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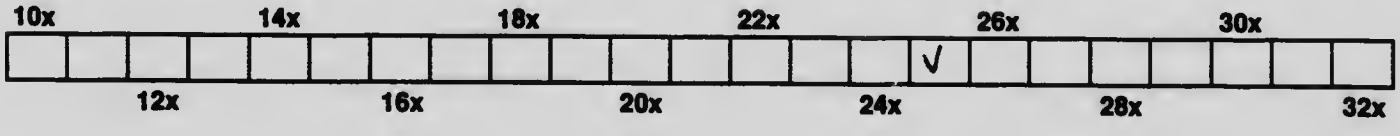

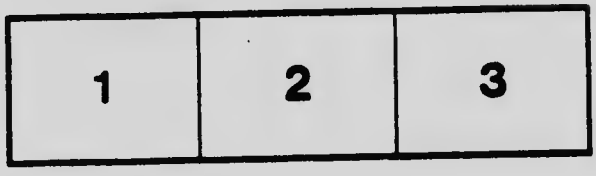

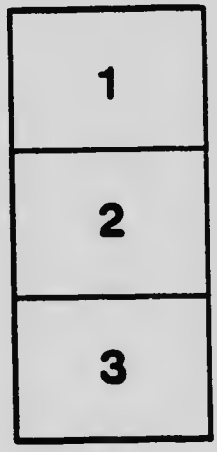

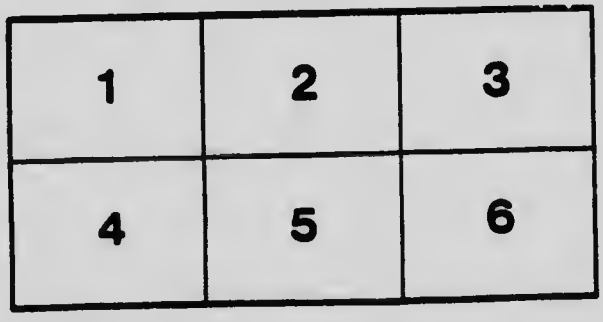

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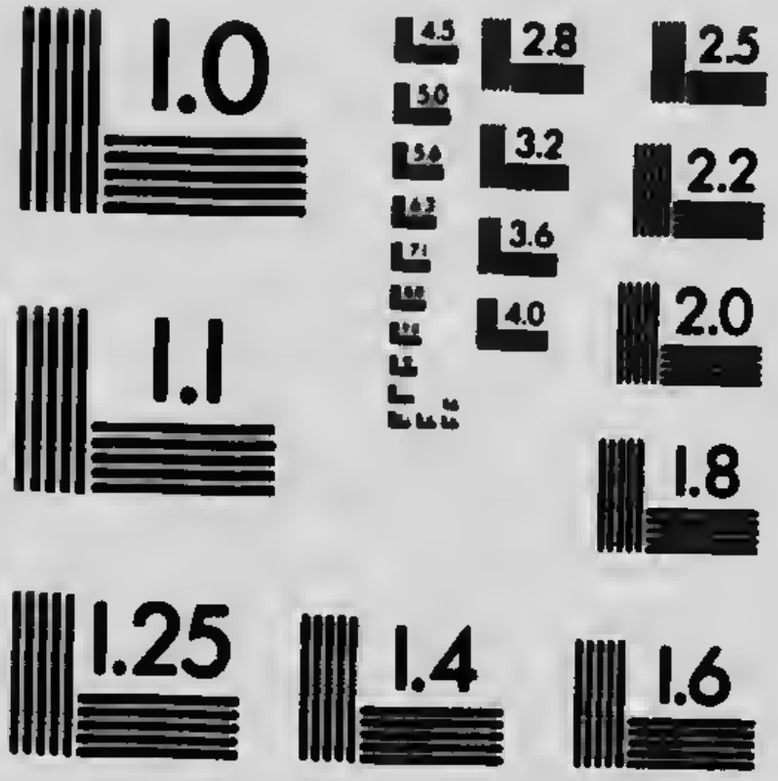

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MEMOIR 121

No. 103, GEOLOGICAL SERIES

The Malagash Salt Deposit, Cumberland County, N.S.

BY
A. O. Hayes

OTTAWA
THOMAS MULVEY
PRINTER TO HIS MOST EXCELLENT MAJESTY
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INTRODUCTION.

The salt at Malagash occurs as a stratified deposit interbedded with rocks of the Mississippian (Lower Carboniferous) period and apparently forms an integral portion of the Windsor (Carboniferous limestone) series.

This report presents the results of field work carried on in June and July, 1919, with the object of ascertaining the mode of occurrence and probable extent of the deposit. The geology is illustrated by two areal maps with structure sections, one of Malagash peninsula on a scale of 1 mile to 1 inch, the other a more detailed map of the vicinity of the mine workings on a scale of 800 feet to 1 inch. After a brief review of the history and previous work, the stratigraphy and structural geology are described.

The discovery of rock salt at a depth sufficiently shallow for its recovery by mining has directed attention to the distribution of sedimentary rocks of similar geological age. In the hope that other sources of salt may be found, and as interest has also been aroused in the possibility that potash, in commercial quantity, may be associated with the salt, a review of the literature describing salt springs in Nova Scotia and New Brunswick is given, and the locations of certain springs is indicated on the index map.

ACKNOWLEDGMENTS.

The kindness of the residents and the hospitality of Mr. Charles W. Clarke, on whose farm a camp was maintained, are greatly appreciated, and the many courtesies by which Messrs. A. R. Chambers and G. Walker McKay aided the work are gratefully acknowledged.

H. W. McKiel and D. D. Foster carried on their work as assistants most satisfactorily. The plane-table topographic map was prepared by Mr. Foster.

HISTORY AND PREVIOUS WORK.

Brine springs have been known locally for many years. Boring for water on his farm at North Shore, in 1912, Mr. Peter Murray obtained a flow of salt water at a depth of about 80 feet. In June, 1917, Mr. A. R. Chambers, associated with Mr. George Walker McKay of New Glasgow, commenced prospecting by drilling. Twelve holes were sunk by a churn drill in an area of about one-tenth of one square mile, and brine was obtained from six of these at depths varying from 85 to 113 feet below the surface. Diamond-drill boring proved the presence of salt in place extending from a

depth of 94 to 173 feet below the surface. A shaft was then sunk 450 feet east of the diamond-drill boring and salt was found at a depth of 85 feet.

Perhaps the earliest reference to the presence of rock salt in Cumberland county was published by Dr. Abraham Gesner eighty-four years ago, in the following words:[1]

"Salt springs are common in the new red sandstone along the coast of Northumberland strait. At River Philip, a large quantity of salt was formerly manufactured, by evaporating the waters of a briny pool. One of the springs at that place yields a larger quantity of muriate of soda than almost any other in the country, and would supply, under proper management, more salt than would be required by the British North American colonies; nor can it be possible that the crystalline deposit from which these waters flow, is beyond the reach of the miner's skill. The infancy of the colony is a trite apology for not entering into useful speculations, but it seems impossible that any country can arrive at manhood, when little pains are taken to develop its growth."

A geological map of the Malagash peninsula was compiled by Scott Barlow, R. W. Ells, and Hugh Fletcher, and published in 1905 as Nova Scotia Geological Sheet No. 60. Ells[2] describes the anticlinal fold which characterizes the structure of Malagash peninsula and gives a section measured along the shore of Wallace river. He concludes that the Lower Carboniferous series is repeated by faulting. Fletcher[3] describes the continuation of the Clairmont anticlinal to Malagash point, and the rocks resembling Permian strata at the head of Tatamagouche bay.

In his report on the salt deposits of Canada, L. Heber Cole[4] lists certain salt springs that occur in Nova Scotia and New Brunswick, which issue from carboniferous rocks of the same age as those enclosing the Malagash deposit.

The discovery, early history, development, and geology of the Malagash deposit are described by Cole[5] and Hayes[6].

Cole also discusses the domestic and foreign markets for salt, pointing out the importance of the discovery at Malagash to Canada and more especially to the Maritime Provinces. From a study of the report on mineral production of Canada in 1918, by John McLeish[7], the conclusion is reached that Canada at the present time imports over half of her annual consumption of salt, the only production being in southwestern Ontario. The import of salt in 1918 amounted to 165,494 tons valued at $1,267,169. Of this amount 100,103 tons were imported for the use of fisheries, about 75 per cent of which is used by the Atlantic seaboard and gulf of St. Lawrence fishing industry.

"The average value of this salt at point of shipment for 1918 was approximately $8.15 per ton of 2,000 pounds. The ocean freight rate to bring this salt to Canadian ports of distribution would bring the cost up to at least $10 per ton.

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[1]Remarks on the geology and mineralogy of Nova Scotia by Abraham Gesner, 1836, p. 144.
[2]Ells, R.W., Geol. Surv., Can., vol. I, 1885, p. 40E.
[3]Fletcher, Hugh, Geol. Surv., Can., vol. V, pt. II, 1890-91, p. 137P; vol. XV, 1902-3, p. 163 AA.
[4]"The salt deposits of Canada and the salt industry," L. Heber Cole, Mines Branch, Dept. of Mines, 1915, No. 325, pp. 16-20.
[5]Cole, L. Heber, "Notes of a discovery of rock salt in Nova Scotia," Dept. of Mines, Mines Branch, Sum. Rept. 1918, pp. 70-73, and Can. Min. Jour. Jan. 8, 1919, pp. 8,9.
[6]Hayes, A. O., Geol. Surv., Can., Sum. Rept. 1918, pt. F, pp. 30F-31F.
[7]Mines Branch, Dept. of Mines, Publication No. 506.

"The price will probably be a normal price for salt for fisheries for a number of years to come—the sales price during war times ranging between $15 and $25 per ton at distributing points in Nova Scotia. If, therefore, a deposit of salt can be developed in a centrally located point in Nova Scotia, and a grade of salt produced suitable for the fishing industry, a market of some 75,000 tons valued at $750,000 should be available.

"In addition to this, a considerable demand for salt for domestic purposes, in the Maritime Provinces, could be supplied from such a deposit.

"Among the foreign markets for the salt from the Malagash deposit, the principal ones will be the fishing industry of Newfoundland, which consumes, according to reports, about 50,000 tons per year, and the fishing and metallurgical industries along the Atlantic seaboard of the United States. It remains to be seen how much of this American market can be captured by salt produced in Canada.

"One feature with regard to the Malagash deposit well worthy of serious consideration for future action, is the possibility of establishing an industry for the manufacture of sodium compounds. Situated as this deposit is, with ready access to shipping facilities both by rail and water, and comparatively close to abundant supplies of fuel, it is probable that an industry using the salt from these beds as the principal raw material could be established, which would turn out products at a price that could compete in foreign markets such as South America and South Africa, with similar material from England and the United States.

"Although the Canadian market alone, for salt for domestic use or for the chemical industries, would guarantee its success, it will be seen that the favourable location of this deposit to water transportation on the Atlantic seaboard should enable it to develop an export trade with the United States, South Africa, and South America."

It should be mentioned that there is no duty on salt, other than medicated salt, imported from Great Britain.

The prospecting and mining developments have also been interestingly described in the bulletin of the Canadian Mining Institute for December, 1919, pages 1191-3. In this article reference is made to active drilling operations conducted in the vicinity of Wallace, Cumberland county, by the engineers of Sir Alex. Maguire, of London, England, and to an installation of an experimental plant at the Malagash mine for hoisting, crushing, and screening the salt. The property is now in a position to supply the market with several tons of salt per day, sized to meet the several grades in demand, and also to supply rock salt for the use of stock. The salt is gradually finding favour in the markets dealing with salt and salt products. For dried cod purposes it turns out a splendid white fish, being free of the discolouring of bacteria, supposed to exist in evaporated sea salt. There should be a great demand shortly for the product of this industry which is new to Nova Scotia. The development of the gulf fisheries, it is declared, has hardly begun. When real development occurs salt will be within reasonable reach and the industry now started should prove to be of great economic importance to the province. The money at present expended for salt in this territory amounts to about $1,000,000 yearly, exclusive of what is required by Newfoundland.

SUMMARY OF CONCLUSIONS.

The Malagash salt is a deposit formed by the evaporation of sea water during a recession of the Mississippian sea in Windsor time.

Mining development has demonstrated the presence of a sufficient quantity of salt for the establishment of an important industry, and the market is now supplied by run of mine salt from a bed 4 feet thick, an average sample from which contained 98 per cent sodium chloride. A bed of clean crystalline salt 21 feet 6 inches thick has been encountered in a boring by a diamond drill at the face of the underground workings. Sixty feet thickness of salt strata measured at right angles to the dip has been cut by a shaft and level, all of which can be utilized for the manufacture of refined salt or other sodium compounds. As only about one-tenth of the ground underlain by brine has been crossed in the Malagash mine workings, the outlook for a much thicker body of salt is good.

Potassium chloride occurs in a lenticular deposit in the form of crystalline masses of pink and yellowish green sylvite in a matrix of halite. A potash zone has been penetrated at two points 30 feet apart, varying in thickness from a few inches to 5 feet. The potash content is variable, dependent on the concentration of sylvite which is probably of secondary origin.

In the shaft near the top of the salt bed a 4-foot seam, with an analysis of 1·16 potash was encountered, and in the face of the drift, about 30 feet lower stratigraphically, a much richer potash zone was exposed. In one place, a full shot from the face ran 8·73 per cent potash.

The salt strata are probably offset by faults at certain localities, but the regularity of the structure along the coast to the north, for a distance of about three-quarters of a mile, suggests that the salt may extend without serious interruption for an equal distance along the strike, and the sedimentary character of the salt points to a continuation in depth, parallel to the dip of the enclosing rocks.

The occurrence at many localities in Nova Scotia and New Brunswick of salt springs issuing from rocks of the same geological age, suggests that other deposits of a similar nature occur in the vicinity of these springs. The salt strata are similar in origin to the extensive Stassfurt deposits in southern Saxony, in which large accumulations of potash-bearing sediments occur. The presence of small quantities of potash at Malagash and in the brines from springs elsewhere indicates that, possibly, potash in commercial quantities may also occur in the Maritime Provinces.

The establishment of a salt and allied chemical industry should receive careful consideration as the favourable location of Malagash with respect to the supply of raw materials and fuel and its exceptional advantages for transportation either by rail or water offer an opportunity for successful competition in both domestic and foreign markets.

PHYSIOGRAPHY.

The dominant feature controlling the scenery of the Malagash peninsula is a ridge rising to elevations between 100 and 200 feet above sea-level, and extending easterly from Wallace ridge north of Golden brook to Malagash point. A second parallel ridge lies to the south of Golden brook

from which the surface slopes gently toward the shallow waters of Tatamagouche bay. There is also a gentle and wider slope inclining northerly toward the shore of Northumberland strait. A good idea of the topography may be obtained by travelling across the peninsula over the Stake road. From the summit of the ridge immediately north of Golden brook, the waters of both Northumberland strait and Tatamagouche bay may be seen. The whole district was covered in glacial times by an ice-sheet which in its progress gave the rocks a rounded and modified surface. The streams follow pre-glacial channels and only a thin veneer of boulder clay was left by the receding glacier. Stratified sands occur to the north of Waugh island, but whether they are outwashed fluviatile deposits or sediments of Champlain age was not determined, as no fossils were found in them. The north and the south shores of the peninsula vary greatly: facing Northumberland strait there is a continuous cliff about 40 feet high extending from the Stake road to a point north of the salt mine. Ocean erosion is proceeding with noticeable effect, and off-shore the water of Northumberland strait is too shallow for shipping purposes. Low lying ground extends to the east of the Malagash salt mine as far as Breen point where reddish-brown rocks of the Millstone Grit reappear as cliffs as far as Saddle island. The relief is controlled in general by the character of the underlying rocks, and wherever the softer rocks of the Windsor series appear the ground is usually low lying and outcrops are few and far between. Malagash point is marked by the reappearance of the cliffs composed of Millstone Grit, and here it is seen that the ridge dominating the peninsula is underlain by a heavy, grey-green sandstone overlying the reddish-brown basal beds of Millstone Grit. Nearly the whole length of the south shore of the peninsula bordering Tatamagouche bay is low lying with intermittent outcrops of bedrock in the tidal area.

A striking feature on the south shore of the peninsula about one mile west of Malagash point is the building up of a sandy shore and the preservation of an earlier beach line rising abruptly about 5 feet above the recently deposited sand and now grown over with grass and shrubs.

The areas in the vicinity of Saddle island, which is connected with the mainland by a broad expanse of sand exposed at low tide, and to the southwest of Malagash point, as described above, appear to be areas of sand accumulation at the present time.

STRATIGRAPHY.

Portions of the eroded edges of each of three series of sedimentary rocks are exposed along an anticlinal fold on Malagash peninsula.

Although the exact age relations of these rocks have not been established, the two older series are known to belong to the Carboniferous group formed during the Mississippian and Pennsylvanian periods respectively. The youngest series was deposited in either late Pennsylvanian or Permian time. The series are separated by two unconformities, indicating periods of earth movements resulting in folding of the rocks, elevation of the land relative to sea level, and erosion. The following provisional classification is employed.

Period.	Series.	Character.
Late Pennsylvanian or Permian.	New Glasgow.	Conglomerate, sandstone, shale.
	Unconformity.	
Early Pennsylvanian	Millstone Grit.	Conglomerate, sandstone, shale.
	Unconformity.	
Mississippian	Windsor.	Conglomerate, sandstone, shale, gypsum, salt.

Rock exposures of each series are shown on Maps 1796 and 1797, by distinctive solid colours, and on the map of Malagash peninsula the inferred areal extent of each series, where the bedrock is concealed by superficial deposits, is indicated by a light tint of the corresponding colour. On the detailed map (No. 1797) of the salt district the areas of bedrock concealed and the area inferred to be underlain by salt are left uncoloured to emphasize the uncertain positions of the boundaries.

Windsor Series.

Intermittent outcrops occur along the shore of Northumberland strait north of the shaft, exposing a thickness of about 300 feet of strata forming a small portion of the north limb of an overturned anticlinal fold. The most easterly outcrop is composed of interbedded limestone and gypsum. Laminated gypsum, about 12 feet thick, filled with selenite crystals, is capped inland by a brecciated gypsiferous limestone, 4 feet of which is exposed beneath boulder clay. Similar fossiliferous limestone to the northeast is exposed at low tide, and may represent a portion of the same bed carried northward by faulting. Fossils collected from the limestone were examined by E. M. Kindle who described them as follows:

"These fossils were embedded in gypsiferous limestone and comprise a small and very poorly preserved lot. The determinations are consequently provisional, as follows:

Productus cf *cora.*

Hartina anna.

Aviculopecten cf *simplex.*

"The fauna is small and poor, but I believe larger collections will confirm my opinion that this fauna represents an horizon in the Windsor series."

The bedrock is not exposed inland and the stratigraphical position of the salt beds in relation to the fossiliferous limestone is not known. The difficulty of establishing this relationship is increased by the presence of a fault lying between the limestone and the strata to the west, containing the salt beds. The disturbed condition of the heavy sandstone beds east of the fault indicates that crushing took place with movement probably

sufficient to offset the salt strata. No proof of the direction of movement was found, but a drag of the eastern beds southward suggests an offset of the east side northwards. The fault appears to extend in a southerly direction, and, if continuous, would pass through the salt deposit east of the shaft, as indicated on Maps 1796 and 1797.

The section exposed immediately west of the fault is as follows:

	Feet.
Grey sandstone, with plant remains	50
Limestone conglomerate	3
Covered	10
Brown limestone } Brown shale... }	15

Another section exposed farther west, and separated from the first by a small fault, is as follows:

Grey sandstone, with drifted plant remains	3
Grey sandstone, with shale layers and coal streaks	7
Greenish, grey sandy shale, with irregular fracture and spheroidal weathering	23
Grey sandstone, with conglomerate layers, drifted plant remains, and resulting coal masses	11
Grey sandstone, with crossbedded layers which indicate conclusively that the top is to the north and the series is overturned	20

The average strike of the beds is nearly parallel to the shore and the dip is uniformly south. The sandstone is usually crossbedded, and the upper portion of the beds is frequently characterized by evidence of erosion contemporaneous with deposition. The resulting truncation of layers of sand is so well shown as to prove conclusively that the top is to the north and the beds are overturned. A nearly continuous exposure about 500 feet thick of this series along the deeply entrenched valley of Ross brook, comprises brick-red strata with interbedded brown and grey sandstone layers, all of which dip steeply southward, and apparently form a continuation westward of the overturned north limb of the anticlinal fold. Brine springs at the source of the stream suggest that the salt is an integral portion of the series at that point, 2 miles west of the mine.

Similar, brick-red shale and sandstone are found along the banks of Wade brook, and farther west, at Plaster cove, a thickness of about 250 feet of gypsum is exposed.

About 1,000 feet of sediments lithologically similar to those of Ross and Wade brooks are exposed in the steep banks of Wallace river, about 4 miles above Wallace bridge. A covered interval occurs at the north end of the exposure on the east bank of the river where Simmons brook enters the valley. In the low-lying ground south of the mouth of Simmons brook a sink hole is partly filled with brine. Since that part of the valley is above tide level, and the surface of the brine is [illegible]y the level of the river, it seems probable that the salt water has ori[illegible]ed from solution of salt strata underlying this locality.

The character of the salt deposit is known only from the beds exposed in the mine workings at Malagash, which are situated centrally in the area

from which brine was obtained in drill holes. The character of the roof and floor has not been determined, nor has the relation of the salt to any horizon marker been definitely established.

Thin, lenticular layers of clay interbedded with the salt indicate the primarily sedimentary nature of the deposit, and a probability of the continuation of the strata both along the outcrop and in depth, subject to the folding and faulting to which the Windsor series as a whole has been subjected.

The dimensions of the salt deposit can be only roughly approximated. An estimate of its stratigraphical thickness must be based on the attitude of the salt strata exposed in the mine workings which have crossed only about one-tenth of the total distance of 600 feet within which brine was obtained from borings. The attitude varies within a horizontal distance of 50 feet from a dip of 25 degrees south, in the shaft, to 80 degrees north, at the face of the level. Assuming that the beds have not been duplicated by folding or deleted by faulting the actual thickness of the original beds is probably more than 300 and less than 500 feet, measured at right angles to the dip.

A small exposure of conglomerate and crossbedded, coarse, arkosic sandstone, apparently in place, outcrops about a quarter of a mile south of the shaft. The rock resembles the basal member of the Millstone Grit series exposed along the north shore, but the conglomerate members of the various rock series resemble each other so closely that no conclusion has been reached regarding its age.

The gypsiferous sediments overlying the salt strata at the shaft are stated by Mr. Alex. Gullons, the foreman in charge of the sinking, to be so soft and broken that the excavation was made without the use of explosives and though it was difficult to decide the average attitude of the beds, he thought the dip to be at a low angle. The suggestion was made, by L. H. Cole, that these sediments lie unconformably above the salt. The Windsor series without doubt suffered subaerial erosion in late Mississippian time when sink holes along the salt horizon may have been filled by such sediments as are penetrated by the shaft, and the basal conglomerate of the Millstone Grit was deposited above when the land was submerged in Pennsylvanian time. Another view suggests that gypsiferous interbedded shale may have slumped over the salt strata when they were dissolved along its outcrop by the development of a deep trough more quickly than the retaining wall rock was reduced by erosion. The full explanation of the origin of the surface cover over the salt strata at the shaft requires further study.

Chemical Analyses. Average samples taken from the shaft by the writer in October, 1918, when a vertical depth of 17 feet through the salt strata had been sunk, were analysed by Mr. Baridon of the Mines Branch, Department of Mines, Ottawa, with the following results:

Sample 3	is from	top of salt	to	8	feet	depth.	
" 2	"	8 feet	"	16	"		
" 1	"	16 "	"	17	"		

Material dried at 105 degrees C. was found to have following composition:

A. Part soluble in hot water.	1.	2.	3.
Sodium (Na)	38·57	23·15	37·42
Potassium (K)	0·17	0·16	0·14
Calcium (Ca)	0·18	0·81	0·31
Magnesium (Mg.)	0·01	0·06	0·03
Chlorine (Cl)	59·58	35·85	57·85
Sulphuric acid (SO_4)	0·64	3·05	1·07
Iodine (I)	none.	none.	none.
Bromine (Br.)	none.	none.	none.
	99·15	63·08	96·82
B. Part insoluble in hot water.			
Silica (SiO_2)	0·61	21·85	1·60
Ferric oxide and alumina (Fe_2O_3 and Al_2O_3)	0·31	7·90	0·77
Lime (CaO)	0·06	0·25	0·06
Magnesia (MgO)	0·07	2·15	0·19
Soda (Na_2O)	.....	0·93	0·09
Potash (K_2O)	.....	trace.	.....
Sulphuric anhydrite (SO_3)	0·10	0·22	.....
Organic (combustible) matter	0·25 1·40	2·06 35·36	0·30 3·01
	100·55	98·44	99·53

A grey, earthy material resembling gritty clay is interbedded with portions of the salt strata. The analyses suggest that silica forms the largest proportion of this material with a certain amount of clay and gypsum. On the walls of the shaft the surface salt dissolves by the action of surface water, leaving the insoluble earthy material standing out more prominently. On this account samples 2 and 3 may show in the analyses an excess of insoluble material.

Bands of salt similar to that represented by sample No. 1 occur in the lower mine workings and about 20 feet north of the shaft a bed 4 feet in thickness, sampled and analysed by H. V. Ellsworth, contained 98 per cent sodium chloride. Bordering this purer salt to the north a potash-bearing stratum occurs, composed of masses of pink and yellow-green sylvite (potassium chloride) embedded in a matrix of halite. In some places these masses have the appearance of a mosaic, and elsewhere are banded parallel to the bedding of the salt strata. A lens-shaped zone was pierced in the level and found to be 5 feet thick, thinning to a few inches on all four walls. An extension of the zone was found about 35 feet west of the level, indicating a continuation of the band between these points and suggesting that the horizon may be persistent even if erratic in thickness. No average potash content has been estimated owing to the extreme variability both in the size of the deposit and concentration of sylvite. The position of the sylvite occurrence is indicated on the section across the mine working shown on the small map (No. 1797) of Malagash district.

Results ranging between 2·5 per cent and 11 per cent have been obtained from average samples.

The masses of sylvite are probably concentrations deposited by replacement of halite, and are consequently of secondary origin.

The sedimentary character of the salt strata and its similarity in origin to the great deposits at Stassfurt in southern Saxony, in which primary potash-bearing minerals occur, suggest the possibility of the presence of primary deposits of potash-bearing minerals.

The total thickness of the Windsor series has not been measured in the Malagash district. At Joggins it is roughly estimated at 2,000 feet by W. A. Bell[1], who describes the rocks as follows:

"*Windsor Formation.* Below the Joggins section in the axial region of the Minudie anticlinorium, near Minudie, there may be seen at low tide some 50 feet (15 m.) or more of black and nodular limestone, associated with red and green shales and calcareous sandstones. The calcareous beds carry a scanty fauna related to that of the upper limestone at Windsor, of Mississippian age. The extension of these beds at Nappan and across the bay in New Brunswick is associated with a thick zone of gypsum, but this mineral is concealed in the low area below the Joggins section. Lying conformably above these definitely marine beds, there are upwards of 2,000 feet (610 m.) of barren, brick-red, arenaceous and argillaceous shales, of which the upper 966 feet (299·4 m.) are well exposed at the base of the Joggins section. These soft, red beds underlie a belt of low country about 2½ miles (4·2 km.) in width, striking in an easterly direction from Cumberland bay to River Hebert. The shales contain abundant flakes of mica, and from their rippled, mud-cracked, and crossbedded character are believed to be the deposits of a receding Mississippian sea and are hence included in the Windsor formation."

Millstone Grit Series.

An erosional unconformity occurs between the Windsor and Millstone Grit series, and the actual overlap of the basal conglomerate is exposed along the shore for half a mile eastwards from Grindstone point. The underlying rocks are overturned and dip south, whereas the overlying beds dip north, forming nearly right angled unconformity. The Millstone Grit is composed of a basal member of the same horizon, predominantly reddish brown in colour, of which 785 feet thickness is exposed west of Garvois point, and a continuation of the same basal phase 725 feet thick is exposed at Malagash point. The basal member is composed of heavy beds of conglomerate interbedded with sandstone and shale, the upper 500 feet being composed almost entirely of shale. The overlying sediments are more variable in character, and include heavy-bedded, greyish-green sandstone, interbedded with brown and green shale and sandstone, with recurrent coarser grit and conglomerate beds. Three beds of blue limestone barren of fossils also characterize the sediments exposed on Malagash point where a cross-section of the whole series is well exposed on the south limb of an anticlinal fold. The actual base and top are concealed so that the total thickness of the series is greater than the 2,525 feet exposed at

[1]Geol. Surv., Can., Guide Book No. 1, pt. II, pp. 331-2.

Malagash point. W. A. Bell[1] gives a thickness of 4,583 feet measured at Joggins.

Thin coal seams and lenticular, bedded deposits of copper sulphides occur in the basal portion of the upper member. No workable coal seams are exposed and attempts made to recover the copper have been without success. The copper occurs as minerals resembling chalcocite and bornite associated with plant remains in fine-grained calcareous conglomerates.

The productive coal measures are absent in this district, and as their place probably lies above the Millstone Grit series it is possible that they may have been originally deposited but carried away by erosion along anticlinal folds before the deposition of the New Glasgow series. They may still be present in synclinal folds of the Pennsylvanian system, lying beneath the cover of the New Glasgow series.

New Glasgow Series.

The age of the New Glasgow series is not definitely established, but the rocks composing it are easily distinguishable from the underlying series by their characteristic colour, and a discussion of stratigraphy and correlation is not necessary in this report. The rocks are an interbedded brown and greenish-grey conglomerate, arkose sandstone and shale alternating recurrently. The dominant colour is characteristically a brighter reddish brown than that of the older rocks. The measures are exposed along the north shore, west of the Stake road and along the south shore, west of the mouth of Golden brook.

An erosional unconformity appears to separate the Millstone Grit from the overlying series and this may represent a time gap during which the productive coal measures were removed by erosion along anticlinal folds. Conclusions regarding the original distribution of the productive coal measures will be better arrived at by stratigraphical and palæontological study in the field.

The three series of rocks extend from Cobequid mountains northward to Northumberland strait, the Windsor and Millstone Grit coming to the surface along the axes of anticlinal folds. The Windsor series, in which the salt is found, appears to extend almost continuously, as a narrow band, from Malagash point westward to Cumberland basin. It is probable that the salt strata accompany gypsum beds, and as outcrops of gypsum are found at various places along the axis of the Clairmont anticlinal, salt may occur in other localities than Malagash.

STRUCTURAL GEOLOGY.

The Windsor series has suffered intense folding and faulting. The strata along the shore north of the salt deposit dip southward, but are overturned, and higher strata in the series outcrop to the north beneath Northumberland strait. If the structure continues uniformly, about 650 feet of strata intervene between the coast and the salt deposit, and the strata lie on the north limb of an anticlinal axis. The heavy-bedded sandstones exposed along the coast north of the shaft are crumpled and

[1]Geol. Surv., Can., Guide Book No. 1, pt. II, pp. 331-2.

shattered as though lying near the axis of a fold, a synclinal to the north, or an anticlinal to the south. The rocks suffered sufficient deformation at the close of Mississippian time to cause the strata to assume a vertical attitude before the deposition of the Millstone Grit series in Pennsylvanian time. Before the deposition of the New Glasgow series, both the Windsor and Millstone Grit series were folded and eroded. Subsequent to the deposition of the New Glasgow series all three, each comprising several thousands of feet thickness of deformed strata, were folded together until the youngest member lies in broad, open folds locally thrust into steeply dipping attitudes. It is impossible to reconstruct and represent the complicated structure of the Windsor series, except where good exposures may be carefully studied. Open folding has been superimposed on the already highly folded older series; various horizons in the older series may, therefore, have been brought to the surface along the anticlinal axes and not necessarily the lower measures, even though an anticlinal form may have been induced upon previous folds of the older rocks.

The salt strata were formed by evaporation of sea water in isolated lagoons and probably overlie limestone and gypsum measures which occur in the lower part of the Windsor series. The gypsum and salt may recur rhythmically interbedded, as do the limestone and gypsum on Smith island, Inverness county.

The Malagash salt horizon lies along the axis of an anticlinal fold, and may, therefore, be crumpled locally and perhaps thickened by isoclinal folding and duplication of its strata. It is impossible to state positively whether the salt strata continue to great depths with the attitude found in the mine workings or are folded so as to retain a more shallow position; but they probably continue with local crumpling for several hundred feet at least and, as far as mining operations are concerned, no immediate difficulty may be looked for regarding depth.

Along the strike, two important sets of faults or zones of faulting traverse the rocks exposed along the shore. Their extension inland is unknown since rock outcrops are wanting, but if these faults are ever met in the mine they should be easily recognized. As indicated on the maps one fault may cut the deposit about 500 feet east, and the other over 3,000 feet west, of the present workings, so that they need occasion no immediate concern at the mine.

The displacement of the salt horizon along the fault west of the shaft may be referred to in greater detail since the amount of the throw of the fault west of the shaft is fairly well indicated. A zone of faulting occurs within a distance of 100 yards west of the mouth of the stream flowing through the farm of Henry Porteous, about three-quarters of a mile west of the shaft, measured along the road.

The fault strikes magnetic south, and the direction of throw, as indicated by slickensiding, is vertical and dips to the west. The base of the Millstone Grit is considered to occur about 1,500 feet south of the shore-line, as indicated by the presence on the shore of about 1,000 feet of exposed strata belonging to a horizon above the conglomerate. The underlying Windsor series should also be dislocated and if the salt strata continue to dip southerly, the downthrow to the west would cause this horizon to be thrown north. Horizontal displacement, if any, would

appear to be southward on the west side and consequently would tend to bring dislocated salt strata nearer together at the fault.

Owing to the lack of outcrops and the consequent uncertainty regarding the structure the best proof of the position of the salt is to be obtained from the location of brine springs and by drilling, and this position west of the fault, determined by such methods, appears to be a point between 3,000 and 4,000 feet north of the forks of the Stake and North Shore roads, near the head of Ross brook.

DRILL RECORDS AND MINING.

DRILL RECORDS.

With the exception of No. 5, a diamond-drill boring, all the holes, seventeen in number, were sunk by a churn drill. No samples of the drillings were taken, and the twelve records given below are copies of the driller's logs. The positions of the drill holes are indicated on the map and section by corresponding numbers.

Number of hole.	Character of rock.	Thickness. Feet.	Total depth. Feet.	Remarks.
1	Brine		70	Struck brine at 70 feet and stopped.
2	Earth	25		Record incomplete, reads 25 feet earth, at from 60-70 feet.
	Gypsum	10	70	Struck gypsum, at 85 feet encountered salt.
	Salt		85	Through salt to 130.
	Salt		130	
3	Brine		85	Struck brine at 85 feet, stopped at 87 feet.
4	Earth	25	25	
	Hard, flinty rock	3	28	Possibly a boulder.
	Soft, red rock	57	85	
	Hard rock	40	125	
5	Red clay and gravel	26	26	
	(No description)	58	84	
	Clay, bluish-grey	10	94	
	(No description)	18	112	
	Hard stone	1	113	
	Salt	60	173	
6	Earth	22	22	
	Hard, red rock	6	28	
	Soft, red rock with bands of hard red 3 to 4 inches thick	47	75	Stream of water at 65 feet
	Hard, red rock	19	94	
7	Surface	12	12	
	Hard rock	3	15	
	Red clay	5	20	
	Red, hard rock	1	21	
	Grey, soft rock	10	31	

Number of hole.	Character of rock.	Thickness. Feet.	Total depth. Feet.	Remarks.
	Grey, soft rock	21	52	
	Hard rock	1	53	
	Plaster rock	23	76	
	Gravel streak			
	Plaster rock	14	90	
	Salt			
8	Mud	12	12	
	Hard rock	2	14	
	Soft rock	6	20	
	Hard rock	1	21	
	White rock	29	50	
	Hard rock	2	52	
	Red rock	6	58	
	White rock	32	90	
	Blue rock	20	110	
	Red rock	3	113	
	Salt	10	123	
9	Mud	12	12	
	Hard rock	1	13	
	Clay	7	20	
	Plaster	70	90	
	Red mud	6	96	
	Red rock	28	124	Sludge gritty.
10	Surface	18	18	
	Hard rock	19	37	
	Soft, red rock	11	48	
	Hard plaster	30	78	
	Soft, red rock	4	82	
	Soft plaster	10	92	
	Hard plaster	20	112	
	Hard grey	10	122	
	Salt	6	128	
11	Surface	12	12	
	Hard rock	1	13	
	Plaster	34	47	
	Red rock	2	49	
	Plaster	49	98	With hard bands.
12	Surface	12	12	
	Hard rock	1	13	
	Soft, red rock	6	19	
	Hard, red rock	10	29	
	Soft plaster	10	39	
	Hard, grey rock	10	49	
	Not very hard rock	16	65	
	A streak of sand and salt about 1 foot, and plaster	4	69	Stream of salt water in this hole, but depth not indicated.

MINE WORKINGS.

On account of the loosely consolidated condition of the overlying rocks, the shaft had to be closely timbered above the salt. The overlying

material was seen only on the dump, but the sequence, described by Mr. Alex. Gullons, in charge of the sinking, is as follows:

	Feet.
Red mud and loose rock	0- 24
Red rock	20- 30
Greenish gypsiferous ?rock	30- 59
Broken clay rocks of dark grey, yellow, and red colours	59- 79
Dark grey material	79- 85
Salt and grey material interbanded with pure white salt	85-120

The dark grey material at 79 to 85 feet depth, resembles the material interbanded with the salt and suggests a residual accumulation due to the solution of a considerable thickness of the former upward continuation of the salt strata, which dip at angles varying from 25 degrees to the south to 80 degrees to the north.

The sediments overlying the salt are described as flat-lying and somewhat broken, suggesting slumping of gypsiferous rocks overlying or interbedded with the salt strata. The upper surface of the salt strata where uncovered in the shaft is described as a smooth, horizontal plane and the nearly similar depths at which brine was obtained in the borings leaves little doubt that the outcrop as a whole is reduced to a nearly uniform depth. To the north of the brine area the comminuted material raised by the churn drills is described as hard and soft —red and grey rock — probably the sandstone and shale that immediately underlie the boulder clay. South of the shaft boring No. 13 penetrated 170 feet of soft, greenish-white rock, the exact character of which is not known.

A diamond-drill hole placed at the north face of the underground workings in the mine was commenced in February, 1920. The hole is flat—just holding water—and as the strata have a north vertical dip at this point, the thicknesses recorded are nearly approximate to the actual thicknesses of the beds. A partial record of the boring February 27, 1920, is as follows:

From.		To: Level now exposed		4 feet, 0 inches, average 8·8 per cent K_2O.
Ft. in.		Ft. in.		Ft. in.
1	—	17 6	=	17 6 Dirty salt, potash zone.
17 6	—	39	=	21 White salt, clean as per sample.
39	—	42	=	3 Grey salt.
42	—	46	=	4 White salt and gypsum.
46	—	49	=	3 Red salt.
49	—	56	=	7 White salt, clean.
56	—	58	=	2 Reddish salt.
58	—	60	=	2 White salt.

(Hole to go a farther 75 feet to 100 feet.)

Pure salt occurs on either side of the potash zone and the bed 21 feet 6 inches thick on the north side promises to produce a superior run-of-mine salt. The sample mentioned in the above record is composed of translucent crystals with a faint pinkish shade.

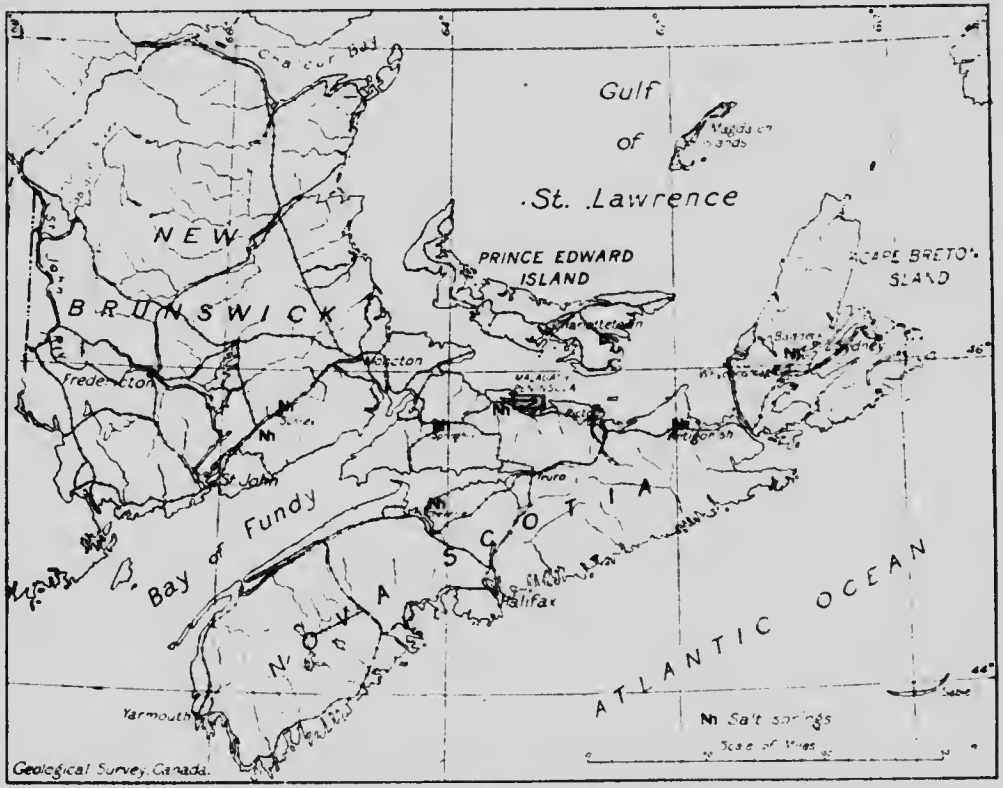

Figure 1. Index map showing location of salt springs.

REFERENCES TO SALT SPRINGS IN NOVA SCOTIA AND NEW BRUNSWICK.

The locations of the more important springs are indicated on Figure 1, and a summary of descriptions by various observers follows:

NOVA SCOTIA.

St. Patrick Channel, Victoria County. Charles Robb[1] describes a spring situated on the northwest shore of St. Patrick channel as follows:

"The brine springs referred to appear to issue from rocks lying towards the base of the Lower Carboniferous formation, and are situated on the north side of the Little Narrows of Bras d'Or lake, between the shore and the road, about 12 miles southwest of Baddeck, on land belonging to John Watson, miller. Here several saline springs of more or less strength occur in close proximity over an area of about 12 acres of flat, marshy land. Much hydrated peroxide of iron is deposited in the water courses, the odour of sulphuretted hydrogen pervades the atmosphere in the vicinity, and the vegetation is destroyed around all the springs. The strongest spring, from which about a gallon was taken for analysis, appeared to me to discharge from 100 to 200 gallons per minute. It was stated that by evaporating in two common iron pots, each containing about 3 gallons, from 2 to 3 bushels of salt were made per day. I was further informed that it had been proposed many years ago to establish works for the manufacture of salt at this place, and that machinery had actually been ordered for that purpose, but I am not aware for what reasons the undertaking was abandoned. The following are the results of an examination, by Mr. Christian Hoffmann, of the sample referred to above:

'When received the brine had a brownish tinge, due to suspended ferric hydrate, which, after the water had been standing for some time, settled down as a reddish-brown sediment, leaving the supernatant liquor perfectly bright and colourless; this had a pure saline taste and was perfectly neutral: boiling caused a deposition of sulphate of calcium. The specific gravity was 1043·1. (Based on unit of 1000).

'The filtered brine contained in 1,000 parts:

Sodium	19·9423
Potassium	0·1019
Calcium	1·6709
Magnesium	0·0403
Iron	absent
Alumina	traces.
Chlorine	30·9585
Sulphuric acid (SO_4)	4·0162
Silica	traces.
Chloride of sodium	50·6881
Chloride potassium	0·1942
Chloride magnesium	0·1593
Sulphate of calcium	5·6810
Alumina	traces.
Silica	traces.
	56·7226

[1] Geol. Surv., Can., Rept. of Progress 1873–74, pp. 180-281.
See also N.S. Geol. Map No. 15.

'The suspended matter for 1,000 parts of the brine amounted to 0·0068 and this contained 0·0054 of ferric oxide which had, in all probability, at one time entered into the composition of the brine as ferrous carbonate.'"

Antigonish, Antigonish County. Hugh Fletcher[1] describes the salt springs, as follows:

"Salt springs and ponds are found everywhere in the neighbourhood of the gypsum, as at Pomquet, and South River, Brierly Brook, Addington Forks, and other places. Salt was made many years ago from the salt pond near the town of Antigonish. In May, 1866, a company called the Nova Scotia Salt Works and Exploration Company, was incorporated under the management of Mr. Josiah Deacon, to conduct boring operations to discover the source of the brine.[2] The first boring was sunk on Town point, near the mouth of the harbour, a 6-inch borehole, lined with iron tubing, being driven through a considerable thickness of soil and clay, then through a thick band of gypsum into sandstones, without finding any indication of brine; so that further operations in this locality were abandoned.

Encouraged by indications of salt water and salt on the surface, where the railway station now stands, a second borehole was put down here; and a 9-inch cast-iron pipe sunk through 16 feet of gravel full of weak surface brine. The auger then passed through red, blue, and brown marl, with thin bands of fibrous gypsum; then through several layers of magnesium sandstone, striking a bed of gypsum 141 feet from the surface.

After penetrating 18 feet into the gypsum, there was a flow of pure, strong, limpid brine from a cleft, which flowed nearly to the surface, could only be lowered a few feet by pumping, and discharged a large volume of sulphuretted hydrogen gas. A steam engine was "erected for pumping, and furnaces, tanks, and evaporating pans of large dimensions constructed for the production of salt. After the manufacture of a considerable quantity of salt, the strength of the brine became very much reduced." Another borehole was accordingly put through "clays to a depth of 650 feet, but finding no indications of brine, that of the other boring being too weak for use, and the working capital exhausted, the work was abandoned."

Salt springs occur also at Springhill, Cumberland county, Cheverie, Hants county, and other localities.[3]

Sir J. W. Dawson[4] describes occurrences of brine springs as follows:

"Brine springs issue from the Lower Carboniferous rocks in several parts of Nova Scotia. In the district now under consideration they are found at Walton in Hants county. A specimen analysed by Professor How gave, in the imperial gallon of water:

	Grains.
Chloride of sodium, or common salt	787·11
Sulphate of lime	161·16
Carbonate of lime	14·73
Chloride of magnesium	4·48
Carbonate of magnesia, carbonate of iron, and phosphoric acid	traces.
	967·48

[1]Geol. Surv., Can., vol. II, 1886, p.124P. See also N.S. Geol. Map No. 34.
[2]Gesner's "Geology," p. 92; How's "Mineralogy of Nova Scotia," p. 145; Trans. Nat. Sc., vol. IV, p. 74; "Acadian geology," p. 350; Report of Commissioner of Mines for 1874, p. 58.
[3]Hayward, A.A., Jour. of the Min. Soc. of Nova Scotia., vol. XI, pp. 112, 113.
[4]"Acadian Geology," 1878, p. 276.

"The large quantity of sulphate of lime contained in this brine is, without doubt, connected with the abundance of gypsum in the Lower Carboniferous series, and points to the association of gypsum and common salt, probably in the gypseous marls. Professor How expresses a favourable opinion of this and other saline springs in Nova Scotia as profitable sources of common salt."

Dunmaglass. Salt springs occur at Dunmaglass, Antigonish county, on either bank of Knoydart brook above and below the highway bridge at Dunmaglass post office. The writer spent half a day examining the locality.

A sample of the brine was examined in the laboratory of the Geological Survey by H. V. Ellsworth, assistant mineralogist, who reported as follows:

"The salt sample from boiling down of spring water is chiefly sodium chloride or common salt, but there is also considerable calcium present, some sulphates, and a small amount of potash. The water is heavily charged with the same salts."

The brine rises through the shattered rocks along a fault separating the James River[1] formation of the Ordovician system to the southeast, from the Knoydart formation of the Devonian? system to the northwest. The source of the brine is not known.

The Maple Mountain Salt Mining Company, organized to prospect this district for salt, commenced drilling in July, 1919. Two shallow holes, bored at the lower spring, penetrated to syenite probably intrusive into the Ordovician sediments. A boring was then commenced one-quarter of a mile farther down stream to the northwest and penetrated the red beds of the Knoydart formation to a depth of 620 feet, without cutting salt strata.

It is conceivable that a salt horizon may exist in the Silurian rocks of Nova Scotia, possibly in a horizon underlying the Knoydart formation, and the results of a deep boring at Dunmaglass are awaited with interest.

The important salt deposits of Ontario occur in the Salina formation of the Silurian system, and it is interesting to note that salt springs in Nova Scotia are associated with rocks of approximately the same age. No exact correlation of the Nova Scotia and Ontario Silurian has been made, as the faunas belong to different provinces.

Fletcher[2] noted the occurrence of salt springs at the above-mentioned localities in the following words:

"A mineral spring much resorted to, occurs on Donald McEachern's land in the hollow near Dunmaglass post office; the water has not been analysed.

"Springs, probably of similar composition and greatly relished by cattle, are found on Barney river at Avondale and at the mouth of Bear brook, oozing from pre-Carboniferous rocks."

Avondale. A salt spring occurs opposite Avondale station on the Canadian National railway on the north bank of Barney river in a small brook valley, issuing from fossiliferous limestone thought by Twenhofel[3] to be the basal portion of the Ross Brook formation of the Silurian system.

[1]Williams, M. Y., Geol. Surv., Can., Mem. 60.
[2]Fletcher, Hugh, Geol. Surv., Can., vol. II, 1886, p. 106P.
[3]Twenhofel, W. H., Geol. Surv., Can., Guide Book No. 1, pt. II, p. 315.

Sussex, Kings County. Bailey[1] describes the history of the salt industry at Plumweseep, 6 miles north of Sussex, as follows:

"As nearly as can be ascertained, the first operations for the manufacture of salt near Sussex were begun fully one hundred years ago, the quantity manufactured being, however, but small, very variable in amount, and employed wholly for local consumption. A similar description, would, to a large extent, apply to more recent undertakings in the same direction. The present proprietor (Mr. Geo. N. Hendricks) commenced work in 1887, since which time, on an average, about 150 barrels of salt per year have been made, each barrel holding four bushels. During the year 1897, 140 barrels were made, at a cost of about $2 per barrel. The salt is sold for $3 per barrel, and is especially esteemed for table and dairy use."

This locality was visited by the writer in September, 1919. Brine was found to issue from five natural springs and one borehole, all situated in an extended east-west course of 600 feet, and within 200 feet north of the highway. The springs occur on the farm of the Chittick brothers, one of whom stated that a small area of land including the springs had been sold, and is now owned by Archibald Richmond, 18 Wallbrook, London, England. A boring stated to be 420 feet deep was drilled about the year 1913, and a shaft sunk to a depth of 40 feet, but work was discontinued on account of the Great War. A sample of brine issuing from the stand pipe of the borehole was sent to the Mines Branch, Ottawa, for analysis.

The following results were obtained by a partial analysis of the sample submitted[2]:

1. Colourless, odourless.
2. Taste—saline (salty).
3. Reaction—as received, neutral; upon evaporation to small volume, very faintly alkaline.
4. Specific gravity at 15·5° C.—1·04.
5. Suspended matter—a very small quantity, light and flocculent in character.

1,000 parts by weight of filtered water contained:

			Hypothetical combination.		
Na	16·00	parts.	NaCl	42·3	parts.
Ca	1·32	"	$CaSO_4$	4·31	"
Mg	0·80	"	$MgSO_4$	0·39	"
SO_4	3·36	"	$CaCO_3$, CO_2	0·20	
CO_3	0·17	"		47·20	
Cl	25·60	"	CO_2 free	0·05	
	47·25			47·25	

Total dissolved saline matter by direct experiment, dried at 180° C.—47·0 parts.
K. not sought for.

Sir J. W. Dawson[3] describes occurrences of brine springs as follows:

[1]Geol. Surv., Can., vol. X, 1897, p. 121M.
[2]Since this report was made out we tested qualitatively for potash, but found none; but there was a faint indication of lithium. L. H. Cole.
[3]"Acadian Geology," 1878, p. 248.

"*Common Salt.* Saline springs, containing variable proportions of common salt, occur in the rocks of the Lower Carboniferous series, at a variety of points, and especially near Sussex, on Salt Spring brook, in the parish of Upham in Westmorland, and on Tobique river in Victoria. No beds of rock salt have been observed, nor is it known at what depth the saliferous strata may be found. Salt has long been made by the evaporation of the brines from Upham and Sussex, and is of excellent quality, but the works have heretofore been conducted upon a very limited scale."

Salina, Kings County. Fifteen miles southwest of Sussex on Salt Springs creek. R. Chalmers[1] describes the locality as follows:

"An examination of the salt springs at this place was made, and samples of material from the borehole and of brine from a spring near by, were forwarded to the laboratory of the Survey for analysis. The boring was 330 feet deep at the time of my visit, disclosing: (1) superficial deposits, 64 feet; (2) gypsum, 21 feet; (3) sandstone, 15 feet; (4) gypsum, 220 feet; (5) sandstone, 10 feet. The pre-Carboniferous rocks were apparently not reached.

'As the beds here are nearly vertical, the above measurements do not represent the actual thickness of the several deposits.' "

The results of an analysis made in the laboratory of the Geological Survey are as follows[2]:

"It was found to contain a small quantity of brown, flocculent organic, matter in suspension. This was removed by filtration leaving the water clear and colourless. Specific gravity at 15·5 degrees C. 1018·5 (based on unit of 1,000). It contained in 1,000 parts by weight:

Potassa	0·177
Soda	9·614
Lime	549
Magnesia	[illegible]
Sulphuric acid	11·3 [illegible]
Chlorine	
	25·223
Less oxygen equivalent to chlorine	2·564
	22·659
Hypothetical combination:	
Chloride of potassium	0·280
Chloride sodium	18·145
Chloride magnesium	0·313
Sulphate of lime	3·762
Sulphate of magnesia	0·159
	22·659

Total dissolved matter, by direct experiment dried at 180 degrees C., 22·605.

An imperial gallon of water at 15·5 degrees C., would contain:

	Grains.
Chloride of potassium	19·963
Chloride sodium	1,293·648
Chloride magnesium	22·315
Sulphate of lime	268·212
Sulphate magnesia	11·336
	1,615·474

[1]Geol. Surv., Can., vol. VIII, 1895, p. 97-98A.
[2]Geol. Surv., Can., vol. VII, 1894, pp. 54-55R.

Bennet Brook near Petitcodiac, Westmorland County. R. Chalmers[1] reports a salt spring which has not been utilized.

Tobique River, Victoria County. Salt springs are noted by E. D. Ingall[2] to occur, but no detailed description is given.

In a report by L. W. Bailey[3] and Wm. McInnes an occurrence of gypsum, 25 miles up Tobique river from its confluence with St. John river, is described, and reference made to the slightly salty taste of the water in Salt creek which empties into the Tobique from the east at this locality. H. Y. Hind[4] describes the same locality in the following words: "Salt brook, which flows into the Tobique a short distance above the plaster cliffs, has a brackish taste and medicinal properties; on examination it was found to contain a small quantity of sulphuretted hydrogen, a considerable percentage of sulphate of magnesia (epsom salts), to which probably its aperient effects are due, and some common salt."

As the result of a reconnaissance of the district from Hillsborough to Hampton lying between the Kennebecasis and Hammond rivers, made by W. J. Wright and the writer in September, 1919, the conclusion was reached that the Windsor series is more extensive than previously reported. Limestone holding Windsor fossils occurs at or near the base of the series at Elgin, Markhamville, and Norton, and on Cedar Camp creek, gypsum is also associated with the limestone at Upham and with the salt springs at Sussex. These facts suggest that the rocks between Elgin and St. John, formerly correlated with the Albert series, belong to the Windsor which lies unconformably above the Albert.

The salt springs at Sussex and Salina occur along antielinal folds in the Windsor series and the salt strata probably lie above the fossiliferous limestone and gypsum which are brought to the surface along the axes of antielinal folds.

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[1]Geol. Surv., Can., vol. IV, 1888-9, pp. 41A, 91N.
[2]Geol. Surv., Can., vol. XII, 1902-3, p. 218S.
[3]Geol. Surv., Can., Ann. Rept., vol. II, 1886, pt. N, p. 7.
[4]"A preliminary report on the geology of New Brunswick," 1865, p. 64.

INDEX.

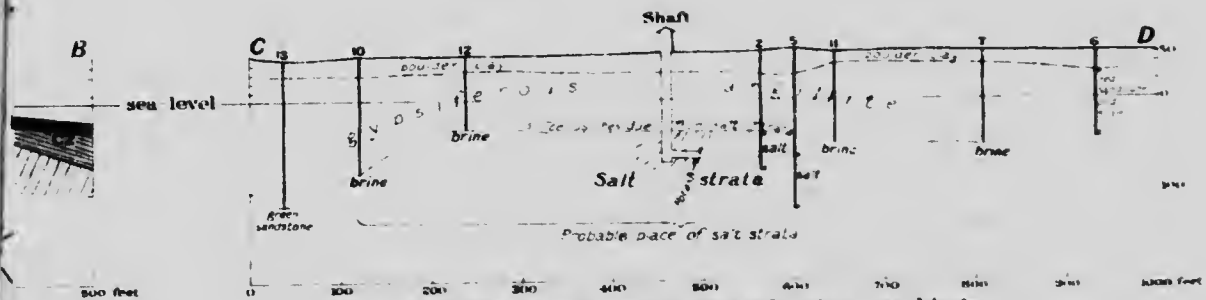
Canada
Department of Mines

HON. ARTHUR MEIGHEN, MINISTER — R. W. BROCK, DEPUTY MINISTER

GEOLOGICAL SURVEY

WILLIAM McINNES, DIRECTING GEOLOGIST

Issued 1920



Section along line *CD*, through nine workings

(position of borings indicated by projection parallel to strike)

Section along line *AB*

LEGEND

PENNSYLVANIAN
(MILLSTONE GRIT)

- Bedrock exposed (shale, limestone, sandstone, conglomerate)
- Cs — Bedrock concealed

MISSISSIPPIAN
(WINDSOR)

- Area underlain by salt (proved by drilling)
- Bedrock exposed (gypsum, limestone, shale, sandstone, conglomerate)
- Cl — Bedrock concealed

Symbols

- Geological boundary
- Geological boundary (position inferred)
- Fault
- Fault (position inferred)
- Fault (downthrown side)
- Fault (direction of displacement)
- Dip and strike
- Dip and strike (strata overturned)
- Horizontal strata
- Drill hole (salt or brine observed)
- Drill hole (barren)
- Contours showing landforms and elevations above sea-level, interval 25 feet

Approximate magnetic declination 28° 30' West

C.O Senécal, *Geographer and Chief Draug[illegible]nan*
J.A Fortin, *Draughtsman*

MALAGASH SAL

To a company Report by A.O.Hayes

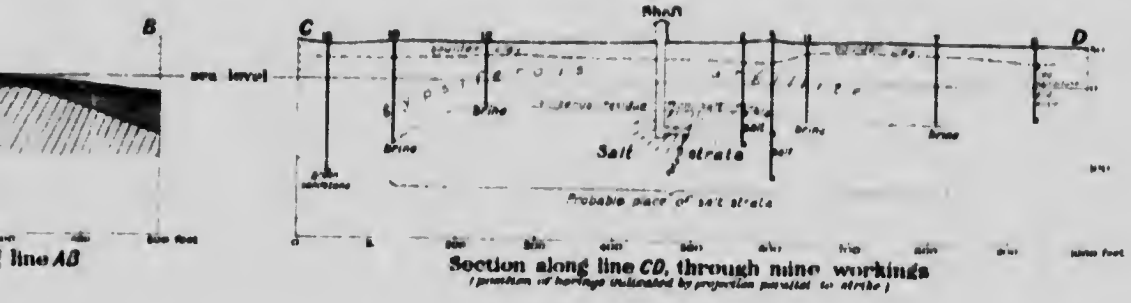
Canada
Department of Mines

HON. ARTHUR MEIGHEN, M.P., Minister — CHARLES CAMSELL, Deputy Minister

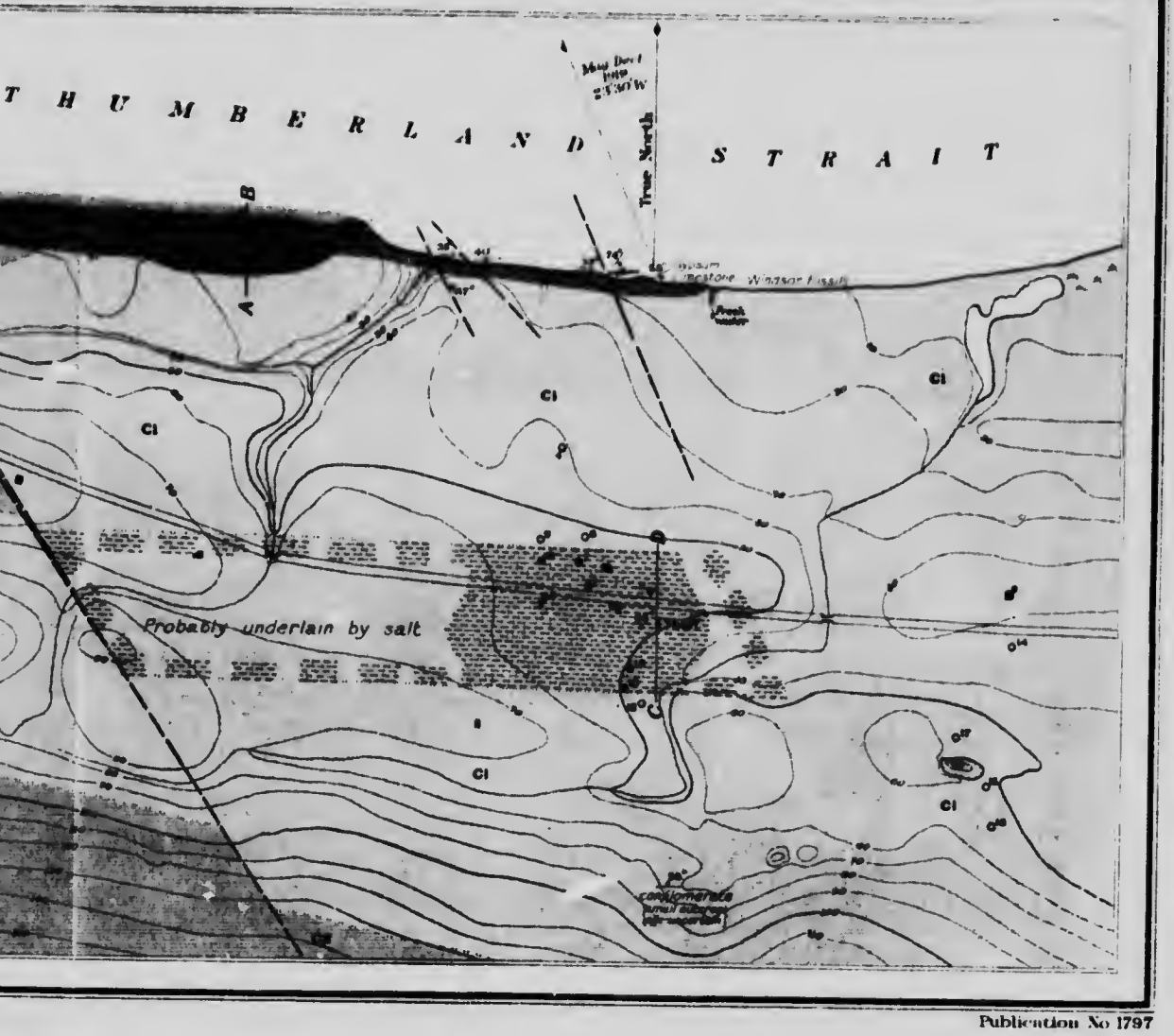
GEOLOGICAL SURVEY

WILLIAM McINNES, Director — R. W. BROCK, Director Emeritus

Issued 1920



OUTLINE MAP

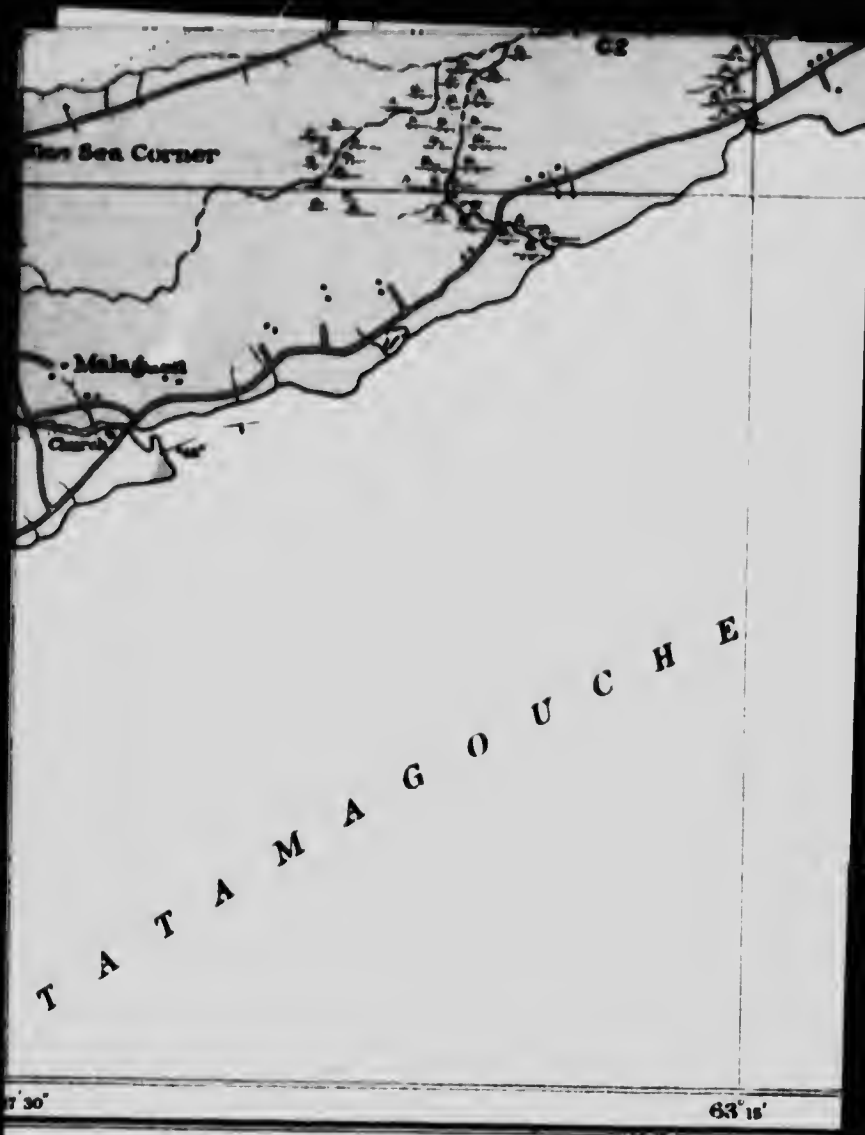


Publication No 1797

H SALT DISTRICT, CUMBERLAND COUNTY, NOVA SCOTIA

Scale of Feet

1000 500 0 500 1000 1500 2000



SCOTIA

Structural Section

LEGEND

PALÆOZOIC

CARBONIFEROUS

MISSISSIPPIAN — WINDSOR — MILLSTONE GRIT

PENNSYLVANIAN — NEW GLASGOW

PERMIAN?

P — Bedrock exposed (shale, sandstone, conglomerate)

P — Bedrock concealed

Bedrock exposed (shale limestone, sandstone, conglomerate)

C2 — Bedrock concealed

Salt strata concealed by overlying strata and boulder clay

Cl — Bedrock exposed (gypsum, limestone, shale sandstone conglomerate)

Cl — Bedrock concealed

Symbols

- Geological boundary
- Geological boundary (position inferred)
- Fault
- Fault (position inferred)
- Dip and strike
- Dip and strike (strata overturned)
- Horizontal strata
- Vertical strata
- Glacial striæ
- Fossil locality
- Limestone
- Gypsum
- Copper

C O Senécal, *Geographer and Chief Draughtsman*
J O Fortin, *Draughtsman*

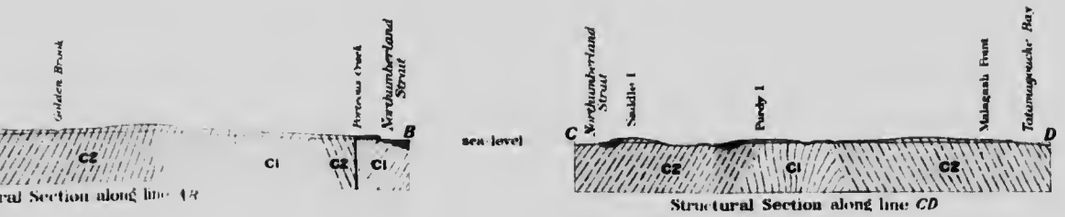
MALAGASH

To accompany Report by A O Hayes

Canada
Department of Mines

GEOLOGICAL SURVEY

Issued 1920



ral Section along line AB

Structural Section along line CD

OUTLINE MA

63°20'
63°17'30"
63°15'

NORTHUMBERLAND STRAIT

Saddle Island

Treen Bluff

Purdy I.

Treen Pt.

C2

C1

Malagash Pt.

Malagash Point

School

C2

C1

Blue Sea Corner

Church

150'

C2

Malagash

Brook

Church

Malagash Centre

P

School

P

Upper Malagash

P

Beds

Waugh Island

TATAMAGOUCHE BAY

63°20'
Longitude West from Greenwich
63°17'30"
63°15'

Publication No 1794

GASH PENINSULA, CUMBERLAND COUNTY, NOVA SCOTIA

Scale of Miles

1