CHAPTER 2
HANTS-COLCHESTER AREA

INTRODUCTION

Seven salt occurrences and two salt deposits are found in the Hants-Colchester area (Fig. 1-4). Several of the occurrences could be upgraded to deposits with further drilling. Each deposit and occurrence is described in alphabetical order: Beaver Brook, Clarksville, Falmouth, Kennetcook, Shubenacadie-Stewiacke, Stanley, Summerville, Upper Walton River, and Walton.

The two salt deposits recognized in the Hants-Colchester area are the Beaver Brook deposit and the Shubenacadie-Stewiacke deposit. The Beaver Brook deposit has only a single deep drillhole into salt, so is less well defined than the Shubenacadie-Stewiacke deposit, but still has good potential for further salt exploration. The gravity survey data and geological maps of the Beaver Brook area indicate a large salt mass, although the purity and extent remains to be proven. The Shubenacadie-Stewiacke deposit described by Boehner (1980a), is defined by a total of 20 drillholes into salt; five of these are deep penetrating. The deposit has a large lateral extent (potentially up to 40 km long by 5 km wide and up to 300 m thick) and appears to be a relatively undisturbed, gently folded stratified deposit (Type A). Preliminary analytical results from two deep drillholes, 9.3 km apart and sampled over salt thicknesses of 315 m and 272 m, show average grades of over 90% through intervals exceeding 30 m. Higher grades of up to 95% are found in thinner intervals. The low degree of deformation and the stratified nature together with the substantial thickness of the salt make the deposit geologically suitable for both mining and underground storage.

GENERAL WINDSOR GROUP STRATIGRAPHY

PREVIOUS WORK

The stratigraphy of the Carboniferous succession in the Hants-Colchester area has been studied by many workers since the early to mid-1800's. A detailed understanding was not achieved until Bell (1929) described the litho- and biostratigraphic subdivision of the lower part (Mississippian) of the Carboniferous. More recently the stratigraphy and structure of the Windsor Group (Fig. 2-1) has been intensively studied by R. G. Moore (1967) of Acadia University, and by the Nova Scotia Department of Mines and Energy (Giles, 1977; Giles and Ryan, 1976; Boehner, 1977b; Moore and Ryan, 1976; Giles and Boehner, 1979 and 1982a). Geological mapping by the Geological Survey of Canada in this area is covered on map sheets by Weeks (1948), Stevenson (1958, 1959), Crosby (1962), Boyle (1963, 1972), Benson (1967) and Taylor (1969). In addition, the area is covered by geological mapping completed by Faribault and Fletcher in the late 1800's and early 1900's.

PRE-WINDSOR GROUP STRATA

The Carboniferous succession underlies a large portion of the Hants-Colchester area occurring for the most part in the low lying valley areas. This area includes the major portion of the Minas Sub-basin of Bell (1958). The surrounding areas of higher elevations are generally underlain by greenschist metamorphosed shales and sandstones of the Cambro-Ordovician Meguma Group and Devonian-Early Carboniferous granitic intrusives.

The Carboniferous succession comprises both marine and continental sediments. The initial sedimentation of the Early Carboniferous is represented by the Horton Group which consists of continental fluvio-lacustrine siliciclastic sediments deposited with angular unconformity upon the metamorphic and intrusive basement. In the type Horton-Windsor area Bell (1929) recognized the following two Formations; a lower, Horton Bluff Formation, comprising dark grey arenaceous and argillaceous shales, grey feldspathic sandstones and grits, and an upper Cheverie Formation, consisting of grey arkose and red shale. Thickness in the type area was estimated by Bell (1929) to be 300-1000 m.

In the Shubenacadie area, Stevenson (1959) estimated a maximum thickness of 900 m. A deep oil well, Soquip et al., Noel No. 1, drilled near Kennetcook, intersected approximately 900 m of Horton Group rocks. This is comparable to thicknesses estimated by Bell (1929) and by Stevenson (1959). The southern limits of Carboniferous outcrop in the Shubenacadie area are marked by a thinning and coarsening trend and an eventual pinch-out of the Horton Group sediments in the Musquodoboit Valley. Horton Group rocks are reported to occur very sparingly in the Musquodoboit Valley area (Boehner, 1977b). This area is interpreted to be near the margins of the Horton Group depocentre and an area of Windsor Group onlap onto pre-Carboniferous basement. Bell's (1929) subdivisions in the type area have not been extended with certainty to the remainder of the Minas Sub-basin or to other outcrop areas in Nova Scotia.

DEFINITION OF THE WINDSOR GROUP

The Windsor Group Group was originally defined by Bell (1929, 1958). It consists of interstratified red-maroon siltstones, limestones, gypsum, salt, and anhydrite. Bell (1929) estimated a minimum total thickness of 472 m in the type area at Windsor.

The Windsor Group in the area was biostratigraphically subdivided by Bell (1929) into two major faunal zones and five subzones based mainly upon their contained Brachiopoda, Cephalopoda and Cnidaria. The Lower Windsor zone of Composita dawsoni was subdivided into Subzone A, the basal limestone (characterized by a paucity of megafauna), and Subzone B, characterized by Diodoceras avonensis . Bell subdivided the Upper Windsor zone of Martinia galataea into Subzone C, characterized by Dibunophyllum lambii and Nodosinella (Paleocrisidia) priscilla; Subzone D, characterized by Productus (Ovatia) semicubiculus; and Subzone E, characterized by Caninia dawsoni and Chonetes politus (Tournquistia polita). The names and ranges of these forms and others have been modified by Moore and Ryan (1976).

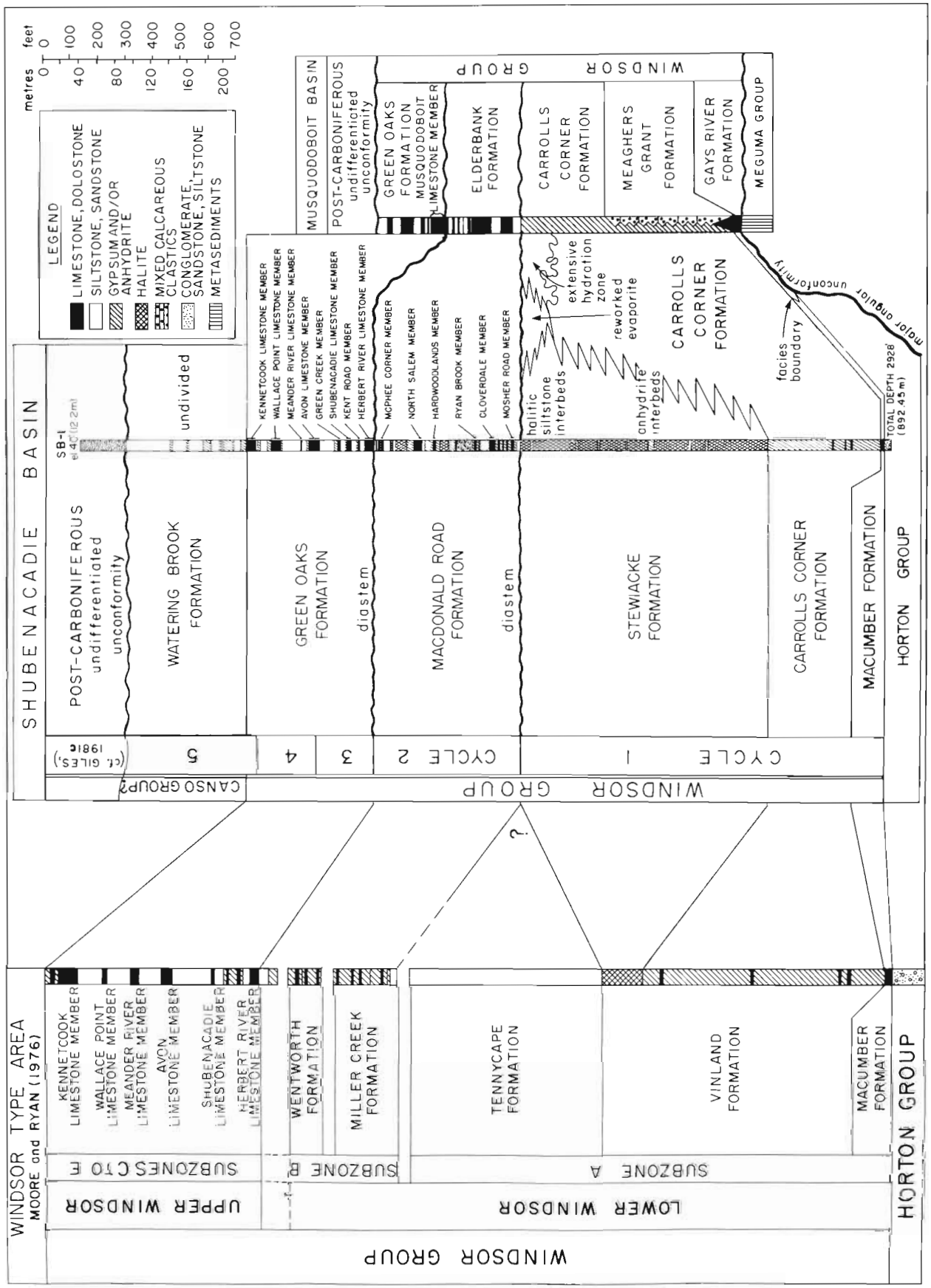


Figure 2-1. Windsor Group stratigraphy and correlation, Hants-Colchester area.

The base of the Windsor Group (Bell, 1929) is marked by a thin laminated basal limestone. Bell (1929) also included an underlying calcareous grey quartzite and limestone conglomerate unit as part of the Windsor Group. In the type area the basal limestone is approximately 4 m thick. The underlying quartzite unit, locally bearing Schizodus cheverensis on its upper surface, is 6.7 m thick and conformably overlies the Cheverie Formation of the Horton Group. Near the type area, the basal limestone is called the Macumber Formation (Weeks, 1948). In other areas it is called A_1 limestone (Sage, 1954), Ribbon Limestone, etc. It is usually overlain by a thick section of gypsum and/or anhydrite.

More recent work in the southeastern extremity of the Shubenacadie-Stewiacke Valley and Musquodoboit Valley (Giles and Boehner, 1979) indicated that the basal A Subzone limestone was deposited upon pre-Carboniferous basement rocks (overstepping the Horton pinch-out), and locally developed a varied flora and fauna. In banks it reaches thicknesses of over 45 m (Gays River Formation, Giles et al., 1979). The thick anhydrite of the overlying Carrolls Corner Formation (Giles, 1977) is also called Subzone A gypsum (Bell, 1929), Lower Sulphate (Weeks, 1948), and part of the Vinland Formation (Moore and Ryan, 1976). This unit intertongues with, and is laterally equivalent to, the Meaghers Grant Formation (Boehner, 1977b), a near shore marine fluvial-deltaic complex in the Musquodoboit Valley. The Stewiacke Formation (Giles, 1977), a thick (up to 300 m) salt unit encountered in the Shubenacadie-Stewiacke Valley, overlies and, in part, may be a lateral equivalent of the Carrolls Corner Formation. These two units have a combined minimum thickness of 400 m. The salt occupies a similar position in the Windsor area (Moore and Ryan, 1976) and is the most important salt unit in the Hants-Colchester area.

An unknown thickness of soft maroon-red shales overlying the Lower Sulphate (Weeks, 1948) is present in the northern part of Hants County. The unit was named the Tennycape Formation by Weeks (1948). A minimum thickness of 183 m was estimated by Weeks (1948). The exact stratigraphy and areal extent of this facies is not well defined. The unit is probably well represented in drilling in the northern and central parts of the Kennetcook Valley where thick sequences of red shales with rare, thin limestone are present. Its relationship to younger strata is not certain, although Weeks (1948) indicated the possible existence of a second or upper sulphate unit overlying the Tennycape Formation. This upper unit could be part of the cyclic B Subzone succession or, as Weeks (1948) suggested, a thrust sheet of the Lower Sulphate. The Tennycape Formation, in any case, is a wedge or tongue shaped unit that is apparently not present in the Shubenacadie area (Fig. 2-1).

In most areas, the thick A Subzone sulphate-halite units are overlain by the B Subzone cyclic sequence consisting of interstratified fossiliferous marine carbonates, siltstones, and evaporites including thin halite beds. In the Windsor area, this section can be subdivided into two parts, according to Moore and Ryan (1976): a lower, Miller Creek Formation in which evaporite is predominant; and an upper, Wentworth Formation in which siltstone becomes more abundant. These units have undergone complex nappe-like recumbent folding (Geldsetzer et al., 1980), probably caused by gravity sliding upon the A Subzone evaporites which acted as décollement surface (Keppie, 1977).

In the Shubenacadie-Stewiacke Valley area, a comparable cyclic succession called the MacDonald Road Formation (Giles, 1977; Giles and Boehner, 1979) is recognized. It contains thin, lensoidal shaped salt beds locally. The sequence has a total thickness of approximately 170 m. In this area the MacDonald Road Formation is overlain with possible slight disconformity (Giles, 1978) by a sequence of alternating fossiliferous marine carbonates, red siltstone and locally gypsum and anhydrite (in a saline facies) called the Green Oaks Formation (Giles, 1977; Giles and Boehner, 1979).

The lithostratigraphy of the upper Windsor carbonate units was described by Moore (1967) and can be readily correlated throughout the Hants-Colchester area as laterally extensive transgressive-regressive marine carbonate sheets. The thickness of this interval ranges from 137 m in the Shubenacadie-Stewiacke Valley to over 730 m in the incomplete composite section, of the Green Creek area (Moore, 1967). Moore (1967) also indicated a thickness of approximately 240 m in the Herbert River and Meander River areas near Windsor.

Moore (1967), on the basis of isopach and other data, concluded the Minas Sub-basin (Bell, 1958) represented a U-shaped trough opening to the northeast. Howie (1979) and Giles (1981b) indicated a seaway area to the south of the Minas Sub-basin opening through the Nova Scotia platform.

In the Shubenacadie-Stewiacke Valley the uppermost unit of the Windsor Group is the Kennetcook Limestone Member, which is overlain by a succession of interstratified grey green siltstone, gypsum and anhydrite and locally halite. The succession is apparently conformable with, and lithologically similar to, the saline facies of the Green Oaks Formation except for the absence of marine carbonate units. The succession is in excess of 200 m thick and is believed to be overlain by younger rocks including buff sandstone and maroon shale. These rocks are lithologically similar to a sequence described in the Windsor area as the Scotch Village Formation of Riversdale Group age (Stevenson, 1959). Howie and Barss (1975), however, indicated that these rocks are probably of Pictou age based on their spore assemblage. The nature of the contact between this sequence and the underlying section is not known, although the apparent age gap suggests a major unconformity. In the Windsor area and western Kennetcook map-area, the Scotch Village Formation generally has flat lying bedding and a wide distribution. The maroon shale is common in several drillholes in the Walton and Kennetcook areas in the central part of the Shubenacadie-Stewiacke Valley. The

relationship between these rocks and the apparently older maroon-red shales of the Tennycape Formation is uncertain. Complex structure, including extensive faulting (Boyle, 1963) and folding (gravity sliding), makes assessment difficult. Red terrigenous clastic sediment is the dominant rock type, making it extremely difficult to determine the stratigraphic position of those sediments overlying the salt and basal anhydrite. This part of the Hants-Colchester area (northwestern Minas Sub-basin) is the least understood stratigraphically and is probably the most disturbed structurally.

STRUCTURAL ZONATION

The Windsor Group rocks in the Hants-Colchester area occur in a series of variably faulted generally northeasterly trending anticlines and synclines locally overturned and recumbently folded. Giles (1977) described a trend toward increasing structural complexity ranging from relatively undeformed gently folded rocks in the Musquodoboit Valley on the southeast through to severely deformed toward the northwest in the Windsor and Kennetcook areas (Fig. 2-2). This

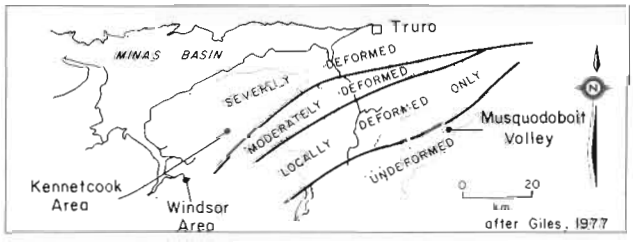


Figure 2-2. Structural zonation of the Windsor Group in the Hants-Colchester area.

structural zonation and the sediment thickening trend in the same direction is suggested by Giles to be due to increased tectonic mobility, both during and after deposition. The regional structural trend is important in controlling the location, limits and structural configuration of the salt deposits in the area.

BEAVER BROOK DEPOSIT

LOCATION

The Beaver Brook deposit is located approximately 14 km southwest of Truro and 11 km west of Hilden (NTS 11E/06W) in Colchester County (Figs. 1-4, 1-10 and 2-3). The area is bordered on the west by the Shubenacadie River and 6 km to the north by the Cobequid Bay.

The area is readily accessible by paved and gravel roads from the Trans-Canada Highway 104 between Truro and Halifax. The terrain in the vicinity is moderately undulating with hills rarely exceeding 120 m.

HISTORICAL BACKGROUND

The Beaver Brook area, mapped by Stevenson (1958), is part of the "Shubenacadie Basin" that was originally investigated for its potash potential by Wright (1931). The scarcity of outcrop and a lack of salt springs combined with the short duration of the investigation resulted in the area being assessed as unpromising for potash exploration.

In 1956 drilling for gypsum in the Hilden area 6.5 km to the east encountered native sulphur veinlets at shallow depths. In 1966 the Nova Scotia Department of Mines drilled a deeper exploration hole in the vicinity of the 1956 drilling. The results of this drilling prompted New Senator-Rouyn and Peel-Elder Consortium to further exploration and drilling. A gravity survey by the Nova Scotia Research Foundation for New Senator-Rouyn and Peel-Elder delineated a large, elongated Bouguer gravity low centred near Beaver Brook, approximately 6.5 km southwest of the initial drilling. This low was believed to have been related to salt and was drilled in 1968.

GEOLOGY

The precise geology of the Beaver Brook deposit is not readily determined, since it is located in an area with very little outcrop and only one drillhole into salt (Figs. 2-3, 2-4 and 2-5). The deposit probably occurs in the lower part of the Windsor Group as mapped by Stevenson (1958) and substantiated by the stratigraphic succession found in the defining drillholes (NSDM 4735 and SD-1). The Windsor Group in the area is probably moderately to severely deformed. Detailed mapping in the area indicates a trend toward increasing structural complexity to the north (Fig. 2-2), making detailed interpretation of the structural configuration of the deposit difficult. The gravity survey by the Nova Scotia Research Foundation outlined a large Bouguer gravity low striking slightly southeast, extending from Princeport (Fig. 2-3) on the Shubenacadie River 13 km toward Brookfield, with the minimum located approximately midway between Beaver Brook and Green Oaks (Fig. 2-3).

New Senator-Rouyn and Peel-Elder drilled a test hole BB-1(SD-1) (Fig. 2-5) at the western end of the minimum to a depth of 428 m (1404 ft.), where the hole was lost. Rock salt was reached at 401.4 m (1317 ft.) and was not completely penetrated at 428 m (1404 ft.). The upper part of the hole consists of alternating red and green clastics, fossiliferous limestone and dolostone, and gypsum and anhydrite. This type of cyclic sequence is typical of the B Subzone of the lower Windsor. Bedding dips in the core range from 10° to 45° down through the section. NSDM 4735 (SD-2, BB-2), a redrill of BB-1 (SD-1), was drilled 28.3 m south of SD-1. The first 305 m (100 ft.) were triconed and the upper salt was intersected at 392 m (1286 ft.) and ended at 411.5 m (1350 ft.). A mixed section of mudstone and salt was intersected between 411.5 and 630.3 m (1350-2068 ft.). Bedding dips in this section are very steep ranging between 60° and 80°. At 630.3 m (2068 ft.) the lower (main) salt mass was penetrated, but was not completely intersected at 733.3 m (2406 ft.) (core depth) where the hole was stopped. Poorly defined bedding dips of 60-75° are described in some intervals. No potash minerals are reported although a few small traces of sulphur were described.

The major structure is probably an east-west trending salt cored anticline that generally follows the Bouguer gravity low (Fig. 2-3). This structural trend is at an angle to and is probably separated by a fault from a synclinal structure to the south. The northern contact of the Windsor Group with the Horton Group was indicated to be concordant by Stevenson (1958) although drill exploration by New Senator et al. indicated the contact is faulted and highly disturbed and may involve reverse or thrust faulting, at least on a local scale. The interpreted structural configuation portrayed in Figure 2-5 is based upon very limited data.

GEOCHEMISTRY

The salt intervals in the NSDM 4735 (SD-2) hole were analyzed by the Nova Scotia Research Foundation. The sampling method involved taking two to three inch whole core samples at five foot intervals through the salt zones. The salt grades and intervals from Nova Scotia Department of Mines and Energy, Assessment File 11E/6B 60-D-26(03) are summarized in Table 2-1 and detailed analyses are tabulated in Appendix B.

The bromine content of the halite indicates brine concentrations were probably low and did not reach potash salt deposition.

Because salt springs were not reported in the area, the salt body is probably well sealed from circulating groundwater and subsurface solution.

The deposit is located close to highway transportation and is within easy reach of any tidal power developments in the eastern part of the Minas Basin. The deposit is deep enough for underground storage development and may be suitable for economic, conventional underground mining extraction of salt. The deposit is considered to have good potential for further exploration and possible development.

CLARKSVILLE OCCURRENCE

LOCATION

The Clarksville occurrence is located 1.5 km north of Clarksville (NTS 11E/04W), Hants County (Figs. 1-4, 1-10 and 2-6). Clarksville is 26 km northeast of Windsor and is located near the southern border of the Kennetcook River valley. The area is readily accessible by paved and gravel highways that parallel the Kennetcook River. The terrain to the north of the occurrence is typical of the Carboniferous Lowlands with very gently undulating hills and maximum elevations rarely exceeding 60 m. The area to the south is dominated by the Rawdon Hills Highlands where elevations locally reach up to 200 m.

Table 2-1. Chemical analyses, NSDM 4735 (SD-2)*

Interval (feet) Representative of	NaCl (per cent) Average of Individual Samples		Soluble NaCl (per cent) Whole Rock Composite Samples
	Whole Rock	Soluble	
Lower Salt			
2067.8-2102.5	93.94	95.57	97.99
2102.5-2162.5	68.64	84.09	88.04
2162.5-2187.5	92.74	94.44	96.41
2187.5-2262.5	56.16	81.35	83.07
2262.5-2322.5	94.06	97.79	94.89
2322.5-2404	82.50	87.26	87.36
Upper Salt			
1286 -1327.5	78.74	89.30	91.68
1327.5-1350	92.51	97.29	92.62

*Nova Scotia Department of Mines, 1968c.

ECONOMIC CONSIDERATIONS

Depth to the lower (main) salt of 630.3 m (2068 ft.) is defined in only one hole, NSDM 4735 (BB-2, SD-2), which did not completely penetrate the lower salt when the hole was abandoned at 733.3 m (2406 ft.). The depth to the upper salt (35 m thick) is 392 m (1286 ft.). Average grade of the deposit is 68.38% NaCl in whole rock and 89.63% in soluble NaCl. Potash was not identified at this location. The size of the deposit as outlined by the Bouguer gravity survey is approximately 5 km by 1 km. Thickness probably exceeds 300 m and possibly could be up to 450 m.

HISTORICAL BACKGROUND

The abundance of salt springs in the "Windsor Basin Area" (Hayes, 1931) initially brought attention to the possible occurrence of exploitable salt and potash. Twelve salt springs were investigated, although none are reported from the immediate vicinity of the Clarksville occurrence. This location was mapped by Stevenson (1959) as part of the Kennetcook map sheet.

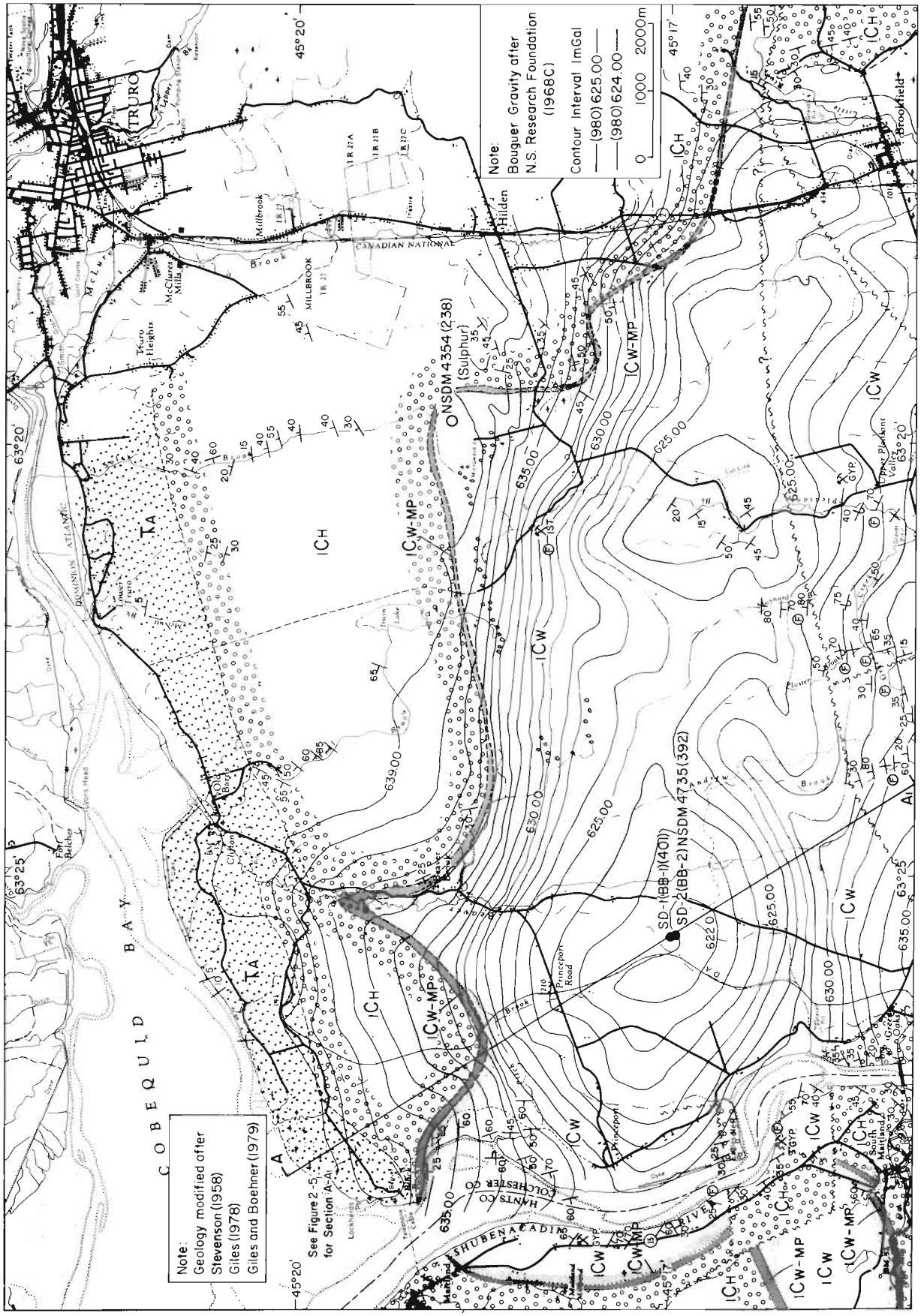


Figure 2-3. Geological map and Bouguer gravity anomaly map, Beaver Brook deposit, Colchester County.

LEGEND

TRIASSIC

TA — *ANNAPOLIS FORMATION:* shale and sandstone

CARBONIFEROUS

UPPER CARBONIFEROUS

UCSV — *SCOTCH VILLAGE FORMATION:* sandstone and shale

LOWER CARBONIFEROUS

WINDSOR GROUP

ICW — Undivided siltstone, shale, anhydrite, gypsum, halite, and limestone

ICW-MP — *MACUMBER AND PEMBROKE FORMATIONS:* limestone and limestone pebble conglomerate

HORTON GROUP

ICHo — Undivided sandstone, shale and conglomerate

ORDOVICIAN

MEGUMA GROUP

OM — Undivided slate and metasandstone

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		

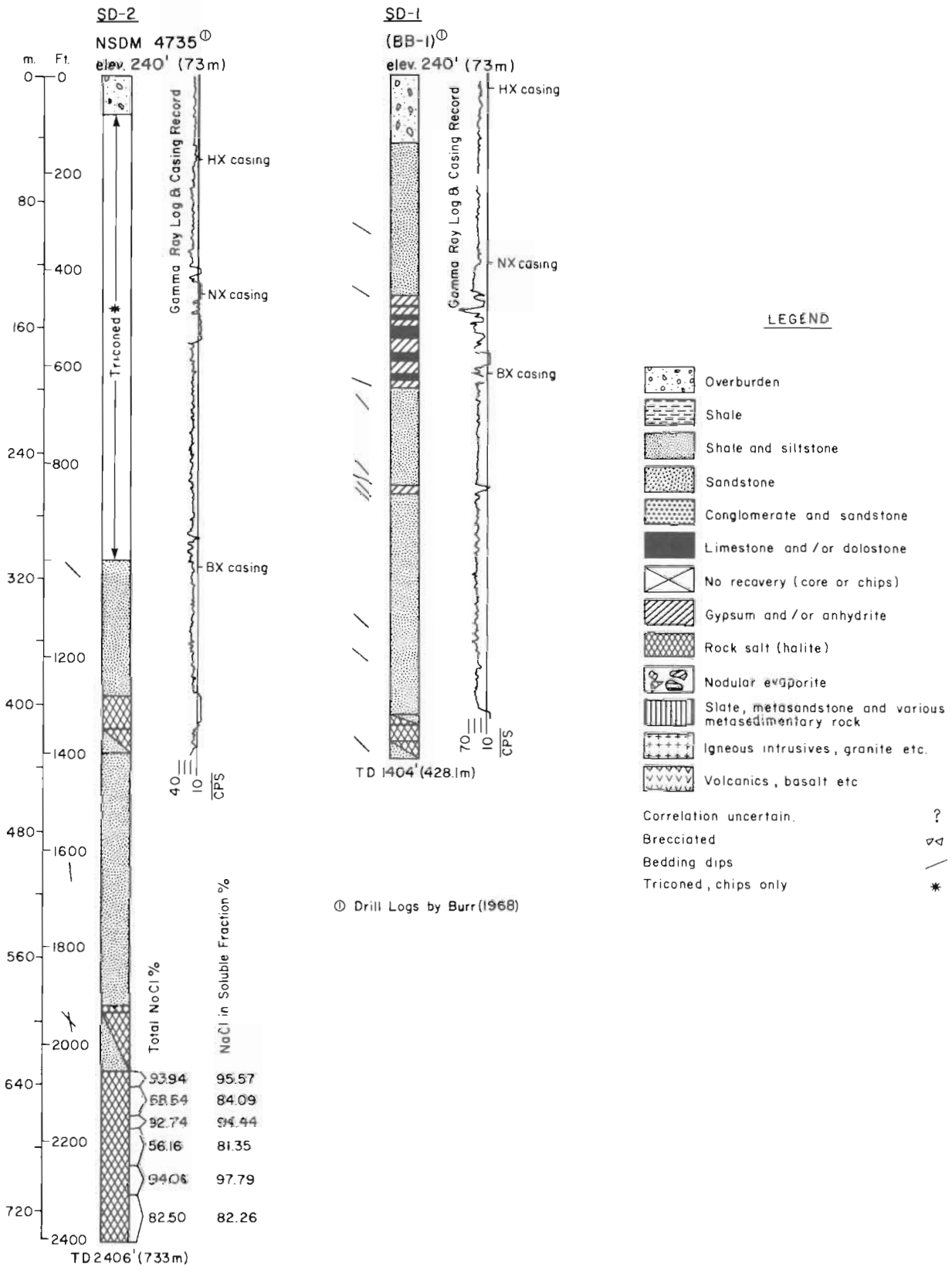


Figure 2-4. Drillhole profiles, Beaver Brook deposit, Colchester County.

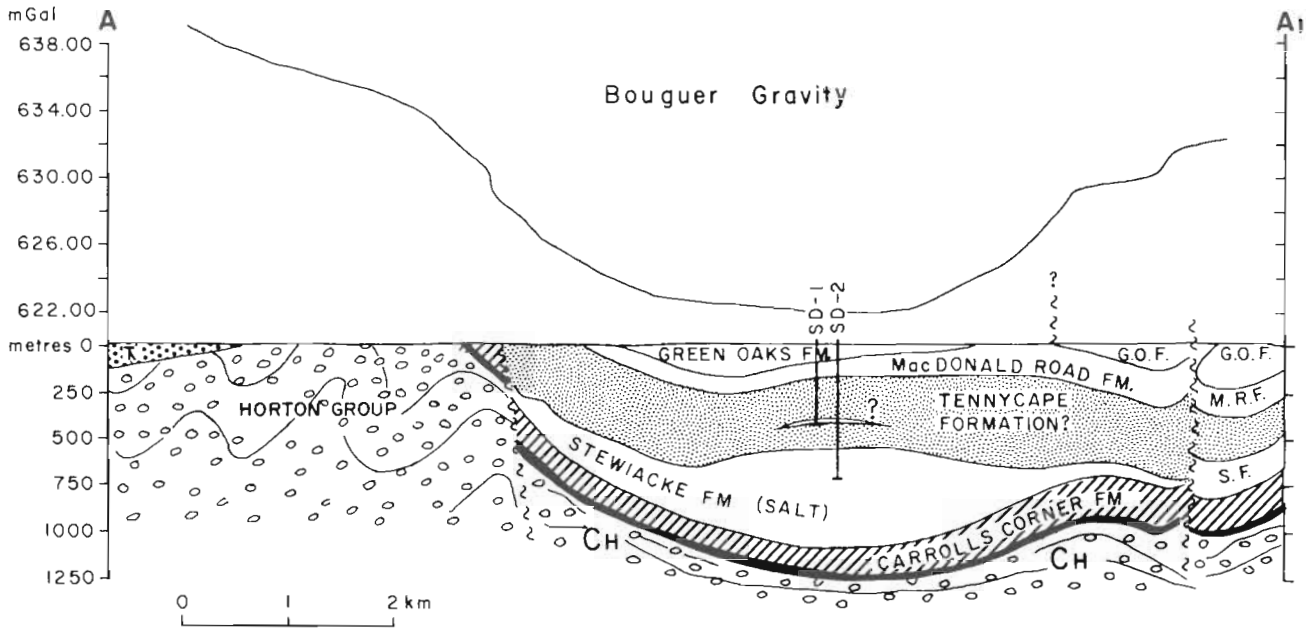


Figure 2-5. Geology and Bouguer gravity cross-section, Beaver Brook deposit (see Fig. 2-3 for location and legend).

In 1966 Scurry-Rainbow Oil Limited drilled an exploration hole for sulphur (SR6-1) approximately 1.5 km west of Clarksville on an elongate Bouguer gravity low. This hole was spudded in the Scotch Village Formation and was abandoned at 277 m (910 ft.). It penetrated a thick sequence of alternating red and grey shale and grey to red sandstone without intersecting salt.

In 1967 Dresser Minerals drilled WS-1 approximately 5 km north-northwest of HC-1. This hole penetrated Scotch Village Formation to a total depth of 171 m (560 ft.). A second hole WCR-1 was drilled approximately 7.5 km south-southwest of HC-1 near Centre Rawdon. This hole intersected alternating red mudstone, calcareous shale, and limestone. The hole was abandoned in anhydrite at a depth of 620 m (2034 ft.). Only two cores were cut in this hole; the first at 393.5-398 m (1291-1306 ft), in which dark shaly limestone was reported; and the second at 442.6-446.5 m (1452-1465 ft.), in which anhydrite breccia was reported.

In 1974, International Minerals and Chemical Corporation drilled an exploration hole for potash, approximately 1.5 km north of Clarksville (Fig. 2-7). This hole, HC-1, was abandoned at 371.2 m (1218 ft.) after penetrating brecciated and steeply dipping halite with anhydrite in the lower 90 m (true thickness of approximately 44 m). Potash was not intersected in the hole and no further drilling has been undertaken in this area. The area was further investigated for potash by Cominco Limited (1981). A drillhole was planned but was not completed.

GEOLOGY

The major rock units in the Clarksville area (Fig. 2-6) are the pre-Carboniferous metamorphic basement rocks belonging to the Meguma Group which form the Rawdon Hills Highlands to the south; the Lower Carboniferous Horton Group sandstones, conglomerate, and shale; and the marine Windsor Group. All units are steeply dipping and trend generally northeasterly except the Scotch Village Formation which is relatively flat lying. Outcrops of Windsor Group rocks are scarce, although karst topography, which indicates the presence of gypsum and anhydrite, is quite common. The bedding attitudes recorded from Windsor outcrops generally have northeasterly strikes and steep (55°) dips to the northwest.

A large 30 mGal Bouguer gravity low (Fig. 2-8) parallels the regional strike and extends from Stanley in the southwest to Kennetcook towards the northeast. The large faults, together with the steeply dipping beds, indicate the area is structurally complex.

The stratigraphy of the Windsor Group in the area is not specifically known, although the extensive development of karst topography indicates basal anhydrite of the Windsor Group is probable along the southern faulted contact. The upper part of the Windsor section is virtually unknown; however, several fossil localities are present indicating possible B Subzone and/or Upper Windsor strata. The Scurry-Rainbow borehole SR6-1 drilled 1.5 km west of Clarksville penetrated a thick section of red and grey shales and sandstones typical of the Scotch Village Formation. This hole probably never reached the underlying Windsor Group succession. The HC-1 drillhole (Fig. 2-7) in comparison penetrated a moderately dipping (bedding steppens with depth) sequence of red and grey shale and siltstone overlying a more steeply dipping sequence of anhydrite interbedded with grey shale which in turn overlies the anhydrite and salt. A similar

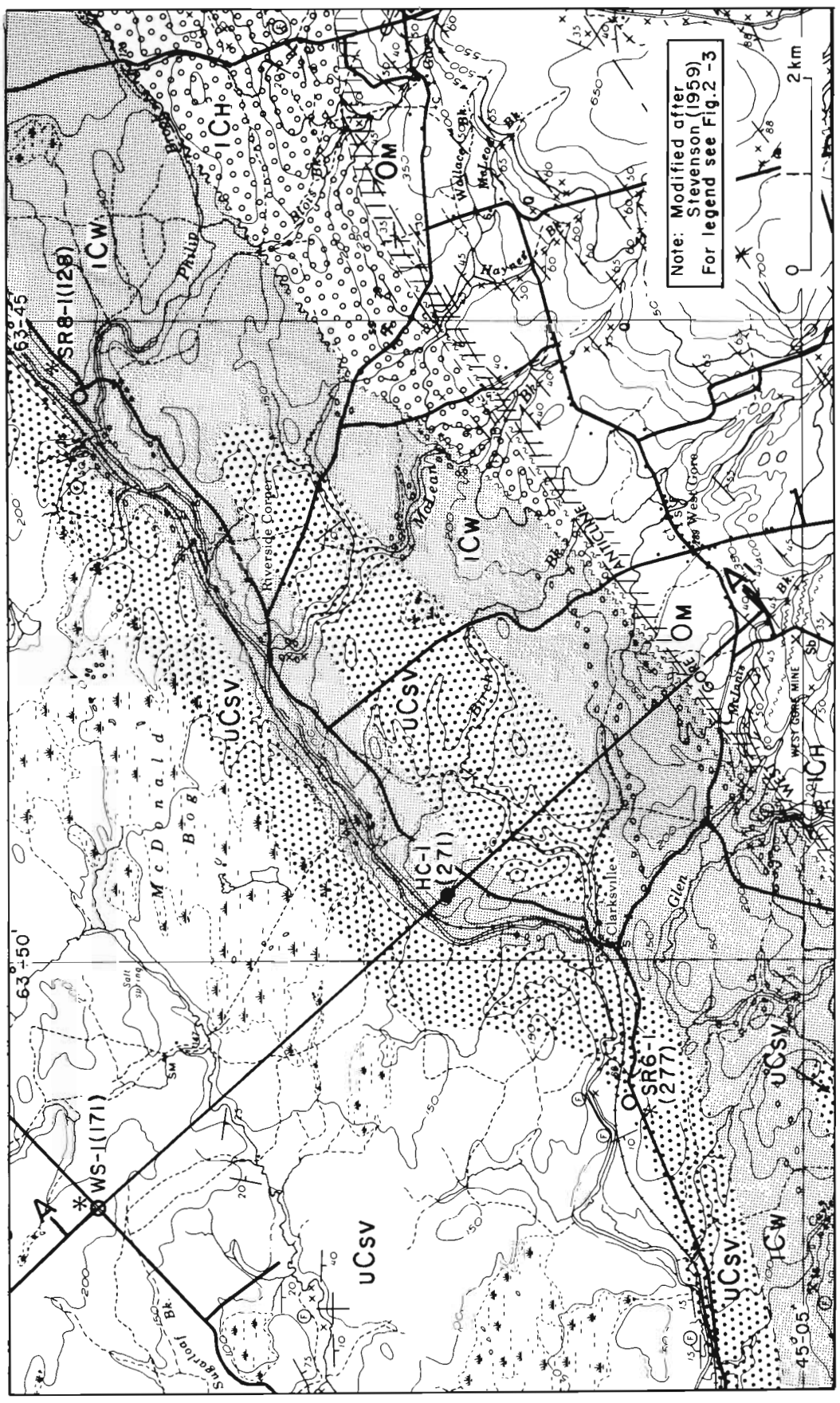


Figure 2-6. Geology in the vicinity of the Clarksville occurrence, Hants County, Nova Scotia.

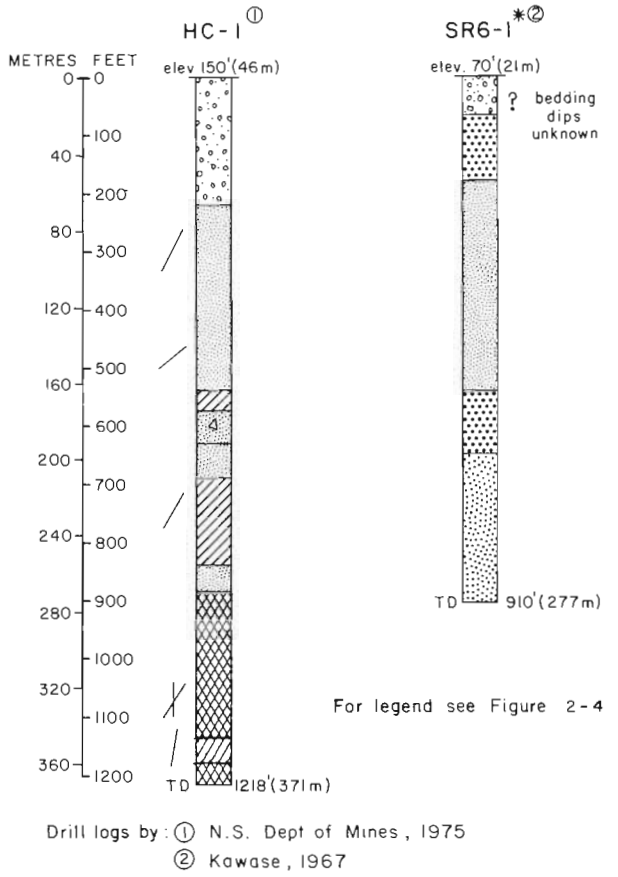


Figure 2-7. Drillhole profiles, Clarksville occurrence, Hants County. (For locations see Fig. 2-6)

sequence of units overlying the Kennetcook Limestone Member in the Shubenacadie area was assigned to the Watering Brook Formation (Giles and Boehner, 1979). It is probable that the entire HC-1 stratigraphic section is younger than the uppermost Windsor Kennetcook Limestone Member and that the salt, anhydrite and siltstone mudstone are part of the Watering Brook Formation (Fig. 2-1). Spore assemblages recovered from samples at depths of 143 m (469 ft.) and 156 m (511 ft.) were assigned by M. S. Barss (written communication, 1980) to Zone III of Utting (1980). This assignment supports the correlation of that part of HC-1 with the Watering Brook Formation. The size and magnitude (30 mGal) of the Bouguer gravity anomaly (Figs. 2-8 and 2-9) indicate a large mass of salt may be present, and if so, it probably is the thickened Lower Windsor main salt. The rocks overlying the salt in the HC-1 drillhole are highly fractured and locally have abundant veins of orangeish halite. This feature is often associated with tectonically disturbed Nova Scotia salt structures.

ECONOMIC CONSIDERATIONS

The Clarksville occurrence comprises halite with no potash reported. The salt is steeply dipping 45-80° and has interbeds of anhydrite. The salt was intersected at a depth of 271 m (889 ft.) and much of the core in the drillhole has been highly fractured and veined by reddish to orange halite. Approximately 87 m (285 ft.) (apparent thickness) were intersected with a probable true thickness of less than 44 m (144 ft.). The precise structural configuation and lateral extent of the salt mass has not been established. When these are better defined the occurrence may be upgraded to deposit status. No analyses are available on the salt in the HC-1 drillhole. The purity is believed to be 80-85% NaCl (visible estimate, whole rock), too low a grade for conventional underground mining. While this is not presently considered an economic deposit, there is good potential for further salt and potash exploration.

FALMOUTH OCCURRENCE

LOCATION

The Falmouth occurrence is located near the Village of Falmouth, 2 km west of Windsor (NTS 21A/16E) and approximately 10 km south of the port of Hantsport on the Avon River estuary, western Hants County (Figs. 1-4, 1-10 and 2-10).

The area is readily accessible by paved roads connected with the Trans-Canada Highway 101. The Windsor to Annapolis Valley line of the Dominion Atlantic Railway passes within 1.5 km of the occurrence.

This area is situated within the Carboniferous Lowlands characterized by gently undulating hills whose elevations rarely exceed 60 m. It is bordered to the west and south by the central Nova Scotia uplands with elevations from 150 m to over 230 m.

HISTORICAL BACKGROUND

The Falmouth occurrence was encountered during petroleum exploration by a private concern which drilled four boreholes between 1911 and 1922. The present knowledge of the occurrence is based on the assessment report by Wright (1931) obtained from an unpublished drilling report by A. E. Flinn. Falmouth Nos. 2 and 4 are reported to have penetrated a salt bed, and Falmouth No. 1 is reported to have produced a salt brine. Salt was not reported in Falmouth No. 3.

E. R. Faribault and H. Fletcher mapped the area in 1909. Bell (1929) published detailed geological maps for the immediate area of the occurrence. The general geology of the area was described by Bell (1929, 1958), who also defined the faunal zones and subzones, and the type section of the Windsor (Series) Group located at Windsor on the opposite shore of the Avon River. Taylor (1969) included part of the area on a regional compilation map.

GEOLOGY

The major rock units recognized in the area include the Meguma, Horton and Windsor Groups. The geology of the Windsor Group around Falmouth appears to have the configuration of a syncline or synclinorium with a faulted southern contact (Butler Mountain Fault, Bell, 1958). The rocks intersected in the Falmouth holes were probably

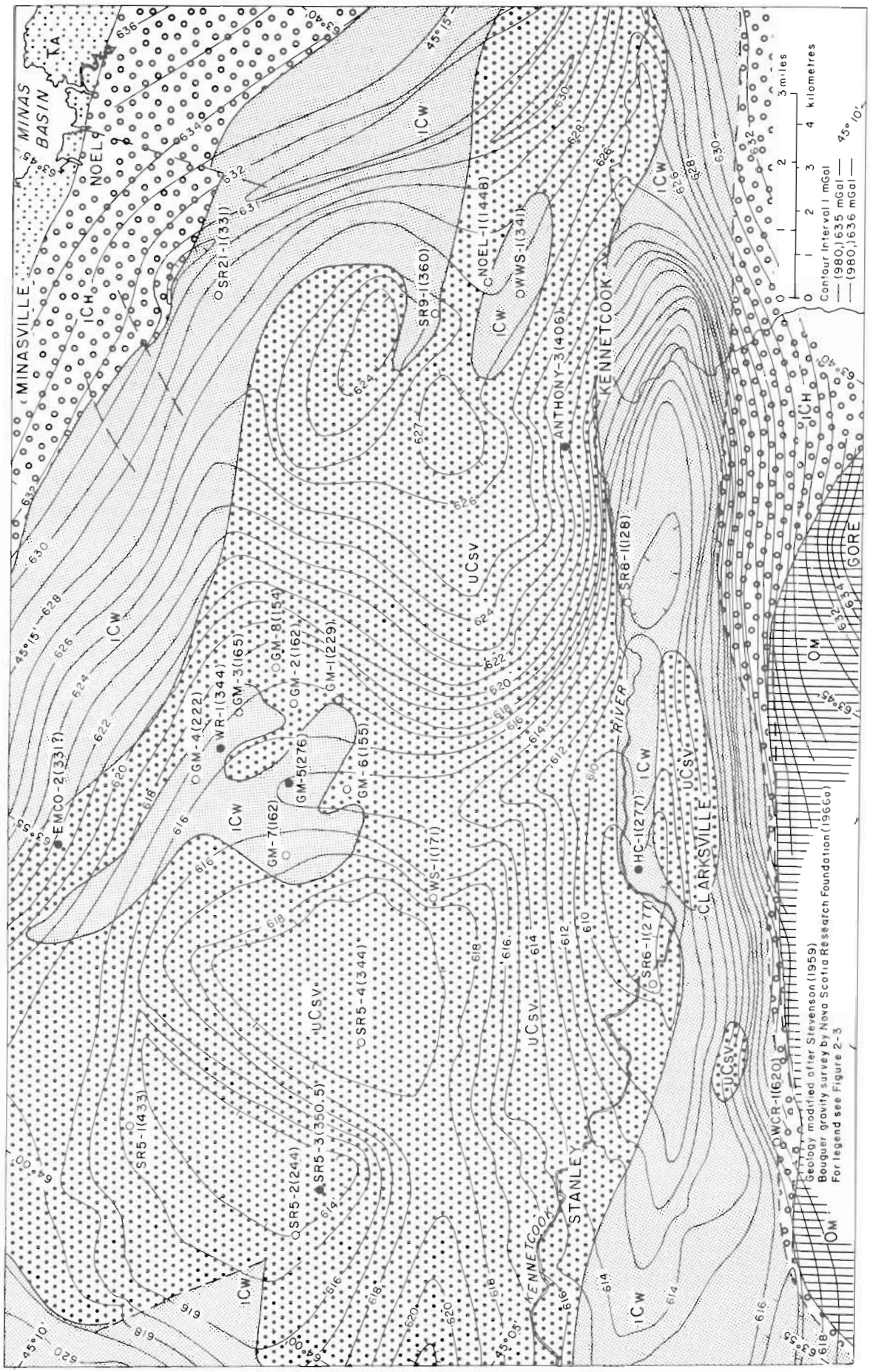


Figure 2-8. Bouguer gravity anomaly map in the vicinity of the Clarksville, Kennetcook, Stanley, and Upper Walton River occurrences.

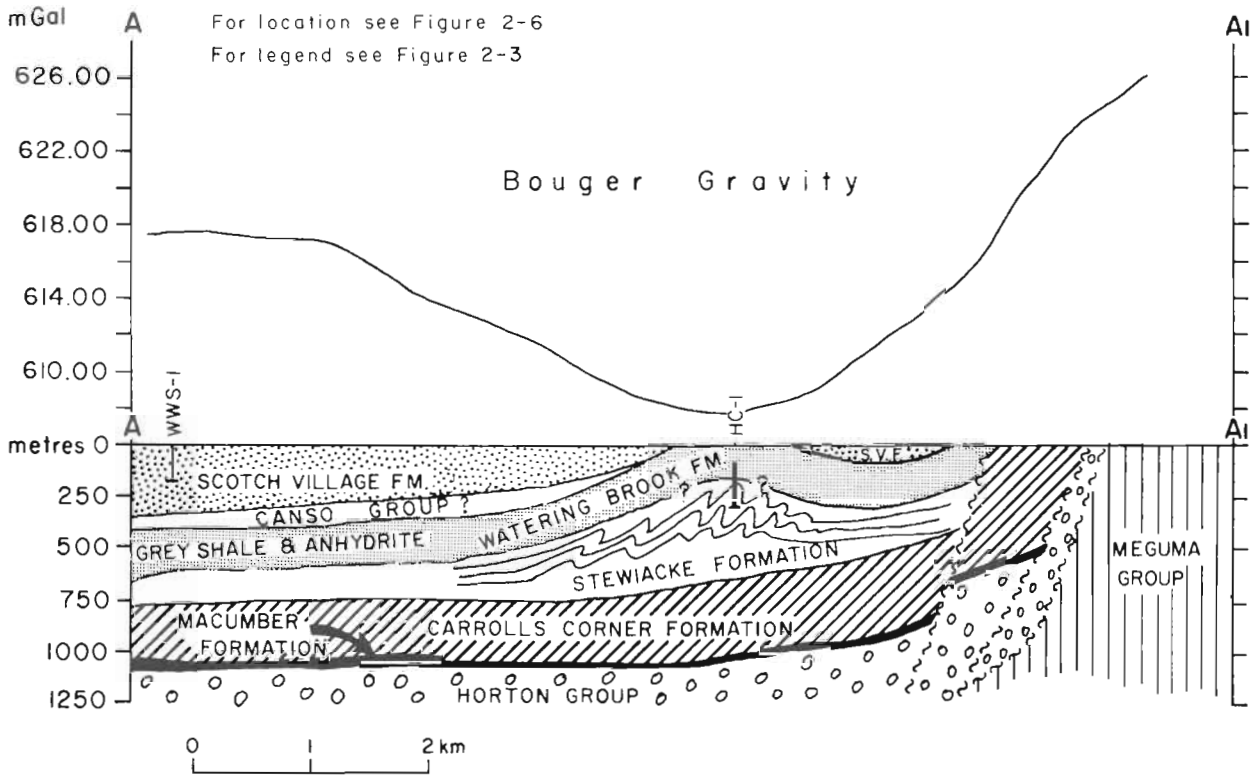


Figure 2-9. Bouguer gravity and geological cross-section, Clarksville occurrence, Hants County.

part of the Lower Windsor A Subzone basal anhydrite (Vinland Formation) (Fig. 2-11). Falmouth Station No. 1 was drilled in 1912 and is reported by Bell (1958) to have penetrated 366 m (1200 ft.) of gypsum before reaching the underlying Horton sandstones and shales, where it was abandoned at 499 m (1637 ft.). The thin basal limestone of the A Subzone was not recorded. This unit is also apparently absent in other drilling in the area, consequently a faulted relationship with the Horton Group may locally be inferred. Alternatively it may not have been deposited in the area.

Bell (1958) reported that salt was intersected in the No. 2 well at a depth of 165.5 m (541 ft.). This hole was abandoned at 237.7 m (780 ft.). The No. 3 well was drilled in 1922 to a depth of 207.8 m (682 ft.) and penetrated only gypsum.

The only reported outcrop in the immediate vicinity of Falmouth Nos. 2 and 4 is reported to be the B Subzone Miller limestone (Wright, 1931), located 100 m southwest of the holes. The tops of the holes are thought to lie below this horizon. Opinions differ regarding the true thickness of the salt bed. The drillers reported a salt bed thickness of 3.35 m (11 ft.) in Falmouth No. 2. Bell (1958) concluded, however, that the true thickness may be as little as "a few inches" when corrected for steep dips. The Miller limestone outcrop reported nearby has a 10° dip and the salt horizon was intersected at approximately the same depth in both Falmouth Nos. 2 and 4. This suggests that the salt bed may be very nearly flat lying and the complex structural nature of the type section 0.5 km to the east suggests the areas are probably separated by a fault.

In 1966, Scurry-Rainbow Oil Ltd. drilled hole SR1-1 near Belmont approximately 10 km northeast of Falmouth. The hole was abandoned after intersecting 293 m (961 ft.) of interstratified limestone, shale and gypsum. This interval is probably part of the Upper Windsor and B Subzone of the Lower Windsor which, in a normal section, would overlie the main A Subzone salt unit. In this area, the salt is probably absent, possibly due to tectonic uplift and gravity sliding described in the Wentworth and Miller Creek Formations type localities by Geldsetzer et al. (1980). In these areas, recumbent folding is described in rocks immediately overlying undisturbed Vinland Formation.

In 1957, the Dominion Rock Salt Company Limited drilled two holes in exploration for salt near Mount Denson approximately 5 km north of Falmouth (Figs. 2-10 and 2-12). The first hole, DRSC-1, was drilled to a total depth of 132 m (433 ft.) and was abandoned in the Horton Group strata. The second hole, DRSC-2, was drilled to a total depth of 247 m (810 ft.) and was also abandoned in Horton Group strata. Although a thick anhydrite section was intersected, no salt or traces of salt were reported.

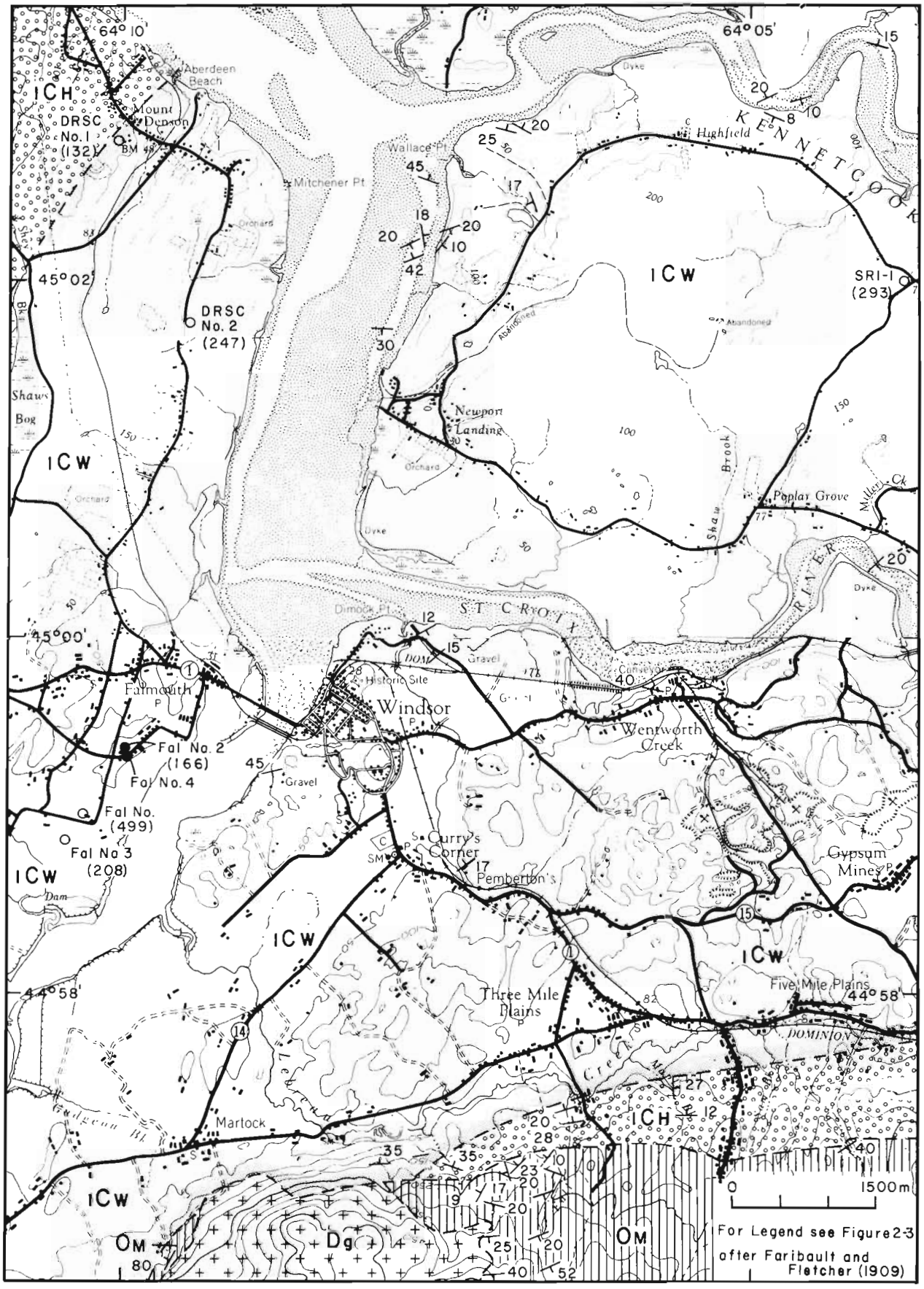


Figure 2-10. Geological map, Falmouth occurrence, Hants County.

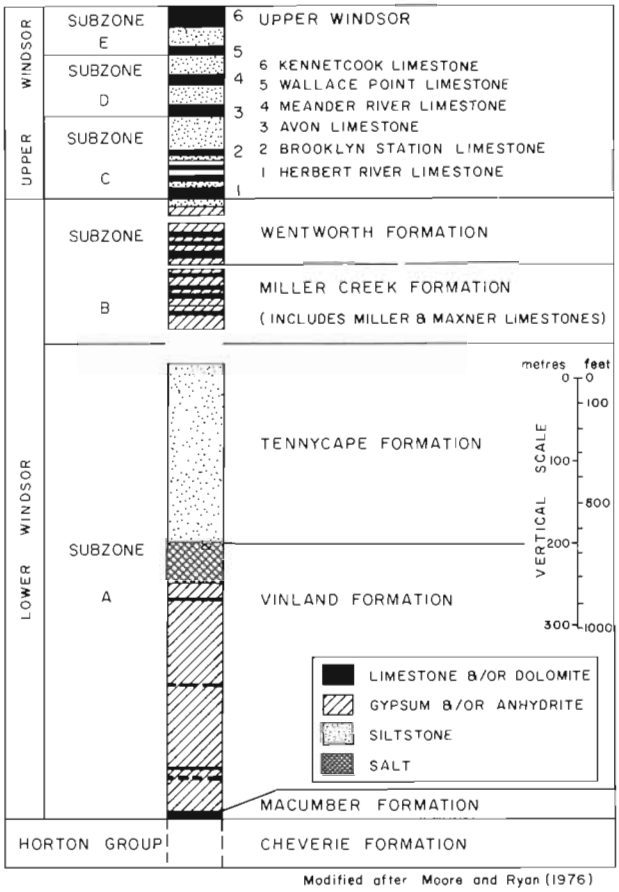


Figure 2-11. Stratigraphic column, western Minas Sub-basin.

GEOPHYSICS

The area in the immediate vicinity of the Falmouth occurrence is covered by Nova Scotia Research Foundation Bouguer anomaly maps (Fig. 2-13). A poorly defined, very low relief gravity low is apparent in the vicinity of Falmouth Nos. 2, 4 and 1. This low appears to extend with uncertain relationship further to the east and also to the west. The drilling in the area has not established the presence of a significant salt mass which could cause the anomaly. Since the anomaly is of such low relief, it may reasonably be attributed to lithology and thickness variations unrelated to salt.

ECONOMIC CONSIDERATIONS

The Falmouth occurrence is believed to consist mainly of anhydrite with halite. Potash is not known to be present. The salt occurs as a thin (3.35 m) bed in gypsum and was intersected at a depth of 165.5 m (543 ft.). This evaporite section is not outlined by a gravity low. An evaporated brine salt sample was reported by Wright (1931) and analyzed by A. E. Flinn at Acadia University as shown in Table 2-2. The brine is essentially a salt brine with minor calcium sulphate and is typical of low $CaSO_4$ salt springs in Nova Scotia.

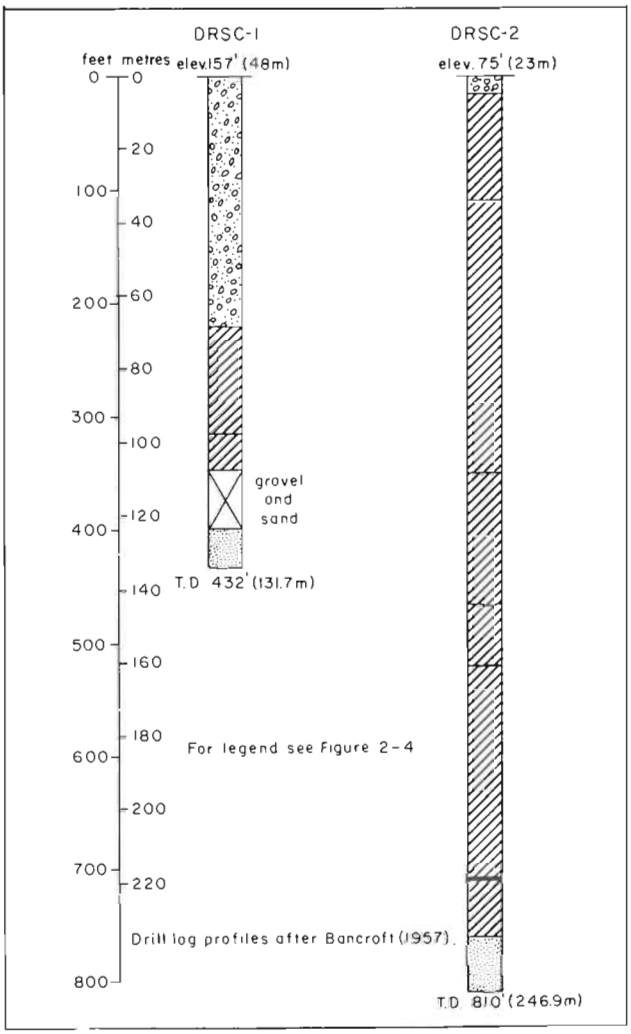


Figure 2-12. Drillhole profiles, Mount Denson, Hants County, Nova Scotia. (For locations see Fig. 2-10)

Table 2-2. Chemical analyses, evaporated brine, Falmouth occurrence (Wright, 1931).

Insolubles	0.12%
Iron and aluminum	0.05%
Lime	1.05%
Sulphuric anhydrite	1.80%
Sodium chloride	97.00%
Total	100.02%

An accurate estimate of the lateral extent and thickness variation of the salt is not possible from the available data. It is most likely a thin lense or tongue of salt within the thick basal anhydrite (Vinland Formation) of the Windsor Group. This deposit is not considered to be of economic importance.

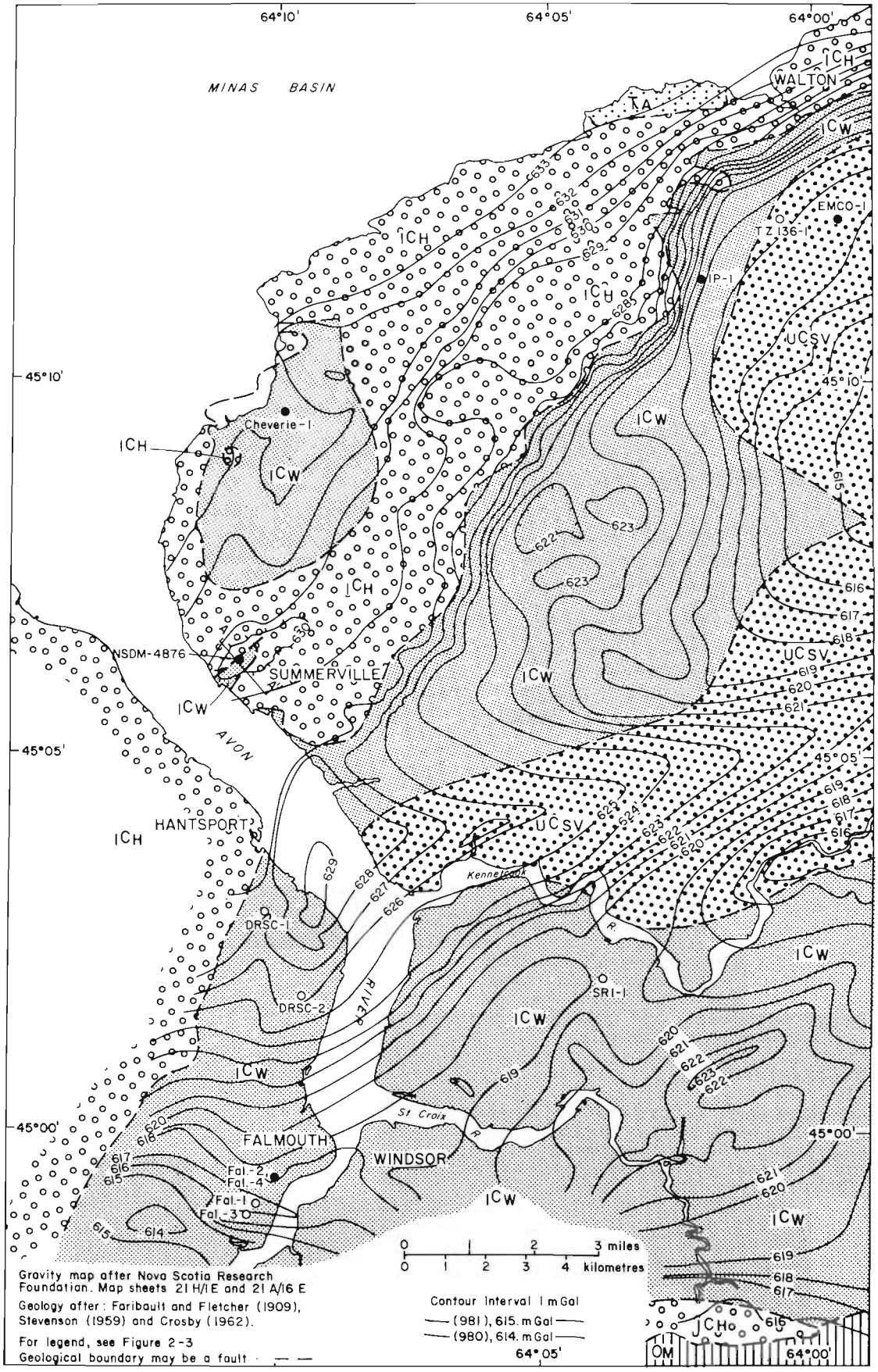


Figure 2-13. Bouguer gravity anomaly map, Falmouth, Summerville and Walton occurrences, Hants County.

KENNETCOOK OCCURRENCE

LOCATION

The Kennetcook occurrence is located near the Village of Kennetcook (NTS 11E/04E) in central Hants County. Kennetcook is located 45 km northeast of Windsor, 13 km south of Noel and is near the southern border of the Kennetcook Valley (Figs. 1-4, 1-10 and 2-14). The area is readily accessible by paved and gravel highways.

The terrain in the vicinity is typical of the Carboniferous Lowlands with gently rolling hills and elevations rarely exceeding 75 m. The Rawdon Hills, with elevations of up to 200 m, are located several kilometres to the south.

HISTORICAL BACKGROUND

At Kennetcook salt was intersected by Anthony No. 3, the petroleum exploration borehole drilled by Nova Scotia Oil and Gas Company in 1944-45. Two other holes (Anthony Nos. 1 and 2) were also drilled for petroleum in the vicinity of the discovery hole, but were abandoned at shallow depths due to drilling difficulties. The geology of the area was described and mapped by Stevenson (1959) (Fig. 2-14). The many salt springs reported in the area indicate salt is being actively dissolved at depth. The area was assessed for its potash potential by Wright (1931), when several salt springs in the vicinity of Kennetcook were located and analyzed.

In 1975, Soquip A.C.C. et al., Noel No. 1 was drilled for petroleum 4.2 km north-northeast of Kennetcook near White Settlement. This hole penetrated the entire Carboniferous section and was abandoned after reaching the pre-Carboniferous basement without intersecting salt.

GEOLOGY

The geology in the Kennetcook vicinity (Kennetcook map area 11E/04) was mapped by Stevenson (1959, Fig. 2-14). The major rock units in the area are similar to those in the Clarksville occurrence.

A major northeasterly trending fault was indicated by Stevenson (1959) between the Windsor and Horton Groups on the southern border. The Windsor Group in this area lies within the severely deformed tectonic zone (Fig. 2-2) described by Giles (1977). Very thick (apparent) limestone intersections are indicated in the several holes drilled in the area which suggests that bedding dips are probably very steep. Steep bedding dips were mapped by Stevenson (1959).

The Kennetcook occurrence is defined in a single borehole, Anthony No. 3, drilled by Nova Scotia Oil and Gas Company (Figs. 2-14 and 2-15). Bell (1958) reported that Stevenson picked the top of the Windsor Group at 265.5 m (871 ft.) and the top of the Horton Group at 555 m (1822 ft.). The anhydrite in the interval 656.5-662.6 m (2154-2174 ft.) was considered to be caved material. The salt sections reported by Bell (1958) are 404.5-409.3 m (1327-1343 ft.), 7% salt and 409.3-423.4 m (1343-1389 ft.), up to 88% salt. The salt interval is thin and appears to lie at or near the normal stratigraphic position of the main Windsor Group salt. A large portion of the Windsor Group above the salt is apparently absent in the borehole. Scotch Village Formation rocks are reported to a depth of 265.5 m (871 ft.). The rocks described above the salt and beneath the Scotch Village Formation comprise red shale and sandstone and may be equivalent to the Tennycape Formation of Weeks (1948). Structural complexity and/or post-Windsor erosion are inferred to be responsible for the present configuration (Fig. 2-16).

Numerous salt springs in this area confirm that salt is present and that it is actively undergoing dissolution by circulating ground water. Many of the springs are located in areas underlain by Scotch Village Formation rocks. The source of the brines is believed to lie in the highly fractured and folded Windsor Group rocks beneath.

The structural configuration of the salt in the area is unknown. The distribution of the salt in the area may be related to several factors. Folding, faulting and circulating groundwaters removed much of the salt that was not sealed. Many of the drillholes in the vicinity of the Kennetcook deposit did not intersect salt. The WS-1 drillhole of Dresser Minerals, 0.8 km to the south of Noel No. 1, is reported to have intersected red shales and gypsum overlying the Macumber limestone at 336 m (1102 ft.). This hole was stopped in Horton Group at 341.4 m (1120 ft.). Scurry Rainbow Oil Ltd. SR9-1, drilled 1.5 km northwest of Noel No. 1, penetrated thickly interbedded limestone and siltstone to a depth of 360 m (1181 ft.). Another hole, SR21-1, was drilled near Gormanville approximately 5 km northwest of SR9-1. This hole intersected interbedded red and grey siltstone, shale and sandstone typical of the Scotch Village Formation to a total depth of 331 m. Scurry-Rainbow Oil Ltd. also drilled SR8-1 approximately 4 km south-southwest of Anthony No. 3 (Fig. 2-14). This hole penetrated interbedded limestone, siltstone and gypsum to a total depth of 128 m (420 ft.). A severely disturbed stratigraphic and structural situation is probable in this area.

GEOPHYSICS

The area in the vicinity of the Kennetcook occurrence is included in Bouguer gravity anomaly map sheet 11E/04 at a scale of two inches equals one mile and a simplified version is included in Figure 2-8. In addition, a small area near Upper Kennetcook is covered on a Bouguer gravity map by Leslie (1967) at a scale of one inch equals 1000 feet.

The Kennetcook occurrence is located at the northeastern end of a narrow, trough shaped gravity low (25 mGal) that extends parallel to the Windsor Group and Horton-Meguma Groups contact. Much of the drilling in the Kennetcook area was directed along the northwestern flank of the gravity trough and, therefore, the Bouguer gravity minimum has yet to be tested. A structural configuration similar to that found in the Clarksville occurrence is probable. The large

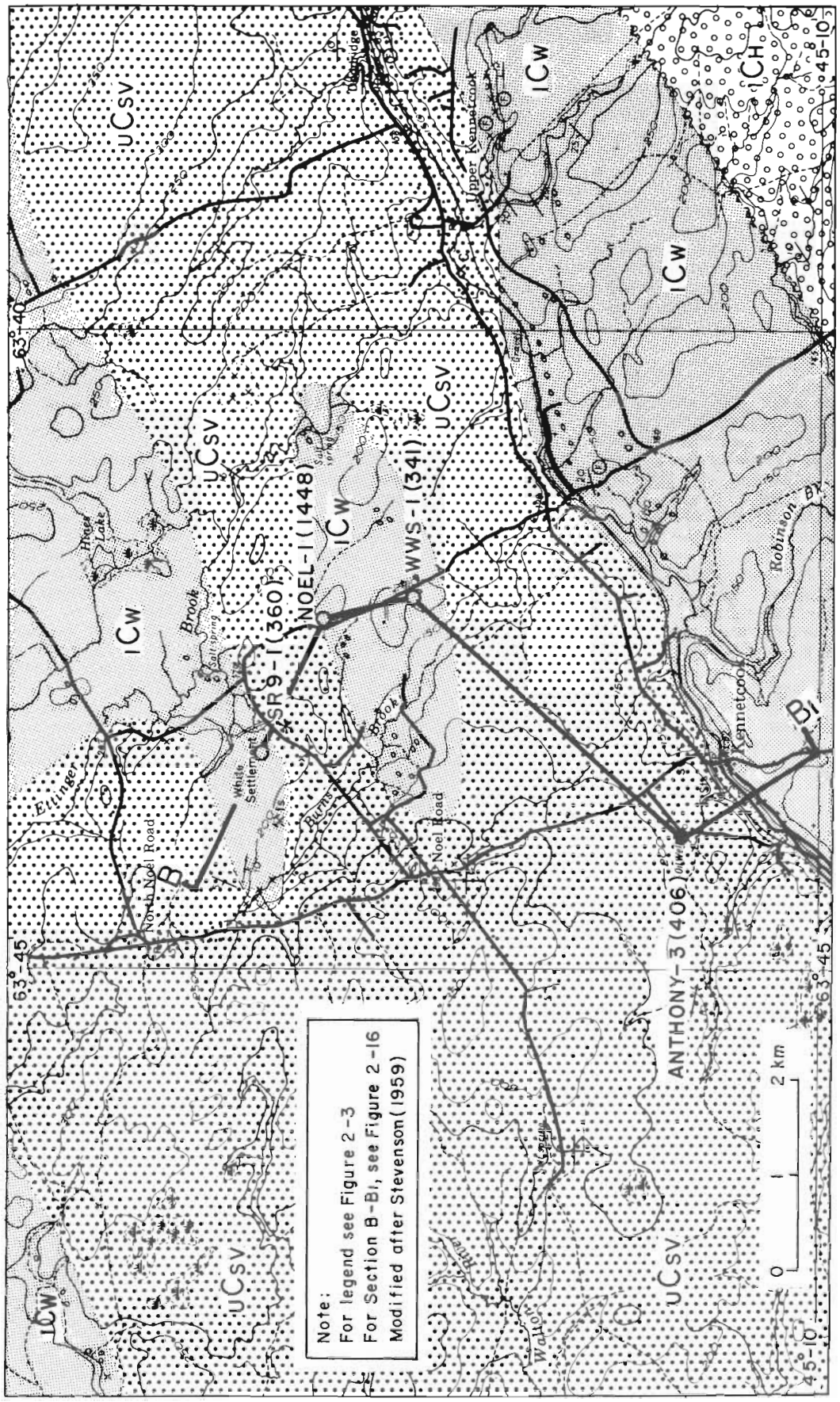


Figure 2-14. Geology in the vicinity of the Kennetcook occurrence, Hants County.

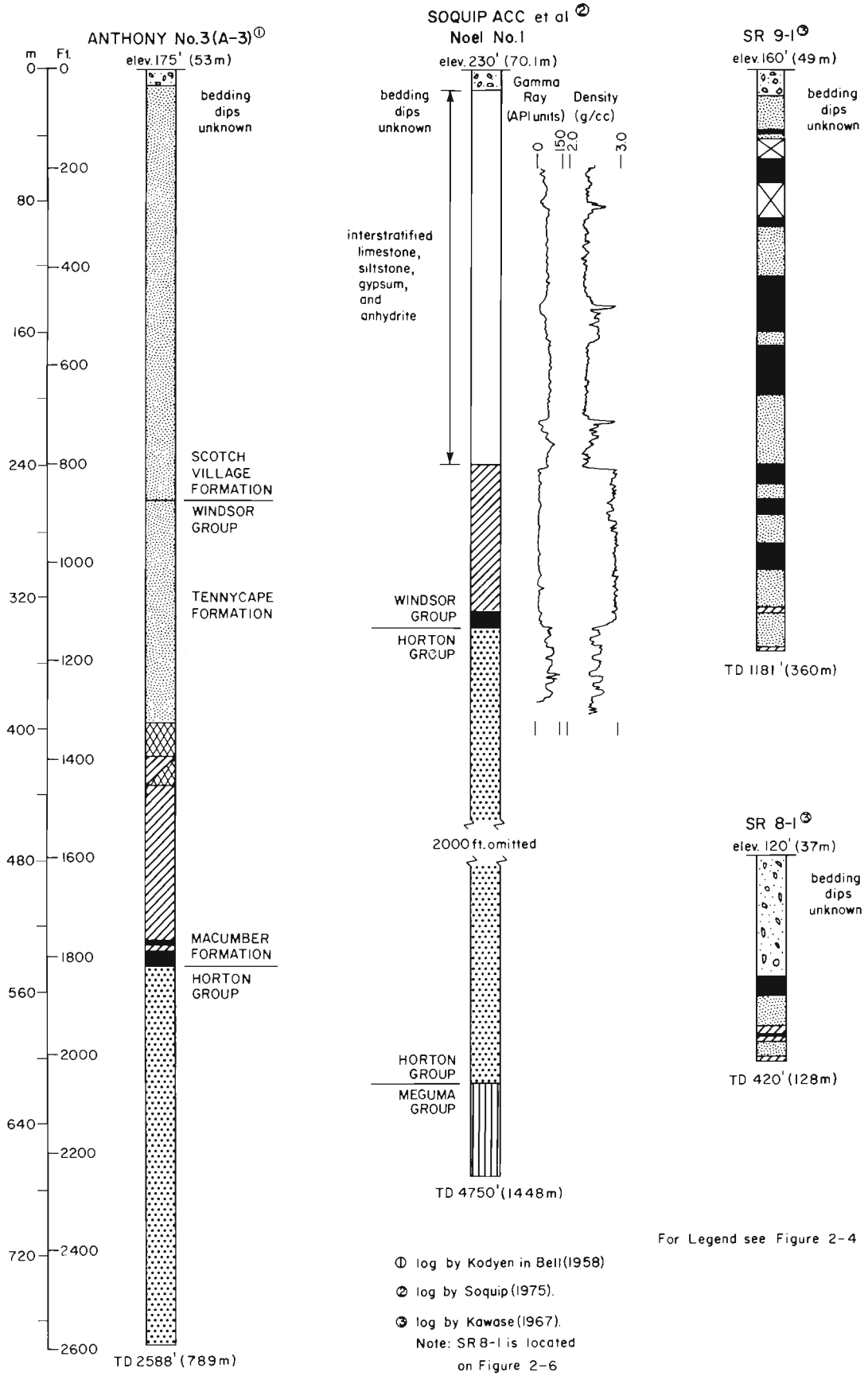


Figure 2-15. Drillhole profiles, Kennetcook occurrence. (For locations see Fig. 2-14).

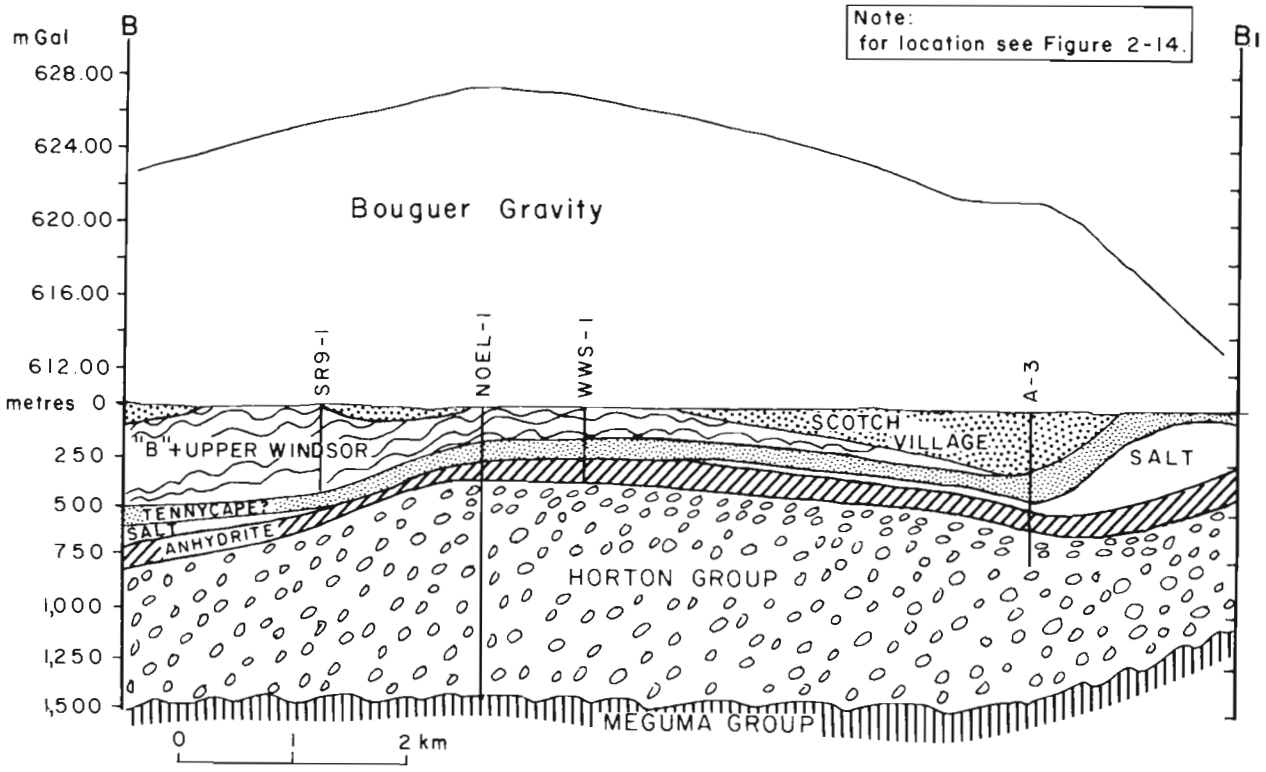


Figure 2-16. Geology and Bouguer gravity cross-section, Kennetcook occurrence, Hants County.

salt mass inferred to be south and east of the area is probably an extension of that inferred in the Clarksville area.

GEOCHEMISTRY

Cole (1930a) described and analyzed three springs located in the vicinity of Kennetcook. The Ettinger Salt Pond (No. 33) is reported to occur on the property of Caleb Ettinger, approximately 5.6 km north of Kennetcook Corner Post Office. This spring is probably the same as the spring located by Stevenson (1959) 1 km northeast of SR9-1 near White Settlement. The Ettinger Brook Spring (No. 34) is reported to be located near a gypsum outcrop on the western bank of Ettinger Brook approximately 2.4 km upstream from its junction with the Kennetcook River. This spring is probably the same one located by Stevenson (1959) 1.9 km east of Soquip et al., Noel No. 1. A third salt spring, Willard Rine's Well (No. 35), was reported by Cole (1930a) to occur 3.2 km northeast of Kennetcook Corner Post Office. Wright (1931) reported the well to be "20 feet deep in gravel, partially filled by very salt water ... A small salt spring lies about 1/4 mile west of the salt well, on the west side of Capt. Scott Brook at its junction with the Kennetcook River".

Spring No. 33 has a high content of $CaSO_4$, indicating dissolution of gypsum or anhydrite in addition to NaCl (Table 2-3).

Windsor Group rocks coincident with Spring No. 34 occur in a small outcrop area near White Settlement. In most of the area, however, the Windsor Group occurs peripheral to the Scotch Village Formation which caps the sequence.

Baar (1966) analyzed weight per cent Br/NaCl from the Anthony No. 3 (Table 2-4). The high value of 0.0195 at a depth of 428 m (1405 ft.) approaches the potash salt deposition threshold and is encouraging for further potash exploration.

ECONOMIC CONSIDERATIONS

Borehole cuttings from the Kennetcook occurrence indicate the presence of halite but not potash. The upper salt in Anthony No. 3 is logged at 404.5 m to 409.3 m (1327-1343 ft.) with the main section at 409.3 m to 423.4 m (1343-1389 ft.). The structural configuration of the occurrence is not known. This salt occurs near the top of the basal anhydrite of the Windsor Group and is overlain by a thick section of red and grey green sandstone and shale assigned to the Windsor Group (Tennycape Formation? of Weeks, 1948) and the (post Windsor) Scotch Village Formation. The salt appears to be limited to the north; further drilling will be required on the gravity low to validate the salt. The area is not readily accessible to tide water shipping. The presence of salt springs in the area indicates salt is present in the subsurface and is being dissolved by circulating groundwater. The occurrence, as presently known, is not considered to be of economic importance, but there are probably other salt deposits and possibly potash in the area.

Table 2-3. Chemical analyses Kennetcook area salt springs*

Spring No.	33	34	35
FIELD NOTES AT TIME OF SAMPLING			
Temperature of atmosphere, °F	n.d.	n.d.	n.d.
Temperature of brine, °F	n.d.	n.d.	n.d.
Baume degrees	n.d.	n.d.	n.d.
Equivalent specific gravity.	-	-	-
LABORATORY NOTES			
Specific gravity at 60°F	1.0000	1.0188	1.014
Total solids at 110°C	0.79	2.43	2.08
Reaction	N	N	N
ANALYSES OF SOLIDS			
Na .....Per cent	23.77	32.24	32.15
K .....Per cent	0.14	0.06	n.d.
Ca .....Per cent	10.58	3.90	4.00
Mg .....Per cent	0.40	0.54	0.42
SO_4 .....Per cent	25.67	12.43	12.91
Cl .....Per cent	37.74	48.72	46.06
Br .....Per cent	n.d.	none	n.d.
I .....Per cent	n.d.	none	n.d.
Totals	98.30	97.89	95.54
HYPOTHETICAL COMBINATIONS			
$CaSO_4$ .....Per cent	35.97	13.26	13.60
$CaCl_2$ .....Per cent	-	-	-
$MgSO_4$ .....Per cent	0.35	2.21	2.08
$MgCl_2$ .....Per cent	1.29	-	-
K_2SO_4 .....Per cent	-	0.12	-
KCl .....Per cent	0.27	-	-
Na_2SO_4 .....Per cent	-	1.98	2.27
NaCl .....Per cent	60.42	80.32	77.58
Totals	98.30	97.89	95.53

*Cole (1930a).

Table 2-4. Bromine analyses, Anthony No. 3, Kennetcook occurrence*

Location	Depth in Feet	Wt. Per cent Br/NaCl
Kennetcook	1366	0.0050
Kennetcook	1375	0.0057
Kennetcook	1383	0.0053
Kennetcook	1405	0.0195

*Baar (1966)

SHUBENACADIE-STEWIACKE DEPOSIT

LOCATION

The Shubenacadie-Stewiacke deposit is located in Colchester and eastern Hants Counties (NTS 11E/06, 11E/04W and 11E/03), Nova Scotia (Figs. 1-4, 1-10 and 2-17). The deposit underlies a large portion of the Shubenacadie and Stewiacke River valleys. The area is readily accessible by a system of paved and gravel highways connected to the Trans-Canada Highway 104, between Truro and Halifax. The Canadian National Railway mainline between Halifax and Truro parallels the Trans-Canada Highway and passes through the centre of the area. The Halifax International Airport is located 40 km southwest of Stewiacke near the geographical centre of the deposit area.

Otter Brook in the northeastern corner of the Valley.

Intensive drilling and exploration for base metal deposits has been undertaken more recently by many exploration companies following the discovery of the Gays River zinc and lead deposit by Imperial Oil Limited, Cuvier Mines Limited and Getty Mines Limited. The abundant drill data produced by this exploration activity together with a field mapping project by the Nova Scotia Department of Mines and Energy have provided a better understanding of the Windsor Group stratigraphy and structure in the area. A significant number of the base metal exploration drillholes unintentionally encountered salt in the area (Giles and Boehner, 1979 and 1982a). Most of these holes were drilled by St. Joseph Explora-

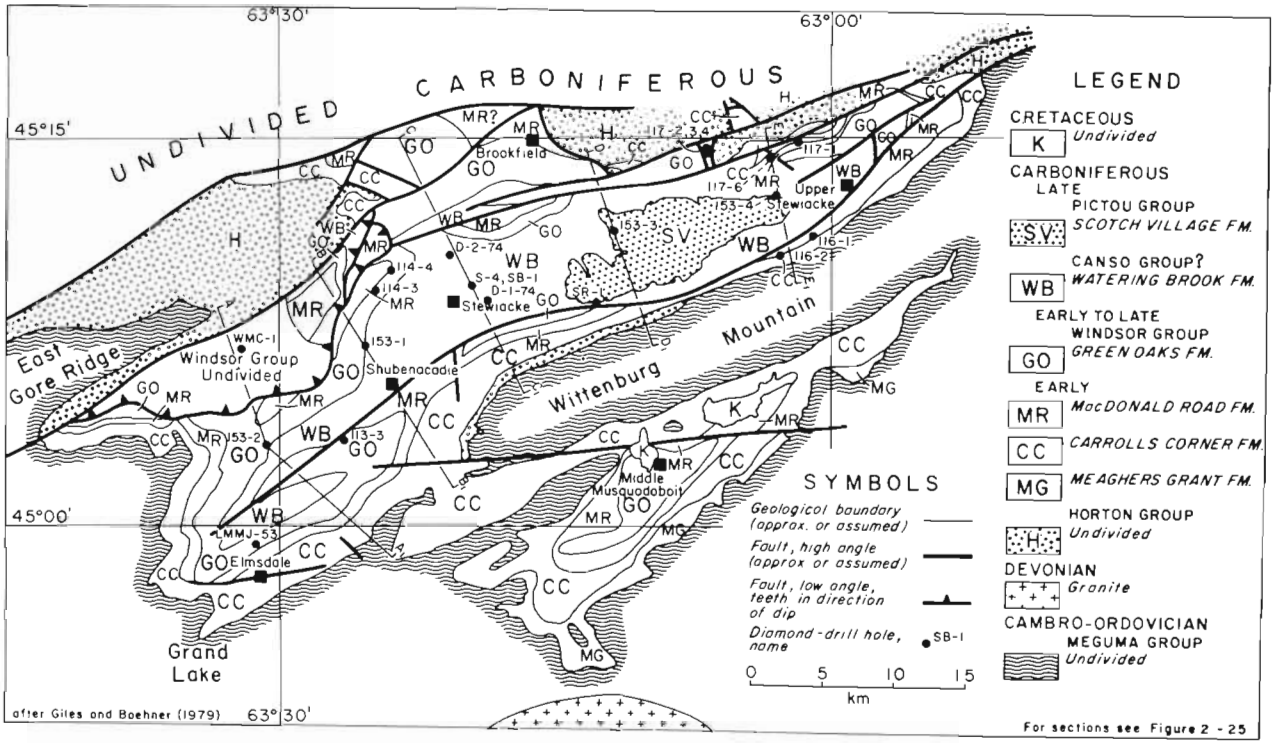


Figure 2-17. Geological map, Shubenacadie-Stewiacke deposit.

The topography in the deposit area is typical of the Carboniferous Lowlands where the gently rolling hills have elevations rarely exceeding 75 m. The Valley is bordered on the southeast by the central Nova Scotia Uplands with elevations up to 170 m and on the north by uplands with elevations of 150-225 m.

HISTORICAL BACKGROUND

Hayes (1931) compiled a regional assessment of the potash and salt potential of Nova Scotia. In this report the Shubenacadie-Stewiacke Valley was discussed by Wright (1931) as part of the "Shubenacadie Basin". The assessment produced inconclusive results due mainly to the scarcity of outcrop and a limited time for field investigation. A single salt spring was located near

tion and Noranda Exploration Limited in the more central parts of the basin. In addition, salt was intersected in holes drilled by Aurum Gold Mines Limited, Amax Exploration, Denison Mines Ltd. and Dresser Minerals. Subsequently, in 1975 a joint exploration venture for potash was undertaken by St. Joseph Exploration Ltd. and Noranda Exploration Limited (Sangster et al., 1975). Four deep holes were drilled into a thick salt zone, but potash mineralization was not encountered. The latest deep drilling in the area was undertaken by Pacific Coast Exploration (U.S. Borax) near Stewiacke where SB-1 (Fig. 2-18) was drilled through the entire Windsor stratigraphic section to the underlying Horton Group. A similarily thick section of salt was intersected in this hole. Two of these deep holes, St. Joseph-Noranda 153-1 and Pacific Coast SB-1, were sampled for analyses through all salt intervals

by the Nova Scotia Department of Mines and Energy.

GEOLOGY

Previous workers in the area, including Faribault and Fletcher in the early 1900's and Stevenson in the late 1950's mapped the Windsor Group as an undivided map unit. The Nova Scotia Department of Mines and Energy has recently remapped (Fig. 2-17) and described in more detail the stratigraphy (Fig. 2-18) and structure of the Windsor Group in the area (Giles and Ryan, 1976; Giles, 1977; Boehner, 1977b and c; Giles and Boehner, 1979; Utting, 1980; Boehner, 1980a; and Giles and Boehner, 1982a).

The Shubenacadie-Stewiacke Valley is underlain by a sequence of limestone, dolostone, gypsum, anhydrite, halite and red-maroon and green siltstone and sandstone belonging to the Windsor Group (Fig. 2-18). The Windsor Group rocks overlie the Lower Carboniferous rocks of the Horton Group which comprise interstratified grey and greenish-grey and red sandstones, grits and conglomerates and maroon siltstones and shales. The Horton Group rocks lie with distinct angular unconformity on the folded slates and metasandstones of the Meguma Group. On the northern border of Wittenburg Mountain (southern side of Stewiacke Valley) the Horton Group thins and pinches out on the Meguma Group basement. Here it is composed of a conglomerate derived from the Meguma Group.

The basal unit of the Windsor Group in the area is called the Gays River Formation (Giles et al., 1979) and overlies the Horton Group with apparent conformity, but may be found directly on the Meguma basement rocks without intervening Horton Group. In such cases the less common and thicker bank facies is best developed. It occurs principally in the extreme southeastern part of the Shubenacadie-Stewiacke area and within the Musquodoboit Valley. Upper Carboniferous sandstone and shale occur in the more central parts of the Valley.

The Shubenacadie-Stewiacke area has the outline of an elongate triangular valley trending northeast-southwest and is separated from the Musquodoboit Valley to the southeast by Wittenburg Mountain and its topographic equivalent highland area from Gays River to Grand Lake. The southeastern border appears to be relatively undisturbed sedimentary contact for the most part, although some folding and faulting are present particularly near Wittenburg Mountain. Giles (1978) indicated a northeast-southwest trending fault on the southeastern border of the area. This fault extends from near Grand Lake to the extreme northeastern end of the area. The northwestern border is much more complex due to faulting and severe structural complications and gives the area a graben-like structural configuration. On its extreme southwestern end the northwestern border is defined by the East Gore Ridge (an extension of the Rawdon Hills Highlands). The northeastern end of this border is marked by Carboniferous Highlands comprising folded rocks of the Horton Group. The central portion of the border is not readily discernible on the basis of topography, but is recognized as a major structural break (fault zone). This structural break continues to the northeast and southwest as a complex fault system (Fig. 2-17).

A large scale overturned section involving the Green Oaks and MacDonald Road Formations in a nappe-like fold was described in the McPhee Corner-North Salem area (Giles, 1977) adjacent to the East Gore Ridge on the northwestern border.

Very complex structural relations are evident from mapping and drilling adjacent to the Carboniferous Highlands portion of the northwestern border. The border is concluded to be a complex fault system with slices of Windsor rocks faulted against the folded and faulted Horton rocks. Units from all stratigraphic levels can be found in faulted relationship with Horton Group rocks. Mineral shows and prospects of interest are relatively abundant along this contact with the host units represented from the base through to the upper portion of the Windsor Group succession. The Windsor Group rocks in the Shubenacadie Basin form a synclinorium (graben) trending northeast-southwest, generally with younger units in the central portion and older units around the periphery. The axial area of the graben contains a large mass of relatively undisturbed stratified salt.

The stratigraphic succession (Fig. 2-18) within the Shubenacadie-Stewiacke Valley was described by Boehner (1984) and Giles and Boehner (1979, 1982a). The following is a summary of this work.

The total section of the Windsor Group in the Shubenacadie-Stewiacke Valley is approximately 760 m thick and its stratigraphic position within the Carboniferous succession is indicated in Figure 2-18. Five formations are recognized as comprising the Windsor Group in the area. The Gays River Formation-Macumber Formation is locally fossiliferous dolostone 1-60 m thick resting with angular unconformity on pre-Carboniferous basement rocks or conformably on Early Carboniferous Horton Group rocks. It is conformably overlain by the Carrolls Corner Formation, which is a thick section (up to 400 m) of pure anhydrite. The Stewiacke Formation is a thick section (up to 300 m) of rock salt (halite) that conformably overlies and appears to be, in part, a stratigraphic equivalent of the Carrolls Corner Formation. The Carrolls Corner and Stewiacke Formations (where present) are disconformably overlain by the MacDonald Road Formation (Fig. 2-18), a 162 m thick cyclic sequence of marine carbonate sheets, red-maroon and green lutite and arenite, anhydrite, and locally halite. The halite units are thin discontinuous lenses (less than 10 m) and are of very limited economic significance. The MacDonald Road Formation is disconformably overlain by the Green Oaks Formation (Figs. 2-18, and 2-19), a 143 m thick sequence of marine carbonate sheets interbedded with red-maroon and green siltstone and sandstone and locally anhydrite. The Green Oaks Formation is conformably overlain by a sequence of grey-green and maroon lutite rocks interbedded with gypsum, anhydrite and halite assigned to the Watering Brook Formation which may belong to the Canso Group.

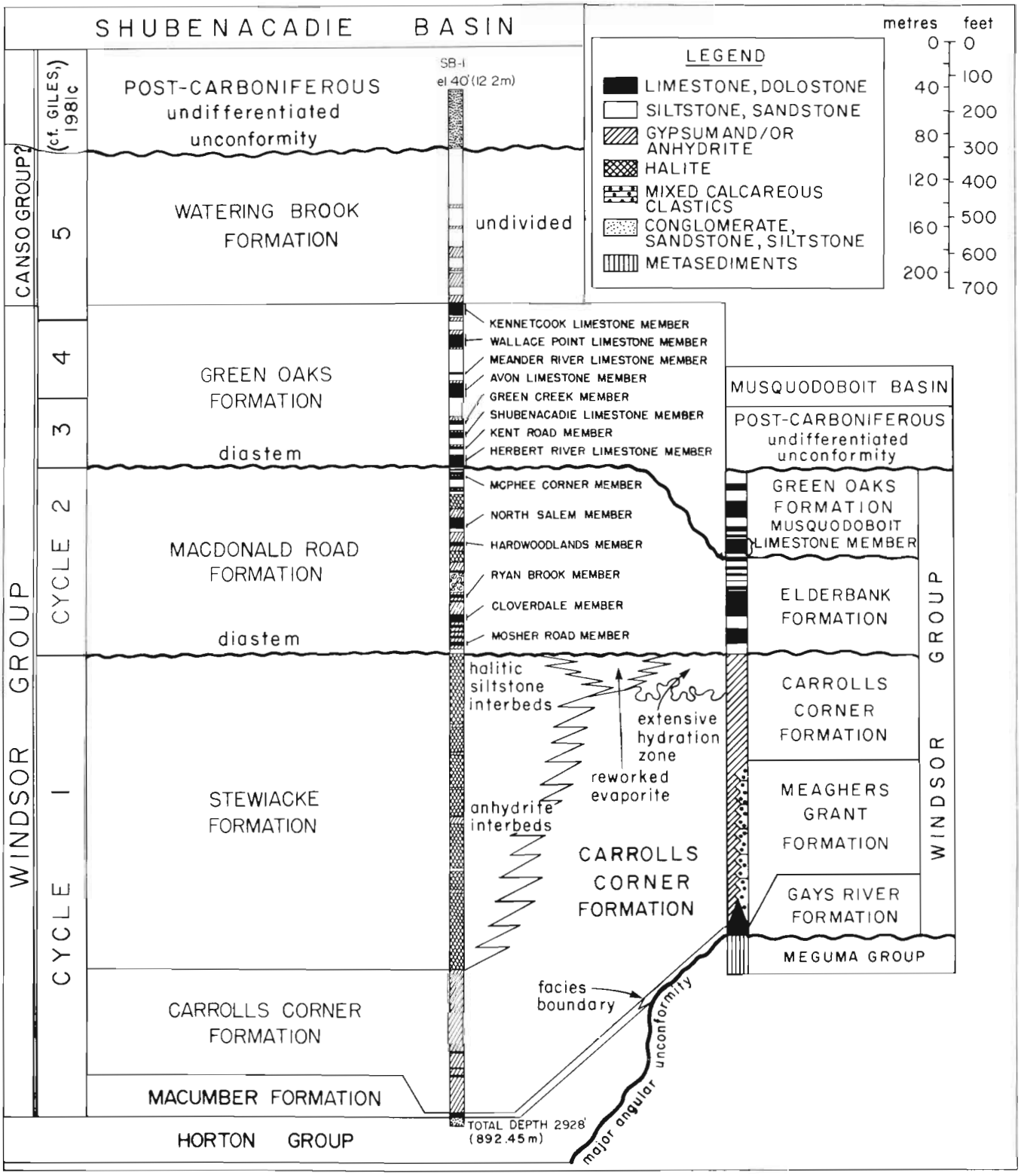


Figure 2-18. Stratigraphic column, Shubenacadie-Stewiacke deposit.

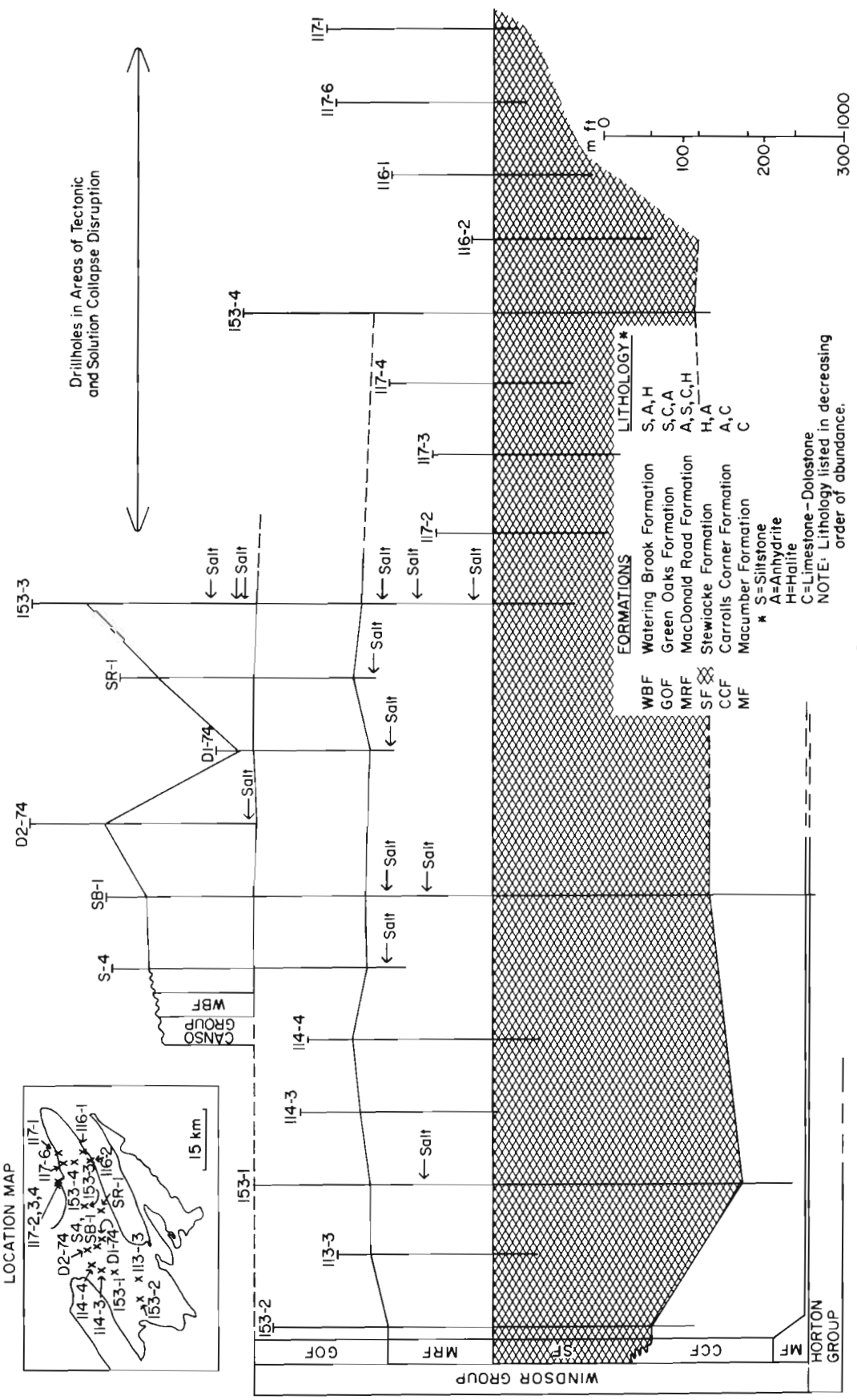


Figure 2-19. Generalized correlation of drillholes intersecting the Shubenacadie-Stewiacke salt deposit.

Stevenson (1959) described the uppermost Windsor rocks in the Shubenacadie and Kennetcook map areas as being locally overlain by a thin veneer of buff to grey sandstone and red shale which he assigned to the Scotch Village Formation. Their representation is poorly known from outcrop and they are not present in drill core although up to 100 m could be present in the triconed interval of drillhole 153-3 (Fig. 2-20). The Scotch Village Formation rock types were considered by Crosby (1962) and Stevenson (1959) to be part of the Riversdale Group. Howie and Barss (1975), however, reported a Pictou (Westphalian) spore assemblage from the Scotch Village Formation.

The interpretation of the geology of salt within the Shubenacadie-Stewiacke Valley is based upon diamond-drill core data (Table in Appendix I and Fig. 2-20) and associated geology (simplified in Fig. 2-17). Twenty holes are indicated as penetrating salt beds (Fig. 2-19) and of these only five have completely penetrated any of the beds. It is, therefore, apparent that the three dimensional aspects of the Stewiacke Formation are not rigorously definable as to thickness, distribution, and composition within the whole area. The incomplete intersections of the Stewiacke Formation, however, are useful in determining the minimum areal extent of the salt beds within the area.

The area along the southeastern border of the area is locally marked by varying degrees of disruption in post Carrolls Corner Formation strata. This may be interpreted as a disconformity paleokarst surface where anhydrite and possibly salt of the Stewiacke Formation were dissolved prior to the deposition of the MacDonald Road Formation. This surface could also be attributed in part to more recent solution collapse. Although the exact relationship between this feature and the faulting is not known, a surface of regional erosion (diastem) prior to the deposition of the MacDonald Road Formation may be the better explanation.

Stewiacke Formation

The Stewiacke Formation is the most important stratigraphic unit with respect to potential salt exploration or development. It is the thickest and most laterally extensive salt unit in the area and is the largest relatively undisturbed stratified salt deposit known in Nova Scotia (Type A, Fig. 1-11). The Stewiacke Formation is known from five deep drillhole intersections: 153-2, 153-1, SB-1, 153-3 and 153-4, located along the axis of the Shubenacadie Basin (Figs. 2-17, 2-18, and 2-19). A detailed correlation of the Windsor Group in these holes is presented in Figure 2-20.

The Stewiacke Formation comprises up to 300 m of banded medium- to coarse-grained halite (0.5 to 1.5 cm), with many thin interbeds of anhydrite and green halitic siltstone. No potash minerals are reported or indicated in the Formation.

The banding in the salt occurs as regular, but ill-defined layers 5 cm to 8 cm thick of alternating clear, pure, medium grained halite and smoky grey halite with finely dispersed anhydrite, organic and clay materials.

The anhydrite layers in the Stewiacke Formation range in thickness from 1 cm to 5 m, but may locally reach up to 20 m or more. They are grey and bluish to brownish grey, variably halitic and locally have borate mineral (danburite) porphyroblasts. Dips are typically gentle, and the thin layers observed in drill core are gently warped and locally dislocated into centimetre scale s-shaped minor folded fragments. No distinct structural fabric has been observed in the halite. The anhydrite layers are generally most common in the lower 1/2 to 2/3 of the section. The beds have no apparent distinctive characteristics and cannot be traced with confidence between the four drillhole sections which are, from west to east, approximately 9.5 km, 9.5 km, 11 km, and 12.5 km apart (Figs. 2-17, 2-20, 2-21, and 2-22).

Near the top of the salt, the insoluble interbeds consist predominantly of the grey-green laminated to massive siltstone with varying proportions of orangeish coloured halite porphyroblasts. The abundance of these layers increases upward in the section being most abundant in the upper 1/2 to 1/3 of the section. In some areas, substantially thick anhydrite beds, up to 20 m, occur in the upper parts of the Stewiacke Formation.

The Stewiacke Formation is probably in part a basinal facies equivalent to the upper part of the Carrolls Corner Formation. This facies relationship has not been defined in drilling, although it is suspected to occur as a narrow intertongued zone.

Salt Deposit Limits

Geological mapping combined with drillhole data indicate the Stewiacke Formation underlies an area 42 km to 50 km long and 6 km wide. This excludes the complex area near the northern border fault zone (Fig. 2-17). The maximum area underlain by the relatively undeformed Stewiacke Formation is inferred to be approximately 300 km^2. Thickness variations within the Stewiacke Formation are less well defined, due mainly to the lack of subsurface data in critical areas across the strike of the Shubenacadie Basin. In the axis of the Basin, the thickness reaches 300 m, but along the margin to the southeast, the Formation is not present. An average thickness of 75 m is calculated for the entire area. The volume of Stewiacke Formation within this block approximates 22.5 km^3 and this would contain approximately 50 Gt (billion tonnes) of rock (15 wt% insolubles).

The depth of the top of the Stewiacke Formation, in the axis of the Basin, reaches a maximum of approximately 555 m (1820 ft.) in drillhole 153-3, but generally lies between 300 and 350 m (985-1148 ft.) where the Watering Brook Formation is thin (Figs. 2-17 and 2-23). Around the perimeter of the Basin, the top of the salt should occur at depths of 100 to 200 m depending upon the remaining thickness of the MacDonald Road and Green Oaks Formations.

GEOPHYSICS

The major part of the Shubenacadie Basin is included on a Bouguer gravity anomaly map at a scale of two inches equals one mile. This map (simplified in Fig. 2-24) is based upon the Nova Scotia Research Foundation 11E/03 and 11E/04 gravity map sheets, with newer infill stations by St. Joseph Exploration. The gravity anomaly patterns within the Basin may be used to interpret the Stewiacke Formation thickness distribution in areas where subsurface data are not available. Cross-sections depicting geology and gravity profiles of several lines transverse to the structural strike (Figs. 2-17 and 2-24) are presented in Figure 2-25. The relationships and variation in the gravity appear to be determined mainly by known variations in the geology i.e. depth to salt, thickness of salt, and the nature of overlying and underlying strata. A differential of up to 20 mGal exists between the minima in the Basin centre and the maxima along the southern border of the Basin. The generally stratified nature and minimal structural disturbance together with good deep drillhole control make the Shubenacadie-Stewiacke deposit an excellent site for detailed quantitative gravity modelling.

Downhole geophysical logs including gamma ray, neutron, density and caliper logs are available for four of the deep holes, 153-1, 153-2, 153-3 and 153-4. These logs are useful in verifying lithologic identification and correlation. In the case of 153-1, which has detailed chemical analyses, a general assessment of grade may be possible. In the event of future exploration drilling, coring could be restricted to the Stewiacke Formation and eventually it may not be necessary to core at all if drilling proves the deposit to be as consistent as believed. In this case, geophysical logs could be used in partially cored or uncored (triconed) drillholes.

GEOCHEMISTRY

Two deep drillholes (SB-1 and 153-1) that penetrated the Stewiacke Formation were selected for detailed chemical analyses in order to assess the purity of the salt deposit (Figs. 2-17, 2-19, 2-20, 2-21, and 2-22). These salt sections, approximately 9.5 km apart, are representative of the Stewiacke Formation and two MacDonald Road Formation salt units.

The salt sections in the drillholes were logged in detail and the core split. Intervals of approximately 3 m (10 ft.) were bagged as bulk samples of continuous halved core. Continuous anhydrite sections more than 1 m thick were avoided in sampling, with intervals stopping at these units. Fortunately, these were not common and sampling is nearly continuous. Whole rock analyses were made at the Technical University of Nova Scotia, Laboratory for Investigation of Minerals, Halifax, Nova Scotia. The following major oxides and trace elements were analyzed (whole rock): Na_2O, CaO, MgO, K_2O, Fe_2O_3, SO_4, CO_3, Cl, Br, Rb, B and per cent insoluble. In addition, U_2O_3 analyses were done by Atomic Energy of Canada Limited in Ottawa. Major and minor oxide analyses and insoluble residue results together with calculated mineral components are presented in Appendix 2.

Preliminary assessment of the data using Br and Sr ratios together with K_2O analyses (whole rock) indicate a probable low degree of brine concentration and no indication of potash salt precipitation.

The Stewiacke Formation section samples in 153-1 (Table 2-5) have an average analysis of 86.79% NaCl and a total thickness of 315 m (1033 ft.). The same section in SB-1 has an average analysis of 88.16% NaCl and a total thickness of 272 m (892 ft.). The analyses indicate very few highly pure salt sections, but this is only an apparent feature if consideration is given to the sampling method and the mode of occurrence of the discrete, solid anhydrite layers within the continously sampled intervals. Chemical analyses and detailed core logging indicate the lower 30 to 60 m of the Stewiacke Formation are the salt section without significant anhydrite interbeds.

Cole (1930a) reported the occurrence of a salt spring near the northeastern end of the Stewiacke Valley. An analysis of a sample from the Otter Brook Spring (No. 36) is presented in Table 2-6. This spring has a high content of $CaSO_4$ indicating dissolution of gypsum or anhydrite in addition to halite.

ECONOMIC CONSIDERATIONS

Potash was not identified as an associate mineral in the halite deposit. The Shubenacadie-Stewiacke deposit is estimated to contain approximately 50 Gt (billion tonnes) of 85% NaCl. It is delineated by 5 deep and 14 shallower holes. The depth to salt ranges from 180 m up to 500 m in the deepest part of the basin. A large block of salt, up to 300 m thick, occurs in the centre of the area and has a length exceeding 40 km and an average width of 6 km. The salt is stratified and only slightly deformed except near the northwestern limits. Some faulting is apparent in the overlying rocks in the central part of the area, but this is believed to be of minor consequence. Chemical analyses indicate that the major Stewiacke Formation salt in two drillholes has an average grade of 86.79% and 88.16%, although significant sections have grades in excess of 90% and sometimes up to 94% NaCl (whole rock). The deposit's thickness, its relatively undisturbed nature, its great lateral extent and reasonable depth, and the virtual absence of salt springs, all favour use for the future development of mines and underground storage facilities. Although this deposit may be of economic value, it has not as yet been utilized.

STANLEY OCCURRENCE

LOCATION

The Stanley occurrence is located 5.6 km northwest of Stanley (NTS 11E/04W), Hants County (Figs. 1-4, 1-10 and 2-26). Stanley is located near the southern border of the Kennetcook River valley 7 km southwest of Clarksville and 19 km northeast of Windsor. The area is accessible by

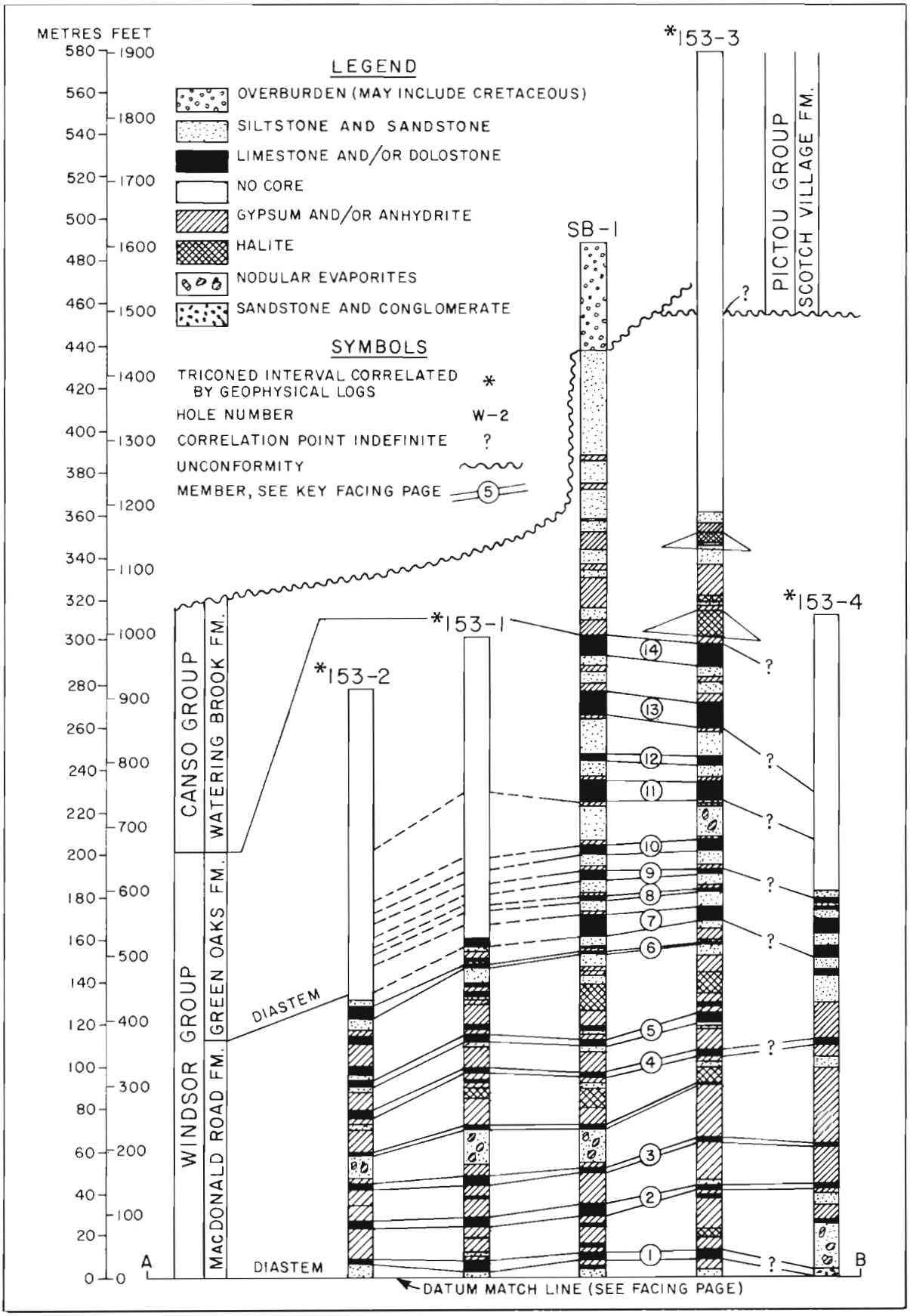


Figure 2-20. Drillhole profiles and correlation, 153-2, 153-1, SB-1, 153-3 and 153-4, Shubenacadie-Stewiacke deposit. (For locations see Fig. 2-17).

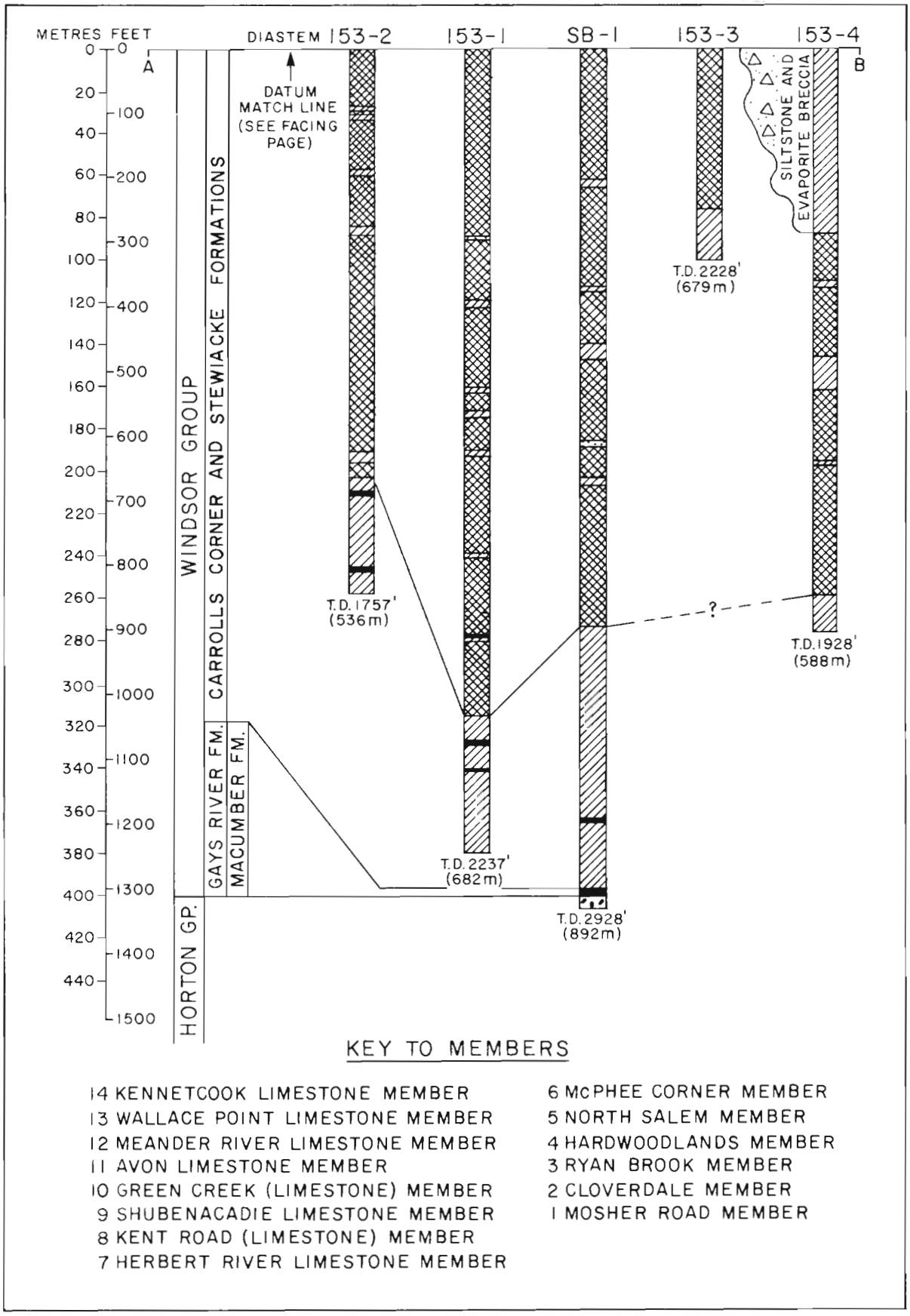


Figure 2-20. Continued.

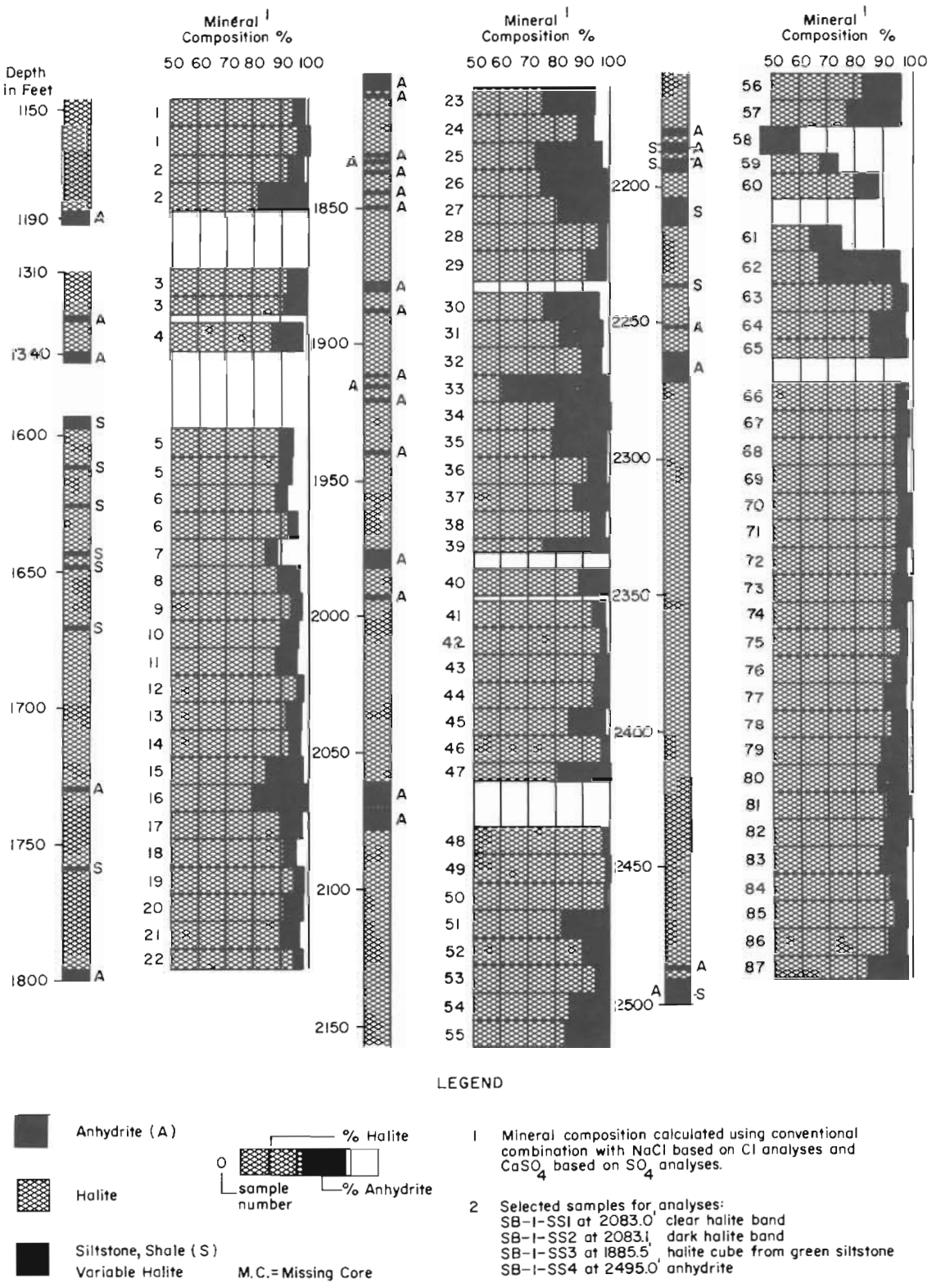


Figure 2-21. Detailed profile of salt sections in drillhole SB-1, Shubenacadie-Stewiacke deposit.

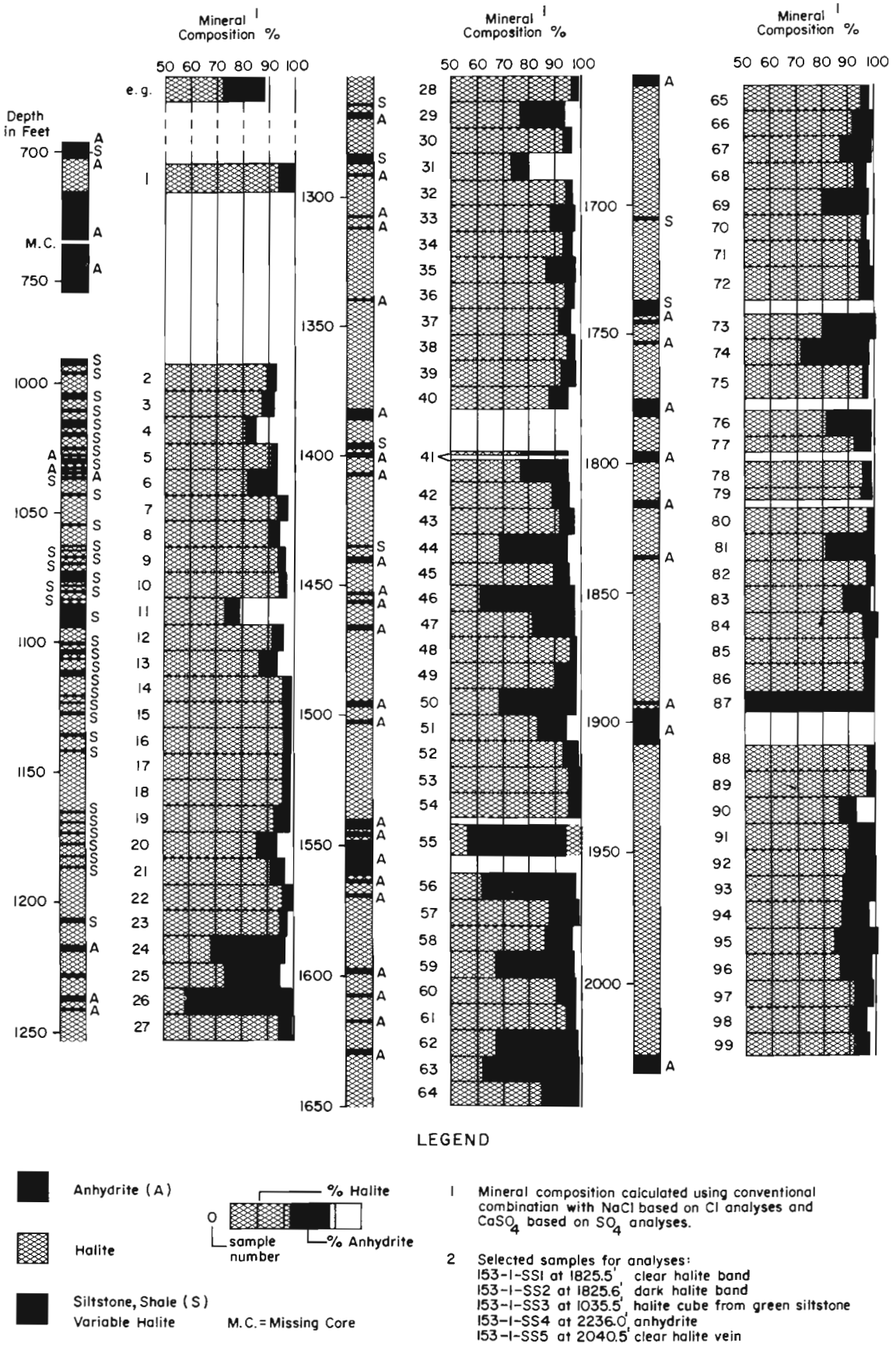


Figure 2-22. Detailed profile of salt sections in drillhole 153-1, Shubenacadie-Stewiacke deposit.

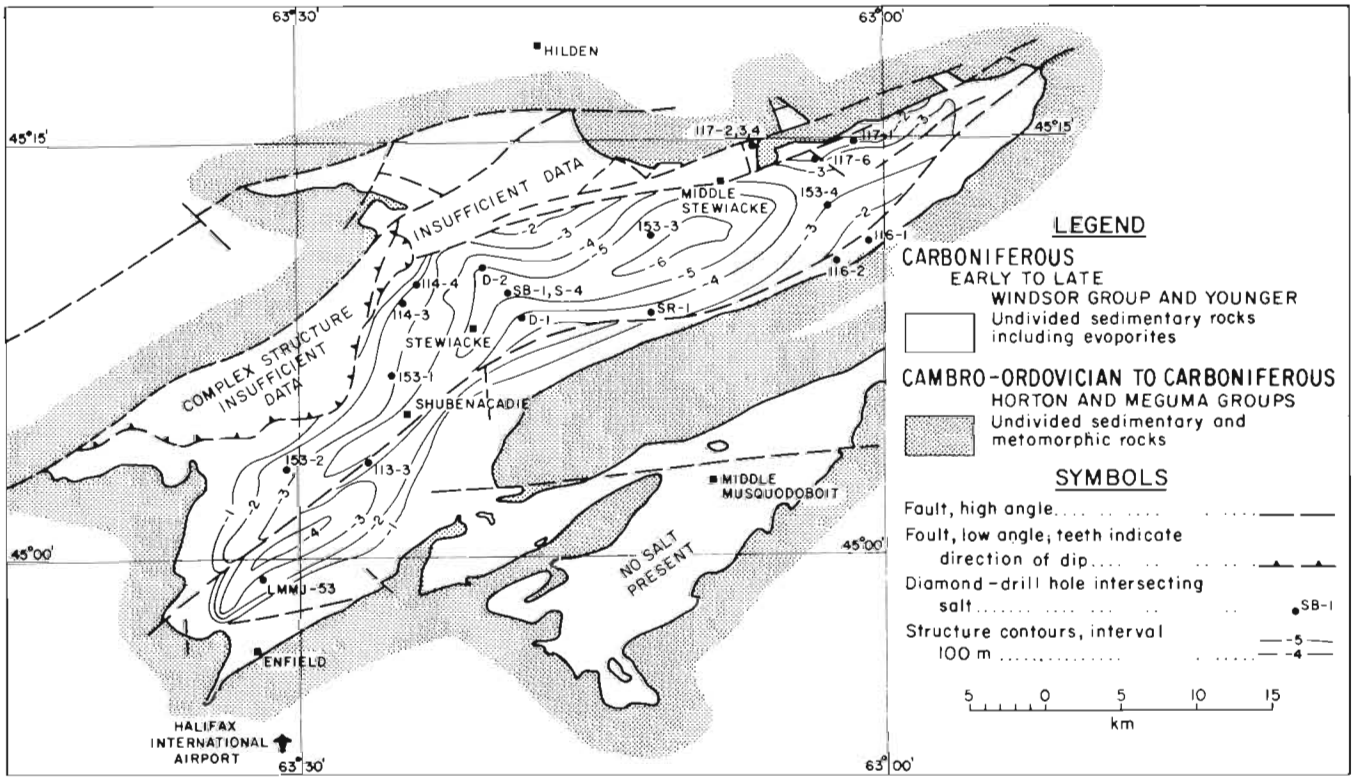


Figure 2-23. Structural contour map, Stewiacke Formation salt, Shubenacadie-Stewiacke deposit.

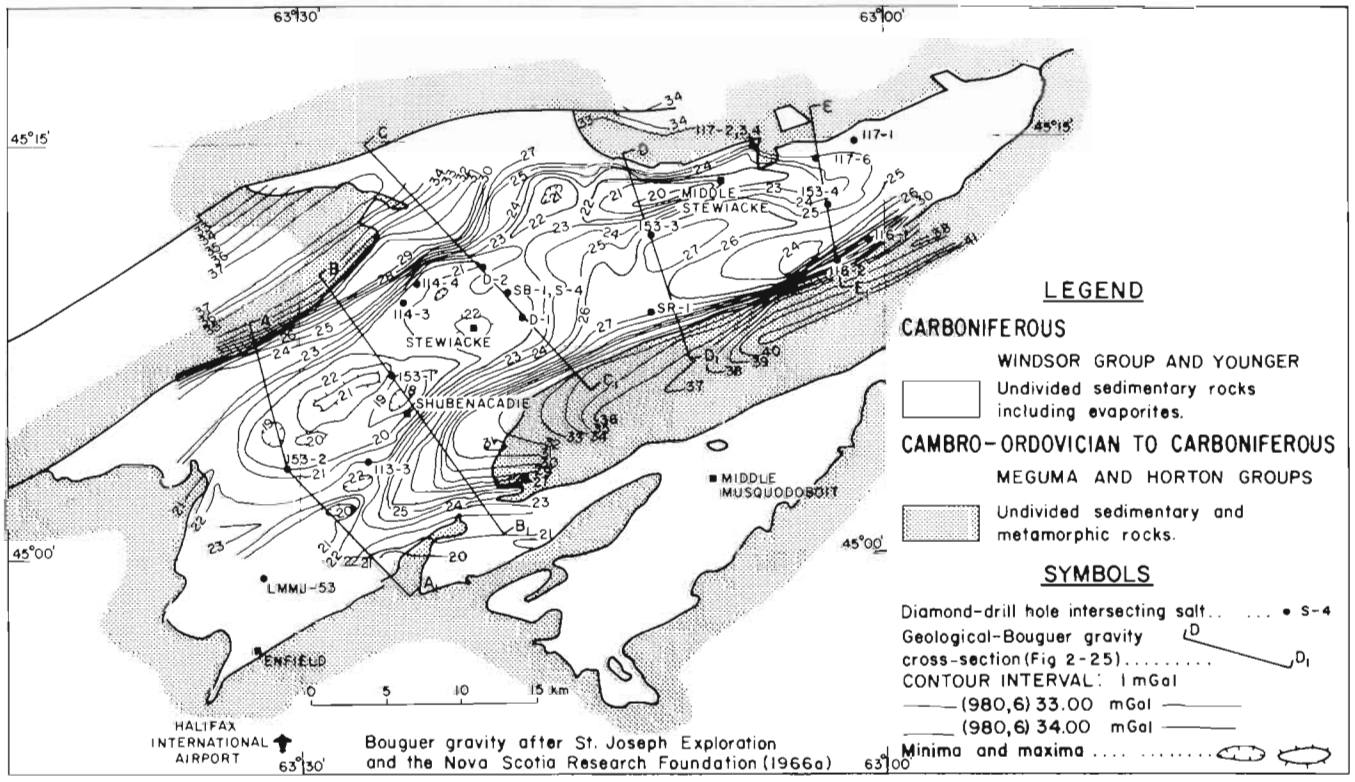


Figure 2-24. Bouguer gravity anomaly map, Shubenacadie-Stewiacke deposit.

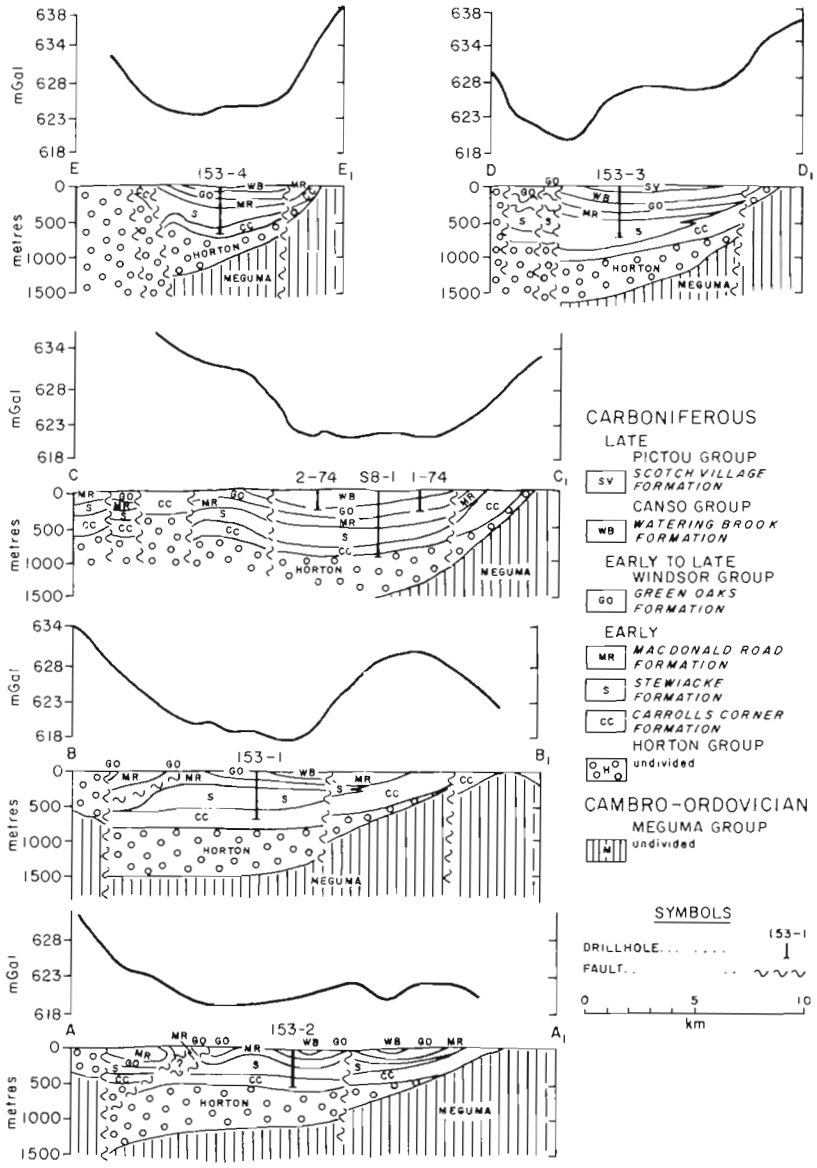


Figure 2-25. Schematic geological and Bouguer gravity cross-sections, Shubenacadie-Stewiacke deposit, Hants and Colchester Counties.

unpaved and bush roads extending from Highway 236 that runs through Stanley from Windsor to South Maitland.

Stanley lies within the central part of the Carboniferous Lowlands of north-central Hants County. This area is characterized by very gently undulating hills with elevations rarely exceeding 50 m in generally marshy terrain. The area is bordered on the south by the Rawdon Hills Highlands where elevations rise up to 150 m and locally exceed 200 m.

HISTORICAL BACKGROUND

The Stanley occurrence is located within the Windsor Basin of Hayes (1931), who assessed the area's potential for potash as part of a regional investigation. Many salt springs indicative of the presence of salt were located. The Stanley area occurs in the western extremity of the Kennetcook map area (Stevenson, 1959) which adjoins the Wolfville map area (21H/01) mapped by Crosby (1962) and the Londonderry, Bass River map areas (11E/05) to the north mapped by Weeks (1948).

In 1966 Scurry-Rainbow Oil Limited explored the area as part of a Province wide exploration program for sulphur possibly associated with Windsor Group evaporites. A gravity survey by the Nova Scotia Research Foundation outlined a Bouguer gravity high and a Bouguer gravity low centred approximately 5.6 km north-northwest of Stanley. Two exploratory boreholes were drilled on the gravity low, one of which penetrated salt.

GEOLOGY

The geology in the immediate area of the Stanley occurrence is not well known. Most of the area

Table 2-5. Summary of salt grades and intervals from drillholes 153-1 and SB-1, Shubenacadie-Stewiacke deposit.

Sample Numbers	Per cent NaCl	Thickness Feet	Thickness Metres	Interval Feet	Interval Metres
Drillhole 153-1					
153-14-19	94.87	60.0	18.2	1113.0-1173.0	339.3-357.5
153-21-23	93.58	30.0	9.1	1183.0-1213.0	360.6-369.7
153-27-39	89.79	130.0	39.6	1243.0-1373.0	378.9-418.5
153-65-72	89.20	83.2	25.4	1653.8-1737.0	504.1-529.5
153-75-86	90.48	126.1	38.4	1762.0-1888.1	537.1-575.5
153-75-89	91.46	166.5	50.7	1762.0-1928.5	537.1-587.8
Drillhole SB-1					
SB-09-14	92.13	60.0	18.3	1658.0-1718.0	505.3-523.6
SB-17-22	92.16	57.7	17.6	1738.1-1795.7	529.8-547.4
SB-41-46	93.72	60.0	18.2	1993.5-2053.5	607.6-625.8
SB-48-53	93.70	60.0	18.2	2077.5-2137.5	633.2-641.4
SB-66-78	94.31	130.0	39.6	2271.8-2401.8	692.4-732.0
SB-66-86	92.95	210.0	64.0	2271.8-2481.8	692.4-756.4

is underlain by nearly flat lying rocks assigned to the Scotch Village Formation (Stevenson, 1959). Outcrops are few and the underlying Windsor Group is rarely present, except 3 km to the west of SR5-3 where a small karst area with a salt spring occurs. Wright (1931) reported the occurrence of two salt springs in the vicinity of the Stanley occurrence as follows: Spring No. 1 "... on the west side of the Deal Road about 300 yards south of Four Mile Brook (about 4.25 miles) in a straight line southeasterly from Walton... A 'Deer Lick' with a trickly of brackish water-...Odour of hydrogen sulphide..." Spring No. 2 is reported to be located 1/4 mile northwest of Pinnacle Hill and one mile south of Spring No. 1. It is a salty seep with no appreciable flow.

The stratigraphy in the area is known only from boreholes drilled by Scurry-Rainbow Oil Ltd (Fig. 2-27). The section of rocks encountered was described from chips, making detailed stratigraphic or structural interpretations tenuous. The recovery of soft highly soluble minerals including salt and potash is especially difficult. The Scotch Village Formation unit mapped in the area appears to be well represented in the drilling, occurring as a thick sequence of red shale with grey sandstone. Drillhole SR5-1, 5 km north of SR5-3, intersected 425 m (1400 ft.) of this sequence apparently without reaching the Windsor Group. This thickness is comparable to the thicknesses intersected in the drillholes at the Walton occurrence to the north. This sequence probably unconformably overlies the highly deformed Windsor Group. This succession comprises interstratified red siltstone, gypsum, anhydrite, and limestone in the lower parts of SR5-2 and most of SR5-3 boreholes. Salt was intersected at a depth of 350 m (1150 ft.) in SR5-3, which was abandoned in salt at 366 m (1200

Table 2-6. Chemical analyses, Otter Brook Spring, Shubenacadie-Stewiacke deposit.*

Spring Sample No.	**36**
FIELD NOTES AT TIME OF SAMPLING	
Temperature of atomsphere, °F .	n.d
Temperature of brine, °F	n.d
Baume degrees	n.d
Equivalent specific gravity ...	
LABORATORY NOTES	
Specific gravity at 60°F	1.0033
Total solids at 110°C	0.60
Reaction	N
ANALYSES OF SOLIDS	
Na .....Per cent	18.64
K .....Per cent	n.d.
Ca .....Per cent	12.33
Mg .....Per cent	0.27
SO_4 .....Per cent	29.12
Cl .....Per cent	29.38
Br .....Per cent	n.d.
I .....Per cent	n.d.
Totals	89.74
HYPOTHETICAL COMBINATION	
$CaSO_4$ .....Per cent	41.25
$CaCl_2$ .....Per cent	
$MgSO_4$ .....Per cent	0.25
$MgCl_2$ .....Per cent	0.86
K_2SO_4 .....Per cent	
KCl .....Per cent	
Na_2SO_4 .....Per cent	
NaCl .....Per cent	47.38
Totals	89.74

* Cole (1930a)

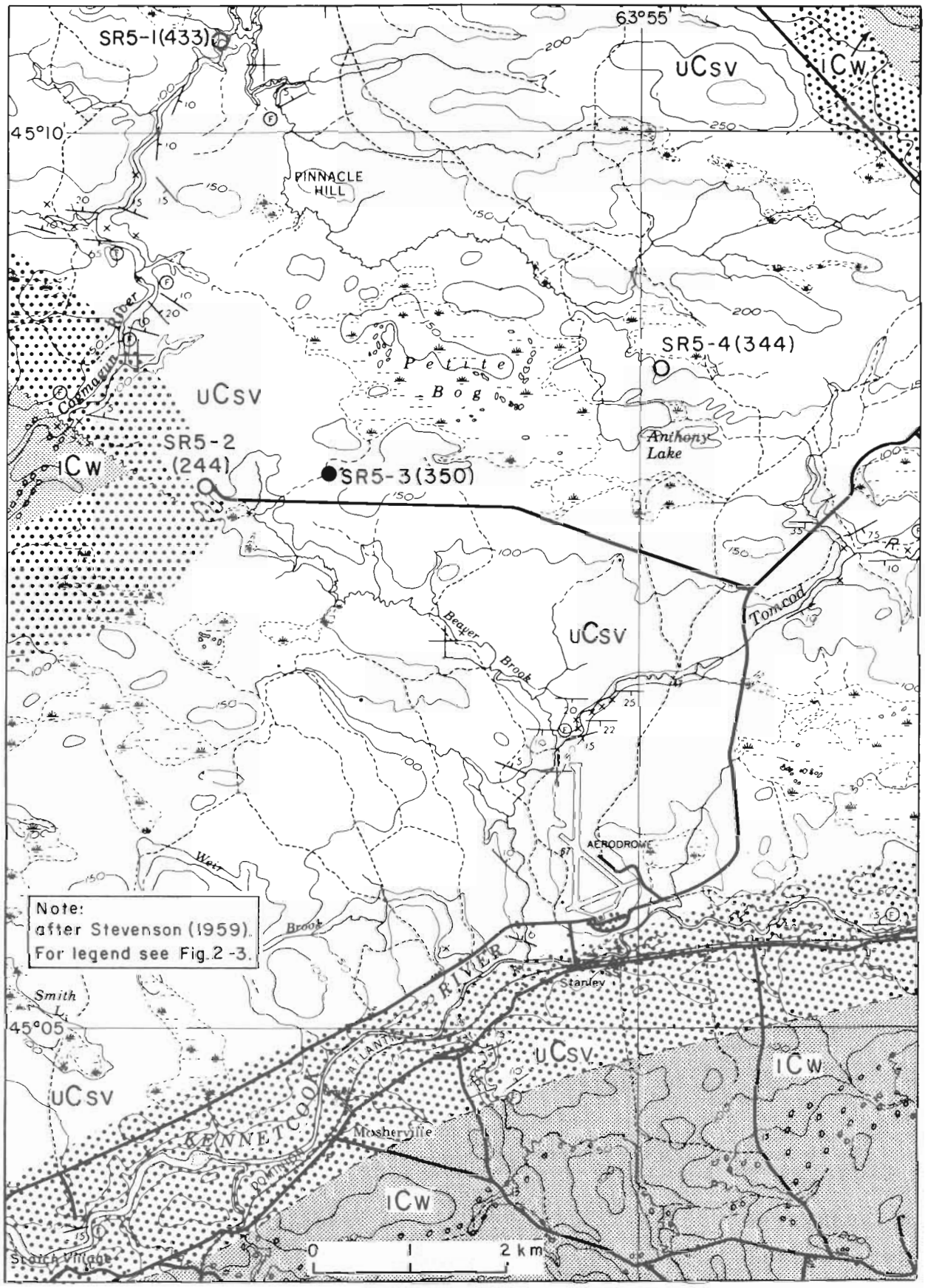


Figure 2-26. Geology in the vicinity of the Stanley occurrence, Hants County.

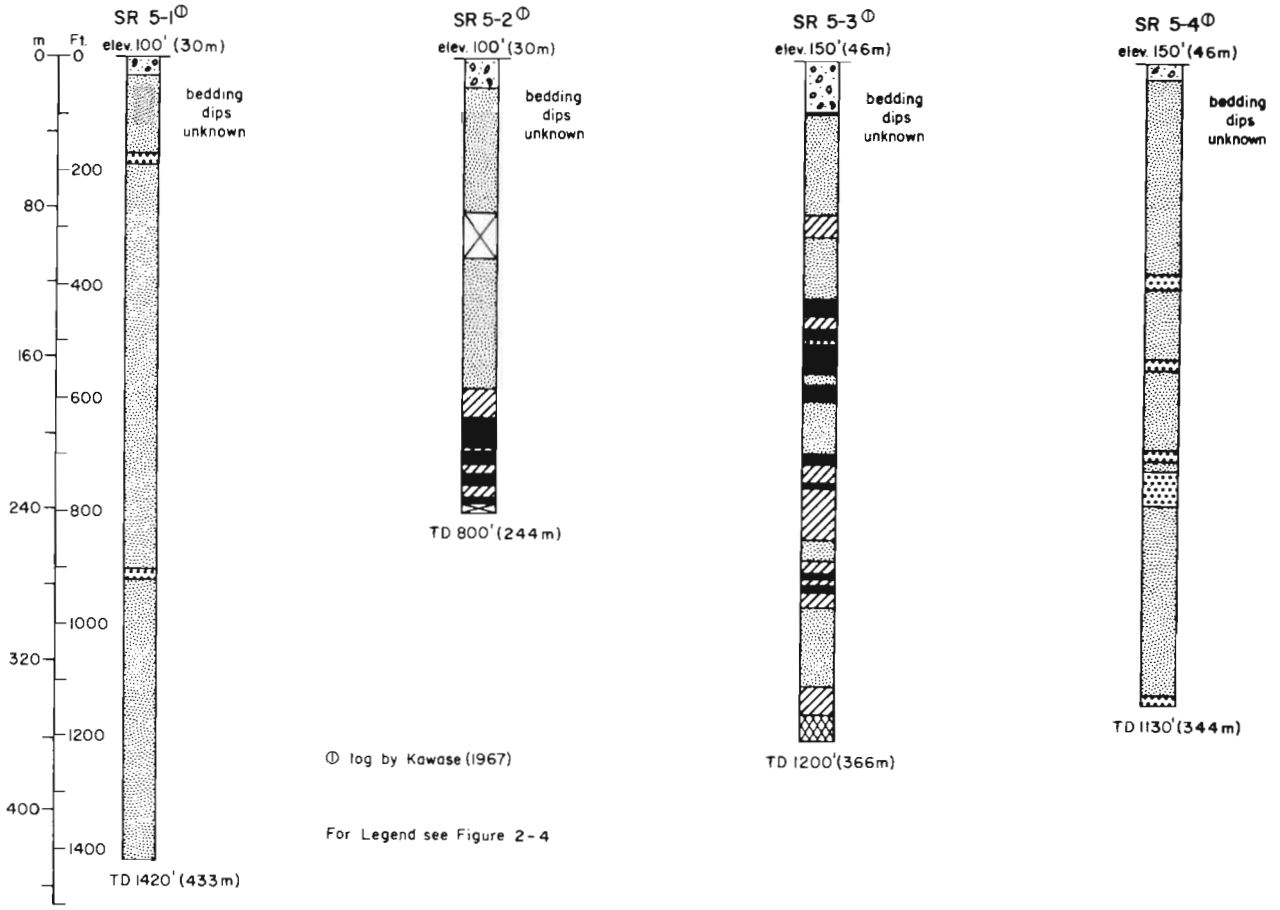


Figure 2-27. Drillhole profiles, Stanley occurrence. (For locations see Fig. 2-26).

ft.). The interstratified sequence above the salt in this borehole is typical of the cyclic B Subzone of the Lower Windsor and/or Upper Windsor units. Since the structural configuration in the area is not readily determinable, it is difficult to assess the nature of the salt occurrence. A large mass of salt may be present at depth, but its presence may only be confirmed by deep drilling.

GEOPHYSICS

The area in the vicinity of the Stanley occurrence is included in the Nova Scotia Research Foundation Bouguer Anomaly map 11E/4, Stanley, Hants County (Fig. 2-28). The major features on the map are a roughly triangular outlined minimum at 613.00 mGal, between adjacent highs of 622.00 mGal to the southwest and northeast. Cross-section C-C_1 (Fig. 2-28) indicates the Windsor Group salt is closest to the surface and possibly thicker towards the centre of the low and at a greater depth beneath Scotch Village Formation strata in the areas of the maxima.

ECONOMIC CONSIDERATIONS

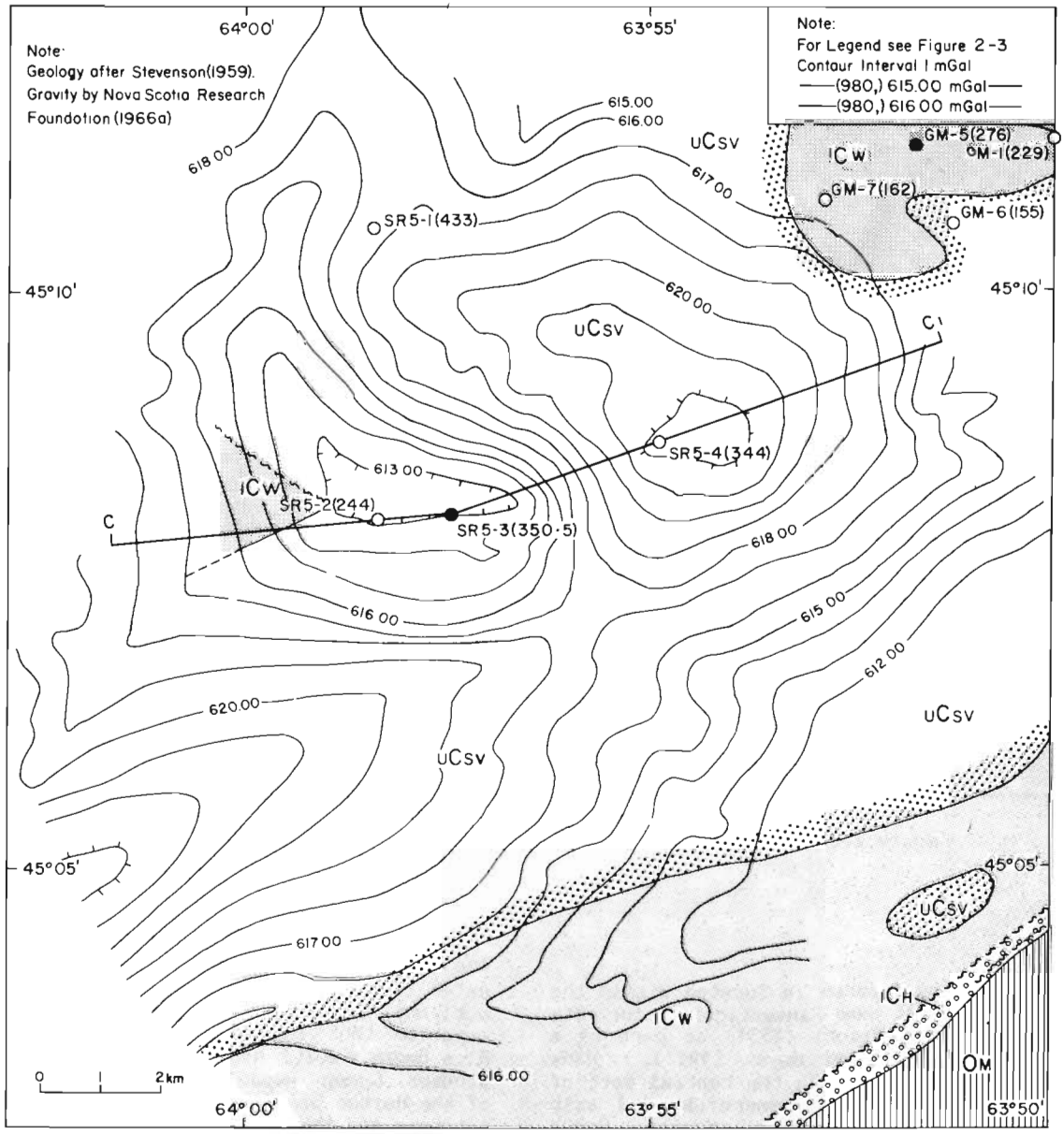
The Stanley occurrence comprises halite, but since it is known only from borehole chips, potash could be present. The area is not readily accessible to tidewater shipping facilities. The salt was intersected in a single borehole SR5-3 at a depth of 350 m (1150 ft.). The hole was abandoned at 366 m (1200 ft.) in salt. The structural configuration, lateral extent and quality of the salt cannot be determined without additional drilling. Based on available data the deposit is not considered to be of economic importance.

SUMMERVILLE OCCURRENCE

The Summerville occurrence is located in the community of Summerville, western Hants County, (NTS 21H/01) (Figs. 1-4, 1-10 and 2-29) located on the eastern shore of the Avon River estuary 13 km north of Windsor and 3 km north of Hantsport.

The area is readily accessible by paved Highway 15 from Windsor. The tidewater port of Hantsport is located on the opposite shore of the Avon River estuary 3 km to the south.

The terrain is typical of the Carboniferous Lowlands with gently undulating hills with elevations rarely exceeding 75 m and poorly drained marshy areas common.



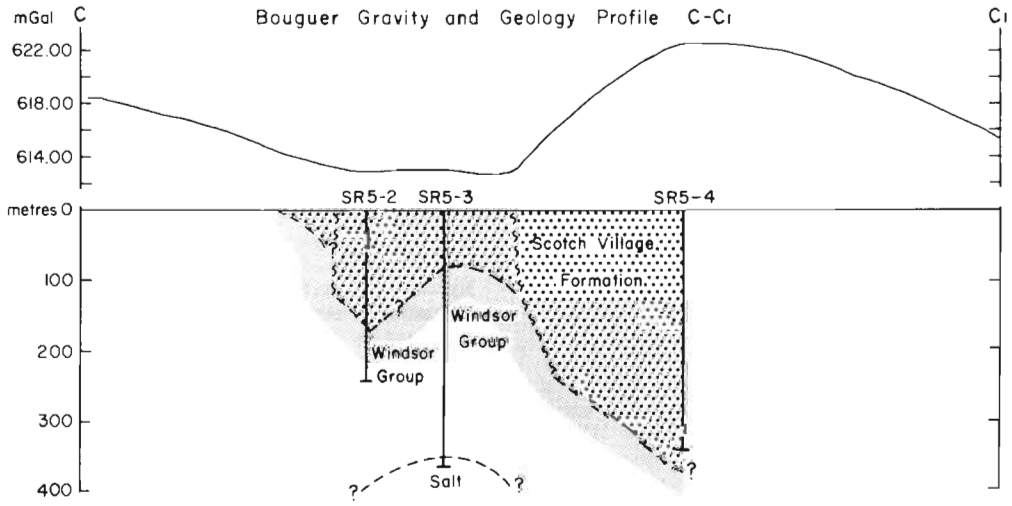


Figure 2-28. Bouguer gravity anomaly map and cross-section, Stanley occurrence.

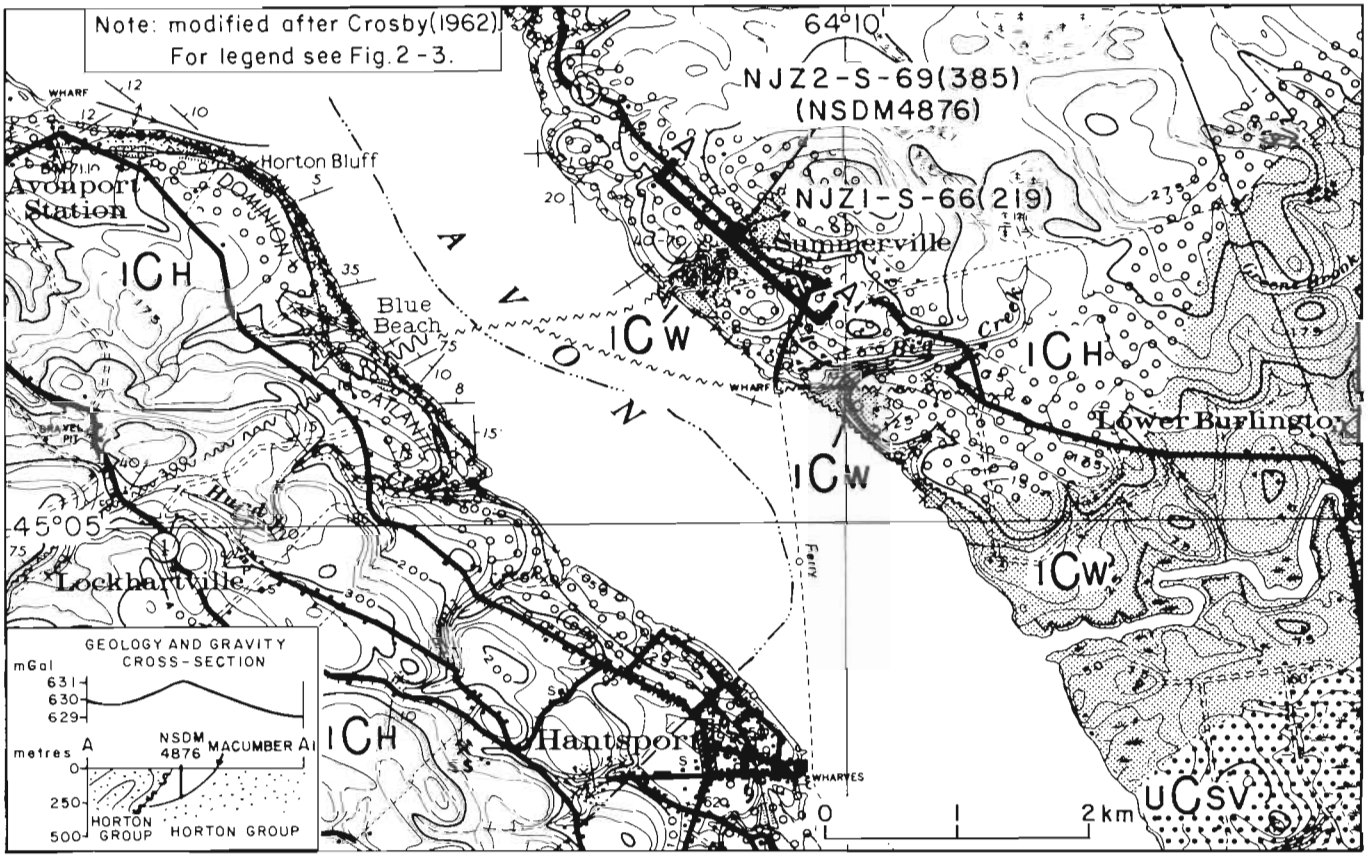


Figure 2-29. Geological map of the Summerville occurrence, Hants County.

LOCATION

The Summerville occurrence is located within the Windsor Basin. It was investigated for its potash potential by Wright (1931) as part of a regional investigation by Hayes (1931). Many salt springs were located in the central part of the area to the east of Summerville and salt brines were encountered in Horton Group sandstones in an oil well boring at Cheverie 6.4 km to the north. No salt springs were located, however, in the immediate area of Summerville.

HISTORICAL BACKGROUND

In 1969 the area was explored for possible base metal deposits by New Jersey Zinc Exploration Company (Canada) Ltd. A diamond-drill hole, NJZ2-S-69 (NSDM 4876), was drilled on a small fault block of Windsor Group consisting mainly of Lower Windsor gypsum and anhydrite. A thick section of gypsum and anhydrite (with minor quantities of salt) overlying basal Windsor Macumber Formation and Horton Group were intersected. New Jersey Zinc Exploration Company Ltd. had drilled a hole, NJZ1-S-66, in 1966 to a depth of 220 m (720 ft.) in the anhydrite unit without intersecting salt.

GEOLOGY

The geology, as mapped by Crosby (1962), indicates the Windsor Group rocks occur as a small outlying fault block (Fig. 2-29). Bell (1929), reported that this fault (an extension of the Blue Beach Fault) had reverse movement with the Windsor Group gypsum underlying black shales of the Horton Group. Karst topography and gypsum outcrops and the adjacent quarry indicate much of the area is underlain by gypsum and anhydrite. The Horton Group rocks outcropping on the northern side of the fault are steeply dipping and locally overturned. Blanchard (1957) reported that gravity data suggested a northerly dipping fault at an angle between 45° and 75°. The nature of the southern contact with the Horton is not clearly discernible from the map but appears to be concordant. The NJZ2-S-69 drill-hole is located near the northeastern extremity of the block and penetrated 12.8 m (42 ft.) of gypsum (surficial hydration of anhydrite); 415.1 m (1362 ft.) of anhydrite (dip ranging from 30°-45°); 1.8 m (6 ft.) of basal Windsor, Macumber Formation limestone; and 5.2 m (17 ft.) of Horton Group (Figs. 2-29 and 2-30). Minor amounts of salt were logged in several intervals in the lower part of the thick anhydrite. Minor salt was found in the 380.0-388.2 m (1247-1274 ft.) interval (especially 384.9-385.1 m).

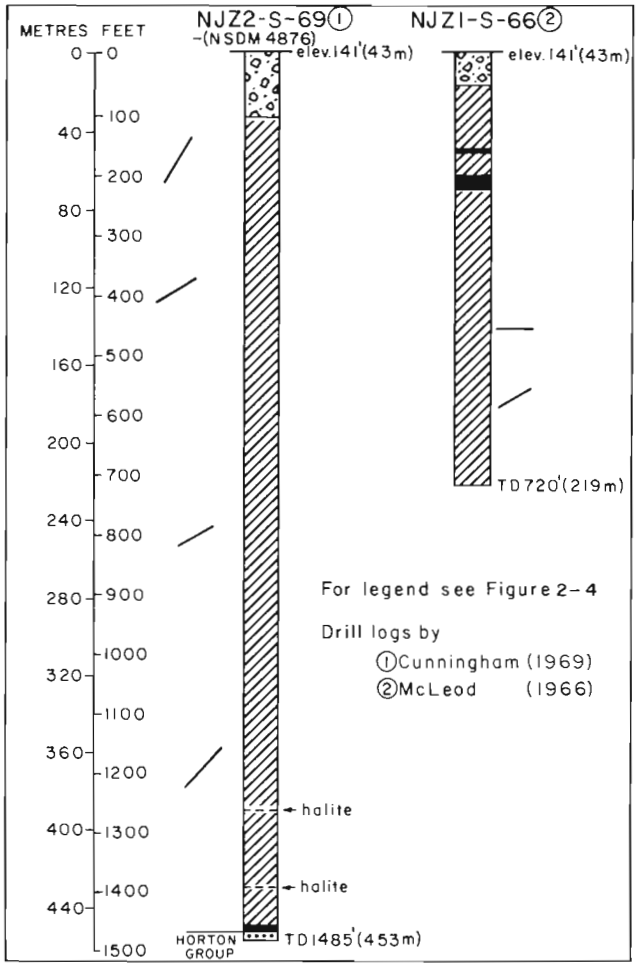


Figure 2-30. Drillhole profiles, Summerville occurrence, Hants County. (For locations see Fig. 2-29)

Salt was logged with anhydrite and gypsum between 413.9 and 424.4 m (1358 and 1392 ft.), and also between 424.4 and 425.6 m (1392 ft. and 1396 ft.) (especially at 425.1 m).

The area in the vicinity of the Summerville occurrence is included on the Nova Scotia Research Foundation Bouguer anomaly map 21H/01E (Fig. 2-13). In addition, there is a Nova Scotia Research Foundation total gravity map for the area (NSDME Open File Report 330). A Bouguer gravity high (Fig. 2-13) is coincident with the Windsor Group outcrop area and is apparently due to the high density of the anhydrite and the absence of significant quantities of salt. The exact mode of salt occurrence is not described in the drill log. It is inferred to occur as either inclusions, thin beds or veins.

ECONOMIC CONSIDERATIONS

At Summerville salt occurs in minor amounts in several intervals of anhydrite (basal anhydrite, part of the Vinland Formation of Moore and Ryan, 1976, Fig. 2-1). This salt probably occurs as minor inclusions or veins with very limited lateral extent and is not likely to occur in economically significant quantities. Potash was not found in this area. The occurrence is not considered to be of economic importance.

UPPER WALTON RIVER OCCURRENCE

LOCATION

The Upper Walton River occurrence is located approximately 13 km southeast of Walton (NTS 11E/04W), Hants County (Figs. 1-4, 1-10 and 2-31). The area is not readily accessible and can only be reached by unpaved roads and trails. The terrain is typical of the Carboniferous Lowlands with very gently undulating hills, with elevations that rarely exceed 75 m. The area is locally marshy making access difficult.

HISTORICAL BACKGROUND

The Upper Walton River area was investigated for its potash potential by Wright (1931) as part of a regional investigation by Hayes. Several salt springs were located in the area indicating the leaching of salt at depth. The area was mapped by Stevenson (1959). Many salt springs and a single lead showing were located in the vicinty. The area has been explored for base metal mineralization by a number of companies two of which undertook diamond drilling. In 1969 Magnet Cove Barium Corporation (Dresser Minerals) drilled several deep holes in the area. The WR-1 borehole was drilled slightly south of the lead showing. It was abandoned at a total depth 609 m (2000 ft.) with salt first reported at 344.4 m (1130 ft) The log of this borehole is rather sketchy, so the nature and quantity of salt indicated from approximately 344 to 609 m is uncertain.

A second hole, EMCO #2, drilled approximately 5 km to the northwest of the main occurrence area, also has a very general log that indicated possible salt in a zone of lost core between 331 and 364 m (1086 and 1194 ft.).

In 1975 the area was explored for base metal deposits by Gulf Minerals Canada. A series of eight holes were drilled (Fig. 2-32). The deepest, GM-5, penetrated salt from 276.8 m to 287.4 m (908-943 ft.) before it was abandoned in the salt. The GM-5 hole was drilled approximately 1.5 km south of WR-1.

GEOLOGY

The geology in the vicinity of the Upper Walton River occurrence was mapped by Stevenson (1959) (Fig. 2-31). The occurrence is located in an area underlain by a Windsor Group outlier

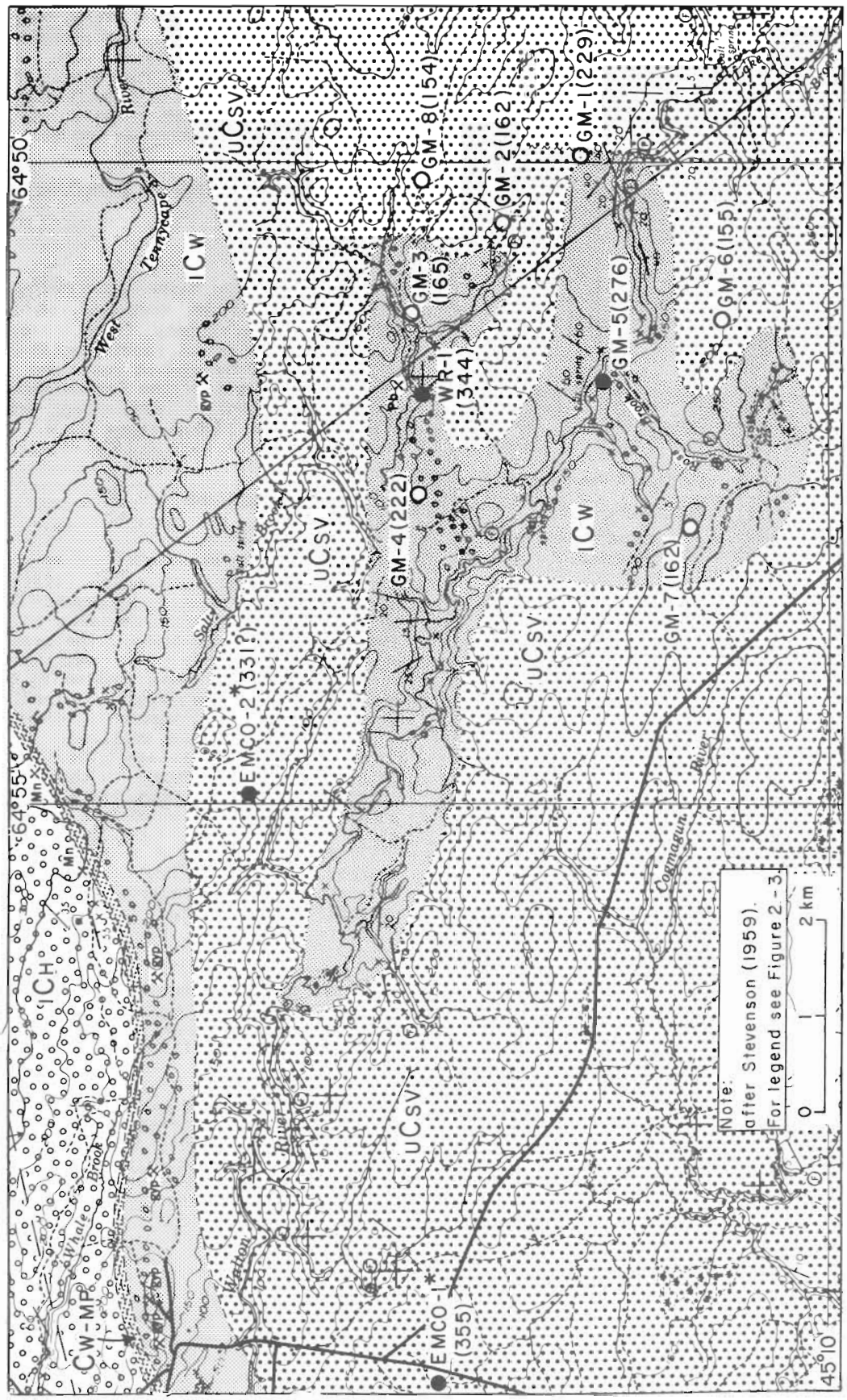


Figure 2-31. Geology in the vicinity of the Upper Walton River occurrence, Hants County.

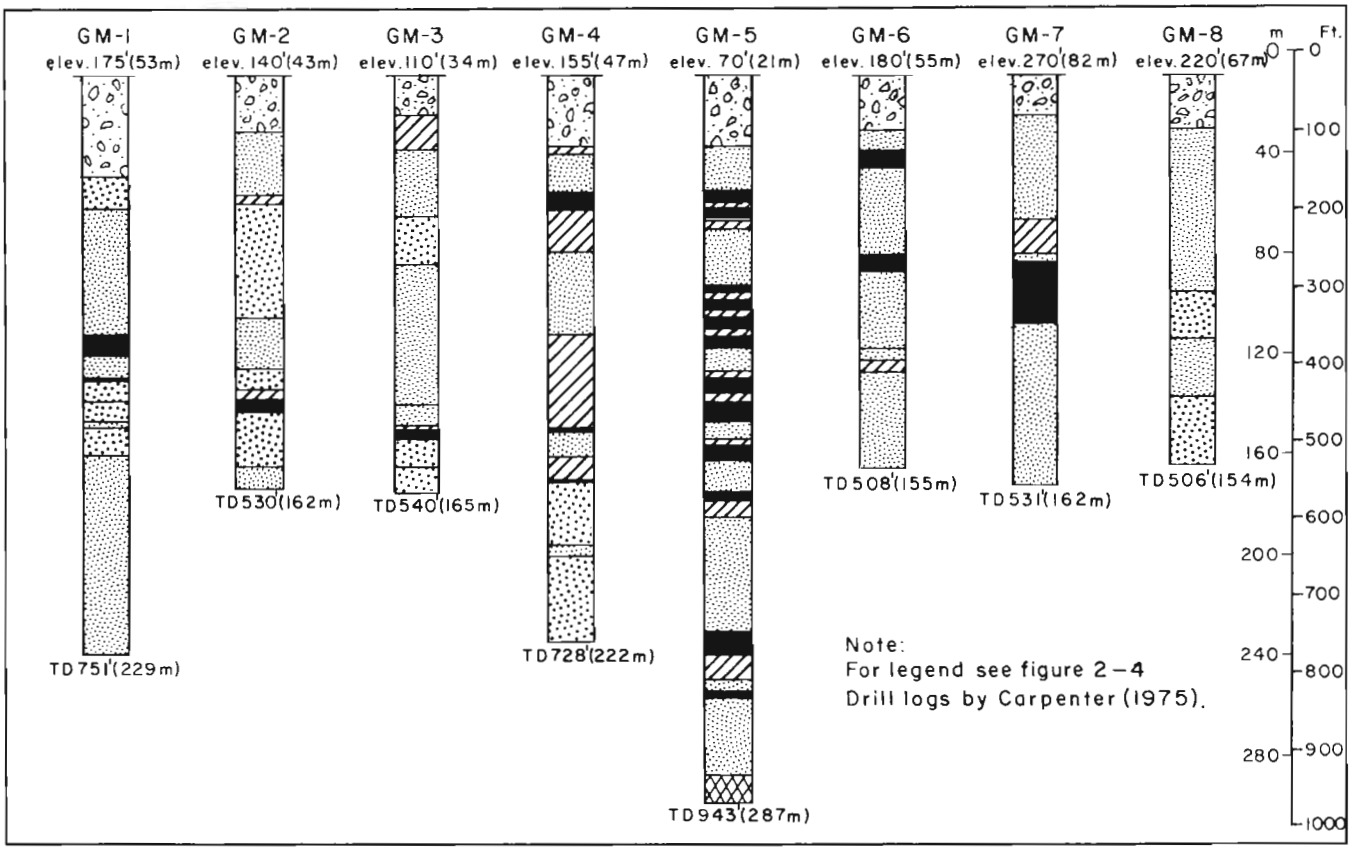


Figure 2-32. Drillhole profiles, Upper Walton River occurrence.

surrounded by relatively flat lying strata assigned to the Scotch Village Formation. The northern limit of the Windsor Group outcrop is marked by the basal Windsor, Macumber Formation limestone, and Pembroke Formation conglomerate which lie with apparent conformity on the Horton Group comprising sandstone, shale and minor conglomerate. Karst topography, salt springs and irregular (bedding) attitudes were observed by Stevenson (1959).

Wright (1931) reported the occurrence of a salt spring on the southern bank of the Walton River 2 km upstream from where the Walton Woods Road crosses. The occurrence is reported to be a "small trickle" from Scotch Village red shales and sandstone. Analyses of these springs are not reported.

The detailed stratigraphy of the carbonate units in the GM-5 drillhole (Figs. 2-33 and 2-34) was studied by Boehner (1977c), who described the presence of multiple repetition of a single unit (B Subzone?) from faulting and isoclinal recumbent folding.

The detailed correlation of the 12 structurally repeated sections of the same carbonate unit are presented as a series of detailed pictorial logs in Figure 2-33 The sections have been plotted on an arbitrary datum (assumed stratigraphic base). In many instances the interval between the sections is continuous as is indicated by the drillhole depths indicated beside the column (ie. sections 5-6, 7-8-9-10, and 11-12). Repetition by isoclinal folding in these intervals is documented by the inversion of the distinctive subunits A-E. A schematic interpretation of the structural repetition in drillhole GM-5 is presented in Figure 2-34. This type of structure has been described in the Windsor area by Geldsetzer et al. (1980) as being related to gravity slide tectonism.

The complex structure encountered in the GM-5 hole (Fig. 2-34) may be indicative of what could occur in the other holes in the vicinity, but without detailed examination of the core it is not useful to make a detailed structural and stratigraphic interpretation. The data presently available from the WR-1 and EMCO-2 holes show that a significant section of salt and red shale is apparently present at depth. The thickness and extent of a potentially large salt mass is not predictable. The stratigraphic position of the salt is also unknown, although it is probably the thick A Subzone salt.

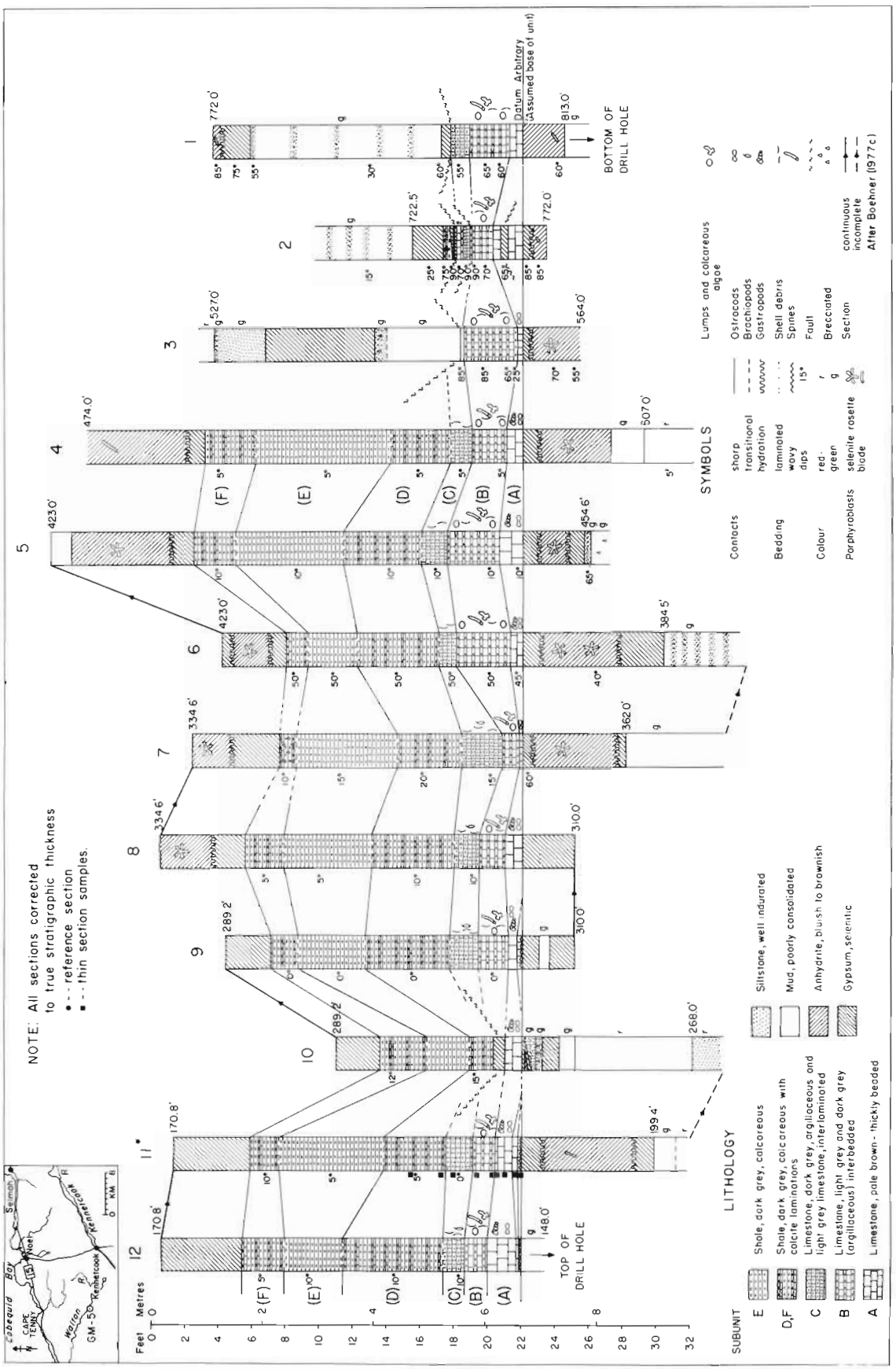


Figure 2-33. Multiple structural repetition of a single carbonate unit in drillhole GM-5, Upper Walton River occurrence.

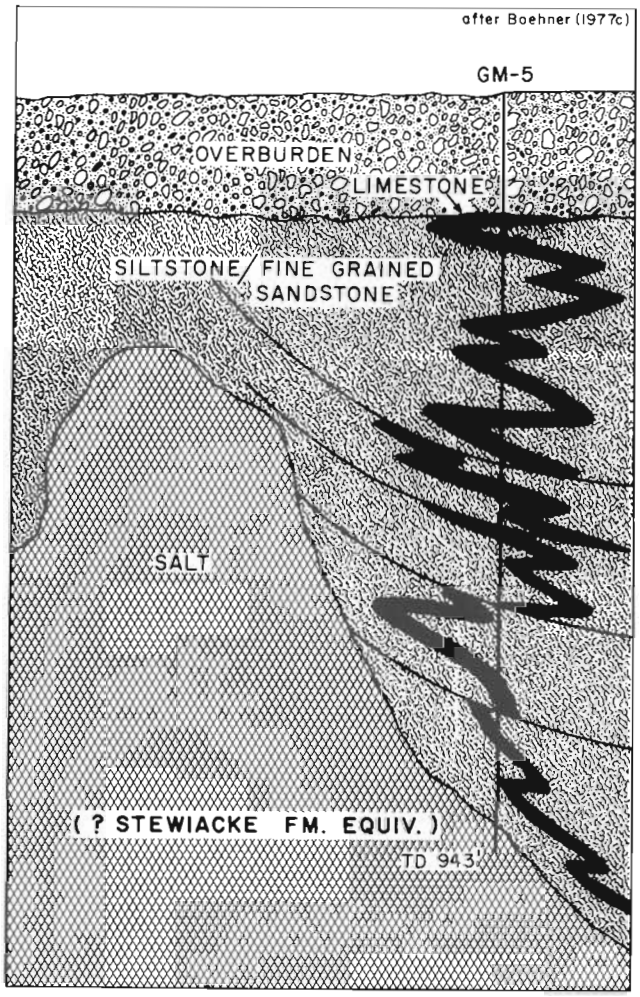


Figure 2-34. Schematic interpretation of multiple repetition in GM-5, Upper Walton River occurrence.

GEOPHYSICS

The area in the vicinity of the Upper Walton River occurrence is included on Nova Scotia Research Foundation Bouguer gravity anomaly map 11E/04 (Fig. 2-8). Unfortunately, the occurrence area has no survey stations because of the lack of road access and, therefore, contouring on the map is based upon interpolation of widely scattered data points. The presently available data indicate an ill-defined trough shaped low in the area which may be attributable to the presence of salt. A detailed survey would be required to further define the anomaly and assess the salt potential.

ECONOMIC CONSIDERATIONS

The Upper Walton River occurrence consists of halite; no potash is reported. The salt was intersected at 277 m (908 ft.) in GM-5 and first reported with red shale at 344 m (1130 ft.) in WR-1. The thickness and lateral extent of the salt is not known.

The structure in the area is extremely complex with multiple repetition of units by folding and faulting making any interpretation of stratigraphy and structure uncertain. The area is not readily accessible by road or railway although the small port at Walton is located approximately 13 km to the northwest. Based on available data this occurrence is not considered to be of economic importance.

WALTON OCCURRENCE

LOCATION

The Walton occurrence area is located near Walton (NTS 21H/01), in northern Hants County (Figs. 1-4, 1-10 and 2-35). The area is not readily accessible and can only be reached by unpaved roads and trails from Highway 15 that runs along the Minas Basin shore between Cheverie and Maitland. The terrain in the vicinity is typical of the Carboniferous Lowlands with gently undulating hills where elevations rarely exceed 75 m. Marshy areas are locally common making access difficult.

HISTORICAL BACKGROUND

The area was investigated for its potash potential as part of the Windsor Basin by Wright (1931) in a regional assessment by Hayes. Many salt springs were located indicating the leaching of salt at depth. Salt water infiltrated the underground workings of the Walton Mine. These waters are probably derived from deeply circulating groundwaters leaching salt from Windsor Group sediments to the south and east of the mine site. The general geology of the Walton area was mapped by Crosby (1962). Detailed mapping by Boyle (1963, 1972) indicated the area is structurally disturbed and extensively faulted along east-west and northwest-southeast trends.

In 1967 Magnet Cove Barium Corporation drilled IP-1, 2 km south of the Walton Mine. Salt was penetrated between 472 m and 515 m and salt with anhydrite between 515 m and 520 m where the hole was stopped.

In 1969 another hole, EMCO #1, intersected salt between 355 m and 418 m where the hole was stopped. This hole was drilled 4 km east of the Walton mine and 3.7 km east-northeast of the IP-1 hole.

GEOLOGY

The geology of the Walton area (Fig. 2-35) is included on part of the Wolfville map area (21H/01) and on part of the Kennetcook map area (11E/04). Detailed mapping and extensive drilling have been concentrated along the Horton-Windsor contact although very little is known about the geology of the deeper parts of the basin away from this margin.

The stratigraphy of the Windsor Group in the area is generalized as follows: the basal

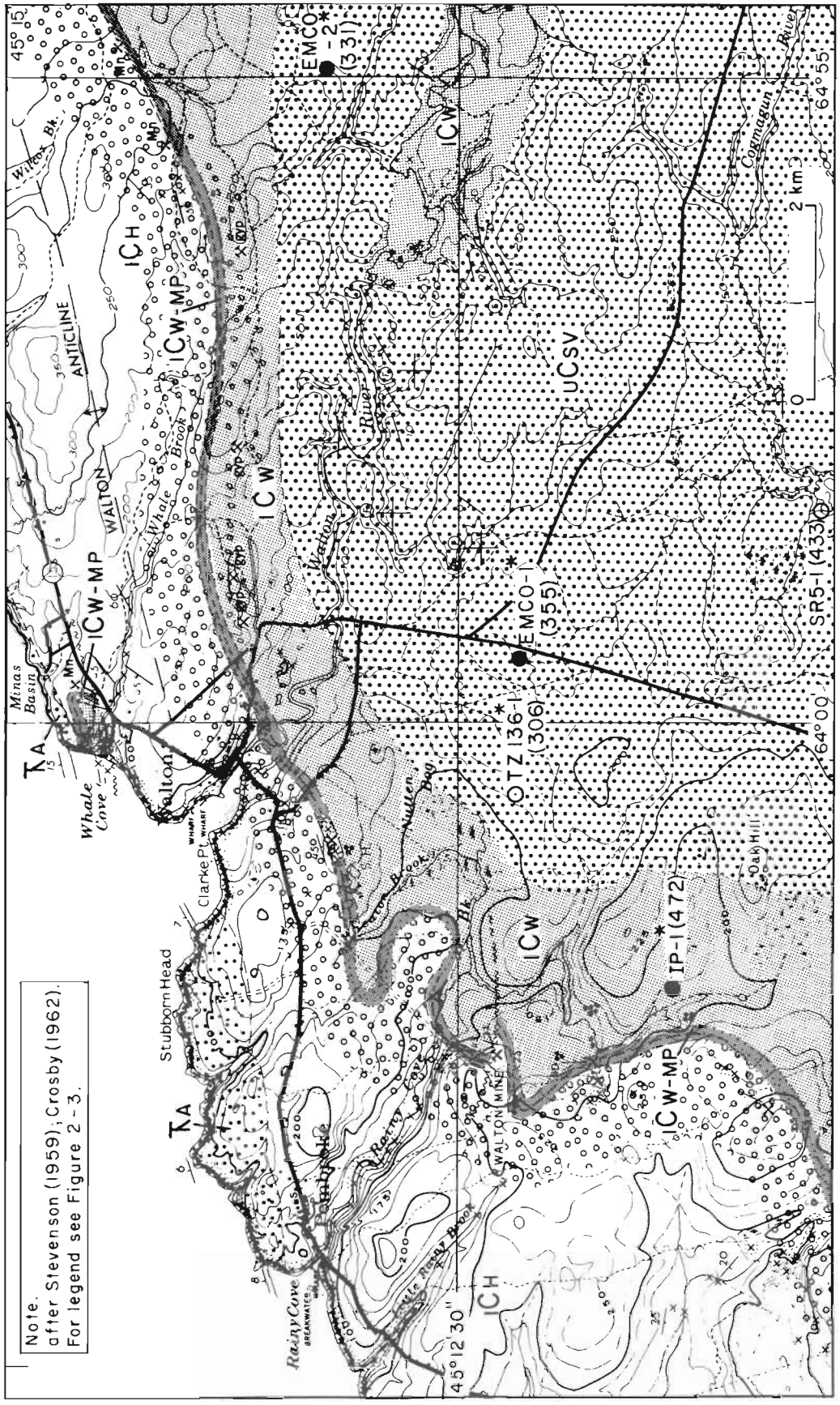


Figure 2-35. Geology in the vicinity of the Walton occurrence, Hants County.

Windsor limestone is the Macumber Formation (Weeks, 1948) which overlies with apparent conformity, sandstone, shale, and conglomerate of the Horton Group. The Macumber Formation is overlain by and is equivalent in part to the Pembroke Formation which consists of limestone pebble conglomerate. This is considered by Clifton (1967) to be a post-Carboniferous solution collapse and cavity fill feature. Both are overlain by a thick basal anhydrite (gypsum), part of the Vinland Formation of Moore and Ryan (1976) or Lower Sulphate (Weeks, 1948). These units appear as relatively continuous outcrop bands along the northern outcrop limits of the Windsor, but are offset by numerous faults.

The basal anhydrite is in turn overlain by a thick sequence of red siltstone and shale (Tennycape Formation of Weeks, 1948), salt and interstratified limestone, shale, and gypsum-anhydrite beds. Due to extensive structural complexity related to faulting and folding (Boyle, 1963) the stratigraphy of this part of the section is not readily discernible from the drilling and outcrop data. The Windsor Group succession is overlain by a nearly flat lying sequence of red shales and red and grey sandstone of the Scotch Village Formation which was assigned to the Riversdale Group by Stevenson (1959); however, more recently these rocks have been dated with spores and are equivalent in age to the Pictou Group (Howie and Barss, 1975). A minimum total thickness of 200 m of Scotch Village Formation is indicated by Bell (1964) in the TZ136-1 hole drilled 2.4 km to the northeast of IP-1. This hole was stopped at 306 m without penetrating salt.

The rocks in the Walton area have been subjected to severe deformation with extensive faulting (Boyle, 1963) and complex folding. The folding is not readily seen in the Windsor Group rocks due to the scarcity of outcrop and cover of the Scotch Village Formation. Complex folding is well exposed, however, in the underlying Horton Group exposed on the Walton River north of the wharfs. This degree of deformation could be expected in the adjacent Windsor rocks, in particular, those occurring above the basal anhydrite and salt as the latter is very mobile when under stress.

The salt in the Walton occurrence probably is the thick A Subzone salt that overlies the basal anhydrite and is overlain by the Tennycape Formation (Weeks, 1948). The lateral extent and thickness variations of the salt unit are unknown and its presence is known only from very general logs of two boreholes 3.7 km apart.

GEOPHYSICS

The area in the vicinity of the Walton occurrence is included on Nova Scotia Research Foundation Bouguer gravity anomaly maps 11E/04W and 21H/01E (Figs. 2-8 and 2-13) at a scale of two inches equals one mile.

Detailed gravity surveys at a scale of 1 inch equals 200 feet by the Nova Scotia Research Foundation (1957) were directed at small mineral exploration targets along the Horton-Windsor Groups contact. In the more central parts of the Windsor outcrop area away from the contact only major roads were traversed. Because of the complex geology and widely spaced survey lines, anomalies that could be attributed to salt may not appear on Figure 2-13.

GEOCHEMISTRY

Salt springs are common in the area. The influx of salt brine into the Walton Mine indicates that salt is being actively dissolved. Cole (1930a) reported two salt springs in the vicinity. The Walton Spring (No. 13) is reported to be located on the western bank of the Walton River, approximately 450 m south of the bridge. The Rainy Cove Spring (No. 32) is reported to occur in a marshy area on the southern side of Rainy Cove Brook, 2.4 km southeast of Pembroke. Cole (1930a), reported the analyses of brine samples from these springs Table 2-7. The moderate $CaSO_4$ analysis indicates the dissolution of gypsum or anhydrite in addition to halite.

Table 2-7. Salt spring analyses, Walton area, Hants County*

Spring No.	**13**	**32**
FIELD NOTES AT TIME OF SAMPLING		
Temperature of atmosphere , °F	76	n.d.
Temperature of brine, °F	47	n.d.
Baume degrees	n.d	n.d.
Equivalent specific gravity ..	-	-
LABORATORY NOTES		
Specific gravity at 60°F	1.0163	1.0170
Total solids at 110°C	2.14	2.41
Reaction	N	N
ANALYSES OF SOLIDS		
Na .....Per cent	31.30	30.83
K .....Per cent	0.19	0.22
Ca .....Per cent	5.13	4.89
Mg .....Per cent	0.09	0.08
SO_4 .....Per cent	11.24	11.12
Cl .....Per cent	49.28	48.34
Br .....Per cent	none	none
I .....Per cent	none	none
Total	97.23	95.48
HYPOTHETICAL COMBINATION		
$CaSO_4$ .....Per cent	15.92	15.75
$CaCl_2$ .....Per cent	1.05	0.72
$MgSO_4$ .....Per cent	-	-
$MgCl_2$ .....Per cent	0.35	0.18
K_2SO_4 .....Per cent	-	-
KCl .....Per cent	0.36	0.42
Na_2SO_4 .....Per cent	-	-
NaCl .....Per cent	79.55	78.37
Total	97.23	95.44

*Cole (1930a)

Wright (1931) reported on the salt spring occurrences in the Walton area. The Walton River Spring (Wright's Spring No. 3) occurs at the contact between Windsor "Zone A" limestone

(Macumber Formation) and the overlying gypsum. According to Wright, Spring No. 7 occurs on the southern side of the Walton-Pembroke Road where it crosses Wheaton Brook. Water is reported to be rich in hydrogen sulphide and to occur in Horton Group strata "a few hundred feet below the base of the Windsor basal sandstone". A sample was reported to show "an appreciable amount of salt but no potassium". Wright (1931) reported that the largest area of springs seen in the area are found 3 km upstream from the mouth of Rainy Cove Brook. This spring (Spring No. 9) area corresponds to the Rainy Cove Spring (No. 32) of Cole (1930a). It is reported to occur in the vicinity of the "Zone A" Windsor limestone which dips 75° south.

ECONOMIC CONSIDERATIONS

The Walton occurrence comprises halite; no potash is reported. IP-1 intersected 43 m (140 ft.) of salt at a depth of 472.4 m (1550 ft.). EMCO #1 intersected 63 m (207 ft.) of salt at a depth of 355 m (1165 ft.). The lateral extent and thickness variation of the salt is not known, nor is it possible to determine the structural configuration from the limited data available. The area is not readily accessible by road or railway. The small port at Walton is located approximately 13 km to the north. Based upon the available data, the occurrence is considered to be of little economic importance.

CHEVERIE

LOCATION

The Cheverie area (NTS 21H/01) is located in the northwestern part of the Hants-Colchester area and is bordered on the north by the Minas Basin and on the west by the Avon River Estuary (Figs. 1-4, 1-10 and 2-36).

HISTORICAL BACKGROUND

Geological mapping by Crosby (1962) indicated that strata of the Windsor Group underlie a large part of the area and define a small circular outlier basin. Dips around the perimeter of the basin range from 20° to 60° and the abundance of sink holes and karst topography indicate that much of the area is underlain by gypsum and anhydrite.

Salt brines were reported to have been encountered at three horizons near the bottom of Cheverie No. 1, a well drilled for petroleum in 1904 (Fig. 2-37). Two other holes are reported to have been drilled by the same company in the Cheverie area, but records of the rocks intersected could not be located according to Wright (1931). He reported that a consensus of opinion at the time was that Cheverie No. 2 intersected more than 300 m (1000 ft.) of gypsum, but Cheverie No. 3 was abandoned at relatively shallow depths. Neither was believed to have encountered salt brines.

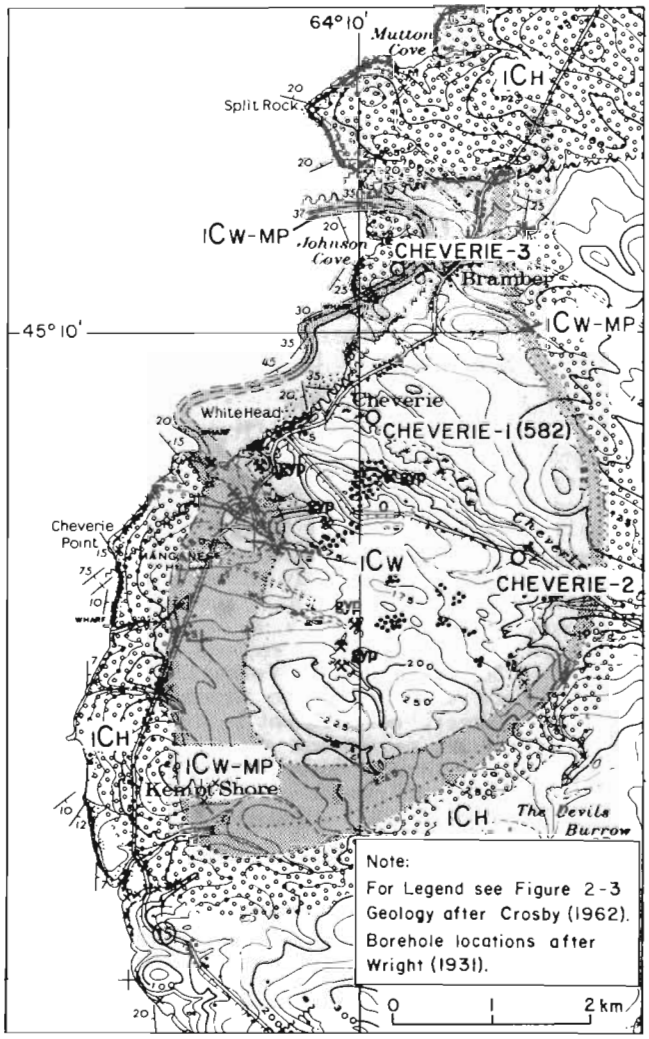


Figure 2-36. Geology of the Cheverie area, Hants County, Nova Scotia.

GEOLOGY

Wright (1931) reported a stratigraphic sequence (Table 2-8) for the area based upon outcrop and the borehole log (Fig. 2-37) of Cheverie No. 1. The stratigraphic sequence in Cheverie No. 1 (Fig. 2-37) agrees with that observed in outcrop with the exception of basal Windsor A Subzone limestone and sandstone. This discrepancy may be attributed to the drillers not recognizing or recording the units or to its removal by faulting. Windsor Group evaporite was encountered to a depth of 113 m (370 ft.) where the Horton shale and sandstone sequence was intersected to the total depth of 582 m (1910 ft.).

A salt water flow in the Horton Group was encountered in the Cheverie No. 1 borehole in a 6 m (20 ft.) bed of grey sandstone at 305 m (1000 ft.), in an 8 m (30 ft.) bed of dark grey sandstone at 552 m (1810 ft.) and in a 6 m (20 ft.) bed of whitish grey sandstone at 576 m (1890 ft.) (Table 2-9). In all instances the brines

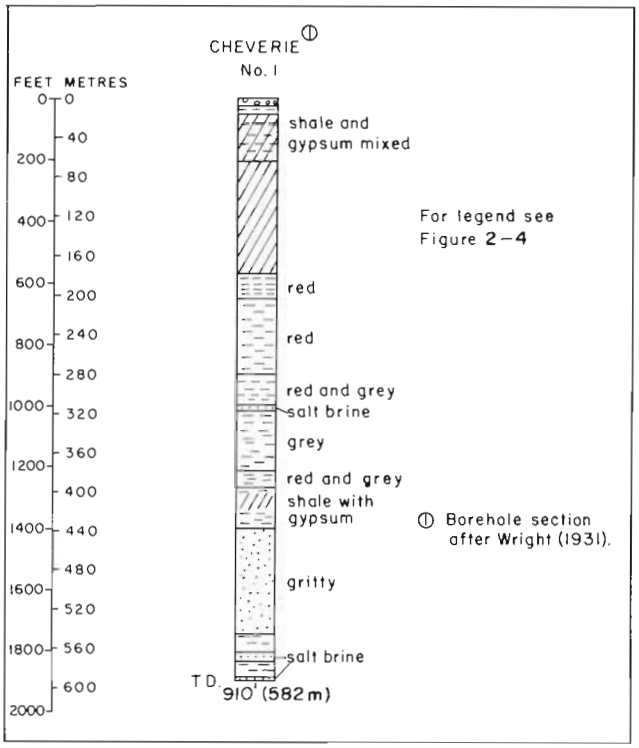


Figure 2-37. Drillhole profile, Cheverie No. 1, near Cheverie.

Table 2-8. Stratigraphic section, Cheverie area*

WINDSOR GROUP

Subzone B Grey fossiliferous limestone 3 m (10 ft.).

Subzone A Gypsum and anhydrite 113 m (370 ft.)
Laminated limestone 15 m (50 ft.)
Red shale 15 m (50 ft.).
Laminated limestone 15 m (50 ft.)
Grey massive sandstone 18.3 m (60 ft.) with Schizodus.

Local Unconformity

HORTON GROUP

Cheverie Formation
Shale and sandstone 396 m (1300 ft.).

Lower Horton
Black shales.

*Wright (1931)

were found in sandstones capped by shales. Slightly saline springs were reported near Wheaton Brook and East Noel by Wright (1931), which is a further indication of a possible salt occurrence in the area.

Wright (1931) reported analyses of Cheverie brine (Table 2-9) that were obtained from L. H. Cole (the analyst of the brine was unknown). The brine is far more concentrated than most natural salt springs and consists mainly of dissolved salt with $CaCl_2$ and $CaSO_4$.

Table 2-9. Chemical analyses of Cheverie brine* (Wright, 1931).

Specific Gravity at 15° C...1.1387

Calcium sulphate	0.3957550
Calcium chloride	0.5152726
Magnesium chloride	0.3261256
Ferrous carbonate	0.0027988
Sodium chloride	16.8279620
Total mineral matter ...	18.0679140
Water	81.9320860
Total	100.0000000

An Imperial Gallon of Cheverie brine contains:

	Grains**
Calcium sulphate	315.46433
Calcium chloride	410.74208
Magnesium chloride	259.96628
Ferrous carbonate	2.23704
Sodium chloride	13414.16587
Total mineral matter ...	14402.57560
Water	65310.97440
Total	79713.55

* Analyst Unknown
** 1 grain = 0.0648 gm

GEOPHYSICS

The Cheverie area is included on Nova Scotia Research Foundation Bouguer gravity anomaly map 21H/01E at a scale of two inches equals one mile (Fig. 2-13). The anomalies do not suggest any significant concentration of salt in the area.

Rock salt has not been encountered in the Cheverie area although concentrated salt brines are known to be present in Horton Group sandstone units capped by shale. The source of these salt brines is not certain. The Horton Group sediments in the area are not known to have salt beds, however equivalent age rocks in New Brunswick and Cumberland Sub-basin do have rock salt. The high salinity and composition of the brine makes the possibility of normal seawater infiltration remote and favours a rock salt or connate brine source. Faulting of the Horton Group and the salt bearing Windsor Group with accompanying brine migration into the aquifers of the Horton Group is a plausible explanation.

ECONOMIC CONSIDERATIONS

The Windsor Group strata occur in a small basin consisting principally of the A Subzone basal limestone-sandstone and basal anhydrite section, but some B Subzone limestone is reported in the central area. In an undisturbed section, the main salt of the Windsor Group should lie between the thick A Subzone anhydrite and the cyclic B Subzone, but has not been encountered in the drilling. The high degree of deformation indicated in the area by Boyle (1963, 1972) together with the thin cover strata of the B Subzone and the absence of salt springs indicate the area is unfavourable for the occurrence and preservation of significant rock salt deposits.