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PORT HAWKESBURY PROJECT

GEOLOGICAL, GEOCHEMICAL AND GROUNDWATER INVESTIGATIONS OF SOUTHWESTERN INVERNESS AND RICHMOND COUNTIES, NOVA SCOTIA

BY

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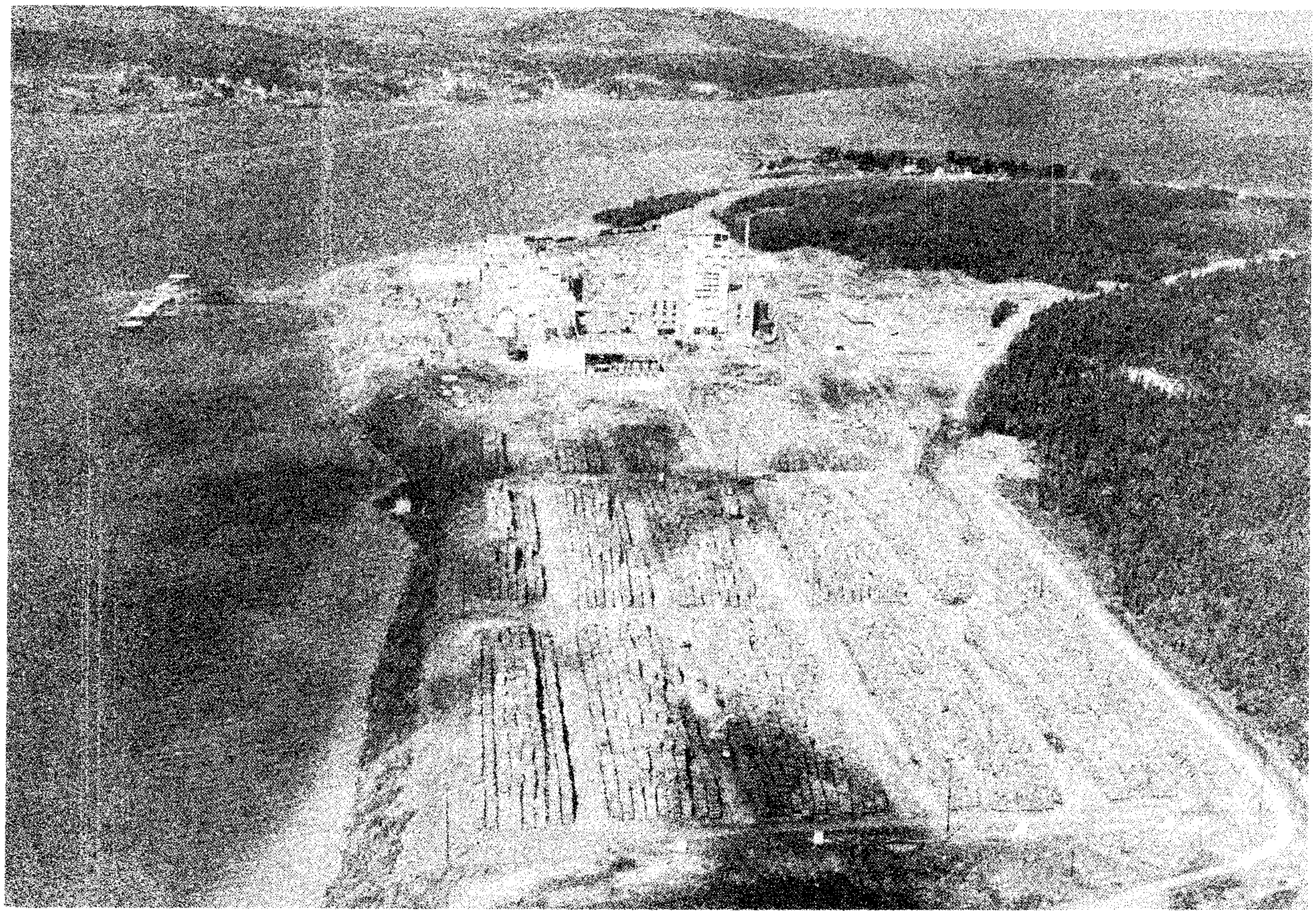


Aerial view of Nova Scotia Pulp Mill Limited site, Point Tupper, Nova Scotia.
The communities of Mulgrave and Port Hastings are seen in the background.

CHAPTER I

INTRODUCTION

INTRODUCTORY STATEMENT

A detailed investigation of the geology and surface conditions in the Port Hawkesbury - Port Hastings - Point Tupper areas of Richmond and Inverness counties was carried out by the Nova Scotia Department of Mines, Geological Division, during the 1960 and 1961 field seasons. This investigation was concerned primarily with the assessment of bedrock and surficial geology with emphasis on economic possibilities in relation to metallic and non-metallic minerals.

The areas under investigation were divided into two parts: (1) the Immediate or Study area which consists of a rectangular block of approximately 18 square miles surrounnding and including the communities of Port Hawkesbury, Port Hastings and Point Tupper, and (2) a larger area which consists of approximately 100 square miles designated as the Metropolitan or "Metro" area.

The Immediate or Study area was mapped on a scale of 1 inch to 400 feet and the "Metro" area on a scale of 1 inch to ¼ mile.

Information gathered in the "Immediate Area" has been recorded in the Preliminary Report, Port Hawkesbury Project, 1961. However, a considerable amount of information found in the preliminary report will be included in this final report in order to maintain a maximum degree of continuity for the entire project area:

The Preliminary Report, Port Hawkesbury Project, 1961, can be obtained on request from the Nova Scotia Department of Mines.

LOCATION AND SIZE

The area surveyed, which includes the Metropolitan and Immediate areas, covers a total of approximately 116.3 square miles. This area involves a portion of southern Inverness County and a portion of southwestern Richmond County on the island of Cape Breton. See Map 1.

The area is bounded on the south, southwest and southeast by the Strait of Canso, Inhabitants Bay and Lennox Passage. It is bounded on the northwest and northeast by a line from Hefferman's Pond to Queensville and thence along the Inhabitants River to Cleveland and easterly along Highway No. 4, and on the east by a line drawn north-south through Shannon Lake. More specifically, it is the area zoned by the Inverness-Richmond Metropolitan Planning Commission in co-operation with the Department of Municipal Affairs of the Province of Nova Scotia. See Map 5.

SCOPE OF INVESTIGATION

The investigation and study of this area was carried out during the field seasons of 1960 and 1961. The major portion of the work carried out in this area was surveying and mapping the bedrock geology. Limited studies were also made of soil conditions, source of building materials, potential water supply and economic geology. A preliminary study was made of the base metal content in the soils of areas underlain by the Windsor-Horton sedimentary series and their contact. This work was done with a portable geochemical testing kit in the field.

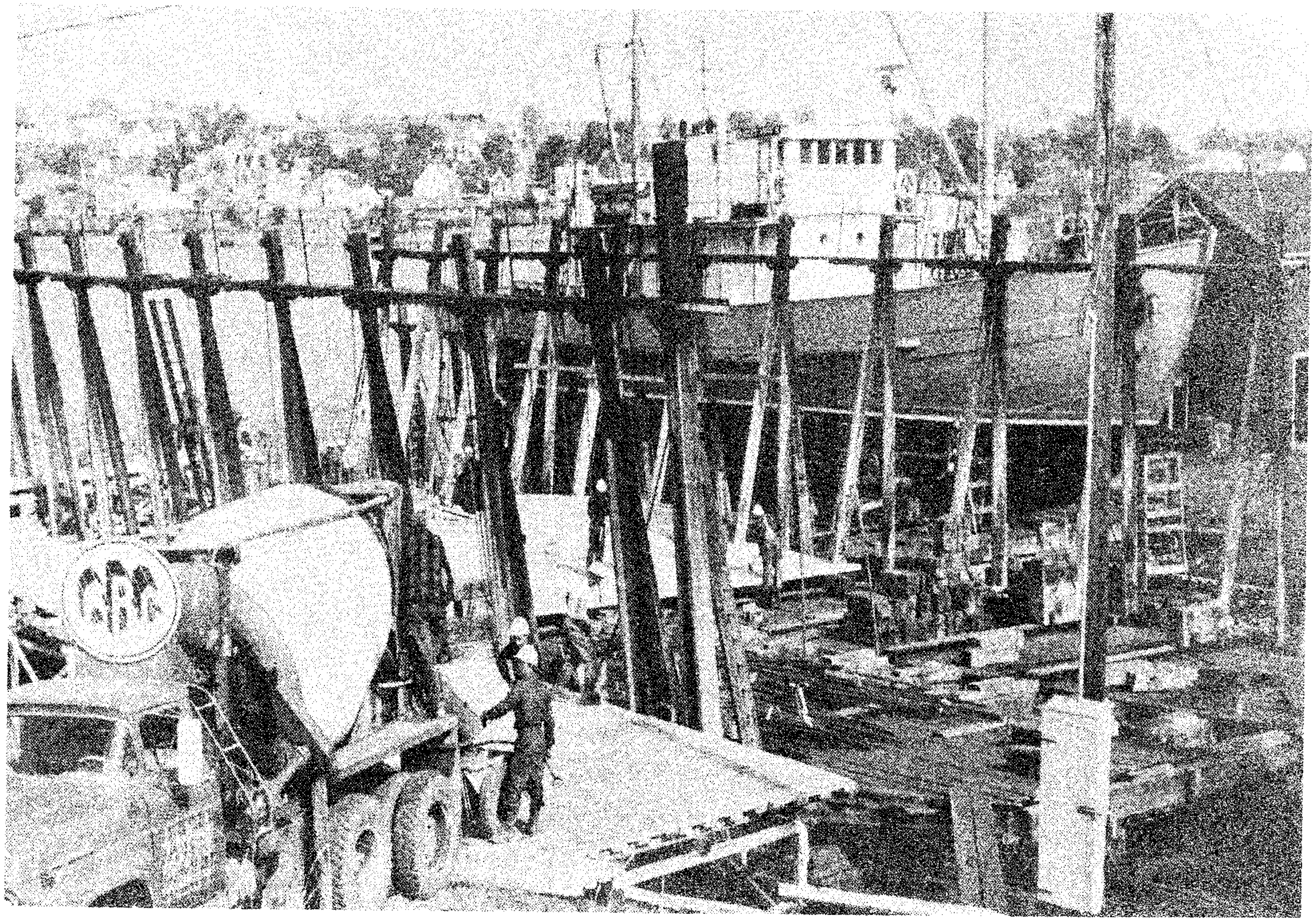
Field staff for the project consisted of two parties which mapped the bedrock geology and a two-man party which carried out soil geochemical surveying. Personnel of the field parties were students and graduates from Nova Scotia universities.

The subject matter of this report will cover information from both the Metropolitan and Immediate area.

TRANSPORTATION

Water, rail and highway are the three modes of transportation to, from, and in this area. Approximately half of the Metropolitan area is bounded by the waters of the Strait of Canso. Inhabitants Bay and Lennox Passage,

PLATE 2



Marine Railway Company Limited, Point Tupper,
Nova Scotia.

giving excellent facilities for coastal transportation between towns and villages in this area.

Prior to the construction of the Canso Causeway in 1955, transportation between mainland Nova Scotia and Cape Breton Island was dependent entirely upon car and railway ferries. Although this service was carried on for many years, it was far from satisfactory as numerous delays in transportation were due to inclement weather, ice conditions, and severe tides at certain times of the year. With the construction of the Causeway, a readily accessible and permanent entry into Cape Breton Island from the mainland has been provided for rail and highway transportation. Probably one of the most important results of the Causeway construction is the formation of an excellent harbor south of the causeway from Port Hastings to Point Tupper. The harbor can readily cater to deep sea and coastal shipping, thus making this area one of the most promising locations for industrial development on the East coast of Canada.

Water transportation has been important to this area in the past, is continuing at the present time, and will evidently play a major role in the future by contributing to its development and prosperity. Examples of this are the construction of docking and loading facilities by the Nova Scotia Pulp Mill Limited and by the British American Oil Company Limited. While only limited loading and docking facilities now exist along the shore line of this area, an unlimited water frontage is ready for development. Loading and storage piers were being constructed in one section of this frontage for the Bestwall Gypsum Company in late 1961.

The Canadian National Railways have one main line and three branch lines which service the Metropolitan area. The main line enters Cape Breton Island from mainland Nova Scotia via the Canso Causeway and runs through Port Hastings, Port Hawkesbury and all major points east to Sydney. One branch line leaves Port Hastings and runs northward, serving western Cape Breton to the town of Inverness. A second branch line serves Point Tupper and the Nova Scotia Pulp Mill Limited, while the third line runs east through Evanston, Whiteside, and Grand Anse to St. Peters, Richmond County. See Map 1.

In relation to its present population of approximately 4,000, the map area is well endowed with paved highways and secondary roads. Route 19 is paved from Port

Hastings to Inverness and around the Cabot Trail. Route 5, a section of the Trans-Canada Highway, runs from Port Hastings to Sydney via Baddeck and North Sydney. Route 4 runs through Port Hawkesbury and serves all major points east to Sydney.

A relatively close network of secondary roads throughout the map area plays an important part in the transportation system. These roads join the various major trunk highways and facilitate residential and commercial development in the area.

Although the nearest air transportation is through air terminals at Sydney and at Trenton, Nova Scotia, assistance by the Department of Mines was given to the Inverness-Richmond Counties Metropolitan Planning Commission and to the Federal Department of Transport in assessing and locating a site considered suitable for constructing an air strip. Several locations were surveyed and one, approximately four miles from Port Hawkesbury at MacIntyre Lake (see Map 1), was found to be favorable. This site has subsequently been approved by the Department of Transport.

INDUSTRY AND MINING

At the present time there are no mining or quarrying operations within the map area. During the last century a small tonnage of gypsum was quarried at Plaster Cove near Port Hastings. The gypsum outcroppings can still be seen at this location. It has been reported that this deposit supplied some of the first commercial gypsum to be exported from Nova Scotia. However, for present day requirements this occurrence is too small and is of questionable grade.

Several small coal operations were carried on in this area at various times during the last century. Included in these operations were the Richmond Mine, Whiteside Mine and the Seacoal Brook Mine. The Richmond Mine, located approximately one mile south of Beaver Dam Lake, was in operation from 1863 to 1878 and reportedly produced 8125 tons of coal. The Seacoal Brook Mine operated in 1863. Little or nothing is known regarding the actual production of this mine. The last coal mine to operate in this area was the Whiteside Mine, located approximately 1 mile south of the community of Whiteside in Richmond County. (See Map 2). This mine was financed and operated by American interests and produced

PLATE 3

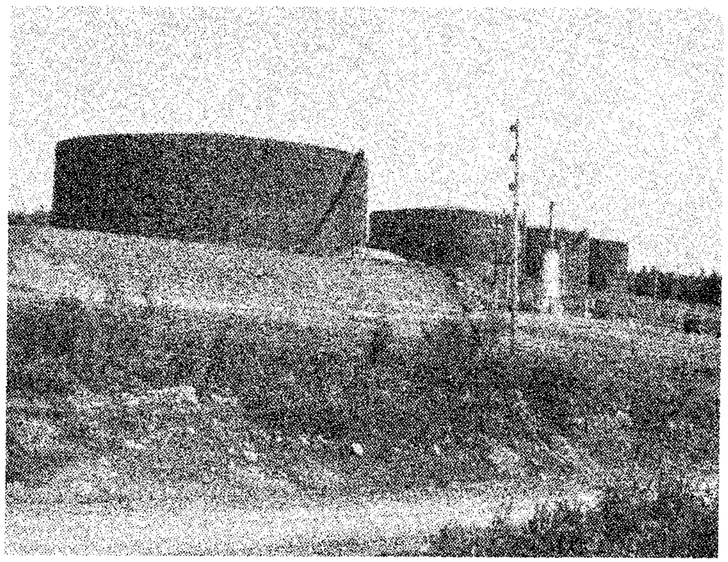


Fig. 1

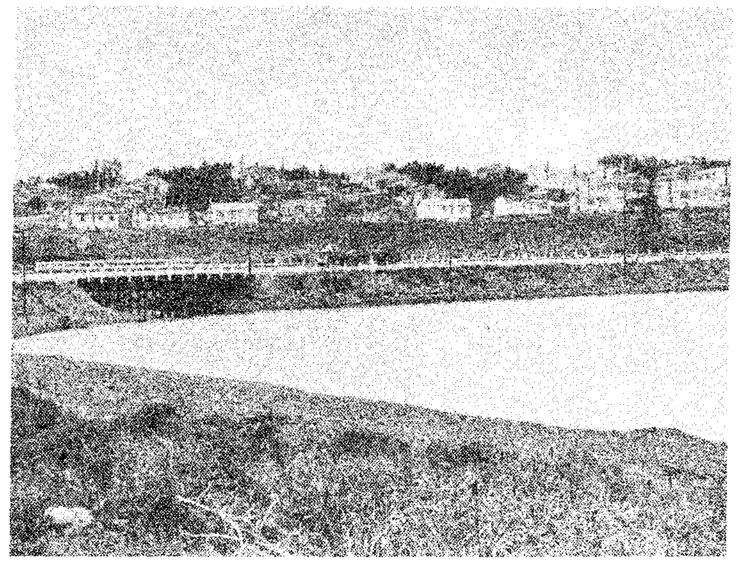
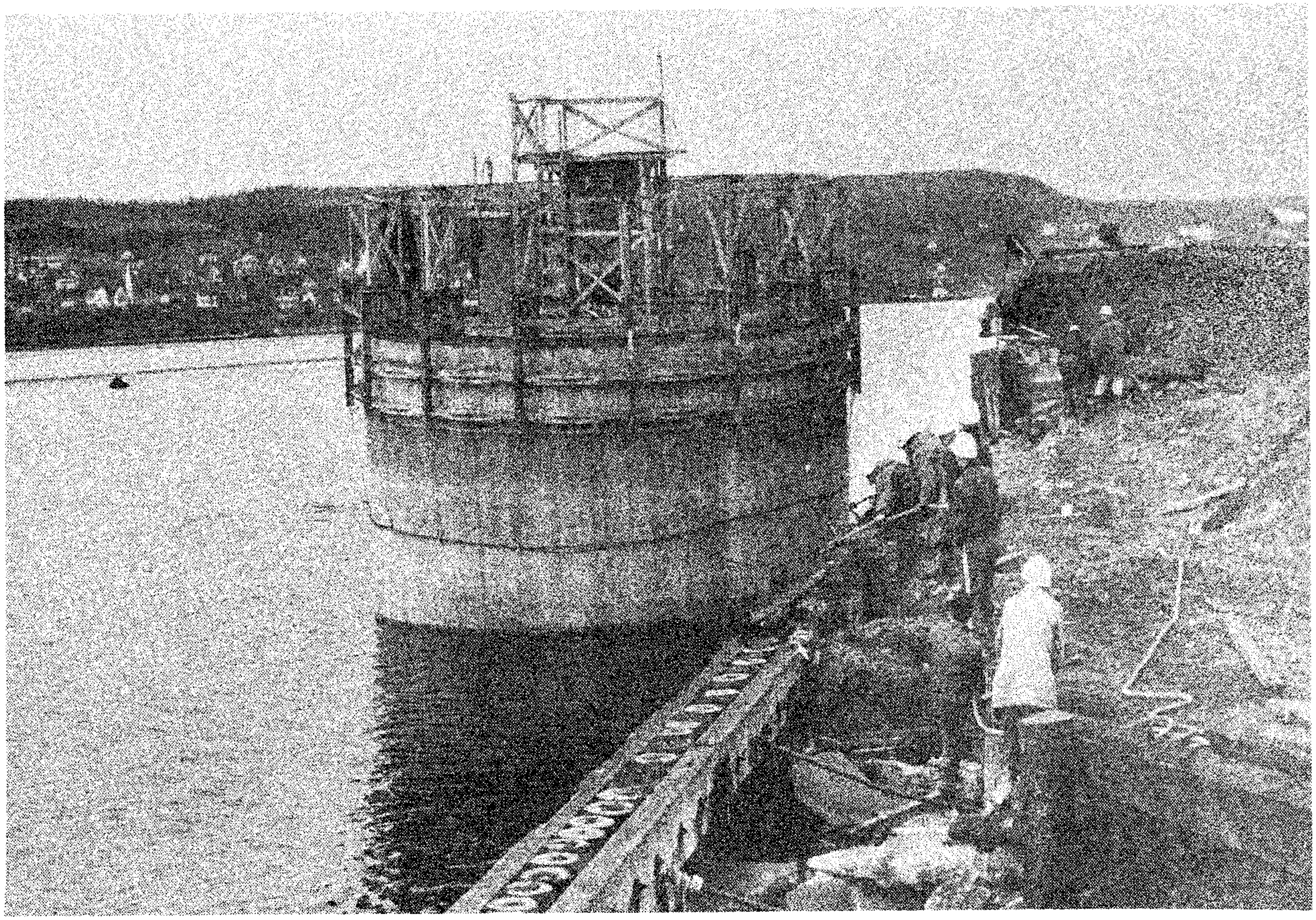


Fig. 2

Figure 1 View of Marine Storage Facilities, British American Oil Company Limited, Point Tupper, N. S.
Figure 2 View of "Hawkesbury Heights" Subdivision, Port Hawkesbury, Nova Scotia.

PLATE 4



Construction of new gypsum loading pier, Point Tupper, Nova Scotia.

toward the southeast and forms part of the drainage system of the Inhabitants River.

The Lowlands of the map area are underlain by sediments deposited during Carboniferous times. The topography is generally controlled by the underlying bedrock and is comparable with other areas in the Province having a similar bedrock lithology. The relatively soft sediments have been greatly denuded to form a peneplaned surface with a gradual slope to the southwest. In detail, the topography within this peneplane to the southeast is a series of small ridges and gullies. The north and northeast portions of the lowlands are generally characterized by gently sloping round hills.

In the extreme portion of the lowland region of the map area the topography and drainage are very closely related to the bedrock and structure. The ridges are composed of the more resistant Riversdale sandstone and thus trend parallel to the general strike of the sandstone horizons. Drainage gullies parallel the ridges and are probably underlain by partially eroded beds of soft shale such as are frequently interbedded with the sandstones.

An excellent example of this "ridge and small valley" topography may be seen in the area between Ship Harbor and MacPherson's Ferry. In this section of the map area the ridges are composed of sandstone while the gullies represent the interbedded shale horizons. Another example of these topographic features may be seen from Turbalton Bay east along Lennox Passage. Here the islands, streams, inlets, and shoreline exhibit clearly the trend of the rock formation and structure.

River Inhabitants is the longest and largest river in the surveyed area. It has mature river-valley characteristics with gently sloping walls and gradient. This river is affected by tides to approximately eight miles from the sea. The elevation of the river in the extreme north of the surveyed area is less than 25 feet above sea level.

The Inhabitants River and its many tributaries drain a large portion of the lowland area. This drainage system flows generally to the east and south. East of this river the drainage flows toward the west and southwest into the Inhabitants Basin.

It is believed that glaciation has played an extensive role in determining the present, or existing, topography.

Although definite signs of glaciation, such as striae, are limited in the area, they indicate, where found, that the ice movement was generally in a southeasterly direction paralleling the present Strait of Canso. Landry Lake, in the southeast portion of the map area, appears to have been formed primarily by ice action.

No positive signs of glaciation were seen in the area east of the Habitants River. However, the topography along the north shore of Lennox Passage, Rabbit Island, and in the vicinity of Garry Passage, indicates that the ice movement was in an east-northeasterly direction. Glacial striae east and northeast of this area show that the movement of ice was in a southeast and southwest direction. From this it appears that the direction of movement of the ice changed quite radically, or that there were two separate local advances of the ice sheet. It is possible that the latter case may be true for this region—one local advance of ice moving in a direction parallel to the now-existing Strait of Canso and the other paralleling Lennox Passage.

Long, narrow ridges superimposed on the peneplain may show noticeable effects of glaciation. These ridges are usually made up of resistant sandstones and siltstones which parallel the direction of ice movement. Small V-shaped valleys are sometimes found more or less corresponding to incompetent shale horizons. Small intermittent streams may be found in these depressions.

PREVIOUS WORK

The first published survey in this portion of Cape Breton was carried out by the Geological Survey of Canada in 1878 and 1879 under the direction of Hugh Fletcher. Prior to this work investigations were carried out by Sir William Dawson in various parts of the area although no geological map was compiled. Information on several locations in the area may be found in Dawson's "Acadian Geology", published in 1855.

With the aid of more specific knowledge regarding Carboniferous rock types, stratigraphy and paleontology, the Geological Survey of Canada, in 1945, carried out a preliminary survey of southwestern Cape Breton which included the area covered in this survey. Field work was done under the direction of S. A. Ferguson and W. A. Bell. In 1947, L. J. Weeks completed the mapping of this area and revised certain portions of the preliminary map. The main object of his work was to collect information for use in locating the causeway to be built across the Strait of Canso. The Mulgrave sheet, No. 995A, published in 1949, and based on Weeks' work, contained the last previous information available.

In 1957 the Hunting Technical and Explorations Services Limited carried out preliminary terrane investigations in this part of Cape Breton. Work was confined primarily to the Point Tupper area and was designed to collect and assemble information relative to the proposed construction of an oil refinery by British American Oil Company.

In 1960 and 1961 the Nova Scotia Department of Mines, Geological Division, undertook to do a survey of the area to assess its potential, if any, in minerals, building materials, and water, as well as to record the general geological characteristics of the map area. The initial phase of this survey was also designed to assist construction companies and industrial concerns in the evaluation and utilization of the resources within the area.

Numerous geologists, paleontologists, prospectors, and others, have worked in the area on one or another specific problem. Some of the more prominent ones were W. A. Bell, N. R. Goodman, and P. H. Hacquebard. Certain areas in the vicinity of Port Hastings have been surveyed and examined by prospectors and geologists for private interests, particularly at or near the Horton and Windsor sedimentary series and their contact zone. Most of this work was done to assess base-metal possibilities considered to exist within this sedimentary series throughout the province.

MAPS PREPARED OF AREA

Four maps covering the Port Hawkesbury Project have been prepared. All maps, including the key map, will constitute a part of this report.

A map of the general geology on a scale of 1" to 2 miles is the primary base map for this report. It shows all the observed and interpreted geology within the Project area as well as other pertinent information. Using the same scale, a map showing the general soil coverage of the area was prepared.

A series of 10 detailed geological maps on a scale of

¼ mile to 1 inch was prepared to cover the Project area. These maps can be obtained upon request from the Department of Mines.

The maps prepared and found in the Preliminary Report, Port Hawkesbury Project, 1961, may also be obtained on request from the Department of Mines.

ACKNOWLEDGMENTS

During the field seasons of 1960 and 1961 Messrs. J. M. Bingley, B. Lewis, D. Gossman, D. Crawley, R. Boylan, D. Capstick, D. Goudge, C. Cole, and D. Murphy ably discharged their duties as field assistants.

The writers express their appreciation to W. H. F. Langley, Chairman of the Inverness-Richmond Metropolitan Planning Commission, for civic and general information gained through his official capacity in that organization, and to others, too numerous to mention, for their assistance during this survey.

Dr. W. A. Bell of the Geological Survey of Canada identified the Mississippian and Pennsylvanian fossils collected by the survey parties, and in addition gave personal counselling regarding fossil identification and stratigraphy in the Project area.

The writers are much indebted to Drs. D. C. Kelley and P. H. Hacquebard of the Geological Survey of Canada for views and discussions on geological problems in this portion of Cape Breton

SUMMARY

This study of an area covering approximately 116.3 square miles of southern Inverness and Richmond counties, bordering the Strait of Canso, was designed to assess: (1) the bedrock and surficial geology; (2) the economic possibilities in relation to metallic and non-metallic mineral occurrences, and (3) to record pertinent data which may assist in the development of this part of the Province as an important industrial area.

Topographically, the map area is a region of upland and lowland areas. The uplands portion is underlain by hard pre-Carboniferous rocks and the lowlands by the relatively soft Carboniferous sediments. Rock outcrops appear to be plentiful in the upland region but otherwise

are scarce and confined to stream beds, shorelines, road and railway cuts.

The oldest rocks in the area are of the George River group and are designated as being Cambrian and/or Pre-Cambrian in age. From rock exposures observed, this group of rocks has been subjected to both regional and local metamorphism. The structures are quite obscure but there is enough evidence to suggest that they were subjected to considerable folding, faulting and shearing. These formations appear to have been intruded by granites of the Devonian period or earlier, causing a certain degree of metamorphism.

A unit of rock also found in this area may be placed as Horton or Post-Horton in age. They are of the volcanic intrusive and pyroclastic type. They vary from basic and intermediate lavas to volcanic breccia and tuffaceous graywackes. Andesites and diabase are the most common rock types exposed of this group. Structurally, there does not appear to be any major deformational features to these rocks but some minor faulting and folding was observed.

The Horton sedimentary series of Lower Mississippian age are the oldest such sediments found in the map area. They overlie the previously mentioned rocks unconformably and are formed through terrestrial deposition in which coarse clastic material is prominent. Generally this group ranges from coarse conglomerates to fine shales within the map area.

Rock of the Windsor marine series of Upper Mississippian age succeed the Horton group and probably rest disconformably upon it. These sediments are found in a narrow zone extending from Port Hastings to Sugar Camp, in a broad belt from Askilton to Richmond Mine, and in a five square mile area which covers the north and northwest shore of Inhabitants Bay and a number of islands in that bay. The sediments of this group are limestones, gypsum, anhydrate, limestone conglomerate, shales, and sandstones. Because of limited outcropping it was not possible to map any significant regional structures other than faults or minor folding.

Stratigraphically overlying the Windsor group is a series of thick, soft, terrestrial sediments known as the Canso group, considered as Upper Mississippian in age. This group consists of red, green and grey shales, siltstones, sandstones, and buff grey limestone beds. Internal structures such as ripple marks, cross-bedding and mud-cracks are quite common. These sediments have been subjected to varying degrees of folding, as evidenced by broad anticlines and synclines in the MacDale area.

Riversdale sediments of Pennsylvanian age overlie and are thought to be conformable with the underlying Canso group. These sediments are the youngest in the map area and, like the underlying group, are terrestrial in origin. This group is composed of dark grey-black slaty shale, grey sandstones, coal seams and thin, calcareous, fragmental beds. This formation forms a basinlike synclinal structure in the Port Hawkesbury area and a gently dipping, nearly circular, basin structure east of River Inhabitants. Both these structures are faulted on the south and east.

The contact between the Horton and Windsor group is of particular interest because of the possibility of finding economic base-metal mineralization, based upon results in other parts of Nova Scotia which are underlain by the same geologic structure. No metallic mineral occurrences of economic significance were observed in the map area. Occurrences of coal, limestone, and gypsum were also assessed in the area but were found to be of little or no economic significance.

A geochemical reconnaissance survey was performed in the map area, particularly in sections underlain by the Windsor-Horton sediments and contact zone. Results of this work have shown a number of anomalous metal concentrations which apparently coincide with folded structures in these sediments.

A survey of a potential water supply was carried out in the map area. The results of this work have shown that detail work on various lakes in the area would be needed before any development plans are put into effect. In relation to rivers and streams, it is felt that none exist in the area to produce a continuous supply of water for domestic and commercial use on a fairly large scale. Subsurface water, particularly from boreholes, is found available for domestic or minor industrial uses in practically all sections of the map area.

Soil conditions in the map area were assessed and found in part to have a relationship to the underlying bedrock. That is, the bedrock was the parent material for the existing soils. For the most part the soils can be classed as a mixture of sand, clay, loam, and boulder material. In some sections the soil resulted as a direct action of glaciers. Weathered material derived from the underlying rock was mixed and transported by the ice and glacial waters and later deposited as unsorted drift. These deposits are in the form of till ground moraine.

CHAPTER II

GENERAL GEOLOGY

General Statement

The area herein described lies entirely within the Appalachian province of Eastern Canada. The rocks range in age from Pre-Cambrian to Upper Carboniferous and for the most part the age of these formations can be quite accurately fixed. As in most sections within the Appalachian province, the rocks here have undergone several periods of folding, deformation, and igneous intrusion.

TABLE OF FORMATIONS

ERA	PERIOD	GROUP Thickness (Feet)	LITHOLOGY
Cenozoic	Quaternary	Pleistocene	Unconsolidated and unsorted glacial till, mostly silty-clay and sand with rock fragment and boulders
		UNCONFORMITY	
Paleozoic	Pennsylvanian	**Riversdale** 11,000-	Grey sandstone; red, grey, black, green, brownish-green shale; minor red sandstone; carbonatized plant remains; grey calcareous conglomerate
		GRADATIONAL (?)	
	Mississippian	Canso 4,200-	Grey, red, green-red mottled shale; minor red sandstone, and thin grey limestone
		CONFORMABLE	
		Windsor 750-	Grey and brown argillaceous limestone; limestone conglomerate, red and green calcareous shale; gypsum, anhydrite

		UNCONFORMABLE(?) — DISCONFORMABLE	
		Horton 3,000	Red, grey, greenish-grey conglomerate; grey, brownish-grey sandstone; red, green, grey, black shale, buff calcareous, shale, minor grey limestone; quartzite, arkose
		UNCERTAIN	
		Horton/or Post Horton(?)	Dark grey and greenish-grey andesite, diabase; tuffaceous greywacke and fragmental flows; diabase dikes
		UNCERTAIN	
	Devonian/or earlier	INTRUSIVE	Granite; alaskite
Pre-Cambrian (?)			Rhyolite; quartzite; altered shale; greenish-grey and reddish-green schist

DESCRIPTION OF FORMATIONS

GEORGE RIVER GROUP

The George River Group type section is found in the vicinity of the village of George River, along the Saint Andrew's Channel in Cape Breton County. This group was first mapped by Dr. David Honey or Hugh Fletcher in the early 1870's. Fletcher (1877) noted that the George River carbonate rocks were interbedded with "felsite, syenite, diorite, mica-schist, quartzite, and quartzose-conglomerate". Guernsey (1928) divided the George River into a lower volcanic member, a carbonate member, and a quartzite-greywacke member. Goranson divided the George River into a quartzite-schist-gneiss unit and an overlying carbonate unit.

Distribution

The unit rock designated as Cambrian and/or Pre-Cambrian on Map No. 2 and classed as the George River, covers an area of approximately 0.6 square mile in a northwesterly trending belt one mile west of Lake Murray. Outcroppings are quite abundant on Brown Brook and General Line Road. Both these sections, however, practically parallel the strike of the formation, hence only a small stratigraphic section of the rocks was observed. Elsewhere, outcroppings are few to non-existent.

Lithology

The lithology of the rocks exposed along the General Line Road is quite variable, being composed of inter-stratified sedimentary rocks and acid to intermediate flows. The sedimentary facies, which is most abundant, is made up predominantly of red and green shale and sandstone with lesser proportions of grey shale, siltstone, and sandstones. These sediments have been sheared and metamorphosed to varying degrees and thus may be entirely or in part transformed to their metamorphic equivalents. Their original nature, however, is rarely in doubt. The red shale is very fine-grained, sometimes appearing to be a mudstone. Numerous sand-sized quartz grains occur, especially near the lower portion of the horizons. Farther up in the bed the material grades into an impure sandstone. This particular section of sediments is approximately fifteen feet thick and is underlain by about ten feet of rhyolite, which in turn overlies about six feet (?)

of red sandy shale. Above this section in ascending order are found red sandstone and grey-green siltstone interbedded, followed by red impure sandstone and tan to pink rhyolite. In the section on Brown's Brook metamorphism appears to have been more intense. A fairly complete section, from oldest to youngest, is as follows: five feet of red and grey quartzite schist, twenty-two feet of grey rhyolite, twenty-one feet of slaty-quartzite with some schistosity, thirteen feet of porphyritic rhyolite and thirty feet of a brick-red slate which contained a three-foot dike or sill of pink rhyolite.

Metamorphism and Structures

It appears that this group of rocks has been subjected to both regional and local metamorphism. Schistosity is quite uniform in attitude and is present in the majority of the rocks in the area. Quartzites, slates, and hornfelsic-quartzites are quite abundant in this unit. Several local zones contain mica schist with very small amounts of talc schist, constituting higher grade metamorphic equivalents of the fine-grained clastic rocks. These zones appear to be a result of shearing or a dynamic type metamorphism.

The structure of the rocks is quite obscure although determinations from graded bedding show that the strike parallels the trend of schistosity and the dip is towards the southwest. No contacts with the neighboring rocks were found. A large mass of white quartzite and crystalline limestone outside the map area, which is believed to be George River in age, appears to be structurally related to this rock unit although the distance between outcrops of the George River carbonate member and the bedded sedimentary and volcanic rocks is quite large. If these two rock masses are of the same age it would place the carbonate member of the George River stratigraphically below the schist member. This, however, does not conform with present knowledge of the George River group. A fault contact or anticlinal axis would therefore have to be assumed as a possible boundary of the sedimentary-volcanic member.

Age and Correlation

There is considerable doubt as to the age of this unit of rocks. Outcroppings are scarce and only small sections could be found. It is probable that these rock units are of the George River type age as they appear to be structurally similar to George River rocks mapped north of the area.

The possibility does exist that this group of rocks is post George River in age and represents strata equivalent to either the Fourchu group, considered to be late Proterozoic in age, or that the group may belong to the Lower or Middle Cambrian. This idea is based chiefly on similarities of stratigraphy, type and degree of metamorphism, and proximity, of both the Fourchu and Cambrian rocks in Southeastern Cape Breton. No fossils were found in any of the rocks on General Line Road or Brown Brook.

DEVONIAN OR EARLIER INTRUSIVE ROCKS

A small body of granite, covering about one-fifth of a square mile in the map area, is exposed on the northwest branch of Brown Brook. This granite is the southern tip of a large body of granite to the north that is outside the limits of the area as mapped. Only seven outcrops were found, hence little information was gained regarding this rock type.

Generally the granite weathers white to pink, and is pink on a fresh surface. The rock has a typical granitic texture and is predominantly medium-grained, although coarse-grained to pegmatitic phases were noted. Quartz and feldspar are the major constituents, while minor amounts of ferromagnesians, now altered to chloritic minerals, may be present in some phases.

It appears that the granite is intruded into the Cambrian or Pre-Cambrian rocks to the east. Close to the assumed contact on the northwest branch of Brown Brook a very coarse, almost pegmatitic, phase of the granite appears to have intruded altered shales and siltstones. Northeast of this location the granite is medium grained and quite uniform in texture and composition.

Age

It is difficult to place the age of this granite to relatively close limits. Due to the apparent absence of Devonian, Silurian, Ordovician, and possibly Cambrian strata, it is almost impossible to date it with any accuracy on a stratigraphic basis. The youngest rocks which the granite cuts in this and adjacent areas are the Cambrian and/or Pre-Cambrian rocks of the Creignish Hills. As far as is known it does not intrude any of the Carboniferous rocks in the area. This would indicate a pre-Carboniferous, i.e., Devonian or Earlier age, on the granite.

HORTON (?) OR POST HORTON (?) VOLCANIC INTRUSIVE AND PYROCLASTIC ROCKS

No formational name has ever been assigned to this unit of rocks. Previously they had been grouped with the metamorphosed and contorted sedimentary and volcanic rocks of the Creignish Hills to the north, which are considered to be Cambrian and/or Pre-Cambrian in age. Although their age has not been established, it is felt that both on the basis of dissimilarities from metamorphosed rocks to the north, and on structural relationships, they should be mapped as a separate geologic unit. For convenience during discussion, these rocks will be referred to as volcanics even though pyroclastic and apparently intrusive rocks are present.

Distribution

Approximately 1.7 square miles of the map area are underlain by these volcanics. They occur in three isolated areas which lie north, northwest, and west, of Horton Lake. The largest of these areas is an elongated mass of approximately one square mile, northwest of Horton Lake, and is the southern extremity of the Creignish Hills. Another area, about one-half of a square mile in extent, forms the hill immediately north of Horton Lake. Between Horton Lake and the north end of Long Pond a small lenticular body of volcanics occurs and covers approximately one-fifth of a square mile. Several outcrops of rocks, similar to those herein described, occur in Horton Brook about one-half mile southwest of the lake.

Outcroppings generally are numerous over these areas, particularly in the southern portion of the Creignish Hills. Many of the outcroppings were examined.

Lithology

In the southern portion of the Creignish Hills, northwest of Horton Lake, the rocks vary from basic and intermediate lavas to volcanic breccia and tuffaceous greywacke.

Andesite and diabase are the most common rock types exposed in this area, with minor, although significant, amounts of volcanic breccia and tuffaceous greywacke occurring at a certain horizon.

With only one known exception the pyroclastic rocks are confined to the extreme southeastern end of the Creignish Hills. The isolated occurrence is on the west slope of the hills east of Troy.

The pyroclastics are dark-grey to greenish-grey, with textures varying from a sand-sized tuff to a volcanic breccia containing fragments up to two inches in diameter.

A thin section of one breccia shows that the angular to subangular fragments include amygdaloidal lava, aplitic material in which only the quartz is fresh, and various other bits and fragments of volcanic debris. The amygdules are filled with a pale-green isotropic material with low birefringence; in some cases this gives little star-like crosses between crossed nicols, and is apparently Chalcedonic silica. The same mineral occurs abundantly in the rock as patches. Some of the fragments of volcanic glass contain tiny elongated feldspars. Iron oxide is present in places.

The tuffaceous greywacke is quite fresh looking and contains angular and sub-angular fragments of various composition up to one-eighth inch in diameter. It is commonly grey on fresh surface and weathers to a dull brownish-grey. A thin section of this rock shows it to be a typical volcanic sediment. It is composed of a great variety of more or less angular fragments of quartz, feldspars, trachytic lavas of various kinds, aplites, and other grains of volcanic origin, in totally unsorted sizes, closely packed together and cemented by a serpentinous aggregate probably derived from glass dust. One buff-coloured bed of tuff of particular interest was very soft on the weathered surface. Examination by thin section showed it to be similar to the previous tuff except that the matrix material is a crystalline mosaic of carbonate with a grain size in the order of 0.1 mm. Volcanic fragments also include glass with or without amygdaloidal and flow structures.

Andesite forms by far the largest percentage of the unit. The exposures in the hills east of Troy and in the lens of volcanics lying between the north end of Long Pond and Horton Lake are practically all of andesitic composition. Several flows of andesite were also noted in the rocks north of Horton Lake. The andesite is in part porphyritic and amygdaloidal, grey and greenish-grey in colour, and the amygdaloidal variety often shows a deep maroon or reddish cast. The weathered surface of these rocks is generally grey or brownish, depending on the colour of the fresh specimen. It appears that a greenish or reddish cast in the fresh rock often results in the brownish-grey weathered surface. Generally the rock is dense, very hard, and fine grained. A hard, dense, apple-green colored mineral, apparently epidote, is found in relatively large proportions in veinlets or stringers up to one inch wide, as cavity fillings, and in blotches which appear to have been painted or smeared on the outcrop. This can be seen quite readily in most of the outcrops in the section from the north end of Long Pond to Horton Lake. Chocolate-brown to red hematite is found as coatings on fracture surfaces in some locations. Most of the vesicules of the amygdaloidal lavas are filled with calcite and chlorite, while a few appear to contain a variety of zeolite. Some of the flows are grey to black and possibly may approach the composition of basalt. There is quite a variation in color and rock textures, both laterally and apparently in depth, which suggests that the various flows are quite thin. Numerous specks of a dark nonmetallic mineral are present in most of the andesite flows.

What appears to be an andesite flow outcrops in Horton Brook about a fifth of a mile southwest of the lake. Both amygdaloidal and vesicular andesite and a medium grained andesite or diabase are exposed. No reliable relationships with the adjoining sediments could be determined, although it appears that the trend of the volcanic flows parallels the strike of the Horton sediments. The rock, although appearing to be extrusive, could be a dyke or sill. It could also be related to the narrow lenticular body of volcanics that runs southeasterly from the north end of Long Pond. The rock assemblage in both localities is very similar, if not identical.

A thin section of porphyritic andesite shows it to be unaltered and having a ground mass of tiny elongated (0.2 mm.) plagioclase feldspars with the interstices filled in part with augite. The phenocrysts are mostly plagioclase which have a composition represented by oligoclase-andesine. Orthoclase is present in small amounts and one or two per cent of ilmenite seems to be associated with a reddish pleochroic mineral. This may be bowlingite or iddingsite since it also occurs sparingly in small grains having the shape of olivine.

The diabase which occurs sporadically northwest of Horton Lake, and more consistently in the hill north of the lake, is mostly medium to dark grey with some exposures having a slight greenish cast. Generally, the rock is fresh looking, varies from fine to coarse grained, and is very hard. Only in some outcrops north of Horton Lake was the rock found to have a coarse texture. It is interesting to note that this coarse-grained diabase is quite deeply weathered on the flat top of the hill.

Thin-section study of the diabase shows the classical ophitic structure, a felt of lath-like idiomorphic feldspars with the interstices filled by augite. The plagioclase is about of the composition of labrodorite and the crystals do not exceed 1 mm. in length. Pseudomorphs of antigorite about 0.5 mm. in diameter represent the one or two per cent of olivine which was originally present. There is also a small percentage of finely disseminated magnetite. Magnetite was also noted in the coarse-grained diabase north of Horton Lake.

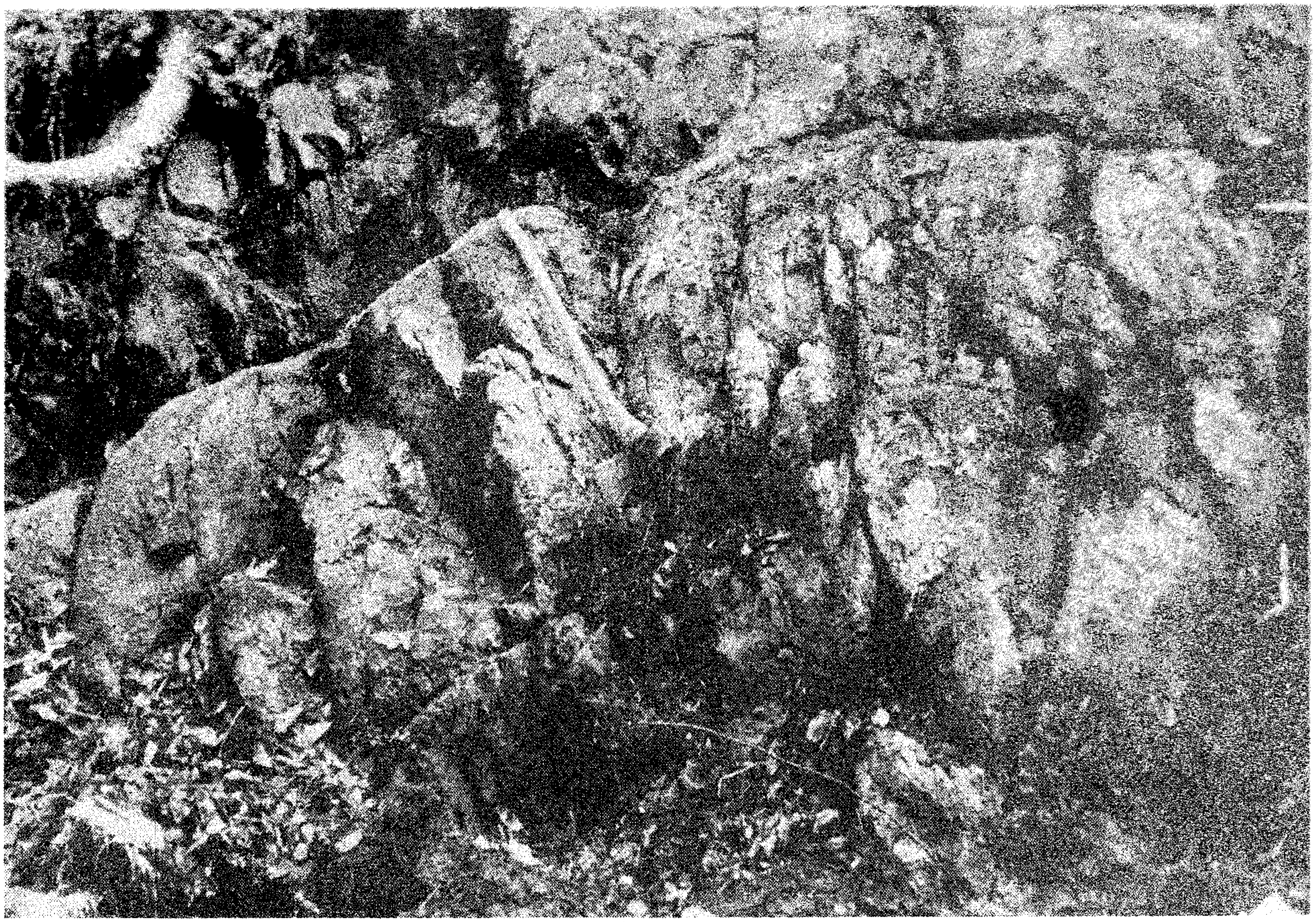
A very good section north of Horton Lake shows the diabase to be a relatively flat-lying body, possibly a large sill or thick flow. The lower portion is very fine grained and appears to be chilled where it is in contact with the underlying rocks. The grain-size or texture of the rock gets coarser with increasing distance away from the contact. In the lower portions of the diabase are several stringlets and cavities filled with a hard light-green material, probably epidote. Some quartz veinlets up to three inches wide were also found in the diabase. These are mostly confined to the areas northwest and west of Horton Lake.

Structures

Deformational structures of any magnitude do not appear to be present in this group of volcanic rocks. No folding was noted in any of the outcrops although there appeared to be a gentle regional dip to the southeast. Slickensides are present on some of the joint or fracture surfaces but do not indicate that there was any appreciable movement in the rocks. Some flows, particularly in the fine-grained phases, exhibit what appears to be cooling fractures. Columnar joints were found in one flow north of Horton Lake outcropping on an old abandoned farm road.

Internal structures such as flow lines, amygdaloidal

PLATE [illegible]



Contact of Horton quartzite and overlying volcanics, north of Horton Lake.

structures, and flow contacts, were noted quite commonly in the andesite and fine-grained diabase flows. One flow exhibited what appeared to be a pillow structure, although no internal structures were seen in the apparent pillows.

The contact between the volcanics and neighboring sedimentary rocks was seen in only a few locations and some of these contacts gave inconclusive evidence as to their nature. Immediately east of Troy on the west flank of the Creignish Hills the volcanics apparently overlie a conglomerate presumably of Horton age. The sedimentary rock is a grey arkosic sandstone and pebble conglomerate and at the contact is a one-inch red band due to hematite enrichment. No movement is evidenced along the contact and the sedimentary rock appears to dip to the east, or under the volcanic rock. The iron enrichment could possibly be due to ground water travelling along the contact or could represent an altered or baked zone along the contact. Approximately one mile southeast of Troy the contact was observed in three places. Due to slump and overburden only very small areas were seen and hence only inconclusive evidence was obtained. One thing of note was an irregular surface of reddish sandstone overlain by the lava and a large 10" x 12" boulder of the sandstone completely engulfed by the lava.

Perhaps the best and most informative part of the contact was found on the north side of the hill north of Horton Lake (See Plate No. 5). Here an angular unconformity or disconformity separates the diabase flow or sill from the underlying quartzite and pebble conglomerate. It appears that a narrow dyke (10") has been intruded along the contact although it could possibly be a separate flow. No good evidence of faulting was found in the igneous rock but several slickensided fault planes were found in the underlying sedimentary rocks. The fault planes generally are near vertical to vertical, trend north-south, and are transgressing the formation. The sedimentary rocks are greenish-grey to brownish-grey in color; the greenish-grey rocks are mostly confined to quartzite near the contact with the volcanics.

Approximately one hundred and fifty feet west of the above location a section of the contact revealed the following lithology, from the oldest to youngest:

(a) 12' (±) Brownish-grey to greenish-grey pebble conglomerate and grit. Very

		hard and tough, slight calcareous matrix.
(b)	7"	Diabase flow, very fine grained, dense, dark grey.
(c)	8"	Conglomerate, brownish, subrounded to subangular pebbles up to ¾" diameter. Pebbles mostly quartz or acid igneous rock.
(d)	2.5"	Diabase flow, very fine grained, dense, dark greenish-grey.
(e)	4"	Grit, brownish, slight calcareous matrix.
(f)	12"	Diabase flow, fine grained, very dark-grey color.
(g)	2"	Grit, few pebbles, brownish, pinches out in one lateral direction, slight calcareous matrix.
(h)	10' (+)	Diabase, zoned, 1" very fine grained, 5' medium grained, 4' (+) coarse grained, dark grey to greenish-grey color, very tough, especially the fine grained and medium grained portions.

The above section shows the results of a simultaneous process of sedimentation and volcanism which is not so strongly exemplified in the other areas where the contact was observed. The tops of the grit and pebble conglomerate beds below the lava flows often show a mixture of the lava with the clastic material, although the bottoms of the sedimentary beds lie flatly on the tops of the flows and show no signs of contact alteration.

Mode of Origin, Age

It appears that the igneous rocks in this group are extrusive and in part intrusive probably under shallow cover. The presence of pyroclastic rocks indicates volcanic action. Tufaceous greywackes, which are common in the ejectamenta, indicate further that the material was in part deposited in water, either shallow or near a shoreline, because of the associated coarse clastic rocks. The pillow structure seen in one andesite flow may be due to extrusion in, or under, water.

Although the contact with the underlying sedimentary rocks is apparent, the age of the sediments could not be determined positively and so the relations between the volcanics and Horton rocks can only be speculative. If the sedimentary rocks beneath the volcanics belong to the Horton group the volcanics could be of Mississippian age. This would not be an unreasonable assumption as intermediate and basic igneous rocks of Horton or Post Horton age intrude Horton sediments on both the mainland and Cape Breton Island.

MISSISSIPPIAN SEDIMENTS

Horton Group

The Horton sedimentary rocks make up the lowermost formation deposited during the Mississippian times. Rocks of this group have a large aerial distribution in the map area covering about fourteen square miles of the north and northwest regions.

One of the major rock groups in the province, the Horton was first mapped in detail by W. A. Bell and subdivided into the lower Horton Bluff Formation and the overlying Cheverie Formation. ('Bell W. A.: Horton-Windsor District, Nova Scotia. Am. Jour. Sci., 5th ser., vol. 1, p. 154, 1921')

The Horton Bluff Formation, at the type locality near Windsor, N. S., is generally composed of feldspathic sandstone, grit, and argillaceous and arenaceous shale members. The Cheverie Formation which overlies the Horton Bluff is mostly composed of grey arkosic grit, red argilloarenaceous shales, and dark shales.

In Cape Breton, detail work on the Horton Group was carried out by Kelly (1954) who divided the Horton into three lithologic units: the Lower Horton, composed of interbedded red calcareous conglomerate, sandstone and siltstone, and grey to red non-calcareous conglomerate that grades to arkose or greywacke; the Middle Horton, consisting mostly of grey siltstone, and the Upper Horton, which consists mostly of the Grantmire conglomerate and red siltstone.

In this area no attempt was made to subdivide the Horton, as the lithology is quite variable, both vertically and laterally. No particular beds are persistent throughout the area and hence there are no marker horizons. Fossils are quite rare, and those which are present in some of the black shales are usually altered beyond recognition. Locally there is sufficient evidence to subdivide the Horton Group into two or more units, but due to lateral discontinuity of the beds, either from facies changes or external structural changes, it is not possible to extend individual rock units laterally with any certainty.

Lithology

The Horton Group in this area generally is composed of clastic rocks that range from coarse conglomerates to fine shales. Two types of conglomerate were noted. One is brick-red, contains sub-angular to rounded pebbles up to two inches in diameter, and is very competent. The pebbles are mostly of quartz and acidic igneous rocks although some of shale and intermediate igneous rocks occur as minor constituents. The matrix is a brick-red siliceous silty-shale, with or without small quartz granules, and is sometimes slightly calcareous. There is no evidence of sorting in this rock type but lenses and patches of coarser or finer material are sometimes present and serve to give some indication of the strike of the formation. The other conglomerate, which appears to occur more frequently than the reddish type, is grey to greenish-grey in color. Pebbles ranging to four inches in diameter are sub-angular to rounded and are generally derived from white quartzite and pink granite. Minor amounts of shale, intermediate igneous rocks, and feldspar pebbles are usually present. The matrix is generally grey or greenish-grey sandy or gritty shale. Rarely is the matrix composed of clean sand. This rock is well cemented and competent. One bed, north of Horton Lake outcropping beneath a diabase flow, has a slightly calcareous matrix and shows differential weathering. Stringers and blebs of white quartz up to two inches in width are often found haphazardly orientated in the grey conglomerate. Thickness of the red and grey conglomerate members is not known as there are no complete sections found in the area.

Medium grained clastic members constitute the majority of the rocks in the Horton Group in this area. Sandstone and arkosic grits, generally grey or brownish grey in color, are most abundant. Red beds with a lithology similar to the grey beds are apparently associated with the red conglomerates but frequently are interfingered with grey members. This is well illustrated in the section along a stream flowing southeasterly into Horton Lake.

PLATE 6

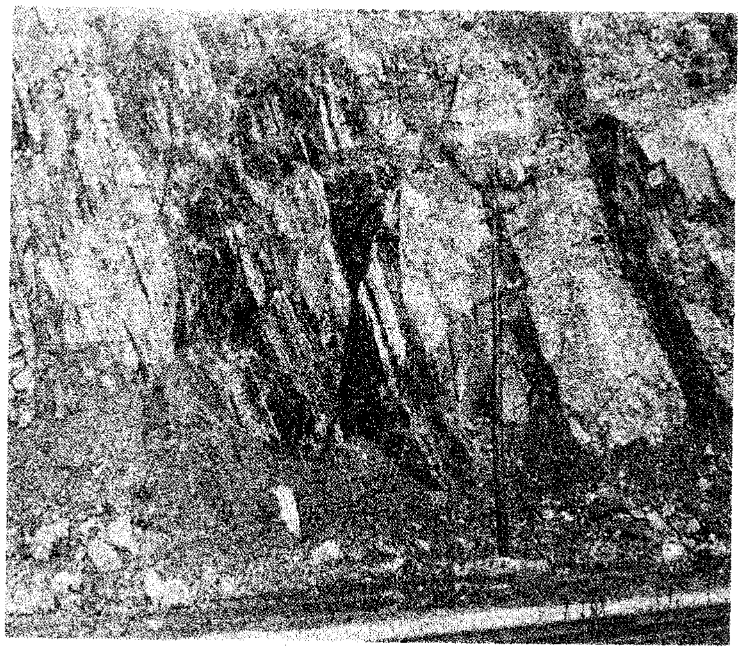


Fig. 1

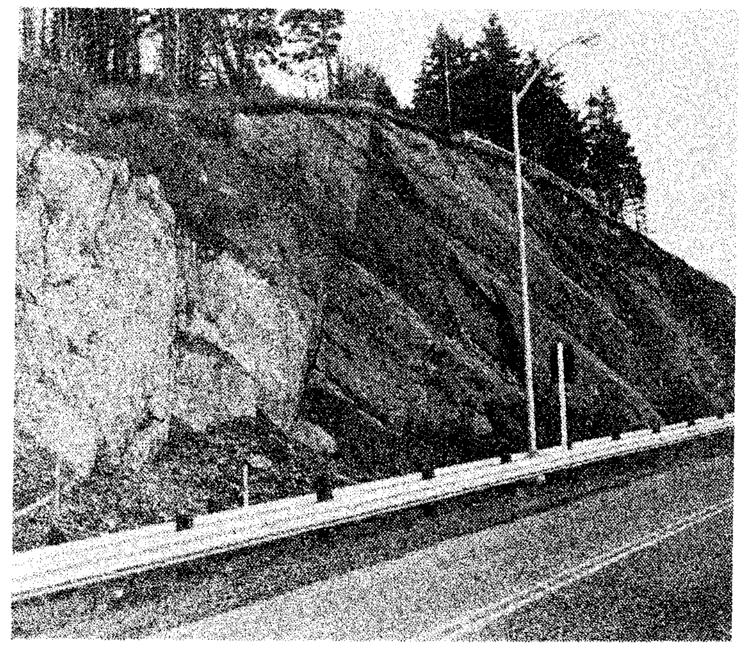


Fig. 2

Fig. 1 View of Horton shale and siltstone beds in Railway cut at Port Hastings, N. S.
Fig. 2. Carbonaceous and calcareous Horton shales in cut on Highway No. 4, Port Hastings, N. S.

Quartz grains are the major constituents of these rocks while feldspar grains are predominant in the arkosic members. Minor amounts of composite rock fragments, mica, and chlorite, are present in certain portions. The mica and chlorite appear to be secondary, probably derived from the clayey portion of the rock, and are associated with rocks showing effects of local dynamic stresses. The greater part of the Horton sandstone in the area has been altered to a quartzite. In most cases the original color of the sediment has been retained during metamorphism, as red and grey quartzites occur in approximately the same proportion as do the less-altered red and grey sandstones. The quartzites are very hard, usually badly broken at the surface, and exhibit a sub-conchoidal fracture. Some of the grey quartzites have a greenish cast on the fresh surface while most are dull grey or whitish on the weathered surface. The beds are generally more than six inches thick and are often bounded by slightly shaly layers or partings which are sometimes altered to a micaceous-chloritic material. Small rounded pebbles up to one-half an inch in diameter are frequently seen in the thicker sandstone or quartzite beds.

Siltstones and shales of various colors occur associated with other rock types throughout the Horton Group. Usually these beds are quite thin, although one complete section of shales and interbedded siltstone in the railway cut at Port Hastings station gave a true thickness of about four hundred feet (See Plate No. 6 Figure 1). In this section the individual beds, usually two feet or less in thickness, are grey, red, green, and black. Shale is the predominant sediment although silty beds do occur. One dark siltstone horizon contains numerous fossil plant remains of which several species were collected. Unfortunately, slippage along the bedding planes has obliterated the surficial ornamentation of most of the specimens. Another shale bed, approximately one hundred and fifty feet thick, occurs in the railway and road cuts at Port Hastings, near the entrance to the couseway (See Plate No. 6, Figure 2). This rock is buff to grey and is in part made up of a calcareous and carbonaceous shale. Some calcite veinlets up to one-half inch thick are associated with the calcareous beds. Numerous other grey, greenish-grey, and red shale and siltstone beds occur interbedded throughout these Horton sediments. Some of the red shales contain calcareous nodules up to one inch in diameter and these nodules often dissolve in the weathered or leached zone, giving the rock a vesicular appearance. This red shale often contains thin lenses of greenish-grey grit or pebble conglomerate. Along the Trans-Canada Highway, east of Lake Murray, greenish-grey silty shales and grey laminated sandy siltstones contain plant remains. None were sufficiently preserved to enable proper identification. Limestone beds are very rare in the Horton sediments in this area. One eight-inch bed associated with grey-green shales and grey sandy siltstones was found in a road cut along Trans-Canada Highway No. 5, south of Lake Murray. This limestone is grey, brecciated, and very brittle, and is recemented by calcite. Because of the associated beds which contain fragments of plant remains, this limestone is believed to be of fresh-water origin.

Structures

Faults occur frequently in the Horton Rocks although those that were mapped do not appear to have any appreciable displacement. It is possible that faults of great stratigraphic displacement do occur, but lack of marker horizons and of outcrops in critical areas prevented observations to this effect. These faults of small stratigraphic displacement seen in various outcrops are considered to be high angle gravity faults (See Plate No. 7, Figure 1 and 2).

Tight anticlinal and synclinal folds are present in the Horton rocks in this area. These are not discernible from surficial examination in all locations. Several such folds, trending north-south, occur in the area northwest of Port Hastings. Similar folding was noted west of Sugar Camp.

Joints are common in most of the Horton rocks, especially in the more competent sandstones and quartzites. In most cases the joints show no local or regional pattern but are closely spaced and are more or less haphazardly arranged in the rocks.

Contact Relations

Nowhere in the map area were the basal beds of the Horton observed in contact with underlying rocks. In one location in North West Arm Brook, northwest of Murray Lake, red and grey Horton sandstone and pebble conglomerate appear to be in near contact with Pre-Mississippian schists. Some brecciation and disseminated pyrite were noted in the rocks of this area.

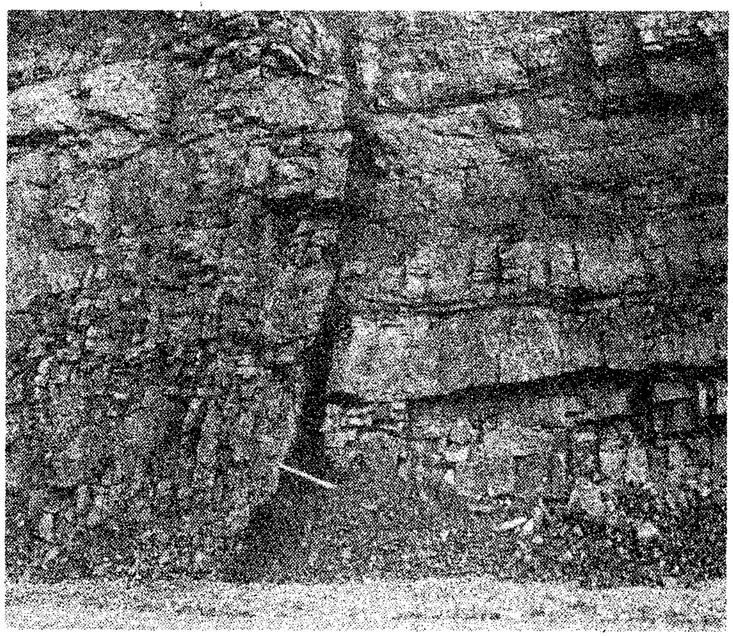


Fig. 1

Fig. 2

Fig. 1. Small fault in Horton shale, Highway No. 5, Port Hastings, Nova Scotia.
Fig. 2 Faults cutting Horton shale in cut on Highway No. 5, Port Hastings, Nova Scotia.

Mode of Origin

The Horton rocks are believed to be continental in origin, deposited in the shallow water of a fluctuating but continuously subsiding synclinal basin. Such primary structures as oscillation and current ripple marks, graded bedding, unsorted beds, cross lamination and mud-cracks substantiate this belief. The presence of land-plant remains in the sediments also tends to the theory of terrestrial deposition. The composition of the contained pebbles makes it seem evident that the predominant source of these sediments was a granite mass. A large body of granite occurs to the north and it is probable that this mass may have been the upland source of sediments deposited in this area during Horton times.

Age

The following lower Mississippian fossils were collected from strata of this group: *Adiantites, Tenuifolius,* and *Asmussia* sp. The sediments are terrestrial in origin and were deposited in shallow seas, the universal sedimentary environment of lower Mississippian times in the Appalachian province. A Horton age is therefore established for this group of rocks.

WINDSOR GROUP

General

Upper Mississippian rocks of the Windsor Group were so named from the type section found near Windsor, N. S. Bell has estimated the thickness to be approximately fifteen hundred feet. The group at the type locality has been broadly divided into the Lower and Upper Windsor, which have been further divided into subzones "A" and "B" of the Lower and "C", "D", "E", of the Upper Windsor. Each of these divisions and subzones has a characteristic fossil assemblage. Detailed work on Windsor stratigraphy and palaeontology was carried out in various parts of Cape Breton Island by M. C. Stacey in 1949-1951 and his findings were generally synchronous with those of Bell's on the mainland. A tabulation of the zonal distribution of the more common Windsor fauna is inserted below.

No attempt was made to zone the Windsor in this area as outcropping is very scarce and no well-defined sections are available for study. A further handicap to accurate zoning is the intense deformation in the form of faulting and folding throughout the relatively incompetent beds, making it practically impossible to complete a composite section.

TABLE OF WINDSOR FAUNA

(After Bell, 1929)

FAUNA		A	B	C	D	E
FORAMINIFERA						
Nodosinella priscilla	(Dawson)		C	CC		
COELENTERATA						
Conularia planicostata	(Dawson)		CC			RR
ANNELIDA						
Serpula annulata	(Dawson)		R			
BRYOZOA						
Fenestrellina lyelli	(Dawson)		CC			
Batostomella exilis	(Dawson)		CC			RR
BRACHIOPODA						
Schellwienella sp.						C
Productus productus var. tenuicostiformis (Beede)			CC	R		R
Linoproductus lyelli (Verneuil)			CC	C		
Linoproductus lyelli var. a. (Bell)			CC	R		R
Pugnax dawsonianus (Davidson)						
Martinia galataea Bell				CC	C	C
Martinia thetis Bell					R	
Composita dawsoni (Hall & Clark)			C			
Composita windsorensis Bell			C			
Spiriferina verneuil Bell			R			

FAUNA	A	B	C	D	E
Beecheria davidsoni (Hall & Clark		CC	C		R
Beecheria latum (Bell)		CC	C	R	
Beecheria miluiformis (Bell)		C			
Cranaena tumida Bell		C			
Romingerina anna (Hartt)		R			
PELECYPODA					
Sanguinolites parvus Bell		C			
Edmondia rudis McCoy		R			
Grammatodon (Parallelodon) hardingi Dawson		CC			
Grammatodon (Parallelodon) dawsoni Beede		C			
Schizodus ch. S. denysi Beede					CC
Aviculopecten lyelli Dawson		CC			
Aviculopecten subquadratus Bell		R			
Lithophaga poolii (Dawson)		C			
GASTROPODA					
Stegocoelia abrupta (Bell)			CC		
Stegocoelia compactoidea (Bell)		R			
Flemingina (Anematina) dispersa (Dawson)			R		
Naticopsis howi Dawson		C	R		
CEPHALOPODA					
Diodoceras avonensis (Dawson)		C			

CC cc—abundant; c—common; r—scarce; rr—rare.

Distribution and Thickness

Approximately twenty square miles of the lowland in the map area are underlain by Windsor sediments and evaporites. The largest area covered by Windsor strata is in the Askilton-Glenora district. Windsor marine sediments also occur in a narrow zone extending from Port Hastings to Sugar Camp, in a broad belt stretching from Askilton to Richmond Mine, and in a five-square-mile area which includes the north and northwest shores of Inhabitants Harbor and parts of Evans, Freeman, Bumbo, and Round Islands.

The Horton-Windsor contact follows a northeasterly zone from Port Hastings to Sugar Camp and thence trends northward. This contact zone, especially when affected by faulting and folding, is of particular interest throughout the province for it is considered a favorable locus for the concentration of base metals. The economic possibilities of the contact zone will be discussed in more detail in a separate portion of this chapter and in Chapter IV. Elsewhere in the map area the Windsor rocks are in fault contact with other sedimentary strata, so that the basal members are not in evidence.

The thickness of the group in this area appears to be quite variable, but due to lack of bedrock exposures, no measurements could be made. It is estimated that the minimum thickness of the Windsor strata in the zone that extends from Plaster Cove to Sugar Camp Lake is six hundred feet. Hyde (1913) estimated the thickness of the section at Plaster Cove to be six hundred and fifty feet.

Geology

The marine sediments of the Windsor group consist of limestone, gypsum, anhydrite, shaly-limestone, sandy-shale, shale, argillite, and limestone conglomerate. Variable amounts of salt may be associated with the evaporites. A number of the streams and springs, particularly those in the Sugar Camp area which traversed ground underlain by Windsor marine sediments, were noted to be quite saline.

Gypsum and a hard, gray arenaceous unfossiliferous limestone were found to be predominant in the area where this limestone forms the basal member of the Windsor. It is characterized by a laminated structure caused by interbedded sandy-silt material and limestone which usually weather differentially. A few fragments of gypsum were noted in one part of this member. Purple fluorite in the form of small (0.3" diam.) granules is sometimes associated with characteristic white calcite stringers. A typical example of this occurs at Port Hastings Railway Station as shown in Plate No. 9. An analysis of a sample of the basal Windsor limestone from an old quarry one mile north of Port Hastings is given in Table 3 below.

TABLE NO. 3

SAMPLE	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	TOTAL	CaO/MgO
124	5.9	0.74	1.98	0.07	89.56	1.51	99.74	70/1
1	5.3	3.82			75.78	14.26	99.16	6.2/1
2								

Sample 124: Old quarry one mile north of Port Hastings.

Sample 1: One and one-half miles east of Queensville in Lamy Brook.

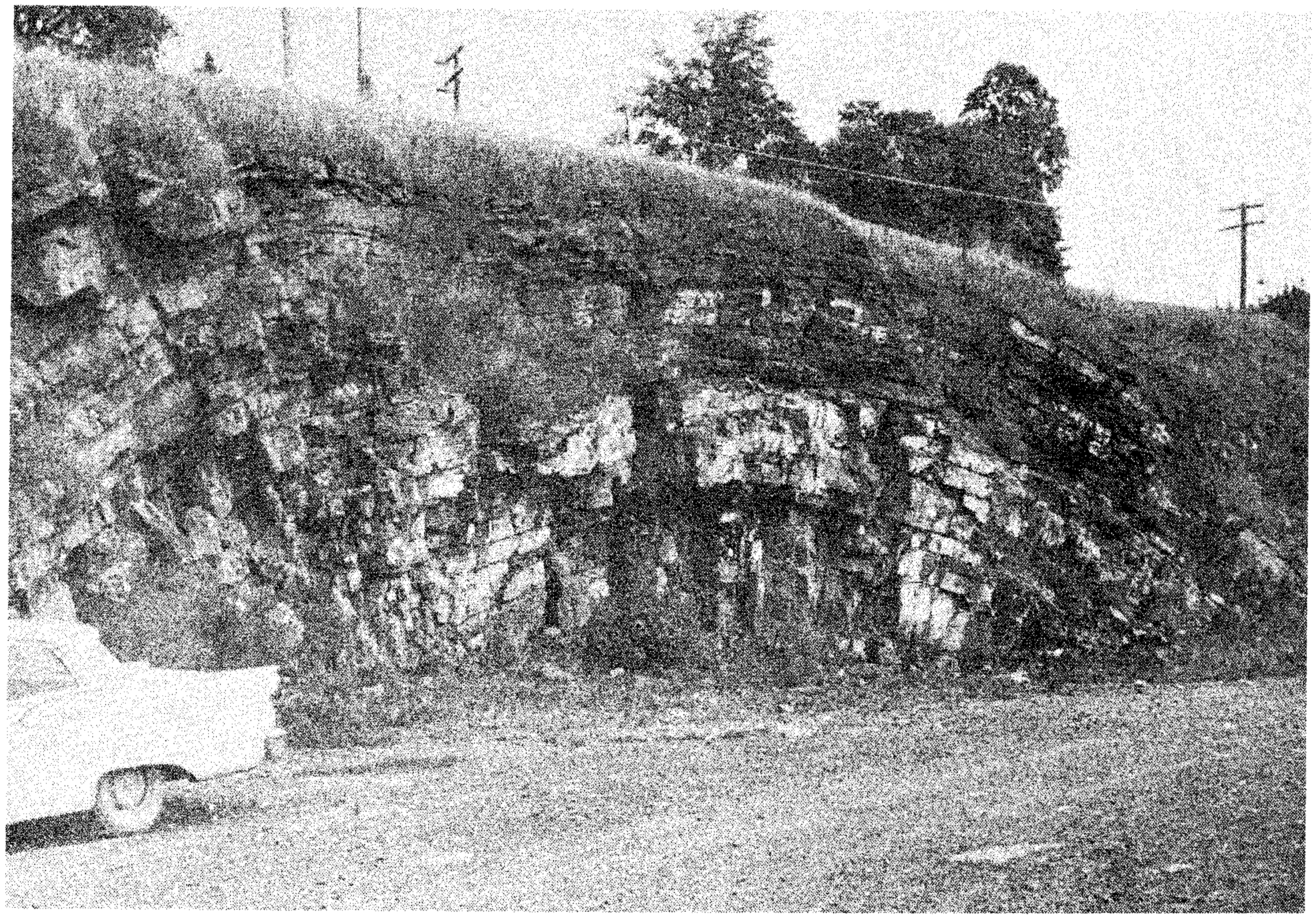
Sample 2: One mile northeast of Port Richmond, Richmond County, N. S.

The thickness of this member has not been measured due to incomplete exposure. At Steep Creek, on the West side of the Strait of Canso, Ferguson (1946) has measured the thickness at sixty-five feet but assumes it to be somewhat thinner at other localities. The present survey indicates that the basal Windsor limestone in this area is not more than twenty-five feet thick.

Several other limestone beds occur throughout the Windsor series in this area. A steeply dipping bed of brownish-grey limestone about twenty-five feet in thickness occurs in the middle creek flowing into Plaster Cove. This rock is argillaceous in part, fossiliferous, and badly broken at the surface. Stratigraphically below this bed, in the same creek, a thinner bed of grey argillaceous limestone is found. Crinoid stems were found in this bed. Limestone members with somewhat similar characteristics as those above and probably correlative with them, occur in Queensville Brook about one and one-half miles east of Queensville. Other occurrences of grey limestone are in North Little River north of Richmond Mine, and in a stream two miles northwest of Beaverdam Lake. Brown fossiliferous limestone, badly broken at the surface, occurs about one mile northeast of Port Richmond just east of the first sharp bend in Little River. An analysis of this rock gave the results as seen in Table 3. No bedding could be found in this poorly exposed outcrop.

Gypsum and anhydrite occur quite frequently throughout most of the Windsor series. Beds of varying thickness occur in the Port Hastings, Sugar Camp, and Richmond Mine areas, and on various Islands in the Inhabitants Harbor. With the possible exception of the gypsum in the Askilton-Sugar Camp district, it appears that the beds are lense-like in nature and have a short lateral extent. The bed of gypsum that is exposed at Plaster Cove does not appear to continue along strike. The rock is greyish-white, coarsely crystalline, and often contains thin lenses of anhydrite and shaly-gypsiferous limestone. Analysis of two samples from the gypsum at Plaster Cove are given in Table 4 below.

PLATE 8



View of anticline in basal Windsor near Port Hastings Railway Station, Nova Scotia.

TABLE 4

	Sample A	Sample B
Lime	40.48%	33.80%
Sulphur Trioxide	55.48	46.08
Water loss on ignition	3.90	19.86
Insoluble mineral matter	0.44	
Total	100.30%	99.74%

South of Askilton and Sugar Camp numerous outcrops of gypsum occur. The rock is grey to white, contains selenite crystals and a number of thin grey silty lenses. It is not known if one or more beds are exposed in this area. No estimate of the thickness of the bed or beds was possible from surficial examination.

What appears to be the most extensive occurrence of gypsum in the map area is located about one mile northeast of Sugar Camp Lake. The gypsum is greyish-white to grey, medium to coarsely crystalline and the surface forms an extremely well developed karst topography. Some of the sinkholes in which gypsum is exposed are over fifty feet in depth. About one mile west of Sugar Camp gypsum occurs on the east side of a small lake. It is not known, however, if this gypsum occurrence has lateral continuity with the previously mentioned occurrence.

Small exposures of gypsum were noted on the western sides of Evans, Freeman, Round, and Bumbo Islands in Inhabitants Harbor but these do not appear to have any economic significance.

Poorly exposed red, green, and grey argillite and shale beds make up the remainder of the Windsor lithology in the map area. These rocks are commonly calcareous, relatively soft, and in part exhibit a laminated structure. Where these soft, red, and green shales are cut by faults, it is not uncommon to find a mass of mottled red-green fault gouge and breccia containing small flakes of specular bematite. Such occurrences were noted northeast of Port Richmond and in the vicinity of Richmond mine.

The only identified fossil found in the Windsor sediments in this area was *Productus lyelli Verneiul.* Fragments of a Zaphrentis cup coral and crinoid stems were also found.

Structural Relations

Because of the few and scattered occurrences of outcrops it was not possible to map any significant regional structures other than faults. It is obvious, however, from the few outcrops that were found, that the relatively soft and incompetent rocks have been deformed by the processes of folding and faulting. A series of anticlinal and synclinal folds occur in the basal limestone at Port Hastings Railway Station (See Plate 8). Associated with this folding are small drag folds and crenulations. These small superimposed structures have the same trend and attitude as the major structure and are therefore considered to have been caused by the same tectonic forces. North and northwest of Mackdale two similar syncline-anticline structures occur on the Horton-Windsor contact (See Map No. 2). In these locations the basal Windsor limestone was the marker horizon used to trace the structures which have a general trend of 030 degrees (astronomic). There is strong evidence of faulting in the structures northwest of Mackdale, with the trend of the fault apparently paralleling the axes of the folding.

As mentioned previously, the only exposed portion of the basal Windsor overlies Horton rocks in an undulating zone generally trending northeast from Port Hastings. Along this zone, over eight miles in length, the contact is nowhere seen to be sharp or well defined but is usually separated by an interval of drift. In several locations in the Mackdale area where the drift interval is only a few feet wide, the basal limestone lies on a coarse grey to greenish-grey conglomerate. No traces of bedding could be found in this conglomerate. At Port Hastings the basal Windsor is contorted and sheared where it is near the contact with the steeply-dipping Horton shales and siltstones. It is evident that the laminated basal limestone is persistent in this area but that the underlying Horton lithology varies along the contact. This would seem compatible with the terrestrial origin of the Horton rocks, and it is therefore considered that the contact between the Horton and Windsor in this area is either conformable or disconformable. Elsewhere in the map area the Windsor sediments are in fault-contact with rocks of the Riversdale and Canso sedimentary groups of the Upper Carboniferous or Pennsylvanian age.

Age and Mode of Origin

The marine sediments and evaporites of this group were deposited in a marine environment, as exemplified by the faunal evidence found throughout the members. Conditions of sedimentation were variable as shown by the many differing lithologic types.

MISSISSIPPIAN INTRUSIVES

Diabase dikes cut the Horton clastic rocks at several locations in the map area. Generally the diabase is dark grey, very dense, and contains varying amounts of disseminated pyrite. At Port Hastings, in the railway cut near the Canso Causeway locks, a dike cuts coarse-grained Horton conglomerate. The rock has a fine- to medium-grained diabasic texture, and is badly fractured, with a fibrous serpentine developed on some of the sheared fracture surfaces. No definite contacts were seen and no estimates of the width of the dike could be made. Several diabase dikes, similar to the one at Port Hastings, cut Horton rocks in the area northwest of Murray Lake. Contacts with the neighboring rock types are visible, showing chilled margins in the diabase and a slightly baked zone in the sediments. These dikes range from ten to twenty-five feet in width and have a general north-south trend. Disseminated pyrite is common in the diabase while the intruded rocks adjacent to the dikes contain considerable amounts of pyrite in small veinlets and disseminations. Minor amounts of chalcopyrite were also found in the neighboring host rocks and are believed to be associated with the dike intrusion.

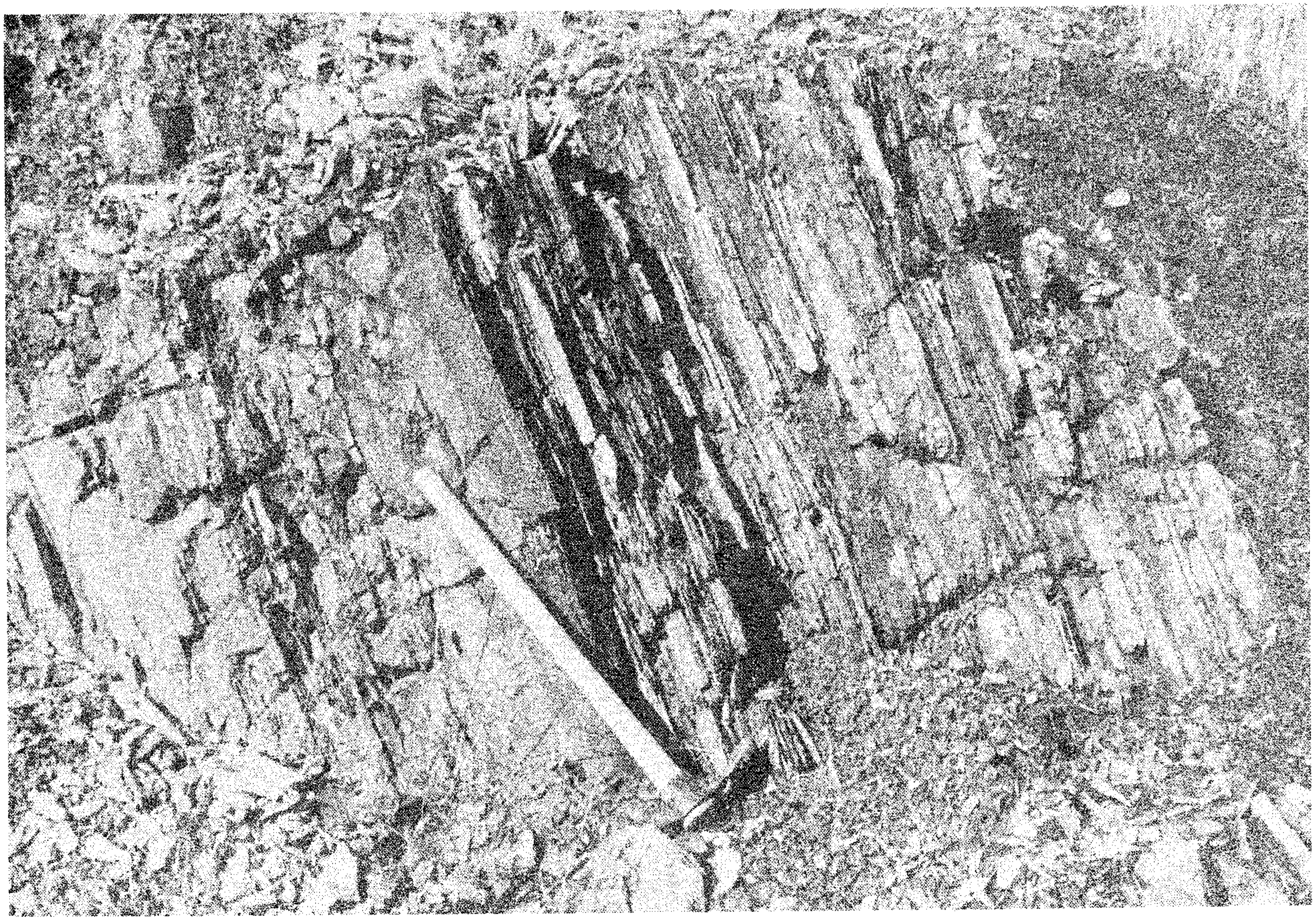
Nowhere in the map area are these dikes known to cut post Horton rocks, but thirty miles to the east, Weeks (1954) has mapped small basic intrusive bodies along the Horton-Windsor contact which cut both Horton and lower Windsor sediments. The diabase dikes in this area may be of the same age as the basic intrusives mapped by Weeks in the Saint Peters-Soldiers Cove district but due to lack of information in this area a Horton or younger age must be assumed.

CANSO GROUP

General

The Canso group is composed of a thick series of terrestrial sediments and covers approximately twelve square miles of the map area. This series of rocks stratigraphically overlies the Windsor group and is exposed

PLATE 9



Thin bedded Canso shales in cut on Highway No. 5, Port Hastings, Nova Scotia.

at three isolated localities (See Map No. 2). Two of these localities, one near Port Hastings, the other near McPherson's Ferry, have been described in part in "The Preliminary Report, Port Hawkesbury Project". The third location is centred at MacIntyre Lake but is very poorly exposed.

The type section of this group occurs along the east shore of the Strait of Canso between Plaster Cove and the west end of Emery Pond. It was first named by Bell (1944) and first described in detail by Fletcher (1879-80), who placed the upper contact two thousand feet above a particular bed containing the fossil Leaia. His measured section at the type locality was 3,666 feet. Ferguson (1946) estimated the Upper contact to lie 2,525 feet below a massive sandstone horizon in the overlying Riversdale and measured the Canso section to be 3,342 feet. During the present survey the top of the Canso was arbitrarily drawn at the base of a fifteen foot cross-bedded grey sandstone bed which outcrops one-half mile southwest of Hector Lake on Kings Road, and also on the east shore of the Strait of Canso about one-quarter mile northwest of Emery Pond. The contact is thought to be disconformable and may be in part unconformable. Bell (1944) believes it to be disconformable in this area due to the abrupt palaeontological and lithological changes.

The basal Canso contact is poorly defined, with only a limited number of outcrops near the Windsor-Canso contact being observed. South of Beaver Dam Lake on North Little River red argillaceous shale and grey laminated shale containing *Leaia CP, leigyi (Lea)* appear to rest conformably on gypsum and gypsiferous limestone. A short interval of drift separates the two outcrops, however, and a definite contact relationship is not known. At Port Hastings the lowermost Canso beds exposed are in a stream flowing southwesterly into Plaster Cove. This sedimentary horizon is a thick bedded reddish siltstone and shale. Bluish-grey laminated shales outcrop in Northwest Arm Brook northwest of Mackdale and may possibly represent the basal Canso in that area.

Lithology

The Canso group consists chiefly of red, green, and grey shales and siltstone with thin intercalated red or brownish-grey sandstone and buff grey limestone beds. Although these various rock types may be found at practically any horizon, it appears that grey laminated shale and grey siltstone are the major constituents in the upper members of the Canso. The shales and siltstones, particularly the grey laminated shales, are generally slightly calcareous while calcareous nodules are commonly found in most of the red shale and siltstone horizons. The red shales and siltstones are medium to thick bedded and sometimes contain sandy and argillaceous material. Throughout most of the Canso group the red, green, and grey beds are interbedded and appear to be the product of cyclic deposition, although no pattern or regular cycle could be established. Numerous buff weathered calcareous beds, usually less than three inches thick, occur sporadically throughout the series but most frequently in the lower part of the group. These thin calcareous bands are very dense and siliceous in appearance.

Red and brownish sandstone beds generally less than four feet thick are a minor constituent of the Canso sediments. These rocks are medium grained, well indurated and quite massive. With the exception of the grey laminated shales and occasional thin sandstone beds, the Canso rocks are quite soft and easily broken (See Plate No. 9).

Structures

Internal structures, such as crossbedding, ripple marks, mud cracks, and worm trails, are quite common. Most of the ripple marks found were due to wave action but a few current ripples were observed. Thin stringers and veinlets of barren quartz and calcite occur throughout the group but are most common in the lower section. No structural trend or pattern was evident from these veinlets.

Strata of the Canso group have been faulted and folded by the same tectonic forces that affected the pre-Canso sediments. This is evident in the Mackdale area where several broad synclines and anticlines and a fault of small displacement show structural features similar to those found in the underlying Windsor measures. Other structures are probably present but lack of outcrop in critical areas prohibits an accurate interpretation.

Mode of Origin and Age

A noticeable absence of coarse clastic material and an abundance of thin, even-bedded, fine-grained clastic sediments suggest that during Canso times the area was of low relief and undergoing relatively slow subsidence and aggradation. The presence of such structures as ripple marks, crossbedding, mud cracks, laminated shales, and worm trails, point to the shallowness of the depositional basin and the probable presence of a fluviolacustrine environment. This type of environment is supported by the presence of the bivalve crustacean Leaie or leidyi (Lea).

The age of the Canso group is rather indefinite as it cannot be determined on faunal evidence, and the floral remains are so fragmental that an accurate dating is impossible. In the past, some authors have placed it in the Upper Mississippian and others have called it Lower Pennsylvanian or transitional between upper and lower Carboniferous. In this area it appears that both the upper and lower Canso contacts are conformable and, in part, transitional with the neighboring strata. In this report the Canso group will be referred to as Upper Mississippian in age.

PENNSYLVANIAN SEDIMENTS

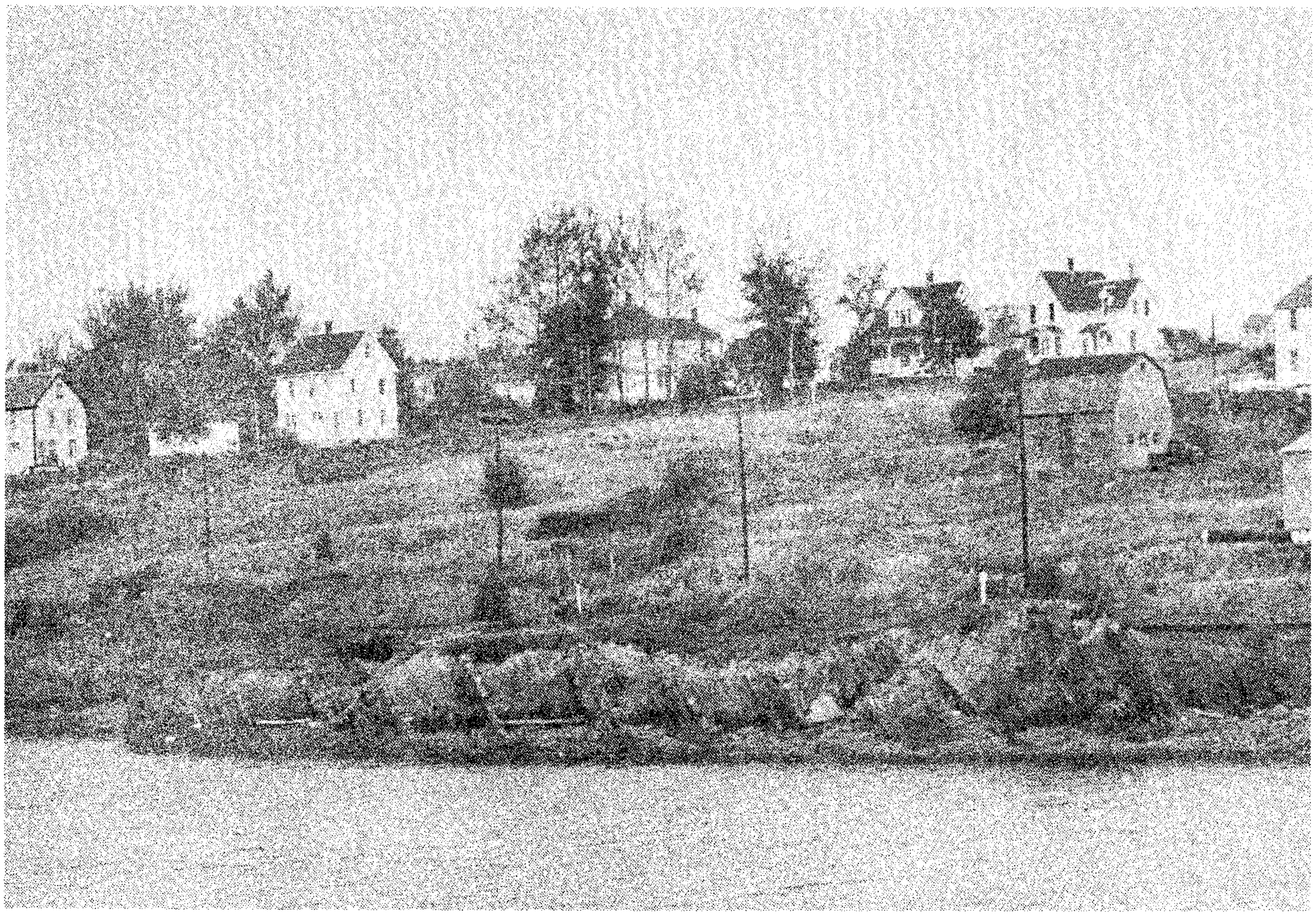
Riversdale Group

The Riversdale group is a series of terrestrial sediments that cover approximately half of the map area and is estimated to be not less than ten thousand feet thick. It is composed of shales, siltstones, sandstones, thin calcareous fragmental beds, and minor thin coal seams. These Pennsylvanian rocks, which are the youngest in the area, occur in a faulted synclinal basin stretching northeast and southeast from Port Hawkesbury, and in a somewhat similar structure northeast of Inhabitants Harbor. Exposures are generally very good along the coastline and stream beds; inland, however, they are mostly confined to the more resistant sandstone members.

The type section of this group is located approximately twelve miles east of Truro near Riversdale, N. S. The lithology there comprises alternating red and grey shales, and sandstone. Locally a basal conglomerate member is present.

The Riversdale coal seams in this area are located at Seacoal Bay; Richmond Mine, about one and one-half miles south of Beaver Dam Lake, and in Coal Brook south of Whiteside. These occurrences of coal and the now defunct mining operations will be treated in a later chapter.

PLATE 10



Shale and sandy shale beds of the Riversdale Group, on northeast shore of Ship Harbor in Port Hawkesbury, Nova Scotia

Lithology

As was mentioned in an earlier discussion on the Canso contact relations, the contact between the Canso and Riversdale was arbitrarily placed below a thick grey sandstone bed. Such arbitrary placing of this contact is necessary because no continuous outcrop showing this section of the stratigraphy is present in the area and palaeontological evidence for the two groups is lacking. A major significant change, however, apparent in the Riversdale sediments, is the development of thick bedded grey sandstone members and an increase in floral content.

The basal 3,800 feet of Riversdale strata are composed mainly of red and green shales and siltstones with a few beds of red and brownish-grey sandstone. The shale is generally quite soft and easily broken and contains calcareous nodules up to two inches in diameter. These nodular red shales occur most abundantly in the basal one hundred feet of sediments. The sandstones in the reddish basal member are quite characteristically ripple marked and cross-bedded. Fragments of fossil plant remains are present but in a much lesser quantity than in most of the succeeding sandstone beds.

In the upper portion of the basal member are beds up to three feet in thickness of a calcareous shaley conglomerate. The calcareous shale fragments are angular and up to one inch in diameter. The matrix is a limy-shale material. In places numerous fossil plant fragments occur in these beds. Some of the plant remains are coalized and some are in part or entirely pyritized. In the area now occupied by the Nova Scotia Pulp Mill at Point Tupper these beds were noted to have a lenticular nature, and quite possibly represent stream beds or channels.

Stratigraphically above the basal member is an ascending succession of grey and green shales, finely laminated dark grey to black shales with thin laminae of yellowish-grey sandstone, and thick bedded to massive grey sandstones increasing in thickness and number. The bedrock beneath the eastern half of the town of Port Hawkesbury is composed of highly competent black shale and grey and yellowish-grey finely laminated shale and sandstone (See Plate No. 10). Numerous thick, grey, crossbedded sandstones containing abundant plant remains occur within the above mentioned measures. *Neuropteris schlehani Stur* was collected from this horizon.

Approximately 7,500 feet above the base of the Riversdale the lithology is mostly composed of crossbedded, fossiliferous grey sandstones and minor grey shales. Some of the shales in this section appear to be quite carbonaceous. Fragments of species of calamites and Lepidodendron are quite numerous in the sandstone beds throughout the group. No coal seams were found in the map area, although several seams have been explored and worked in the past.

Most of the Riversdale sandstone is grey, medium to coarse grained, and is composed chiefly of quartz and feldspar grains. The red pigment in the sandstone is due in part to a ferruginous stain on the quartz grains and also to a certain amount of reddish silt present. Disseminated pyrite is present in many of the grey sandstone beds, particularly those containing appreciable quantities of plant remains, thus giving the rock a brownish-colored weathered surface. Medium bedded to massive grey sandstone beds with minor grey shales occur abundantly in a down-faulted block southeast of the road between McPherson's Ferry and Port Malcolm. A similar lithologic sequence is found on the southeast side of a fault in the Whiteside area. The southeast side is the down-thrown block in this locality. It is interesting to note that coal seams occur in both these down-faulted blocks and they may correlate with the Richmond mine seams in the Upper Riversdale members south of Beaver Dam Lake.

During the summer of 1961 the Nova Scotia Department of Mines drilled three test holes in the Port Hawkesbury Immediate area to evaluate the bedrock at various horizons in the Riversdale group. During the tests a check was made on the quantity of available ground water. Results of the water tests will be given in Chapter V, "Water Resources". Drill Hole No. 1, located about one mile east of Port Hawkesbury, penetrated massive grey sandstone containing Calamites. Hole No. 2, located about one and one-half miles northeast of Emery Pond, cut black shale. Hole No. 3, located on a powerline about one mile southeast of Port Hawkesbury, penetrated the finely laminated black shale and grey sandstone member.

Structures

The Riversdale rocks form a basin-like synclinal structure in the Port Hawkesbury area, and a gently-dipping, nearly circular basin structure east of River Inhabitants. Both these structures are faulted on the east and south edges. A westerly plunging broad syncline occurs in the fault block east of Whiteside. Several minor northeasterly trending folds were noted, especially in the area southeast of Cleveland.

Mode of Origin and Age

Rocks of the Riversdale group are of continental origin. Such structures as crossbedding, ripple marks, mud-cracks, and channeling, combined with the lithology and floral evidence substantiate this belief. The calcareous-shale conglomerate facies is thought to be a thin fanglomerate-like sediment deposited at the mouths of streams on a broad delta. The ripple-marked black laminated shales indicate that there must have been shallow basins isolated for periods of time from the source area. The lithology and its contained fossils mark these sediments to be Lower Pennsylvanian or Riversdale in age.

POST RIVERSDALE SEDIMENTS

A partially consolidated sediment was found in Northwest Arm Brook about one and one-quarter miles east of Mackdale. The bed dips to the southeast and lies unconformably on the Canso group of sediments. This sediment is located on the down-throw side of a fault block in the Canso and appears to have been preserved from glacial action on this account. About thirty feet of glacial till overlies the partially consolidated rock which is composed of organic peaty-material, silt, and plant debris, apparently derived from coniferous trees. No carbon dating has been carried out on this material but it is believed to have a pre-glacial age.

CHAPTER III

STRUCTURAL GEOLOGY

Folds

Two periods of folding can be detected from the rocks in the map area. The most prominent folding movements affected the entire suite of lower and upper Carboniferous sediments and is probably related to the Appalachian Orogeny.

In the Carboniferous sedimentary formations, the folded structures have a general northeasterly trend and appear to be more tight and pronounced in the Horton and Windsor sediments than in the younger Canso and Riversdale groups. An excellent example of this can be found in the Mackdale area where anticlinal and synclinal folds affect the Horton, Windsor, and Canso sediments. This feature has been noted in various areas, similar in lithology throughout the Maritime region. Two explanations of this phenomena are: (1) that several periods of folding occurred during the Carboniferous and (2) that the deformation was entirely post Carboniferous in age, being expressed by concentric folding. In this area either of the above explanations could be accepted.

There is no direct evidence of major deformational breaks between the various Carboniferous formations in this area. East of Mackdale the thickness of the Canso appears to be much less than in the Port Hastings area. This conceivably could be due to differential subsidence which apparently was characteristic of the Carboniferous sedimentary basins.

Faults

All major faults in the map area are considered to be gravity faults and to represent the final stage of tectonic deformation. Although practically none have been observed in outcrops, several faults can be postulated on a structural and stratigraphic basis.

A north-south fault and one trending 110 degrees intersect at a point about two and one-half miles northeast of the head of Ship Harbor and form the boundary between two large fault blocks (See Map 2). The movement on these faults appears to hinge on the north end of the north-south fault as is seen by relative stratigraphic displacement.. From the increased dips in the basin-like sedimentary structure in the west block, it can be assumed that this block moved down relative to the gently dipping sedimentary structure east of the fault. Ferguson (1946) has shown that at the point of intersection of the faults the Windsor beds in the westerly block have been depressed in the order of two and one-half miles.

Two northeasterly striking faults, one near MacPherson's Ferry and the other near Whiteside on the north shore of Inhabitants Bay, mark the northwest boundaries of downfaulted Riversdale sediments. Because of the occurrence of thin coal seams and associated lithology, it is believed that in both these downfaulted blocks the upper Riversdale or younger Pennsylvanian strata have been preserved.

Faulting has exposed a triangular area of Windsor and Canso rocks on the northern shore of Inhabitants Bay and on parts of Evans, Freeman, Bumbo, and Round Islands. This block has moved up relative to the surrounding rocks, forming what is considered to be a horst structure.

Evidence of faulting across the Horton-Windsor contact was found near Mackdale. Fault lines parallel to fold axis in this area and the faults are believed to be associated with the folds. No major displacement was noted.

At surface the major faults are confined to post Horton rocks in the northeast portion of the project area, but it is reasonable to assume that at depth they do affect the Horton rocks, as is the case in the adjacent area to the southwest.

A number of faults have been recorded in the project area but are not believed to have caused any significant stratigraphic displacement (Plate No. 8, Figure 2). Topographic expression is seldom apparent along these faults except near shorelines where they frequently are the locus of drainage gullies. The small brooks or gullies entering the coastal waters at MacPherson's Ferry, Sea Coal Bay, and Port Malcolm, serve to illustrate this point.

Age of Faults

With the exception of the faults associated with folding near Mackdale, which are believed to be related to the Appalachian revolution, of late Palaeozoic age, it appears that all movements are related to a later orogeny. The forces that caused the faulting were non-compressive. As folding and thrusting movements were associated with the Appalachian revolution, it is possible that the block-faulting developed during a more recent period. In the Londonderry and Bass River map areas, Weeks (1948) has shown that block-faulting of Carboniferous beds occurred in late Triassic and Cretaceous times. There is no way to identify accurately the age of the block-faults in the Port Hawkesbury area, but a late Triassic or Cretaceous age would be quite possible.

CHAPTER IV

ECONOMIC GEOLOGY

Horton-Windsor Contact

In this map area the Horton-Windsor contact is of interest because economic base metal mineralization has been found at other locations in Nova Scotia. This contact occurs as a northeasterly trending zone for a length of nine miles from Port Hastings to the extreme north limits of the map (See Map 2). Folding and indications of associated faulting within this zone give some expectancy of metallic mineralization.

Near the Horton-Windsor contact at Port Hastings, varying amounts of disseminated galena and sphalerite were noted in Horton pebble-conglomerate. One sample from a mineralized sheared zone in this conglomerate outcropping on the Strait of Canso gave a combined copper-lead-zinc assay of O.84 per cent. About one mile northwest of Mackdale a small amount of disseminated galena was found in the basal Windsor limestone. If the structure along the Horton-Windsor contact at Port Hastings is related and continuous with that of the Mackdale area, it would appear that a considerable area of ground northeast of Port Hastings may be a host for base metals.

METALLIC MINERAL OCCURRENCES

Copper

Occurrences of pyrite and chalcopyrite have been found in the Riversdale sandstone at several locations in the map area but do not appear to have any economic significance. These occurrences are limited to localized replacement of fragments of coalized plant remains. Copper mineralization in the form of chalcopyrite has been found associated with basic dikes at Port Hastings.

Iron

Small pockets of clay and fault gouge containing disseminated specularite were found at several locations throughout the map area. These occurrences coincide with the placement of major faults that cut the Windsor strata. These occurrences of iron are considered to be of no economic importance.

NONMETALLIC DEPOSITS

Gypsum

Gypsum occurs at Port Hastings, Askilton, north of Sugar Camp, southwest of Beaver Dam Lake, northeast of Port Richmond, and on Evans, Freeman, Bumbo, and Round Islands in the Inhabitants Bay. Only the occurrences in the Sugar Camp area are considered to be of possible economic importance.

Near Port Hastings the gypsum occurrence is estimated to be less than one hundred feet thick and considerable quantities of impurities are evident. A small amount of this gypsum is reported to have been exported during the last century. Analysis of two samples from this deposit are given in Table II.

The gypsum deposit in the Sugar Camp area is larger than the Port Hastings occurrence and exploration efforts to assess this deposit have recently been carried out by private interests. Some diamond drilling has been done on this property but the extent and findings of the exploratory work is not immediately known.

Most of the other gypsum occurrences in the map area are small, poorly exposed, and are considered to be uneconomical at present.

Limestone

No limestone deposits of commercial quality and quantity are know at present to exist in the map area. Practically all the known limestone beds in the area are thin and dip too steeply to permit satisfactory and economical quarrying operations, although several small quarries have been operated in the past to produce agricultural lime. For this purpose the rock was quarried from basal Windsor limestone beds, crushed, and burned in crude kilns. The lime thus produced was applied to fields cultivated in the area. Present-day requirements for agricultural limestone are far above those that could be supplied from the basal Windsor limestone beds in this area (See Table 1, samples 124 and 1).

A limestone horizon suitable for quarrying may exist approximately one mile northeast of Port Richmond. The limestone here is of sufficient quality (See Table 1, sample 2), but the exposure is poor and no estimates of thickness or attitude of the bed could be obtained from surface examination.

Fluorite

Some thin white calcite veinlets cutting the basal Windsor limestone contain small amounts of purple fluorite. Such veinlets were noted in the anticlinal structure near the Port Hastings Railway Station. The fluorite occurs as granules up to one-quarter inch in diameter but is considered to be of no economic importance.

Coal

The Riversdale group is characterized by the occasional occurrence of coal seams but none were found in the area. Three mines which once produced coal, the Richmond Mine, Sea Coal Bay Mine, and Whiteside Mine, were visited but none of the seams were observed at surface as the old workings are caved in and filled with water. Mining at these sites was carried out principally in the years 1863 to 1868. The seams ranged from a few inches to four feet in thickness and the quality of the coal was variable. Near-vertical dips, poor-quality coal, and the pinch and swell nature of the structures which increased the cost of production, were the apparent causes of pit closures. In 1928 the Tidewater Fuel and Navigation Company carried out some development work on the Whiteside Mine and produced approximately nine hundred tons of coal. This output apparently depleted the workable tonnage of available coal as the mine was closed permanently after this operation.

AEROMAGNETIC SURVEY

No magnetic anomalies were recorded on aeromagnetic survey sheets which cover the map area. Aeromagnetic maps of this area are available at the Nova Scotia Department of Mines.

GEOCHEMICAL SURVEY

During a part of the 1960 and 1961 field seasons reconnaissance geochemical work was performed in the map area with emphasis on those sections underlain by the Horton-Windsor sediments and contact zone (see Map No. 4). The results of this survey have shown a number of anomalous metal concentrations which apparently coincide with fold structures found in these sediments and at the contact zone.

Southeast of Askilton along Black Brook, a geochemical anomaly, later found to be due chiefly to copper, was recorded. The entire area within this anomaly is pasture and hay land and it is probable that the copper concentration in the soil of this area is due to the presence of fertilizers. Several other samples that had high copper values were taken from pasture or hay lands.

Numerous anomalous values of zinc and lead were detected in traverses across the Horton-Windsor contact zone between Port Hastings and the MacMaster Road west of Glenora. High values were recorded in several locations between Mackdale and the Trans-Canada Highway along Northwest Arm Brook, on Sugar Camp Brook east and west of the road, on MacMaster Road, and in a stream between the northwest end of Plaster Cove and the Trans-Canada Highway. These anomalies are small in areal extent but seem to have a general northeast trend. It is interesting to note that the anomalies coincide fairly well with the theoretically placed fold axis in the Mackdale area (See Map No. 4).

This survey is not definite but it does show that there are significant amounts of base metals, particularly zinc and lead, in the soils of various areas along the Horton-Windsor contact zone in this part of Cape Breton Island. No attempt was made to map the areal extent or limits of these apparent anomalies. While coincidence with fold axis seems evident, most of the geochemical traverses were perpendicular to the trend of the structures so that the cause of this apparent lineation cannot be confirmed definitely. A more detailed survey would be necessary to evaluate the true size and economic implications of these results.

BUILDING STONE

Several sandstone horizons, particularly some of the Upper Riversdale members, are considered to possess building-stone qualities. West of River Inhabitants, however, the dip of the beds generally exceeds fifty degrees from the horizontal and prohibits economic quarrying operations.

One area of particular interest is the central basin-like structure southeast of Cleveland. The rock here is generally grey, thick bedded to flaggy Riversdale sandstone with a few beds of reddish-brown silty sandstone. The beds dip less than ten degrees and contain a set of vertical joints which are very nearly perpendicular to each other. The area is cut by Mill Brook on which a long section of rock is exposed. The Canadian National Railways branch line and Highway No. 4 pass within two and one miles respectively from this area, and the Basin Road, which runs from Highway No. 4 to the Canadian National Railway line, passes directly through the area. This appears to be the only locality within the map area that merits any serious attention as a source of building stone.

CHAPTER V

WATER RESOURCES

General

An adequate water supply is essential for the expansion and growth of any industrial or commercial centre. A detailed study of this resource in the Port Hawkesbury Immediate area was conducted during the 1960 field season. The results and implications of this survey may be found in the Preliminary Report, 1961.

SURFACE WATER

Lakes

A number of freshwater lakes surround the Port Hawkesbury Immediate area and are considered as potential water sources. Most of these lakes are shallow and cover less than one hundred and twenty acres.

East of River Inhabitants are the MacMillan Lakes, White Lake, and Shannon Lake. These lakes are relatively shallow and are in part becoming filled with mosses and reverting to peat bogs. The catchment areas of these bodies of water are small and mostly confined to swamp and muskeg ground. Because of these factors and their considerable distance from the Port Hawkesbury area, it is not likely that these natural water reservoirs will be of any importance to the industrial development of the area.

West of River Inhabitants, Landrie Lake, Hector Lake, MacIntyre and Beaver Dam Lakes, and Horton Lake, are located between two and four miles from the town of Port Hawkesbury. For details on Landrie and Hector Lakes, see the Preliminary Report, Port Hawkesbury, 1961.

MacIntyre and Beaver Dam Lakes are considered as a unit body of water because they are only slightly over one-half mile apart and are joined by a stream. The southwestern end of Beaver Dam Lake is slightly more than three miles from the new Port Hawkesbury shopping centre. The catchment area of these lakes is about ten square miles, considerably larger than that of any other lakes in the map area. Part of the rock formation beneath Beaver Dam Lake belongs to the Windsor group. It is therefore possible that in dry weather water salinity may increase due to adjacent salt-rich formations characteristic of these sediments. No known tests have been made on these lakes to determine the depths or saline factors during wet and dry seasons, but such tests should be carried out in detail before any development plans for the lakes are put into effect.

Horton Lake is situated about four linear miles from the Hawkesbury Heights sub-division, at an elevation of approximately two hundred and seventy feet above sea level in the southern end of the Creignish Hills. The bedrock underlying the lake is relatively porous, consisting of Horton sandstone and pebble conglomerate. The lake has a catchment area of about two square miles.

During the dry summer months the water level in Horton Lake dropped approximately twelve inches but the lake continued to maintain itself without replenishment from rain. This suggests that the lake is in part fed by a system of springs. It is important to note that it would be possible to raise the water level over thirty feet by constructing a dam about one thousand feet long at the south end of the lake. This would probably triple the water capacity of the lake.

Rivers and Streams

There are no streams in the map area capable of producing a continuous supply of water for domestic or commercial use.

River Inhabitants, which is the only large river in the area, is affected by tides for approximately eight miles from its mouth at Inhabitants Bay, thus leaving the water of this portion of the river unfit for consumption. The majority of the remaining streams are intermittent or are reduced to a mere trickle during the dry summer months.

The area north and northwest of MacIntyre Lake is drained by North West Arm Brook, Lamey Brook, and their tributaries, which empty into River Inhabitants.

SUB-SURFACE WATER RESOURCES

Bored Wells

An adequate supply of water for domestic and minor industrial use is available below the water table in practically all regions of the map area.

The town of Port Hawkesbury owns several deep wells which range in depth from 150 to 420 feet and produce up to eight gallons a minute. Privately owned wells are common in the area and no problems are encountered in obtaining an adequate flow in the range of approximately six gallons a minute. The depth at which a sufficient quantity of water (Private Domestic Use) will be reached, is about one hundred feet, but varies with the depth of overburden and type of underlying bedrock (See Preliminary Report, Port Hawkesbury project, 1961). It should be noted that in the Port Hastings area the bedrock structures are more complex and may have varying effects on the depth at which water is encountered.

Water Tests in Drill Holes

During the 1961 field season three holes were drilled (See Map No. 2) at various stratigraphic horizons in the Riversdale group in the vicinity of Port Hawkesbury. These holes were drilled primarily to get information on specific sections of the Riversdale lithology but tests were also made on the quantity of available ground water. The holes were two inches in diameter and were drilled to a depth of 75 feet. Hole No. 1 was mostly in massive gray sandstone, Hole No. 2 was in dark grey shale and Hole No. 3 penetrated laminated gray shale and sandstone. Identical tests were carried out on each hole and gave similar results. Water was pumped from the hole for an hour and at the end of that period the quantity of flow was measured. Results showed that all holes were producing in the vicinity of eight gallons a minute over a period of one hour. When the test was completed the water level in each hole rose to within five feet of the surface in a few minutes. It should be noted that the type of pump used for the test would not lift water from a depth greater than twenty-five feet. It is therefore reasonable to assume that these holes or wells are capable of producing in excess of eight gallons a minute which is more than that required for normal domestic private use.

The black shale penetrated in Hole No. 2 was very badly broken and fractured to a depth of forty feet from the surface, and it is probably due to this fracturing that appreciable quantities of water were encountered.

From the tests made in these drill holes, it appears that quantities of water sufficient for present needs are available in the subsurface rock formations. Due to weathering and fracturing of the uppermost portion of the rocks, which renders them permeable and susceptible to the passage of water, normal private domestic requirements probably can be found with relatively shallow drilling regardless of the underlying bedrock lithology. Any industrial concern requiring subsurface water in quantities above the average domestic requirements would be well advised, however, to pay close attention to bedrock conditions, as the most favorable acquifers in the map area appear to be the Riversdale sandstone horizons. At surface these are mostly confined to the north and east of central Port Hawkesbury.

CHAPTER VI

SOIL CONDITIONS

General

Parent materials are an essential factor in soil formation. The characteristics of such materials determine to a large degree the type of soil that is developed. Soils in this map area appear in part to have a relationship to the underlying bedrock. These rocks differ in their hardness, texture, and resistance to weathering. The nature and attitude of the rock formations also determine in part the nature of the relief and drainage of the area.

During the last glacial period this area, in common with most of Nova Scotia, was covered with a thick sheet of ice. Weathered material derived from the underlying rock was mixed and transported by the ice and glacial waters and later deposited as unsorted drift. These deposits are largely in the form of till ground moraine and form the basic material for the present soils. They have a clay loam appearance, are stony in part, compact, and are relatively plastic and impermeable.

DESCRIPTION OF SOIL IN MAP AREA

In part from the present survey but primarily from the results of a soil survey of Cape Breton Island by the Nova Scotia Department of Agriculture, the various soils in this area have been established with approximate boundaries. The following tabulation and accompanying map Number 3 describes and illustrates this soil coverage. Classification names were obtained from the Nova Scotia Department of Agriculture, Soil Division.

Diligence Series

Soils of the Diligence series, located in the vicinity of Port Hawkesbury, Whiteside, and on the islands in the Inhabitants Bay, cover about seventeen square miles of the map area. The parent material of this soil, which is a greyish-brown plastic clay loam till, is derived primarily from grey and black shales and siltstones. It is associated with a gently rolling to hilly topography. This soil is not usually stony, except where numerous sandstone beds are interbedded with the shale in the underlying bedrock, and is characterized by having a slow internal drainage.

Queens Series

Soils of the Queens series have the largest coverage in the area, approximately thirty square miles, and are mostly confined to the central and eastern parts of the map area.

The parent material of this soil is a moderately plastic, reddish-brown clay loam glacial till, and varies considerably in stone content. It is slowly permeable to water and the texture becomes heavier with depth. This type of soil is chiefly associated with an undulating to rolling topography.

Kingsville Series

Soils of the Kingsville series cover about twenty square miles of the map area and are closely associated with the Queens soils but generally contain more stone. The parent material is a red-brown clay loam that appears to have been water-worked and laid down in shallow water. This soil is developed chiefly on a gently undulating to depressional topography. The water table in these soils is very near the surface and drainage is a major problem.

Woodbourne Series

The Woodbourne soils cover approximately twelve square miles of the map area and are mostly located on higher elevations of the lowland plains. This soil type is most prominent in the Sugar Camp area. The parent material is reddish-brown glacial till having a gravelly clay loam texture similar to the Queens but more gravel is present. It is associated with a rolling to hilly topography and usually found on steep slopes.

Shulie Series

Soils of the Shulie series cover about ten square miles of the map area on a gently undulating to hilly topography. The parent material is brown sandy loam till and has a relatively good internal drainage.

Thom Series

Soils of the Thom series are restricted to the southern portion of the Creignish Hills in this map area and cover about seven square miles. The parent material is a greyish-brown sandy loam till derived largely from metamorphic sedimentary rocks. The soil is quite porous and occasionally very stony. It varies in thickness from a few inches to several feet and has very fast surface and internal drainage. This soil type is associated with hilly to mountainous topography.

Peat Series

Soils of the peat series in this area cover about five square miles and are generally less than three feet thick. The parent material is mostly a poorly-farmed sphagnum type moss usually found in black, mucky layers with a considerable amount of moisture content. There is no commercial value to the limited material in this area.

Mira Series

Approximately five square miles of the map area is covered by soils of the Mira series. This soil type is associated with long sloping to level topography. It is similar to the Thom soils but the nature of the topography and the attitude of the underlying bedrock restricts water movement and it is reflected in the soils by a mottled profile. Generally the Mira soils are extremely stony.

Hebert Series

Soils of the Hebert series cover about one square mile of the map area. They are located along a narrow belt from Proctor Cove, near the mouth of River Inhabitants, to Morrison Siding, northwest of Cleveland, along Northwest Arm Brook south of Sugar Camp, and along Lamey Brook east of Queensville. The parent material is coarse-textured, stratified gravel, sand, and clay, deposited by glacial waters. This soil is characterized by having an extreme range of coarseness of material and very good drainage. It is generally found on gently rolling to level topography. The Hebert series is very important as it is the only soil type in the area that contains commercial deposits of gravel, sand, and clay.

Coastal Beach Series

About one-half square mile of the map area is covered by Coastal Beach soils. Although this type has a relatively small areal extent, it is important as a source of construction aggregate materials. The parent material is sand and gravel derived chiefly from granitic material. These soils have very rapid drainage and are confined to the coastal areas northwest of Port Hastings. Private construction companies are exploiting the Coastal Beach soils in this area.

Others

The remaining soil types cover about two square miles of the map area and are mostly confined to tidal marsh and swampy areas having little or no economic possibilities.

AUGER BORINGS

During the 1961 field season determinations of depth and composition of the overburden were made at various locations throughout the map area. Drilling was carried out by means of an hydraulic auger mounted on the rear of a jeep and operated by a power takeoff mechanism. The main object of this drilling was to locate deposits of gravel, sand, and clay in the map area. (A detailed report of this drilling and accurate location of the holes is on file with the Nova Scotia Departmeent of Mines.)

The results of the drilling showed that three areas, notably those covered by the Hebert soil series, contained gravel, sand, or clay materials. It was found that the sand and gravel in the Grantville area south of Cleveland is associated with an esker which is about fifteen feet high and twenty-five feet wide. This esker trends along the west side of River Inhabitants for about two miles. Numerous gravel and sand pits have been worked along this esker and at present one quarry is being operated about one mile south of Morrison Siding.

In the Queensville area, along Lamey Brook, a deposit of gravel and clay was located by drilling. No development work was carried out on the deposit, but surface investigations indicate an extensive gravel deposit which seems to overlie a deposit of fire-clay. Most of the pebbles in the gravel are less than three inches in diameter and are composed of igneous and metamorphic rock. The gravel is generally clean and has little associated silt and clay material.

A drill hole immediately beyond the northern limit of the gravel deposit penetrated over fifteen feet of brownish-red fire clay. A firing test showed it to have good qualities and economic possibilities. The clay appears to underlie the gravel deposit.

About one and one-half miles northeast of Mackdale near Dorton's Bridge a small amount of stratified gravel, sand, and clay was found. The material in this deposit is very poorly sorted. No lateral extension to this occurrence could be found and it is considered to be uneconomic.

THE RICHMOND-INVERNESS METROPOLITAN PLANNING COMMISSION

Planning on a regional basis had been non-existent in the Canso Strait area prior to the industrial expansion experienced in recent years. This industrial expansion and accompanying residential growth led county and town officials to realize the need for an overall planning authority in the area. On March 2, 1960, the Richmond-Inverness Metropolitan Planning Commission was established, making it the first such planning region in Nova Scotia.

The planning commission is made up of nine members, three from each participating municipality. Although the commission has not as yet seen fit to employ any staff, it has been active in many fields. The commission has prepared a zoning plan for the Metropolitan area which has not been approved. The location of the airport site was promoted by the commission and it has advocated a seawall or other marine berthing facilities for the area. The county councils have adopted the short form of the National Building Code upon the recommendation of the planning commission.

The plan showing probable future land use in the Metropolitan area, which is seen in this report, has been approved by the planning commission. This future land use map indicates how the Metropolitan area should grow, and in the opinion of the commission, how it will grow and expand. Many features shown on this plan are totally non-existent today. The airport, for example, is only in the planning stage and future trends in growth will probably determine when its construction begins.

The real task of preparing plans to guide this region in the future has only just begun, and it is hoped that soon industry, and all other elements of the economy, will have the protection, service, and encouragement that a sound regional plan of the metropolitan area can provide.

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