CHAPTER 7
CANSO-BRAS D'OR AREA

INTRODUCTION

The Canso-Bras d'Or area encompasses the Carboniferous outcrop areas in southeastern and central Cape Breton Island and is located in portions of Inverness, Richmond, Cape Breton and Victoria Counties (Fig. 1-10). Hayes (1931) outlined the salt-potash exploration potential of the area as part of a Province-wide potash survey. Many salt springs and seeps were located and analyzed. With the exception of some unsuccessful drilling at Bucklaw in the early 1920's, no significant attempts to exploit salt were made until the mid 1960's when Dow Chemical Limited and Domtar Limited began exploration near the Strait of Canso. Several major salt deposits were outlined with planned uses including salt mining and developing underground storage facilities. These deposits have been relatively well-defined by diamond-drill holes and gravity surveys.

The geology in the Canso-Bras d'Dr area has been described in the reports and maps by Ferguson (1946), Ferguson and Weeks (1950), Weeks (1954), Collins (1962), Kelley (1967b), Bell (1958), Milligan (1970), Shea and Wallace (1962), and Jones and Covert (1972).

The nine deposits which have been outlined in the Canso-Bras d'Or area are: the Cleveland, Estmere, Kingsville , McIntyre Lake, Malagawatch, Orangedale, Port Richmond, St. Patricks Channel, and St. Peters (Fig. 7-1). Data on the Cleveland, Estmere and St. Patricks Channel deposits have become available after the completion of this report. Consequently they have not been described in the format of the other deposits. For similar reasons the Malagawatch and Orangedale deposits are not completely described.

The Kingsville deposit outlined by Domtar Limited is defined in twelve diamond-drill holes. A brining test well has indicated that salt could be produced using that method. The McIntyre Lake deposit contains four diamond-drill holes and it has been under investigation by Home Oil Canada Limited et al. for potential underground storage development. The Malagawatch deposit has been outlined in potash exploration drillholes by Chevron Standard Ltd. The Orangedale deposit is defined from one hole drilled by Noranda Exploration Ltd. The Port Richmond deposit is outlined by 5 diamond-drill holes and has been evaluated by Dow Chemical Limited for underground storage purposes. The St. Peters deposit is the least well-defined deposit because it contains only one drillhole. The Seaview occurrence is the only salt occurrence known in the area and it is defined in only a single drillhole by Domtar Limited.

GENERAL GEOLOGY AND CARBONIFEROUS STRATIGRAPHY

The Canso Bras d'Or area includes the Bras d'Or Sub-basin of Bell (1958) and the area to the south of the Sydney Sub-basin. The geology in this area is poorly understood and probably rather complex. The Carboniferous rocks, including the Windsor Group, occur in a series of interconnected outcrop areas separated by highland areas of pre-Carboniferous rocks.

The pre-Carboniferous basement rocks comprise complex intrusive and metamorphic massifs of Lower Paleozoic to Proterozoic age. These basement blocks are unconformably overlain by and surrounded in whole or in part by the Lower Carboniferous Horton Group terrigenous rocks, comprising interstratified sandstone, shale and conglomerate. The stratigraphy of the Horton Group has been studied in some detail by several workers including Murray (1960) and Kelley (1967b) who described the basic stratigraphic subdivisions in Cape Breton. These subdivisions were outlined in the introductory section of the Antigonish-Mabou area. Kelley (1967b) presented an isopach map showing original thicknesses of the Horton Group in central and western Cape Breton. The major areas of deposition and the approximate area of pinchout and Windsor Group onlap are readily seen on this map. Major deposition occurred to the west of the Creignish Hills and also in the Whycocomagh-Lake Ainslie area (Fig. 7-1).

Although not contoured by Kelley (1967b) the Strait of Canso-St. Peters area may also be inferred to have substantial sections of Horton Group rocks (Weeks 1954; Ferguson and Weeks 1950; and Ferguson, 1946). In its thickest sections, such as in Graham River, Kelley (1967b) measured in excess of 3000 m. These sections may thin drastically by pinchout and onlap to less than a few hundred metres or to nil in the vicinity of pre-Carboniferous basement highs. In areas of such extreme thinning and Windsor Group onlap it has been a mapping difficulty to determine which terrigenous rocks are Horton Group and which are Windsor. An example of this situation occurs along the southeastern contact of the River Denys Basin. This border of the Basin is defined by the pre-Carboniferous basement rocks of North Mountain (Fig. 7-1). Along the border, Kelley (1967b) mapped a band of red sandstone and conglomerate, and assigned the unit to a marginal facies of the Horton and/or Windsor Groups in a fashion after Weeka (1954). Weeks (1954) indicated the Windsor Group in the southeastern part of Cape Breton occurred in two distinct relationships with underlying rocks, the "Central Basin Succession" and "Marginal Basin Succession". The marginal basin succession occurs in onlap relationship with pre-Carboniferous rocks. It is invariably associated with coarse, ill-sorted conglomerate and interpreted as marginal facies of the more basinal sections which rest on Horton Group rock.

Bell and Goranson (1938) introduced the term Grantmire member and applied it to coarse terrigenous rocks beneath lower Windsor marine strata in the Sydney map area, which were believed to have been marginal basal Windsor Group facies. Weeks (1954) applied the name Grantmire Formation to a conglomerate and sandstone unit in the St. Peters map area and considered it part of the Windsor Group. This unit was also mapped in the Iona-Washabuck area. More recently Kelley (1967b), in the adjoining

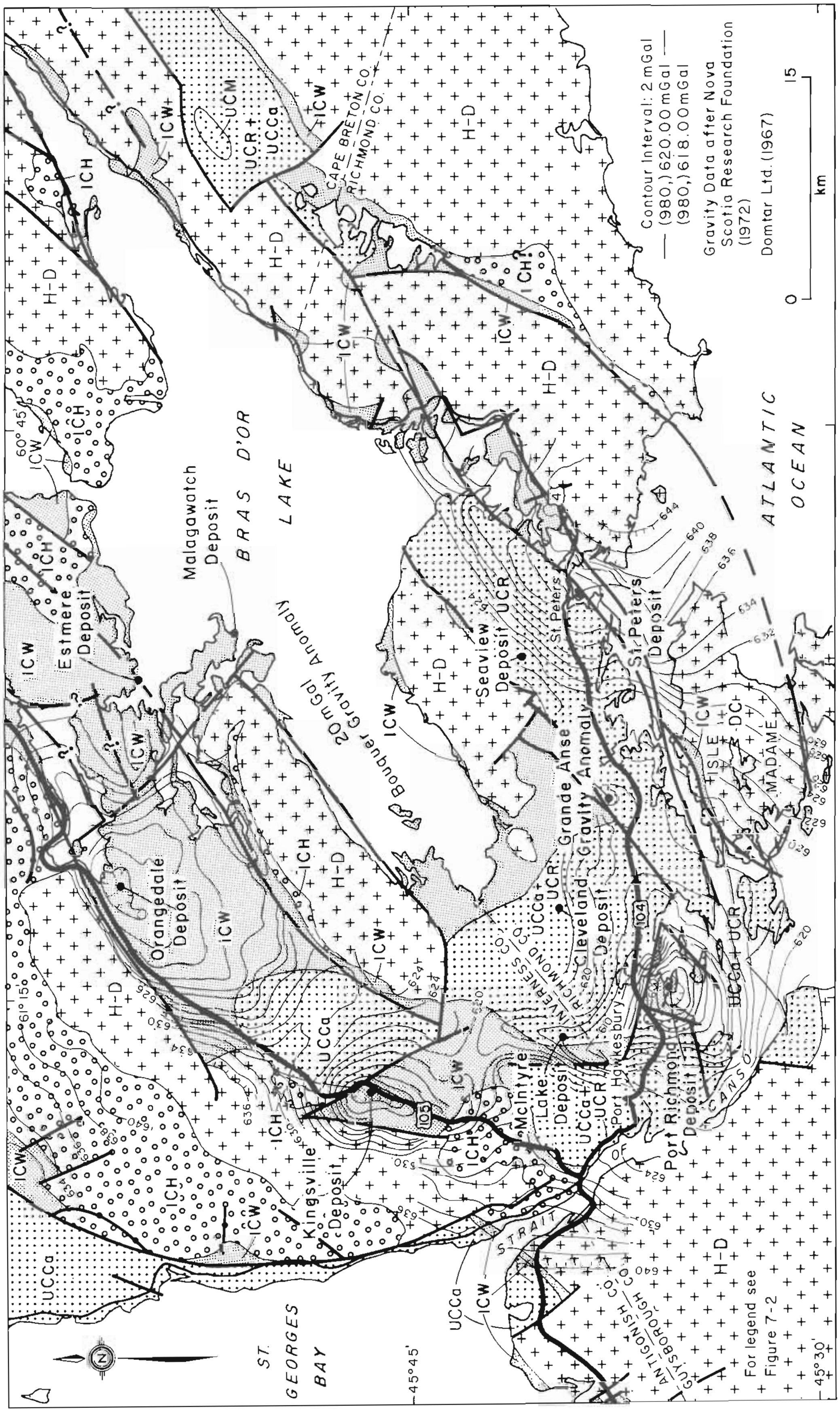


Figure 7-1. Composite Bouguer gravity anomaly map, Canso-Bras d'Or area, Cape Breton Island.

map area recognized typical Horton Group rocks rather than Grantmire introducing a nomenclature conflict. In this specific area, modification and reassignment of the coarse terrigenous map unit to the Horton Group is not a problem, because a typical basal Windsor carbonate and lower sulphate succession are apparent at the topographic and mapped boundary. In other areas, the problem is not so easily resolved however, especially where conglomerate is interstratified with the marine carbonates of the Windsor Group Loch Lomond area (Boehner, 1981b).

With the exception of the River Denys and Strait of Canso-St. Peters areas, the Windsor Group outcrops in small areas peripheral to the Highlands. The Bras d'Or Lakes occupy a large part of the Carboniferous Lowland area in central Cape Breton. The stratigraphy of the Windsor Group in the central and southeastern Cape Breton Island areas has not been studied or described in any detail. Ferguson (1946), Weeks (1954) and Kelley (1967b) did however, make important observations regarding contact relationships. These, when considered with more recent subsurface data and extrapolation from other areas, make it possible to interpret the stratigraphy of a given area even though the picture as a whole may not be clear.

The Windsor Group stratigraphy in the Antigonish-Mabou area, as interpreted by Norman (1935), Sage (1954) and Stacey (1953), was outlined in the previous section. Norman (1935) measured 530 m (1739 ft.) of Windsor Group in the Port Hood Island section. Here the basal Windsor limestone and lower part of the section including the main salt and anhydrite section are apparently absent. Stacey (1953) measured 542.5 m (1780 ft.) in the same section and estimated a total thickness for the Windsor Group in western Cape Breton Island of 670-823 m (2200 to 2700 ft.). Stacey (1953) also measured and described the Cape Dauphin section near the northeastern tip of Kellys Mountain and reported 306 m (1005 ft.) of Windsor Group. In this section he concluded that much of the Lower Windsor was absent due to faulting. Sage (1954), in contrast, considered the base to be an unbroken B Subzone succession. Whether this section represents marginal onlap or faulting is uncertain.

Experience mapping Windsor Group rocks on mainland Nova Scotia indicates the most important interval with regard to thick salt occurs above the lower sulphate-basal Windsor limestone section and beneath the interstratified siltstone, sandstone, gypsum-anhydrite, and limestone dolostone that comprise the middle and upper parts of the Windsor Group. Thinner and possibly significant salt horizons, however may also occur at any level in the Windsor Group. In central Nova Scotia they are known to occur above the highest Windsor Group carbonate member (Giles and Boehner, 1979; Giles, 1980).

In central and southern Cape Breton the basal limestone-evaporite section is well represented. It was referred to as "basal laminated limestone" by Weeks (1954) and Ferguson (1946) and "A_1 Windsor limestone" by Kelley (1967b). This unit concordantly and probably conformably overlies the Horton Group (Kelley 1967b; and Ferguson, 1946). The unit was originally described by Ferguson (1946) as a fine grained, dull grey rock with individual laminae one-quarter inch thick and a maximum total thickness of approximately 20 m (65 ft.). Weeks (1954) reported that the lower most bed in his "central basin succession" is a characteristic black, laminated, sandy, unfossiliferous limestone with a maximum thickness of approximately 21 m (70 ft.). Kelley (1967b) described the A_1 limestone as thinly laminated, fine grained, medium to dark grey with quartz or gypsum and anhydrite grains scattered on bedding planes. Kelley (1967b) also reported Ostracoda and Spirorbis at several localities of the A_1.

A thick section of anhydrite normally overlies the basal Windsor limestone. Broad outcrop belts of anhydrite and gypsum are evident on maps and drilling has established thick anhydrite sections (locally exceeding 300 m) near Little Narrows at Jubilee and in the River Denys area. In some areas, the basal part of the Windsor Group section is complicated by onlap onto intrabasinal highs such as along the northwestern side of North Mountain where Kelley (1967b) and Ferguson (1946) reported basal limestone overlying thin conglomerate on pre-Carboniferous rocks. More extreme onlap and the appearance of coarse terrigenous facies are evident in the Mira Hills-East Bay Hills area. Here the middle and upper Windsor sections have overlapped the basal Windsor section and were deposited directly on deeply incised pre-Carboniferous basement. This line of onlap occurs in the vicinity of the Bras d'Or Lake-East Bay shoreline along the northwestern side of the East Bay Hills. Spectacular onlap onto steep terrain is present in the Loch Lomond-Lake Enon area (Boehner, 1981b; Forgeron, 1977; and Crowell, 1971).

The stratigraphy of the post-salt rocks comprising mainly the middle and upper parts of the Windsor Group is not well understood in the area. No stratigraphic columns or measured sections have been described by previous workers with the exception of the aforementioned Loch Lomond area. Examination of the maps and fossil localities described and reported by Kelley (1967b) indicate a substantial section might be worked out through field examination. It is reasonable to expect a succession with similar general stratigraphy to that described for western Cape Breton by Stacey (1953) and Norman (1935) or a section similar to that in the Shubenacadie Basin as described by Giles and Boehner (1979). Extreme variations in thickness may be present in the central and southern Cape Breton area due to rapid changes in topography. Postdepositional structural adjustments are also severe in most areas. Undisturbed areas with stratified salt sections are probably rare in the Canso-Bras d'Or area because of extensive tectonism.

The Windsor Group in the Canso-Bras d'Or area, as in other areas of Nova Scotia, is overlain conformably to disconformably by younger, typically nonmarine strata assigned to the Canso

Group and Riversdale or Pictou Groups. The section above the Windsor Group has a complex history of stratigraphic subdivisions and age assignment by a variety of workers including Ferguson (1946), Bell (1944), Belt (1962), Norman (1935), Kelley (1967b) and Weeka (1954). These rocks comprise stratified red and grey shale, sandstone, conglomerate and rare coal. Thickeat and most complete Upper Carboniferoua sectiona occur near the Strait of Canao, St. Petere and Kingsville. Bell (1944) indicated approximately 610 m (2000 ft.) of Canao Group in the type section at the Strait of Canso. Belt (1962) who incorporated the Canso and Riversdale Groups in this same section assigned more than 2743 m (9000 ft.) to his Mabou Group including 914 m (3000 ft.) considered by Ferguson (1946) to be Canso Group and more than 1829 m (6000 ft.) considered by Ferguson (1946) to be Riversdale Group. Kelley (1967b) calculated a minimum total thickness of 2134 m (7000 ft.) for the section of Upper Carboniferoua, Mabou Formation (Canso-Riversdale Groups equivalent) in the Maple Brook Syncline near Kingsville. Kelley (1967b) reported that along the western border of the Maple Brook Syncline the Windsor Group A_1 limestone is overlain concordantly by 4.6 m (15 ft.) of red siltstone, which in turn ia overlain by Mabou Formation. Further to the north the Mabou Formation overlies apparently younger Windsor Group strata.

Ferguson (1946) reported that the thicknese of the Windaor Group beneath the Canso Group varied and attributed this to erosion of parts or, in some instances, nearly all of the original Windsor Group section. Kelley (1967b) suggested this erosion may have been contemporaneous with some Mabou Formation depoaition. Areas where the Windsor Group is extremely thin occur mainly in the vicinity of the Strait of Canso, but also occur along the aoutheaetern border of the Antigonish Basin. In the latter areas low-angle faulting is suspected along at least part of the contact between the Windsor and Canso Groups.

The complex stratigraphy in the Canso-Bras d'Or area ia further complicated by faulting and folding. One major fault occurs on the northwestern side of the River Denys structural basin and bringa the Windsor Group in contact with Horton Group and pre-Carboniferous rocks. The southeastern side of the area is likewise marked by major faults that extend from Lennox Passage northeasterly to the Salmon River area. Faulting in the area is dominated by a aeries of major northeast trending faults and fault systems that can be traced from the Strait of Canso-Chedabucto Bay area. Many major faults have been mapped by previoue workers and more recent subsurface and geophysical data indicate others are probable. Interpretations of tectonics and sedimentation are included in the reports by Belt (1968), Kelley (1967b), Bell (1958), Ferguson (1946), and Weeks (1954). The reader is directed to these for more detailed descriptions.

KINGSVILLE DEPOSIT

The Kingsville deposit is located near Kingsville in the southwestern end of the River Denys Valley, Inverness County, Cape Breton (11F/14). Kingsville is located approximately 18 km north of the Port Hawkesbury-Point Tupper industrial area on the Strait of Canso (Figs. 1-10 and 7-1).

The area is easily acceaeible through a series of paved and unpaved roads connected with the Trans-Canada Highway 105 between Port Hastings and North Sydney. The Canadian National Railway mainline between Port Hawkesbury and Sydney is located on the eastern side of the River Denys Valley approximately 10 km east of Kingaville. The Port Hawkesbury regional airfield is situated off the Trans-Canada Highway 105, 15 km south of Kingsville.

The terrain in the vicinity of the Kingsville deposit (Fig. 7-2) is marked by diatinct topographic contrast. The Carboniferous lowlands are generally leas then 50 m in elevation though locally reach up to 200 m in the south-central part of the area. In contrast, the highlands of the Creignish Hills to the northwest have elevationa locally exceeding 275 m and the North Mountain to the southeast haa elevations of up to 230 m. A broad flat lowland area with a thick drift cover is located between Kingsville and McIntyre Mountain, and extends southeast along River Inhabitanta.

HISTORICAL BACKGROUND

One of the earliest references to salt in the area waa made by How (1869) who noted the presence of 4 salt springs issuing from conglomerate at the Salt Mountain at Whycocomagh approximately 25 km northeast of Kingsville.

The Cape Breton area was investigated for its salt and potash potential by Hayes (1931). Although no salt springs or indications of selt were found in the Kingsville area, many were deecribed in the Whycocomagh, St. Patricks Channel, Orangedale, Bucklaw areas and near Dundee-West Bay. Drill exploration for salt was initiated in the Kingsville area between 1968 and 1971 by Domtar Limited (1968a) on the significant Bouguer gravity anomalies in the area.

GEOLOGY

The geology in the Kingsville area (Fig. 7-2) was described by Kelley (1967b) and Ferguson and Weeka (1950). The two highland ridges that border the area are the Creignish Hills to the northwest and North Mountain to the southeast. The Creignish Hills compriae Devonian and possibly older quartz monzonite, granodiorite and minor granite. These have intruded older, (possibly Hadrynian) George River Group rocks which comprise quertzo-feldspathic and micaceous quartz schist, quartz gneiss, limeatone, quartzite, minor volcanic rocks and greywacke. The Lower Carboniferous Horton Group, Strathlorne-Ainslie Formation onlaps the older rocka of the highlands and occurs in a narrow outcrop band to the north near Glendale where the geology is obscured by thick drift cover. To the north of Kingsville, the Windsor Group is apparently overstepped by Mabou Formation strata which occur in a broad syncline in the central valley area and form hills with elevations of up to 200 m.

Windsor Group rocks outcrop both north and south of Maple Brook Syncline defined by the Mabou Formation strata. North Mountain, like the Creignish Hills, comprises pre-Carboniferous intrusives and Hadrynian George River Group metasedimentary rocks. These older rocks are overlain by a stratified section of sandstone, conglomerate and siltstone which Kelley (1967b) mapped as marginal facies of Horton Group and/or Windsor Group. This unit occurs in a narrow outcrop band between Big Brook and River Denys Station. This section is overlain with uncertain relationship by Windsor Group strata which occur in a southerly narrowing outcrop band beneath the Mabou Formation in the Maple Brook Syncline.

The salt drilling by Domtar Limited between 1968 and 1971 at Kingsville (Figs. 7-2 and 7-3) indicates the present geological maps require revision and reinterpretation at map borders. Interpolation between map sheets indicate a band of Horton Group outcrop in the salt deposit area. Previously unmapped faults may be used to explain this discrepancy. The contact between the Windsor Group (salt section) and the pre-Carboniferous to the west is interpreted as a fault (Fig. 7-2). Keppie (1976), based on radar imagery interpretation, indicated a major lineament paralleling River Inhabitants. This lineament may reflect the position of a major fault bounding the northeastern side of the salt mass. The Bouguer gravity anomaly coincident with the salt is oriented approximately north-south and parallels the western border fault (Fig. 7-1). Although the precise structural configuration of the salt mass is not clear, abnormal thickening is apparent along the axis of a complexly folded anticline (Figs. 7-2 and 7-4). A structural setting similar to that described by Giles (1981a) in the McIntyre Lake deposit area may be present in the Kingsville deposit. Further comparison will require detailed examination of the drill core from the Kingsville deposit.

In 1967 Domtar Limited (1968a) made a preliminary review of potential Maritime salt deposits and selected Kingsville, St. Peters and Seaview for diamond-drill testing the following year. The first hole at Kingsville (Kingsville No. 3) intersected salt at 376 m (1235 ft.) and was terminated in salt at 916 m (3006 ft.) (Fig. 7-3). Encouraged by the success of this hole an additional 4 holes were completed. Kingsville Nos. 4 and 5 were located in the immediate area of No. 3 and Kingsville Nos. 6 and 7 were drilled approximately 3 km south. Kingsville No. 4 was drilled 1220 m (4000 ft.) northwest of No. 3 and intersected salt at 494 m (1620 ft.), but was abandoned at 766 m (2512 ft.) due to drilling difficulties. Kingsville Nos. 6 and 7 are reported to have intersected "excellent salt" sections. In 1969 Domtar Ltd. drilled 5 more diamond-drill holes, all of which intersected salt (Kingsville Nos. 8-12).

Based on these data a solution mining test (KBW No. 1) was drilled near Kingsville No. 9 at the northern end of the salt body. This hole, completed at approximately 1220 m (4000 ft.) was fitted with an 8-5/8 inch production casing for the brining test that was begun near the bottom of the well. The testing indicated that brining was a satisfactory method to extract the salt.

GEOPHYSICS

The area in the vicinity of the Kingsville deposit is included on Nova Scotia Research Foundation Bouguer anomaly map Whycocomagh (Domtar, 1967) at a scale of two inches equals one mile (Figs. 7-1 and 7-5). The presence of salt indicated by the large circumscribed high amplitude (16 mGal) Bouguer gravity low has been established in diamond-drill holes.

GEOCHEMISTRY

Although salt springs have not been reported from the Kingsville area several were reported by Hayes (1931) to occur near Whycocomagh 20 km to the north and West Bay 12 km to the east. The presence of these salt springs indicates that salt probably underlies a large part of the River Denys Valley area. Chemical analyses of the salt at Kingsville are not as yet available for publication. The success of the brining test, however indicates the grade is sufficient for economic extraction.

ECONOMIC CONSIDERATIONS

The Kingsville deposit comprises halite with no potash reported. It is defined by 12 drillholes and coincides with a high amplitude Bouguer gravity low.

Domtar Ltd. (1968a) reported proven salt reserves, based on the drilling data, of approximately 28.6 million t (31.5 million tons). The company estimated probable reserves adjacent to the drilled area of approximately 1.04 billion t (1.15 billion tons). Domtar Limited has also considered the deposit for possible development of an underground salt cavern for petroleum storage. The Kingsville deposit is well suited for this use because it is situated approximately 20 km north of the ice free deep water port facilities on the Strait of Canso. Further developmental work on the deposit has been deferred.

MCINTYRE LAKE DEPOSIT

The McIntyre Lake deposit is located near McIntyre Lake which is situated approximately 7 km northeast of Port Hawkesbury, Inverness County (11F/11) (Figs. 1-10 and 7-6).

The area is readily accessible by highway and railway with Highway 4 and the mainline of the Canadian National Railroad passing within 1 km of the deposit. Excellent ice free deep water port facilities and the Point Tupper industrial area are situated between Point Tupper and Madden Cove on the Strait of Canso 10 km to the southwest. The small Port Hawkesbury regional airfield is situated 4 km north of Port Hawkesbury.

The terrain in the vicinity is typical of the Carboniferous Lowlands in southern Cape

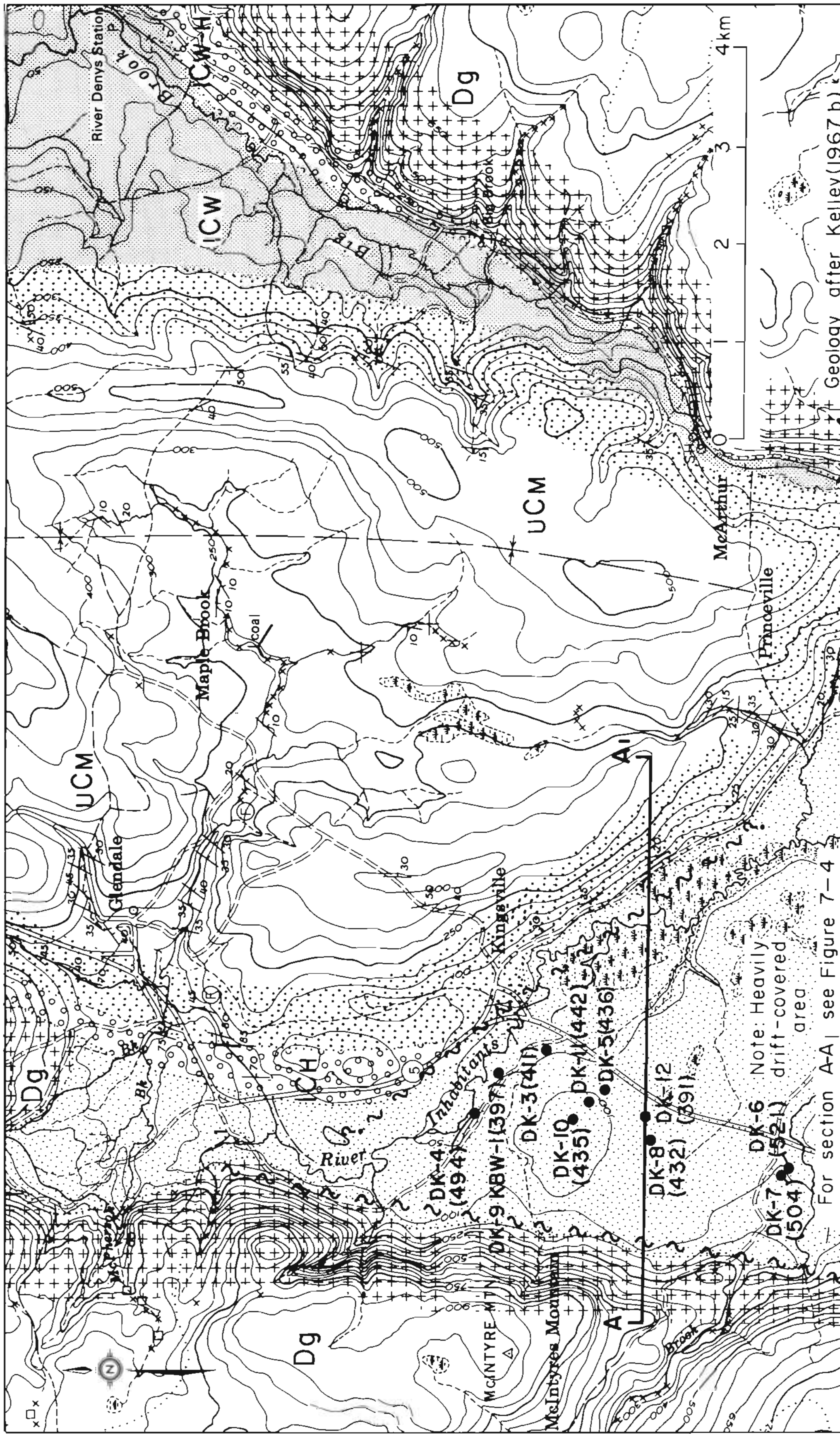


Figure 7-2. Geology in the vicinity of the Kingsville deposit, Inverness County.

LEGEND

UPPER CARBONIFEROUS

MORIEN GROUP

uCM — Undivided: sandstone, conglomerate, shale and coal

PICTOU GROUP

uCI — *INVERNESS FORMATION:* sandstone, shale and coal

RIVERSDALE GROUP

uCR — Undivided: sandstone, conglomerate, shale and coal

CANSO GROUP

uCCa-m — *MABOU FORMATION:* sandstone, siltstone and shale

uCCa — Undivided: sandstone, siltstone and shale

uCg — Gabbro, diabasic gabbro

LOWER CARBONIFEROUS

WINDSOR GROUP

lCw — Undivided: siltstone, gypsum, anhydrite, halite and limestone

lCw-u — Upper: siltstone, gypsum, anhydrite and limestone

lCw-L — Lower: gypsum, anhydrite, siltstone and limestone

lCw-G — *GRANTMIRE FORMATION:* conglomerate and sandstone

lCw-m — Marginal basin beds (Weeks, 1954): conglomerate, sandstone and limestone

HORTON and/or WINDSOR GROUP(S)

lCw-H — Marginal facies: conglomerate and sandstone

HORTON GROUP

lCH-SA — *STRATHLORNE-AINSLIE FORMATION:* sandstone, conglomerate and shale

lCH — Undivided: conglomerate, sandstone and shale

DEVONO-CARBONIFEROUS

DCFB — *FISSET BROOK FORMATION:* mafic and felsic volcanic rocks, conglomerate and sandstone

DEVONIAN

DML — *McADAM LAKE FORMATION:* conglomerate, sandstone, shale and tuff

Dg — Granite, diorite, granodiorite

CAMBRO-ORDOVICIAN

€Os — Undivided: conglomerate, grit, sandstone and shale

PROTEROZOIC

Pgd — gd, granodiorite; qd, quartz diorite; v, volcanics

HADRYNIAN

Hg,gd — Granite, granodiorite

FOURCHU GROUP

HF — Undivided: volcanic and sedimentary rocks

GEORGE RIVER GROUP

HGR — Undivided: metasedimentary rocks

HADRYNIAN-DEVONIAN

H-D — Undivided (may include lCH)

SYMBOLS

Heavily drift-covered area ....

Rock outcrop, area of outcrop ....

Limestone or dolomite outcrop (Faribault-Fletcher maps) ....

Gypsum outcrop ....

Geological boundary (defined, approximate, assumed) ....

Bedding, tops known (inclined, vertical, overturned, horizontal) ....

Bedding, tops unknown (inclined) ....

Schistosity (inclined, vertical, dip unknown) ....

Gneissosity (inclined, vertical) ....

Plunge of minor fold ....

Drag fold (arrow indicates plunge) ....

Fault (defined, approximate, assumed) ....

Fault (solid circle indicates downthrow side) ....

Joint (inclined, vertical) ....

Anticline (defined, approximate, arrow indicates direction of plunge) ....

Syncline (defined, approximate, arrow indicates direction of plunge) ....

Fossil locality ....

Spore sample ....

Glacial striae (ice flow direction known) ....

Gravel deposit ....

Quarry ....

Diamond-drill hole .... DDH

Borehole .... BH

Sinkhole .... SH

Salt spring ....

Observed karst topography ....

Drillhole intersecting salt; number (depth to salt, metres) IP-1 (520)

Drillhole without salt; number (Total depth, metres) SR6-1 (277)

Drillhole location precise to 150 m .... *

MINERALS

Anhydrite	ah	Limestone	lst
Gypsum	gyp	Pyrite	py
Lead	Pb	Zinc	Zn
Celestite	Sr		

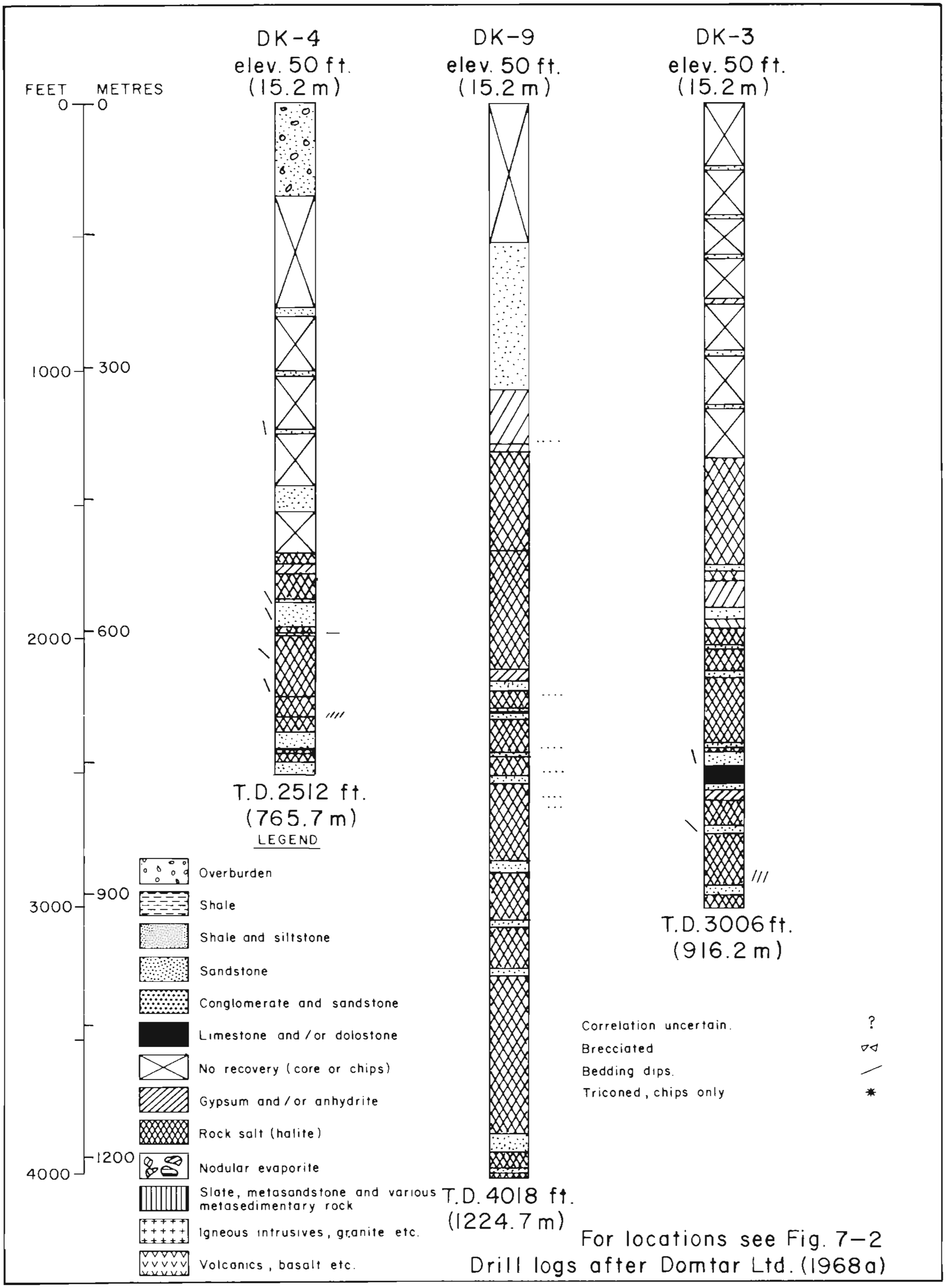
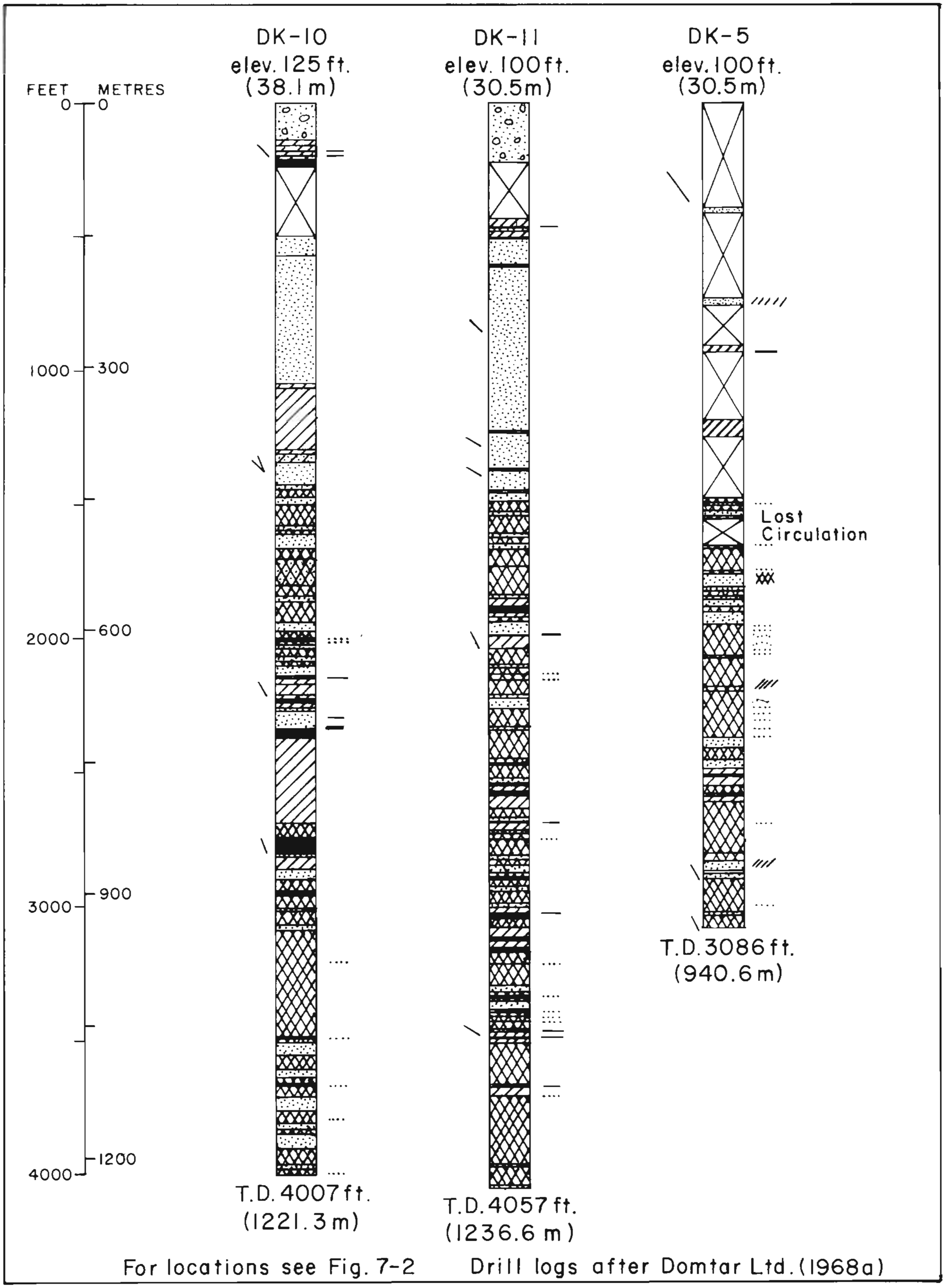


Figure 7-3. Drillhole profiles, Kingsville deposit, Inverness County.



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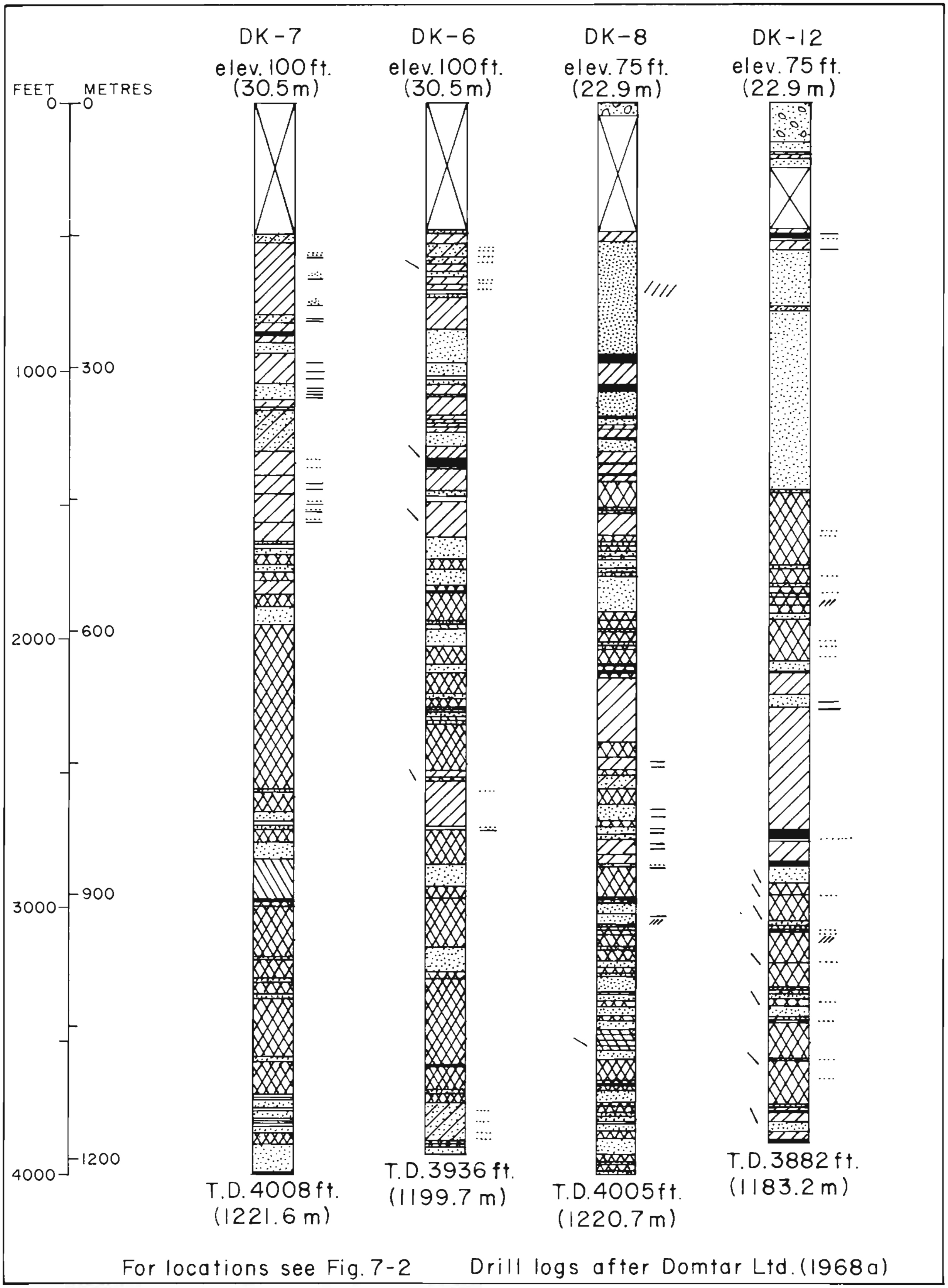

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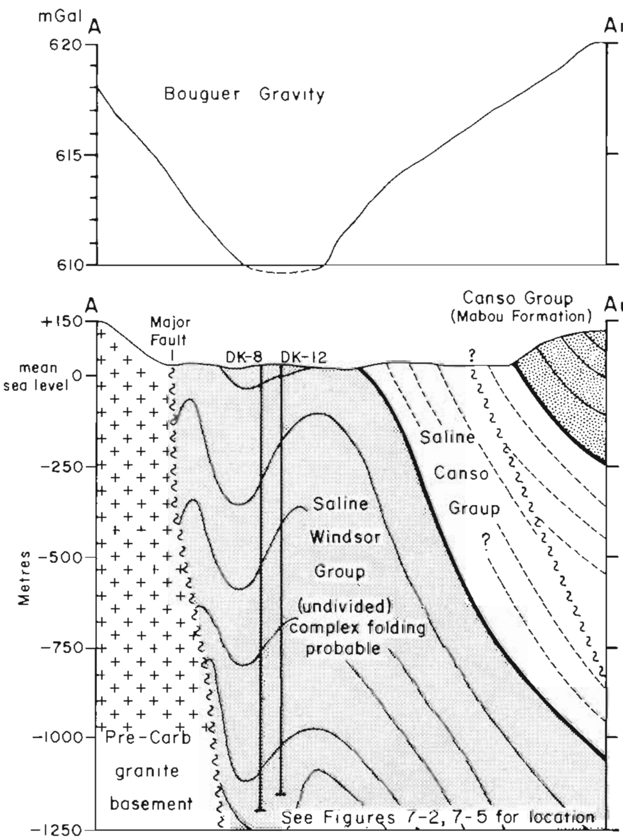


Figure 7-4. Geological and gravity cross-section, Kingsville deposit, Inverness County.

Breton Island. In this area elevations rarely exceed 125 m although in the bordering highlands, such as the Creignish Hills to the north and North Mountain to the northeast, elevations often exceed 200 m.

HISTORICAL BACKGROUND

Until recently, the McIntyre Lake area has received little attention directed at salt or potash exploration. The potash survey under Hayes (1931) did not locate salt springs in the immediate area of McIntyre Lake. Several were described, however in the Dundee-West Bay area located approximately 15 km northeast. Although salt springs were not located in the area by Ferguson (1946), the brooks traversing Windsor Group outcrop areas were reported to have a high degree of salinity. This was attributed to possible lenses of salt in the Windsor Group. The geology in the area is included in maps and reports by Ferguson (1946), Ferguson and Weeks (1950), Collins (1962) and Shea and Wallace (1962).

The potential for salt exploration in the area was not realized until the late 1960's when Bouguer gravity surveys outlined high amplitude gravity lows believed to be caused by substantial salt related structures (Fig. 7-1). Murphy Oil Company Limited and Northern Canadian Oils Limited followed up the initial studies by diamond-drill exploration programs in 1972 and 1974. This drilling established the presence of major salt deposit. Home Oil Canada Limited subsequently conducted further exploration and drilling in 1978 (Giles, 1981a). The McIntyre Lake deposit is being evaluated as a possible strategic petroleum reserve for the United States, with a view towards similar future

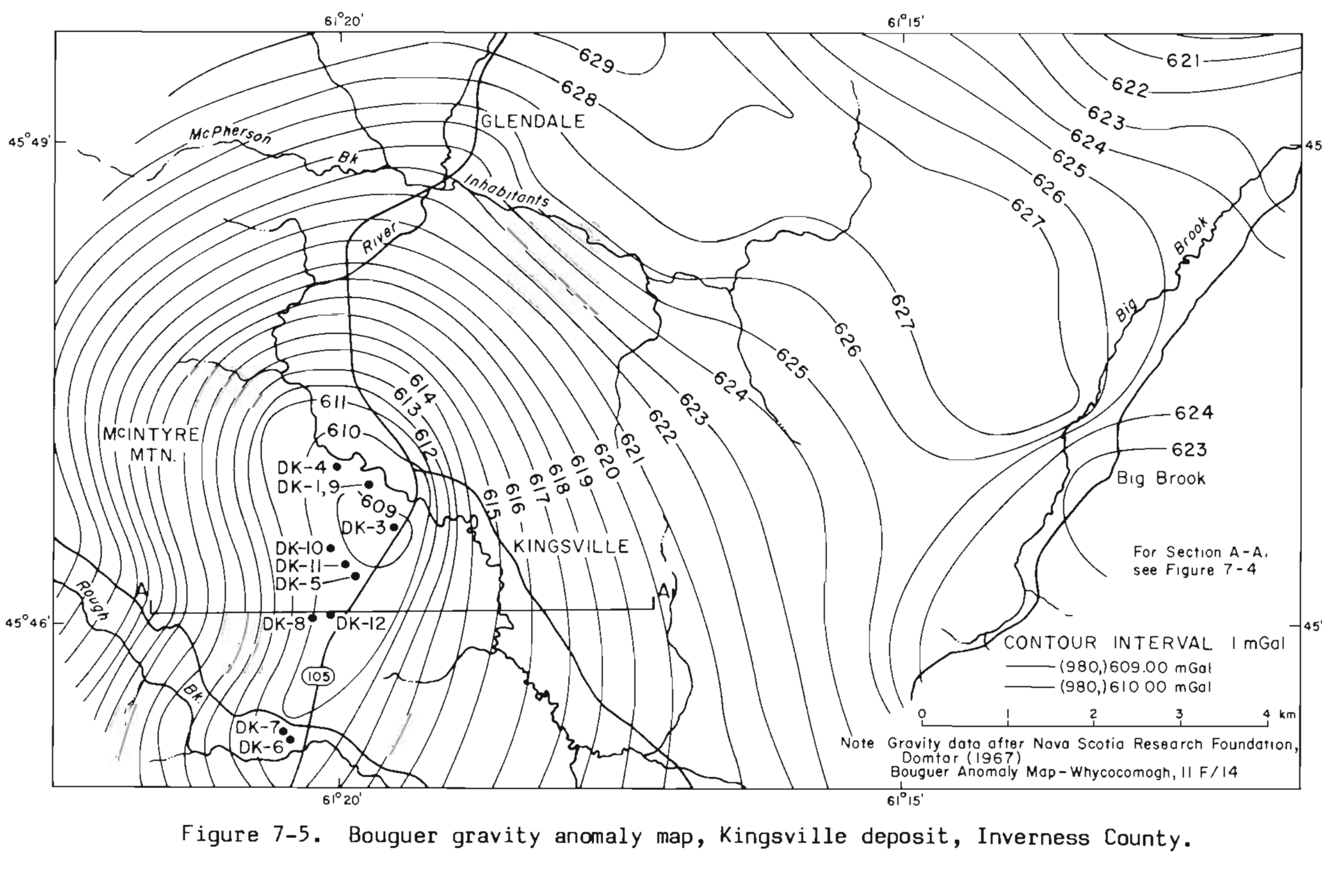


Figure 7-5. Bouguer gravity anomaly map, Kingsville deposit, Inverness County.

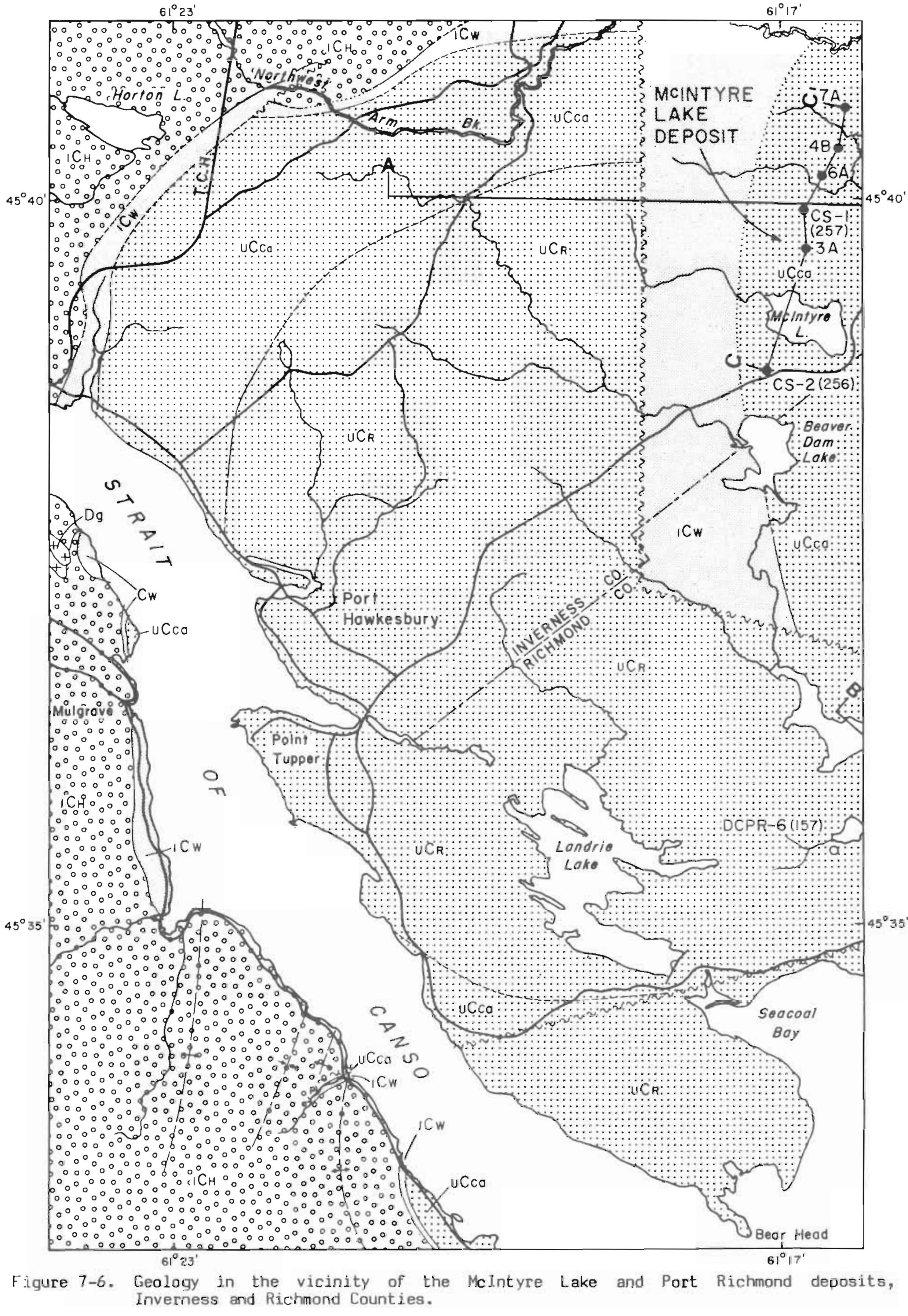


Figure 7-6. Geology in the vicinity of the McIntyre Lake and Port Richmond deposits, Inverness and Richmond Counties.

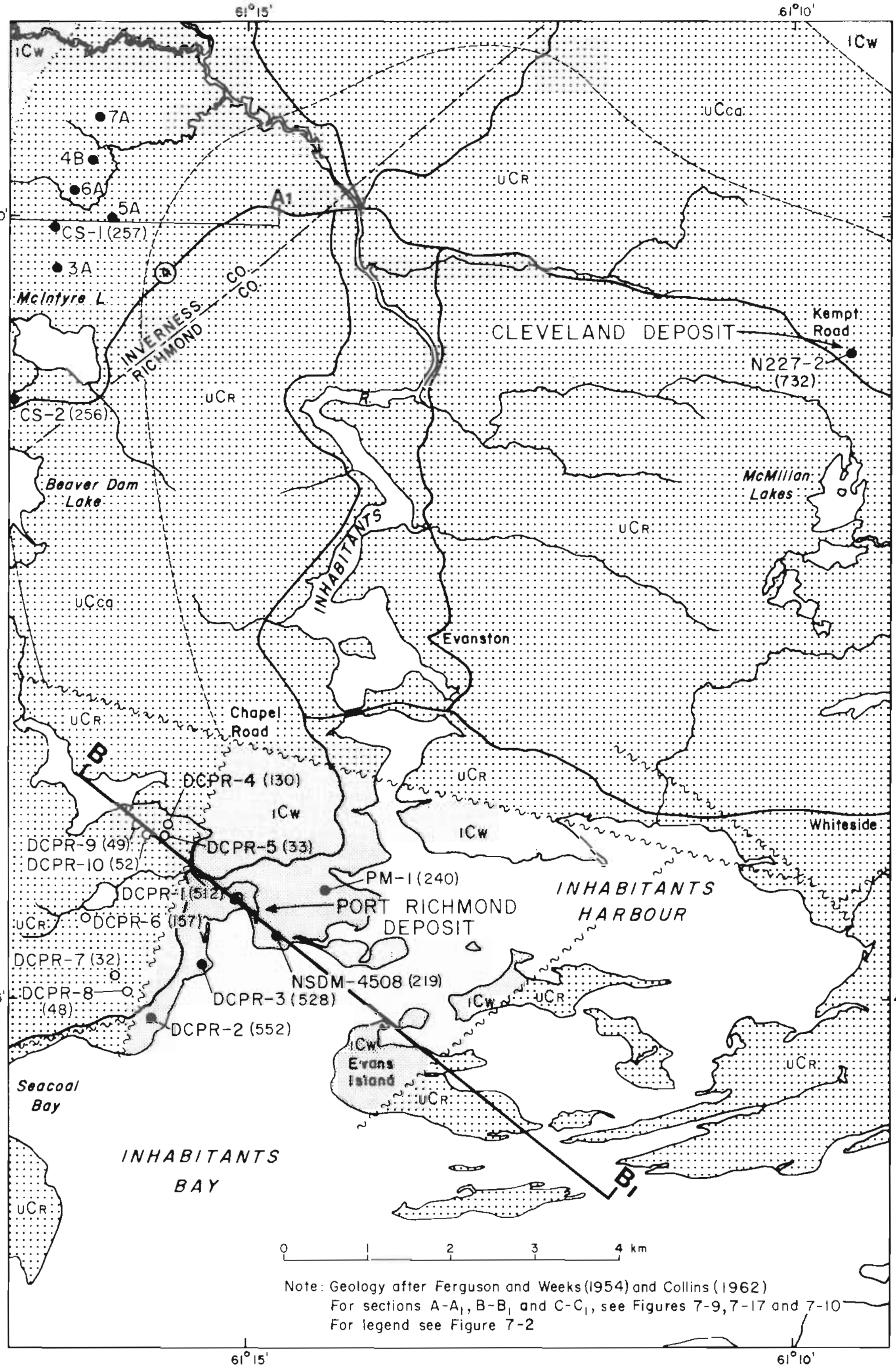


Figure 7-6. Continued.

development as a Canadian reserve and as a trans-shipment complex.

GEOLOGY

The geology in the immediate vicinity of the McIntyre Lake deposit (Fig. 7-6) has been described and mapped by Ferguson (1946) as part of the Mulgrave map sheet (11F/11W). The adjoining map area (11F/14) to the north was described and mapped by Kelley (1967b) and the eastern half of NTS 11F/11 was described and mapped by Collins (1962). The Port Hawkesbury-Strait of Canso area is the location of one of the thicker sections of Carboniferous rocks. The major structure in the area is a large syncline, defined by the Windsor Group and younger Canso and Riversdale Groups. This major structure is complicated by several major faults associated with or bounding in part outcrop areas of Windsor Group. Two such areas are McIntyre Lake and Port Richmond. In the western and northwestern margins of the area the Windsor Group outcrop areas are extremely narrow, the strata steeply dipping, and locally faulted and overturned. The Canso Group rocks overlie the Windsor Group in onlap relationship (Ferguson, 1946). Although there are some discrepancies in units from map to map, the broad outcrop area of Windsor Group rocks mapped to the north of McIntyre Lake are considered to extend into the adjoining map area.

The Horton outcrop belt on the eastern side of the Creignish Hills (Fig. 1-10) may be terminated by north-northwestward trending faults extending from the McIntyre Lake area. One of these faults appears to coincide with the River Inhabitants lineament of Keppie (1976) and define the southern border of the Maple Brook Syncline (Fig. 7-2). A second fault, on the western border of the Kingsville deposit, may extend through the Queensville area into the fault defining the western border of the McIntyre Lake structure (Fig. 7-6). The eastern border of the McIntyre Lake structure appears to be a relatively undisturbed section from the Windsor Group through the Canso and Riversdale Groups. Drilling indicates the Canso Group outcrop belt may extend farther to the west than previously mapped. In addition, evaporites including anhydrite and halite probably occur in the Canso section. If the Windsor Group contact with the Canso Group is conformable then the large scale onlap described in marginal areas (such as north of Kingsville) is very local or suspicious. Low angle faulting and complex folding may have produced these abnormal contacts. The extension of Ferguson's (1946) Canso and Riversdale outcrop belts into adjoining map areas is not consistent, particularly near North Mountain and West Bay (Fig. 7-1). Kelley (1967b) indicated the Maple Brook Syncline should extend southward into the West Bay Road area, but outcrop there was mapped as Windsor Group by Ferguson (1946). The Windsor outcrop belt between the Mabou Formation and pre-Carboniferous basement of North Mountain narrows rapidly southward and is apparently onlapped by the Canso Group (Mabou Formation).

Collins (1962) indicated a faulted contact with Canso Group rocks against the southeastern and southern borders of North Mountain. The extension of this fault into the Mulgrave map area was not recognized by Ferguson (1946). Keppie (1976) noted a lineament through West Bay parallel with the trend of North Mountain and a fault mapped by Collins (1962).

The southern border of the McIntyre Lake structure is also defined by a fault. This fault trends slightly south of east and extends from near the Inverness-Richmond Counties line into the Inhabitants Harbour area where it defines the northern border of the Port Richmond structure.

The surface expression of the McIntyre Lake structure, as presently mapped, may be interpreted as anticlinal with bounding faults to the west and south and possibly a relatively normal succession towards an adjacent syncline to the east.

Field mapping in the McIntyre Lake area and subsequent drilling by Murphy Oil Canada Limited et al. (Hale, 1972) indicated a complexly folded structural configuration. This structure, based upon the gravity and subsurface data, may be grossly interpreted as a diapiric anticline similar in some respects to those occurring in the Cumberland area and near Mabou.

NCO Canso Strat No. 1 (CS-1) well was the first drillhole put down in the McIntyre Lake structure (Figs. 7-6 and 7-7) (Hale, 1972). It was drilled in 1972 by Northern Canadian Oils Limited and Murphy Oil Company Limited. The hole intersected overburden to 55 m (180 ft.) and Windsor Group comprising brecciated clay-shale, gypsum with several thick massive highly permeable intervals of limestone to 256.6 m (842 ft.). Coring in the hole began at a depth of 96 m (315 ft.). A major salt section was then penetrated to the final total depth of 670.6 m (2200 ft.). Fairly thick anhydrite intervals were reported at 526.4-528.7 m (1727-1734.5 ft.), 531.6-563 m (1744-1847 ft.), and 580-582 m (1902-1909 ft.). Traces of potash salts were indicated throughout the salt sections. The dip in the main salt section was reported to range from 60° to 70°.

Based upon the encouraging results of Canso Strat No. 1, a second hole, Canso Strat No. 2 (CS-2) was spudded in 1974 approximately 2.2 km (1.4 miles) south of No. 1, in the area of McIntyre Lake and Beaver Dam Lake (Figs. 7-6 and 7-8). In summary, Canso Strat No. 2 (Hale, 1974) encountered the following section: overburden to 27.4 m (90 ft.); gypsum and clay to 76.2 m (250 ft.) where coring was begun; anhydrite with minor gypsum to 136.2 m (447 ft.); dark limestone and shale to 189 m (620 ft.); shale, gypsum and limestone breccia to 255 m (836 ft.) where the salt section was then entered. The exact structural nature and interrelations of the section from 255 m (836 ft.) to the final total depth of 916.5 m (3007 ft.) is not clear. Two fault or shear zones are reported to occur in this interval; the first at 559-559.9 m (1834-1837 ft.) and the second at 898 m (2946-2947 ft.). In addition, the section comprises a heterogeneous lithologic suite including thick intervals of interstratified limestone, anhydrite and claystone-shale (Fig. 7-8). This section

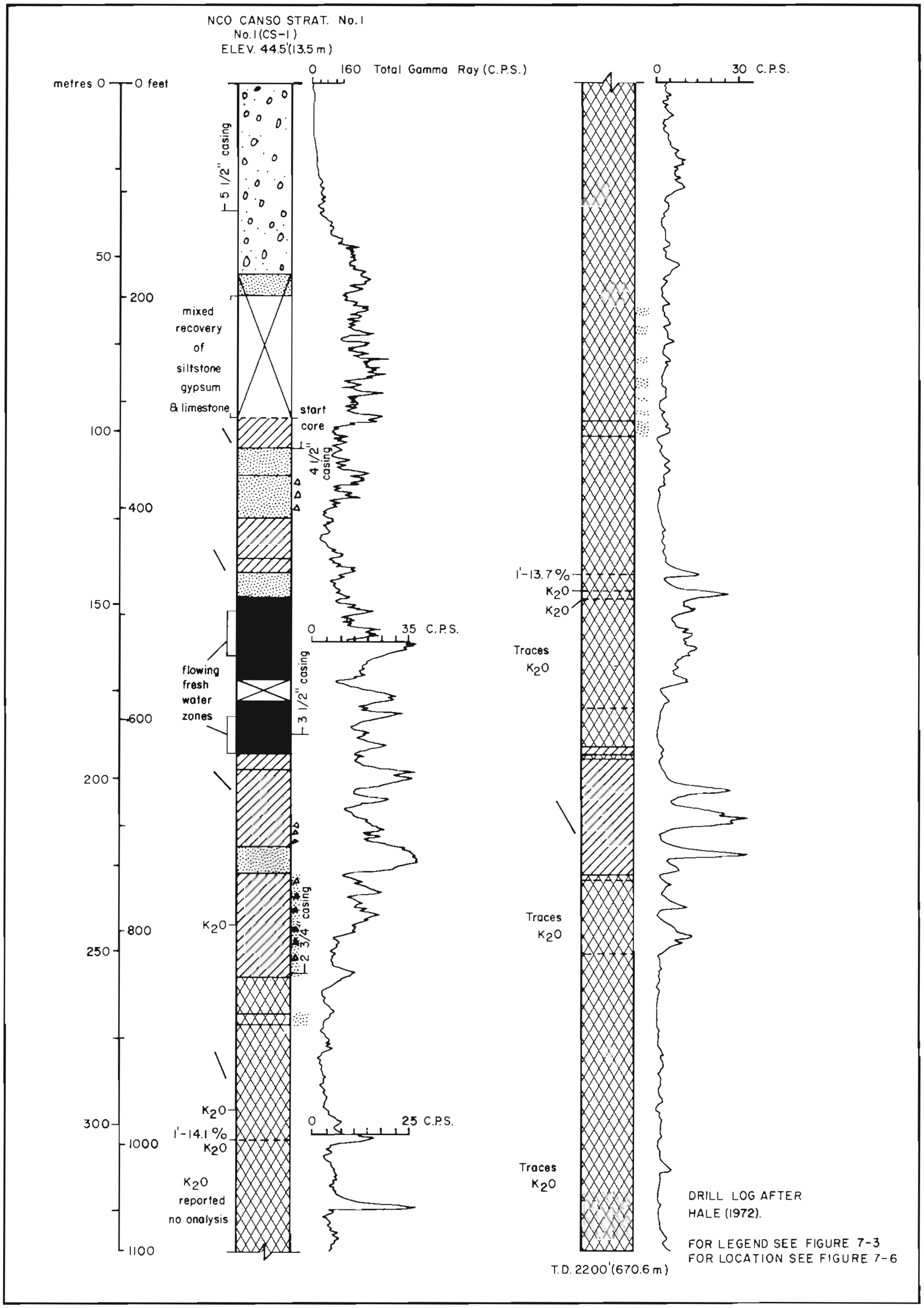


Figure 7-7. Drillhole profile NCO Canso Strat No. 1, McIntyre Lake deposit, Richmond County.

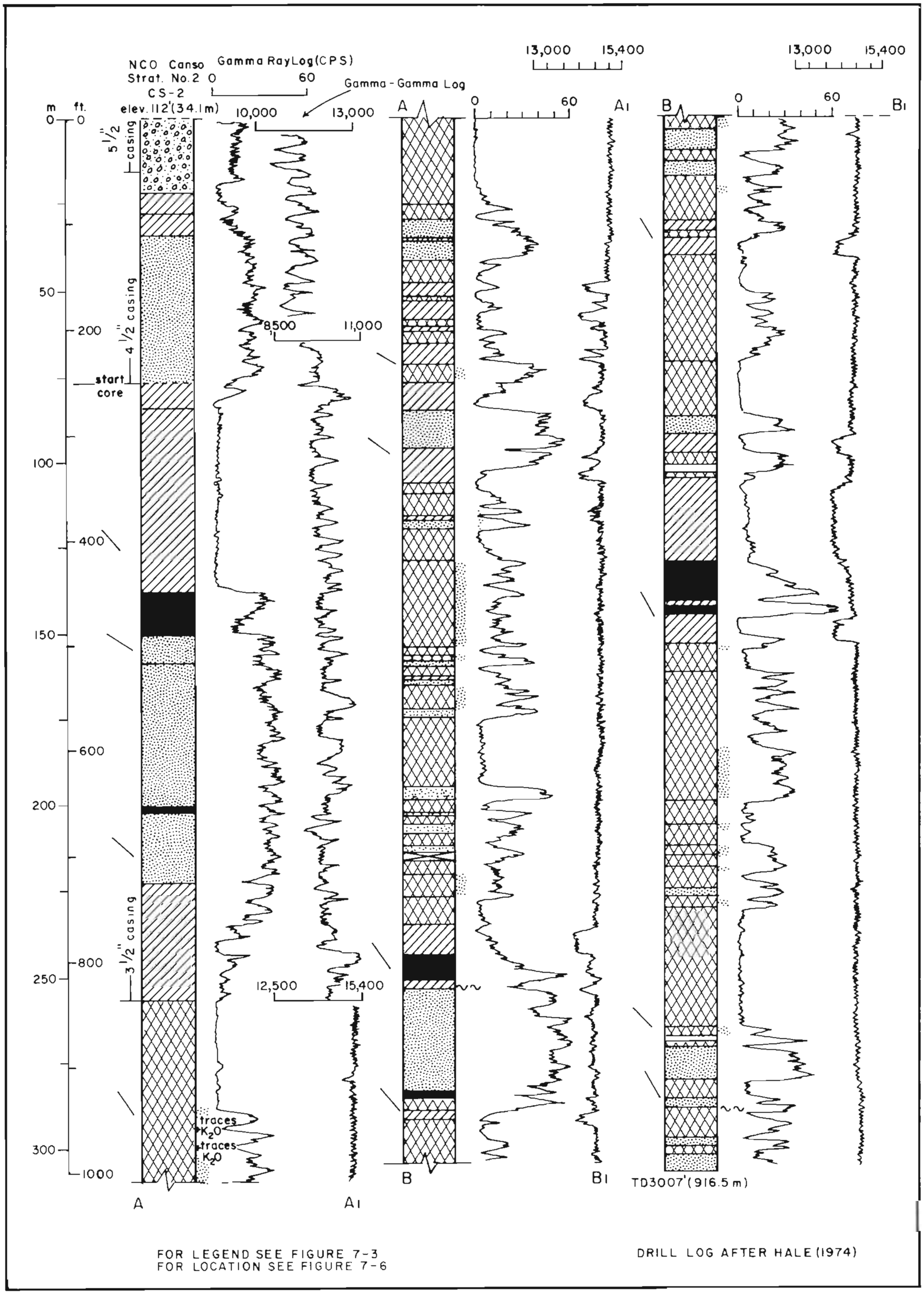


Figure 7-8. Drillhole profile NCO Canso Strat No. 2, McIntyre Lake deposit, Richmond County.

appears to be different from that reported in the Canso Strat No. 1 test and is probably the result of structural complexity related to faulting and folding (Fig. 7-9). Major, locally brecciated, claystone and anhydrite intervals occur at 356-472 m (1167-1548 ft.). Limestone layers were first reported at 502-551 m (1647-1807 ft.) and extend to 592 m (1942 ft.). Claystone and anhydrite rocks with halite continue to 682 m (2237 ft.) and resume at 698-840 m (2289-2756 ft.). Limestone reappears at 740-755 m (2427-2477 ft.). Halite with claystone breccia reappears at 875 m (2870 ft.) to the bottom of the hole at 916.5 m (3007 ft.). Bedding dips throughout the section are variable, but generally very steep at 60°-80°. Details of NCO Canso Strat Nos. 1 and 2 are included in the well history reports by Hale (1972, 1974).
leave 30 lines for Fig. 7-9

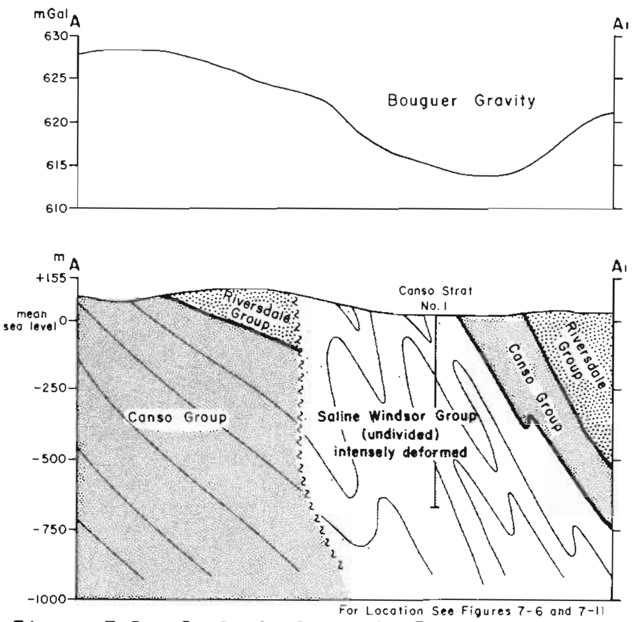


Figure 7-9. Geological and Bouguer gravity cross-section, McIntyre Lake deposit, Inverness County.

Hale (1972, 1974) recognized the following intervals of suggested lithologic correlation: the "Reefoidal limestone" section, 152-193 m (499-632 ft.) in No. 1 with the "fractured limestone" section, 137-175 m (449-575 ft.) in No. 2; "Black Anhydrite", 532-563 m (1744-1847 ft.) in No. 1 and 356-392 m (1167-1287 ft.) in No. 2. More recently detailed examination of the stratigraphy of the NCO drillholes and later drillholes by Home Oil et al. have provided greater insight into the probable structural configuration (Giles, 1981a, Figs. 7-6 and 7-10). Serious consideration must be given to problems encountered historically in the interpretation of Windsor Group salt geology in Nova Scotia. Moderate to steep dips are described in both holes, but correlation requires minimal dips. Salt structures in the Cumberland area were initially interpreted as little disturbed relatively simple anticlines. Subsequent workers including Evans (1972) and deep petroleum wells have indicated that the simplicity was only superficial. In fact, the structures were major anticlinal diapirs, with complex internal structure.

GEOPHYSICS

The area in the vicinity of the McIntyre Lake deposit is included on several gravity survey maps. The Nova Scotia Research Foundation (1967c, 1971) conducted gravity surveys in the area. The Nova Scotia Research Foundation Gravity Survey (1971), gravity map was used by Airborne Geophysical Surveys Ltd. in a gravity interpretation for Murphy Oil Company Limited (Galeski, 1971). In 1970 a gravity survey by Overland Exploration Services (1969) Ltd. was conducted for Murphy Oil Company Limited (Salt, 1970).

A distinct, high amplitude, Bouguer gravity outlined in the Port Richmond deposit area extends as a trough, into the McIntyre Lake area (Figs. 7-11). The western border of the anomaly is highly linear and is parallel with the northwestern border of North Mountain. The latter border is inferred to be a major fault. The presence and possible extension of this fault toward Port Hawkesbury is speculative.

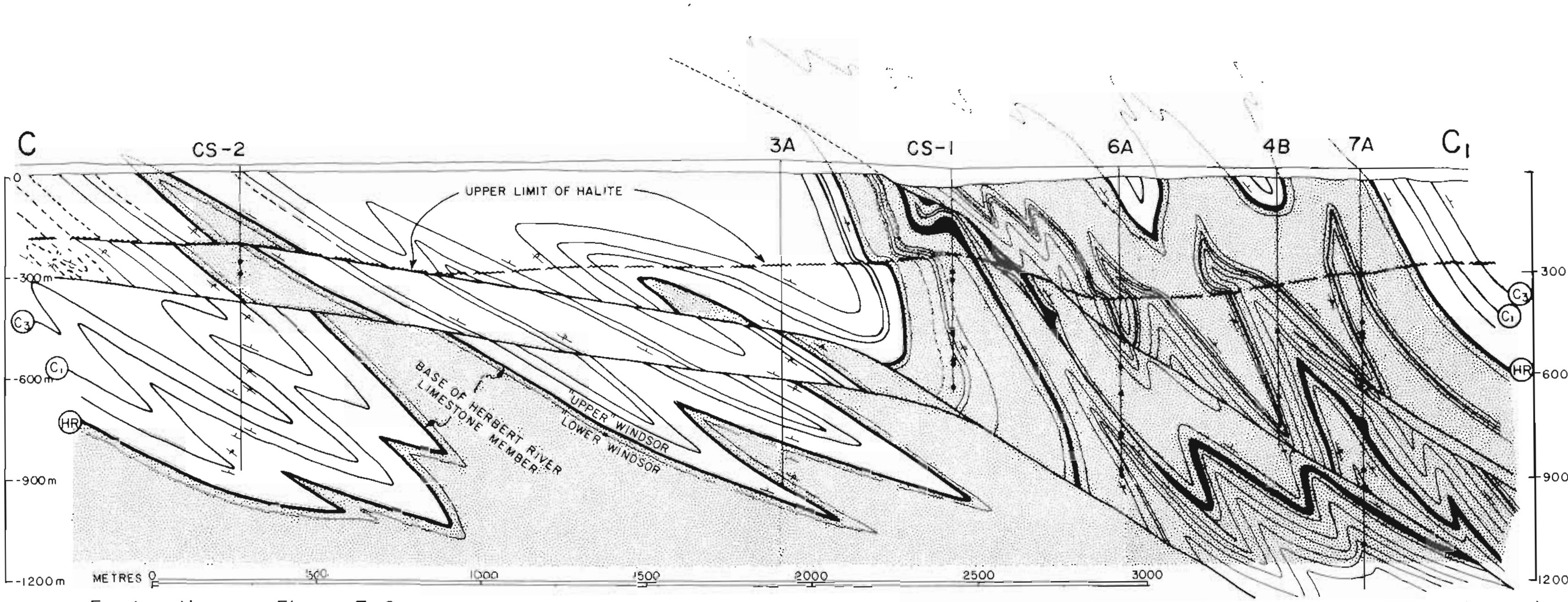
Geophysical-mechanical logging was carried out in both NCO Canso Strat Nos. 1 and 2 by the Nova Scotia Research Foundation. In Canso Strat No. 1 total gamma ray and caliper logs were completed and in Canso Strat No. 2 total gamma ray, micro-caliper and gamma-gamma (density) logs were completed (Figs. 7-7 and 7-8). These logs are useful in establishing lithology and correlation especially in the uncored parts of drillholes. Rock density measurements (Table 7-1) from selected core samples were done by the Nova Scotia Research Foundation as an aid to interpreting the geophysical logs.

GEOCHEMISTRY

Salt springs have not been described in the area. Chemical analyses on selected salt and potash samples and intervals were carried out by Core Laboratories Canada Ltd. on NCO Canso Strat No. 1 (Table 7-2). More detailed analyses were done on the NCO Canso Strat No. 2 drill core (in Hale, 1972) (Table 7-3 and notes on methods in Appendix 2) at intervals of 3.048 m (10 ft.) from 255.1 m (837 ft.) to the final total depth of 916.5 m (3007 ft.). The salt varies in purity ranging from 80-95% NaCl with an average of approximately 85%. Potash is present in minor amounts with analyses rarely exceeding 0.1% K.

ECONOMIC CONSIDERATIONS

The McIntyre Lake deposit comprises halite with local thin (less than 30 cm) potash salt zones with K_2O analyses of up to 14%. A significant Bouguer gravity anomaly coincident with an outcrop area of Windsor Group, together with the drill data available, indicate the presence of a potentially large salt deposit. The Canso Strat No. 1 hole intersected salt at 256.6 m (842 ft.) and was abandoned in salt at 671 m (2200 ft.). An accurate estimate of proven reserves is pending the completion of further exploration work by Home Oil et al. who have been exploring for potential development of solution mined underground storage structures. The project, although planned for a United States strategic



For location see Figure 7-6

Figure after Giles (1981a)

Figure 7-10. Stratigraphic and structural section C-C_1 showing distribution of Lower (screened) and Upper Windsor strata, and potash occurrences (black dots); HR, C_1 and C_3 refer to the Herbert River, C_1 and C_3 limestone members respectively. Form lines in heavy black indicate carbonate marker horizons; other form lines reflect correlative anhydrite-carbonate-siltstone-halite contacts.

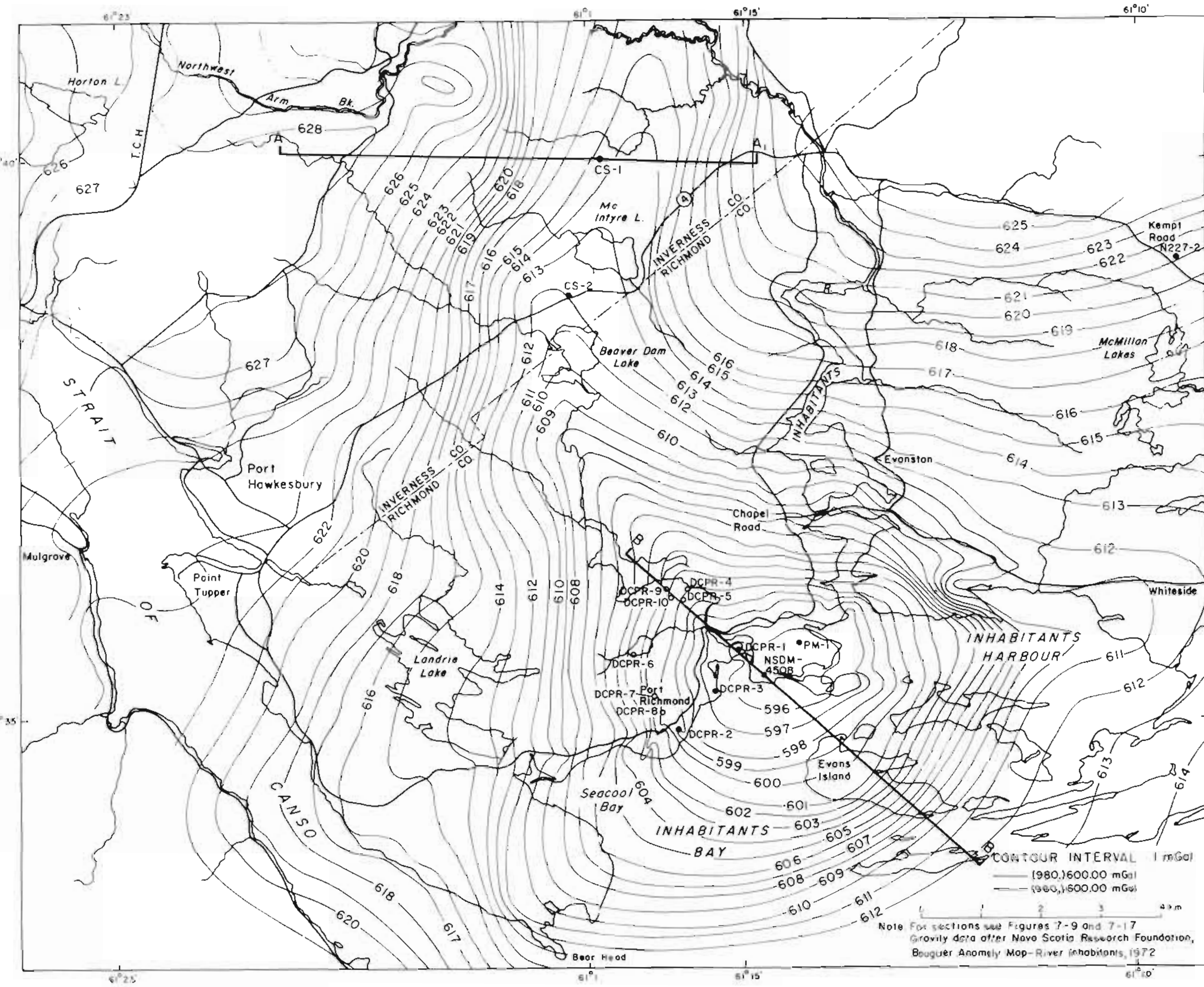


Figure 7-11. Bouguer gravity anomaly map, McIntyre Lake and Port Richmond deposits.

petroleum reserve could be expanded for future use as a Canadian reserve and/or petroleum trans-shipment facility. In addition, the salt deposit could supply a petrochemical industry. The Strait of Canso is an excellent ice free deep water port capable of handling VLCC (Very Large Crude Carriers) ships. This together with the close proximity of the McIntyre Lake deposit are encouraging for future development possibilities.

MALAGAWATCH DEPOSIT

The Malagawatch deposit is situated along the western shore of Bras d'Or Lake near Malagawatch, Inverness County (NTS 11F/15, Figs. 1-10, 7-1 and 7-12). Malagawatch is located approximately 40 km northeast of Port Hawkesbury and 20 km southeast of Whycocomagh. The area is accessible by paved and unpaved roads connected with Highways 104 and 105. The Canadian National Railway mainline between Port Hawkesbury and Sydney is situated 10 km to the west.

The topography in the area is dominated by the North Mountain which rises abruptly to 230 m. The Carboniferous Lowlands are largely submerged beneath Bras d'Or Lake and rarely have elevations that exceed 50 m.

HISTORICAL BACKGROUND

Although salt springs are not known in the Malagawatch area, several have been reported by Hayes (1931) in the Orangedale, Whycocomagh and West Bay areas (Figs. 1-10 and 7-1). The recent discovery of salt and potash near Malagawatch was complicated as well as serendipity (Dekker, 1982a). Chevron Standard Ltd. (1978) unexpectedly encountered light crude oil in base metal exploration drilling near Malagawatch (Fig. 7-12). The area became a petroleum prospect that was drilled in 1980 under a joint venture between Chevron Standard Ltd. and Irving Oil Company Ltd. The third well drilled was located near Malagawatch Point and unexpectedly intersected a significant section of salt and potash. The Malagawatch area then became a promising potash prospect that encouraged further potash exploration in the central part of Cape Breton Island by Chevron Standard Ltd. and Noranda Exploration Co. Ltd.

Table 7-1. Rock density determinations, NCO Canso Strat No. 1, McIntyre Lake deposit, Inverness County.***

Sample Depth (ft.)	**Rock type**	**Medium H_2O or Oil**	**Saturated Density(S)**	**"Dry" Density(D)**	**"Grain"* Density**	**(S-D)**	**Porosity****
1850	Anhydritic Claystone	H_2O	2.57	2.53	2.64	0.04	0.0416
1959	Anhydrite	H_2O	2.93	2.92	2.94	0.01	0.0101
1973	Dark salt	Oil	2.16	2.16	2.16	0	0
1993	Light salt	Oil	2.13	2.12	2.14	0.01	0.0101
2977	Green-grey Anhydrite	Oil	2.404	2.378	2.452	0.026	0.027
2982	Bed Claystone	Oil	2.422	2.406	2.455	0.016	0.016

NOTES: *density in g/cm^3

** $\frac{D}{1-(S-D)}$

Procedure used in density measurements
a) heated sample for 3 hours in oven at 110°C to completely dry
b) completely filled sample with water or oil under vacuum
c) weighed samples after each preparation
d) density of 12R7M Oil 0.8603 g/cm at room temperature

***Data by Nova Scotia Research Foundation (<u>in</u> Hale 1974)

Detailed information regarding the geology of the salt and potash in the Malagawatch deposit has only become available after the preparation of this report. Detailed descriptions of the stratigraphy and structure of the salt and potash in the area therefore are not included in this report. Dekker (1982b) reported that the stratigraphy and structure of the Windsor Group at Malagawatch were generally similar to those in the McIntyre Lake deposit area. Potash occurred at three stratigraphic levels (Fig. 7-13), one in Cycle 2 (upper potash) and two near the top of Cycle 1 (middle and lower potash) with the lower potash the major economic horizon (Table 7-4). For further information the reader is directed to the excellent summary report on the Malagawatch Project by Dekker (1982b).

ORANGEDALE DEPOSIT

The Orangedale deposit is situated near Orangedale in central Cape Breton Island (NTS 11F/14, Figs. 1-19, 7-1 and 7-12). Orangedale is located approximately 10 km south of Whycocomagh which is located approximately 45 km northeast of Port Hawkesbury.

The area is readily accessible by a series of all weather paved and gravel roads connected with Highway 105. The Canadian National Railway Mainline between Port Hawkesbury and Sydney passes through Orangedale.

The topography in the area is typical of the Carboniferous Lowlands where elevations rarely exceed 50 m. Highlands with elevations exceeding 275 m form the northwestern and southeastern borders to the Lowlands.

HISTORICAL BACKGROUND

Salt springs have been known in the area for at least 100 years. Systematic exploration for salt and potash was not recorded until Hayes (1931) described the area as part of a regional survey. Although drill exploration was not a part of this study, salt springs were described from nearby localities including Bucklaw, Baddeck, Whycocomagh, Orangedale and Dundee. Exploration activity was not renewed until 1977 when Noranda Exploration Co. Ltd. (1977, 1978 and 1979), following geophysical and geochemical surveys, drilled an exporation hole (N225-1) near Wilburn approximately midway between Orangedale and Whycocomagh (Fig. 7-12). This hole was located on the northeastern flank of a large Bouguer gravity low (Fig. 7-14) and intersected a highly brecciated salt bearing section from a depth of approximately 610-892 m (2000-2927 ft.). Potash salts were not reported from this drillhole.

Following the reports of significant potash intersected in the Malagawatch area by Chevron Standard Ltd. (1978) and Irving Oil Ltd. exploration was expanded and resulted in the drilling of a series of 4 more holes across the Bouguer gravity low. Detailed descriptions of the stratigraphy, structure and quality of the salt and potash are not available at this time (Noranda, 1981). The stratigraphy and structure of the Windsor Group appears to be generally similar to that described in the Malagawatch deposit area by Dekker (1982b). Descriptions and interpretations of geological, geochemical and geophysical surveys in the area prior to the exploration drilling are included in reports by Fundy Geoservices Ltd. (1978 and 1980).

Table 7-2. Chemical analyses, NCO Canso Strat No. 1, McIntyre Lake deposit, Inverness County.*

File Number	Interval (Feet)	Water Insolubles	Acid Insolubles
2302-01	1980-1990	12.91%	
2302-02	1990-2000	36.52%	19.84%
2302-03	2000-2010	28.57%	
2302-04	2010-2020	42.86%	
2302-05	2020-2030	18.55%	
2302-06	2030-2040	3.61%	
2302-07	2040-2050	4.62%	
2302-08	2050-2060	11.99%	
2302-09	2060-2070	33.47%	15.83%
2302-10	2070-2080	18.05%	
2302-11	2080-2090	16.91%	
2302-12	2090-2100	15.48%	
2302-13	2100-2110	14.69%	
2302-14	2110-2120	29.49%	
2302-15	2120-2130	16.21%	
2302-16	2130-2140	4.68%	
2302-17	2140-2150	20.31%	
2302-18	2150-2160	13.35%	
2302-19	2160-2170	16.80%	
2302-20	2170-2180	7.55%	
2302-21	2180-2190	1.04%	
2302-22	2190-2200	8.46%	

* Core Laboratories Canada Ltd. (in Hale, 1972) reports submitted to Nova Scotia Department of Mines and Energy.

PORT RICHMOND DEPOSIT

The Port Richmond deposit is situated along the western shore of Inhabitants Harbour near Port Richmond, Richmond County (Figs. 1-10, 7-1 and 7-6). Port Richmond is located approximately 8 km east of Port Hawkesbury on the Strait of Canso (NTS 11F/11).

The area is readily accessible by all weather roads connected with Highway 4 at Port Hawkesbury and Cleveland. The Canadian National Railway is situated approximately 2 km north of the deposit area.

Topography in the vicinity of the Port Richmond deposit is typical of the Carboniferous Lowlands in southern Cape Breton. In these Lowlands elevations rarely exceed 100 m.

HISTORICAL BACKGROUND

Exploration for salt in the Strait of Canso area was initiated in the Port Richmond area by Dow Chemical Company of Canada, Limited and Dew Mining Corporation Limited in 1967. Interest in the Port Richmond area was stimulated by the presence of a high amplitude negative Bouguer gravity anomaly located by the Nova Scotia Research Foundation (1965a). The anomaly was outlined in greater detail by subsequent gravity surveys and two diamond-drill holes drilled by Dow in 1967. By 1972 5 deep exploration holes intersected significant salt sections. A series of 7 shallow holes were also drilled to obtain structural and stratigraphic information. In 1973 a brining well DCPR-11 was drilled at the PR-1 location and test caverns were developed between 1973 and 1976. In 1975 a second brining well was drilled and a test cavern developed between 1975 and 1976. Further development at the Port Richmond deposit is presently in a state of deferment (Dow Chemical of Canada Ltd., 1975).

GEOLOGY

Geological mapping in the vicinity of the Port Richmond deposit has been carried out in surveys

Table 7-3. Chemical analyses, NCO Canso Strat No. 1, McIntyre Lake deposit, Inverness County.*

Interval (Feet)	Insolubles	K_2O	Magnesium	Carnallite	Carnallite K_2O	Sylvite K_2O	Sylvite
996-997	0.76	14.11	0.002	0.02	0.003	14.11	22.29
1556-1567	10.37	13.37	0.017	0.19	0.030	13.34	21.08
1586-1586.5	36.43	0.28	0.041	0.47	0.077	0.20	0.32
1666.5-1667.5	22.02	0.11	0.024	0.27	0.044	0.07	0.11

*Data by Core Laboratories Limited (in Hale,1972).

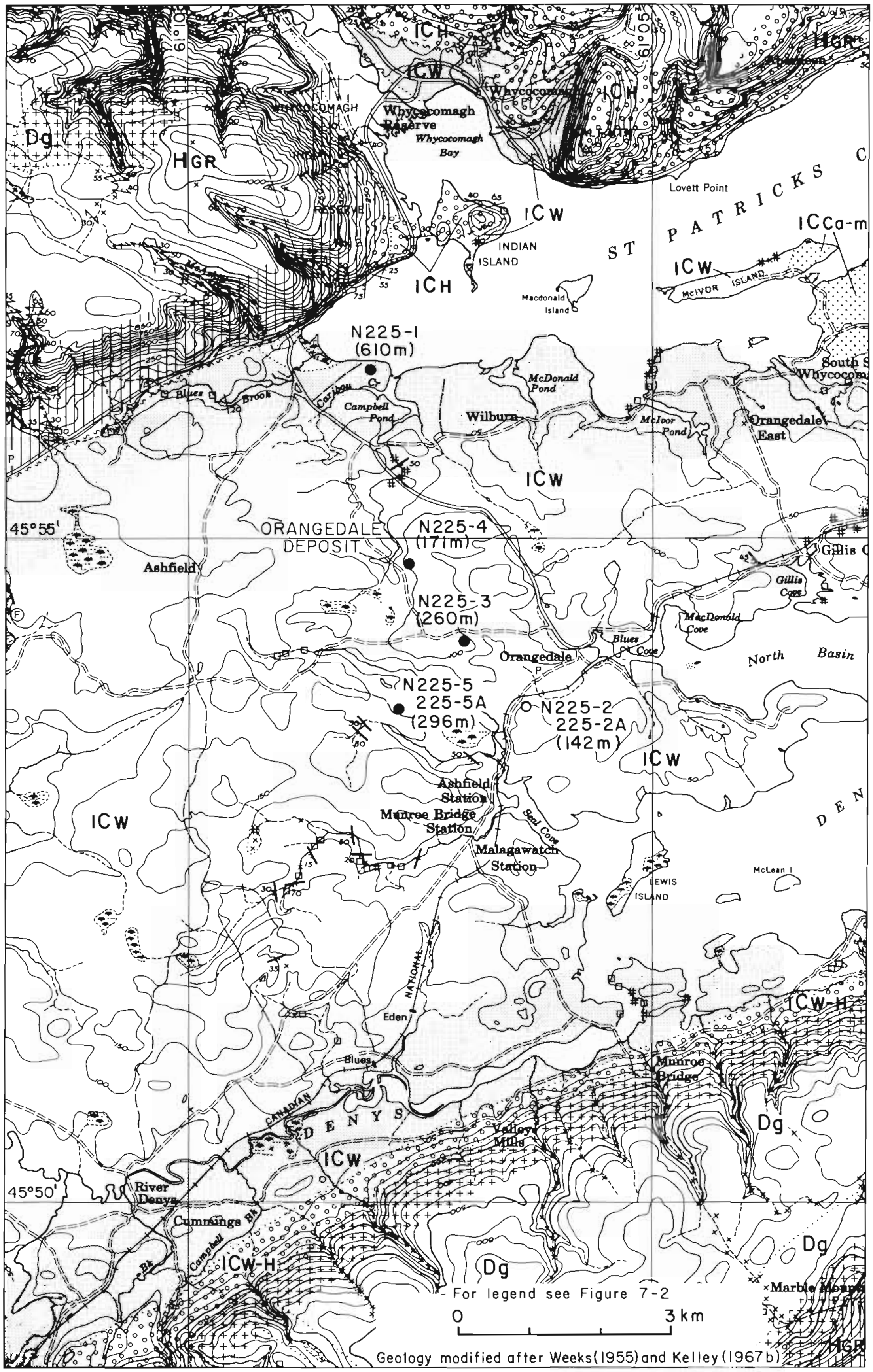


Figure 7-12. Geology in the vicinity of the Malagawatch, Estmere and Orangedale deposits, Inverness County

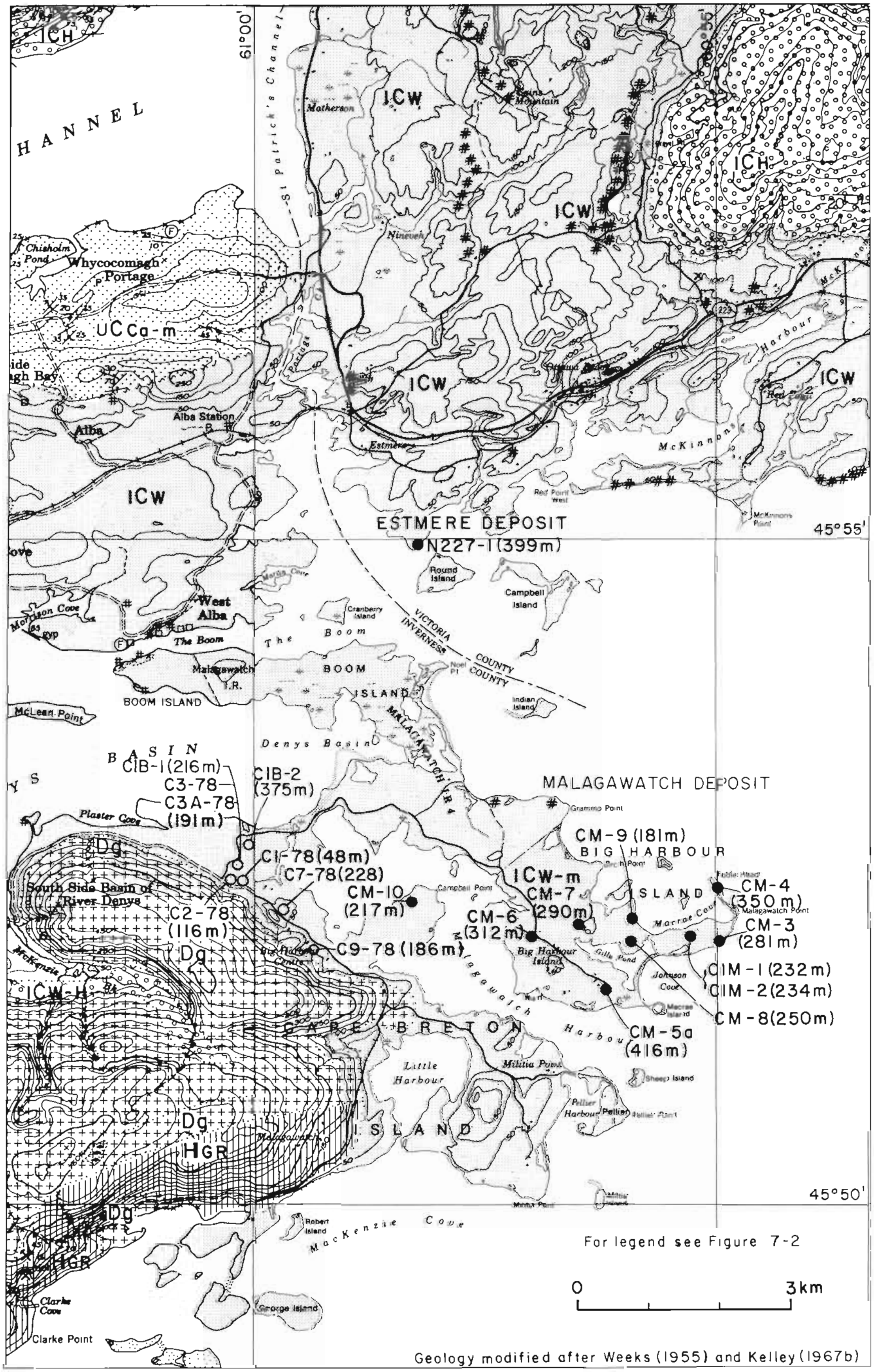


Figure 7-12. continued.

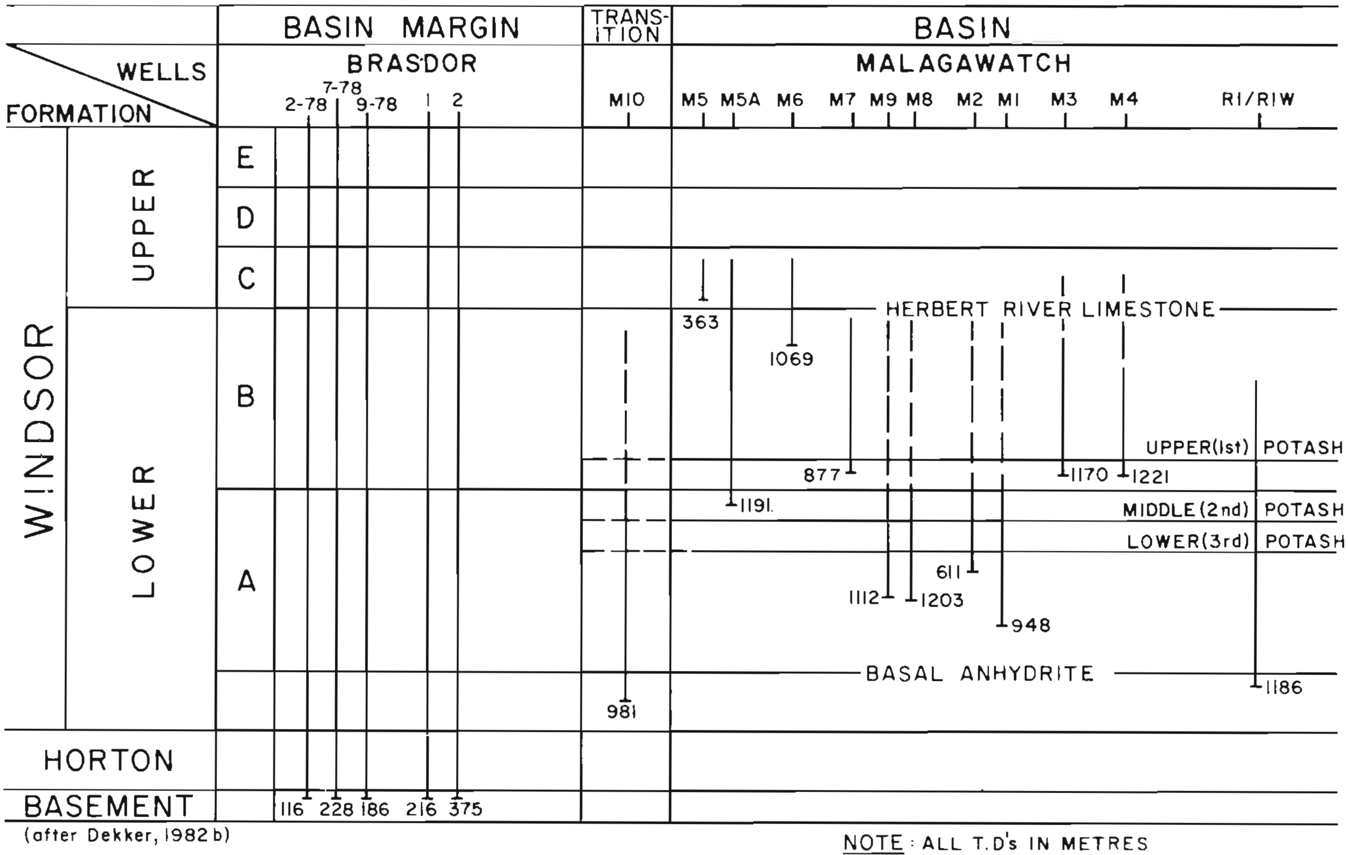


Figure 7-13. Schematic summary of total depth and stratigraphic section penetrated in Chevron Standard Ltd. drilling at Malagawatch and St. Patricks Channel.

by Ferguson (1946), Ferguson and Weeks (1950), Collins (1962) and Shea and Wallace (1962).

Outcrops of Windsor Group rocks are very rare and appear to be represented mainly by gypsum, shale and limestone. The geological maps covering the Port Richmond structure area portray it as a fault bound Windsor Group outcrop triangle bordered by Upper Carboniferous Riversdale Group. The majority of the structure appears to lie beneath the waters of Inhabitants Bay and Inhabitants Harbour (Fig. 7-6). The western border of the structure is defined by a north-northeasterly trending fault extending from Carleton Head towards Chappel Road. Here it is offset by an east-southeasterly trending fault that extends from the southern border of the McIntyre Lake structure into Inhabitants Harbour. This fault forms the northern border of the structure. The western border fault may extend from Carleton Head across Sea Coal Bay to the Strait of Canso (Shea and Wallace, 1962). The shallow drilling (DCPR-4 to -10) confirms the fault location (Figs. 7-6 and 7-15) along the western border. The southeastern border of the structure is also defined by faulting. The precise location of this boundary varies depending on which geological map you refer to (Shea and Wallace, 1962 and Collins, 1962). The fault or faults trend generally northeasterly and may be inferred to extend across Inhabitants Bay and connect with the western border fault.

In March 1967, Dow Chemical of Canada Limited drilled Port Richmond No. 1 (DCPR-1) (Fig. 7-10) on the point on the northern side of Murray Cove (Figs. 7-6 and 7-16). This hole was drilled to a total depth of 763 m (2503.5 ft.), intersected salt first at 508 m (1667 ft.) and did not completely penetrate the salt at final total depth (Rowe, 1967). In late 1967 Dow drilled a second hole, Port Richmond No. 2 (DCPR-2) near Carleton Head, south of Port Richmond (Rowe, 1968a). Salt was intersected in this hole at 549-643 m (1802-2110 ft.). Steep dips of 45°-75° were reported and several sections of shale and shale-salt breccia were reported (Fig. 7-16). From 643 m (2110 ft.) to the total depth at 732 m (2401 ft.) black shale, quartzite and conglomerate were tentatively identified as Horton Group although assignment to the Canso-Riversdale Group should not be ruled out. Traces of carnallite were reported in this well from 608-632 m (1994-2072 ft.).

At about the same time as Dow Chemical of Canada Limited was drilling DCPR-2, Dew Mining Corporation Limited was drilling CIL-1 (NSDM 4508) near the point on the eastern side of Murray Cove (Figs. 7-6 and 7-16). Salt was first intersected at 249.6 m (818.8 ft.) and was not completely penetrated at the final total depth at 679.8 m (2230.3 ft.). Scattered bands of anhydrite, shale and thin limestone are reported in the salt section. This type of section was

Table 7-4. Summary of assay results, Chevron Standard Ltd. drilling at Malagawatch and St. Patricks Channel (all intersections in all holes)**

Hole No.	Upper	Middle	Lower	Interval (m)	Length (m)	Dip	True Width (m)	$\%K_2O$	%Insols
M-1		+		*342 - 351	9	45°?	6.3	2.0	?
				*486 - 533	47	70°	15.8	>25	?
				*543 - 560	17	70°	5.7	>25	?
			+	560 - 571	11	70°	3.7	28.3	8
M-2		+		337 - 348	11	45°	7.7	2.3	2
			+	459 - 545	85	45°/70°	±40	10.3	2.1
M-3	+			946 - 950	4	45°	2.8	3.9	1.8
M-4	+			868.6 - 875.9	7.3	45°	5.1	1.8	2.9
M-5A	+			936 - 941.3	5.3	45°	3.7	3.6	3.9
M-6									
M-7	+			306.5 - 312.6	6.1	30°	5.3	14.8	5.4
M-8			+	331.4 - 351.6	20.2	70°	6.8	6.1	2.3
			+	492.9 - 500.7	7.8	70°	2.6	11.6	1.2
			+	688.2 - 700.4	12.2	70°	4.1	10	1.9
			+	969.2 - 978.2	9	45°	6.3	18.4	2.6
M-9			+	336.6 - 339.6	3	45°	2.1	16.2	1.4
			+	764.4 - 766.6	2.2	30°	1.9	27.1	5.1
			+	911.0 - 921.6	10.6	30°	9.1	13.4	2.8
M-10	+			290.9 - 300.2	9.3	45°	6.5	2.5	1.4
	+			430.9 - 433.3	2.4	30°	2.1	3.0	1.8
	+			444.8 - 446	1.2	30°	1.0	8.6	5.9
R-1		+		474.9 - 481.0	6.1	40°	4.2	<1	?
		+		502.2 - 508.3	6.1	40°	4.2	<1	?

All intervals in metres   0.63% K_2O cutoff (1% KCl)   *Gamma Ray Log Calculated Assay Result

**after Dekker, (Table IX, 1982b)

also described in Canso Strat No. 2 at McIntyre Lake (Hale, 1974). In early 1968 Dow Chemical Company drilled PR-3 (DCPR-3, Rowe, 1968b) on the point east of Port Richmond (Figs. 7-6 and 7-16). Salt was first intersected at 528 m (1732 ft.) and the hole was stopped in salt veined siltstone at 1576 m (5172 ft.). Numerous sections of siltstone, shale and salt-shale breccia were intersected in the salt interval. Bedding-banding dips throughout the salt section were reported to be steep (45° to 80°). Traces of carnallite were reported with a breccia interval at approximately 760 m (2500 ft.). Much of the salt was reported to be orange in colour. The section was interpreted to represent, for the most part, a fault zone. Palynology samples of some of the shale sections may be useful in determining the age of the nonevaporitic rocks in the section. It is not clear from the available data whether the shales are part of the Windsor, Canso-Riversdale or Horton Groups.

In late 1970 Dow Chemical Company Limited continued exploration by drilling a series of 7 shallow holes, DCPR-4 to DCPR-10 (less than 200 m) in the area west and north of Port Richmond (Figs. 7-6 and 7-15). DCPR-8, -7 and -6 were drilled in a northwestern trending line away from PR-2. DCPR-5 and -9, and DCPR-4 were similarly drilled northwest of PR-1. With the exception of veins and a thin section in DCPR-8, no evaporites were intersected in the holes. These holes

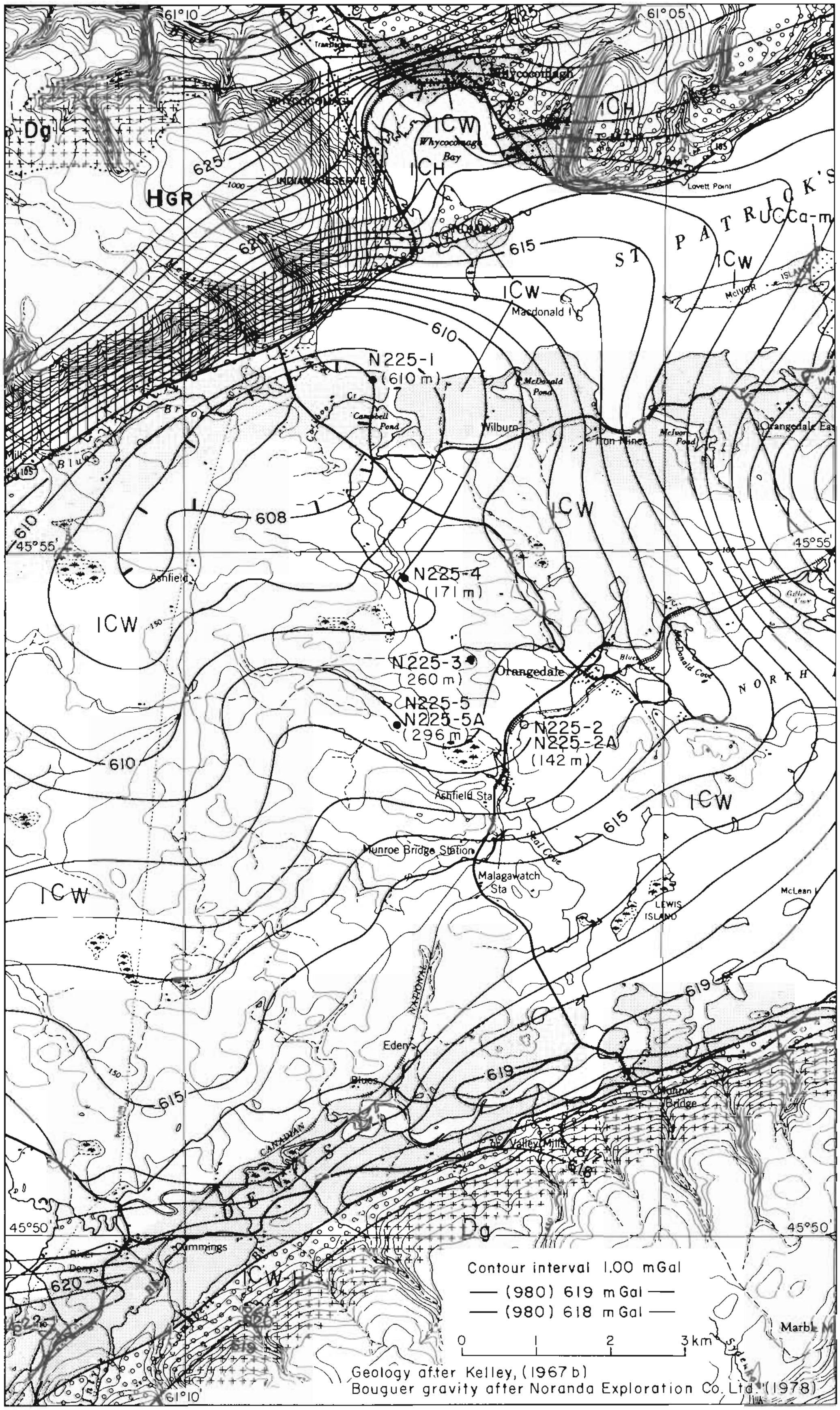


Figure 7-14. Bouguer gravity anomaly map, Orangedale deposit, Inverness County.

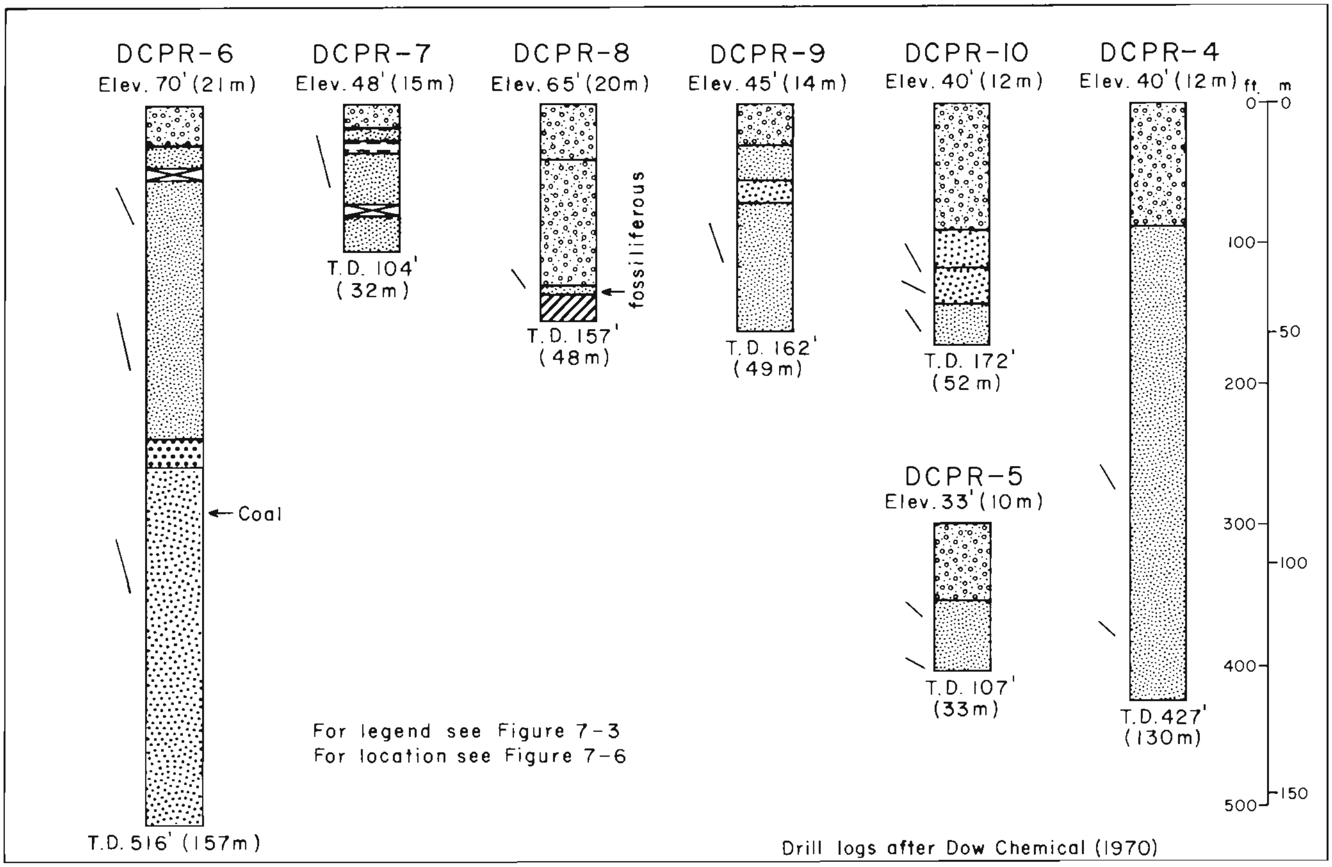


Figure 7-15. Drillhole profiles DCPR-4 to -10, Port Richmond deposit, Richmond County.

intersected variably disturbed terrigenous rocks of the Canso and Riversdale Groups and possibly some of the Windsor Group. In 1972 Dow Chemical Limited completed its exploration drilling program with the drilling of Port Malcolm No. 1 approximately 1 km east of DCPR-1 (Figs. 7-6 and 7-12). Salt, mainly as thin intervals alternating with anhydrite, siltstone and limestone, was reported in significant layers from 282.4 m (926.5 ft.) to the bottom of the hole at 624 m (2047 ft.). Dips throughout the section were reported to be steep (45° to 75°).

In early 1973 Dow Chemical of Canada Limited drilled a brine well (DCPR-11P) at the site of Port Richmond No. 1 to produce an underground storage cavity. This well was drilled to a total depth of 1227 m (4025 ft.). Three zones were considered as favourable for brining: Zone 1, 578.2-673.3 m (1897-2209 ft.); Zone 2, 784.3-837 m (2573-2746 ft.); and Zone 3, 857.1-907.7 m (2812-2978 ft.). Zone 3 was selected for development as a storage cavity. From 1973 to 1976 brining was carried out in Zone 3 and to a limited extent in Zone 2. As conditions were found to be unfavourable for the required capacity at this site, a second well (DCPR-12P) was drilled in 1975 approximately 300 m (1000 ft.) west of DCPR-11P. The favourable salt zones in this well were Zone 1, 484.6-535.2 m (1590-1756 ft.); and Zone 2, 675.4-752.2 m (2216-2468 ft.). Brining of Zone 2 began in July 1975. Problems encountered were related to the complex geology and the resultant unpredictability of insoluble layers. Although DCPR-11P and -12P are only 300 m (1000 ft.) apart the suitable salt zones are at drastically different depths and appear to have no apparent correlation. The Port Richmond deposit may be structurally similar to the Pugwash deposit or the McIntyre Lake deposit. Faulting and diapirism are considered responsible for the complex internal structure in this deposit (Fig. 7-17). Younger Windsor Group rocks, comprising variably disturbed interstratified anhydrite, limestone and shale with some halite occur as thick sections in NSDM 4508 and Port Malcolm No. 1 (PM-1) and as thinner disturbed sections in DCPR-1, -2, and -3. Due to a lack of data, a detailed assessment of the internal structure of the Port Richmond deposit is not possible at this time.

GEOPHYSICS

Attention was first drawn to the possibility of significant salt structures in the Port Richmond area by the presence of a high amplitude (30 mGal) Bouguer gravity low outlined by the Nova Scotia Research Foundation. Further surveys and model interpretations were carried out in the area by the Nova Scotia Research Foundation (1965a and b, 1966b, 1967c, 1971 and 1972) for Dow Chemical Company Limited and also for Dew

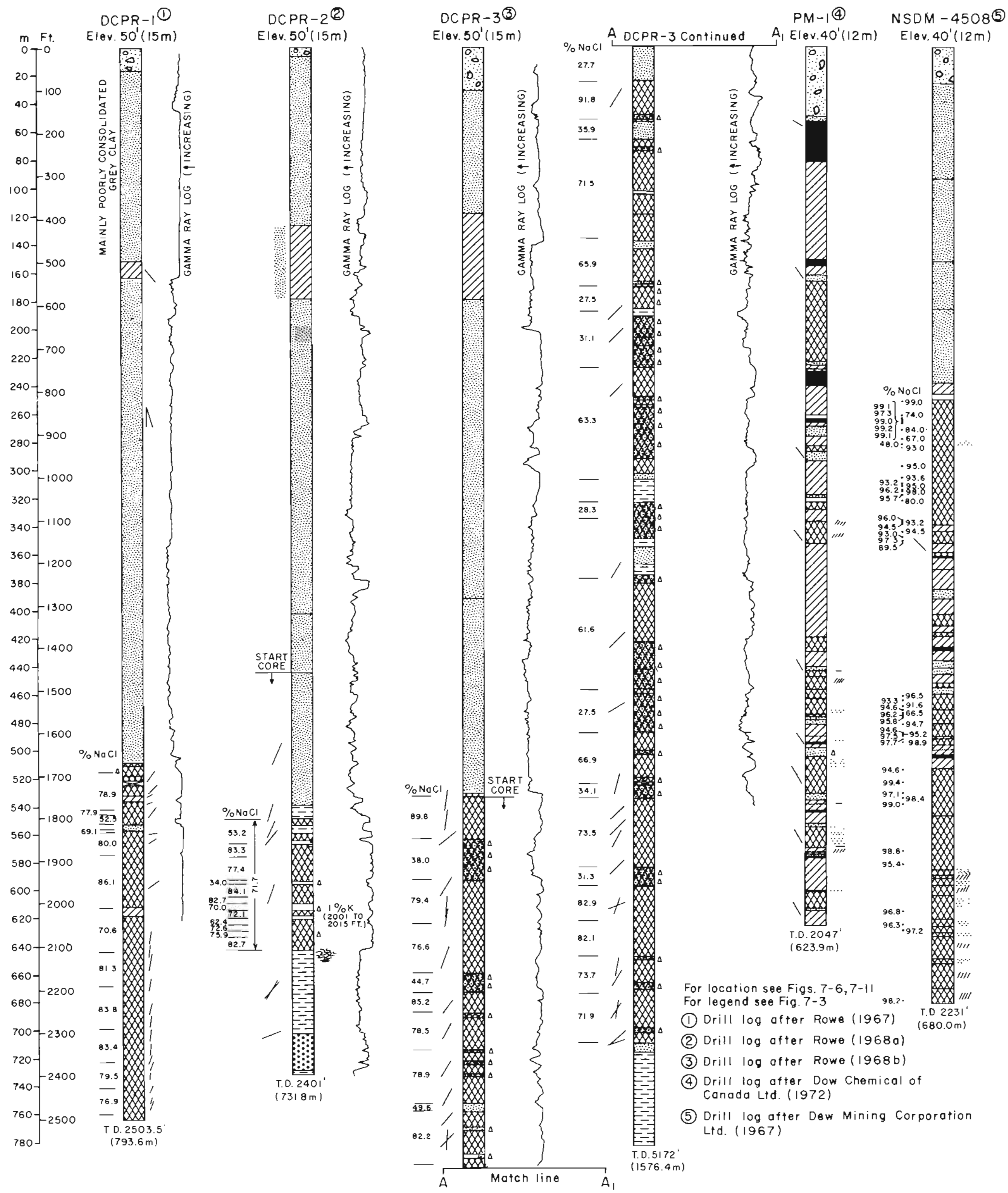


Figure 7-16. Drillhole profiles DCPR-1 to -3, PM-1 and CIL-1, Port Richmond deposit.

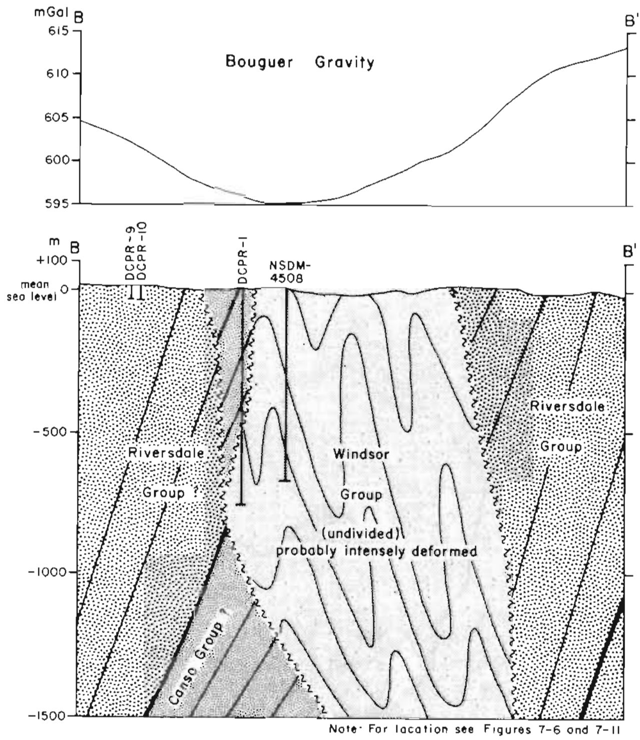


Figure 7-17. Geological and Bouguer gravity cross-section, Port Richmond deposit, Richmond County.

Mining and Explorations. Details regarding these surveys and model interpretations are contained in the following unpublished maps and reports filed in the Nova Scotia Department of Mines and Energy, Halifax: Nova Scotia Research Foundation, 1965a (Report 20-65), 1965b (Report 20A-65), 1966b (Project C-5; Report 8-67), 1967c (Report 1-67), and 1972 (Report 2-72). The most recent map available is presented in Figure 7-11.

In addition to the gravity surveys, the Nova Scotia Research Foundation (1968d) was engaged by Dow Chemical of Canada Limited to do a Hydrosonde seismic survey in the Bay of Inhabitants. Approximately 14 track miles were surveyed and despite the limitation of penetration by shallow water, a number of shallow structural features were recognized.

As part of the diamond-drill exploration programs by Dow Chemical Company Limited downhole gamma ray logs were run by the Nova Scotia Research Foundation (Fig. 7-16) on Port Richmond Nos. 1, 2 and 3 (Rowe 1967, 1968a and b). More detailed downhole logs, including Compensated Sonic Log with gamma ray and caliper logs, and Compensated Formation Density Log with gamma ray and caliper logs, were run on DCPR-11P. At various stages during cavern development, sonar surveys were run to record the solution rate and the geometry of the cavern.

GEOCHEMISTRY

The exploration work by Dow Chemical of Canada Limited and to a lesser extent Dew Mining and Exploration has produced a relatively large volume of analytical data. These data are summarized on Figure 7-16, and in Tables 7-5, 7-6, 7-7, 7-8, 7-9 and 7-10 in Appendix 2.

ECONOMIC CONSIDERATIONS

The Port Richmond deposit is presently defined in five deep exploratory holes drilled on a high amplitude (30 mGal) Bouguer gravity anomaly. Significant sections of salt (exceeding 1000 m) were intersected although the continuity and correlation of the intervals was difficult to interpret due to the complex structure. Anhydrite, siltstone, shale breccia and limestone are interlayered with the salt in some sections. Potash salts (carnallite) were reported locally in trace quantities. The depth to the top of the salt section is variable, but it generally occurs at approximately 500 to 550 m below the surface.

Brine springs and seeps indicative of subsurface solution, have not been reported in this area. Possible development of the Port Richmond deposit may be hindered because the major portion of the salt structure occurs beneath Inhabitants Bay.

Dow Chemical Company Limited proceeded with the development of brined caverns for possible underground storage in the DCPR-11P and DCPR-12P wells until 1976 when the project was placed in a state of deferment. The Port Richmond deposit is advantageously situated in close proximity to ice free deep water port facilities and a heavy industrial area, including an oil refinery, along the Strait of Canso approximately 8 km west.

ST. PETERS DEPOSIT

The St. Peters deposit is situated near Tillard Point approximately 1 km west of the Town of St. Peters, Richmond County (NTS 11F/10) (Figs.1-10 and 7-18). St. Peters is located on southern Cape Breton Island approximately 40 km east of Port Hawkesbury on the Strait of Canso.

The area is readily accessible by an all weather highway, Route 4, between Port Hawkesbury and Sydney. A branch line of the Canadian National Railway to St. Peters, parallels Route 4, and passes within 300 m of the discovery drillhole, St. Peters No. 1.

The terrain in the area is typical of the Carboniferous Lowlands in southern Cape Breton where the gently rolling hills rarely exceed 75 m. Local relief is present, however, in the vicinity of gabbroic rocks forming a series of small hills along the southeastern side of St. Peters Inlet. The area to the northeast of the Lowlands is marked by flat topped highland area named Sporting Mountain, where elevations rise upward to 180 m.

HISTORICAL BACKGROUND

In 1967 the St. Peters area was selected by Domtar Limited as a potential area for salt

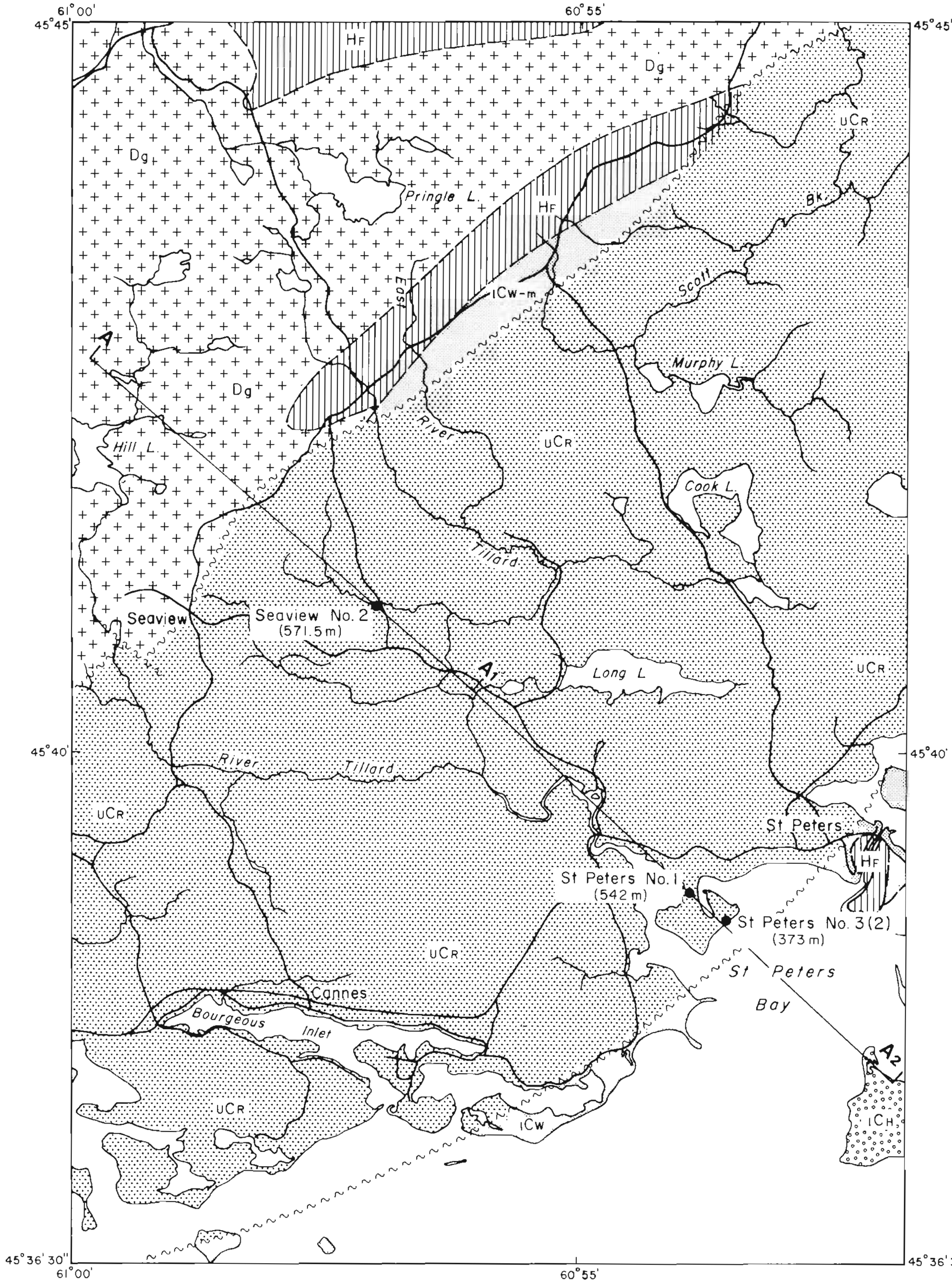


Figure 7-18. Geology in the vicinity of the St. Peters deposit and Seaview occurrence, Richmond County.

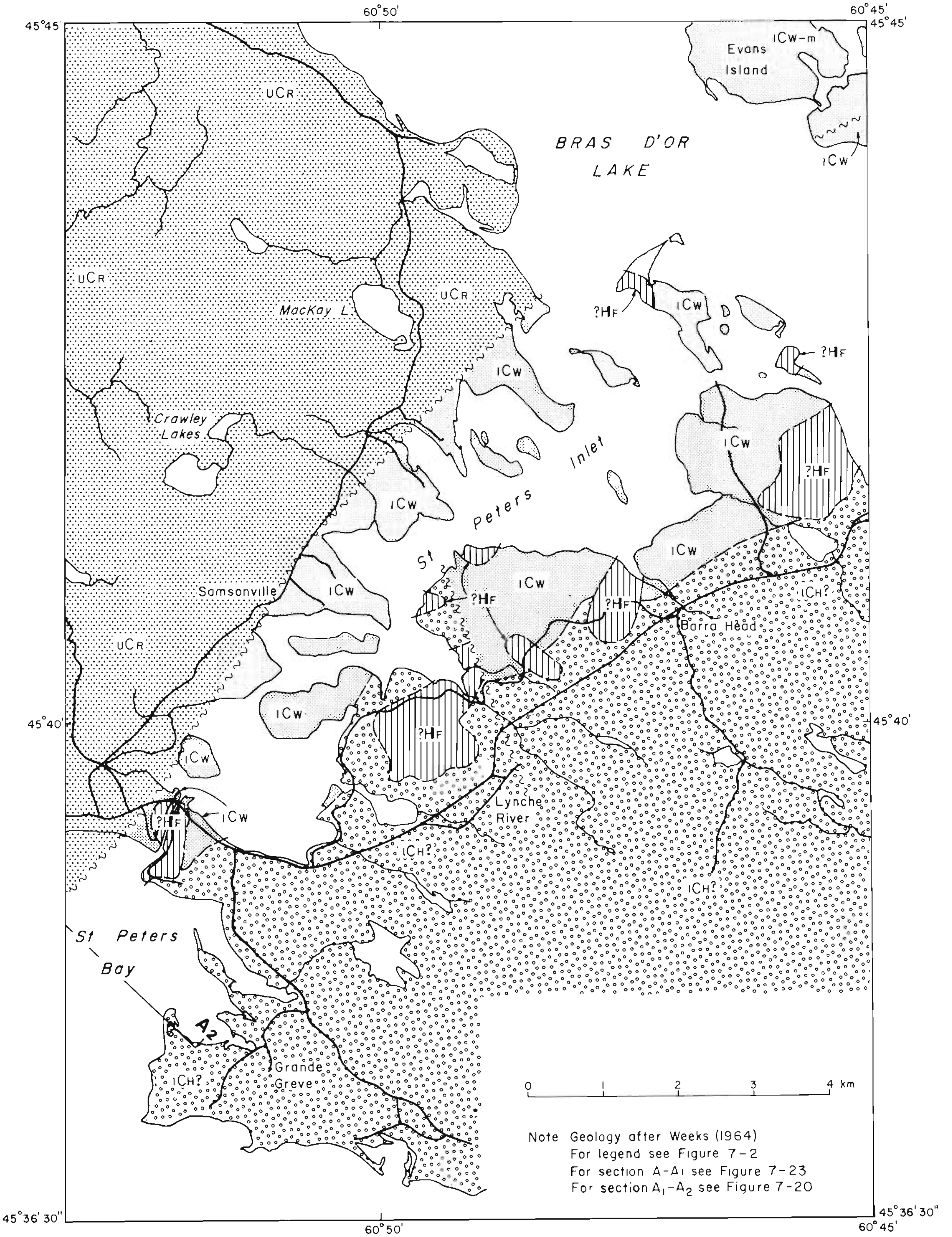


Figure 7-18. Continued.

exploration based on gravity surveys conducted for the company by the Nova Scotia Research Foundation (1967d).

Two exploration drillholes (Domtar, 1968b), St. Peters No. 1 and No. 2, were drilled in 1968 on a negative Bouguer gravity anomaly centred in St. Peters Bay (Figs. 7-1 and 7-19).

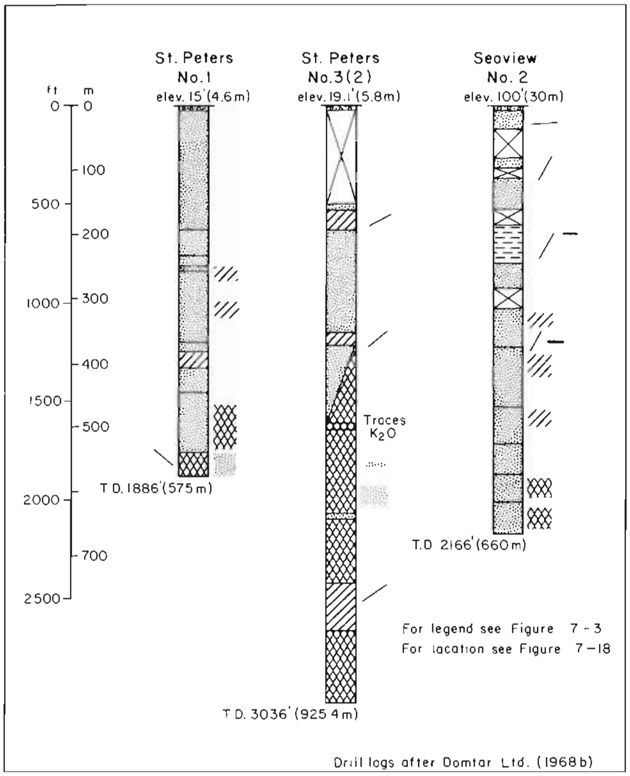


Figure 7-19. Drillhole profiles, St. Peters Nos. 1 and 3 (2) and Seaview No. 2, St. Peters deposit and Seaview occurrence, Richmond County.

Although previous investigators did not realize salt was present in the St. Peters area Kindle (in Hayes, 1931) reported several salt seeps in the vicinity of a fault near Seaview, approximatley 7 km to the northwest.

GEOLOGY

The geology in the vicinity of the St. Peters deposit was described and mapped by Weeks (1954, Map 1026A) and Weeks (1964; Fig. 7-18).

The major part of the Carboniferous Lowlands in the area is underlain by Pennsylvanian Riversdale Group comprising sandstone, shale and conglomerate occurring in a syncline that extends into the Strait of Canso area. The Carboniferous rocks occur in a northeasterly trending graben defined by a pair of northeasterly trending faults. The fault to the north brings Riversdale Group in contact with the pre-Carboniferous basement rocks of Sporting Mountain. Onlap slivers of "marginal basin beds" and Grantmire Formation occur in several areas along this contact, including Seaview and Oban. The major fault to the south is indicated by Weeks (1954) to be part of the L'Ardoise thrust and to extend from River Bourgeois northeast to near Lake Uist (Figs. 7-18 and 1-10). This fault apparently brings Riversdale Group rocks in contact with Windsor Group "central basin beds". It appears to be reasonable to interpret the fault, in the vicinity of St. Peters, to be a high angle (normal or reverse) fault. Gabbroic rocks believed by Weeks (1954) to be possibly Mississippian age were described near the Windsor Group-Horton Group contact between St. Peters and Soldiers Cove. Keppie and Smith (1978) concluded that these rocks occur as fault slices, are at least pre-Horton age, and suggested petrographic and chemical similarities to Fourchu Group volcanics (Precambrian).

The Horton Group to the southeast occurs in a triangular outcrop area described by Weeks (1954) as the L'Ardoise thrust block whose structural configuration with Horton Group thrust over Windsor Group was defined in an exposure near Mount Auburn (Grand Narrows, Map 1040A Weeks, 1955). Domtar Limited (1968b) drilled St. Peters No. 1 on the western flank of a northeastern trending Bouguer gravity low near St. Peters (Figs. 7-19, 7-20 and 7-21). The hole was collared in rocks assigned by Weeks (1954) to the Riversdale Group which were intersected to approximately 244 m (800 ft.). Windsor Group shale and gypsum were intersected to approximately 448 m (1470 ft.) then siltstone with salt veins to approximately 549 m (1800 ft.) and pink halite with variably abundant shale to the final total depth at 575 m (1886 ft.). Dips throughout the hole are reported to be moderate to steep at 40°-60°. St. Peters No. 3 intersected a similar section and was abandoned in salt at a depth of 925.4 m (3036 ft.).

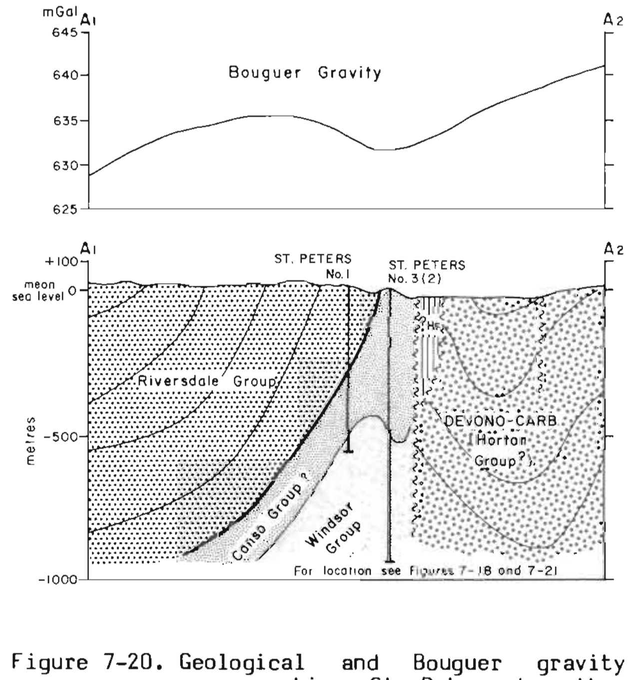


Figure 7-20. Geological and Bouguer gravity cross-section, St. Peters deposit.

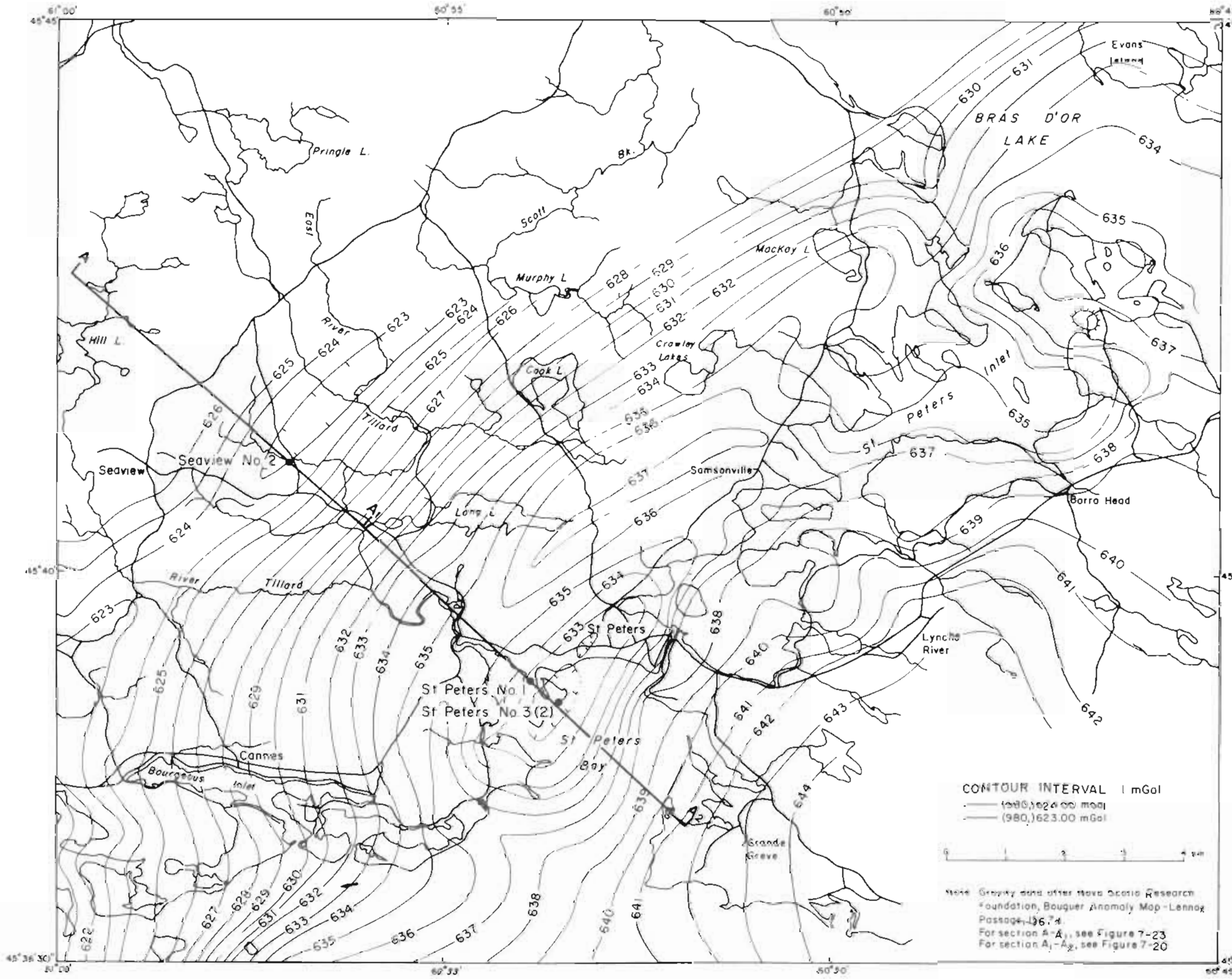


Figure 7-21. Bouguer anomaly map, St. Peters-Seaview area, Richmond County.

St. Peters No. 1 and No. 2 are the only exploratory drillholes drilled to date on the St. Peters gravity anomaly. The location of the St. Peters Fault is inferred to lie to the south of St. Peters No. 3, but has not been accurately defined. Sites for potential exploration drillholes occur in the area of the core of the anomaly near the southern and eastern points of the Tillard Point penninsula and also in the vicinity of St. Peters and Jacksonville. The salt mass, presumed to be causing the gravity low, is inferred to be a fault related intrusion whose depth and configuration have yet to be established.

GEOPHYSICS

The area in the vicinity of the St. Peters deposit is included on Nova Scotia Research Foundation (1967d) Lennox Passage at a scale of 2 inches equals 1 mile (Fig. 7-21). In addition a Nova Scotia Research residual anomaly map, Lennox Passage, is available at a scale of 2 inches equal 1 mile (Fig. 7-22). The Bouguer gravity anomaly (12 mGal) is coincident with Windsor Group outcrop and has its long axis oriented northeast parallel to the major fault through St. Peters. In a larger view (Fig. 7-1) the Bouguer gravity low is a small depression in the major trough that extends into the Port Richmond low to the southwest.

ECONOMIC CONSIDERATIONS

The St. Peters deposit comprises variably pure, structurally disturbed halite associated with shale and siltstone breccia. Potash has not been reported in trace amounts at this location. A large part of the salt, as inferred from the Bouguer gravity anomaly, probably occurs beneath St. Peters Bay. Exploration to date on this structure has not been very encouraging. The deposit will require further exploration to determine its economic significance.

SEAVIEW OCCURRENCE

The Seaview occurrence is located approximately 2 km northeast of Seaview, Richmond County (11F/10) (Figs. 1-10 and 7-18). Seaview is situated

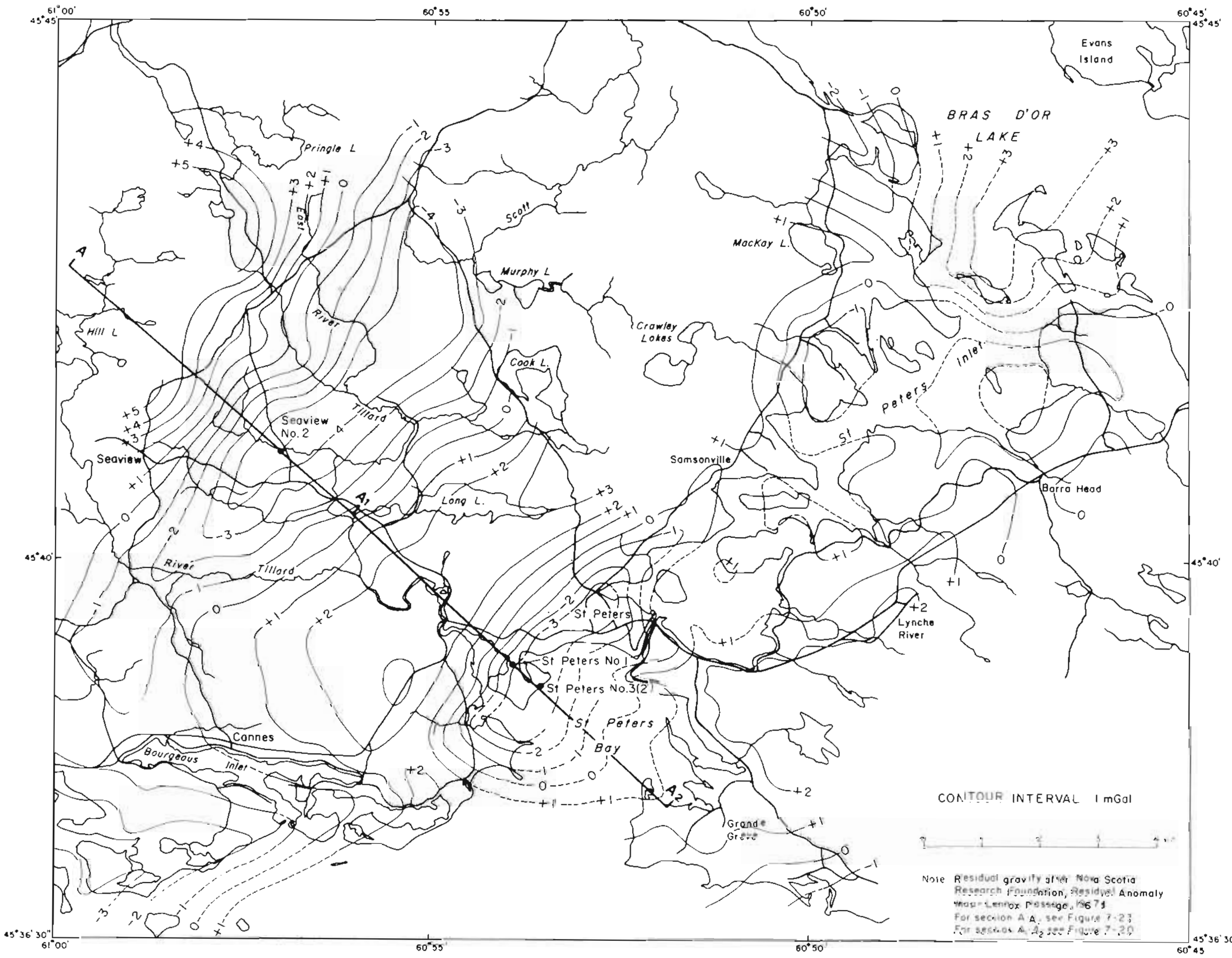


Figure 7-22. Residual gravity anomaly map, St. Peters-Seaview area, Richmond County.

approximately 8 km west-northwest of St. Peters and approximately 30 km northeast of Port Hawkesbury.

The Seaview area is accessible through a series of unpaved all weather roads connected with Route 4 which runs between Port Hawkesbury and Sydney. A Canadian National Railway branchline terminates at St. Peters and is located approximately 2 km south of Seaview.

The Seaview area is situated near the boundary of the Carboniferous Lowlands where elevations rarely exceed 75 m and the flat topped highlands of Sporting Mountain to the northwest where elevations rise rapidly to 180 m.

HISTORICAL BACKGROUND

The Seaview area was investigated for its salt and potash potential by Kindle as part of a regional survey under Hayes (1931). Several salt springs and seeps indicative of the dissolution of salt at depth were located and a geological map was prepared.

No further salt exploration activity was undertaken in the area until 1968 when Domtar Limited (1968b) drilled a Bouguer gravity low outlined by Nova Scotia Research Foundation (1967d).

GEOLOGY

The geology of the Seaview area is included in the published maps and reports by Weeks (1954 and 1964). Adjoining areas are covered by maps 11F/11W by Collins (1962) and Shea and Wallace (1962) and 11F/15 by Weeks (1955). The Seaview occurrence is situated on the northwestern side of a graben structure defined by Upper Carboniferous Canso-Riversdale Groups (Fig. 7-18). This structure is bounded by two faults trending northeast and is probably an extension of the synclinal structure described in the Canso Strat area. Mapping by Weeks (1954 and 1964) indicated the Windsor Group occurs in a series of slices of "marginal basin beds" or Grantmire Formation on the northwestern side of the Sporting Mountain Fault (Fig. 7-18). In these areas the Windsor Group apparently has onlapped onto the pre-Carboniferous basement rocks of Sporting Mountain.

Kindle (in Hayes, 1931) reported that a three quarter mile long continuous section of Windsor Group occurs along the East Branch River Tillard situated approximately 2 km east of Seaview No. 1. Several outcrops of gypsum and laminated limestone were reported to be disturbed by a fault and associated locally with overturned beds. A salt spring was reported near the section and several salt springs were also reported adjacent to the Sporting Mountain Fault approximately 2 km north-northeast of Seaview No. 2. Subsequent mapping in the Seaview area by Weeks (1954 and 1964) did not recognize the Windsor Group indicated by Kindle (in Hayes, 1931) on East Branch River Tillard. Drilling by Domtar Limited (1968b) on a Bouguer gravity low indicated the Windsor Group occurs at a depth of approximately 380 m. Salt as veins and in shale-siltstone breccia was encountered from approximately 500 m to the bottom of the hole at 660 m (Fig. 7-19). The section in the upper part of the hole comprised shale and siltstone and may be part of the Canso Group. Although it is not unreasonable that Windsor Group occurs in the section described by Kindle (in Hayes, 1931b) along the East Branch River Tillard, it is also possible that the rocks may belong to the basal Canso Group. Thin gypsum and locally thin laminated limestone have been reported in some Canso Group sections such as Ragged Point (Norman, 1935). Saline facies including halite and anhydrite are recognized above the uppermost Windsor Group limestone in the Shubenacadie Basin (Giles and Boehner, 1979) and probably occur in the Port Richmond and McIntyre Lake deposits.

GEOPHYSICS

The area in the vicinity of Seaview is included on Nova Scotia Research Foundation (1967d) Bouguer anomaly map, Lennox Passage at a scale of 2 inches equals 1 mile (Fig. 7-21). A Nova Scotia Research Foundation (1967d) residual anomaly map, Lennox Passage covers a similar area at the same scale (Fig. 7-22). The Seaview occurrence is situated near the southeastern end of a narrow northeastward trending gravity trough.

The salt mass presumed to have produced the gravity low has not yet been established by drilling. The Bouguer anomaly map (Fig. 7-21) indicates that a northeastward trending gravity anomaly separates the Seaview and St. Peters anomalies. The Sporting Mountain Fault is inferred to be a high angle longitudinal fault with significant strike and dip slip motion (Fig. 7-23). The residual Bouguer anomaly (Fig. 7-22) indicates the structure may continue several kilometres to the northeast.

Since salt springs and seeps were reported by Kindle (in Hayes, 1931) approximately 2 km north of Seaview No. 2, this area may warrant further investigation. A small deflection in the residual gravity contours, together with the proximity of Windsor Group outcrop may be favourable indications of the presence of salt.

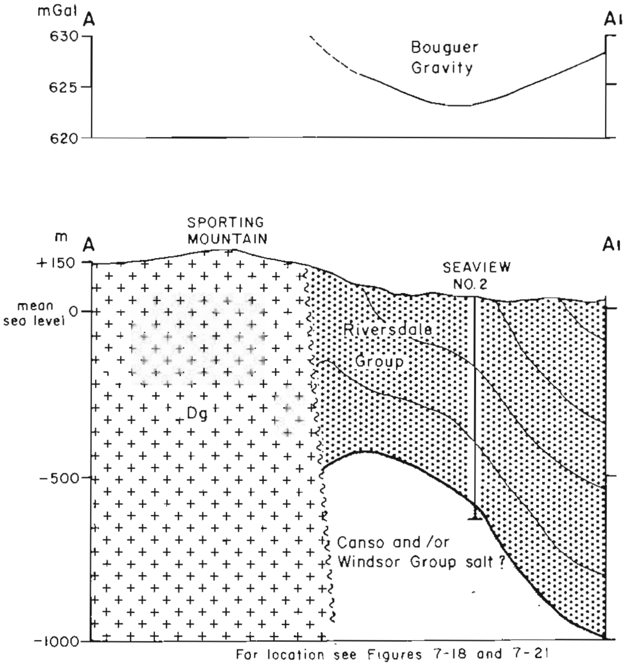


Figure 7-23. Geological and Bouguer gravity cross-section, Seaview occurrence.

ECONOMIC CONSIDERATIONS

The Seaview occurrence consists of halite in veins and in association with shale-siltstone breccia. Salt springs, possibly related to the bounding fault, are reported approximately 2 km north of Seaview No. 2. A narrow Bouguer and residual gravity low outlined in the Seaview-Oban area may be caused by Windsor Group adjacent to the fault. Although salt encountered in Seaview No. 2 is not of economic importance, further exploration may establish a significant salt deposit.

RECENTLY DISCOVERED SALT DEPOSITS AND AREAS WITH SALT INDICATIONS IN THE CANSO-BRAS D'OR AREA

The preceding section has dealt with the known (i.e. drilled) salt deposits and occurrences in the Canso-Bras d'Or area. Exploration for salt in the area has occurred only in recent times and to date has been directed mainly at the major gravity anomalies and particularly those that are near the Strait of Canso. Salt springs and seeps indicative of the subsurface dissolution of salt are also relatively common away from the known salt areas. These salt springs and seeps located and described in reports by How (1869), Hayes (1931) and Cole (1930a) form the basis for the following summary. Several of these have been located on more recent maps by Kelley (1967a, b).

CLEVELAND DEPOSIT

The Cleveland deposit (Figs. 1-10 and 7-6) has been discovered recently in potash exploration drilling by Noranda Exploration Co. Ltd. (1981)

near Cleveland (Fig. 7-6). Salt was intersected in drillhole N227-2 at 732 m (2403 ft.) to the total depth at 1054 m (3457 ft.). Traces of potash salts were reported.

ESTMERE DEPOSIT

Exploration drilling by Noranda Exploration Co. Ltd. (1981) has recently established a new salt deposit near Estmere (Figs. 1-10 and 7-12). Salt bearing section was intersected in drillhole N227-1 from 399 m (1308 ft.) to the total depth at 860 m (2822 ft.).

ST. PATRICKS CHANNEL DEPOSIT

Salt has recently been discovered by Chevron Standard Ltd. (Dekker, 1982b) in drillhole R1/R1W at McIvor Pt. located 25 km northeast of the Orangedale deposit (Fig. 1-10). Salt bearing section was intersected at 396.5 to 1174 m (1301-3853 ft.)

ST. PATRICKS CHANNEL AREA, BRAS D'OR LAKES

The St. Patricks Channel area is situated approximately 15 km southwest of Baddeck, near Whycocomagh in the River Denys Valley, Victoria County, central Cape Breton (Figs. 1-10 and 7-1). The geology in the vicinity was described and mapped by Kelley (1967b) which includes the Whycocomagh and Baddeck map areas 11F/14 and 11K/03. Salt was confirmed in Orangedale deposit area by Noranda Exploration Co. Ltd. (1979).

Bucklaw

According to Cole(1930a) indications of salt in this area were first reported by Robb in 1873 who described the occurrence of a salt spring at Bucklaw, located 100 m south of Route 105 and just east of the Victoria and Inverness Counties line.

Cole (1930a) stated that Robb described the salt springs as follows:

> 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 James 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 by evaporating in two common iron pots, each containing about three gallons, from which two to three 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 reason the undertaking was abandoned.

The sample taken from this spring by Robb was analyzed by Hoffman and the following analyses in Table 7-11 were reported by Cole (1930a).

Table 7-11. Chemical analyses, Bucklaw spring, Victoria County*

Bucklaw Spring

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
OR	
Chloride of sodium	50.6881
Chloride of potassium	0.1942
Chloride of magnesium	0.1593
Sulphate of calcium	5.6810
Alumina	traces
Silica	traces
	56.7226

*Hoffman in Cole (1930a)

Hayes (1931), reported that boring operations were begun at the Bucklaw site in the fall of 1921 by Ross for Prospectors Limited.

Hayes (1931) stated:

> At the time of the visit (1922) three bore holes, numbered 1, 2, and 3, had been drilled to depths of 170, 95, and 71 feet, respectively, and boring was still in progress at No. 3 bore hole. Nos. 2 and 3 holes gave flows of strong brines registering from 26 to 32 per cent saturation with the salometer. At No. 2 hole, 70 to 100 gallons per minute was flowing from a 3-inch pipe and overflowed 10 feet above the surface. The flow of saline water began at a depth of 46 feet in No. 2 hole, and 70 feet in No. 3 hole, after having passed through a layer 3 and 2 feet thick, of mottled red and white, very plastic clay, which evidently acts as an impervious cover preventing the escape of the saline water and entry of the surface water. Hence, the necessity of keeping this cover of clay undisturbed and well closed to conserve the quantity and quality of the brine available. Below the flow of brine to the bottom of the two bore holes the drill passed through soft clay-shale dipping vertically. Samples of the borings have been received from George J. Ross by the Borings Division. A sample of salt obtained by the writer from the evaporation of about one gallon of the brine has been submitted to the Mineralogical Division to be

assayed. It is reported that drilling operations are still in progress, and the company is considering the erection of a plant for the evaporation of the brine and the manufacture of salt of good quality.

The springs occur on a strip of flat land at the foot of Skye Mountain, between the sea shore and the post road, along a narrow zone for a distance of about 1500 feet in a northeasterly direction. Three kinds of springs were observed. Nearer to the shore are the saline springs; one to three hundred feet back are bitter, sulphurous and ferruginous water springs; and quite near these are a few cold, clear, pure water springs.

Much hydrated peroxide of iron is deposited in the water sources; the odour of sulphuretted hydrogen pervades the atmosphere in the vicinity, and the vegetation is destroyed around some of the springs. In the dry season, evaporation produces crystalline salt which looks like snowflakes on the black muck of the dried up saline ponds, and on the stones surrounding the springs.

In a small brook that crosses the springs area, friable red concretionary shale, grit and conglomerate of lower Carboniferous age outcrop just above the road and dip southeasterly at an angle of 80 degrees. A short distance up the brook these rocks are underlain by gray, sparkling, micaceous, compact and banded quartzites, which pass still farther up into granite and syenitic gneiss with specks of hornblende that form Skye Mountain and are Precambrian, according to Fletcher. Westward from the springs area, along the road that skirts the mountain, gypsum, limestone and conglomerate outcrop on the lowland, and micaceous quartzite on the mountain side. Saline and other mineral springs are said to occur at several places along the road to and beyond Whycocomagh.

In early 1925 the Nova Scotia Department of Mines (1926) drilled a diamond-drill hole (NSDM 478) for Prospectors Limited. This hole intersected red shales and gypsum and was abandoned at a depth of 470 feet.

Cole (1930a) sampled and analyzed water flowing from the drillhole in 1927 and 1928 and reported the results in Table 7-12. The spring has a low $CaSO_4$ content and is typical of the NaCl salt springs in Nova Scotia.

Little Narrows

Little Narrows is located near the southern end of St. Patricks Channel approximately 2 km south of Bucklaw and 8 km east-northeast of Whycocomagh (Figs. 1-10 and 7-1).

A large open-pit gypsum mine is operated at Little Narrows by the Little Narrows Gypsum Company. Salt in minor, erratically distributed impurity zones has been encountered in certain parts of the gypsum mine and its distribution and chemistry were studied and described by Holleman (1976) in an unpublished M.Sc. thesis at Acadia University.

Table 7-12. Chemical analyses, drillhole NSDM 478, Bucklaw, Victoria County.*

Sampled 1927

	% in Brine	**Total solids calculated %**
Potassium	trace	trace
Sodium	2.307	32.86
Calcium	0.366	5.21
Magnesium	0.009	0.13
Sulphuric Acid (SO_4) ..	0.440	6.26
Chlorine	3.900	55.54
Bromine	trace	trace
Iodine	none	none
Total	7.022	100.00

Total dissolved saline matter by direct experiment, dried at 110°C - 7.18%
Specific gravity at 15.5°C - 1.050

Sampled 1928

Sample No.		**16**
FIELD NOTES AT TIME OF SAMPLING		
Temperature of atmosphere, °F		85
Temperature of brine, °F		56
Baume degrees		6.25
Equivalent specific gravity		1.043
LABORATORY NOTES		
Specific gravity at 60°F		1.049
Total solids at 110°C		5.83
Reaction		N
ANALYSES OF SOLIDS		
Na	Per cent	34.51
K	Per cent	0.07
Ca	Per cent	2.71
Mg	Per cent	0.11
SO_4	Per cent	6.10
Cl	Per cent	53.89
Br	Per cent	none
I	Per cent	none
Total		97.39
HYPOTHETICAL COMBINATION		
$CaSO_4$	Per cent	8.64
$CaCl_2$	Per cent	0.47
$MgSO_4$	Per cent	-
$MgCl_2$	Per cent	0.43
K_2SO_4	Per cent	-
KCl	Per cent	0.13
Na_2SO_4	Per cent	-
NaCl	Per cent	87.72
Total		97.39

*Cole (1930a)

Whycocomagh

Hayes (1931) also described salt springs in the vicinity of Whycocomagh as follows:

> A small stream which crosses the main road in Whycocomagh Village, Inverness County, is slightly saline but the actual spring feeding the creek was not located. About four miles

east of the village on the north shore of St. Patrick Channel, three springs flow out of the base of the escarpment beneath the Whycocomagh Baddeck highway. These springs have a combined flow of approximately 100 gallons per minute, but their salinity is low.

Cole (1930a) reported the analyses of salt brine sampled at the Whycocomagh spring in Table 7-13. This spring hss a low $CaSO_4$ content but is anomalous in that high $CaCl_2$ is indicated in a normative calculation.

Table 7-13. Chemical anslyses, Whycocomagh spring, Invernesa County.*

Sample No.	**7**
FIELD NOTES AT TIME OF SAMPLING	
Temperature of atmosphere, °F ..	73
Temperature of brine, °F	43
Baume degrees	0.5
Equivalent specific gravity	1.003
LABORATORY NOTES	
Specific gravity at 60°F	B1.001
Total solids at 110°C	0.33
Reaction	N
ANALYSES OF SOLIDS	
Na ....Per cent	36.92
K ....Per cent	0.08
Ca ....Per cent	2.00
Mg ....Per cent	0.26
SO_4 ....Per cent	0.90
Cl ....Per cent	59.05
Br ....Per cent	none
I ....Per cent	none
Total	99.21
HYPOTHETICAL COMBINATION	
$CaSO_4$ ....Per cent	1.28
$CaCl_2$ ....Per cent	4.49
$MgSO_4$ ....Per cent	-
$MgCl_2$ ....Per cent	1.02
K_2SO_4 ....Per cent	-
KCl ....Per cent	0.15
Na_2SO_4 ....Per cent	-
NaCl ....Per cent	92.27
Total	99.21

*Cole (1930a)

Kelley (1967b), who described and mapped the geology in this area, indicated the occurrence of a salt spring at Whycocomagh.

Baddeck

Salt springs are also described in the vicinity of Baddeck by Cole (1930a), as follows:

> There are two brine springs on the north side of the Baddeck-Ross Ferry highway about three miles east of Baddeck, Victoria County. The more easterly spring (No. 19) has a flow of about 1 gallon per minute. This spring occurs just off the north side of the road in a meadow swale and seeps up in a numbsr of places. The shore of Baddeck bay for several acres in the vicinity is covered with the typical salt plant on the flat between the road and high tide level. The west spring (No. 20) has a flow estimated at 2 gallons per minute. This spring comes out of the side hill on the north side of the road 100 yards west of spring No. 19. It is situated 75 feet east of stand pipe and watering trough on the north side or road.

Hayes (1931) indicated that these might easily be mistaken for a portion of tidal water until carefully examined. Both springs were sampled and analyzed by Cole (1930a) (Table 7-14). The composition of these two springs is very similar with low $CaSO_4$ in a dominantly NaCl water.

Table 7-14. Chemical analyses, Bsddeck springs, Victoria County.*

Sample No.	**19**	**20**
FIELD NOTES AT TIME OF SAMPLING		
Temperature of atmosphere, °F .	76	76
Temperature of brine, °F	60	51
Baume degrees	6.0	5.0
Equivalent specific gravity ...	1.041	1.034
LABORATORY NOTES		
Specific gravity at 60°F	1.0357	1.0177
Total solids at 110°C	5.00	2.36
Reaction	N	N
ANALYSES OF SOLIDS		
Na ....Per cent	36.45	35.12
K ....Per cent	0.21	0.21
Ca ....Per cent	1.11	1.06
Mg ....Per cent	0.17	0.18
SO_4 ....Per cent	1.65	11.48
Cl ....Per cent	57.65	55.98
Br ....Per cent	none	n.d.
I ....Per cent	none	n.d.
Totals	97.24	94.03
HYPOTHETICAL COMBINATION		
$CaSO_4$ ....Per cent	2.34	2.09
$CaCl_2$ ....Per cent	1.16	1.25
$MgSO_4$ ....Per cent	-	-
$MgCl_2$ ....Per cent	0.67	0.71
K_2SO_4 ....Per cent	-	-
KCl ....Per cent	0.40	0.40
Na_2SO_4 ....Per cent	-	-
NaCl ....Per cent	92.67	89.58
Totals	97.23	94.03

*Cole (1930a)

Orangedale

Cole (1930a) described salt springs in the Orangedale area located approximately 8 km south of Whycocomagh. He reported s salt spring located one mile west-southwest of Orangedale and 600 m (2000 ft.) south of the McAulay rosd. This spring wss sampled and analyzed by Cole (1930a) (Table 7-15).

The composition of this spring is typical of low-moderate $CaSO_4$ bearing salt springs in Nova Scotia. The spring is anomalous in its $MgCl_2$ content.

Table 7-15. Chemical analyses, Orangedale Spring, Inverness County.*

Sample No.	**18**
FIELD NOTES AT TIME OF SAMPLING	
Temperature of atmosphere, °F	68
Temperature of brine, °F	47
Baume degrees	5.0
Equivalent specific gravity	1.034
LABORATORY NOTES	
Specific gravity at 60°F	1.0239
Total solids at 110°C	3.26
Reaction	N
ANALYSES OF SOLIDS	
Na ...Per cent	31.91
K ...Per cent	0.06
Ca ...Per cent	4.16
Mg ...Per cent	0.26
SO_4 ...Per cent	9.27
Cl ...Per cent	50.54
Br ...Per cent	none
I ...Per cent	none
Totals	96.20
HYPOTHETICAL COMBINATION	
$CaSO_4$ ...Per cent	13.13
$CaCl_2$ ...Per cent	0.83
$MgSO_4$ ...Per cent	-
$MgCl_2$ ...Per cent	1.02
K_2SO_4 ...Per cent	-
KCl ...Per cent	0.11
Na_2SO_4 ...Per cent	-
NaCl ...Per cent	81.11
Totals	96.20

*Cole (1930a)

Dundee-Black River Area

Kindle (in Hayes, 1931) described the occurrence of salt springs in the Dundee area, Cape Breton. Dundee is located on the southern shore of West Bay, Richmond County, approximately 6 km east of West Bay which is located approximately 18 km northeast of Port Hawkesbury (Fig. 1-10). Kindle reported that Windsor Group rocks outcrop three miles up the Black River near Dundee.

The occurrence of salt springs is described by Kindle (in Hayes, 1931) aa follows:

> Two miles upstream from tidewater alongside a tributary stream are five or more salt springs reading 3.6 Baume scale on J. Smith's and Nathan Hill's land, the strongest flowing 1 1/2 gallons per minute. Northward 300 feet are two large water-filled sinkholes, gypsum in the creek, and at 600 feet another strong salt spring. Still another small salt seep occurs 1 1/2 miles down the river (shown on the map). Analyses for potash have not yet been made. The structure of the enclosing beds at Smith's and Hill's springs is anticlinal, a limestone of the north limb of which is marked by Windsor Zone E fossils. Thick beds of gypsum riddled with red ochre are exposed downstream 3/4 mile, East side, at road ford at Murray's old house where they have been faulted up against Pennsylvanian sandstone.
>
> This exposure of Windsor is closely bounded and overlain by Pennsylvanian sandstones and conglomeratea on the west. To the north, east, and southeast, pre-Carboniferous hills stand up high within half a mile of the aprings. The Windsor series seems to have been faulted and turned on edge 1/4 mile to the southwest at the Falls on Black River, but westward for four miles the salt bed may remain covered with gently dipping Pennsylvanian sandstones. The anticline in the Windsor at the springs is outlined by the 20° easterly dip of Zone E limestone, associated with gypsum in the creek strikes the aame direction in line with two sinkholes. Southward, approximately 660 feet, limestone and sandstone dip 35° S.E. and 180 feet farther south gypsum and limestone dip 42° in the same direction. These two strikes converge slightly eastward with the Zone E limestone nearly one-half mile N.

How (1869) reported the occurrence of several mineral springs in Cape Breton as follows:

> There are three springs mentioned as affording the water examined; they are situated near Kelly's, on the high road from Sydney to St. Peters, in a brook which empties into the Salmon River and is distant about two or three miles from the source of the river and six or seven from the southern shore of Bras d'Or Lake. The waters rise in syenitic rocks and the flow is not more than a gallon per minute.

The following analyses were calcuated for an Imperial gallon of 70 000 grains (How, 1969):

	grains per gallon*
Iron and phosphoric acid	traces
Carbonates of lime and magnesia	0.60
Sulphate of lime	0.94
Chloride of sodium	343.11
Chloride of potassium	4.55
Chloride of calcium	308.90
Chloride of magnesium	4.47
Total	662.57

sg at 54°F 1007.397
*1 grain/imp. gal. = 0.01425 gm/l

Note the anomalous calculated calcium chloride reported by How (1869). It is not clear from How's description which spring was sampled, furthermore the reported association with "syenitic rocks" make these springs truly peculiar.

GRANDE ANSE AREA

The Grande Anse Bouguer gravity low is situated near the community of Grand Anse approximately midway between the Port Richmond deposit and the Seaview-St. Peters area (Figs. 7-1 and 7-21). This gravity low (8 mGal)is not as great in magnitude as the other known salt related anomalies in the area and has not been tested by drilling. It is small (less than 2 km wide), slightly oblate in outline and is located on the southeastern side of the major northeastern trending Sporting Mountain Fault. This configuration is very similar to that in the Seaview area and may represent a small low density salt mass related to the Sporting Mountain Fault.