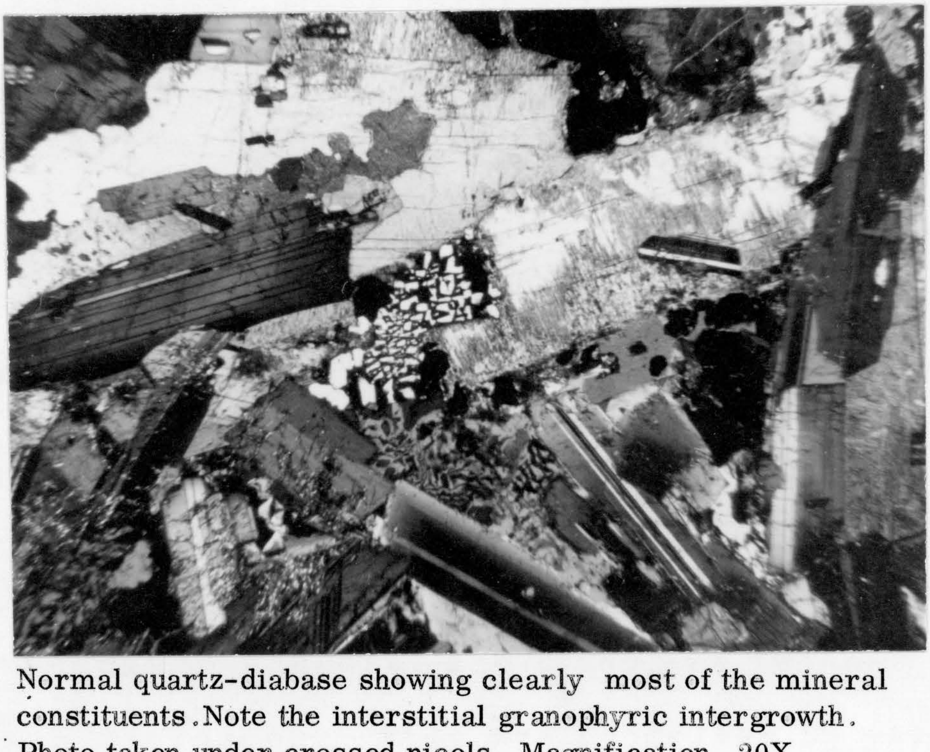


Figure 24 Normal quartz-diabase showing clearly most of the mineral constituents. Note the interstitial granophyric intergrowth. Photo taken under crossed nicols. Magnification, 20X.

pyroxenes are usually equidimensional and anhedral. The interstitial habit of the quartz and the alkali-feldspar is conspicuous as a striking granophyric or micropegmatic eutectic intergrowth. At Robert's Mountain some of the samples show an apparent vesicular texture which is caused by the filling of the interstices with glass, quartz-feldspar intergrowth, zeolites, chlorite and calcite. The vesicular appearance is caused by the radiating habit of the zeolites.

The minerals found in the normal diabase are, in order of abundance, plagioclase, pyroxene, quartz and alkali-feldspar (as an intergrowth), ore minerals, chlorite, biotite, amphibole, and apatite.

The plagioclase constitutes about 50 per cent of the rock and has a composition in the labradorite range. The crystals range in size up to 3mm; they are always twinned and frequently zoned. The plagioclase is fresh and relatively unaltered, although a white flaky alteration product is often observed.

The predominating pyroxene is augite; it forms about 30 per cent of the rock. The crystals are subhedral to anhedral and many are twinned. Under the microscope, they are colorless to pale brown; in some cases there is a slight purple tint but they are not pleochroic. Individual well-formed crystals are rare, while aggregates of differently orientated anhedral grains are the usual habit. Randomly-orientated anhedral grains of another pyroxene of the same or slightly higher relief, and with approximately the same birefringence are common as inclusions. Due to their small 2V, they are believed to be pigeonite. On many of the longitudinal sections of augite there are very fine lines or striations at, or nearly at, right angles to the crystal outline. These are believed to be exsolution lamellae of pigeonite.

These pyroxenes are altered to uralitic amphipole, brown biotite, and chlorite which often form reaction rims.

The orthopyroxene is usually not more than one or two per cent in the coarse-grained diabase and seems to be restricted to the chilled margins. The notable exception to this is at West Ironbound Island where up to 8.5 per cent of orthopyroxene is found. LaHave Island rocks show a few per cent orthopyroxene, while other locations have less than one per cent. When found in the normal diabase it is in all respects similar to that already mentioned under chilled margins.

Quartz and alkali-feldspar are the next most abundant minerals. These two minerals occur as individual grains but much more commonly they are observed as a eutectic intergrowth filling the spaces between the previously crystallized minerals. The intergrowth is found only in the coarse-grained phases of the dyke and never in the chilled margins. On the average, the rock is about ten per cent granophyric intergrowth. The close relationship of these two minerals makes optical determination difficult. The feldspar appears altered and more cloudy than the quartz. Staining of the alkali-feldspar makes it easier to distinguish between the two minerals. Within any one unit of intergrowth, all the quartz has the same optical orientation; similarly all the feldspar grains have the same optical orientation. It is not known if there is any relationship between the orientations of the two minerals.

The ore minerals, magnetite, ilmenite, and pyrite, constitute about three per cent of this rock type. The pyrite is found only as a few small grains scattered throughout the rock; it is estimated that their total volume is less than one half of one per cent. Magnetite and ilmenite are found as small grains, but more commonly as large (up to 5mm) skeletal crystals.

Apatite, in long slender needles is ubiquitous. Other minerals, (hornblende, biotite, calcite, sericite, epidote, etc.) are believed to be alteration products.

Inclusion

Only one inclusion was found within the dyke. This inclusion was found on the northeastern shore of West Ironbound Island, it measures about one foot by six inches. It is a fine-grained, dark grey rock. The contact between the inclusion and the diabase is very well defined. The shape of the inclusion is smooth and well rounded; there are no sharp or angular corners.

The main mineral constituents of the inclusion are plagioclase, orthoclase and quartz; present in minor amounts are biotite and opaque minerals. Mineral identification was difficult because of the small grain size and the turbid and altered nature of the minerals.

The feldspars are altered and often closely associated with the quartz, which makes the estimate of their relative abundance difficult. Plagioclase crystals are smaller than the orthoclase and are more intensely altered. The feldspars and the quartz form over 80 per cent of the rock.

The biotite forms about 10 per cent of the inclusion. Half of the biotite has been stained a brick red color by the iron oxide of the altered opaque minerals.

Many of the opaque grains show a brassy color in reflected light; they are identified as pyrite. The rest of the opaque minerals are magnetite and hematite.

It is obvious that the constituents of the inclusion are different from those of the diabase. It is evidently an inclusion of foreign material.

If the country rock (slate) were to be assimilated by the dyke and be recrystallized it is possible that it would form an inclusion like that described above. Since the slate is chemically equivalent to a granitic rock and the inclusion is thought to be very similar, the author suggests that it is country rock material.

Summary of Rock Types

The main characteristics of each of the main rock types discussed are listed below:

Glassy Contacts

This rock type is characterized by the dark glassy groundmass, the small percentage of phenocrysts of plagioclase and pyroxene and the microporphyritic texture.

Chilled Margins:

The chief characteristics of this rock type are: the ophitic texture of the groundmass, the presence of phenocrysts, the absence of granophyric intergrowth, and the presence of large altered orthopyroxene crystals.

Normal Diabase:

The chief characteristics of this rock type are: the black and white spotted appearance in hand specimen, the subophitic or diabasic texture, the large grain size (one to three mm), the presence of abundant granophyric intergrowth, and the relative scarcity of orthopyroxene.

3.4 Mineral Constituents

Plagioclase

The amount of plagioclase varies from 43.4 to 61.8 per cent in the crystalline phases of the dyke. The usual range is between 50 and 55 per cent while the average of all samples studied is 51.3 per cent. In the chilled margins of the dyke, plagioclase is found in the groundmass and as phenocrysts. The amount of plagioclase as phenocrysts averages about 13 per cent.

The plagioclase varies from An_{63} to An_{75}; thus it is, for the most part, labradorite. In the chilled margins the anorthite content is as high as 74 to 75 per cent and is always higher than in the center of the dyke where it averages 66 per cent.

The crystal size of the feldspars ranges from barely visible under the microscope up to 3mm in length. In the contact zones, small euhedral phenocrysts from 0.3 mm to 1 mm are found embedded in glassy material. Toward the center of the dyke, the size of the crystals increases to a maximum of about 3 mm. These crystals are usually well-formed laths.

Cleavages are found in two prominent directions, (001) and (010) cleavages are perfect to good, and intersect at angles of about 93 degrees. A poor cleavage may be seen parallel to (110). Fractures in various directions may also be seen in many crystals.

There are numerous inclusions of small anhedral (0.1 to 0.5 mm) crystals of more calcic plagioclase; accurate determination of their composition was difficult. Other inclusions are small pieces (0.1 mm) of opaque material which were not identified.

The feldspar crystals are generally idiomorphic, but in several areas there is a fading of the feldspar into adjacent quartz alkali-feldspar intergrowths. It appears that there has been some interaction between the quartz and the feldspar. This will be discussed in more detail under the heading "Granophyric Intergrowth".

In most cases the feldspars are quite fresh and unaltered. Where alteration is observed it is along small fractures, most of which seem to be at right angles to the elongation of the lath-shaped crystals. Often the alteration appears as a flaky material on the surface of the mineral. The alteration products appear to be epidote, sericite and saussurite.

Twinning of the plagioclase was observed in all samples. The most common twinning is polysynthetic according to the albite law. Carlsbad and pericline types of twinning are also common. Combinations of the carlsbad and albite twins are extremely common. Zoning is not extensive but may be seen on sections cut nearly parallel to (010).

The optical properties are as follows: colorless, non pleochroic, low relief, maximum birefringence weak (.008 to .009), extinction normal to (010) according to the albite law varying from 36 to

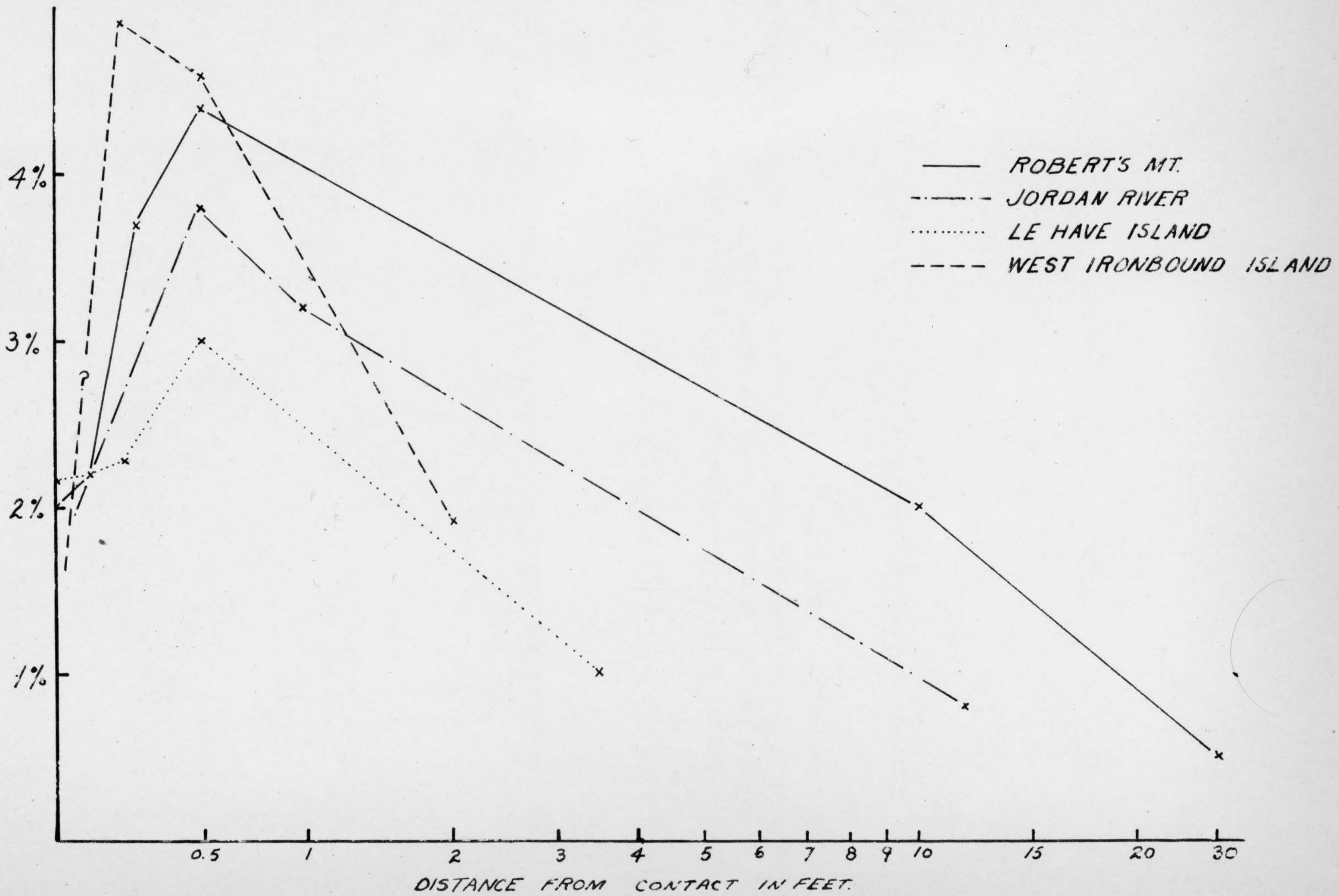
42 degrees, interference figure biaxial positive, 2V very large.

Orthopyroxene

The amount of orthopyroxene is generally less than one per cent, with the exception of the LaHave-Ironbound area and contact areas. At West Ironbound Island the orthopyroxene concentration is abnormally high; it averages about 2.3 per cent in the well-crystallized part of the dyke. This represents a marked divergence from the orthopyroxene content found elsewhere in the dyke. In all contact areas examined, there is a concentration of orthopyroxene (fig. 25). At the contacts the orthopyroxene averages 1.8 per cent, it rises to a maximum, averaging four per cent six inches from the contact, and then declines steadily as the normal diabase is approached. A base level of less than 0.5 per cent is usually reached 15 to 20 feet from the contacts. It is quite possible that the content of orthopyroxene is slightly higher than stated, because sections at right angles to the c-axis appear very similar to the clinopyroxenes.

On the basis of ten measurements of 2V, the pyroxene was determined to be enstatite.

Orthopyroxenes occur as euhedral to subhedral elongated prisms or laths. The



ORTHOPYROXENE CONCENTRATIONS fig. 25
AT DIKE CONTACTS

DEL Jan 8 1966

Figure 26 Large orthopyroxene crystal in the fine grained groundmass of the chilled margin . Note the small included lath of feldspar. Photo taken under crossed nicols. Magnification, 20X.

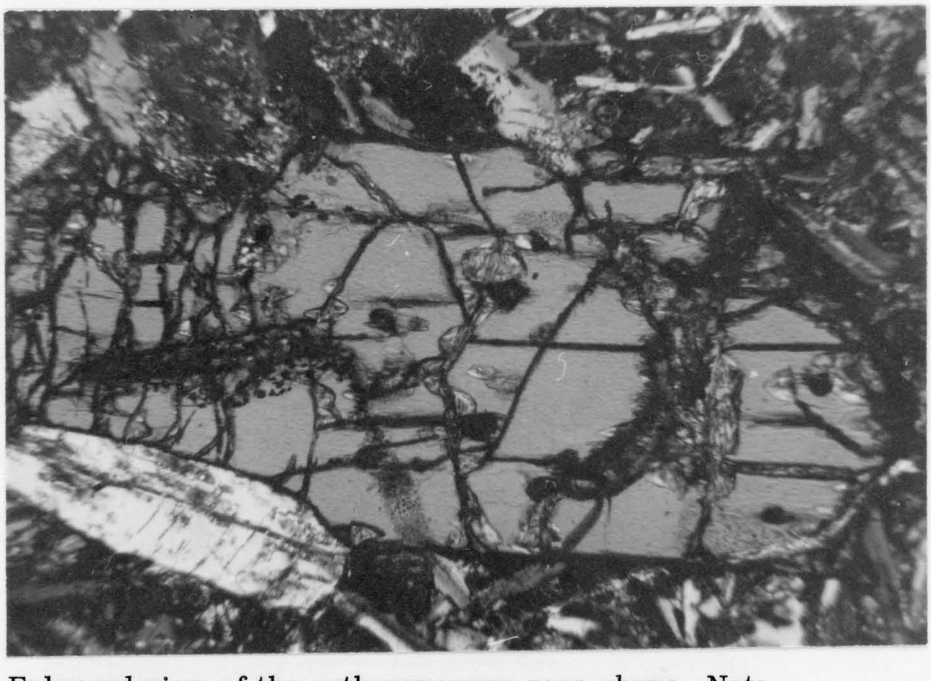


Figure 27 Enlarged view of the orthopyroxene seen above. Note the alteration along cracks. Magnification, 90X.

orthopyroxenes are always the largest crystals, and are colorless. In the chilled margins, they are observed as microphenocrysts 0.8 to 2 mm in length, while in other areas they are slightly less well-formed and may be up to 4.5 mm in length (fig. 26 and 27). Normal cleavage occurs parallel to (100) and (010). Irregular distinct fractures cutting across the cleavage are common in longitudinal sections. Euhedral and anhedral plagioclase and a few resorbed olivine grains are the only noteworthy inclusions in the orthopyroxenes.

There is some alteration along the prominent fractures and around crystal borders resulting in a greenish material, probably antigorite. In some cases the orthopyroxene has been completely replaced by secondary minerals which are pseudomorphic.

The optical properties are as follows: colorless; high relief; maximum birefringence 0.009; extinction parallel or nearly so to the cleavage and crystal outlines; orientation length slow: interference figure, biaxial positive; 2V, 84 to 90 degrees.

Clinopyroxene

Clinopyroxene is the second most abundant mineral; it constitutes from 17 to over 40 per cent of the rock. In the chilled margins the pyroxenes occur in the groundmass and as phenocrysts. The phenocrysts usually constitute from eight to fifteen per cent of the rock of the chilled margins.

Generally the clinopyroxenes are smaller than the feldspars; they vary in size from barely visible (in the contact areas) to a maximum of about 2 mm (in the coarse phases of the dyke). In the chilled margins the phenocrysts occur in groups or clusters rather than as single isolated crystals, and are subhedral to anhedral. The crystals are usually short and prismatic with four or eight sided cross-sections (fig. 28).

There are two good cleavages which form angles of about 90 degrees in sections normal to the c-axis. These cleavages are seen parallel to (100) in longitudinal sections. There are also numerous irregular fractures.

Twinning is very common with (100) as the twin plane, but zoning is much less frequent.

In the clinopyroxenes, small anhedral crystals of plagioclase feldspar as well as smaller specks of opaque material are plentiful as inclusions. Small, irregular, fresh pyroxenes of a different type also occur as inclusions. The included pyroxene has a much smaller axial angle than the host pyroxene.

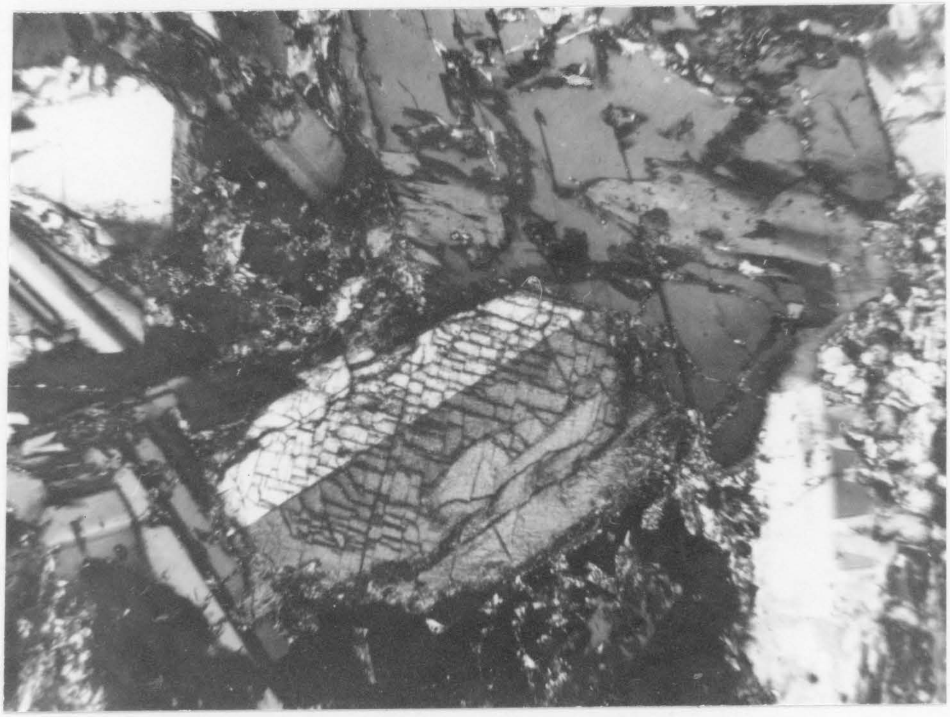


Figure 28 Subhedral augite crystal showing twinning and cleavage. Photo taken under crossed nicols. Magnification, 20X.

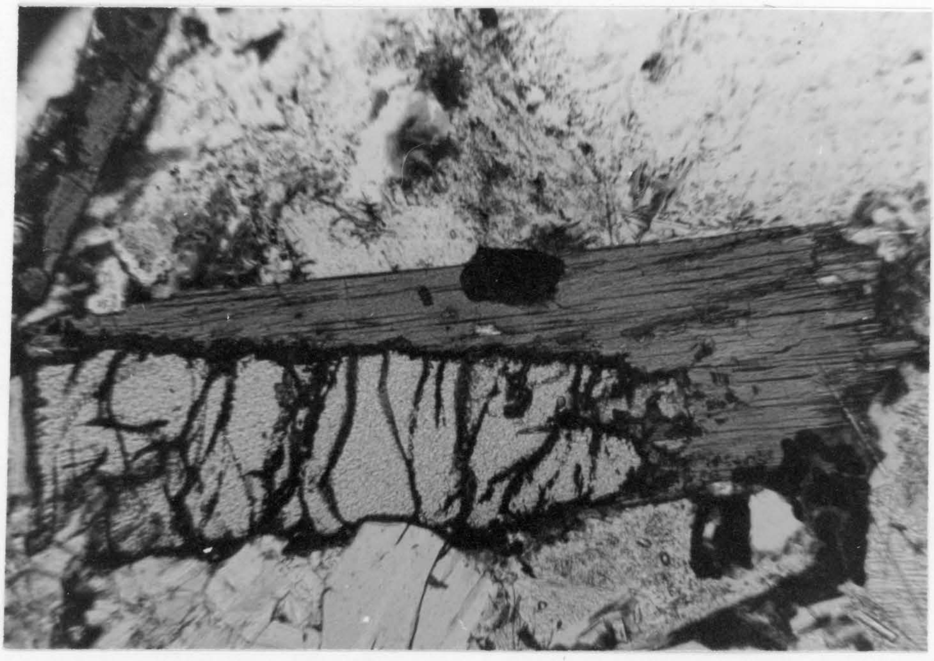


Figure 29 Augite with a reaction rim of hornblende. Photo taken in plane light. Magnification, 90X.

This would indicate that the host pyroxene is augite and the included mineral is pigeonite. These two pyroxenes are very similar in all respects except the axial angle.

On some augite grains, exsolution lamellae were observed. According to Deer et al, (1963)

> The lamellae orientation in respect to the augite is, however distinctive; orthopyroxene lamellae are exsolved parallel to the (100) plane, and the pigeonite lamellae parallel to the (001) plane of the augite host.

Since the lamellae observed were parallel to the (001) plane of the augite, they were considered to be pigeonite.

Reaction rims of brown or uralitic hornblende often surround the original pyroxene (fig. 29). This, in turn, is usually enclosed by a layer of chlorite. Also present are biotite and magnetite in small amounts. The alteration also takes place along cracks within the crystals and around the borders.

The optical properties of the clinopyroxenes are as follows: colorless or pale brown to purplish, high relief, moderate birefringence (maximum, second order), extinction in longitudinal sections 25 to 45 degrees from the cleavage traces, interference figure biaxial positive, 2V for augite varies from 48 to 60 degrees and for the pigeonite less than 20 degrees.

Granophric Intergrowth

This intergrowth is not a mineral but a combination of two closely associated minerals which are impossible to treat separately; thus they were counted as a single phase, and are so discussed here.

The amount of the intergrowth ranges between 3 and 21 per cent. In the chilled margins it is not found, but in the coarse diabase it averages about nine per cent.

The intergrowth is interstitial to all other minerals. In most cases it seems to be in close association with the plagioclase (fig. 30). It occurs in various sizes from small blebs (0.05 mm) to more extensive areas (0.6 or 0.7 mm in diameter). Staining showed that the feldspar is potassium bearing.

The quartz in most sections is clean and clear and shows sharp contact with the alkali-feldspar which is turbid and cloudy in appearance. The ratio of quartz to feldspar was not determined but was estimated as 1:2.

Within an intergrowth unit, the optical orientation of all quartz grains is the same. The feldspars of the unit have a common orientation also, but not that of the quartz.

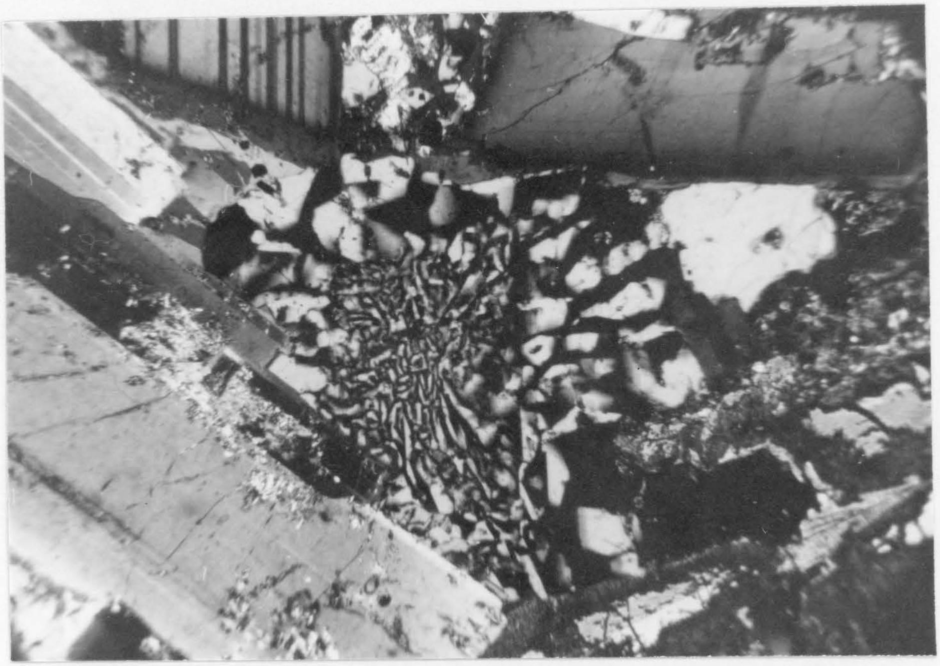


Figure 30 Graphic intergrowth. Note the radiating texture and the interstitial habit. Photo taken with crossed nicols. Magnification, 90X.

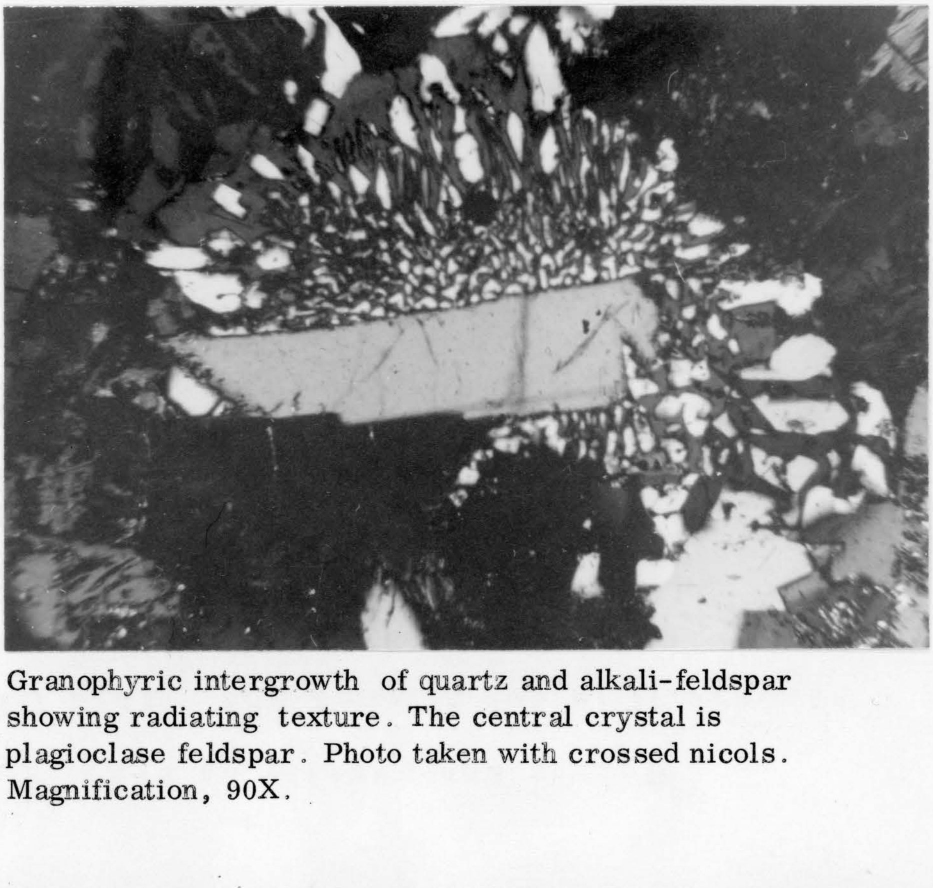


Figure 31 Granophyric intergrowth of quartz and alkali-feldspar showing radiating texture. The central crystal is plagioclase feldspar. Photo taken with crossed nicols. Magnification, 90X.

Quartz can usually be readily identified because it is not altered and turbid like the alkali-feldspar. The initial identification of the feldspar was made by staining methods.

In several instances a reaction between the plagioclase and the intergrowth is observed. It appears as if the quartz and the plagioclase have intergrown to form a zone of myrmekite; a similar intergrowth was observed between two plagioclase crystals (fig. 35). In the vast majority of cases the boundaries between the granophyre and the adjacent minerals, including the plagioclase, are very sharp and distinct.

The textural variations of the intergrowth are interesting but are not fully understood. Some of the main textural types observed are described as follows:

a.) Graphic: This type is characterized by the angular or cuneiform shapes of the quartz which appears distinctly against a background of alkali-feldspar. The boundaries between the quartz and the feldspar are distinct (fig. 32 and 33).

b.) Radiating: This pattern is characterized by a rosette arrangement. The particles radiate outward from a central point or area which is often a small

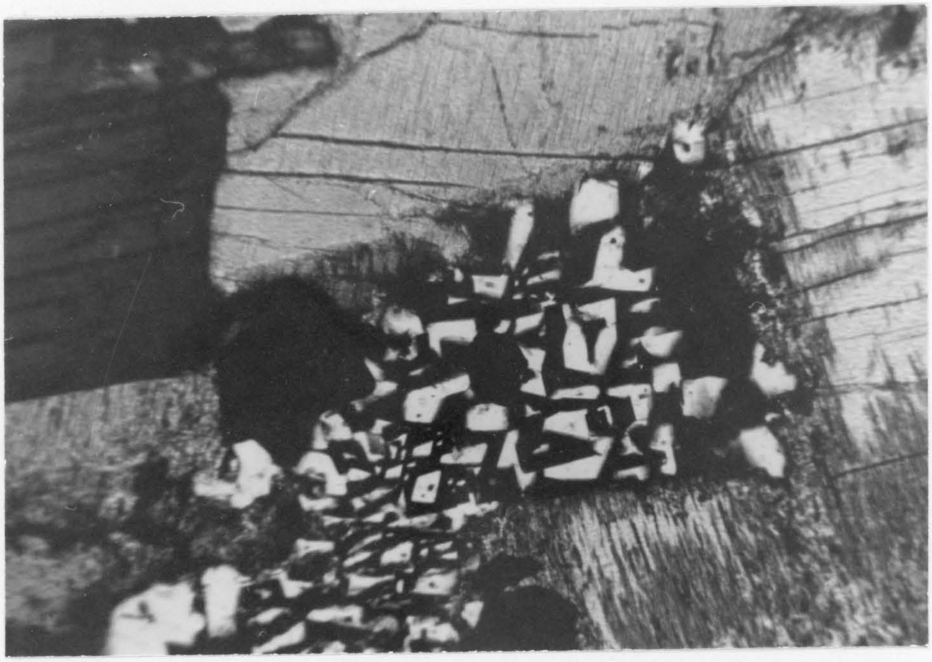


Figure 32 Graphic intergrowth of quartz and alkali-feldspar. Note the cuneiform habit of the quartz. Photo taken with crossed nicols. Magnification, 90X.

Figure 33 Radiating graphic intergrowth. Photo taken with crossed nicols. Magnification, 90X.

quartz grain or a larger feldspar (fig. 31). The quartz may be seen as distinct grains with sharp boundaries or as irregular blebs or elongated patches, usually with more diffuse grain boundaries.

c.) Dendritic: These intergrowths are usually found around the circumference of one of the other intergrowth types. The pattern appears as crooked primary stems with smaller second and third order branches growing outward in various directions (fig. 34).

d.) Diffuse: In rhis type the boundaries between the quartz and the alkali-feldspar are very cloudy and indistinct. In some locations, notably Robert's Mountain, the intergrowth appears extremely fine grained.

Minor Minerals

Ore Minerals

The ore minerals include magnetite, ilmenite, pyrite and hematite. These minerals constitute about three per cent of the rock; locally the percentage may be as high as 6.1 or as low as 1.8 per cent. In the chilled margins it is believed that the ore minerals may account for as much as eight to ten per cent of the rock.

Small pyrite crystals are found scattered throughout the rock; they are recognized by their

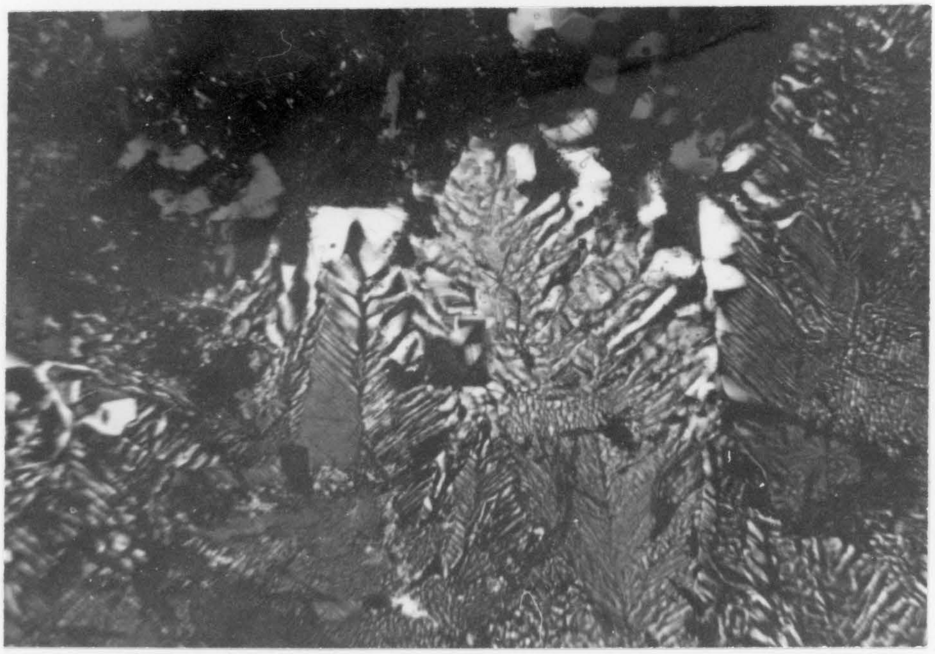


Figure 34 Dendritic granophyric intergrowth. Photo taken with crossed nicols. Magnification, 130X.

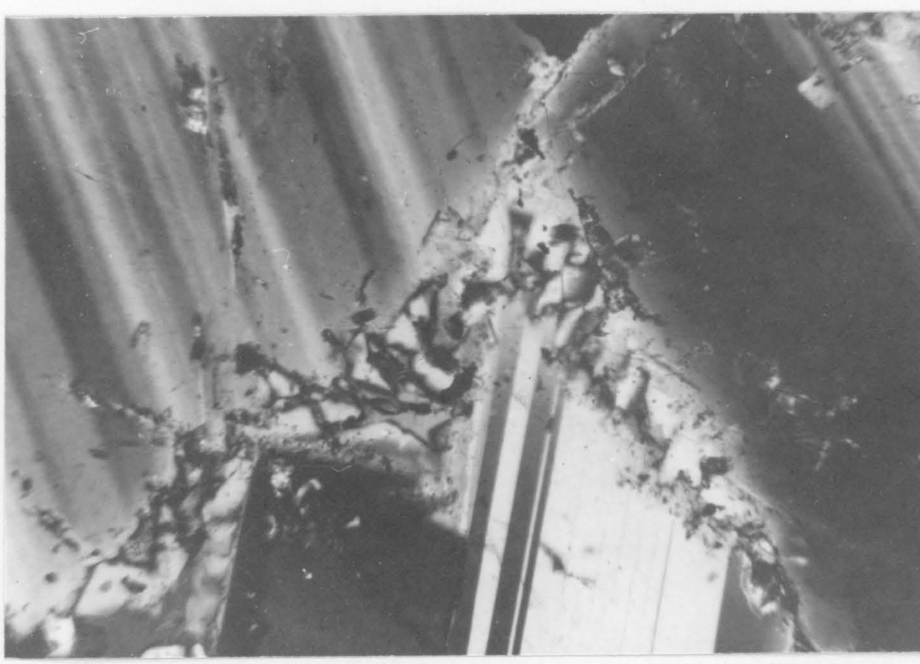


Figure 35 Reaction zone around a plagioclase crystal. Photo taken with crossed nicols. Magnification, 130X.

bright metallic lustre in reflected light. The pyrite is usually found in association with chlorite and ore minerals.

The hematite was observed infrequently as thin red flakes which under reflected light appear dark and opaque.

Primary magnetite is found in the chilled margins of the dyke as small anhedral to euhedral grains distributed throughout the groundmass. Secondary magnetite is found in association with chlorite derived from altered pyroxenes.

Ilmenite and magnetite also occur as large skeletal crystals up to 5 mm in length (fig. 36 and 37). In reflected light, some grains show lamellae of a lighter-colored material. These lamellae are believed to be ilmenite.

Alkali-feldspar

The alkali-feldspar, as previously described, usually occurs as an intergrowth with quartz but sometimes it occurs as irregular, clouded and often as altered grains. The feldspar has a refractive index slightly lower than the associated quartz. No twinning has been detected. Therefore, it is presumed to be orthoclase or anorthoclase.

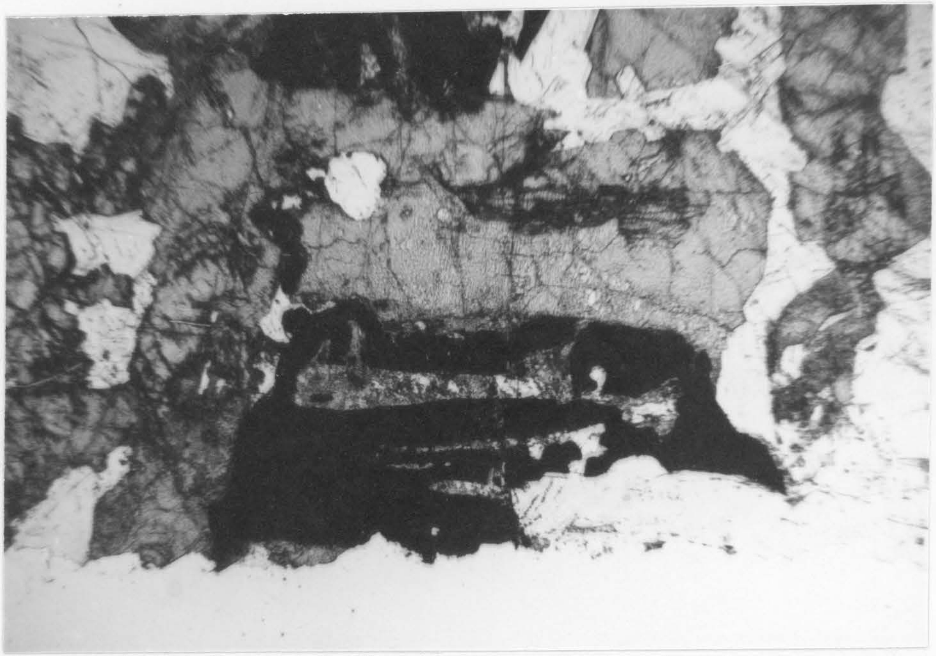


Figure 36 Large skeletal crystal of magnetite. Photo taken in plane light. Magnification, 20X.

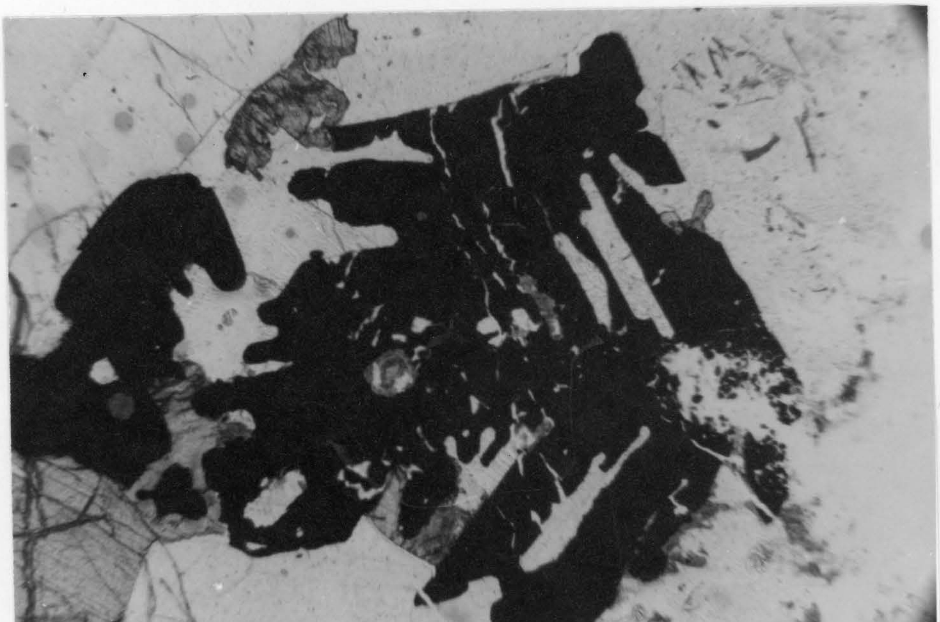


Figure 37 Large skeletal crystal of magnetite with intergrown ilmenite. Photo taken in plane light. Magnification, 20X.

Quartz

Quartz is found in intergrowth with the alkali-feldspar. It is present also as single irregular interstitial grains.

Olivine

Olivine was observed as small resorbed and altered grains in several thin sections. They are recognized by their high relief, anhedral shape and extensive alteration. Optical determinations were difficult due to the small size and the alteration.

Apatite

Apatite is a very minor constituent. It is found as very long, slender, colorless prisms with straight extinction; perpendicular to (001)- they appear as hexagonal prisms. It is most conspicuous where the rock is coarse grained.

Amphibole

Brown uralitic amphibole and hornblende are found in small amounts as an alteration product of pyroxene. In aggregates and in anhedral crystals these minerals show pleochroic brown colors but in places they may be bleached to almost colorless.

Biotite

Brown pleochroic biotite is found as an alteration of pyroxene and it is often associated with amphibole and chlorite.

Chlorite

The amount of chlorite is variable. It appears as aggregates and it is an alteration product of the pre-existing pyroxenes, hornblende and biotite. Chlorite is, in many cases, found in reaction rims around pyroxene.

Calcite

Calcite is a very minor mineral. It is found in patches or filling cracks within the rock. This mineral was introduced to the rock after consolidation.

3.5. Comparison With Other Diabases

A comparison of the petrology of the Great Dyke of Nova Scotia with other diabases shows that they are very similar. The Triassic diabases of the eastern United States, which were emplaced at about the same time, show some similarity.(table 1).

Also the Whin Sill and the tholeiite dykes of Great Britain (fig. 38) are very similar in mineral compositions to the Great Dyke of Nova Scotia.

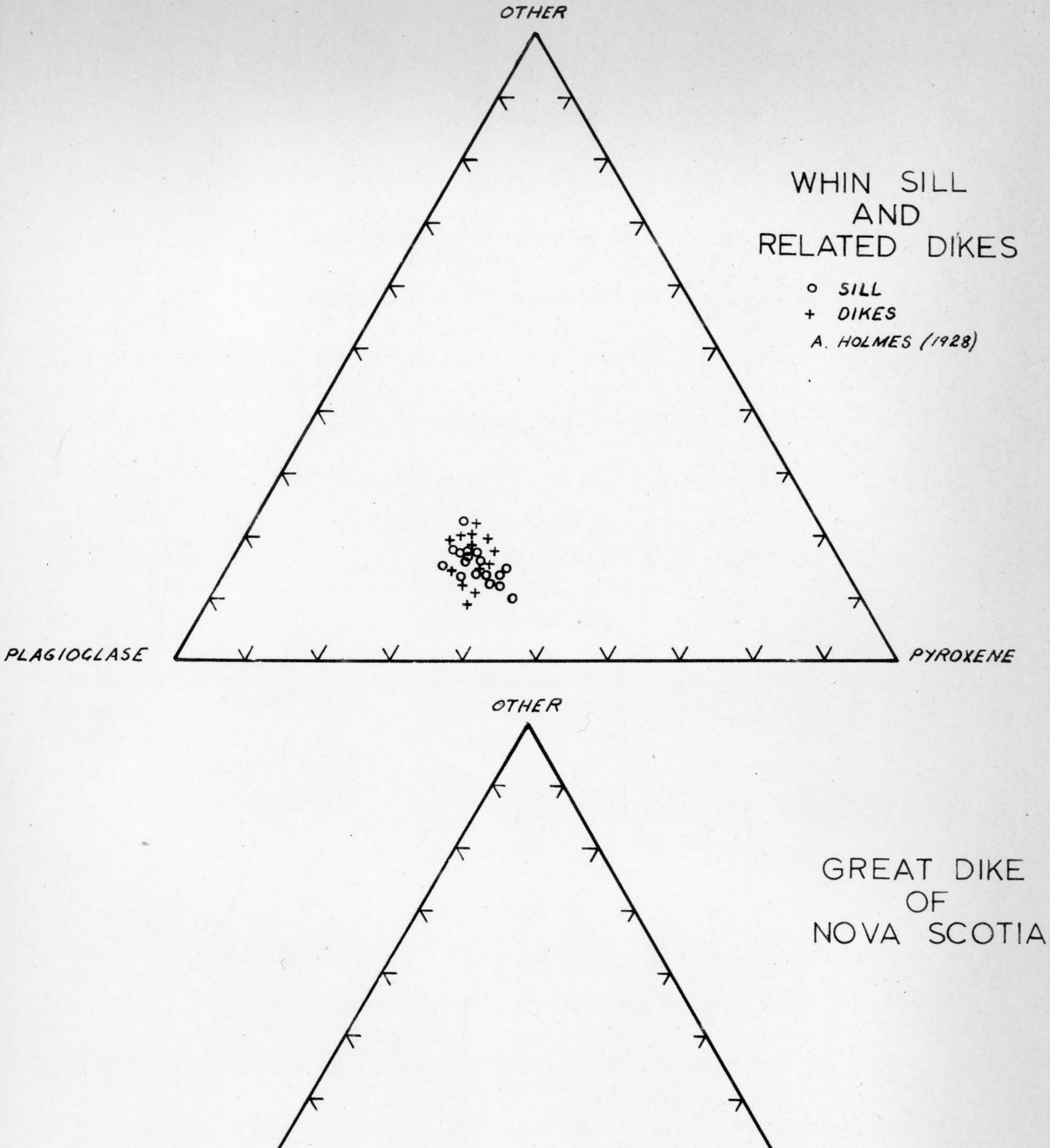
TABLE 1

MODAL COMPOSITION OF SOME TRIASSIC DIABASES

1-6 From Stose and Lewis (1915)
7-10 Great Dyke of Nova Scotia (1966)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Quartz	19	7	-	-	-	-	17	8	10	9
Feldspar	44	42	37	20	38	18	49	54	48	51
Pyroxene	27	34	59	73	46	58	27	34	33	33
Biotite	3	-	-	1	1	1	2	1	1	-
Olivine	-	-	1	4	13	20	-	-	-	-
Magnetite	7	17	3	2	2	3	2	2	3	4
Other	-	-	-	-	-	-	3	2	5	4

(1) Quartz-Diabase Holmstead, N.J.
(2) Quartz-Diabase Jersey City, N.J.
(3) Diabase The Palisades, Englewood Cliffs, N.J.
(4) Diabase The Palisades, Englewood Cliffs, N.J.
(5) Olivine-Diabase The Palisades, Weehawken, N.J.
(6) Olivine-Diabase The Palisades, Englewater, N.J.
(7) F5 Quartz-Diabase Great Dyke, Little Rocky Mt., Shelburne, N.S.
(8) F8 Quartz-Diabase Great Dyke, Little Rocky Mt., Shelburne, N.S.
(9) Q9 Quartz-Diabase Great Dyke, Black Cove, N.S.
(10) S4 Quartz-Diabase Great Dyke, West Ironbound Island, N.S.



COMPARISON
OF
MINERALOGY

fig. 38

DER Feb '66

The description of these diabases indicates that the textures and mode of occurrence are also similar; this holds especially true for the Triassic diabases of the Newark system in the United States.

The basaltic rocks of the adjacent Triassic basin (North Mountain) are very similar in their mineralogy. The ranges of composition of the North Mountain and the Great Dyke are compared below.

MINERAL	NORTH MOUNTAIN Lund (1930) and Hudgins (1960)		GREAT DYKE	
Labradorite	38-50%	av. 50%	45-60%	av. 51%
Augite	20-40%	av. 30%	18-45% (Augite and Pigeonite)	av. 30%
Pigeonite	0-15%			
Orthopyroxene			0-5%	
Glass and Magnetite	5-10%		10-30%	av. 18%

3.6 Chemistry

The chemistry of the Great Dyke of Nova Scotia has been compared with that of similar rock types in other parts of the world. Tabulations of the oxides and of the Niggli numbers for the Great Dyke and seven other areas are given (table 2). The Niggli numbers of these rocks were used to calculate the basis-group values Q, L, and M (Burri, 1964) which are graphically presented in figure 39.

TABLE 2

CHEMICAL ANALYSES OF THOLEIITIC ROCKS
FROM DIFFERENT PARTS OF THE WORLD
(See also figure 39)

	(A)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SiO_2	52.0	52.65	51.50	52.5	51.91	50.25	50.83	45.78
Al_2O_3	14.8	16.23	13.69	15.4	15.31	13.76	14.07	14.64
Fe_2O_3	2.2	0.51	3.25	1.2	0.98	3.87	2.88	3.16
FeO	7.7	8.21	6.97	9.3	9.31	8.50	9.06	8.73
MnO	0.14	0.15	0.16	0.2	0.08	0.16	0.18	0.20
MgO	6.3	6.84	7.85	7.1	7.52	5.42	6.34	9.39
CaO	9.7	11.34	10.54	10.3	9.71	9.09	10.42	10.74
Na_2O	2.6	1.58	2.49	2.1	2.30	2.42	2.23	2.63
K_2O	2.2	0.90	0.84	0.8	0.79	0.96	0.82	0.95
H_2O	1.3	1.33	1.24		1.18	2.27	0.91	0.76
TiO_2	1.06	0.58	1.00	1.0	1.25	2.39	2.03	2.63
P_2O_5	0.14	0.01	0.33	0.1	0.08	0.26	0.23	0.39

NIGGLI VALUES

	(A)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
al	21	23	20	21	22	21	20	18
fm	43	42	48	46	46	46	46	50
c	26	30	25	26	26	25	27	25
alk	9.6	5.2	7.1	6	6.4	7.7	6.4	6.9
si	128	127	125	124	124	129	123	97
ti	2	1.2	1.9	1.9	1.8	4.6	3.6	4.2
p	.15		.29	.14	.14	.31	.14	.38
k	.35	.28	.2	.19	.18	.22	.21	.15
mg	.54	.59	.59	.55	.59	.45	.49	.59

(A) Great dyke of Nova Scotia, average of 7 analyses (G.S.C., 1966).
(1) Undifferentiated Tasmanian dolerite, average of 6 analyses (A.B. Edwards, 1942).
(2) North Mountain basalts, Nova Scotia, average of 15 analyses (Walker and Parsons, 1922 and Lund, 1930).
(3) Karoo dolerite, average of 43 analyses (Walker and Poldervaart, 1949).
(4) Average Undifferentiated Palisades diabase (Walker, 1940).
(5) Whin Sill, average of 6 analyses (Holmes and Harwood, 1928).
(6) World average tholeiitic basalt, average of 137 analyses (Nockolds, 1954).
(7) World average alkali basalt, average of 96 analyses (Nockolds, 1954).

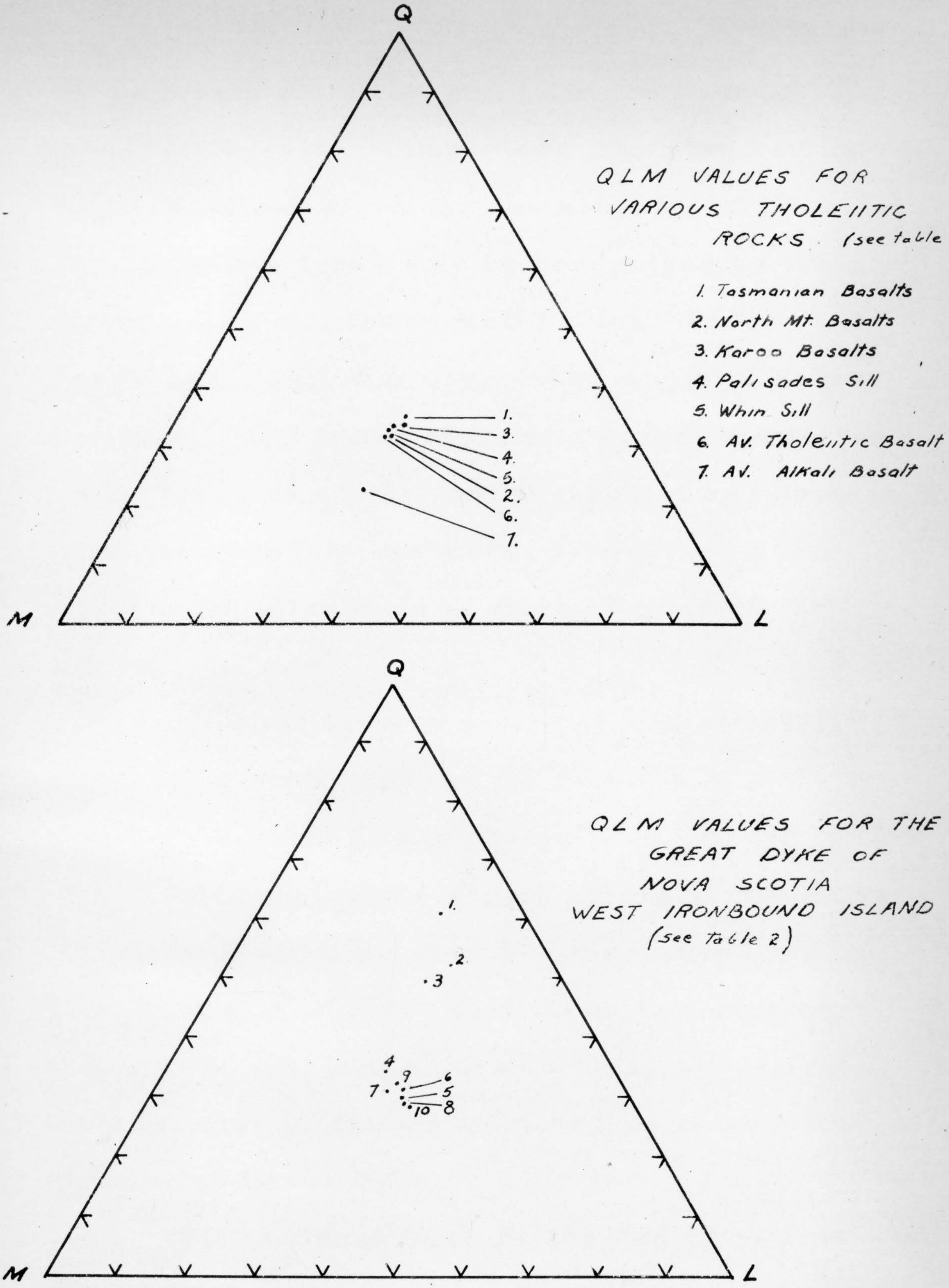


FIG. 39

QLM VALUES FOR SOME THOLEIITIC ROCKS

D.E.L. MAK

It may be seen that the Great Dyke compares very closely with that given for the average tholeiitic basalt. Comparison may also be made with the values given for the average alkali basalt. The tholeiitic types may be recognized by their higher SiO_2 and lower MgO values. Turner and Verhoogen (1951) state that Na_2O and K_2O values are also lower in the tholeiitic types than in the alkali types of basalt, but it may not be obvious from the chemical analyses. These and other differences often become more obvious in the Niggli values.

In comparing the dyke to other tholeiitic rocks it is noted that the fm value is slightly lower, and the alk value is substantially higher.

Comparing the Niggli values of the North Mountain basalts and those of the Great Dyke of Nova Scotia it is noted that there is a remarkable similarity. All values are in close agreement, with the exception of the alk value which is abnormally high in the Great Dyke.

If the Great Dyke is derived from a parent magma with a composition similar to that given for the average tholeiitic basalt, (table 2 No. 6) addition of K_2O at the expense of the femic oxides is apparent.

The mechanism for this addition has not be explained.

Variations in the chemical composition across the dyke at West Ironbound Island are given (table 4) and are graphically represented (fig. 40) This set of samples was analysed by the Geological Survey of Canada. Partial analyses of six samples of the normal diabase (analysed at Dalhousie) from various locations along the dyke are given below.

TABLE 3
CHEMICAL ANALYSES OF THE GREAT DYKE
(analysed at Dalhousie)

	(C1)	(F5)	(H5)	(N5)	(Q9)	(R10)	(av.)
SiO_2	51.9	52.2	53.7	53.3	53.3	53.9	53.0
Al_2O_3	16.4	16.1	16.1	15.0	15.0	14.9	15.6
Total Iron FeO	8.77	9.85	9.58	10.92	10.06	11.28	10.23
MgO	5.72	4.61	4.0	4.76	6.3	4.51	4.98
MnO	0.11	0.11	0.11	0.01	0.13	0.15	0.13
CaO	10.2	9.39	9.62	9.01	9.72	8.80	9.46
TiO_2	0.75	1.05	1.09	1.11	1.02	1.29	1.05

C1 Pubnico Lake N. S.
F5 Little Rocky Mt. Shelburne N. S.
H5 Jordan Falls N. S.
N5 Brystol N. S.
Q9 Back Cove N. S.
R10 LaHave Island N. S.
av. Average of the above analyses.

It is noted that the values of SiO_2, and Al_2O_3 are consistently higher and the values of MgO and FeO are constantly lower (Dalhousie analyses) than those from the material analysed by the Geological Survey of Canada. It is not known if these differences are real or if they are due to differences in analytical procedures.

Inspection of the six analyses done at Dalhousie (table 3) shows a trend from the south-western portion of the dyke (sample C1) to the northeastern portion of the dykè (sample R10). There is an increase in the SiO_2 and a decrease in the Al_2O_3 from the Pubnico Lake area to LaHave Island. It is not known if this trend is real or apparent. As the change is only about one per cent over a distance of over 70 miles, the author feels that it is not meaningful because a difference of one per cent could be found in samples taken only a few feet from each other. Also, the accuracy of the analyses is not high enough to delimit these differences.

It is noticed that the oxide profiles from the West Ironbound area (fig. 40) are in most cases flat and regular at a distance of more than 20 feet from the contact (rock type, normal diabase), although the K_2O values are erratic, and the Al_2O_3 value drops to a minimum about 50 feet from the contact. As the contact with the country rock (Halifax slate) is approached there is an increase

Table 4

CHEMICAL ANALYSES ACROSS THE GREAT DYKE OF NOVA SCOTIA
AT WEST IRONBOUND ISLAND
(analyses by G.S.C., 1966)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SiO_2	71.8	70.1	64.5	51.7	52.0	51.9	51.5	52.3	52.2	52.5
Al_2O_3	12.7	13.6	16.1	15.4	14.8	14.5	14.1	15.3	15.3	14.3
Fe_2O	1.9	3.4	3.5	3.1	2.2	2.7	2.3	1.3	1.8	2.1
FeO	2.0	2.6	3.0	6.7	7.7	7.0	7.1	8.3	7.8	9.2
MnO	0.05	0.07	0.09	0.02	0.17	0.15	0.17	0.16	0.18	0.20
MgO	1.7	2.4	2.5	6.5	6.7	7.0	6.7	6.5	5.9	4.7
CaO	0.5	0.4	0.6	10.0	9.8	9.9	10.0	9.7	10.2	8.5
Na_2O	3.3	2.6	2.8	2.5	2.5	2.7	2.6	2.6	2.7	2.9
K_2O	1.57	2.34	2.77	0.38	2.98	1.91	1.60	3.21	1.80	3.90
H_2O	2.2	2.7	2.8	1.6	1.2	1.6	1.4	1.1	1.2	1.2
CO_2	.1	.1	.1	.1	.1	.1	0.1	.1	.1	.1
TiO_2	0.57	0.67	0.75	1.11	1.06	1.06	1.06	1.06	1.1	1.06
P_2O_5	0.08	0.09	0.11	0.14	0.14	0.13	0.14	0.13	0.14	0.19
Total	98.4	101.0	99.6	99.3	101.3	100.6	98.7	101.7	100.3	100.8

(For oxide profiles and sample locations see figure 40)

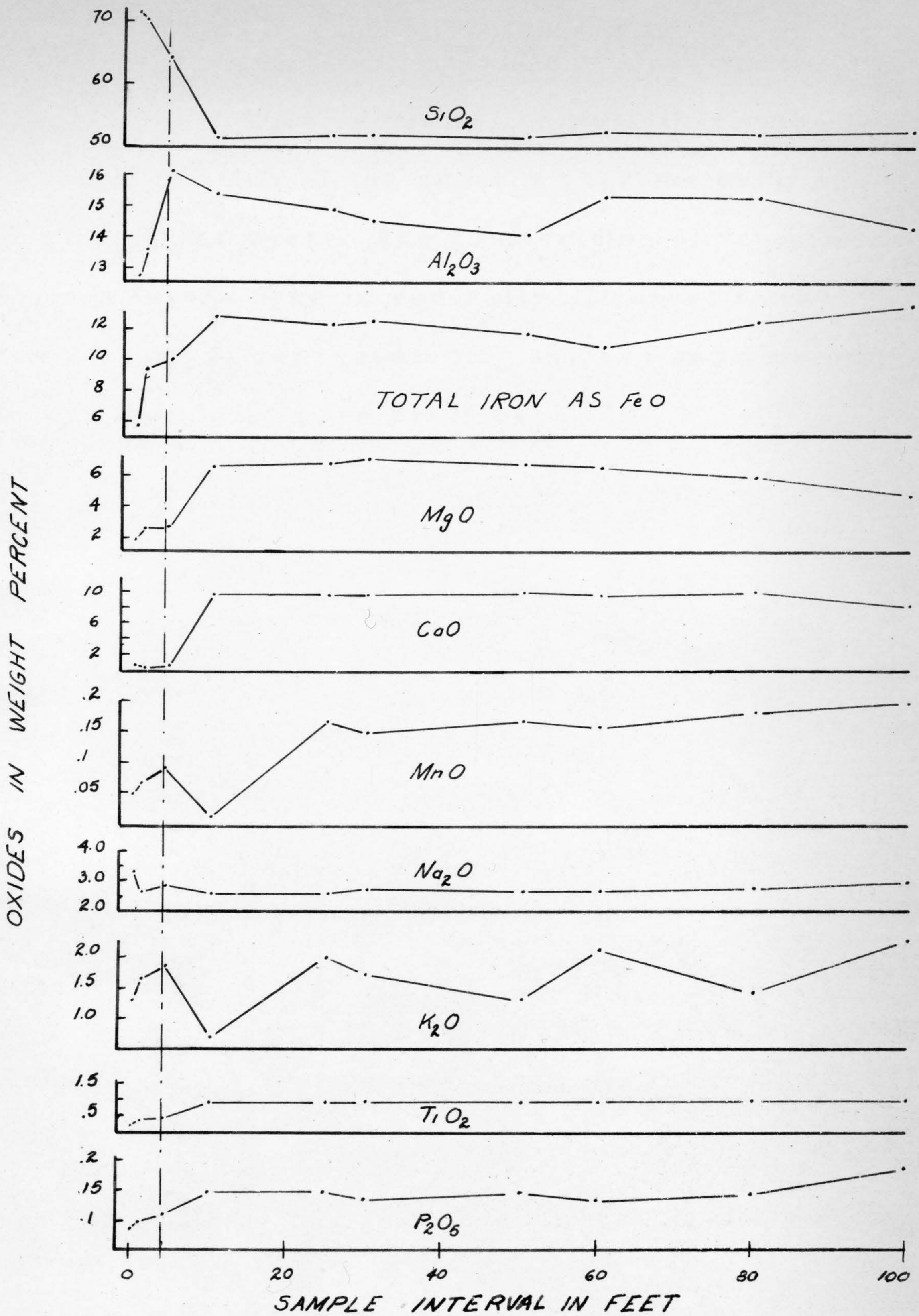


FIG. 40 CHEMICAL VARIATIONS ACROSS DYKE AT WEST IRONBOUND ISLAND

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in SiO_2 and Al_2O_3 at the expense of most of the other oxides. This seems to indicate that there has been assimilation of the country rock material into margins of the dyke. The composition of the slate adjacent to the dyke is radically different from the dyke and is represented by the two samples on the extreme left of the profiles.

CHAPTER IV

SUMMARY and CONCLUSIONS

In the late Triassic time, after the deposition of the majority of the clastic sediments which now fill the eastern Triassic Basins of the United States and Canada, there was a period of basic igneous activity. During this period large amounts of basalt were intruded and extruded along faults opened or reopened near the borders of the basins. The Palisades of New Jersey and the North Mountain of Nova Scotia give an idea of the large quantities of basalt involved in these flows and sills. Diabase dykes were also formed at this time; they are believed to follow tension cracks which were caused by the weight of the Triassic sediments deforming and buckling the crust. These dykes are common both within the basins and in the adjacent Paleozoic country rock. In most cases they are parallel or closely parallel to the basins (Stose and Stose 1944). Evidence of the rather quiet nature of this activity is indicated by the fact that there are only very small amounts of ash and pyroclastic deposits, although in small local areas this may not be entirely true.

There is very good evidence that the Great Dyke of Nova Scotia occupies one of the above mentioned tension cracks and that the dyke and the North Mountain basalts were derived from a common magma source at depth. Criteria used in the correlation of the Great Dyke of Nova Scotia and the North Mountain are their chemistry, mineralogy and their time-space relationship.

In comparing work done on the dyke with the work of Lund (1930) and Hudgins (1960) on the North Mountain basalts this author found that the minerals and their relative percentages were very similar. The North Mountain has been termed a tholeiitic basalt and the Great Dyke a quartz-diabase. It is realized that a comparison of lithology alone is not firm ground for correlation, especially when the rock types are so common throughout geological time and are so widely distributed.

Analyses of the dyke rocks support the statement that the North Mountain and Great Dyke rocks are very similar. It may be seen from the chemical data that both have originated from a tholeiitic magma. Further proof of their similarity is the fact that both have characteristically low fm values.

In the comparison of the ages of the dyke and the North Mountain there is also close agreement. The North Mountain basalts have been dated by the fossils found in sedimentary formations which lie both above and below them and have been determined to be Upper Triassic. The age of the Great Dyke has been determined by both radiactive and paleomagnetic methods. These indicate Upper Triassic.

In the light of the foregoing and considering that the dyke fits into the general picture for Newark igneous dyke rocks, the author correlates the Great Dyke with the North Mountain basalts thus making it a part of the Acadian Triassic.

Possibilities For Future Study

Below are listed a few of the studies which would appeal to the author as possible projects on the Great Dyke. Other interesting and profitable studies could also be developed.

1. A study, in detail of the graphic intergrowths within the dyke and their comparison to similar phenomena would prove to be a most interesting undertaking.

2. An attempt in the explanation of the Pubnico magnetic anomaly might develop into a worthwhile investigation.

3. From the economic point of view, the study of the weathering characteristicsand the search for dyke rock suitable for building might prove to be a profitable investigation.

APPENDIX No. I

MODAL ANALYSES OF DYKE THIN SECTIONS

The modal compositions given in the following table are based on a count of 1000 points on each slide.

The numbers tabulated are the volumes, in per cent, of the respective minerals, this includes their alteration products if they are clearly derived from that mineral and are not extensive. The pyroxenes are listed under two headings, orthopyroxene and clinopyroxene. The quartz and alkali-feldspar were not recorded separately because these two minerals are closely inter-related as a granophyric intergrowth and thus are recorded under intergrowth. "Ore minerals" includes magnetite, ilmenite and pyrite.

A horizontal dash (-) indicates that the mineral was not observed and an oblique bar (/) indicates that the mineral was observed, but in amounts less than 0.1 or 0.2 per cent. A blank space indicates that the mineral was not considered in that particular tabulation and was not counted. This is often the case when the groundmass was very fine and thus only the groundmass and phenocrysts were considered. The letters n. d. indicate that no determination was made.

APPENDIX No. 1

MODAL ANALYSES OF DYKE THIN SECTIONS
(for sample locations see maps in back cover)

Sample	Plag.	Clino-pyrox.	Ortho-pyrox.	Inter-growth	Ore	Chlorite	Amph. and Biotite	Apatite	Calcite	Ground mass	%An.
B1	50.4	29.8	-	8.3	6.1	2.6	2.8	/	-		66
B2a	49.2	27.8	-	13.5	4.0	2.3	3.2	/	-		69
B2b	50.2	28.2	0.6	13.1	4.0	3.3	0.6	/	-		64
C1	46.0	41.5	-	8.2	1.3	2.0	1.0	/	-		67
F1	60.3	17.5	-	16.1	2.9	/	3.2	/	-		64
F3	45.1	40.2	-	10.9	1.7	1.3	0.8	/	-		64
F5	49.0	27.4	-	17.4	1.8	1.2	1.9	/	1.3		70
F6	47.9	23.1	-	23.9	1.4	2.2	1.0	/	0.5		64
F7	57.0	25.0	/	12.8	3.0	1.7	0.5	/	-		70
F8	53.5	34.3	/	8.0	2.1	0.9	1.3	/	0.1		68
G1	46.2	38.1	-	6.0	2.2	5.1	2.3	/	-		70
H1Ca	19.6	8.7	/							71.7	73

Sample	Plag.	Clino-pyrox.	Ortho-pyrox.	Inter-growth	Ore	Chlorite	Amph. and Biotite	Apatite	Calcite	Ground mass	%An.
H1Cb	19.6	8.7	/							71.7	73
H1C-1	14.1	6.9	3.2							75.9	68
H3	43.4	29.0	/	13.5	5.4	5.1	3.6	/	-		68
H4	56.0	23.3	-	13.7	3.5	2.9	0.6	/	/		70
H5	50.5	28.4	-	14.7	4.4	2.0	0.9	/	/		68
I3	55.5	15.8	-	19.4	4.2	2.1	3.0	/	-		66
I6	52.0	22.0	-	17.6	2.6	5.4	0.4	/	-		68
L1	51.2	31.2	-	11.3	1.9	3.9	0.5	/	-		65
M1	46.6	29.8	-	15.2	4.1	4.3	/	/	-		68
N2	47.2	28.7	-	16.3	4.3	3.5	/	/	-		64
N3	53.8	28.4	-	10.9	1.6	5.2	/	/	-		64
N5	54.0	19.2	-	14.6	3.7	8.5	/	/	-		66
P2	59.3	17.3	/	7.7	2.8	11.4	1.5	/	-		62
Q3	12.6	5.6	3.5							78.3	n.d.
Q9	48.4	30.8	-	9.6	2.7	6.2	1.2	/	-		65

Sample	Plag.	Clino-pyrox.	Ortho-pyrox.	Inter-growth	Ore	Chlorite	Amph. and Biotite	Apatite	Calcite	Ground mass	%An.
E3-6	57.4	19.9	-	16.4	3.1	2.6	o.6	/	o.3		64
E3-10	45.8	36.1	-	15.1	2.0	0.8	0.2	/	-		64
E3=25	54.8	23.7	-	15.3	3.1	1.9	0.7	/	0.5		63
E3-38	58.4	23.9	-	14.3	2.2	1.1	0.1	/	-		n.d.
E3-50	47.1	24.7	0.4	19.6	4.2	2.6	0.6	/	0.8		n.d.
E3-75	53.7	32.4	0.9	10.1	1.6	0.7	0.5	/	0.2		n.d.
E3-150a	45.7	34.3	0.8	13.6	3.3	2.1	/	/	-		n.d.
E3-150b	61.8	23.1	0.5	9.0	3.0	2.6	/	/	-		n.d.
E3-175	55.2	26.0	2.0	12.8	2.0	2.0	/	/	-		64
E3C-5	14.9	7.8	4.4							72.9	69
E3C-3	12.8	10.0	3.7							73.5	68
E3C	11.2	13.4	2.0							73.4	73
R4a	14.0	14.4								71.6	75
R4b	17.6	8.0	2.2							72.3	74

Sample	Plag.	Clino-pyrox.	Ortho-pyrox.	Inter-growth	Ore	Chlorite	Amph. and Biotite	Apatite	Calcite	Ground mass	%An.
R5	17.8	11.2	2.2							68.8	n.d.
R6	16.3	12.4	2.9							68.4	67
R8	53.9	36.6	1.0	3.4	2.8	1.7	/	/	-		66
R10	53.1	15.7	-	21.3	4.3	5.8	/	/	-		68
S1C	14.7	8.8	3.5							73.0	71
S1	14.8	4.8	4.9							75.5	71
S1+6	12.8	5.1	4.6							77.5	70
S2	13.2	11.3	1.9							73.6	69
S3	52.0	30.0	4.2	4.4	4.2	5.0	0.2	/	-		67
S4	50.8	30.6	2.2	8.5	3.4	3.9	0.6	/	-		69
S5	54.5	27.6	4.5	8.6	3.2	1.3	0.3	/	-		66
S6	54.3	30.8	0.3	9.8	2.7	1.8	0.2	/	0.1		68
S7	58.1	25.4	1.6	9.2	2.7	2.1	0.9	/	-		68
S8	53.9	25.7	4.8	10.7	1.8	2.9	0.2	/	-		67

Sample	Plag.	Clino-pyrox.	Ortho-pyrox.	Inter-growth	Ore	Chlorite	Amph. and Biotite	Apatite	Calcite	Ground mass	%An.
S10	58.8	20.5	1.1	11.1	3.3	4.1	1.1	/	-		68
S12	15.2	9.8	1.0							74.0	74

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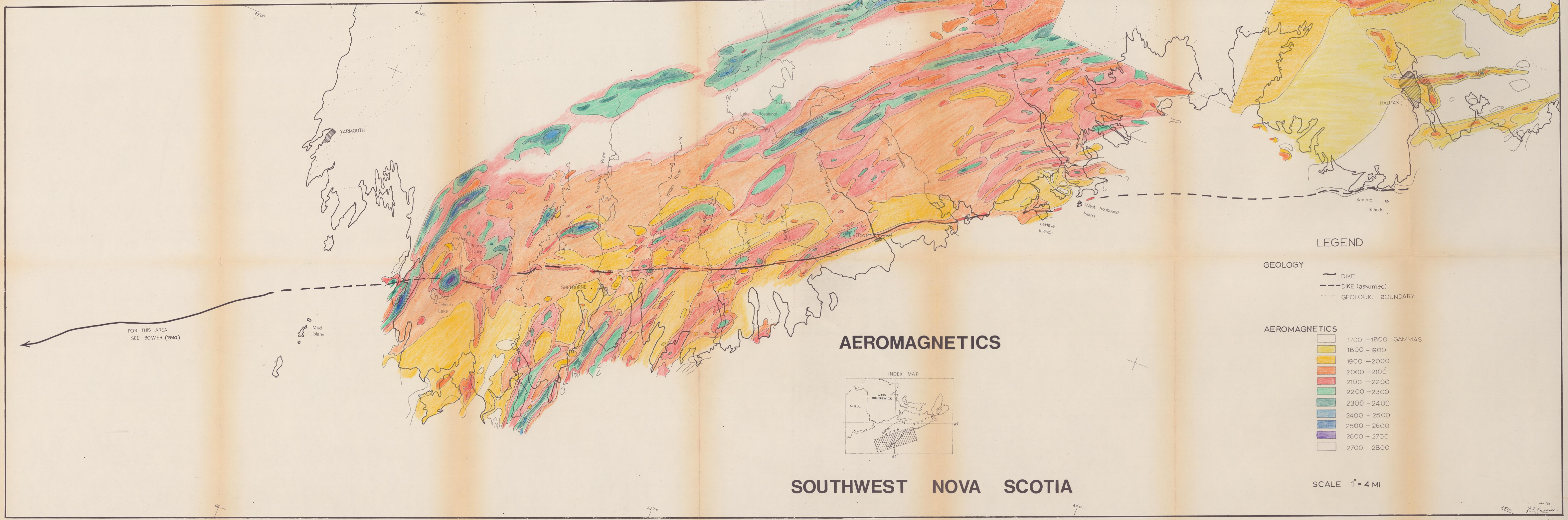
AEROMAGNETICS
SOUTHWEST NOVA SCOTIA
YARMOUTH
Lake Rossignol
HALIFAX
Sambro Islands
West Ironbound Island
LaHave Islands
LIVERPOOL
SHELBURNE
French Lake
Mud Island
Roseway River
Jordan River
FOR THIS AREA SEE BOWER (1962)
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DIKE (assumed)
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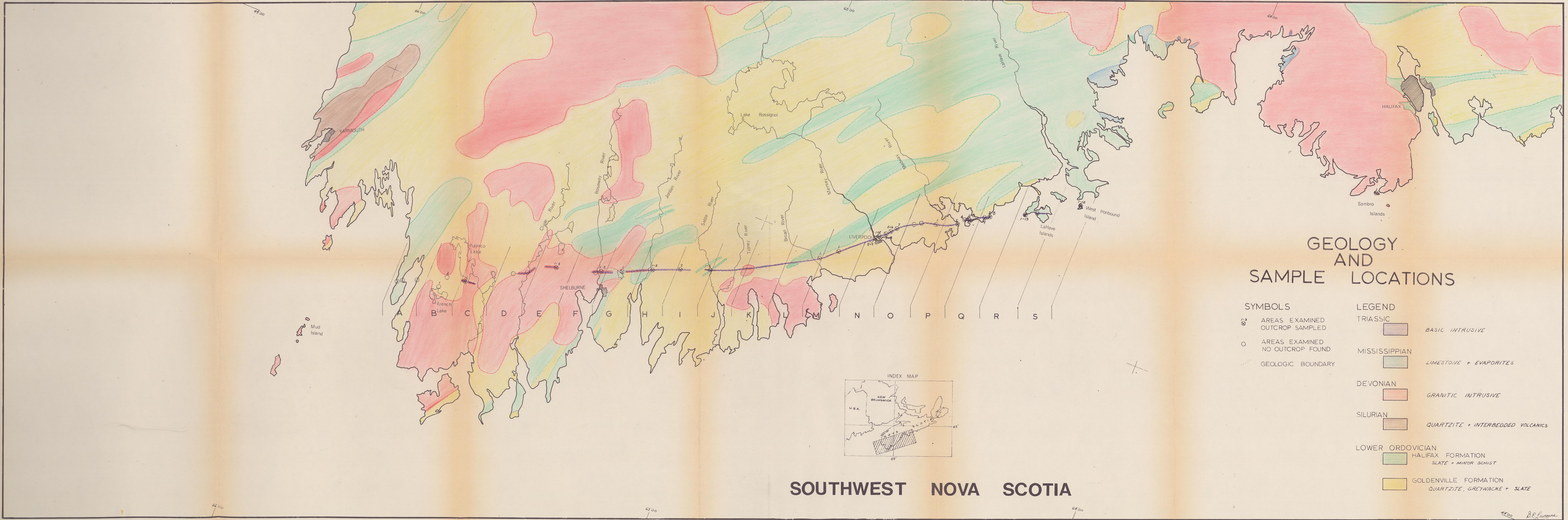
1800 – 1900
1900 –2000
2000 –2100
2100 –2200
2200 –2300
2300 –2400
2400 – 2500
2500 – 2600
2600 – 2700
2700 2800
SCALE 1" = 4 MI.


GEOLOGY AND SAMPLE LOCATIONS
SYMBOLS
AREAS EXAMINED OUTCROP SAMPLED
AREAS EXAMINED NO OUTCROP FOUND
GEOLOGIC BOUNDARY
LEGEND
TRIASSIC
BASIC INTRUSIVE
MISSISSIPPIAN
LIMESTONE + EVAPORITES
DEVONIAN
GRANITIC INTRUSIVE
SILURIAN
QUARTZITE + INTERBEDDED VOLCANICS
LOWER ORDOVICIAN
HALIFAX FORMATION
SLATE + MINOR SCHIST
GOLDENVILLE FORMATION
QUARTZITE, GREYWACKE + SLATE
YARMOUTH
Lake Rossignol
Pubnico Lake
French Lake
SHELBURNE
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LaHave Islands
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A B C D E F G H I J K L M N O P Q R S
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