# The Windsor Group of the Mahone Bay Area, Nova Scotia

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Department of Mines
and Energy

a joint project with the
Canada Department of
Regional Economic Expansion

Paper 81-3

PROVINCE OF NOVA SCOTIA

DEPARTMENT OF MINES AND ENERGY

Paper 81-3

# THE WINDSOR GROUP OF THE MAHONE BAY AREA, NOVA SCOTIA

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Halifax, Nova Scotia
1981

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## ABSTRACT

In the Mahone Bay area of southern Nova Scotia, the Lower Carboniferous Windsor Group is represented in bedrock by carbonate rocks of the Gays River Formation (new name) and by an undetermined thickness of gypsum and shales known mainly from water well records. These rocks were deposited in a pre-Carboniferous depression in the underlying Paleozoic rocks, but have been largely removed by post-Carboniferous erosion.

The Gays River Formation, which reaches a maximum known thickness of 26.2 m, is sparsely distributed and consists mainly of limestone with lesser dolostone. A thin dolomitic sandstone occurs locally at its base. These rocks rest with angular unconformity upon rocks of the Cambro-Ordovician Meguma Group, or upon granitic rocks of Devonian age, and are overlain by grey shales and mudstones of possible Carboniferous age at the single locality where the upper contact was observed. The base of the Windsor Group in the Mahone Bay area is defined as the base of the thin sandstone which locally underlies the Gays River Formation, or as the base of the Gays River Formation where the basal terrigenous rocks are not present.

Large boulders of limestone, rich in large productid brachiopods and colonial rugose corals, are common in the glacial deposits in the area, and suggest that Upper Windsor (subzone C) limestone bedrock may also be locally preserved beneath the waters of Mahone Bay and St. Margarets Bay. The presence of such a distinctive faunal assemblage in these limestone boulders invites comparison of the study area with the Musquodoboit Basin.

The Mahone Bay area, in Viséan time, formed part of a shallow marine shelf which extended southeasterly approximately 200 km to a major ocean basin. A linear landmass, periodically inundated, may have extended the length of southern mainland Nova Scotia, and may have separated the Mahone Bay area from the Shubenacadie and Musquodoboit Basins except at the height of marine transgressions. It is doubtful that the thin veneer of shelf sediments deposited upon this postulated arch will be indicated by other than rare, isolated outliers preserved in structural depressions like the Mahone Bay area.

## INTRODUCTION

The Windsor Group throughout Nova Scotia is the subject of continuing stratigraphic and paleogeographic study by the Nova Scotia Department of Mines and Energy. In the Mahone Bay area, located approximately 32 km southwest of Halifax (Fig. 1), marine limestones of Viséan age belonging to the Windsor Group have been known since the work of Faribault (1908). These rocks are exposed on the coast and, less commonly, up to 3.2 km inland (Fig. 2).

The work of Sage (1954) provided the first comprehensive description of rocks of the Windsor Group in the Mahone Bay area. Sage carefully located each exposure of Carboniferous rocks, although several of these have since been obscured by housing development or by natural causes. A major contribution to the knowledge of the paleontology of the

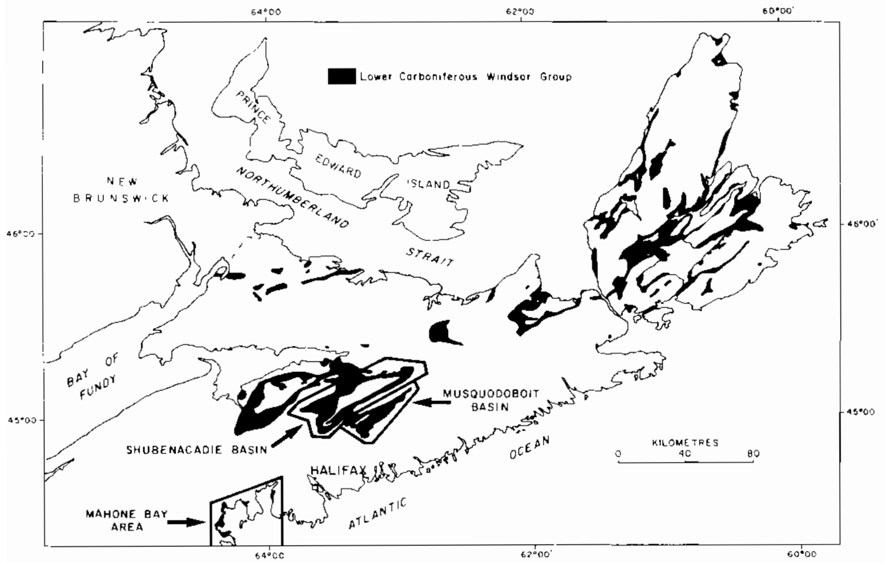


Figure 1. Map showing the distribution of rocks of the Windsor Group in Nova Scotia and the respective locations of the Mahone Bay area and the Shubenacadie and Musquodoboit Basins.

Windsor Group was made by Sage (1954), in his description of several newly reported genera of rugose corals and brachiopods.

More recently, Taylor (1969) remapped the Mahone Bay area. Only minor alterations to Sage's (1954) map boundaries depicting the distribution of the Windsor Group appear on Taylor's map, although Taylor (1969) was the first to map bedrock of the Windsor Group beneath part of Oak Island and in the southern parts of the town of Chester (Fig. 2). Also, Taylor (1969) was apparently unable to confirm Sage's (1954) report of Windsor bedrock at Upper Blandford (Gaetz Cove of Sage, 1954), Queensland (Red Bank of Sage, 1954) (Fig. 2), and the locality midway between East River and Fox Point (locality 4, Fig. 2). Taylor (1969) deleted these localities from his map.

Mahone Bay area limestones were sampled by Mamet (1970) in his regional study of calcareous Foraminifera and algae in the Windsor Group. Adams (1978) recently completed a detailed study of the gigantoproductids of the Windsor Group, and included material from the Mahone Bay area in his study. Ryan (1978) included data from the Mahone Bay limestone in his study of the Gays River Formation.

The submarine geology of the Mahone Bay area has been the subject of recent research by staff and students at Dalhousie University, Halifax.

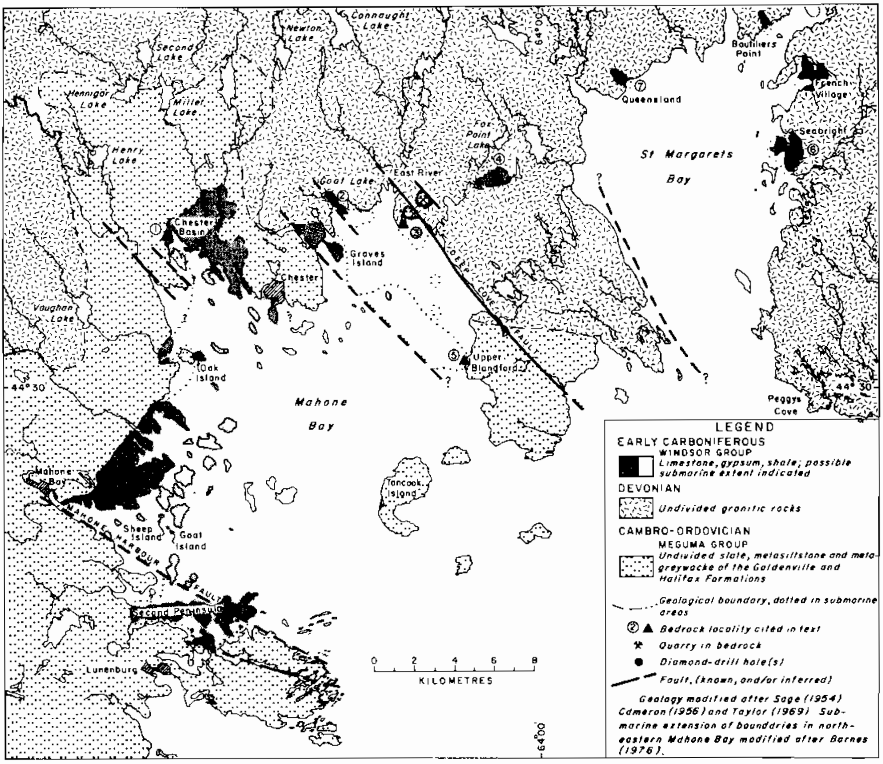


Figure 2. Geological map of the Mahone Bay area (after Sage, 1954, and Taylor, 1969) showing known outcrops of the Gays River Formation and associated Windsor Group strata.

Barnes (1976) and Barnes and Piper (1978) described the geology of the eastern part of Mahone Bay, and reported a thin veneer of Windsor bedrock as indicated by Nova Scotia Research Foundation Teledyne multi-tip sparker surveys. Piper and Keen (1976) conducted a similar survey of St. Margarets Bay, and reported that the bedrock beneath the Bay consisted of granitic rocks. They were unable to extend known onshore occurrences of Windsor strata into the adjacent submarine areas. In neither area was a description of the submarine Windsor strata presented.

Goudge (1934) provided a brief description of Windsor limestone quarried in the community of East River for use in paper manufacture. As part of a Province-wide inventory of limestone and dolomite resources, six diamond-drill holes were completed in 1966 by the Nova Scotia Department of Mines in the vicinity of the East River quarry (Figs. 2 and 3). Cores from five of these holes provide excellent stratigraphic data and permit detailed study of Windsor limestones and dolostones for comparative purposes. Hole No. 1 penetrated only granitic rocks and was not considered in this study. The data gathered during the examination of these cores are presented in this report, supplemented by information gleaned from all known exposures of rocks of the Windsor Group in the area (Fig. 2). Summary descriptions of cores used in this study are presented in Appendix I. Standard petrographic thin sections supplemented the study of diamond-drill core slabs. Appendix II lists the thin sections stored in the collection of the Nova Scotia Department of Mines and Energy, and readily available for study by interested persons.

## GEOLOGICAL SETTING

Mahone Bay and St. Margarets Bay are marine basins overdeepened by glacial erosion (Barnes, 1976; Barnes and Piper, 1978; Piper and Keen, 1976). The bays are connected with the Atlantic Ocean across shallow sills. Carboniferous strata outcrop in an irregular pattern on the shorelines of the bays (Fig. 2), and are preserved as thin postglacial remnants in submarine areas (Barnes and Piper, 1978). Barnes and Piper (1978) believed that the configuration of the present land suface might be largely controlled by the exhumed unconformity at the base of the Carboniferous rocks.

Carboniferous rocks lie unconformably upon rocks of the Meguma Group, or upon granitic rocks of Devonian age (Fig. 2). Penetrative foliation is well developed in slates of the Meguma Group which is folded in a series of upright, gently-plunging, northeasterly trending folds. The Carboniferous rocks are, in contrast, gently inclined and conform to irregularities in the surface of unconformity.

Northwesterly trending faults cut the area. These were considered by Cameron (1949, 1956) to be pre-Carboniferous features. Sage (1954) believed that the Deep Cove Fault (Fig. 2), and several associated smaller faults cut the Carboniferous strata and thus postdated these rocks. Unfortunately, no faulted contacts are presently exposed to resolve this difference in interpretation. The author has followed Sage (1954) in Figure 2, in which many of the small outcrop areas of Windsor strata are shown to be bounded by faults. This interpretation suggests that the present basin-like configuration of Mahone Bay (and St. Margaret Bay) could have been in part produced by block faulting in post-Carboniferous time, thus preserving remnants of a regionally more extensive sedimentary succession. This view contrasts with that of Cameron (1956) who believed that the bays (basins) were of pre-Carboniferous origin, and that Carboniferous deposition took place in pre-existing depressions. In the absence of definitive data, neither view can be fully supported. A compromise interpretation favoured by the author, is to presume that post-Carboniferous fault movements occurred on older, pre-existing faults.

The Mahone Bay area is blanketed by a thick cover of Pleistocene drift. Drumlins in the area are conspicuous and abundant, and were depicted on the geological map of the area prepared by Sage (1954).

## WINDSOR GROUP STRATIGRAPHY

### Gays River Formation in the Mahone Bay Area

#### NAME AND GEOGRAPHIC DISTRIBUTION

Named by Boehner (1977), the Gays River Formation forms the lowermost rock unit of the Windsor Group in the Musquodoboit Basin and on the southern periphery of the Shubenacadie Basin (Fig. 1; Giles and Boehner, 1979; Giles et al., 1979). The Formation is here locally defined as that succession of pelletal, intraclastic and algal limestones and dolostones which, with associated thin basal sandstones, comprise the lowermost rock unit of the Windsor Group in the Mahone Bay area. The base of the Formation is placed at the base of the lowest bed of dolomitic sandstone or dolostone of Middle to Late Viséan age. The top is placed at the base of an overlying succession of shales, mudstones and gypsum, to which no formal unit name is applied. In field exposure, the Gays River Formation is typically overlain directly by unconsolidated materials of Pleistocene to Recent age. All known local exposures of the Gays River Formation occur on or near the shores of Mahone Bay.

The principal local reference section of the Gays River Formation is designated as those rocks intersected between depths of 9.1 m and 34.5 m in diamond-drill hole ER-3. This hole was drilled in the rural community of East River, Lunenburg County, and its specific location is indicated in the inset map of Figure 3. Core from this hole is stored permanently in the core repository of the Nova Scotia Department of Mines, and is readily available for examination. Hole ER-4, which intersected rocks of slightly different character in its lower parts, is designated a second reference section (Fig. 3).

Known exposures of the Gays River Formation are indicated in Figure 2. Each of these localities was described by Sage (1954).

The Chester Basin exposure (locality 1, Fig. 2) is located immediately northwest of the local service station in the village of Chester Basin. Approximately 1.5 m of dolostone are exposed in contact with greywacke of the Goldenville Formation. The dolostone is thinly to medium bedded, and sparsely fossiliferous with small gastropods. Recent excavation has removed much of the exposure, and the remainder will no doubt be partially covered by vegetation in a relatively short period of time.

Near Frail Cove (locality 2, Fig. 2), limestone is exposed on the eastern shore of Goat Lake at the site of a former lime kiln. Nearly 6 m of thickly bedded to massive limestone are exposed here. No contacts were observed, although outcrops a short distance to the south on the eastern shore of Frail Cove, rest upon Goldenville greywacke. In the latter small coastal exposures, approximately 1 m of impure carbonate rocks can be seen, the lowermost beds of which contain angular greywacke pebbles in a dolomitic matrix.

Several outcrops occur in the vicinity of East River (locality 3, Fig. 2). On Indian Point, 100 m west of the old breakwater, a thin veneer of dolomitic limestone is partially exposed near the lowwater mark.

Beds are undulatory and appear to drape over irregularities in the underlying granite. The limestone is medium bedded, brown in colour, and sparsely fossiliferous with smooth-shelled brachiopods. Tabulate corals of the genus *Cladochonus* were recovered from large slabs resting on the outcrop, but could not be found in situ. Sage (1954) identified *Beecheria* sp., *Straparollus minutus*, and *Conularia planicostata* from bedrock in this same exposure. *Conularia* has since been revised to *Paraconularia* (Moore and Ryan, 1976) and is reported as such in Table 1 of this report.

The abandoned limestone quarries in the vicinity of East River (see inset map, Fig. 3) provide the thickest available sections of Windsor limestone in the Mahone Bay area. Quarry No. 1 is partially water filled. A thickness of almost 7 m of thickly bedded mottled grey and brown limestone is exposed. Sage (1954) reported that the quarry was abandoned when dolomitic rocks were encountered in the deepest parts of the quarry. These dolomitic rocks are presently covered by up to 3 m of water and could not be examined. Quarry No. 2 exposes more than 8 m of high calcium limestone, but is rapidly being filled with debris and abandoned automobiles dumped into the pit by the local inhabitants. No contacts can be seen in the quarry. Quarry No. 3 was used as a settling pond for industrial waste from an adjacent wood-processing factory, and provides little exposure at present. Sage (1954) reported approximately 5 m of limestone exposed in the latter quarry.

Sage (1954) reported a few small exposures of sandy, limonitic Windsor limestone preserved as a thin veneer covering the granitic rocks midway between the East River exposures and Fox Point (locality 4, Fig. 2). The writer did not attempt to confirm this occurrence.

Water wells at Upper Blandford (locality 5, Fig. 2) were reported by Sage (1954) to contain limestone at the bottom. These limestone occurrences were not confirmed during this study, but presumably should rest upon slate of the Halifax Formation of the Meguma Group.

Sage (1954) reported an exposure of Windsor limestone between Glen Margaret and Seabright (locality 6, Fig. 2) which the writer was unable to confirm. This limestone is apparently now concealed, although Mamet (1970) reported Foraminifera from this locality and, like Sage, assigned the limestone to the B Subzone of Bell (1929). Sage (1954) believed that both B and E Subzone limestones were represented at the locality, and correlated the lowest outcrops (stratigraphically) with those at East River.

At Queensland (locality 7, Fig. 2), Sage (1954) reported a small exposure of laminated limestone. This exposure is now concealed.

The exposures at localities 1, 2, 3, 4 and 6 were each considered by Sage (1954) to represent the same limestone unit, and were considered representative of Bell's (1929) B Subzone on the basis of their fauna. The writer concurs with Sage in equating the limestones at these scattered exposures, but differs with the assignment to the B Subzone for reasons presented later in this report. In addition, the writer also suggests that the limestone at localities 5 and 7 may also be correlated with the East

River exposures, and that all exposed carbonate rocks may be assigned, throughout the Mahone Bay area, to a single rock unit.

In summary, the Gays River Formation is known in outcrop at localities 1, 2 and 3, has been reported but unconfirmed at localities 4 and 6, and is probably represented at localities 5 and 7, although previously reported exposures cannot presently be confirmed. The remainder of the outcrop areas of bedrock of the Windsor Group in the Mahone Bay area, are mapped (Fig. 2) on the basis of karst topography, or using the local abundance of limestone boulders in glacial drift. Thus, throughout much of the area, only limited confidence can be placed in the mapped boundaries of the Windsor Group. In the marine area of eastern Mahone Bay, the boundaries of Barnes and Piper (1978) are shown as located by those authors, although the nature of the boundary (Fig. 2), is interpreted by the present author, based upon inferred relationships onshore, and upon submarine topography.

## LITHOLOGIC CHARACTER

The Gays River Formation in the Mahone Bay area consists typically of limestone ranging in colour from pale greyish white to medium and dark brown. The Formation is characteristically thickly bedded and is dolomitic in the lowermost 1-3 m. Allochemical constituents consist of small pellets, rod-like faecal(?) or algal pellets (intraclasts), and very locally, coated intraclasts and pseudooids. The Formation is only sparsely fossiliferous (Table 1).

The basal beds of the Gays River Formation consist locally of dolomitic sandstone and conglomerate, the composition of which closely reflects the adjacent and underlying bedrock. These rocks (Unit T-1, Fig. 3) are usually less than one metre in thickness.

In the most complete sections of the limestone, the carbonate rocks vary systematically, permitting a five-part subdivision (Units C-1 to C-5, Fig. 3). The presence of these distinct subunits, described under subsequent headings, may locally typify the Gays River Formation. Because the present data are so sparsely distributed, this suggestion must be considered tentative.

## CONTACT RELATIONSHIPS

The Gays River Formation rests with angular unconformity upon rocks of the Meguma Group (localities 1 and 2, Fig. 2), and unconformably upon granitic rocks in the East River area (locality 3, Fig. 2).

Unconsolidated materials of Pleistocene to Recent age overlie the Formation at each locality with the exception of the Chester Basin exposure (locality 1, Fig. 2). At this locality, dark brown shale and mudstone, thinly bedded and in part ochrous, overlies dolostone of the Gays River Formation. The actual contact is concealed by material caving from the walls of the man-made excavation. Attempts to extract spores from these mudstones were not successful. A Viséan age is suggested by reports, in water well records, of slate (shale ?) associated with gypsum, resting upon limestone presumed to represent the Gays River Formation.

Table 1. Fauna and flora of the Gays River Formation, southern Nova Scotia

| TYPE AREA* | MAHONE BAY AREA |
| --- | --- |
| *Cladochonus* sp. | *Cladochonus* sp. |
| *Paraconularia planicostata* | *Paraconularia planicostata* |
| *Batostomella abrupta* | |
| *Batostomella exilis* | |
| *Fenestrellina* sp. | |
| *Cyclopora* sp. | |
| *Beecheria davidsoni* | *Beecheria davidsoni* |
| *Pteronites gayensis* | |
| *Aviculopecten* sp. | |
| *Aviculopecten lyelli* | |
| *Aviculopecten lyelliformis* | |
| *Leptodesma* sp. | |
| *Leptodesma acadica* | |
| *Leptodesma borealis* | |
| *Leptodesma dawsoni* | |
| *Diodoceras avonensis* | |
| *Streblopteria debertianum* | |
| *Pseudozygopleura (?) cara* | |
| *Plocezyga (?)* sp. | |
| *Straparollus minutus* | *Straparollus minutus* |
| *Koninckopora* sp. *(alga)* | *Koninckopora* sp. |
| *unknown Codiaceae (alga)* | *unknown Codiaceae* |

* data from Ryan (1978)

The upper contact of the Formation is thus placed variously at the contact between these carbonate rocks and terrigenous rocks of probable Viséan age, or at the unconformity between these carbonate rocks and materials of Pleistocene to Recent age.

## THICKNESS

Because the Gays River Formation in the Mahone Bay area is not completely exposed anywhere, its true stratigraphic thickness remains unknown. At locality 1, the Formation does not exceed 2 m in total thickness. In the East River diamond-drill holes (Fig. 3), the thickness reaches 26.2 m. Little variation in total thickness is apparent at this locality, although individual units change dramatically in thickness over very short distances.

## FAUNA AND FLORA

Table 1 summarizes the faunal and floral elements presently known or previously reported from Gays River rocks of the Mahone Bay area and reported from the Gays River Formation in its type area by Ryan (1978).

Mamet (1970) reported the calcareous Foraminifera *Biseriammina* ? sp., *Biseriammina* ? *windsorensis*, and *Earlandia* of the group *E. clavatula*, from Quarries Nos. 1 and 2 at East River, in limestones here assigned to the Gays River Formation.

Mamet (1970) also reported abundant calcareous Foraminifera from a limestone outcrop at Redman Hill (locality 6, Fig. 2), apparently the same outcrop located by Sage (1954) and assigned by Sage to the B Subzone of Bell (1929). Because Sage equated this limestone with the East River exposures, the Foraminifera reported should represent forms typical of the Gays River Formation of this study. The following calcareous Foraminifera and algae were identified by Mamet (1970).

*Archaediscus* sp.
*Archaediscus* of the group *A. krestovnikovi*
*Archaediscus* of the group *A. moelleri*
*Archaediscus* of the group *A. chernoussovensis*
*Calcisphaera* sp.
*Calcisphaera laevis*
*Calcisphaera pachysphaerica*
*Climacammina* of the group *C. patula*
*Climacammina* of the group *C. prisca*
*Earlandia* of the group *E. vulgaris*
*Endothyra* sp.
**Koninckopora* sp.
*Palaeotextularia* of the group *P. consobrina*
*Parathurammina* sp.
*Radiosphaera* sp.
*Tetrataxis* of the group *T. conica*
*Vicinesphaera* sp.

* Calcareous alga

It is apparent that little similarity exists between the East River exposures and the Redman Hill outcrop with respect to species and abundance of species of calcareous Foraminifera. This observation, with the writer's inability to relocate the Redman Hill exposure, urges caution in correlating the Redman Hill outcrop with rocks of the Gays River Formation.

## SUBDIVISIONS OF THE GAYS RIVER FORMATION

### Introduction

In its type and reference sections (diamond-drill holes ER-3 and ER-4) and in contiguous diamond-drill holes, the Gays River Formation exhibits a six-part subdivision, defined by an orderly distribution of contrasting rock units in vertical sections. Less complete sections can also be assigned, on the basis of lithology, to one or more of these rock units, which are described in ascending order in subsequent paragraphs. The classification and terminology of Folk (1959, 1962) has been used throughout this paper for the carbonate rocks.

**Basal Sandstone and/or Conglomerate (Unit T-1, Figure 3)**

Terrigenous rocks occur at the base of the Gays River Formation in diamond-drill holes ER-3, ER-4, ER-5 and ER-6. In each hole, coarse grained sandstone predominates (Fig. 4A, B and D), with lesser fine conglomerate and medium grained sandstone (Fig. 4D). These rocks are typically dark grey-brown in colour, and are cemented by dolomite. Some beds are comprised of sandy dolostone, although terrigenous beds predominate within the Unit.

Detrital components in the sandstones consist mainly of quartz with lesser feldspar and mica. In the coarsest grained rocks, fragments of the underlying granite are abundant. These terrigenous grains, ranging in maximum apparent dimension from 0.1 mm to 3 mm, are typically poorly sorted (Fig. 4A and C). Grains are highly angular (Fig. 4), and show little evidence of significant abrasion. Where a high proportion of terrigenous grains is present, the sandstones may exhibit equigranular textures (Fig. 4D).

The dolomitic matrix is typically devoid of carbonate allochems, but may locally contain a high proportion of ooids and superficial ooids with minor shell fragments (Fig. 4B). Bituminous material is often present in these rocks (Fig. 4A and C), and is also present in the overlying carbonate rocks.

The basal beds at the Frail Cove exposure (locality 2, Fig. 2) are composed of dolostone containing numerous angular fragments of Meguma greywacke, described by Sage (1954) as a sharpstone conglomerate. This lithology is considered a variant type, equivalent in nature to the basal sandstones in the East River diamond-drill holes. The limited data available suggest that in the Mahone Bay area, coarse breccias occur where the Gays River Formation rests upon rocks of the Meguma Group, and that sand-sized detritus is more characteristic when the Gays River Formation rests upon granite. The preeence of the basal terrigenous rocks depends entirely

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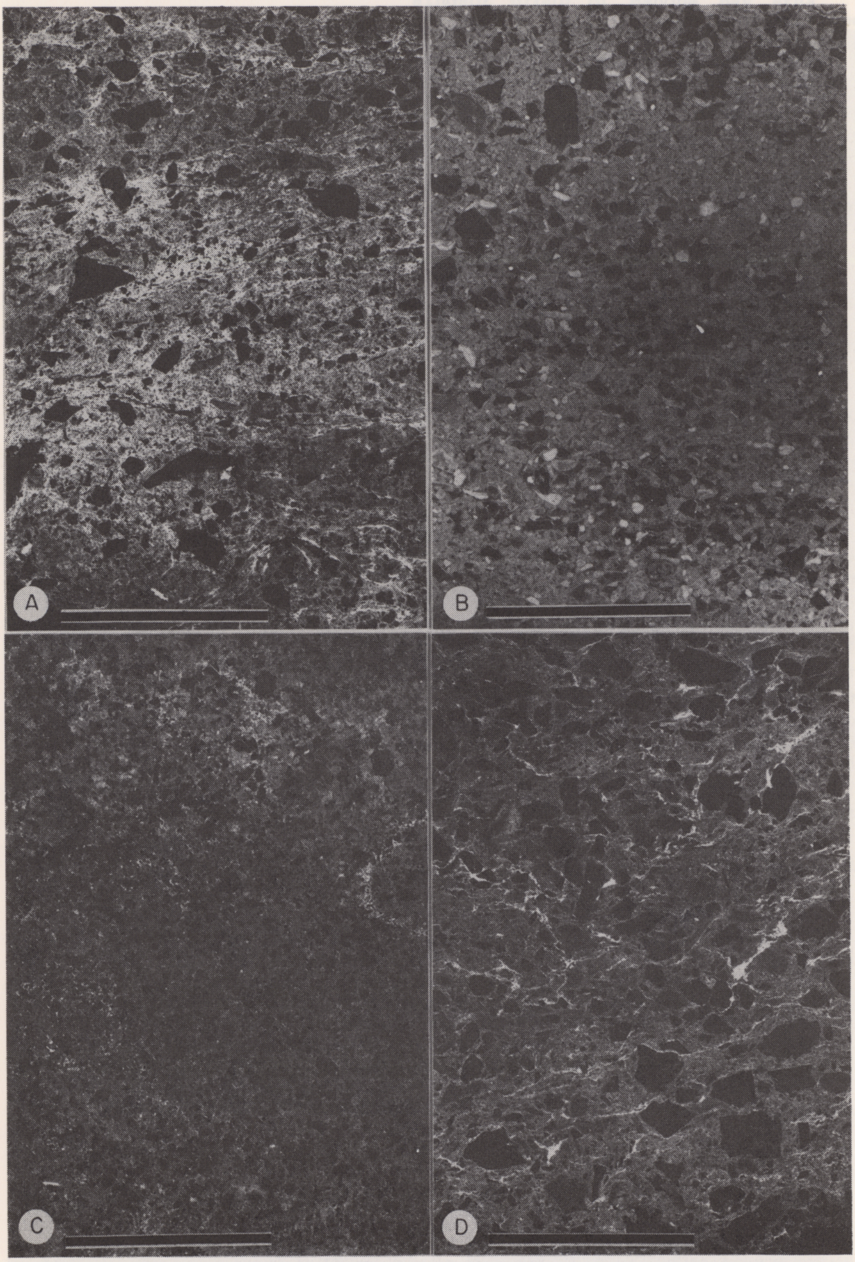
**Explanation of Figure 4**

Negative prints of thin sections. Bar scale = 10 mm

Terrigenous rocks from the basal Unit T-1 of the Gays River Formation in the Mahone Bay area. The matrix in each photograph consists of dolomite. Note the angular and poorly sorted detritus in A, B and D. The irregular white stringers in A and C are composed of bituminous material. In C, a high proportion of detritus results in a finely granular texture. A high proportion of feldspar grains are present in C, whereas grains in A, B and D are dominated by quartz. In B, small ooids are abundant in the matrix. This sample is representative of thin carbonate interbeds within the basal sandstone unit in hole ER-3, (Fig. 3, in pocket).

Sample in A ER5 - 77.0, Hole ER-5, depth 23.5 m
Sample in B ER3 - 110.0, Hold ER-3, depth 33.8 m
Sample in C ER5 - 77.6, Hole ER-5, depth 23.7 m
Sample in D ER4 - 1D4.3, Hole ER-4, depth 31.8 m


A
B
C
D

upon the local availability of detritus, as indicated by the absence of such rocks in the bedrock exposure at Indian Point (locality 3, Fig. 2).

The thickness of the basal sandstone in the East River drillholes ranges from 0.2 m to 1.4 m. This range encompasses the observed thickness in each outcrop where the basal terrigenous rocks can be seen.

The contact of the basal sandstones and conglomerates with the overlying carbonate rocks is abrupt and distinct in the East River drillholes. The Frail Cove exposure changes very rapidly upwards from sharpstone conglomerate to dolostone, but the upper contact of the conglomerate is not sharply defined. The upward change is instead typified by a very rapid decline in pebble content.

**Carbonate Unit C-1**

Carbonate rocks of Unit C-1 occur on the eastern shore of Goat Lake (locality 2, Fig. 2) and are well exposed in the East River area at Indian Point and in Quarry No. 1 (see inset map, Fig. 3). They are also common in diamond-drill holes ER-3 and ER-6, and to a lesser extent in hole ER-5 (Fig. 3).

Macroscopically, carbonate rocks of Unit C-1 are typified by their thickly bedded to massive character, and by their mottled grey and brown appearance. Porosity is sporadically well developed, but is most often diminished by infilling by calcite or dolomite (Fig. 5). Vugs filled with fluorite or galena have been observed, although these minerals are volumetrically unimportant. Smooth-shelled brachiopods, filled with calcite or dolomite, are sparsely distributed throughout this rock Unit, and are most abundant in its lower parts (Fig. 3). The tabulate coral *Cladochonus* sp. (Fig. 6B) occurs in dolostones of this Unit in drillholes ER-6 and ER-3, but is limited to the lowermost parts of the Unit (Fig. 3).

Petrographic examination reveals the common presence of small carbonate intraclasts, indistinct pellets, and minor shell fragments (Fig. 5A and B; Fig. 6A). These allochems are enclosed in a matrix of finely

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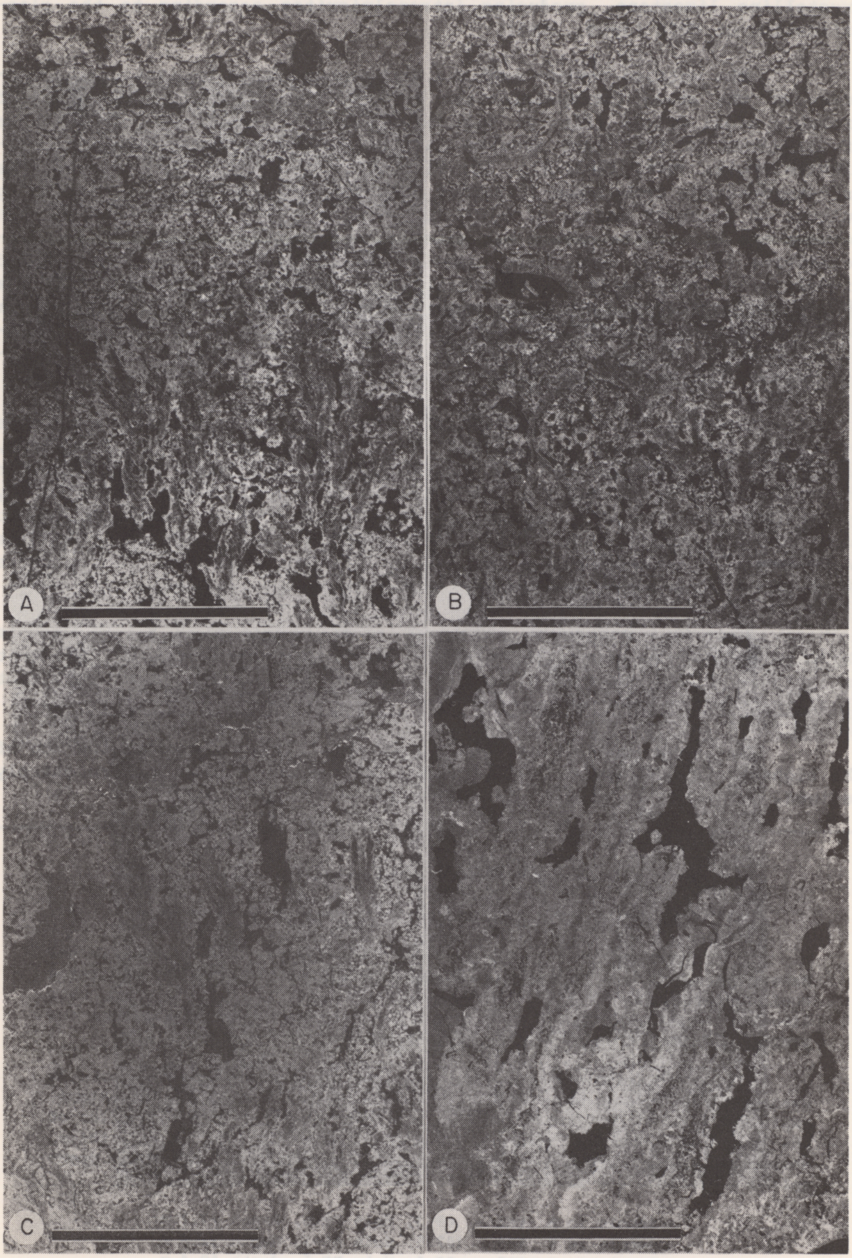
**Explanation of Figure 5**

Negative prints of thin sections. Bar scale = 10 mm

Limestone and dolostone typical of Unit C-1. Small intraclasts and pellets comprise the bulk of A, B and C. Shell material, probably *Beecheria* sp., can be seen in the lower centre and upper left part of B. Note the presence of upwards-bifurcating tubular structures tentatively identified as an alga of the *Codiaceae*. Stratigraphic top is towards the top of each photograph. Note the common presence of irregular voids (black) in A and B. In C, similar voids are filled with clear calcite.

Texture in D is tentatively attributed to algal genesis. Note the control of void shape by the strong subvertical fabric.

Sample in A ER3 - 89.0, Hole ER-3, depth 27.1 m
Sample in B ER3 - 93.8, Hole ER-3, depth 28.6 m
Sample in C ER3 - 98.7, Hole ER-3, depth 30.1 m
Sample in D ER6 - 49.2, Hole ER-6, depth 15.0 m


A
B
C
D

crystalline limestone, producing intrapelmicrites according to the classification of Folk (1959, 1962).

The mottled textures of the Unit are produced by irregular admixtures of the above intrapelmicrites with finely crystalline limestone of probable algal origin (Fig. 5; Fig. 6C). In many cases, the predominance of limestone of this type results in classification of the rocks as biolithite (Folk, 1959, 1962; Fig. 5D; Fig. 6C). More typically the rock type is heterogeneous with large irregular patches of intrapelmicrite, enclosing bulbous or elongate masses of biolithic carbonate. Large irregular spaces between the biolithite masses are sometimes incompletely filled with intrapelmicrite (Fig. 7B) indicating clearly that the sediment was cohesive and rigidly bound very early in its history. Organic binding by algae offers a reasonable explanation for this early lithification. The small vermiform gastropods in these biolithites (Fig. 7B) are common in algal-bound limestones of Carboniferous age in Britain (Burchette and Riding, 1977), lending support to this interpretation.

Further evidence of algal growth concurrent with sedimentation is suggested by the fabrics illustrated in Figure 5A, B and C. In each case, irregularly branching, tubular organic structures are present in an intrapelmicrite matrix. These structures were tentatively identified by Ryan (1978) as calcareous algae of the Family *Codiaceae*, and appear to occur in life position. Textures produced by these algal growth forms range from linear (Fig. 5A, B and C) to irregular, anastomosing patterns which produce the mottled textures typical of the Unit.

Unit C-1 ranges in thickness from a maximum of 8.4 m in hole ER-3, to only a few metres in hole ER-5 (Fig. 3). The rocks of this Unit interfinger with rocks of Unit C-1A, and appear to represent resistant algal reefs where best developed.

The upper contact of Unit C-1 is arbitrarily placed at the top of the highest bed of algal-mottled limestone. The contact is nowhere sharply defined.

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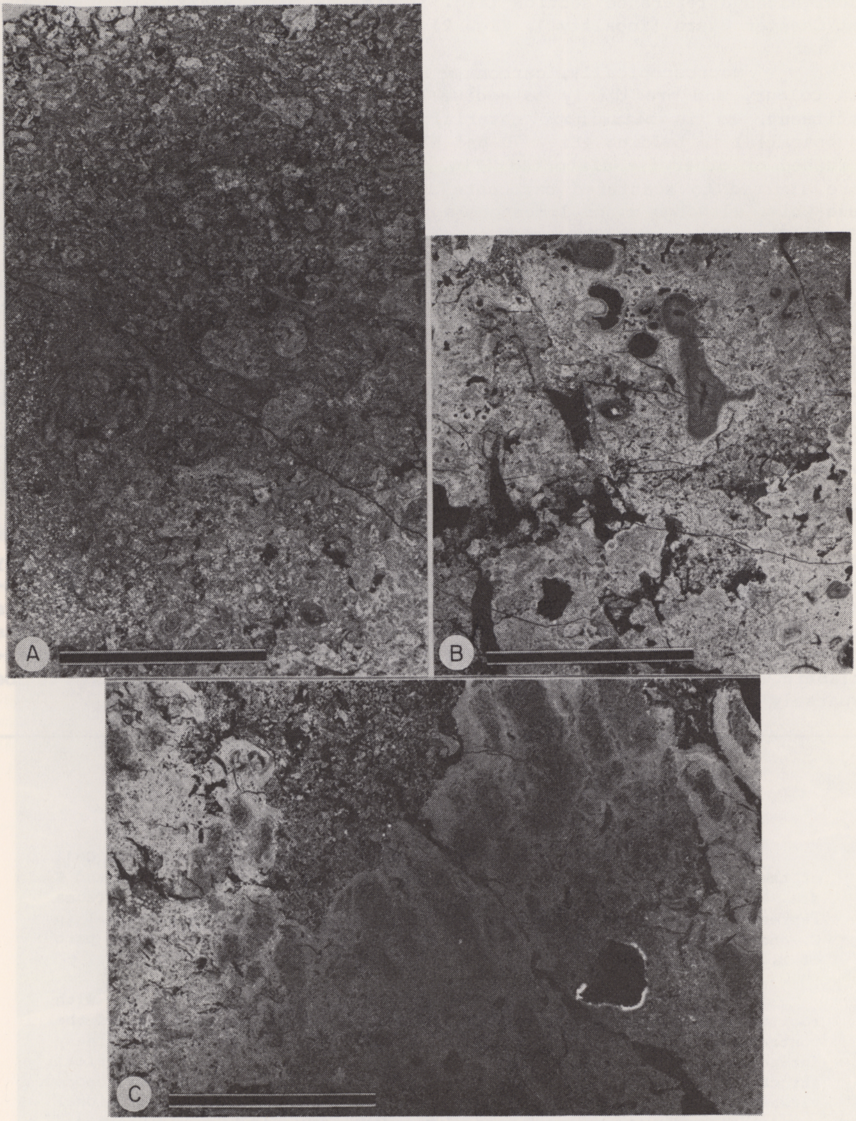
**Explanation of Figure 6**

Negative prints of thin sections. Bar scale = 10 mm

Limestone typical of Unit C-1 of the Gays River Formation in the Mahone Bay area. Note the abundance of small intraclasts and scattered shell material in A, and in the upper left part of C. Contrast this limestone type with the biolithite which predominates in C, and note the preferred fabric apparent in the biolithite.

A single specimen of the tabulate coral *Cladochonus* sp. can be seen in the upper centre part of B. Finely crystalline limestone, representing recrystallized cement, almost completely fills the interior of the coral. The lower parts of B are in part algal-bound biolithite, whereas in the upper part, pellets and small intraclasts with small open-spired gastropods are abundant.

Sample in A ER6 - 69.7, Hole ER-6, depth 21.2 m
Sample in B ER3 - 107.5, Hole ER-3, depth 32.8 m
Sample in C ER5 - 60.5, Hole ER-5, depth 18.4 m


A
B
C

**Carbonate Unit C-1A**

Rocks of Unit C-1A are best seen in core from hole ER-4, here designated a reference section (Fig. 3; Fig. 7A, C, D and E). The exposure at Chester Basin (locality 1, Fig. 2) belongs to this Unit.

Macroscopically, carbonate rocks of this Unit are dark grey-brown in colour, and are thinly to medium bedded. Quartz silt is a common constituent, as is bituminous material in irregular stringers parallel or subparallel to bedding (Fig. 7D and E). Faunal elements are rare and often crushed or otherwise distorted (Fig. 7C and E). Allochemical constituents are limited to scattered carbonate intraclasts. Dolostone is typical in the Unit, although minor limestone appears near the top of the Unit in hole ER-4 (Fig. 3).

Petrographically, rocks of this Unit are best classified as sparsely fossiliferous silty dolomicrites (Folk, 1959, 1962), or locally, silty micrites.

The thickest section of this Unit is 3.6 m in the principal reference section, where it is overlain abruptly by rocks of carbonate Unit C-2 (Fig. 3). In hole ER-5, the Unit passes upwards through intercalation, into rocks of Unit C-1, clearly establishing the lateral equivalence of Units C-1 and C-1A (Fig. 3).

**Carbonate Unit C-2**

Unit C-2 is composed of grey-brown limestone, medium to thickly bedded with numerous stylolitic surfaces oriented both parallel and perpendicular to bedding. The Unit is not apparently fossiliferous, and is typified by its uniform somewhat nondescript character throughout its thickness. With etching, using dilute hydrochloric acid, finely intraclastic beds become macroscopically apparent, but these appear to be sparsely distributed.

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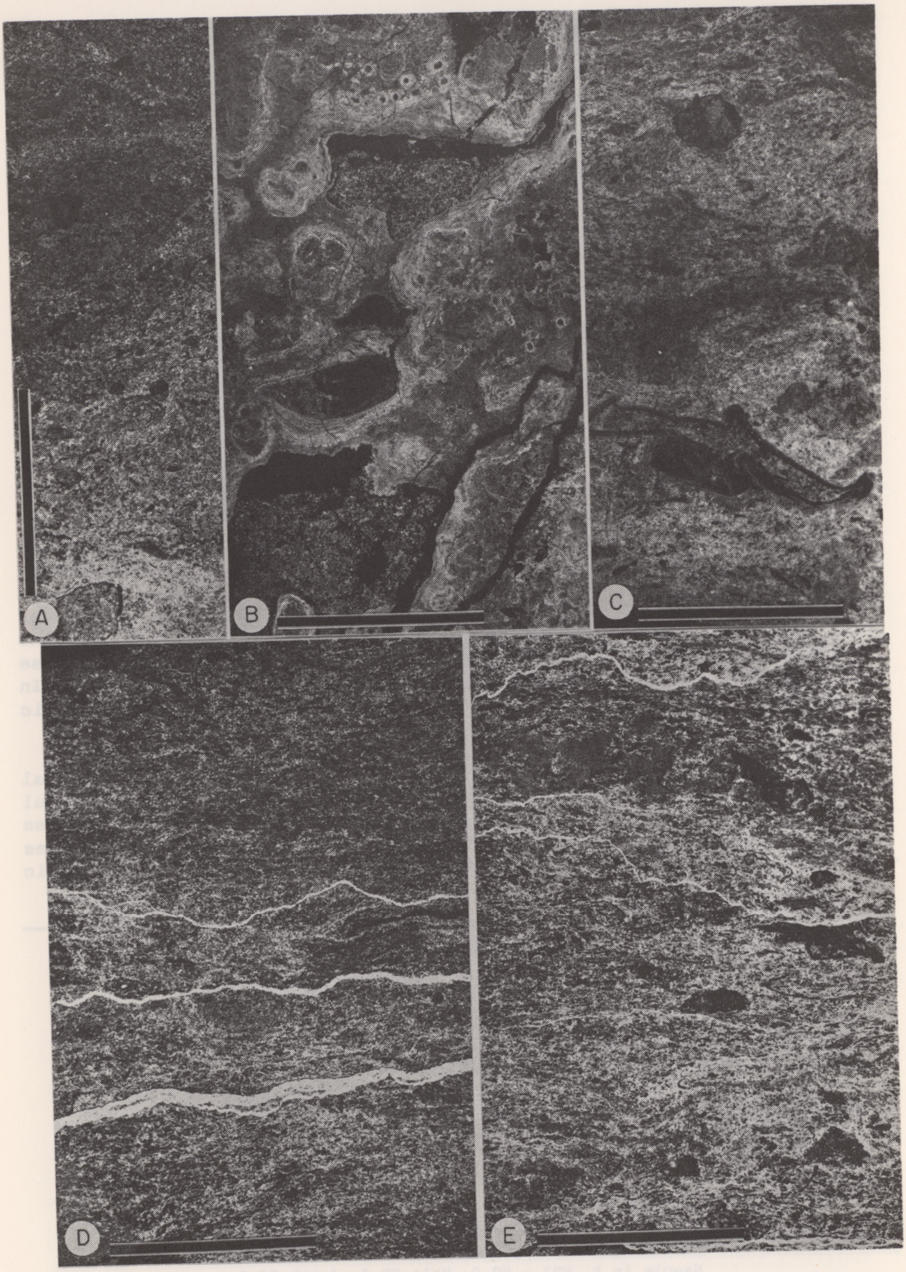
**Explanation of Figure 7**

Negative prints of thin sections. Bar scale = 10 mm

Thinly bedded argillaceous and bituminous dolostones of Unit C-1A of the Gays River Formation in the Mahone Bay area. White veins in D and E are bituminous material. Note the characteristically sparse fauna represented by thin shelled fragments in A, by distorted shell material in C, and by a poorly preserved high-spired gastropod in the upper right part of E.

Limestone in B represents a bed of Unit C-1, intercalated with rock types of A, C, D and E character. Note the irregular texture, and the contrasting granularity of finely crystalline biolithite and finely intraclastic matrix which incompletely fills large voids. Small spherical structures in upper centre part of B are open-spired veriform gastropods viewed in cross-section. Note the apparent lack of post-depositional compaction in B, and contrast with C where the fossil is highly distorted.

Sample in A ER5 - 75.0, Hole ER-5, depth 22.9 m
Sample in B ER5 - 73.6, Hole ER-5, depth 22.4 m
Sample in C ER5 - 70.5, Hole ER-5, depth 21.5 m
Sample in D ER4 - 99.7, Hole ER-4, depth 30.4 m
Sample in E ER4 - 98.5, Hole ER-4, depth 30.2 m


A
B
C
D
E

Petrographic examination reveals that the limestones of Unit C-2 are composed almost entirely of tiny round intraclasts and pellets, often so tightly packed that the rock appears micritic (Fig. 8C). More typically, a fine porosity is apparent (Fig. 8A, B, D and E), but usually effectively sealed by clear calcite, most apparent in Figure 8B. The distribution of this pore-filling calcite imparts a small-scale mottling to the limestone, not unlike that of Unit C-1, but differing in scale and in origin.

Rocks of Unit C-2 are classified as intrapelmicrites. Their uniformity in vertical succession is disrupted only by the appearance of large patches of calcite in fracture-induced pore spaces.

The thickness of Unit C-2 ranges from a minimum of 2.2 m in hole ER-4, to a maximum of 7.9 m in hole ER-3. The Unit is best developed where it rests upon Unit C-1A (Fig. 3).

The upper contact of Unit C-2 is placed at the base of an algal-mottled limestone which comprises Unit C-3.

**Carbonate Unit C-3**

Unit C-3 forms a thin, but distinctive traceable horizon in the cores from diamond-drill holes in the East River area (Fig. 3). A coarsely mottled grey-brown and brown colour is typical in this massive limestone bed. No fossils have been observed, and the only allochems consist of large irregular lumps of limestone, surrounded by a finely crystalline limestone matrix (Fig. 9A). No certain origin can be suggested for these lumpy textures, although the writer favours an organic (algal) origin. In contrast, are the textures of Figure 9B, the origin of which may be organic or entirely diagenetic.

Rocks of Unit C-3 may be classified as lumpy micrite or algal biolithite (Folk, 1959, 1962). Their macroscopic character is most useful in recognizing the Unit. The Unit ranges from 0.5 m to 1.8 m in thickness (Fig. 3) and is best developed in hole ER-6 where Unit C-1 also achieves its maximum thickness. The upper contact of Unit C-3 is a sharp lithologic break.

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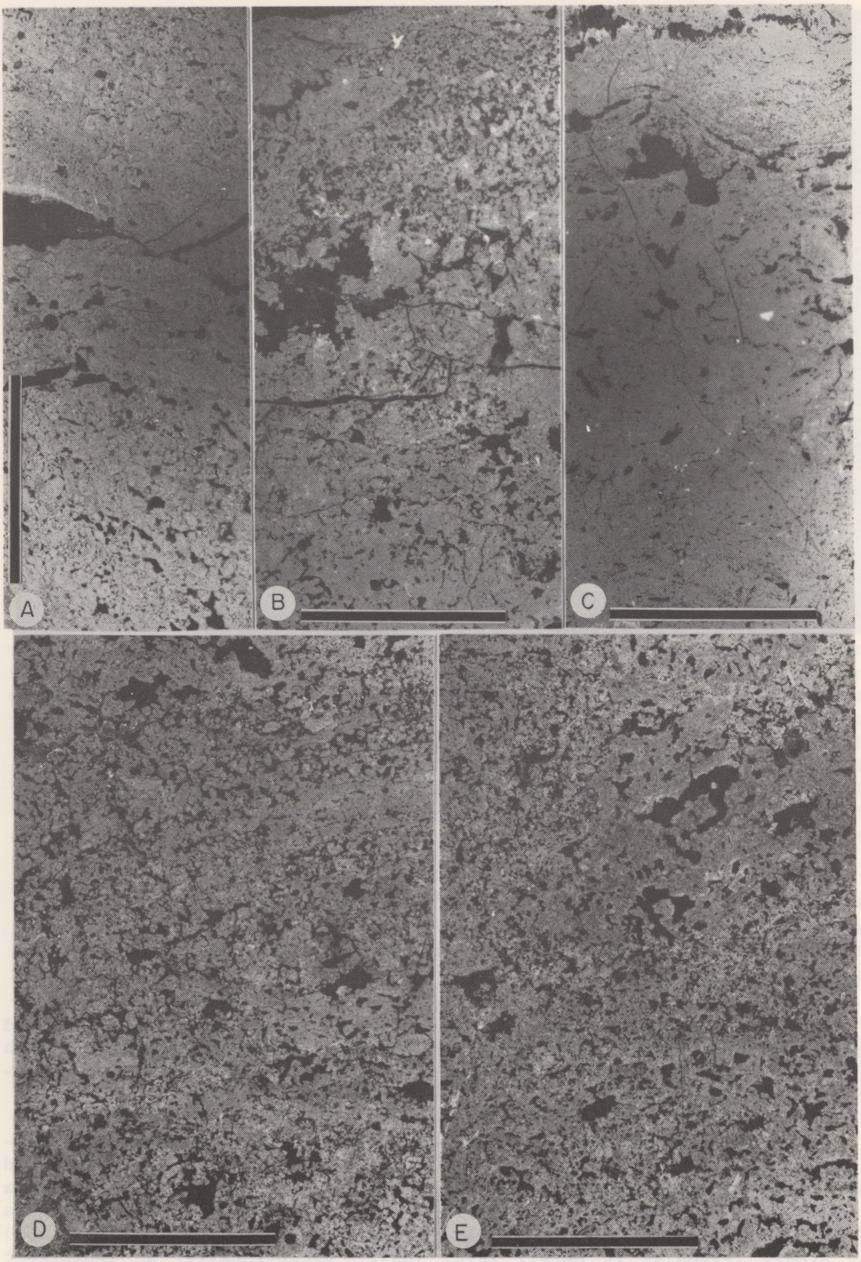
**Explanation of Figure 8**

Negative prints of thin sections. Bar scale = 10 mm

Pelletal and intraclastic limestones of carbonate Unit C-2 of the Gays River Formation in the Mahone Bay area. Note the lack of obvious bedding and the high proportion of small irregular voids in A, D and E, calcite-filled in B and C. The exceptionally close packing of small intraclasts in C gives the rock a micritic appearance. Note the microstylolite in the centre of C. Note the absence of shell material in all photographs.

Sample in A ER3 - 55.8, Hole ER-3, depth 17.0 m
Sample in B ER4 - 89.2, Hole ER-4, depth 27.2 m
Sample in C ER4 - 91.2, Hole ER-4, depth 27.8 m
Sample in D ER3 - 75.0, Hole ER-3, depth 22.9 m
Sample in E ER3 - 80.0, Hole ER-3, depth 24.4 m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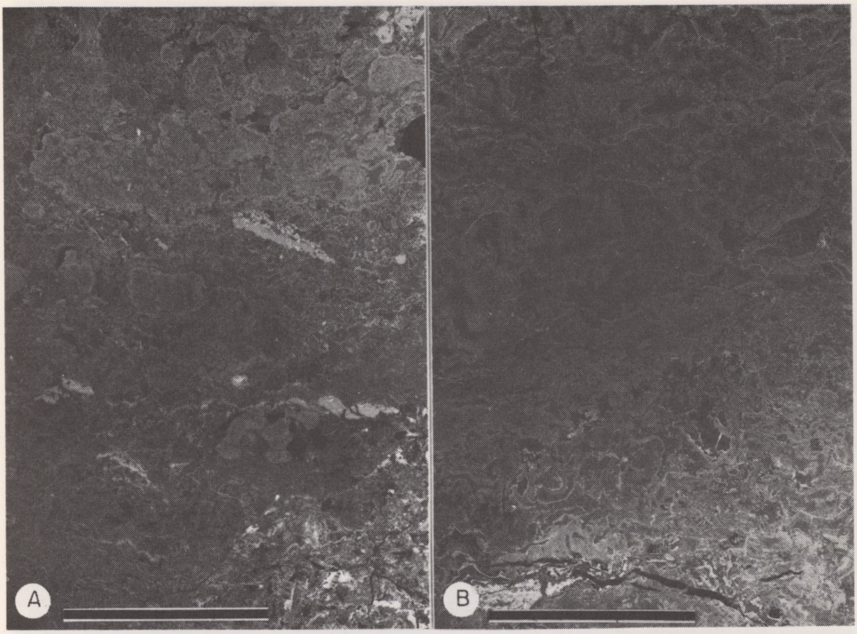


**Explanation of Figure 9**

Negative prints of thin sections. Bar scale = 10 mm

Limestones of Unit C-3 of the Gays River Formation. The textures in A are typical. Note the irregular coalescing lumps in the upper part of A. These lumps are considered to be of probable algal origin. Compare with the convolute textures in B, also tentatively ascribed to algal growth in situ.

Sample in A ER4 - 84.7, Hole ER-4, depth 25.8 m
Sample in B ER3 - 51.0, Hole ER-3, depth 15.5 m

**Carbonate Unit C-4**

Limestones of Unit C-4 are characteristically banded grey and medium brown in bands 0.5-1 cm in thickness. Several thin bands are rich in small fragmental fossils and carbonate grains, quite evident in macroscopic examination.

Petrographic study reveals that the banding is produced by alternating layers of micrite (Fig. 10A) and intramicrite (Fig. 10B), and ostracodal intraoosparite (Fig. 10C and D) (Folk, 1959, 1962). In some cases, fossil fragments and scattered intraclasts may be found within the micritic bands (Fig. 10A). The banding may be sharply defined (Fig. 10C) or highly irregular in detail (Fig. 10A). Exceptionally, an indistinct banding may be imparted by alternating layers of intraoosparite and intraoomicrite (Fig. 10D).

Intraclasts are poorly sorted and in part represented by irregular fragments of mottled limestone (Fig. 10D), similar to that in Unit C-3, suggesting derivation from the underlying rocks. Many grains are coated with a thin black rind (Fig. 10C and D) of probable algal origin. Disarticulated ostracod carapaces constitute the principal faunal elements in the Unit, although small gastropods are also present.

The thickness of Unit C-4 ranges from 1.5 m to 2.3 m. The thickest section occurs in diamond-drill hole ER-3, the local reference section for the Gays River Formation. The upper contact of the Unit is a position of abrupt and distinct change in lithology.

**Carbonate Unit C-5**

Limestones of Unit C-5 are classified as pelmicrites,and are particularly distinctive in character. They have been noted in diamond-drill core from holes ER-2, 3, 4 and 5 and are well exposed in Quarry No. 3 at East River (see inset map, Fig. 3). In fresh samples, the colour of Unit C-5 limestone is medium to pale brown. In holes ER-2 and ER-4, the rocks of the upper part of the Unit are highly porous, crumble easily in the hand, and are very pale grey to almost white in colour.

Bedding is defined by thin interbeds of laminated limestone (Fig. 11A), but is not otherwise distinct in hand specimen. Acid etching reveals, however, a strong internal fabric produced by the parallel alignment of elongate, rod-shaped allochems (Fig. 12D) in a micritic limestone matrix. The most probable origin of these allochems was as faecal or algal pellets. The pellets occur throughout the Unit. They range in size from 0.1 mm to 2 mm, and may be concentrated in discrete bands (Fig. 12B) separated by thin laminae of algal origin. The pellets may also be distributed regularly throughout thick beds (Fig. 12A and C) of pelmicrite (Folk, 1959, 1962). These allochems are closely comparable to algal pellets described by Huh et al. (1977), and in the absence of preserved fossils, seem less likely to represent true faecal remains.

Discrete beds of laminated limestone within the Unit are interpreted as algal biolithites (Fig. 11A) probably representing fossil algal mats. The thin interbands of laminated limestone within the intramicrite are often internally convolute (Fig. 11C), possibly representing irregular surfaces of algal mat layers.

At two discrete horizons in each of holes ER-4 and ER-5, thin stromatolitic layers with well developed microstructure (Figs. 11B and 12D), occur within the intramicrite. The interval containing these stromatolitic structures is thought to be correlative between holes ER-4 and ER-5 (Fig. 3).

The thickness of Unit C-5 reaches a maximum in hole ER-4, where 12.7 m of the Unit were cored. The range of thickness apparent in Figure 3 may reflect mainly the position of the Unit at the top of the Gays River Formation.

The upper contact of the Unit has not been observed. It apparently is overlain by unconsolidated materials, not recovered in the drilling program at East River.

## DEPOSITIONAL HISTORY OF THE GAYS RIVER FORMATION

The Gays River Formation was deposited in a marine environment in an area free from significant influx of terrigenous detritus. The limited thickness and erratic distribution of the basal sandstone unit, suggests that such detritus was derived mainly from the local regolith. Ooids and pseudooids noted within sandy dolostone beds at the base of the Formation establish clearly that shallow subtidal environments were established very early during the marine transgression into the Mahone Bay area.

The presence of Codiacean algae and *Koninckopora*, in association with tabulate corals, demands interpretation of a subtidal, moderate energy environment for rocks of Unit C-1. Dolostones of Unit C-1A occur downslope at the East River quarrys, and should thus record subtidal deposition in slightly greater water depths.

Carbonate rocks of Unit C-2 are indicative of quiet-water deposition in water depths comparable to those for the underlying unit.

Carbonate Unit C-4 records shallow subtidal to intertidal deposition as indicated by the presence of ooids and ostracod remains in current-sorted layers.

Unit C-5, by virtue of its algal character, and the absence of body fossils, is interpreted as the deposit of an ecologically restrictive shallow water environment. Giles et al. (1979) noted that rocks of this character are associated with anhydrite of the Carroll's Corner Formation, and interpreted them as carbonates deposited marginally to a major evaporite basin. Ecological restriction could thus be due to elevated salinities, and need not demand deposition in supratidal or high-intertidal environments.

The depositional history can be summarized as marine invasion followed by regression. This apparent drop in sea level resulted in progressively more ecologically restricted depositional environments.

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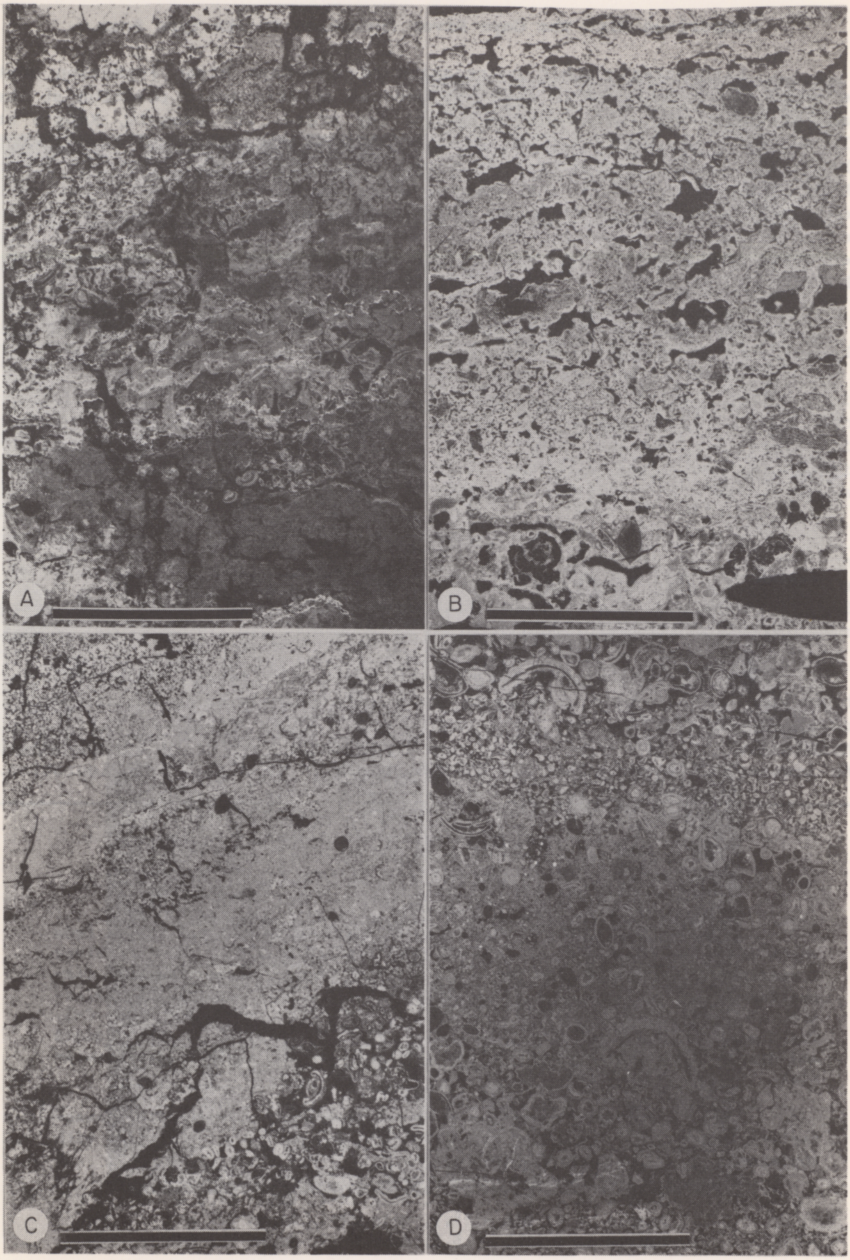
**Explanation of Figure 10**

Negative prints of thin sections. Bar scale = 10 mm

Limestones of carbonate Unit C-4 of Figure 3 (in pocket). Note the presence of fragmented and whole ostracods in each photograph. Sample in D is typical of the most allochem-rich bands in the Unit, showing fragmental shell material, ooids and superficial ooids, as well as larger intraclasts of biolithite, probably derived from Unit C-3. Almost every allochem is coated by a thin rind of algal(?) origin. Note the variation in grain distribution which results in a vague stratification. Compare D with lower part of C. Contrast with A, B and the upper part of C, in which small intraclasts and pellets predominate. Note the similarity of the sample in B to limestone of Unit C-2 (Fig. 8).

Sample in A ER3 - 45.6, Hole ER-3, depth 13.9 m
Sample in B ER3 - 49.3, Hole ER-3, depth 15.0 m
Sample in C ER4 - 82.8, Hole ER-4, depth 25.2 m
Sample in D ER5 - 37.9, Hole ER-5, depth 11.6 m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## Comparison With The Gays River Formation In Its Type Area

Lithostratigraphic correlation of the Gays River Formation must be based on criteria other than its present stratigraphic position at the base of the Windsor Group in the Mahone Bay area. For example, Keppie et al. (1978) have shown that an upper Windsor limestone member constitutes the lowest marine horizon of Viséan age in the McAras Brook-Knoydart Point shore section in Antigonish County, and that lower Windsor beds were completely overstepped by upper Windsor beds in that area. Thus, the lowermost marine limestone at any given locality need not necessarily represent the deposits of the earliest regional Viséan transgression into the Atlantic region.

Recent work in the Musquodoboit Basin (Boehner, 1977) and the Shubenacadie Basin (Giles and Boehner, 1979) has documented the presence of a highly fossiliferous carbonate unit, which lies at the base of the Windsor Group and which represents the earliest Viséan deposits in southern Nova Scotia. The description of this rock unit, which is the type Gays River Formation (Boehner, 1977; Giles et al., 1979) provides the basis for lithologic comparison with the lowermost Windsor limestone in the Mahone Bay area, and for comparison of associated fauna and flora.

Like the lowermost limestone in the Mahone Bay area, the type Gays River Formation rests directly upon rocks of the Meguma Group throughout the Shubenacadie and Musquodoboit Basins (Boebner, 1977; Giles et al., 1979). In each of these areas, carbonate-cemented sandstones or conglomerates very locally comprise the basal beds of the Windsor Group.

The Gays River Formation in its type area ranges considerably in thickness, and is best developed where algal-dominated carbonate mounds occur. Total thickness in these mounds may locally exceed 50 m, although the Formation is more typically 2 m to 3 m thick. In the Mahone Bay area, the lowermost Windsor limestone appears to occur in similar configuration,

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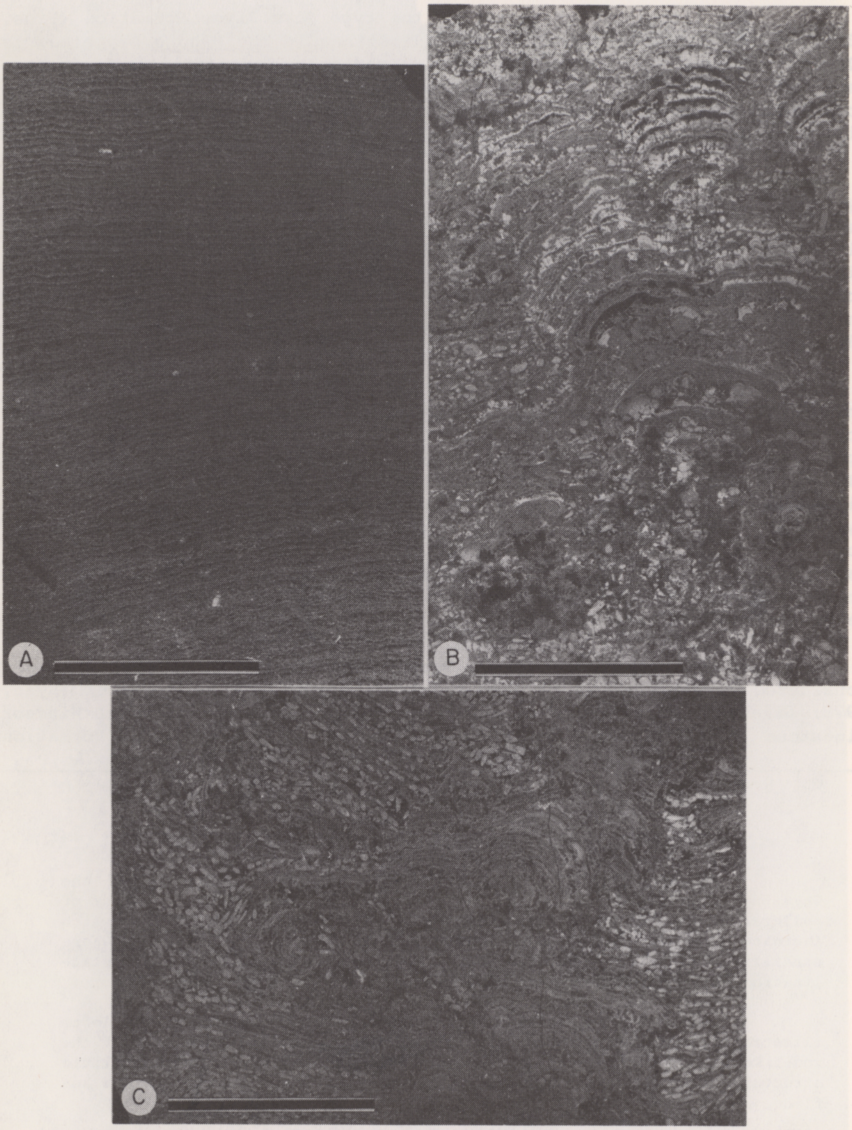
**Explanation of Figure 11**

Negative prints of thin sections. Bar scale = 10 mm

Sample in A is representative of algal-laminated biolithite beds which occur at several levels within carbonate Unit C-5 of the Gays River Formation in the Mahone Bay area. These beds appear to be laterally discontinuous and occur at several stratigraphic levels. Compare the lamination in A with that in C which occurs sporadically throughout Unit C-5. The lamination in C is interpreted as irregular algal mat, possibly domed and disrupted by gas bubbles produced by decomposition of the organic material.

The sample in B represents an algal-mat biolithite with characteristic and distinctive microstructure. Compare the microstructure, with the mineature growth forms in Figure 12D.

Sample in A ER4 - 70.0, Hole ER-4, depth 21.3 m
Sample in B ER5 - 11.5, Hole ER-5, depth 3.5 m
Sample in C ER5 - 5.5, Hole ER-5, depth 1.7 m


A
B
C

with thick algal-dominated accumulations (Unit C-1 of Fig. 3), flanked by thinner bituminous dolostones (Unit C-1A of Fig. 3).

The lithologic character of the type Gays River Formation (Figs. 13 and 14) and the lowermost Windsor limestone in the Mahone Bay area, is closely comparable. Mottled algal biolithites are prolific in carbonate banks of the type Gays River Formation (Giles et al., 1979), in localized mound-like deposits. Finely intraclastic and pelletal dolostones equate with similar limestones in the Mahone Bay area.

The lowermost Windsor limestone in the Mahone Bay area is typically comprised of high calcium limestone, except for the lowermost beds of the Formation. In contrast, the type Gays River Formation is virtually entirely dolomitic, except for local accumulations of cavernous limestone at its top. These cavernous limestones (Fig. 14), where not totally altered by recrystallization, closely resemble rocks of carbonate Unit C-5 of the limestone drilled at East River in the Mahone Bay area (Figs. 11 and 12).

Comparison of the fauna of the Gays River Formation (Ryan, 1978) in its type area with that of the limestone at East River shows a good correspondence, although the latter locality appears to be much more sparsely fossiliferous than typical localities of the Gays River Formation (Table 1). It is significant that all forms known from the lowest Windsor limestone in the Mahone Bay area have previously been reported from the type Gays River Formation. In addition, each of these rock units is impoverished with respect to representatives of the *Productidae* and other families of costate and plicate brachiopods. Also unreported, are crinoids and echinoids, groups represented in abundance at higher stratigraphic levels within the Windsor Group.

The fauna of the Gays River Formation in its type area is considered representative of the A faunal subzone of Bell (1929) (Ryan, 1978; Giles et al., 1979). Similarity of the fauna of the basal Windsor limestone of the Mahone Bay area to that of the Gays River Formation

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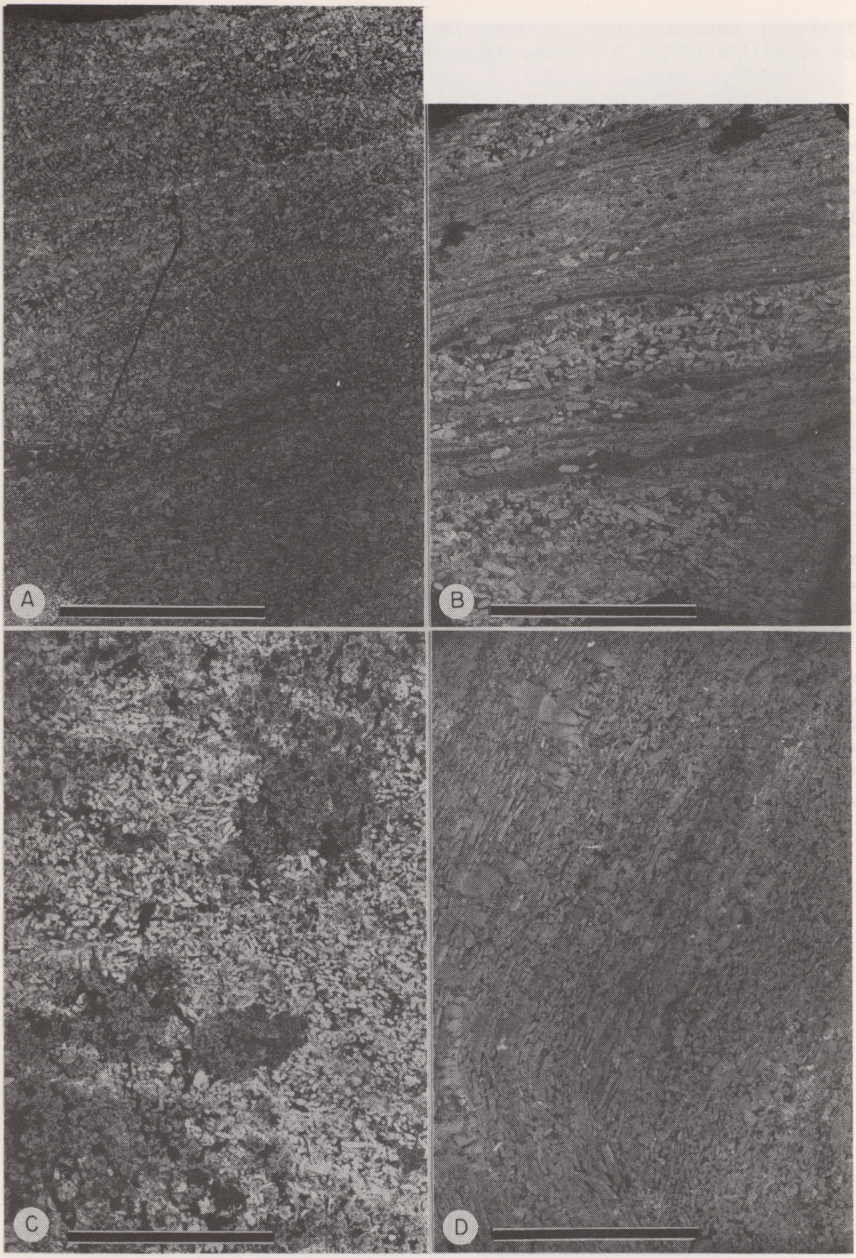
**Explanation of Figure 12**

Negative prints of thin sections. Bar scale = 10 mm

Intraclastic and algal limestones of carbonate Unit C-5 of the Gays River Formation. Note the elongate rod-like form of the majority of pellets. Note the vague stratification in A. Contrast with B, in which laminated biolithite layers sharply define bedding, and with C where stratification is not apparent. Dark grey areas in C are due to recrystallization which obliterates the allochems.

Sample in D, oriented with the stratigraphic top to the left, illustrates a pronounced preferred fabric, defined by the long axes of the rod-like pellets. Several thin layers show small-scale stromatolitic structures which appear to originate as colonial encrustations on the sea floor, not from continuous algal mat layers such as those in B.

Sample in A ER4 - 59.9, Hole ER-4, depth 18.3 m
Sample in B Sample from Quarry No. 2, East River (Fig. 2)
Sample in C ER3 - 40.0, Hole ER-3, depth 12.2 m
Sample in D ER4 - 62.6, Hole ER-4, depth 19.1 m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D

(Table 1) indicates that it too, is representative of the A subzone, and not of Bell's (1929) B subzone as suggested by Sage (1954).

The high degree of litholigic similarity, the common stratigraphic position, and the similarity in faunal constituents, argue for correlation of the basal Windsor limestone in the Mahone Bay area with the Gays River Formation of Boehner (1977). Because this correlation seems to be supported beyond all reasonable doubt, the term Gays River has been applied in the Mahone Bay area, despite its geographic separation from the type area of that Formation.

## Stratigraphically Higher Rock Units Of Viséan Age

Evidence for the presence of younger Windsor strata in the Mahone Bay area is meagre. Grey shales and mudstones, resting upon carbonate rocks of the Gays River Formation at locality 1, have been previously mentioned. A total thickness of less than 2 m is exposed at that locality. Sage (1954) indicated possible shale and gypsum outcrops on Sheep Island (Fig. 2), reported first by Faribault (1908) and by Dr. W. A. Bell in written communication to Sage. Sage did not confirm these outcrops, and a search by the writer failed to reveal any evidence for these rocks in bedrock, although on nearby Goat Island (Fig. 2), gypsum boulders occur in glacial drift. Faribault (1908) reported gypsum bedrock on Goat Island which could not be confirmed at the present. Possible gypsum bedrock beneath Graves Island near locality 2 (Fig. 2) was reported by Sage (1954), but remains unconfirmed.

Mr. F. G. Nolan (personal communication, 1978) informed the writer that gypsum was encountered at depths of approximately 50 m in a series of approximately two dozen diamond-drill holes drilled on Oak Island (Fig. 2) in 1967 or 1968. Mr. Nolan personally examined samples from these wells, completed with percussion drills. Unfortunately, no samples are presently available for study. Taylor (1969) did not report this drilling,

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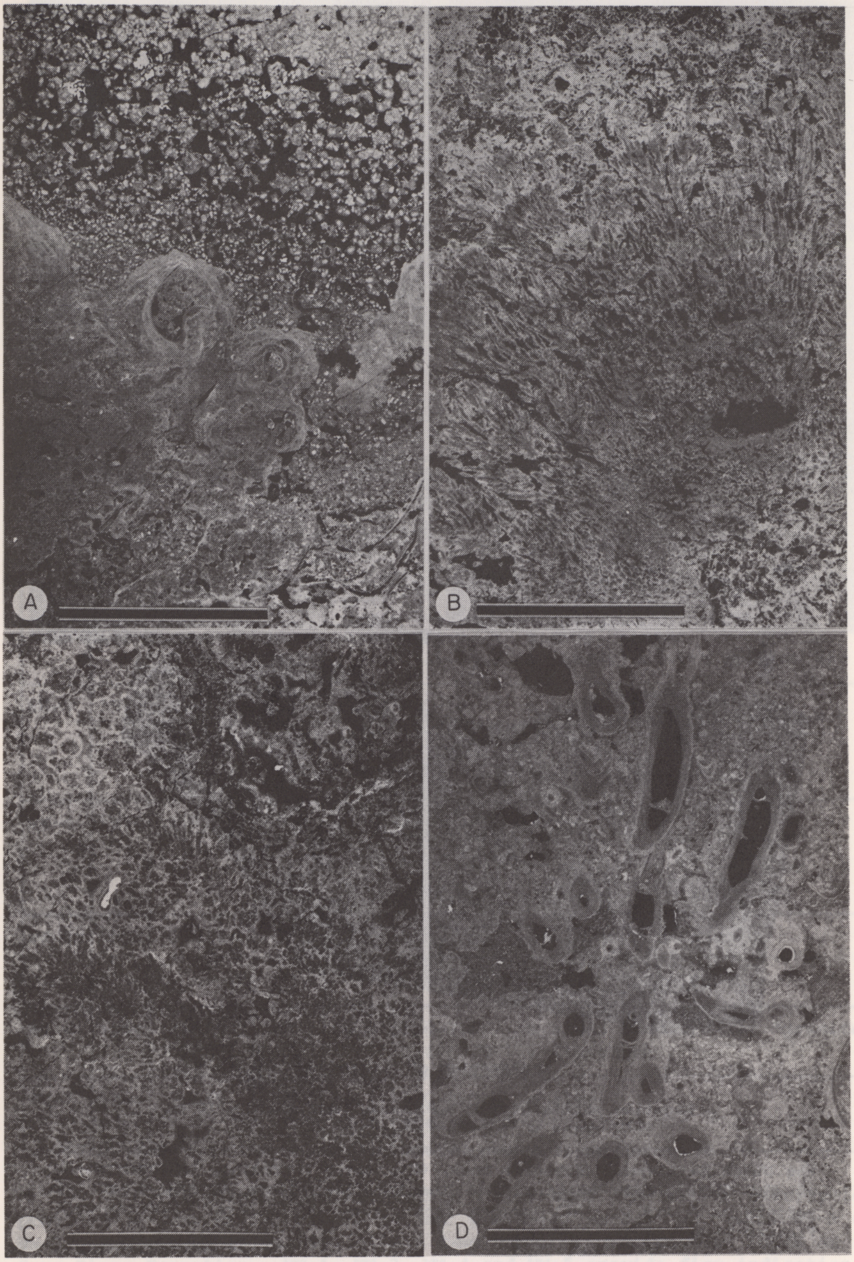
**Explanation of Figure 13**

Negative prints of thin sections. Bar scale = 10 mm

Algal biolithites of the type Gays River Formation in the Shubenacadie Basin. Irregular botryoidal biolithite mass in A illustrates overgrowth of small gastropods by algal material. Compare A with Figures 6C and 7B. Compare the finely intraclastic matrix in A with that in Figure 6A and 6C. Sample in A is dolostone.

Dolostones in B and C illustrate textures produced by in situ growth of unknown *Codiacean* alga. Compare with photographs of Figure 5. Dolostone in D illustrates the abundance of the tabulate coral *Cladochonus* sp., with associated shell material. This fossil is typically abundant in the lower parts of carbonate mounds of the Gays River Formation in the Gays River type area.

| | |
|---|---|
| Sample in A | GR256 - 122.0, Hole GR256, depth 37.2 m, Gays River Formation type section. |
| Sample in B | GR256 - 157.5, Hole GR256, depth 48.0 m |
| Sample in C | GR256 - 84.0, Hole GR256, depth 25.6 m |
| Sample in D | Grab sample, decline at Gays River mine property. |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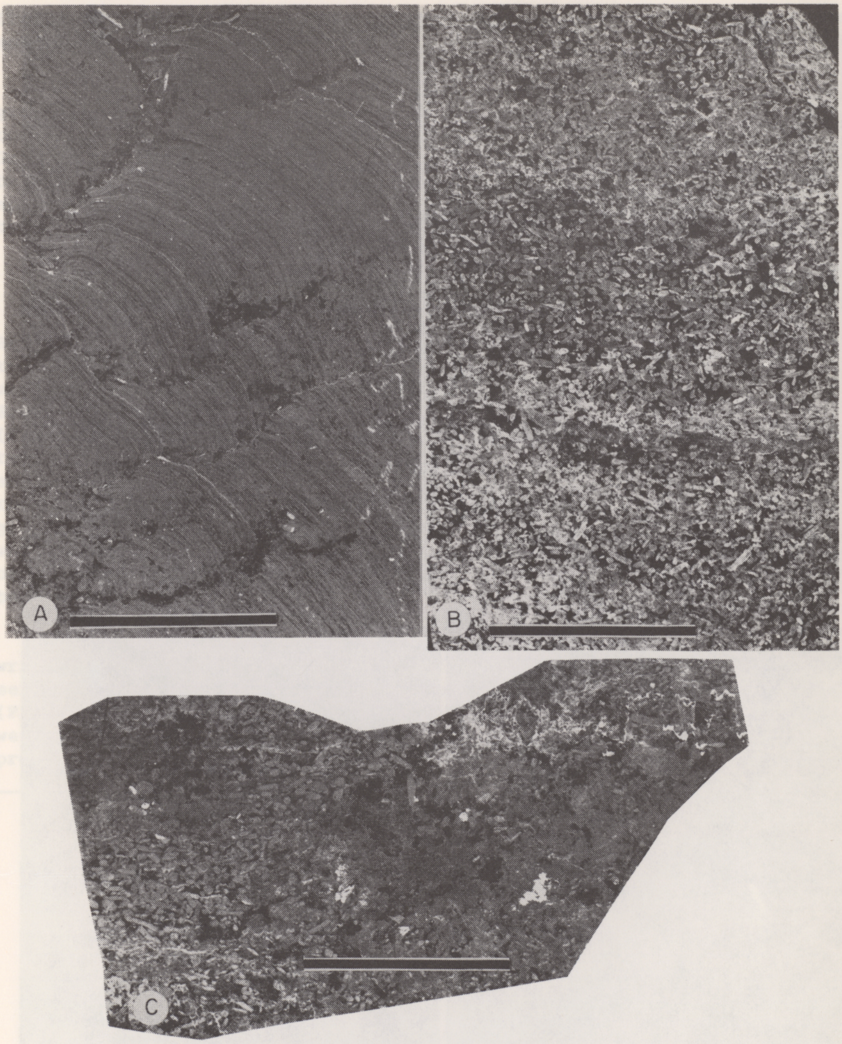


**Explanation of Figure 14**

Negative prints of thin sections. Bar scale = 10 mm

Stromatolitic limestone (A) and pelletal limestone (B and C) from the Dutch Settlement carbonate bank, Gays River Formation, southern flank of the Shubenacadie Basin. Note the rod-like nature of the algal (?) pellets in B and C. All samples from diamond-drill core. Compare with Figures 11 and 12.

Sample in A Hole DS-25, depth 25.8 m
Sample in B Hole DS-23, depth 13.3 m
Sample in C Hole DS-25, depth 25.9 m

but may have based his interpretation of Windsor bedrock beneath Oak Island (Fig. 2), on these or other unpublished data.

Water well records published by the Groundwater Section of the Nova Scotia Department of Mines in 1968, 1969 and 1970, and unpublished records maintained by the Province of Nova Scotia, Department of the Environment, provide confirmation of gypsum bedrock in the Mahone Bay area. Pertinent records are summarized in Table 2.

Table 2. Water well records indicative of Windsor Group bedrock in the Mahone Bay area.

| Water well No. | Year | Map Area | Tract | Total Depth (m) | Well Record (provided by driller) |
|---|---|---|---|---|---|
| WW-1 | 1974 | 21A/9 | 36 | 67.1 | 0.0-30.5 m clay, boulders<br>30.5-67.1 m gypsum |
| WW-2 | 1976 | 21A/9 | 36 | 74.7 | 0.0-7.9 m granite boulders and sand<br>7.9-15.8 m grey clay<br>15.8-20.7 m granite boulders and sand, bearing salt water<br>20.7-23.8 m broken "slate"<br>23.8-38.1 m grey "slate"<br>38.1-44.2 m salt water, no rock described<br>44.2-67.1 m grey "slate"<br>67.1-74.7 m limestone with granite (?) |
| WW-3 | 1974 | 21A/9 | 37 | 67.1 | 0.0-18.3 m boulders, clay<br>18.3-34.1 m soft "slate", gypsum<br>34.1-67.1 m rock, not further identified by driller |
| WW-4 | 1974 | 21A/9 | 50 | 61.6 | 0.0-56.4 m overburden<br>56.4-59.4 m gypsum<br>59.4-61.6 m hard rock, not further identified by driller |
| WW-5* | 1974 | 21A/9 | 51 | 20.1 | 0.0-20.1 m clay and boulders<br>*Water Assays Ca 460 ppm<br>$SO_4$ 904 ppm |
| WW-6 | 1969 | 21A/9 | 65 | 19.8 | 0.0-3.4 m sand, boulders and "granite"<br>3.4-19.8 m limestone |
| WW-7 | 1967 | 21A/9 | 66 | 24.4 | 0.0-4.9 m clay<br>4.9-24.4 m limestone |

Stratigraphic interpretation based upon the meagre descriptions provided by the well-drillers is not possible, except for wells WW-6 and WW-7 which appear certainly to have been drilled in carbonate rocks of the Gays River Formation. WW-1, WW-3, WW-4 and WW-5 provide firm indication of gypsum bedrock in the Chester and Chester Basin areas, whereas WW-2 suggests the presence of mudstones and shales, similar to those seen at locality 1 (Fig. 2) in Chester Basin, beneath the town of Chester in contact with carbonate rocks of the Gays River Formation.

The writer was unable to confirm Sage's (1954) report of upper Windsor bedrock exposures at localities 5, 6 and 7 (Fig. 2). Sage's assignment of laminated algal limestone at the latter exposure to the upper Windsor is based on his recognition of similar limestones in boulders containing upper Windsor fossils, and is questioned by the writer. In particular, the exposures at Upper Blandford and Queensland (localities 5 and 7 respectively) appear to most probably represent rocks of Unit C-5 of the Gays River Formation, rather than upper Windsor rocks.

Large boulders of limestone derived from the glacial material which blankets the area, are widely distributed throughout the Mahone Bay area. Faunas reported from these boulders (Sage, 1954), indicate clear affinities with upper Windsor faunas in the type area and in the Musquodoboit Basin, described by Boehner (1977). Also, many of the boulders contain forms typical of the B faunal subzone of Bell (1929). The presence of limestones other than those of the Gays River Formation is thus indicated, but to date, unconfirmed in the area.

The presence of several genera of colonial rugose corals in association with brachiopods of the Family *Gigantoproductidae* in many limestone boulders in the Mahone Bay area, suggests that the lateral equivalent of the Musquodoboit Limestone (Boehner, 1977), the lowermost upper Windsor carbonate unit in the Musquodoboit Basin, may be locally represented in bedrock.

**Inferred Windsor Group Stratigraphy In The Mahone Bay Area**

Because the confirmed bedrock exposures in the Mahone Bay area are limited to the Mahone Bay Limestone and a small thickness of overlying mudstones and shales, the stratigraphic succession of the Windsor Group must be inferred from (1) data reported by earlier workers, but unconfirmed in this study, (2) data from water wells or other sources, and (3) suggested similarities with the known succession in adjacent areas.

The area thought to be most closely comparable is the Musquodoboit Valley area (here termed the Musquodoboit Basin) described by Boehner (1977). Comparable features include (1) the apparent absence of pre-Windsor Carboniferous rocks, (2) the presence of correlative carbonate rock units at the base of the Windsor, (3) the occurrence of shales and sandstones above the basal carbonate in the Musquodoboit Basin (but not in the Shubenacadie Basin), compared with mudstones and shales in similar position in the Mahone Bay area, (4) gypsum and anhydrite of the Carroll's Corner Formation of Giles and Boehner (1979) in the Musquodoboit Basin, comparable with gypsum bedrock indicated by water wells in the Mahone Bay area, and (5) the presence of gigantoproductids and colonial rugose corals in limestone bedrock in the Musquodoboit Basin, and in numerous limestone boulders in the Mahone Bay area. Comparison of the data available for the Mahone Bay area with the stratigraphic succession in the Shubenacadie and Musquodoboit Basins, is shown in Figure 15.

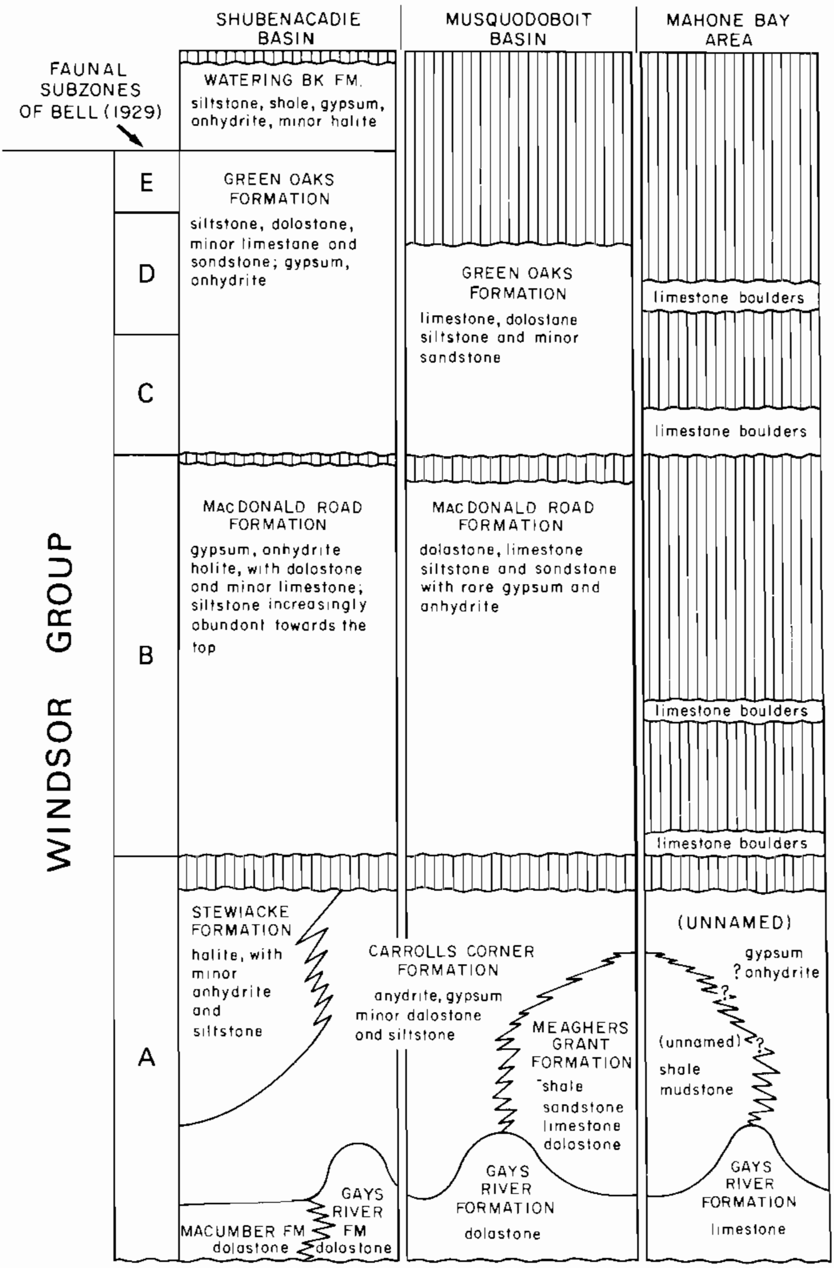


Figure 15. Suggested correlation of the Windsor Group of the Mahone Bay area, with that of the Musquodoboit and Shubenacadie Basins.

It is apparent that no precise stratigraphic thickness can be assigned to the postulated Windsor succession in the Mahone Bay area due to the limited nature of the data available. To infer the presence of a thick, more nearly complete succession in the adjacent marine areas, would be incorrect, for in the eastern part of Mahone Bay, Barnes (1976) and Barnes and Piper (1978) reported a maximum thickness of only 10 m as indicated by geophysical records. Thus, it appears doubtful that the local post-glacial remnants of Windsor strata exceed 100-150 m in thickness, and they may indeed be much thinner.

## PALEOGEOGRAPHIC SETTING OF THE MAHONE BAY AREA

Mamet (1970) showed that calcareous Foraminifera in the Windsor Group reflected increasingly restricted assemblages towards the northwest and thus concluded that the regional paleoslope in Atlantic Canda was towards a major Viséan sea which lay southeast of Nova Scotia. Keppie (1977) proposed a similar regional setting and termed the major sea the Mid-European Ocean.

On a more local scale, Boehner (1977) presented firm evidence for a northwesterly paleoslope in the Musquodoboit Basin, deduced from lateral facies relationships and based largely upon the recognition of a marginal-marine, terrigenous succession in the southern parts of the Musquodoboit Basin.

The close similarity of rock units and faunal assemblages between the Mahone Bay area and the Musquodoboit Basin clearly establishes marine connections between these areas. The paleogeographic model thus suggested places both areas within the same marine shelf environment during transgressive maxima (Fig. 16), at which time marine connections were maintained across the shelf between a major Viséan ocean located approximately 200 km to the southeast, and a large inland sea covering large parts of Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland. This model is consistent with that of Mamet (1970). The shelf here postulated corresponds to the Nova Scotia positive arch of Mamet (1970). The southeastern shelf margin is postulated to coincide with the edge of the Sedimentary Ridge Province of Jansa and Wade (1975). Regression following deposition of the Gays River Formation resulted in the emergence of significant parts of the shelf and permitted northwards progradation of sandstones and shales in the Musquodoboit Basin (cf. Boehner, 1977) and shale deposition in the Mahone Bay area.

The model presented in Figure 16 depicts the Mahone Bay area and the Musquodoboit Basin in mirror-image configuration on opposite sides of a highly asymmetric Nova Scotia positive arch. This reconstruction presumes that the present physiography of southern Nova Scotia is a reflection of only recently exhumed Carboniferous physiography, in the same token that the present local relief reflects the local paleorelief in the Mahone Bay area (Barnea, 1976; Barnes and Piper, 1978) and on the southern flanks of the Shubenacadie Basin (Hatt, 1978).

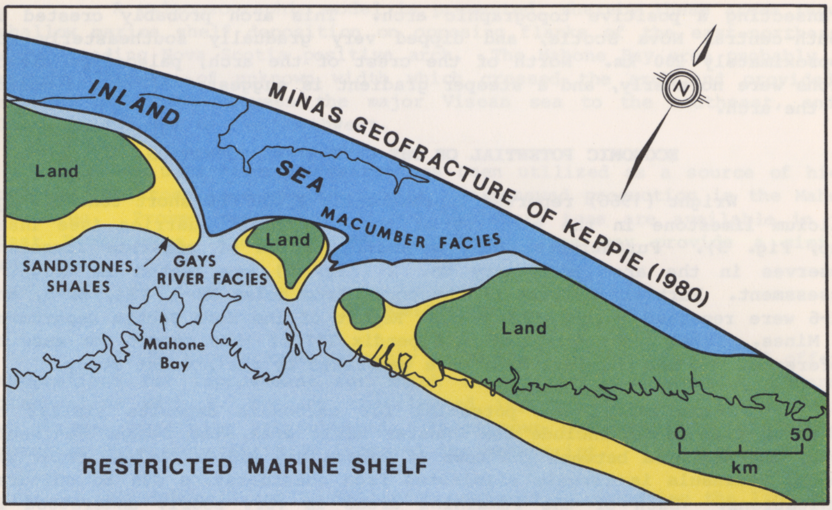


Figure 16. Postulated paleogeographic setting of southern Nova Scotia during deposition of the Gays River and Macumber Formations. The model applies as shown only to the early stages of the major transgressive-regressive cycle.

In a broad sense, the model is very similar to that proposed for southern Nova Scotia in Late Triassic time by Jansa and Wade (1975) with strata transported rift-ward to the north and seaward toward the south from a broad arch in southern Nova Scotia. It is of interest to note that the major Triassic sea to the south of Nova Scotia was, according to Jansa and Wade (1975), a highly saline one from which major Triassic salt deposits were precipitated.

The absence of known Viséan strata on the Scotian Shelf appears to seriously compromise this paleogeographic model. However, it is possible to explain this lack. Firstly, if the Nova Scotia positive arch were mainly emergent, deposition would occur only in the seaway or seaways which crossed it. Secondly, evidence from the Musquodoboit Basin indicates clearly that numerous breaks in sedimentation appear, represented by lacunae. Superposition and near-superposition of beds representing only the transgressive maxima are common. Still higher on the arch, one might reasonably predict that even more limited preservation of these transgressive deposits would result in the accumulation of only a very thin record of Viséan marine deposition. Much of this thin record may have been removed except in paleotopographic depressions or in the seaways crossing the arch, in the interval from Latest Viséan to Latest Jurassic time, for which no rock record is known in the Musquodoboit Basin (Boehner, 1977; Giles and Boehner, 1979).

In summary, Viséan deposition in the Mahone Bay area is believed to have occurred in a shallow shelf environment, possibly in a seaway transecting a positive topographic arch. This arch probably crested in south-central Nova Scotia, and dipped very gradually southeasterly for approximately 200 km. North of the crest of the arch, paleoslope directions were northerly, and a steeper gradient is suggested by the asymmetry of the arch.

## ECONOMIC POTENTIAL OF THE GAYS RIVER FORMATION

Wright (1966) reported approximately 3 000 000 short tons of high calcium limestone in the vicinity of the East River quarries (see inset map, Fig. 3). Furthermore, only a small portion of possible limestone reserves in the area of Quarry No. 2 (Fig. 3) was tested in Wright's assessment. Partial analyses of the cores from holes ER-3, ER4, ER-5, and ER-6 were reported in the 1976 Annual Report of the Nova Scotia Department of Mines. These are reproduced in Appendix III of this report for ease of reference. No new chemical data were generated by the present study.

Areas which have potential for carbonate deposits similar to those at East River include the Chester Basin area, the Second Peninsula area, and the area between the town of Mahone Bay and Oak Island (Fig. 2). Second Peninsula is largely eliminated from consideration due to cultural limitations. Each of the remaining areas is very poorly understood in terms of Windsor Group stratigraphy. Map boundaries are admittedly very imprecise. Diamond-drilling would be necessary to assess the potential for limestone deposits in both the Chester Basin and Mahone Bay-Oak Island areas. However, it is not unlikely that high calcium deposits might occur in these areas.

Base metal occurrences in the Mahone Bay area are limited to very minor vug-fillings of galena noted in this report. However, the reader is reminded that the Gays River Formation in the Shubenacadie Basin is host to the Gays River zinc-lead deposit. The possibility for similar deposits in the Mahone Bay area cannot be discounted. The very limited distribution of Windsor strata, however, may be a limiting factor in base metal exploration.

## SUMMARY AND CONCLUSIONS

The oldest Carboniferous strata in the Mahone Bay area are assigned to the Windsor Group. The lowest strata, and the only strata confirmed in bedrock exposure, consist of limestones and dolostones with associated sandstones and conglomerates. These rocks are collectively assigned to the Gays River Formation (new name). This rock unit is comparable in lithology and fauna to the type Gays River Formation of the Shubenacadie and Musquodoboit Basins, and is in part representative of the deposits of the earliest Viséan marine transgression into Atlantic Canada.

The remainder of the stratigraphic succession of the Windsor Group is not fully documented with present data. It appears most similar to the succession in the Musquodoboit Basin described by Boehner (1977). This similarity in both lithology and faunal assemblages indicates marine connection between the latter area and the Mahone Bay area.

A paleogeographic model is presented, whereby these areas record shallow marine shelf deposition on opposing flanks of the east-northeasterly trending Nova Scotia positive arch. The Mahone Bay area probably lay within a seaway of unknown width which crossed the arch and provided a marine connection between the major Visean sea to the southeast, and a large inland sea to the northwest.

The Gays River Formation has been utilized as a source of high-calcium limestone, and reserves exist for renewed production in the Mahone Bay area. Proven reserves of 3 000 000 short tons are available in the East River area, and at least two other areas may provide a similar resource.

## ACKNOWLEDGMENTS

J. D. Keppie read an early version of the manuscript and offered suggestions for improvement for which the writer is grateful. Numerous discussions with R. Boehner contributed improvements to the manuscript which are gratefully acknowledged. An unknown reviewer provided critical comments which substantially improved the manuscript.

G. McDonald and P. Belliveau assisted in preparing the line drawings, and C. McKinnon assisted in the preparation of photographic illustrations. Sandra Parsons, Susan Saunders and Rita Jones typed the manuscript. The writer is indebted to each of the above. Critical editoral comments by Katharine Mills are appreciated.

Heather Cross of the Department of the Environment, Province of Nova Scotia, assisted the writer in obtaining water well records from unpublished sources.

Funds for this work were provided jointly by the Province of Nova Scotia and the Canada Department of Regional Economic Expansion.

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# APPENDIX I

## DESCRIPTION OF CORES FROM HOLES 2 TO 6

## EAST RIVER QUARRIES

## LUNENBURG COUNTY

HOLE NO. 2 - EAST RIVER - LUNENBURG COUNTY

| Depth in metres | Description |
|---|---|
| 0.0-15.2 | Overburden, limestone boulders with a few granite boulders; no core recovered. |
| 15.2-23.2 | Limestone, pale grey to white, highly porous, coarsely crystalline and sucrosic in part, crumbles easily in the hand; in part thinly bedded but bedding is more typically obscure; the principal allochems are pellets or small intraclasts, 1-3 mm in length and almost exclusively cylindrical, rod-shaped, presumably of faecal or algal origin. Within this interval, core was lost from 15.4-16.8 m, 17.1-18.0 m, 20.0-20.9 m, 21.6-22.9 m. The core recovered within the interval 15.2-23.2 m belongs entirely to Unit C-5 of the Gays River Formation. |

TOTAL DEPTH 23.2 m.

HOLE NO. 3 - EAST RIVER - LUNENBURG COUNTY

| Depth in metres | Description |
|---|---|
| 0.0-9.1 | Overburden, granite and limestone boulders; ground core consists of fragments of porous white limestone containing prolific rod-like intraclasts of faecal or algal origin with fragments of planar-laminated limestone of algal origin; each of these litholgies is typical of Unit C-5 of the Gays River Formation. |
| 9.1-13.1 | Limestone, finely crystalline, light to medium brown in colour, medium to thickly bedded, stylolitic with horizontally oriented forms of low relief; the single allochems present are rod-like intraclasts which lie mainly in the plane of the bedding; this limestone is typical of Unit C-5 (Fig. 3, in pocket). |
| 13.1-15.4 | Limestone, finely crystalline, medium and dark brown, banded, thinly to medium bedded, pelletal in thin bands with small, indistinct pellets; abundantly ostracodal in the intervals 13.9-14.0 m and 14.9-15.1 m, with associated small high spired Gastropoda; the upper contact is abrupt; the limestone in this interval comprises Unit C-4 of the Gays River Formation. |
| 15.4-16.8 | Limestone, finely crystalline, medium brown and darker grey-brown mottled in what appear to represent algal structures; bedding is not apparent, although the unit is locally stylolitic; no fossils are apparent, the lower contact is sharp; the limestone within this interval represents Unit C-3 of the Gays River Formation as it is subdivided in the East River area (Fig. 3, in pocket). |
| 16.8-24.7 | Limestone, finely crystalline, medium brown, finely pelletal in thin, widely separated beds, otherwise apparently featureless; bedding thick to massive with numerous stylolitic bedding surfaces; occasional thin bituminous bands are present within the interval; irregular calcite patches are present throughout, the largest occurring at 18.3 m and 23.6 m; the limestone in this interval comprises Unit C-2 of the Gays River Formation. |
| 24.7-30.6 | Limestone, finely crystalline, massive to very thickly bedded, mottled grey-brown and grey, stylolitic throughout; mottled algal facies typical of the Gays River Formation in its type area; limestone within this interval is typical of Unit C-1 of Figure 3 (in pocket). |

| | |
|---|---|
| 30.6-32.7 | Dolostone, finely crystalline, massive to thickly bedded, mottled grey and brown, with irregular small patches of white dolomite; stylolitic throughout; one small fluorite (purple)-filled vug noted at 30.2 m; the unit contains scattered brachiopods of the *Beecheria* type, but these are not at all common; except for its dolomitic nature, the unit is very similar to the overlying unit. |
| 32.7-33.1 | Dolostone, thickly bedded to massive, rich in *Cladochonus* tabulate corals; lower contact abrupt lithologic change but actual contact not observed in split core; the interval 24.7-33.1 m constitutes Unit C-1 of the Gays River Formation. |
| 33.1-34.0 | Sandstone, coarse grained, conglomeratic, grey, medium to thickly bedded at 90° to the core axis; the matrix is dolomitic; detritus includes quartz and feldspar grains with scattered mica flakes; the interval 31.1-34.5 m constitutes Unit T-1 (Fig. 3, in pocket). |
| 34.0-34.5 | Conglomerate, mottled yellowish grey, medium grained, well sorted with minor coarse sandstone layers; this rock unit forms the local base of the Gays River Formation. |
| 34.5-35.3 | Granite, grey, coarsely and evenly crystalline, deeply weathered in appearance with a pseudo-bedded appearance. |

TOTAL DEPTH 35.3 m.

HOLE NO. 4 - EAST RIVER - LUNENBURG COUNTY

| Depth in metres | Description |
|---|---|
| 0.0-11.4 | Overburden, granite and limestone boulders, no core recovered |
| 11.4-17.0 | Limestone, pale grey to white, very coarsely crystalline, highly porous, appears to be a product of deep weathering; no visible fossils; allochems limited to small rod-shaped intraclasts of faecal or algal origin; these are probably present throughout, but are rarely obvious in the coarsely crystalline core; the limestone of this interval constitutes part of Unit C-5 of the Gays River Formation in this diamond-drill hole. |
| 17.0-21.2 | Limestone finely crystalline, thickly bedded, stylolitic, with abundant closely packed rod-like intraclasts of faecal or algal origin which lie mainly in the plane of bedding producing a pronounced fabric perpendicular to the core axis; laminated algae, species unknown, were noted from 19.0-19.1 m, and from 20.0-20.1 m; the limestone in this interval is placed within Unit C-5. |
| 21.2-21.6 | Limestone, light brown, massive, internally laminated with a stromatolitic type of lamination; part of Unit C-5. |
| 21.6-24.1 | Limestone, as in interval 17.0-21.2 m; base of Unit C-5 of the Gays River Formation. |
| 24.1-25.4 | Limestone, medium to finely crystalline, medium brown and grey-brown in irregular bands; highly pelletal, ostracodal and oolitic in thin beds; Unit C-4 of the Gays River Formation. |
| 25.4-25.9 | Limestone, brown, finely crystalline, massive, mottled texture, probably of algal origin; Unit C-3 of the Gays River Formation. |
| 25.9-28.1 | Limestone, brown, very finely crystalline, finely pelletal in widely separated beds; stylolitic, thickly bedded, finely porous, Unit C-2 of the Gays River Formation. |
| 28.1-28.5 | Limestone, fragmental, possibly representing a debris flow or storm deposit; the fragments consist of pale grey (?) algal limestone in a brown argillaceous matrix; assigned to the top part of Unit C-1A of the Gays River Formation (Fig. 3, in pocket). |

28.5-31.7 Dolostone, finely to medium crystalline, medium to thinly bedded, dark grey-brown, bituminous, slightly calcitic in the uppermost part; the interval from 28.1-31.7 m constitutes Unit C-1A of the Gays River Formation in the East River quarries; in this hole, the unit lacks the mottled "algal" limestone or dolostone seen in Unit C-1 in Holes 3 and 6.

31.7-32.0 Sandstone, dark grey-brown, coarse grained, dolomitic, Unit T-1 of Figure 3 (in pocket).

32.0-32.6 Granite, coarse grained deeply weathered and showing possible exfoliation joints preseved by the Carboniferous sedimentary cover.

TOTAL DEPTH 32.6 m.

HOLE NO. 5 - EAST RIVER - LUNENBURG COUNTY

| Depth in metres | Description |
|---|---|
| 0.0-1.5 | Overburden, no recovery. |
| 1.5-1.7 | Limestone, pale grey to white, highly porous, core recovery only partial; associated with laminated limestone of presumed algal origin; elongate, rod-like intraclasts of faecal or algal origin constitute the principal visible allochem. |
| 1.7-2.8 | No core recovery. |
| 2.8-3.0 | Limestone, with rod-like (?) algal intraclasts, as above. |
| 3.0-3.1 | Limestone, medium brown, finely crystalline, laminated in what appears to be a planar stromatolitic fabric. |
| 3.1-3.3 | No core recovery. |
| 3.3-3.5 | Limestone, pale grey, containing abundant rod-like intraclasts; similar to overlying limestones in character. |
| 3.5-3.6 | Limestone, laminated in a very regular organic structure produced by an unknown species of alga. |
| 3.6-4.2 | No core recovery. |
| 4.2-4.4 | Limestone, medium brown, with rod-like faecal or algal intraclasts, and laminated organic structures produced by an unknown species of alga, similar to that in the interval from 3.3-3.6 m; these structures also appear in Hole No. 4. |
| 4.4-5.8 | Limestone, finely crystalline, medium brown, with abundant rod-like intraclasts; similar to overlying limestones. |
| 5.8-6.1 | No core recovery. |
| 6.1-6.8 | Limestone, as above (4.4-5.8 m). |
| 6.8-7.6 | No core recovered. |
| 7.6-10.1 | Limestone, as above, but recrystallized so that allochems are less apparent; interval from 1.5-10.1 m comprises Unit C-5 of the Gays River Formation. |
| 10.1-11.6 | Limestone, medium brown and grey in irregular bands, finely crystalline, pelletal with small, round indistinct pellets; ostracodal and possibly oolitic in thin beds; Unit C-4 of Figure 3 (in pocket). |

| | |
|---|---|
| 11.6-12.4 | Limestone, mottled grey and brown, finely crystalline, massive, unfossiliferous, probably of algal origin; Unit C-3 of the Gays River Formation. |
| 12.4-15.8 | Limestone, very finely crystalline, medium to thickly bedded, stylolitic, finely pelletal in thin and widely separated beds; part of Unit C-2 of the Gays River Formation. |
| 15.8-16.2 | No core recovered. |
| 16.2-17.6 | Limestone, as from 12.4-15.8 m; lower portion of Unit C-2. |
| 17.6-18.3 | No core recovered. |
| 18.3-20.0 | Limestone, mottled grey and brown, finely crystalline, massive to thickly bedded, probably of algal origin; uppermost part of Unit C-1 in this drillhole. |
| 20.0-20.1 | Limestone, finely to medium crystalline, dark grey-brown, thinly bedded, argillaceous and bituminous; assigned to Unit C-1A of the Gays River Formation. |
| 20.1-21.0 | Limestone, dolomitic, mottled grey and grey-brown, thickly bedded, probably of algal origin. |
| 21.0-22.3 | Dolostone, slightly calcitic, medium to finely crystalline, medium bedded, bituminous and slightly argillaceous, fossiliferous with small high-spired gastropods; represents a tongue of Unit C-1A intercalated with rocks of Unit C-1 in this diamond-drill hole. |
| 22.3-22.6 | Dolostone, medium crystalline, mottled grey and dark grey-brown, probably of algal origin, as from 20.1-21.0 m. |
| 22.6-23.6 | Dolostone, as from 21.0-22.3 m; lower contact abrupt; interval from 18.3-23.6 comprises Units C-1 and C-1A of the Gays River Formation. |
| 23.6-23.8 | Sandstone, dark grey-brown, conglomeratic in thin beds, dolomitic; coarse detritus granitic in composition; assigned to Unit T-1 (Fig. 3, in pocket). |
| 23.8-25.5 | Granite, grey, fine grained, becoming coarser downwards. |

TOTAL DEPTH 25.5 m

## HOLE NO. 6 - EAST RIVER - LUNENBURG COUNTY

| Depth in metres | Description |
|---|---|
| 0.0-0.5 | Overburden, no core recovered. |
| 0.5-1.0 | Limestone, medium to finely crystalline, banded grey-brown and medium brown, pelletal in thin bands; believed to represent Unit C-4 of the Gays River Formation, although the ostracodal nature of the unit is not apparent in this hole. |
| 1.0-1.5 | No core recovered. |
| 1.5-3.3 | Limestone, finely crystalline, mottled grey and brown, thickly bedded, of probable algal origin; Unit C-3 of Figure 3 (in pocket). |
| 3.3-4.8 | Limestone, brown, finely crystalline, pelletal in thin, widely separated bands, part of Unit C-2. |
| 4.8-5.5 | No core recovered. |
| 5.5-7.2 | Limestone, as from 3.3-4.8 m; part of Unit C-2. |
| 7.2-18.1 | Limestone, finely crystalline, thickly bedded, mottled grey and brown, of probable algal origin; characterized by irregular small patches of white calcite throughout the interval; upper part of Unit C-1 of the Gays River Formation. |
| 18.1-20.5 | As above, but dolostone; tabulate coral *Cladochonus* occurs from 20.0 to 20.5 m in the mottled algal (?) dolostone; a single fragment of the calcareous alga *Koninckopora* sp. was seen at 20.0 m. |
| 20.5-21.8 | Dolostone, calcitic, medium to dark brown, medium to thickly bedded, bearing tabulate corals of the Genus *Cladochonus;* small high-spired gastropods are common near the base of the interval; rocks between 7.2 and 21.8 m comprise Unit C-1 of the Gays River Formation. |
| 21.8-22.5 | Sandstone, becoming conglomeratic towards the base, dark grey-brown in colour, dolomitic; Unit T-1 of Figure 3. |
| 22.5-23.2 | Granite, coarse grained, grey, micaceous. |

TOTAL DEPTH 23.2 m

# APPENDIX II

## WINDSOR GROUP - THIN SECTION COLLECTION

## (SAMPLE CODE* GAYS RIVER FORMATION AND ASSOCIATED ROCKS)

CARBONATE ROCKS

| | | | | |
|---|---|---|---|---|
| Unit C-5 | ER3 - 30.4 | ER4 - 55.1 | ER5 - 5.5 | |
| | 34.8 | 59.9 | 11.5 | |
| | 36.5 | 62.6 | 14.1 | |
| | 40.0 | 65.8 | | |
| | 42.5 | 67.8 | | |
| | | 70.8 | | |
| | | 77.5 | | |
| Unit C-4 | ER3 - 45.6 | ER4 - 82.8 | ER5 - 36.9 | |
| | 47.1 | | 37.9 | |
| | 49.3 | | | |
| Unit C-3 | ER3 - 51.0 | ER4 - 84.7 | | |
| Unit C-2 | ER3 - 55.8 | ER4 - 86.1 | | |
| | 64.0 | 89.2 | | |
| | 68.0 | 91.2 | | |
| | 75.0 | | | |
| | 80.0 | | | |
| Unit C-1 | ER3 - 84.0 | ER4 - 92.5 | ER5 - 60.5 | ER6 - 49.2 |
| | 89.0 | 95.0 | 70.5 | 69.7 |
| | 93.8 | 95.5 | 73.6 | |
| | 98.7 | 97.0 | 75.0 | |
| | 101.2 | 98.5 | 77.0 | |
| | 103.5 | 99.7 | | |
| | 107.5 | 101.0 | | |
| | | 102.4 | | |
| | | 103.6 | | |

BASAL SANDSTONE

| | | | |
|---|---|---|---|
| Unit T-1 | ER3 - 111.0 | ER4 - 104.3 | ER5 - 77.6 |

GRANITE (BASEMENT)

ER3 - 115.8

* Sample Code HOLE NAME - DEPTH IN FEET

# APPENDIX III

## PARTIAL CHEMICAL ANALYSES OF DIAMOND-DRILL CORES FROM THE EAST RIVER AREA, LUNENBURG COUNTY (For drillhole locations, see inset map, Figure 3)

| Drill-Hole No. | Footage | $SiO_2$ | $R_2O_3$ | CaO | MgO | Loss on Ignition |
|---|---|---|---|---|---|---|
| ER-3 | 28-35 | 4.80% | 1.21% | 52.10% | 0.31% | 40.81% |
| | 35-40 | 3.51 | 1.36 | 52.01 | 0.36 | 41.50 |
| | 40-45 | 1.64 | 0.88 | 54.20 | 0.30 | 42.50 |
| | 45-50 | 3.88 | 1.70 | 52.23 | 0.61 | 40.92 |
| | 50-55 | 3.02 | 1.69 | 52.90 | 0.24 | 41.30 |
| | 55-60 | 2.17 | 1.30 | 53.47 | 0.55 | 41.72 |
| | 60-65 | 1.25 | 0.76 | 53.60 | 0.69 | 42.60 |
| | 65-70 | 1.13 | 0.36 | 54.70 | 0.50 | 42.70 |
| | 70-75 | 0.59 | 0.79 | 54.80 | 0.30 | 42.80 |
| | 75-80 | 0.51 | 0.81 | 55.10 | 0.37 | 42.81 |
| | 80-85 | 1.57 | 1.15 | 54.20 | 0.68 | 43.30 |
| | 85-90 | 0.30 | 0.96 | 54.40 | 0.48 | 43.05 |
| | 90-95 | 0.41 | 0.93 | 54.33 | 0.99 | 42.83 |
| | 95-100 | 0.79 | 1.53 | 53.00 | 1.05 | 43.10 |
| | 100-105 | 1.10 | 3.64 | 32.70 | 17.4 | 44.40 |
| | 105-109 | 5.47 | 5.82 | 31.80 | 15.51 | 41.76 |
| ER-4 | 35-45 | 3.94% | 1.27% | 52.50% | 0.24% | 41.06% |
| | 45-55 | 6.50 | 1.29 | 50.40 | 0.32 | 41.80 |
| | 55-60 | 5.40 | 1.63 | 51.20 | 0.27 | 40.01 |
| | 60-65 | 7.25 | 1.47 | 50.01 | 0.27 | 39.50 |
| | 65-70 | 3.93 | 1.27 | 51.40 | 0.57 | 40.90 |
| | 70-75 | 2.40 | 1.49 | 52.50 | 0.36 | 41.80 |
| | 75-80 | 1.75 | 1.25 | 53.50 | 0.32 | 42.50 |
| | 80-85 | 4.12 | 2.08 | 51.90 | 0.47 | 41.20 |
| | 85-90 | 3.79 | 1.67 | 51.60 | 0.32 | 41.30 |
| | 90-95 | 5.12 | 3.64 | 48.20 | 2.10 | 40.40 |
| ER-5 | 5-20 | 4.85 | 1.16 | 51.90 | 0.32 | 40.80 |
| | 20-30 | 1.46 | 0.99 | 53.50 | 0.46 | 42.50 |
| | 30-35 | 0.30 | 1.10 | 54.50 | 0.36 | 42.80 |
| | 35-40 | 3.48 | 2.10 | 52.00 | 0.36 | 41.80 |
| | 40-45 | 2.89 | 2.18 | 53.02 | 0.45 | 41.35 |
| | 45-50 | 2.49 | 2.07 | 52.82 | 0.53 | 42.10 |
| | 50-55 | 1.10 | 1.42 | 54.00 | 0.27 | 43.00 |
| | 55-60 | 1.10 | 1.20 | 54.10 | 0.55 | 43.00 |
| | 60-65 | 0.90 | 2.44 | 45.60 | 7.30 | 43.70 |
| | 65-70 | 3.36 | 5.50 | 38.80 | 10.40 | 41.70 |
| | 70-75 | 7.85 | 6.57 | 31.58 | 12.90 | 40.30 |
| | 75-77 | 13.62 | 7.16 | 29.89 | 12.10 | 37.39 |
| ER-6 | 1.5-10 | 2.12 | 0.77 | 53.60 | 0.88 | 42.20 |
| | 10-15 | 1.99 | 1.09 | 53.20 | 0.49 | 42.10 |
| | 15-20 | 2.50 | 1.00 | 53.50 | 0.42 | 42.00 |
| | 20-25 | 1.47 | 0.86 | 54.50 | 0.36 | 43.00 |
| | 25-30 | 0.84 | 0.57 | 55.10 | 0.24 | 43.00 |
| | 30-35 | 0.69 | 0.52 | 55.00 | 0.43 | 43.00 |
| | 35-40 | 0.96 | 0.69 | 55.00 | 0.48 | 42.95 |
| | 40-45 | 0.48 | 0.55 | 54.00 | 1.37 | 43.20 |
| | 45-50 | 0.95 | 0.77 | 54.90 | 0.48 | 42.90 |
| | 50-55 | 1.10 | 1.94 | 54.06 | 0.35 | 42.50 |
| | 55-60 | 2.86 | 4.12 | 47.50 | 4.35 | 41.60 |
| | 60-65 | 1.54 | 4.14 | 44.20 | 7.90 | 43.16 |
| | 65-71 | 2.71 | 6.50 | 32.20 | 15.00 | 43.20 |


**FIGURE 3.**

**SUBDIVISION AND CORRELATION OF THE GAYS RIVER FORMATION IN DIAMOND-DRILL HOLES ER-2 TO ER-6**

East River area, Lunenburg Co.

TO ACCOMPANY
NOVA SCOTIA DEPARTMENT OF MINES AND ENERGY
PAPER 81-3
BY PETER S. GILES

Paper 81-3 The Windsor Group of the Mahone Bay Area, Nova Scotia