Sedimentary and Faunal Facies of an Upper Silurian marine succession near Creswell Bay, Somerset Island, N.W.T.

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By

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Abstract

Upper Silurian strata near Creswell Bay, Somerset Island belong to the Cape Storm, Read Bay, and Somerset Island Formations. The succession represents a transgressive-regressive sequence.

The Cape Storm and Somerset Island Formations are composed predominantly of generally unfossiliferous planar-laminated dolomite, sandy dolomite, and sandstone, and represent intertidal-supratidal conditions.

The Read Bay Formation consists predominantly of fossiliferous mottled limestone, and minor rubbly argillaceous, peloidal, bioclastic, and oncolitic limestone, and represents subtidal conditions. The formation is divided into two informal members: a lower member distinguished by predominantly brachiopod faunas, and an upper member by predominantly coral faunas. The lower member is interpreted as representing semi-restricted, lagoonal conditions, whereas the upper member represents more open conditions. Oncolitic limestone or dolomite units containing abundant *Megalomoides* separate the two members, and represent local offshore shoals. The shoals apparently developed parallel to the Boothia Uplift, which may have been a mildly positive topographic feature during the Upper Silurian. This feature, in combination with low lying land masses to the north and east of Somerset Island, may have restricted sea water circulation in the area, causing slightly hypersaline tendencies, as suggested by the high strontium content of the limestones.

Stromatoporoids in the Read Bay and Somerset Island Formations include *Plexodictyon katriense* Nestor, *P. heclae* n.sp., *Diplostroma* sp., *Actinostroma furyi* n.sp., *Actinodictyon netsiliki* n.sp., and *Vicinostachyodes sokolovi* (Riabinin).

CONTENTS

Page

Text-figures

Tables

Plates

CHAPTER 1

INTRODUCTION

Nature and Objectives of the Study

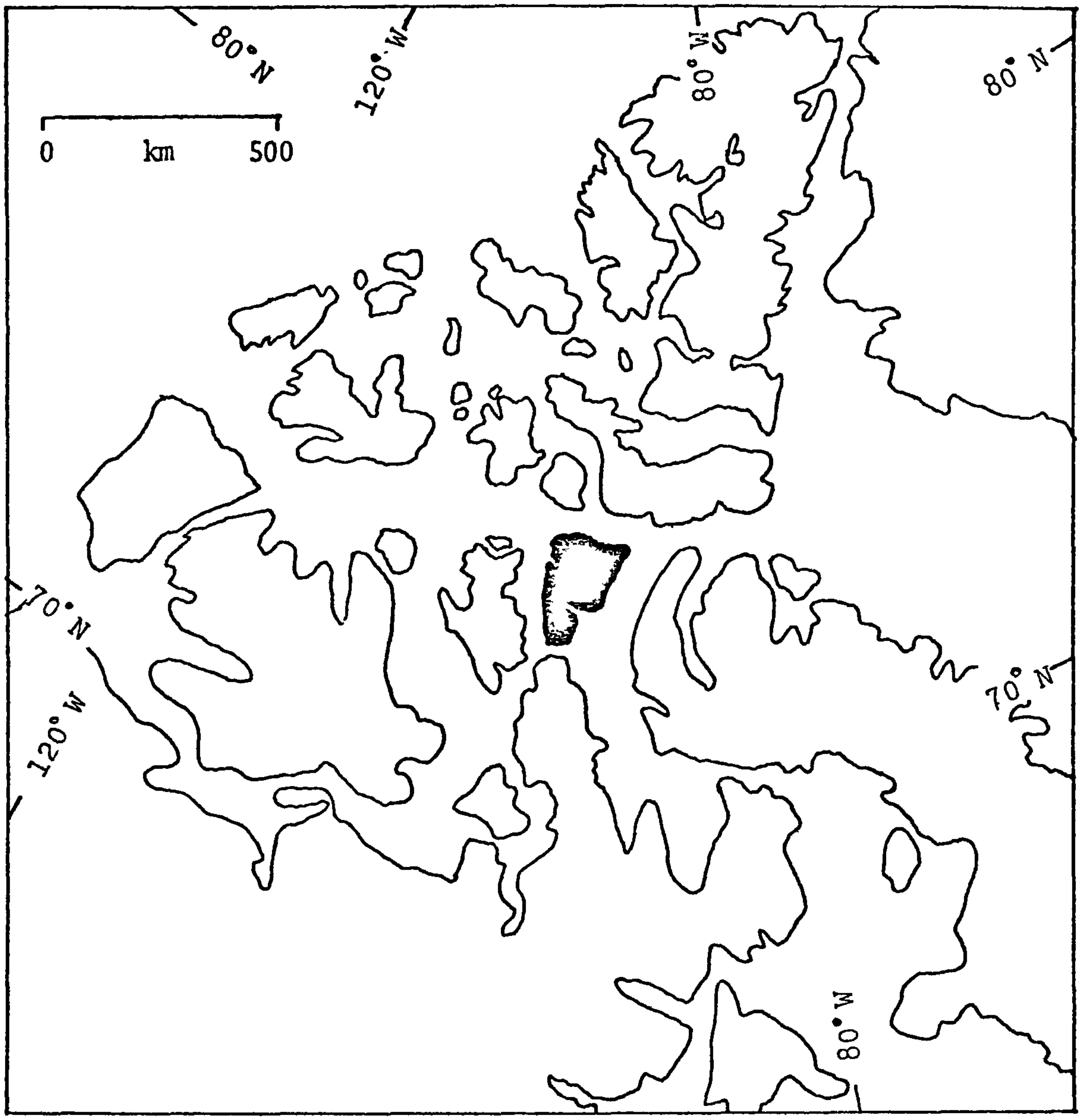
The study area is on Somerset Island in the southern part of the Canadian Arctic Archipelago (Text-fig. 1). Somerset Island is uninhabited, but is accessible by small aircraft from the settlement of Resolute, situated on the south coast of nearby Cornwallis Island.

The project involved the detailed examination and interpretation of a sequence of Upper Silurian carbonate rocks, and concentrated on the following objectives: recognition of the stratigraphic relationships of the Upper Silurian formations; determination of lithofacies and biofacies relationships; determination of the depositional environments of the formations using lithological, paleontological and geochemical criteria; and taxonomic appraisal of Upper Silurian stromatoporoids collected in the study area.

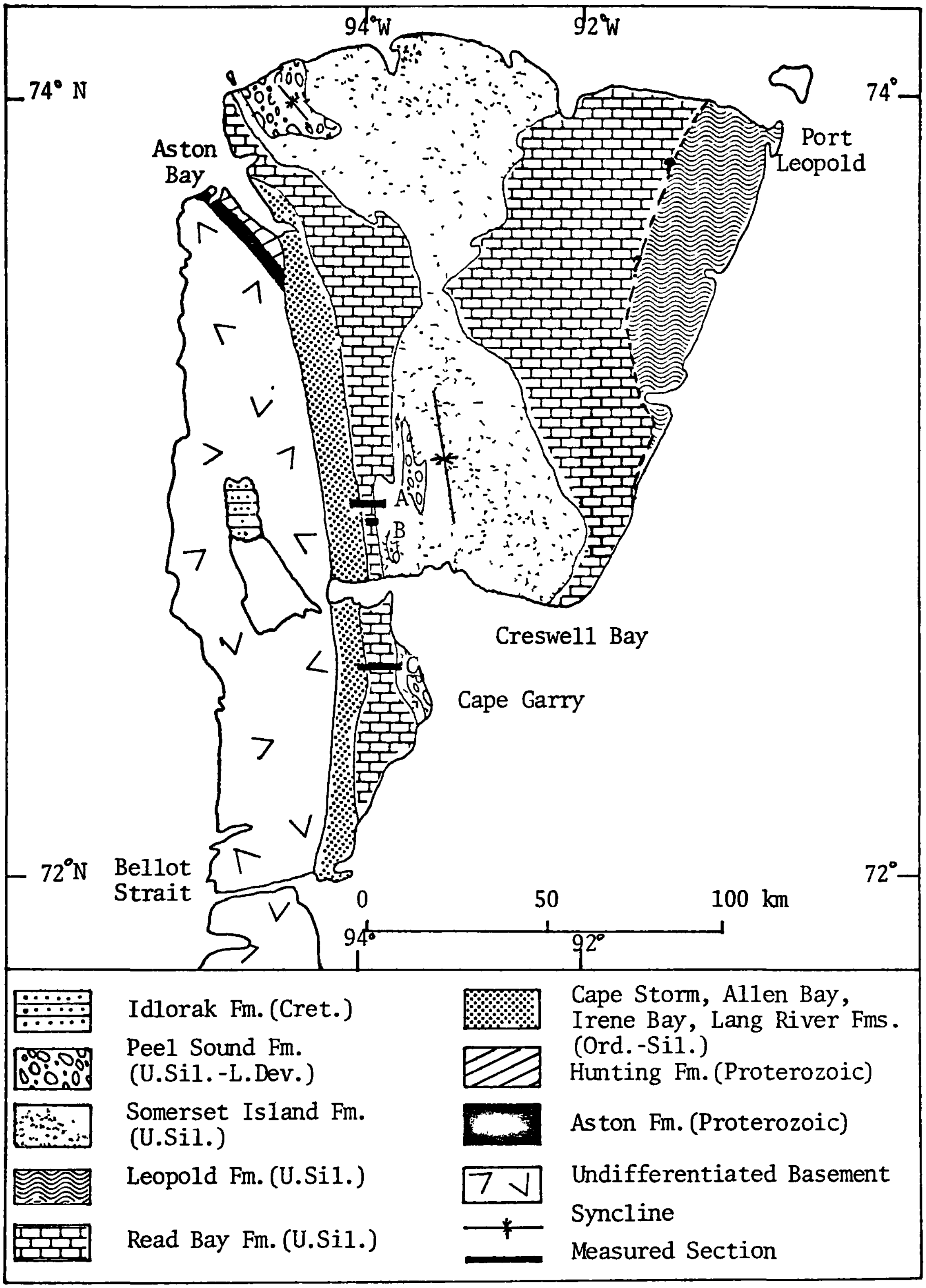
Since river gorges provided the most continuous exposures in the study area, stratigraphic sections were examined in two river gorges north of Creswell Bay (sections A and B, Text-fig. 2) and in a third river gorge south of Creswell Bay (section C, Text-fig. 2). During the field season in 1973, each section was measured in detail, rock samples were taken from each lithological unit described, and extensive fossil collections were made wherever practicable.

Previous Work

Somerset Island was originally inhabited by Inuit and there is archaeological evidence of a succession of cultures (Vanstone 1962). The island was the scene of intense activity in the nineteenth century during the search for the Northwest Passage and the ill-fated Sir John Franklin



Text-figure 1. Location of Somerset Island (in black) in the Canadian Arctic Archipelago.



Text-figure 2. General geology of Somerset Island showing locations of measured sections (after Jones and Dixon 1975; Miall et al. 1978).

expedition. Summary accounts of Arctic exploration are given in Dunbar and Greenaway (1956), Fortier *et al*. (1963) and Neatby (1970). Although the early expeditions were generally non-scientific in nature, several geological observations and fossil collections were made, which resulted in the assigning of a Silurian age to most of the Paleozoic outcrop on Somerset Island (eg. Salter 1852; Haughton 1857; Etheridge 1878; Foerste 1921; Teichert 1937).

The first large scale reconnaissance of the Arctic Archipelago was conducted by the Geological Survey of Canada in 1955 (Operation Franklin), the results of which were published in Fortier *et al*. (1963). Blackadar and Christie (1963) published a geological map and Christie (1967) provided detailed stratigraphic sections of Somerset and Prince of Wales Islands. Kerr and Christie (1965) investigated the structural history of the area while Gregory *et al*. (1961) published results of an aeromagnetic survey of the southern Arctic Islands. More detailed mapping and regional stratigraphic work on the sedimentary rocks of Somerset Island were carried out during Operation Boothia (Reinson *et al*., 1976; Miall and Kerr 1977).

The University of Ottawa has been involved in geological studies on Somerset and Prince of Wales Islands since 1964. Preliminary investigations were carried out by Dineley (1965, 1966) while more detailed studies of the Paleozoic rocks have been conducted by Broad (1968), Miall (1969), Dixon (1973), Jones (1974), and Gibling (1978). Detailed biostratigraphic and sedimentological studies by G.M. Narbonne, J. Packard and W. Parkins are in progress.

Geological Setting

Regional Geology

The geological history of the Arctic Archipelago has been extensively reviewed by Thorsteinsson and Tozer (1960, 1970) and Dineley (1971), and that of the southern Arctic Archipelago by Daae and Rutgers (1975). The reader is referred to those papers for more detailed accounts than that presented below.

The Paleozoic rocks of the southern Arctic Archipelago are part of an extensive platform, termed the Arctic Lowlands (Text-fig. 3), underlain by predominantly flat-lying rocks. The lowlands are divided into several basins by arches of Precambrian rocks. The Boothia Uplift is the most prominent, and extends 950 km from Boothia Peninsula north to the Parry Islands. The uplift consists of a core of Precambrian rocks flanked by folded and faulted Paleozoic rocks on Somerset and Prince of Wales Islands. To the north, the Precambrian basement rocks underlie Paleozoic rocks, and the uplift is expressed as a belt of northward-trending folds termed the Cornwallis Fold Belt (Thorsteinsson 1958; Kerr and Christie 1965, Kerr 1977). The main period of activity of the Boothia Uplift was in the late Silurian and early Devonian, but there was also apparently some movement in the Cenozoic (Thorsteinsson and Tozer 1970). Throughout the Lower Paleozoic, however, the Boothia Uplift was probably only a mildly positive feature. The positions of the other arches are shown in Text-figure 3.

North of the Arctic Lowlands the Franklinian Geosyncline was the site of more or less continuous sedimentation from the late Precambrian to the late Devonian. Rocks bordering the Arctic Lowlands are miogeosynclinal, whereas the northern-most exposures on northern Ellesmere Island and

Text-figure 3. Geological provinces of the Canadian Arctic Archipelago (after Thorsteinsson and Tozer 1970).

northern Axel Heiberg Island are eugeosynclinal. The Late Devonian or Early Carboniferous was a period of extensive folding in the Franklinian Geosyncline (Ellesmerian Orogeny) producing the Parry Islands and Central Ellesmere Fold Belts.

From the end of the Ellesmerian Orogeny until the Late Cretaceous the principal site of sedimentation was the Sverdrup Basin, a regional depression superimposed upon the Franklinian Geosyncline. During the early Cenozoic, intense folding and faulting and the emplacement of piercement bodies took place within the basin (Eurekan Orogeny).

The Arctic Coastal Plain on the northwest coasts of the islands bordering the Arctic Ocean is underlain by little-disturbed Pliocene and Pleistocene sediments which unconformably overlie rocks of the Sverdrup Basin.

Local Geology

Rocks of the Boothia Uplift, predominantly amphibolite-granulite transitional facies gneisses (Brown *et al*., 1969, p. 526), are exposed along the west coast of Somerset Island between Aston Bay and Bellot Strait (Text-fig. 2).

The basal sedimentary rocks on the Precambrian basement are the Proterozoic sandstones of the Aston Formation and overlying predominantly dolomitic rocks of the Hunting Formation (Tuke *et al*. 1966; Dixon *et al*. 1971; Dixon 1974b). Both formations are exposed immediately south of Aston Bay (Text-fig. 2). Unconformably overlying the Hunting Formation are the Cambrian(?) or Ordovician to Lower Silurian Lang River, Irene Bay, and Allen Bay Formations. The Lang River Formation consists predominantly of thin-thick bedded dolostone, stromatolitic dolostone, and intra-formational conglomerate, the Irene Bay Formation predominantly of bioclastic limestone, and the Allen Bay Formation predominantly of sandy dolostone and dolostone (Dixon 1973, 1974a; Miall and Kerr 1977). The Allen Bay Formation is in turn conformably overlain by the sandy dolostone, dolostone, and limestone of the Lower-Upper Silurian Cape Storm Formation (Reinson et al., 1976; Miall and Kerr 1977).

The Lang River, Irene Bay, Allen Bay and Cape Storm Formations are exposed east of the Boothia Uplift in a north-south-trending belt approximately 50 km wide from Aston Bay south to Bellot Strait.

The Cape Storm Formation grades conformably upward into the Upper Silurian Read Bay Formation, which consists predominantly of fossiliferous limestone (Blackadar and Christie 1963, p. 10; Jones 1974). The lower boundary of the Read Bay Formation is placed at the top of the last planar-bedded dolomite, sandstone, or sandy limestone unit underlying a continuous sequence of limestone units. In the type section on Cornwallis Island, Thorsteinsson (1958, p. 48) divided the Read Bay Formation into fourmembers, A to D. The Read Bay Formation on Somerset Island compares lithologically with Member A, the lowest (Gibling and Narbonne 1977). With the exception of the westernmost exposures, the Read Bay strata are generally flat-lying on Somerset Island and cover much of the northern, central and eastern parts of the island.

On the northeastern part of Somerset Island, the predominantly dolomitic rocks of the Leopold Formation are laterally equivalent, at least in part, to the Read Bay Formation (Jones and Dixon 1975, p. 407).

Grey, planar-laminated dolostone and limestone, and red siltstone and sandstone of the Upper Silurian-?Lower Devonian Somerset Island Formation conformably overlie the Read Bay Formation, and are exposed on Somerset Island in a north-south trending belt from the center of the north coast south to Cape Garry (Miall *et al*. 1978). The Somerset Island Formation grades conformably upward into the red sandstone and conglomerate of the Lower Devonian Peel Sound Formation, which are exposed to the north at Pressure Point and to the south in the Creswell Bay syncline and at Cape Garry (Miall *et al*., 1978).

Shale, siltstone and sandstone of the Idlorak Formation (Cretaceous-Tertiary) lie unconformably on the basement rocks immediately north of Stanwell-Fletcher Lake (Dineley and Rust 1968). Cretaceous-Tertiary rocks are also exposed near Cunningham Inlet (Hopkins 1971) and north of Creswell Bay(Dixon *et al*., 1973).

Acknowledgments

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CHAPTER 2

ROCK TYPES

Introduction

Since quartz, calcite and dolomite are the main constituents of rocks in the sections studied, the classification scheme comprises these three end members. Modifiers to the name of the principal end members indicate significant proportions (10-50%) of either of the other two end members (eg. dolomitic sandstone, calcitic sandstone, sandy dolomite). Two exceptions are mottled limestone and rubbly argillaceous limestone which have been classified according to overall texture and appearance, criteria useful for field identification.

Thin sections were stained with Alizarin Red and potassium ferrocyanide solutions (Dickson 1965) to distinguish calcite from dolomite and also to determine differences in iron content between various generations of calcite and dolomite.

The bedding classification used (Table 1) is that devised by Ingram (1954) and cited in Blatt *et al*. (1972, p. 112).

The proportions of the different rock types in the Cape Storm, Read Bay and Somerset Island Formations are summarized in Text-figure 4. In addition, the relative percentages of bioclasts within each formation are represented in Text-figure 5. Since the bioclast content was determined from thin section, large unbroken fossils such as corals are generally under-represented. The nature of the sedimentary structures is described in the following chapters.

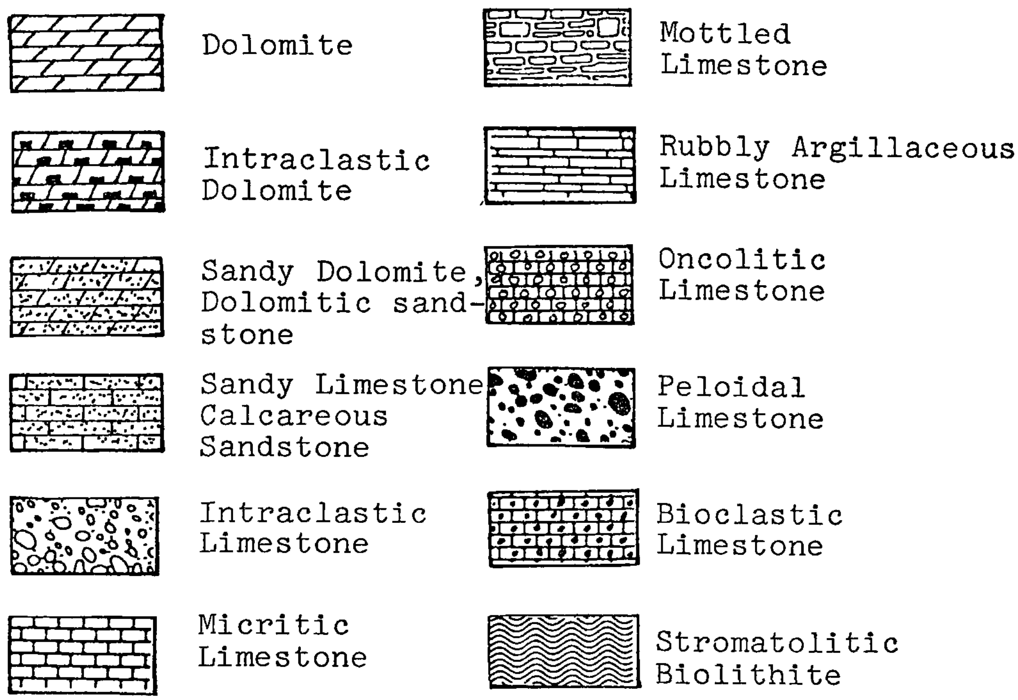
Dolomite

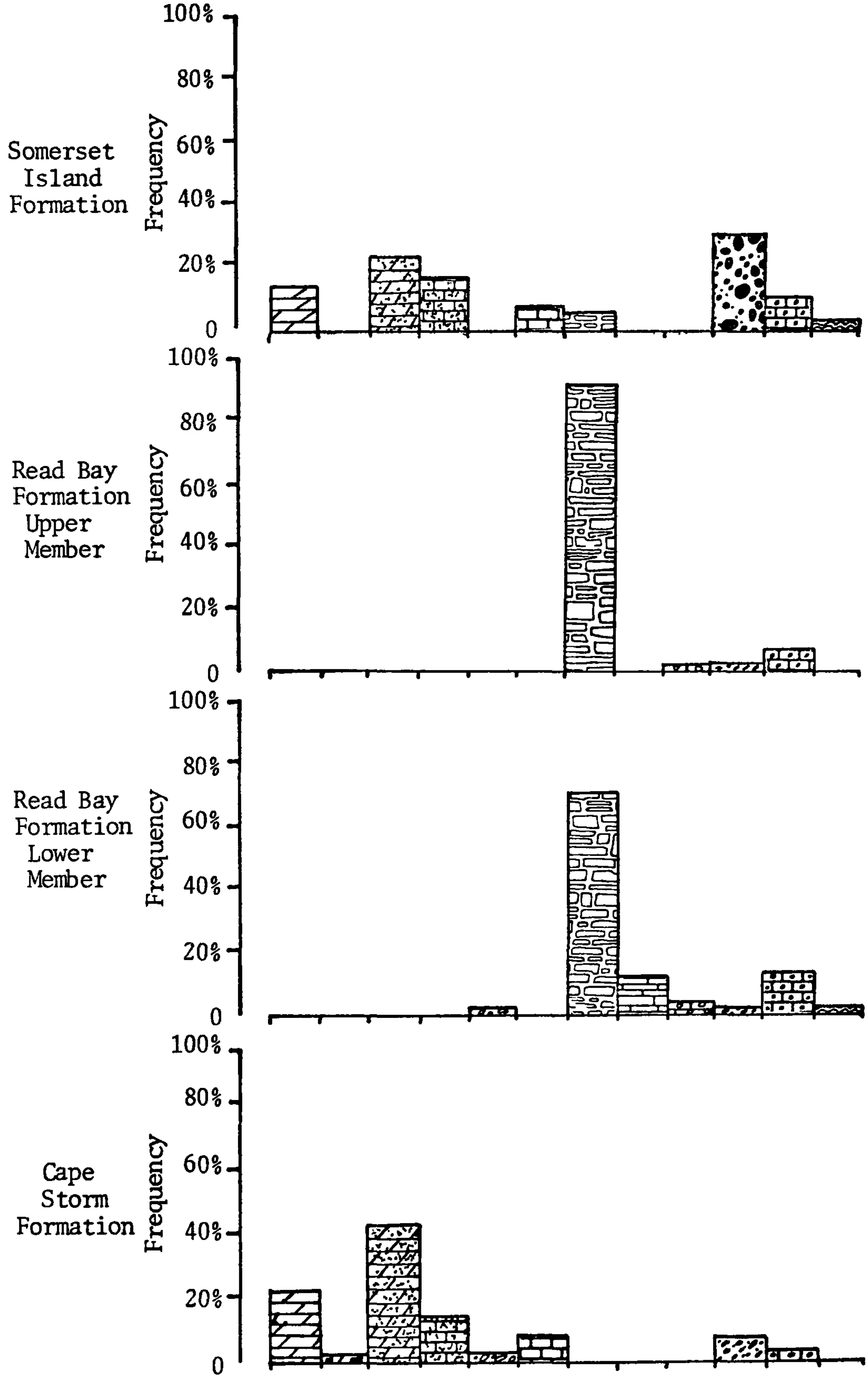
Buff, generally very fine to finely crystalline dolomite is common in the Cape Storm and Somerset Island Formations. The rock commonly contains

Very thickly bedded	Thicker than 1 m
Thickly bedded	30-100 cm
Medium bedded	10-30 cm
Thinly bedded	3-10 cm
Very thinly bedded	1-3 cm
Thickly laminated	0.3-1 cm
Thinly laminated	Thinner than 0.3 cm

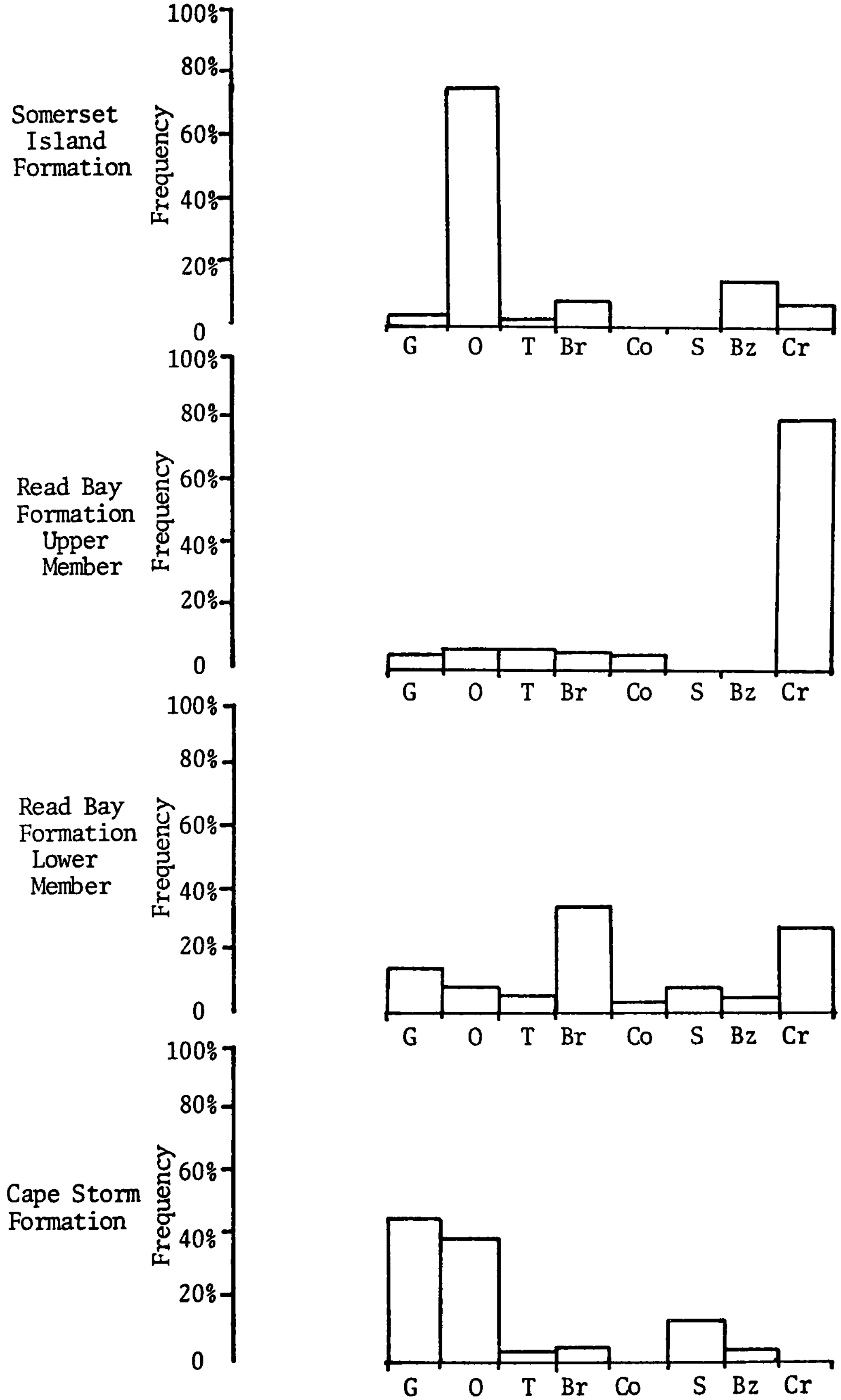
Table 1. Bedding classification used in the study (after Ingram 1954).

Text-figure 4. Summary of rock types of the Cape Storm, Read Bay, and Somerset Island Formations. Thicknesses from interlaminated units are divided evenly between their principal components.




Somerset
Island
Formation
Frequency
100%
80%
60%
40%
20%
0
Read Bay
Formation
Upper
Member
Frequency
100%
80%
60%
40%
20%
0
Read Bay
Formation
Lower
Member
Frequency
100%
80%
60%
40%
20%
0
Cape
Storm
Formation
Frequency
100%
80%
60%
40%
20%
0

Text-figure 5. Summary of bioclasts identified in thin-sections from the Cape Storm, Read Bay, and Somerset Island Formations. G=gastropods, O=ostracods, T=trilobites, Br=brachiopods, Co=corals S=stromatoporoids, Bz=bryozoans, Cr=crinoids.


Somerset Island Formation
Read Bay Formation Upper Member
Read Bay Formation Lower Member
Cape Storm Formation
Frequency
0
20%
40%
60%
80%
100%
G
O
T
Br
Co
S
Bz
Cr

euhedral to subhedral dolomite rhombs up to 0.1 mm and trace amounts of calcite, usually finely crystalline.

Trace amounts of muscovite blades up to 0.3 mm long are scattered randomly throughout the rock and generally oriented parallel to bedding surfaces. Trace quantities of subangular to subrounded, very fine to fine sand-sized grains of quartz and feldspar are commonly scattered randomly throughout the rock, or rarely are concentrated in lenses approximately 0.1 mm thick and up to 6.0 mm long.

In some units organic material is dispersed through the rock or concentrated in very thin laminae. The organic material imparts medium grey and dark grey colours to weathered and fresh surfaces respectively. Local ostracod fragments 0.2 to 0.4 mm long are the only fossils recognized in the dolomite.

Individual euhedral pyrite crystals up to 0.1 mm in diameter are relatively common, but constitute less than 1.0% of the rock.

A light brown-weathering, thick-bedded dolomite unit (B5) occurs in the Read Bay Formation at section B. The rock consists of coarse to very coarse, euhedral to subhedral, ferroan dolomite crystals. Any original structures or fossils that may have been present have been obscured by dolomitization, although the rock contains many well-rounded dark dolomite patches enclosed by lighter dolomite. The rounded patches range from 0.2 to 2.0 mm in diameter and may represent dolomitized bioclasts. Large (up to 10 cm) moulds of disarticulated Megalomoides valves are common in the unit.

Intraclastic Dolomite

Intraclastic dolomite occurs in both the Cape Storm and Somerset Island Formations. The intraclasts are blade- to disc-shaped and constitute 50-80% of the rock. Most intraclastic dolomite is restricted to thin layers at bedding surfaces, although some units (eg. A19, A54) are up to 0.5 m thick. The intraclasts are usually of very finely crystalline dolomite or sandy dolomite, some with as much as 20% dispersed angular to subangular quartz grains 0.05-0.3 mm in diameter. The intraclasts are generally well rounded but poorly sorted, and range from 0.05-4.0 cm in diameter. The matrix is usually sandy, finely crystalline dolomite with local individual dolomite rhombs up to 0.1 mm in length. Subangular to subrounded quartz grains 0.05-0.3 mm in diameter constitute up to 10% of the matrix.

Intraclastic Limestone

Intraclastic limestone units occur in the Cape Storm and Read Bay Formations. Generally well-rounded but poorly sorted clasts constitute up to 75% of the rock, ranging from 0.2 to 3.0 mm (longest axis) in unit C108 up to 10 cm (longest axis) in unit A90. Large clasts tend to be oriented parallel to bedding surfaces.

The intraclasts are principally micrite or sandy micrite, although in unit C108 some are elongate fragments of ferroan sparite with micrite borders. The latter are possibly recrystallized bioclasts. Gastropod and brachiopod fragments commonly constitute up to 10% of the rock.

Quartz is common, either as subangular to subrounded grains up to 0.2 mm in diameter, as in unit C108 where it constitutes 10% of the rock, or as large well-rounded grains up to 1.0 mm in diameter, as in unit A117, where it constitutes up to 25% of the rock. Muscovite blades up to 0.3 mm long are present locally in trace quantities.

The clasts are usually enclosed by sparite cement, although sandy micrite fills the whorls of most gastropod shells in unit C108. Minor amounts of dolomite in rhombs and patches up to 0.1 mm in diameter are present locally.

<u>Sandy Dolomite, Dolomitic Sandstone</u>

Two distinct types of sandy dolomite and dolomitic sandstone, based on the character of the dolomite in the rock, can be recognized in the Cape Storm and Somerset Island Formations. The first type consists of very finely to finely crystalline dolomite with detrital material either scattered through the rock or in thin lenses up to 3.0 mm long. Individual dolomite rhombs up to 0.1 mm in diameter are common. The second type consists principally of medium crystalline dolomite and generally occurs as thin to thick laminae. Calcite, usually interstitial ferroan or non-ferroan sparite, or less commonly micrite, is often present in minor quantities (5-15%).

Subangular to subrounded quartz grains 0.05 mm to 0.2 mm in diameter are the predominant detrital material. Muscovite blades up to 0.3 mm long are common, constituting up to 2% of some units, and are generally oriented parallel to bedding surfaces. The rocks contain trace amounts of angular to subangular plagioclase and microcline grains up to 0.1 mm in diameter. Local ostracoderm, ostracod and gastropod fragments are the only obvious fossils present.

Limonite, usually in the form of pseudomorphs after pyrite, and pyrite crystals up to 0.1 mm in diameter, occur locally in trace quantities.

Dolomitic sandstone is generally easily distinguished in the field by light orange-buff-weathering, whereas sandy dolomite generally weathers buff to light grey.

Sandy Limestone, Calcareous Sandstone

Sandy limestone and calcareous sandstone are generally similar to sandy dolomite and dolomitic sandstone except that they have a predominantly calcareous rather than dolomitic cement, and weather light to medium grey. Sandy limestone is restricted to the Cape Storm Formation, whereas calcareous sandstone occurs in both the Cape Storm and Somerset Island Formations. The cement is usually nonferroan sparite, although remnant micrite patches are also common. Individual dolomite rhombs or patches up to 0.1 mm in diameter are common, and locally constitute up to 10% of the rock.

Quartz, feldspar and muscovite, similar in texture to the detrital components in dolomitic sandstone and sandy dolomite, constitute from 10 to 50% of the sandy limestone and 50 to 90% of the calcareous sandstone.

Fossils are common in some units and are usually well-sorted ostracod and gastropod fragments.

Micritic Limestone

Units of pure micritic limestone are rare in all of the sections measured. The rock consists predominantly of micrite and contains only trace amounts of detrital or fossil material. It weathers light to medium grey and is medium grey on fresh surfaces.

Mottled Limestone

Mottled limestone is the predominant rock type in the Read Bay Formation, and occurs locally in the overlying Somerset Island Formation. Units of mottled limestone range from 0.15 to 10.0 m in thickness. The mottling is due to the presence of typically buff-weathering dolomite, distributed through light to medium grey-weathering limestone (Pl. 1, fig. 1). Irregular layers of argillaceous material and fine to medium crystalline dolomite up to 4.0 cm thick are generally parallel to bedding surfaces, and may be continuous for several metres. The amount of dolomite varies, but generally constitutes from 10 to 40% of the rock, although in some units the dolomite is restricted to bedding surfaces and forms less than 5% of the rock.

The boundaries between the dolomite and limestone in thin section are relatively sharp. The dolomite layers are commonly associated with stylolites, along which generally ferruginous insoluble residues are concentrated. The stylolites are generally horizontal and laterally continuous, but locally are steeply inclined to bedding surfaces. They are gently to strongly undulatory, with amplitudes generally between 1.0 and 10.0 mm. Bioclasts, although commonly incorporated in the dolomite layers, are rarely dolomitized. The dolomitizing fluids appear to have passed around the bioclasts, dolomitizing the enclosing lime mud but not the bioclasts.

The limestone is generally micrite and less commonly neomorphic microspar or macrospar, although in such cases gradations from micrite to neomorphic sparite are common. In many units the micrite is partly replaced by finely crystalline euhedral to subhedral dolomite crystals scattered throughout the micrite, the degree of dolomitization ranging from less than 1% up to 30%. Sparite veins up to 1.0 mm wide, usually of ferroan calcite, are common and are generally associated with stylolites.

Angular to subangular (less commonly subrounded) quartz grains up to 0.1 mm in diameter occur locally in trace quantities in sections A and B, but commonly constitute up to 10% of some units in section C. Muscovite blades 0.1 to 0.3 mm long are common in trace quantities, and locally constitute up to 1% of the rock. Angular plagioclase grains up to 0.1 mm in diameter occur locally in trace quantities. Small (0.1 mm in diameter) euhedral to subhedral pyrite crystals are common, and are generally associated with stylolites.

Gastropod, brachiopod, ostracod, trilobite, crinoid and indeterminate shell fragments are common, whereas bryozoan, coral, and stromatoporoid fragments are less common. The bioclasts are usually poorly sorted and poorly to moderately rounded, and rarely show preferred orientation, although the more elongate fragments tend to be parallel to bedding surfaces. The fragments have commonly been leached, and the voids filled with finely to coarsely crystalline sparite, as are cavities within paired ostracod valves and gastropod whorls. Many crinoid fragments, and less commonly shell fragments, are partly silicified, although the silica rarely constitutes more than 1% of the rock.

Structures which may be burrows appear in thin section as concentric whorls ranging from 1.0 to 5.0 mm in diameter. Neomorphic sparite in the centers of the whorls gives them a lighter appearance than the surrounding micrite. The concentric patterns are usually emphasized by any shell fragments on the outer margins. Shell fragments and detrital material rarely occur within the whorls.

Rubbly Argillaceous Limestone

Rubbly argillaceous limestone occurs in the Read Bay Formation only in section C, where it forms distinctive medium- to dark-grey units with a characteristic rubbly, recessive-weathering appearance (Pl. 1, fig. 2). It consists of irregularly shaped micritic limestone masses up to 20 cm in length, separated by thin zones of argillaceous material. The units range from 0.5 to 7.0 m thick. The micrite is locally replaced by isolated dolomite rhombs up to 0.05 mm in diameter, or less commonly by dolomite patches similar to the dolomite in mottled limestone.

Angular to subangular quartz grains up to 0.1 mm in diameter are common, constituting up to 15% of some units. Plagioclase and muscovite occur locally in trace quantities.

Bioclasts are common, and are similar in composition and texture to the bioclasts in mottled limestone.

Oncolitic Limestone

Only four oncolitic limestone units occur in the sections studied (A96, A99, B30, B33). They vary in thickness from 0.3 to 1.0 m and are typically brownish-grey on weathered surfaces (Pl. 1, figs. 3 and 4). The oncolites range from 0.3 to 20.0 mm long, averaging 1.5 mm, and constitute 60 to 70% of the rock. The smaller oncolites tend to be spherical, the larger ones elongate. The thickness of the algal coating varies from less than 0.1 m on smaller fragments to 0.8 mm on larger fragments. The nucleus is invariably greater in thickness than the algal coating. The nuclei are primarily indeterminate shell or crinoid fragments, and less commonly gastropod, bryozoan, coral or trilobite fragments. Most gastropod, coral and shell fragments have been replaced by sparite. Individual oolites or clusters of 2 or 3 rarely form oncolite nuclei.

All the oncolites are well-rounded, and on some, the concentric algal laminae have been abruptly truncated by abrasion. Elongate oncolites are generally oriented parallel to bedding surfaces.

Oolites with radial crystal structure constitute up to 40% of the allochemical constituents of some units (eg. A99). While some oolites have recognizable nuclei, usually shell fragments, others have lost much of the internal structure and only a ferroan sparite mozaic remains.

Small quantities (less than 2%) of well-rounded peloids averaging 0.2 mm in diameter occur in units A99 and C30.

The allochemical constituents are cemented by finely to coarsely crystalline sparite. Sparite bordering the allochems commonly consists of fine to medium crystalline scalenohedra with their long axes perpendicular to the allochem surfaces. In the interstitial spaces the sparite forms a coarsely crystalline mozaic.

Stylolites are present in unit A99, and are associated with ferroan sparite veins 0.1 to 0.2 mm in width. Ferroan sparite veins are also present in unit A96.

Peloidal Limestone

Medium grey, thin-to medium-bedded units of peloidal limestone, consisting predominantly of aggregates of very finely crystalline calcite, termed peloids (McKee and Gutschick 1969, p. 101) occur in all three formations. The peloids are generally well-rounded, but vary in size (commonly 0.1 to 0.5 mm in diameter) and sphericity within a single unit. They constitute from 30 to 80% of the rock. In only one unit (A57) are the peloids of uniform size (0.2 mm), possibly evidence of an organic origin or of sorting.

Angular to subangular quartz grains up to 0.3 mm in diameter are commonly present, along with trace amounts of muscovite blades up to 0.3 mm long.

Bioclasts are locally present, chiefly gastropod and ostracod fragments, and less commonly brachiopod, crinoid, trilobite, bryozoan and indeterminate shell fragments.

The cement is primarily non-ferroan sparite, less commonly ferroan sparite. Where micrite is a matrix constituent, sparite occurs only around the peloids. Dolomite occurs locally in patches and seams, similar to its occurrence in mottled limestone, or as euhedral to subhedral crystals up to 0.1 mm in diameter.

Bioclastic Limestone

Bioclastic limestone is common in the upper part of the Cape Storm Formation and throughout the Read Bay Formation and occurs in unit A137 of the Somerset Island Foramtion. It forms medium to dark grey lenses and units from less than 0.3 m up to 1.0 m thick. The bioclasts in the Cape Storm Formation are principally of gastropods and ostracods, although brachiopod, trilobite, bryozoan and stromatoporoid fragments are locally present. In the Read Bay Formation, fragments of crinoids, brachiopods, gastropods and ostracods are most common, whereas trilobite, coral, bryozoan and stromatoporoid fragments are locally present. The bioclasts in unit A137 of the Somerset Island Formation are principally crinoid, stromatoporoid, and indeterminate shell fragments.

Several bioclastic units consist predominantly of crinoid fragments (up to 60%) and weather light to medium grey or pinkish grey. The fragments are commonly enclosed in syntaxial cement rims, and pore-filling cement is also syntaxial with the host fragment. In some of these units minor quantities of the crinoid fragments are alga-coated.

Angular to subrounded quartz grains up to 0.1 mm in diameter occur in most units in trace quantities, although in section C they constitute up to 10% of some of the units. Trace quantities of feldspar and muscovite occur locally.

The individual bioclasts range in size from 0.2 to 35.0 mm (averaging 1.0 to 2.0 mm) and constitute 50 to 75% of the rock. The bioclasts are moderately to well rounded and generally moderately well sorted. Elongate fragments are commonly oriented parallel to bedding surfaces. The fragments are commonly replaced by sparite, leaving ghost structures. Well-rounded intraclasts are present in several units, but constitute less than 5% of the rock.

The bioclasts are enclosed chiefly by sparite cement, although micrite is present in some units, commonly as deposits in gastropod whorls. Dolomite occurs locally in minor quantities (up to 10%) and is associated with stylolites.

Ferroan sparite occurs in several units as veins up to 0.2 mm wide, or as a cement in bioclasts, and, where present, tends to be associated with dolomite. In unit A51, gastropod whorls have been filled with ferroan sparite, post-dating an earlier deposit of non-ferroan sparite on the inner walls of the chambers.

Crinoid fragments are locally partly silicified, but the silica constitutes less than 2% of the rock.

Stromatolitic Biolithite

A light orange- to buff-weathering 2.0 m thick stromatolitic biolithite occurs within the Read Bay Formation in section B (unit B1). Due to extensive silicification, individual stromatolites are difficult to distinguish. Those that can be identified range from 2.0 to 20.0 cm in height, and appear to be laterally linked hemispheroids (Logan et al. 1964). The lamination is produced by alternating light and dark layers varying in thickness from 0.5 to 2.0 mm. The light laminae are composed of authigenic quartz, whereas the darker laminae, although also highly silicified, exhibit very fine algal lamination.

Bornite occurs commonly in fractures in the unit. Malachite, azurite and iron oxide staining are common, and are apparently weathering products of the bornite.

A light grey-weathering stromatolitic biolithite occurs in the Somerset Island Formation in section C (unit C57). The stromatolites range from 4.0 to 6.0 cm in diameter and from 1.0 to 2.0 cm in height and are laterally linked hemispheroids (op. cit.). The stromatolites consist of very fine (less than 0.1 mm thick) calcitic laminae.

CHAPTER 3

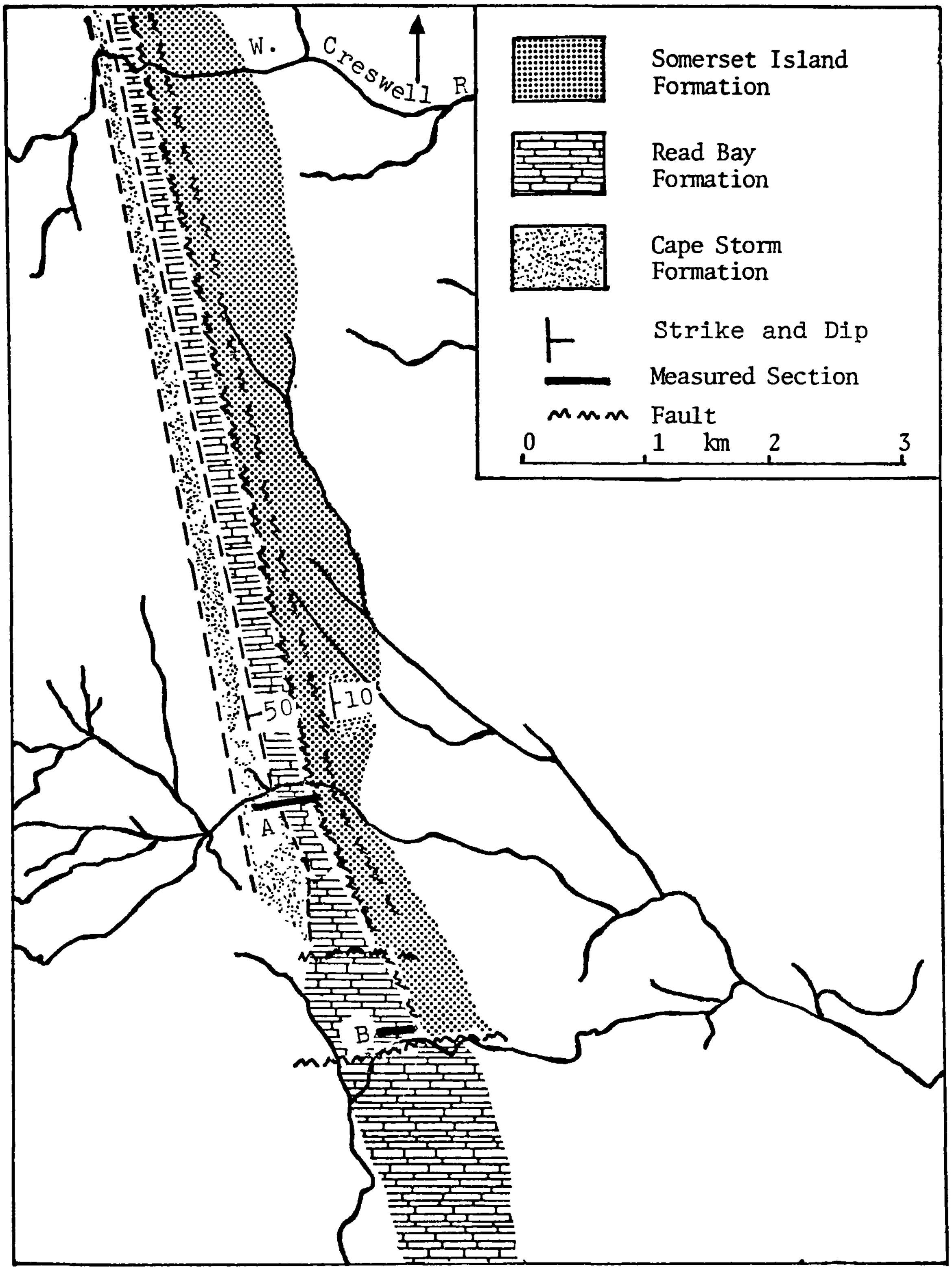
STRATIGRAPHIC SECTIONS-CRESWELL BAY NORTH

Introduction

Two sections were measured in river gorges north of Creswell Bay, the first in an unnamed gorge 9 km inland (section A, Text-fig. 6), and the second in an unnamed gorge 6.5 km inland (section B, Text-fig. 6). A third section on the West Creswell River (Text-fig. 6) was examined briefly but not measured due to inaccessability of much of the exposure.

In section A, 170 m of Cape Storm Formation are conformably overlain by 220 m of Read Bay Formation. The total thickness of the Cape Storm Formation could not be determined since the lower boundary is not exposed. However, on the north bank of the West Creswell River the entire Cape Storm Formation is exposed and is approximately 240 m thick based on calculations from aerial photographs. In section B only 91 m of the upper part of the Read Bay Formation are exposed. The Read Bay Formation in section A is in turn overlain by the Somerset Island Formation, of which 70 m were measured. The Somerset Island Formation is not exposed in section B.

The sections are on the west limb of the Creswell Bay Syncline (Text-fig. 2), and the Cape Storm and Read Bay Formations and lower part of the Somerset Island Formation dip eastward approximately 50°. The Read Bay Formation forms a prominent flat-topped ridge approximately 300 m wide, bounded on the east by a strike fault, and contrasts sharply with the generally recessive formations immediately below and above (Pl. 1, fig. 5). Across a second strike fault approximately 90 m further east the dip changes markedly, and the upper strata of the Somerset Island



Text-figure 6. Sketch map of area north of Creswell Bay showing the geology and location of measured sections A and B.

Formation dip 10° eastward (Text-fig. 6). Both strike faults can be recognized in strata at the West Creswell River.

Near section B, the prominent ridge of Read Bay strata is laterally offset approximately 600 m by a west-trending dip fault (Text-fig. 6). Between sections A and B a minor dip fault has resulted in a lateral displacement of approximately 20 m. The trends of these faults are similar to those described by Dixon (1973, p. 23) approximately 13 km to the west.

Cape Storm Formation

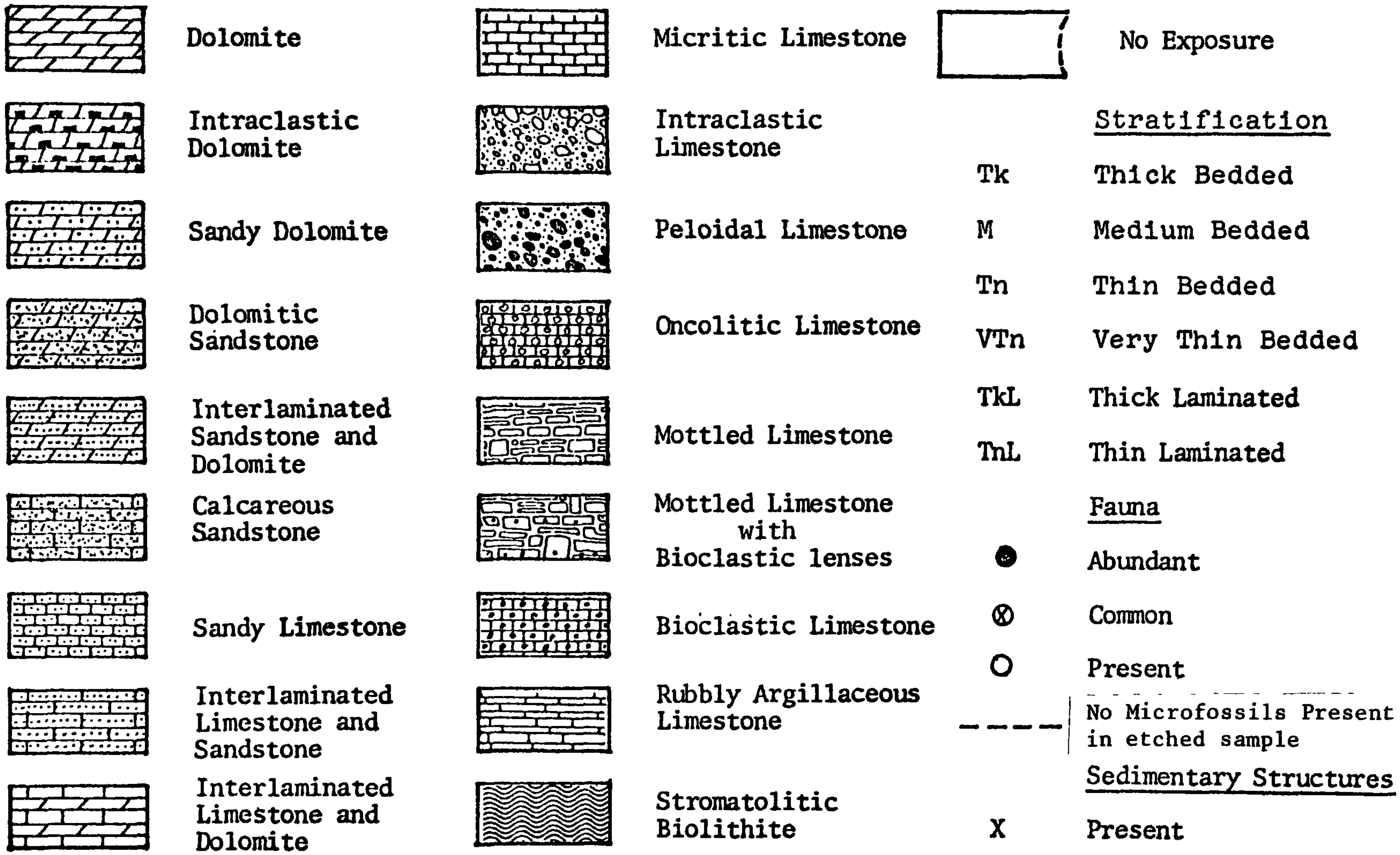
Lithology

Details of the lithological succession are presented in Text-figures 7 and 8. The lower part of the Cape Storm Formation consists predominantly of buff to light-grey, very thin- to medium-bedded dolomitic sandstone, sandy dolomite, and thin- to thickly-interlaminated units of dolomite with dolomitic sandstone. In the upper part, buff to medium-grey, thin-bedded sandy dolomite, dolomitic sandstone, calcareous sandstone, peloidal limestone, and thinly- to thickly-interlaminated units of limestone with dolomite and limestone with sandstone predominate.

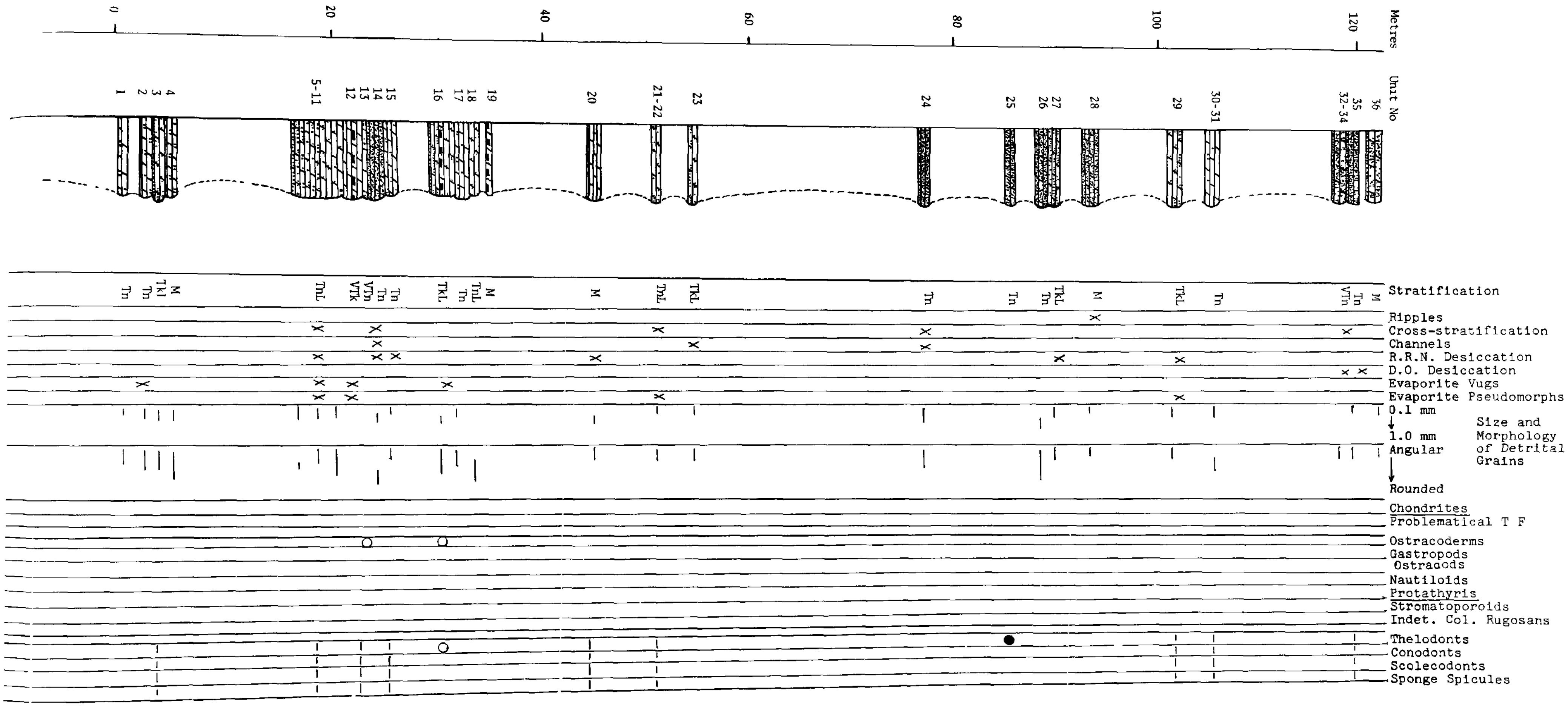
The predominant detrital component in the Cape Storm Formation is generally well sorted, angular to subangular, or rarely subrounded, quartz, ranging from 0.05-0.4 mm in diameter and exhibiting straight to undulose extinction. Plagioclase, microcline and muscovite are minor components.

Intraclasts of dolomite in units A12, A16, A19, A47, and A50 are up to 0.05 cm thick, and range in longest axis from 1.0 to 8.0 cm, their longest axes being oriented parallel to bedding. Commonly the intraclasts cover up to 80% of the bedding planes.

Text-figure 7. Detailed stratigraphy of the lower part of the Cape Storm Formation, section A.

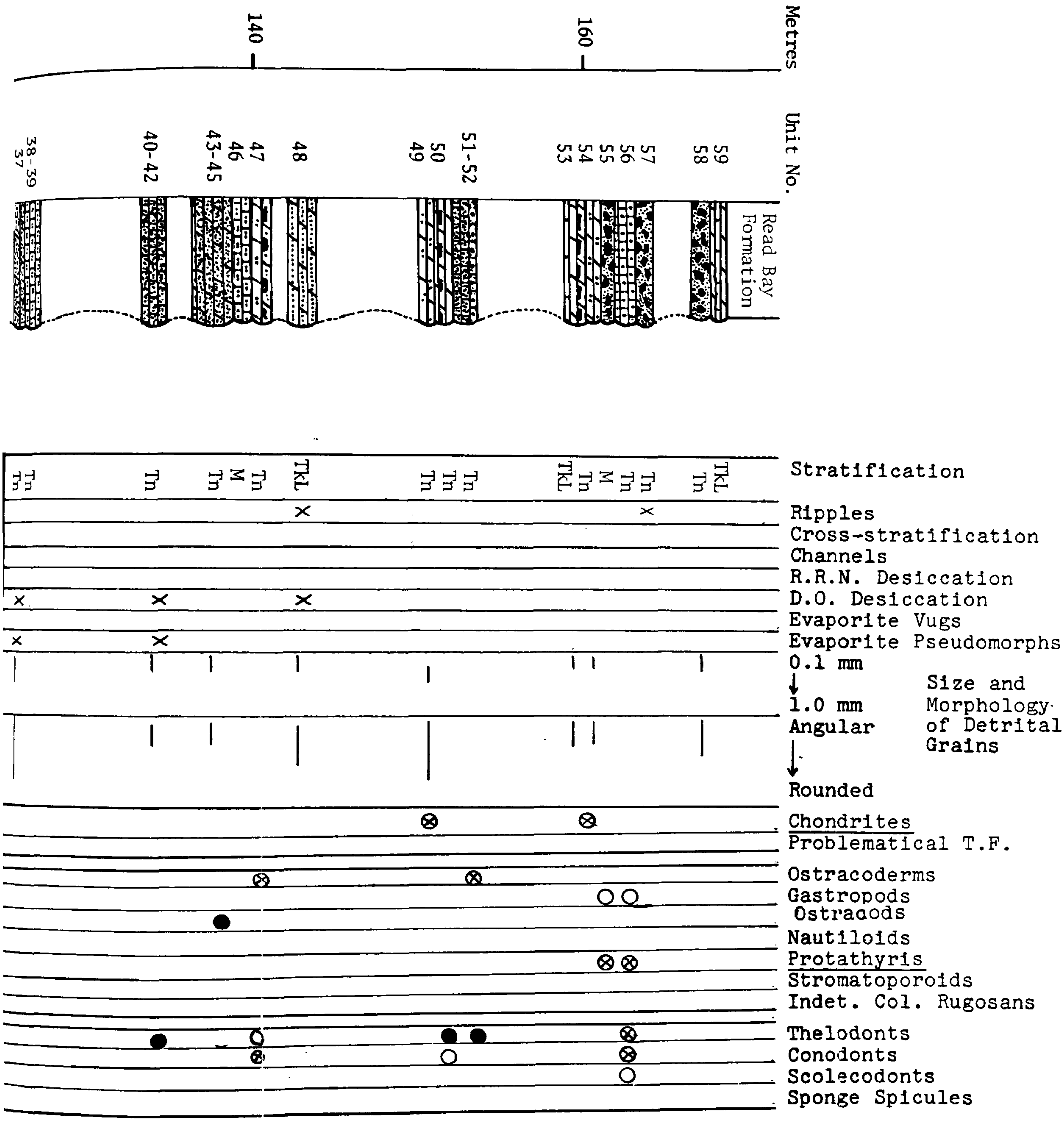


Desiccation Types: R.R.N. — regular random nonorthogonal, D.O. — discontinuous oriented



Metres
0
20
40
60
80
100
120
Unit No
Stratification
Ripples
Cross-stratification
Channels
R.R.N. Desiccation
D.O. Desiccation
Evaporite Vugs
Evaporite Pseudomorphs
0.1 mm
1.0 mm
Angular
Rounded
Size and Morphology of Detrital Grains
Chondrites
Problematical T F
Ostracoderms
Gastropods
Ostracods
Nautiloids
Protathyris
Stromatoporoids
Indet. Col. Rugosans
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Text-figure 8. Detailed stratigraphy of the upper part of the Cape Storm Formation, section A. Lithological symbols as in Text-figure 7.


Metres
140
160
Unit No.
38-39
37
40-42
43-45
46
47
48
49
50
51-52
53
54
55
56
57
58
59
Read Bay Formation
Stratification
Ripples
Cross-stratification
Channels
R.R.N. Desiccation
D.O. Desiccation
Evaporite Vugs
Evaporite Pseudomorphs
0.1 mm
1.0 mm
Angular
Rounded
Size and Morphology of Detrital Grains
Chondrites
Problematical T.F.
Ostracoderms
Gastropods
Ostracods
Nautiloids
Protathyris
Stromatoporoids
Indet. Col. Rugosans
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules
Tn
TKL
M

Sedimentary Structures

Regular random nonorthogonal and discontinuous desiccation cracks (Kahle and Floyd 1971, p. 2080) occur in the Cape Storm Formation. The former are restricted to the lower 105 m whereas the latter occur in the upper 65 m. Calcite pseudomorphs, gypsum molds, and vugs up to 4.0 x 1.0 cm partly filled by gypsum are common in the lower 60 m of the formation, but are rare in the upper part. Asymmetric ripples up to 2.0 cm in amplitude and small solitary sets of cross-laminae up to 3.0 cm thick are also common in the lower 60 m, but rare in the upper part. Channels up to 26.0 cm wide and 5.0 cm deep occur in units A14 and A23.

Fauna

Fossils are generally sparse in the Cape Storm Formation. Protathyris, gastropods, ostracods, conodonts, and scolecodonts occur in the uppermost limestone units. Thelodonts are common to abundant in the upper 45 m, but rare in lower units. Unidentified ostracoderms, chiefly disarticulated head shields and scales occur in several units, and are commonly associated with intraclastic dolomite units. Trace fossils are rare, although Chondrites occurs in units A49 and A54. Several specimens of a distinctive unidentified problematical trace fossil were found in scree material from the Cape Storm Formation. These trace fossils are elongate, parallel-sided structures up to 25 x 10 cm, with crescentic ridges crossing the long axis and concave toward the center of the structure. They are very similar to those described by Jones (1974, p. 108, Pl. 23).

Read Bay Formation

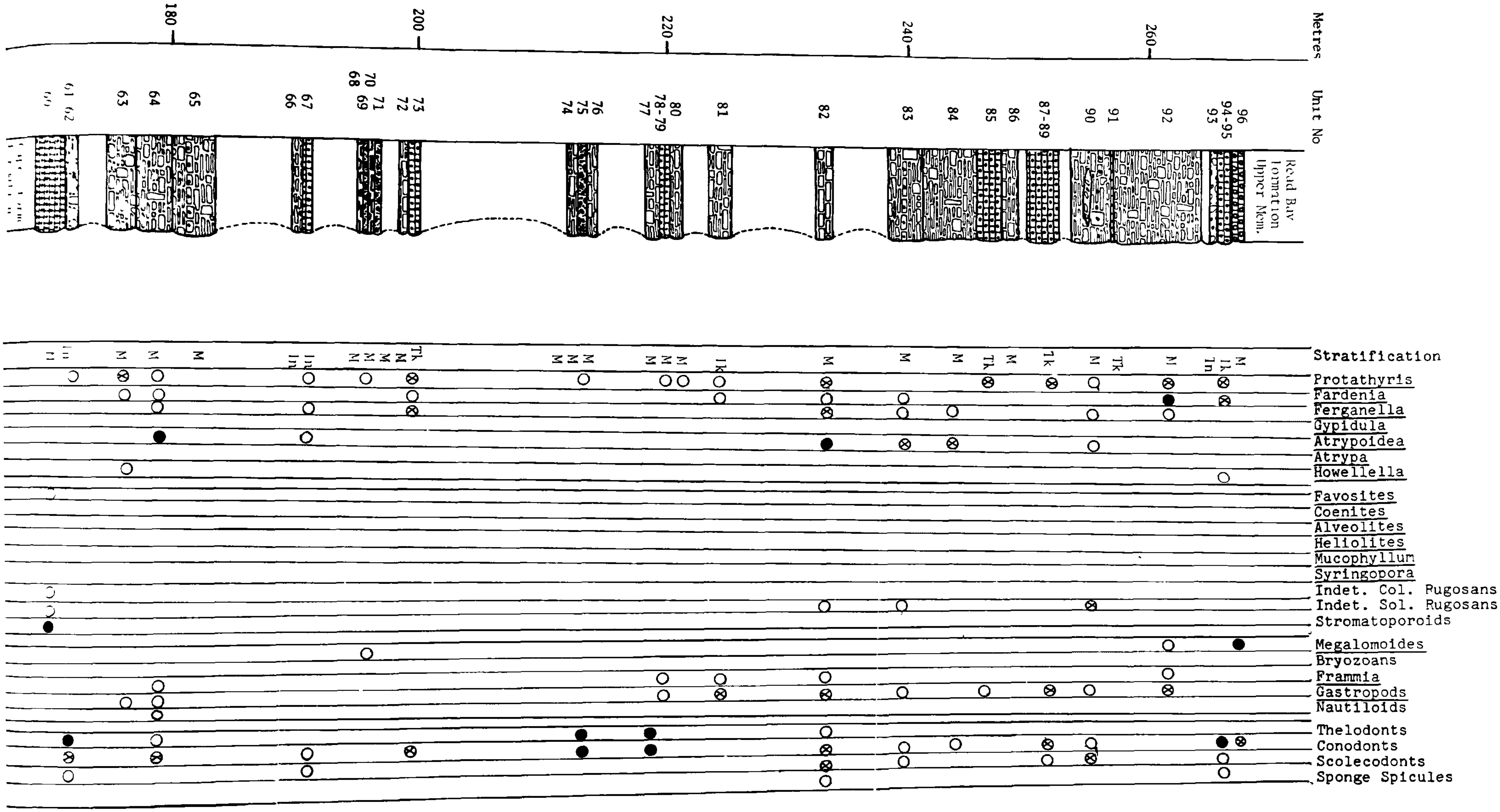
Lithology

Details of the lithological succession are represented in Text-figures 9, 10 and 11. The light- to medium-grey limestone of the Read Bay Formation is relatively well exposed on the south side of the gorge in section A, but poorly exposed in section B.

The lower boundary of the formation is placed at the bottom of a very resistant, medium-bedded bioclastic limestone unit (A60) containing numerous lamellar to hemispherical stromatoporoids. The unit forms a prominent ridge on the north and south sides of the gorge in section A, (Pl. 1, fig. 6) and on the south side of the West Creswell River. The lower boundary is not exposed in section B.

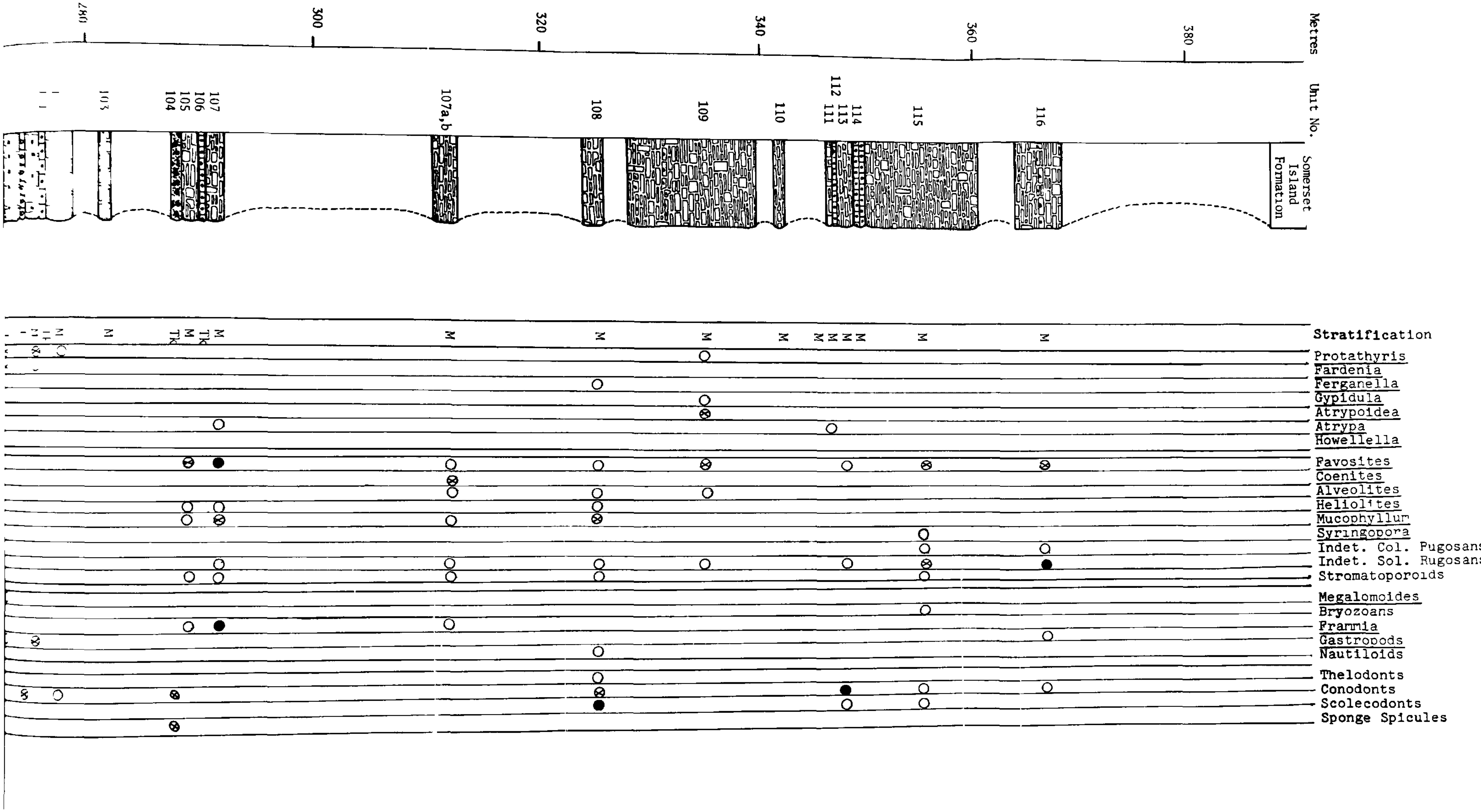
The predominant rock type is thin- to medium-bedded mottled limestone, some of which contains lenses of bioclastic limestone up to 15 cm thick and several metres long. The dolomite content of the mottled limestone ranges from a few percent to approximately 40%. In rocks with a low dolomite content, the dolomite is restricted to thin layers along bedding planes. In rocks with a higher dolomite content, the dolomite occurs as well defined layers (up to 4 cm thick) parallel to bedding or as scattered irregular patches (up to 3 cm in diameter) and stringers. Minor amounts of thin- to thick-bedded bioclastic, peloidal, oncolitic, and intraclastic limestone are also present. A thick-bedded, light-brown, coarsely crystalline dolomite unit and a silicified stromatolitic biolithite occur in section B near the base of the exposure. Bedding is generally irregular or wavy.

Text-figure 9. Detailed stratigraphy of the lower member of the Read Bay Formation, section A. Lithological symbols as in Text-figure 7.



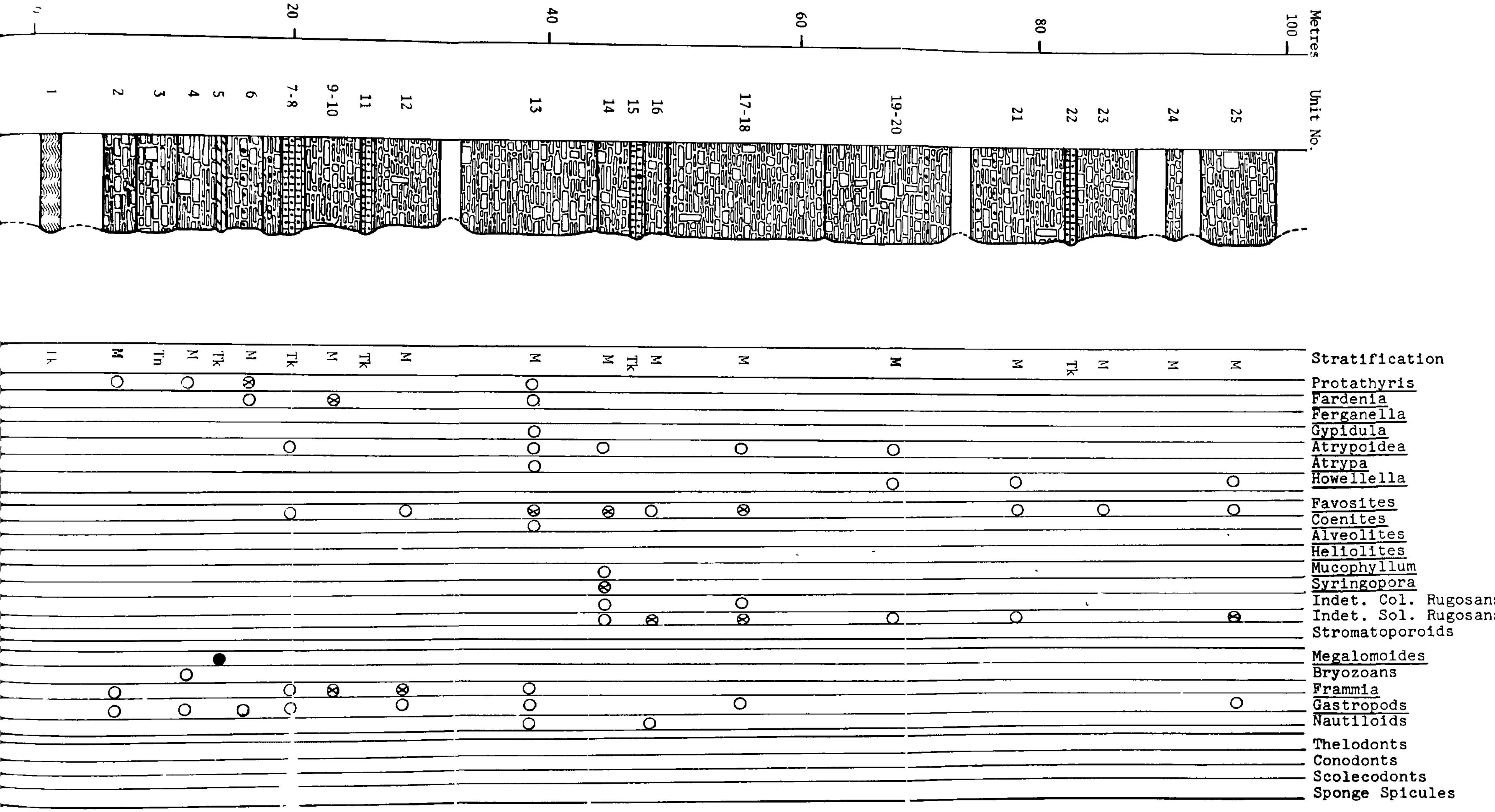
Metres
180
200
220
240
260
Unit No
Read Bay Formation Upper Mem.
Stratification
Protathyris
Fardenia
Ferganella
Gypidula
Atrypoidea
Atrypa
Howellella
Favosites
Coenites
Alveolites
Heliolites
Mucophyllum
Syringopora
Indet. Col. Rugosans
Indet. Sol. Rugosans
Stromatoporoids
Megalomoides
Bryozoans
Frammia
Gastropods
Nautiloids
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Text-figure 10. Detailed stratigraphy of the upper member of the Read Bay Formation, section A. Lithological symbols as in Text-figure 7.



Metres
280
300
320
340
360
380
Unit No.
103
104
105
106
107
107a,b
108
109
110
111
112
113
114
115
116
Somerset Island Formation
Stratification
Protathyris
Fardenia
Ferganella
Gypidula
Atrypoidea
Atrypa
Howellella
Favosites
Coenites
Alveolites
Heliolites
Mucophyllum
Syringopora
Indet. Col. Pugosans
Indet. Sol. Rugosans
Stromatoporoids
Megalomoides
Bryozoans
Framnia
Gastropods
Nautiloids
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Text-figure 11. Detailed stratigraphy of the Read Bay Formation, section B. Lithological symbols as in Text-figure 7.



Metres
20
40
60
80
100
Unit No.
1
2
3
4
5
6
7-8
9-10
11
12
13
14
15
16
17-18
19-20
21
22
23
24
25
Stratification
Protathyris
Fardenia
Ferganella
Gypidula
Atrypoidea
Atrypa
Howellella
Favosites
Coenites
Alveolites
Heliolites
Mucophyllum
Syringopora
Indet. Col. Rugosans
Indet. Sol. Rugosans
Stromatoporoids
Megalomoides
Bryozoans
Frammia
Gastropods
Nautiloids
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Crinoid, gastropod, and brachiopod fragments are common in limestone throughout the formation. Minor quantities of coral, bryozoan, stromatoporoid, ostracod and trilobite fragments occur locally.

Although there is no fundamental lithological difference between the upper and lower parts of the formation, there is a distinct difference in the contained fossils. In the lower part (units A60-A96) of section A, brachiopods are the main faunal element, whereas in the upper part (units A97-A116) corals are the main faunal element (Text-figs. 9 and 10). The boundary between these two informally designated members is drawn at the top of a conspicuous oncolitic limestone unit (A96) containing numerous convex-up disarticulated Megalomoides valves up to 15 cm long. In section B, this unit (B5) is highly dolomitized.

Angular to subangular quartz grains, up to 0.1 mm in diameter, occur in minor quantities (less than 1%) in the lower member, whereas near the base of the upper member the detrital content increases sharply to 10%. Above this unit the quartz content decreases upward to less than 1% in unit A108. A similar distribution of quartz occurs in section B. Muscovite blades up to 0.3 mm long occur locally in trace quantities.

The uppermost part of the Read Bay Formation is covered in both sections A and B. Highly fossiliferous limestone fragments which form the scree over the covered interval suggest that the covered strata should be assigned to the Read Bay Formation.

Sedimentary Structures

Wavy and irregular bedding are the only primary sedimentary structures recognized in the Read Bay Formation. Stylolites are common secondary sedimentary structures, especially in mottled limestone, and vary from horizontal to inclined, with amplitudes up to 1.5 cm.

Faunas in the Lower Member

Although brachiopods occur in various proportions and frequency within the lower member two assemblages can be distinguished: 1. *Protathyris* assemblages — ones in which *Protathyris* predominates; 2. *Atrypoidea* assemblages — ones in which *Atrypoidea* predominates. Although *Atrypoidea* has been referred to as *Atrypella* in previous Arctic geological studies, Copper (1977) considered *Atrypella* a junior synonym of *Atrypoidea*. The term assemblage is used here to denote a group of fossils found together and restricted to a single lithological unit.

Protathyris assemblages tend to occur in relatively thin units of bioclastic limestone and mottled limestone with bioclastic lenses, whereas *Atrypoidea* assemblages tend to occur in relatively thicker units of mottled limestone. *Fardenia* and *Ferganella* occur commonly in both assemblages, while *Howellella* occurs only in *Protathyris* assemblages near the base and top of the lower member.

Lamellar to hemispherical stromatoporoid colonies are abundant in unit A60 and ramose stromatoporoids in unit A61, but are rare elsewhere. Gastropods are common throughout the lower member, whereas trilobites, nautiloids, *Favosites* and streptelasmatid solitary corals occur locally. *Megalomoides* is abundant in unit A96 but rare elsewhere. Conodonts are common throughout the lower member, scolecodonts less common, and siliceous sponge spicules rare. Thelodonts are generally abundant in lower units, but absent in upper units.

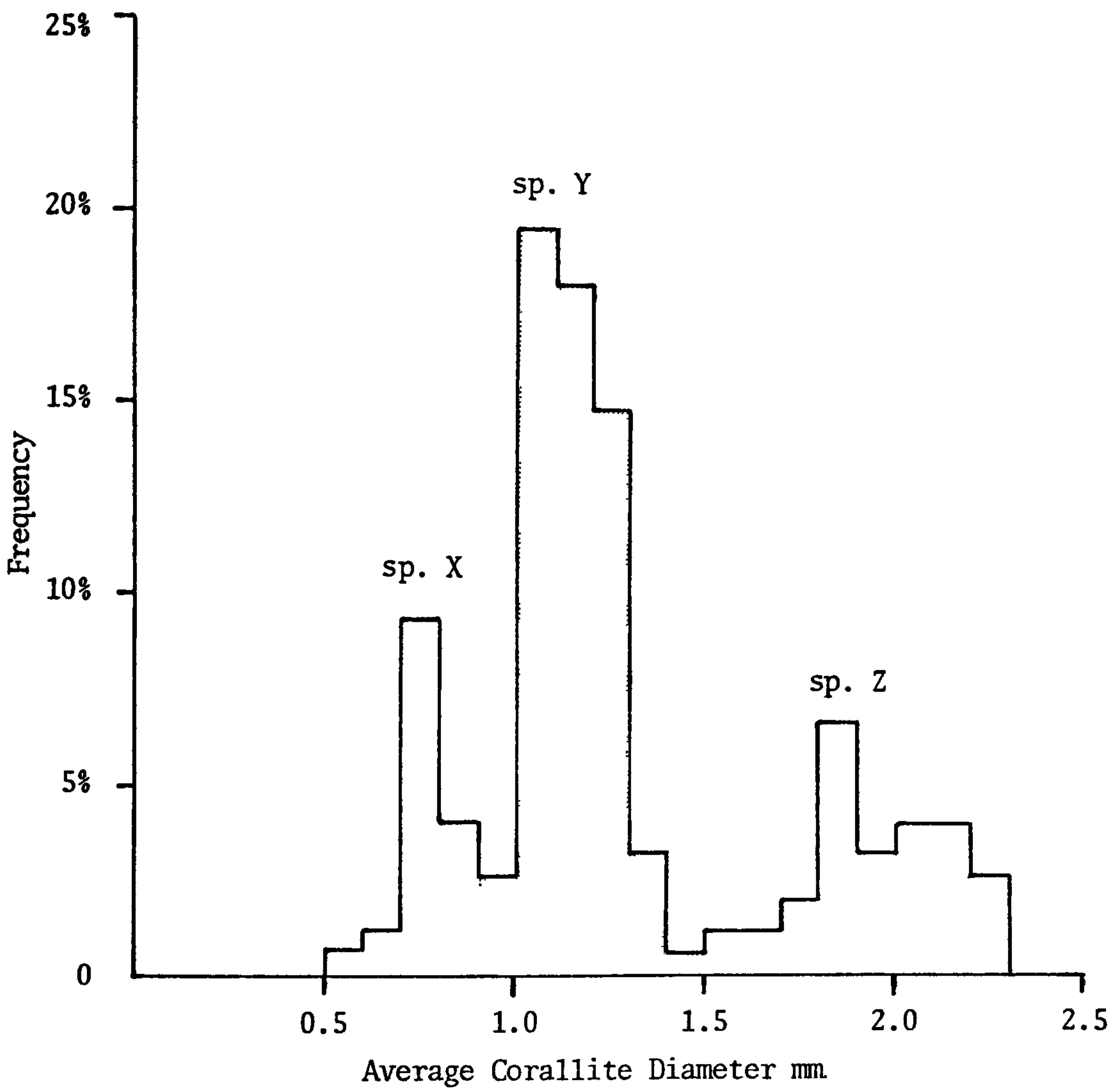
Faunas in the Upper Member

Favosites is the most common coral and occurs throughout the upper member (Text-figs. 10 and 11) as isolated discoid to subcolumnar colonies up to 0.7 m in diameter. Streptelasmatid solitary corals that have been transported or overturned are locally common. The remainder of the diverse coral fauna, and stromatoporoids, occur locally. Gastropods, bryozoans, and nautiloids are rare. Frammia occurs abundantly in units A107, B10, and B12, but is rare in other units. Conodonts and scolecodonts are common to abundant in lower units but are rare in upper units. Siliceous sponge spicules and thelodonts are very rare. Samples from section B were not etched for microfossils. Brachiopods occur locally in the upper member, and include Gypidula and Atrypa, not recognized in the lower member.

The 114 Favosites colonies collected from the upper member in section A and the 35 Favosites colonies collected from section B show consistent patterns of variation in morphology and diversity in relation to stratigraphic position. Most specimens were collected from the outcrop but scree specimens were included wherever their stratigraphic position could be determined with reasonable certainty.

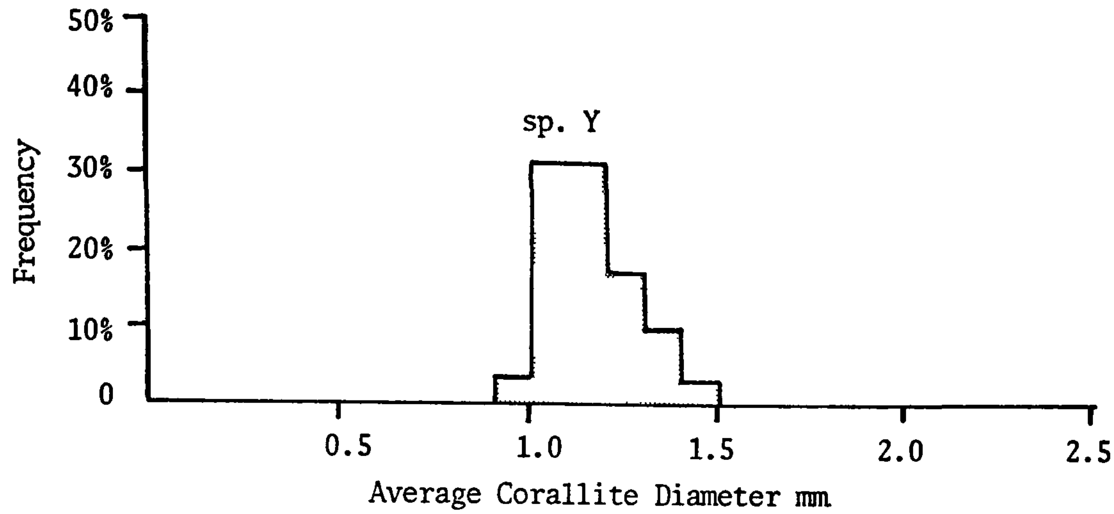
There appear to be three species of Favosites (designated X, Y, and Z for convenience), each with different average corallite diameters, in sections A and B (Text-fig. 12). In section A, all three species occur in the lower units (A105-A109), 2 species (Y and Z) are present in unit A115, and only one species (Y) is present in unit A116 and overlying scree material (Text-fig. 13).

Parameters of the corallum are compared in Text-figure 14. Favosites colonies in the lower units tend to be relatively large and discoid, whereas colonies in the upper units are smaller and hemispherical to subcolumnar. The distribution of Favosites species and colony forms is similar in section B. Species X, Y, and Z are present in the lower units (B13-B17), but only one species (Y) occurs in the upper units and overlying scree material (Text-fig. 15). The colonies are predominantly

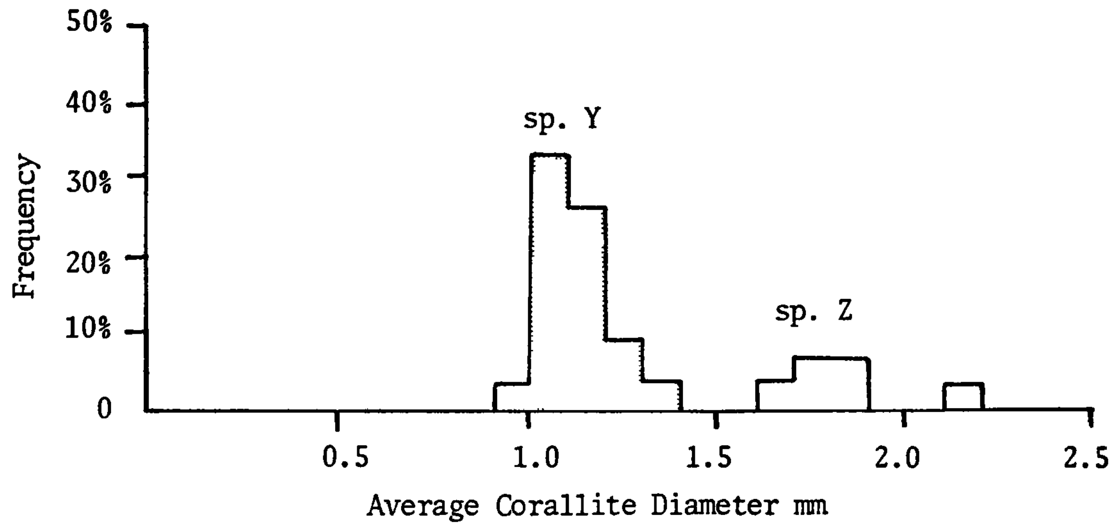


Text-figure 12. Histogram of average corallite diameters of Favosites colonies from the Read Bay Formation, sections A and B, based on 149 specimens. Based on the average of the ten largest corallites in each colony.

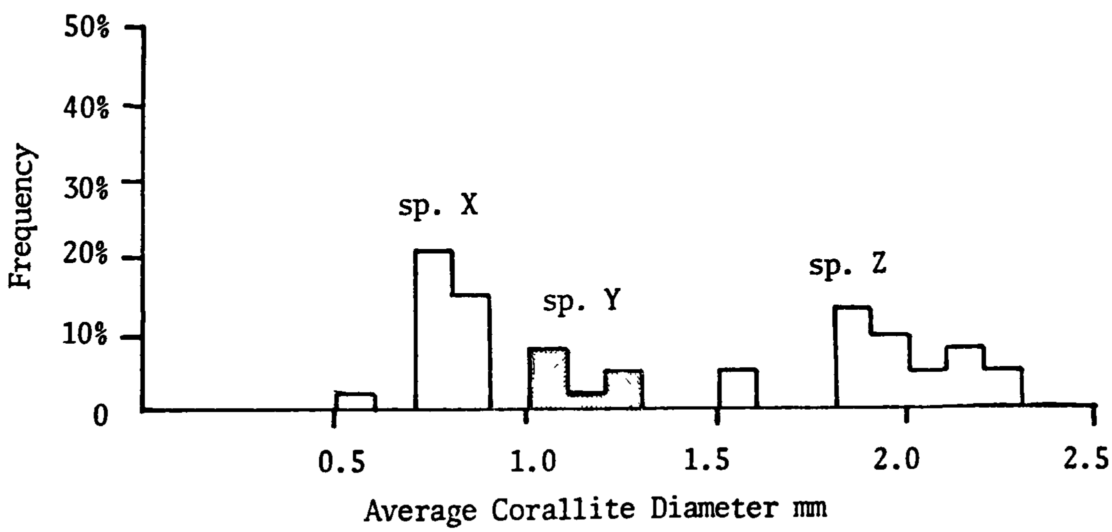
Text-figure 13. Comparison of average corallite diameters of *Favosites* colonies from various stratigraphic intervals of the Read Bay Formation, section A. N=number of specimens measured.



Unit A116 (n=30)

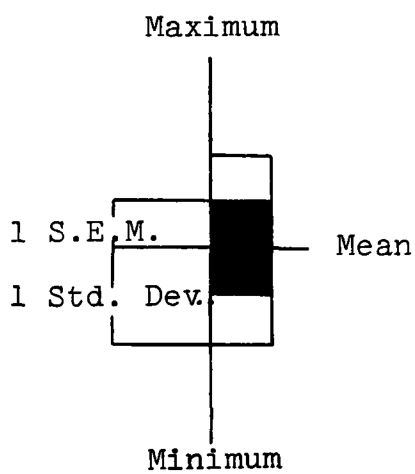


Unit A115 (n=45)

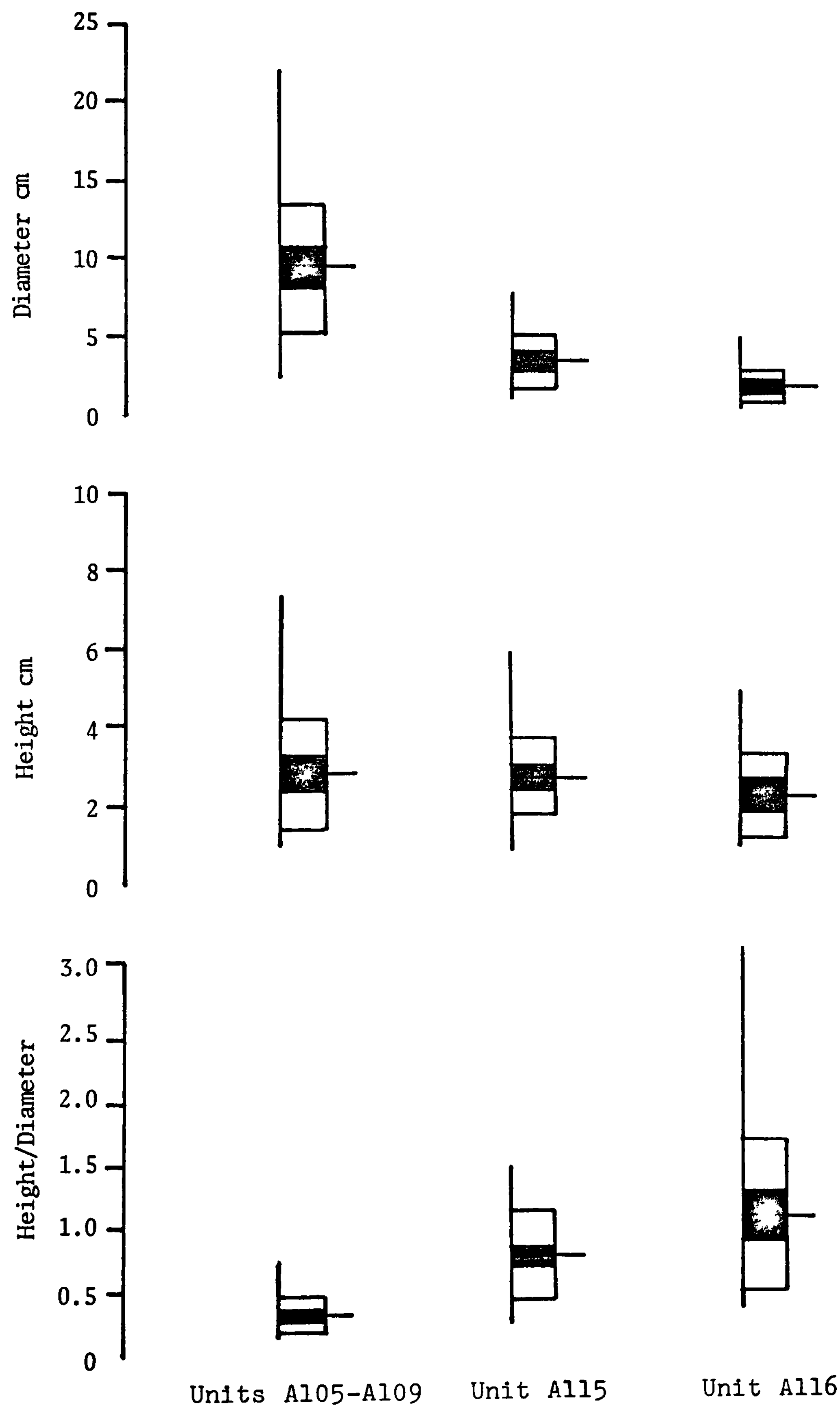


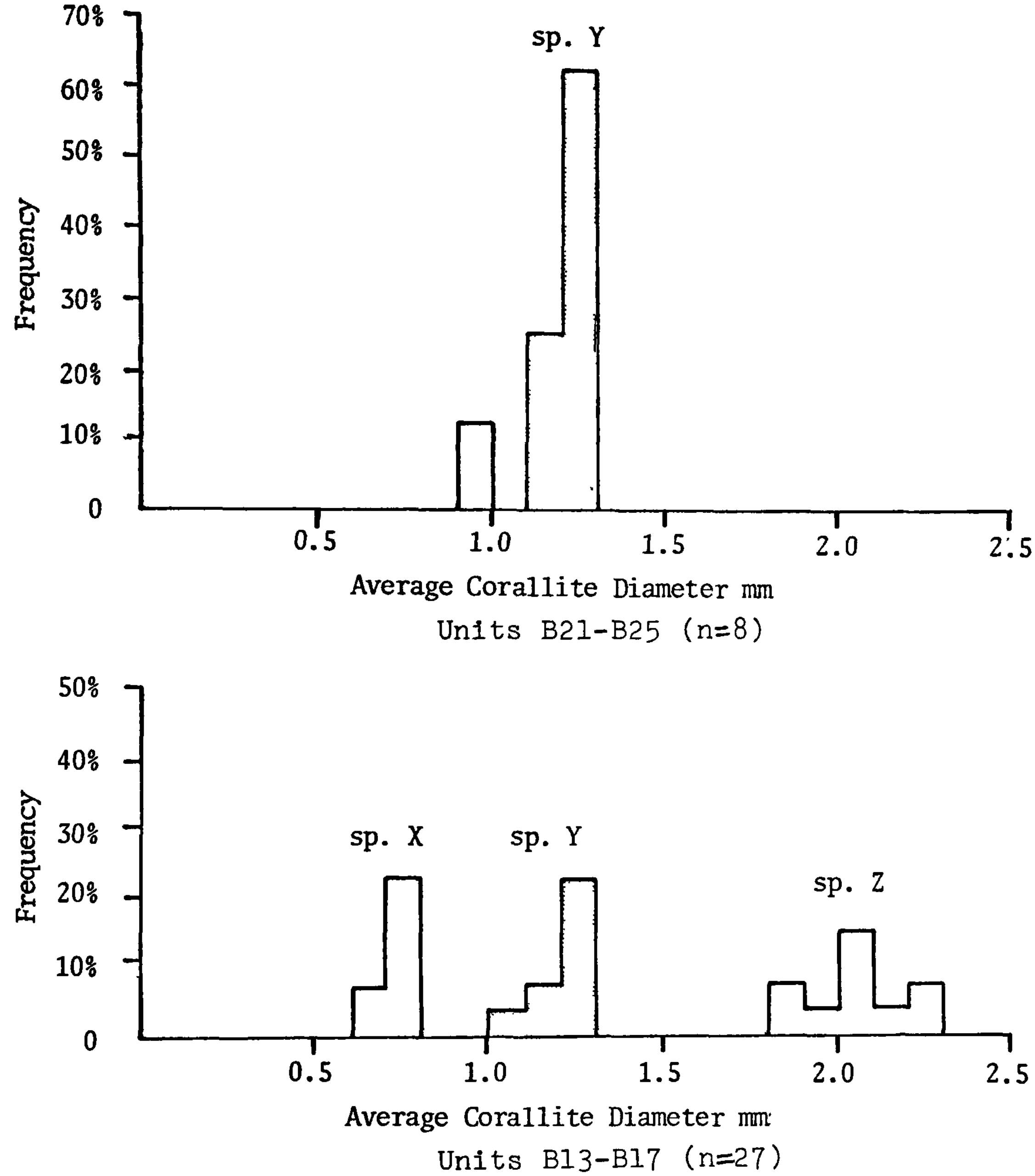
Units A105-A109 (n=39)

Text-figure 14. Dice-diagrams comparing height, diameter, and height/diameter ratios of Favosites colonies from various stratigraphic intervals of the Read Bay Formation, section A.



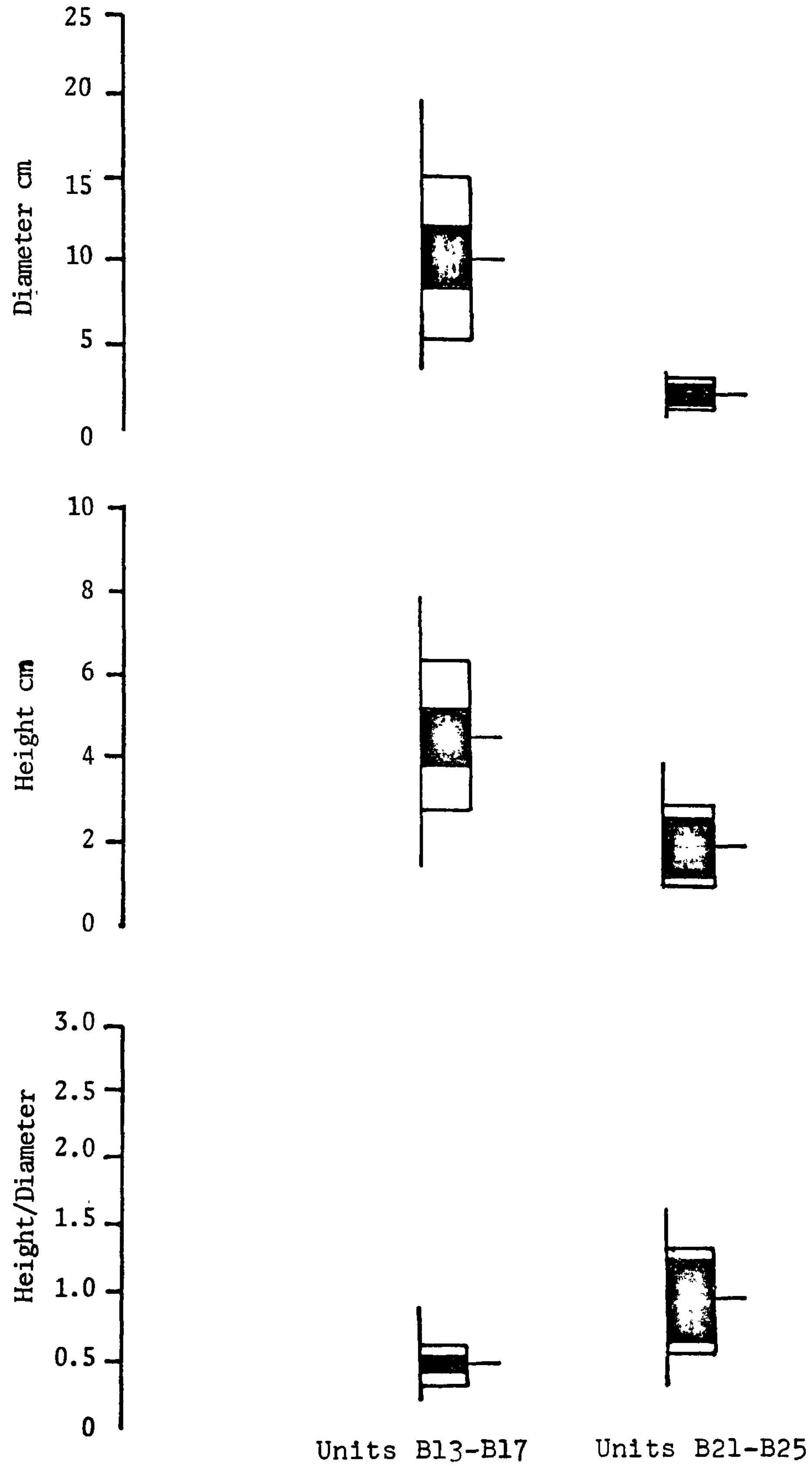
S.E.M.= Standard error of the mean
Std. Dev.= Standard deviation


25
20
15
10
5
0
Diameter cm
10
8
6
4
2
0
Height cm
3.0
2.5
2.0
1.5
1.0
0.5
0
Height/Diameter
Units A105-A109
Unit A115
Unit A116



Text-figure 15. Comparison of average corallite diameters of Favosites colonies from various stratigraphic intervals of the Read Bay Formation, section B. N=number of specimens.

Text-figure 16. Dice-diagrams comparing height, diameter, and height/diameter ratios of *Favosites* colonies from various stratigraphic intervals of the Read Bay Formation, section B.


Diameter cm
25
20
15
10
5
0
Height cm
10
8
6
4
2
0
Height/Diameter
3.0
2.5
2.0
1.5
1.0
0.5
0
Units B13-B17
Units B21-B25

discoid in the lower units, whereas they tend to be smaller and subhemispherical in the upper units (Text-fig. 16).

Somerset Island Formation

Lithology

Details of the lithological succession are represented in Text-figure 17. The lower boundary of the Somerset Island Formation is placed at the base of a medium-grey, thickly-interlaminated limestone and sandstone unit (A117), which occurs approximately 20 m stratigraphically above the uppermost exposed Read Bay strata in section A (Pl. 1, fig. 7).

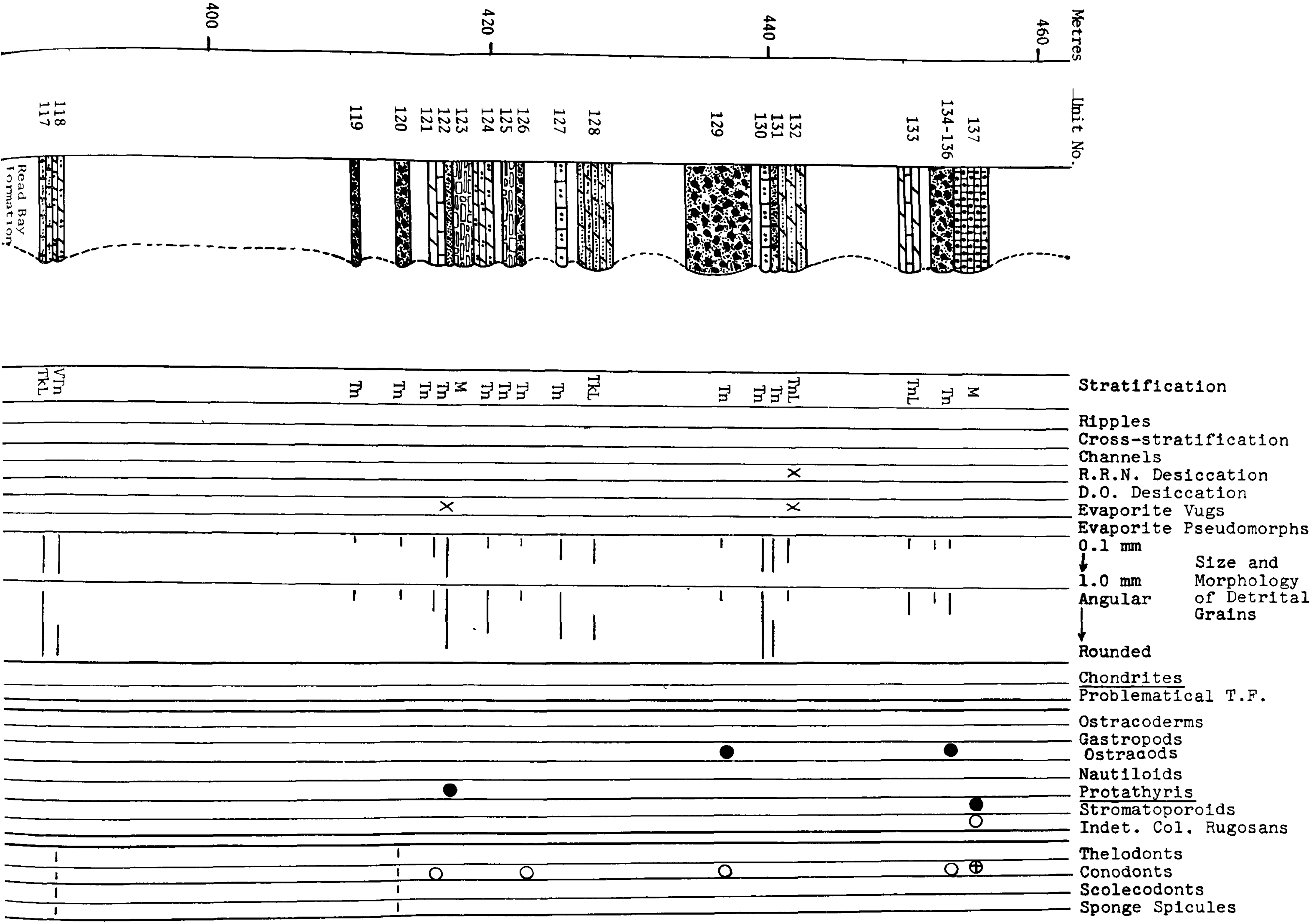
The Somerset Island Formation consists primarily of thin- to medium-bedded peloidal and bioclastic limestone, thin- to thickly-interlaminated dolomite and sandstone, and thin-bedded sandy dolomite and sandy limestone. Most units are buff to light-grey, depending upon whether dolomite or limestone is the predominant constituent. Some of the units are slightly pink on weathered surfaces due to iron oxide staining of the sand grains. The first 'red bed' that is easily distinguished in the field is unit A124, a sandy dolomite.

Angular to subangular quartz grains approximately 0.1 mm in diameter tend to occur in limestones, whereas well-rounded spherical quartz grains up to 1.0 mm in diameter are common in sandstone and dolomite. Muscovite blades up to 0.3 mm long occur in small quantities (less than 1%).

Ostracod fragments are relatively common in most units, whereas brachiopod, gastropod, and stromatoporoid fragments are generally restricted to peloidal and mottled limestones.

Sedimentary Structures

Regular random nonorthogonal desiccation cracks occur in unit A132 and vugs up to 7 cm in diameter (commonly partly filled with gypsum) occur


Metres
400
420
440
460
Unit No.
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134-136
137
Read Bay Formation
Stratification
Ripples
Cross-stratification
Channels
R.R.N. Desiccation
D.O. Desiccation
Evaporite Vugs
Evaporite Pseudomorphs
0.1 mm
1.0 mm
Angular
Rounded
Size and Morphology of Detrital Grains
Chondrites
Problematical T.F.
Ostracoderms
Gastropods
Ostracods
Nautiloids
Protathyris
Stromatoporoids
Indet. Col. Rugosans
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Text-figure 17. Detailed stratigraphy of the Somerset Island Formation, section A. Lithological symbols as in Text-figure 7.

in units A122 and A132. Except for planer bedding and lamination, no other primary sedimentary structures were recognized.

Fauna

Ostracods are abundant in units A129 and A135 but are absent from other units, although fragments are common in most thin sections. Poorly preserved indeterminate cerioid rugose corals in unit A137 are overgrown by secondarily silicified stromatoporoids, all of which appear to have been transported. Isolated specimens of Protathyris occur locally. Conodonts are common but generally in small numbers (less than 20 per 600 g of rock). Unidentified trace fossils, similar to those described from the Cape Storm Formation, although not observed in the section, occur in large numbers on a bedding plane in the Somerset Island Formation in a small tributary to the West Creswell River approximately 3.2 km north of section A.

CHAPTER 4

STRATIGRAPHIC SECTIONS-CRESWELL BAY SOUTH

Introduction

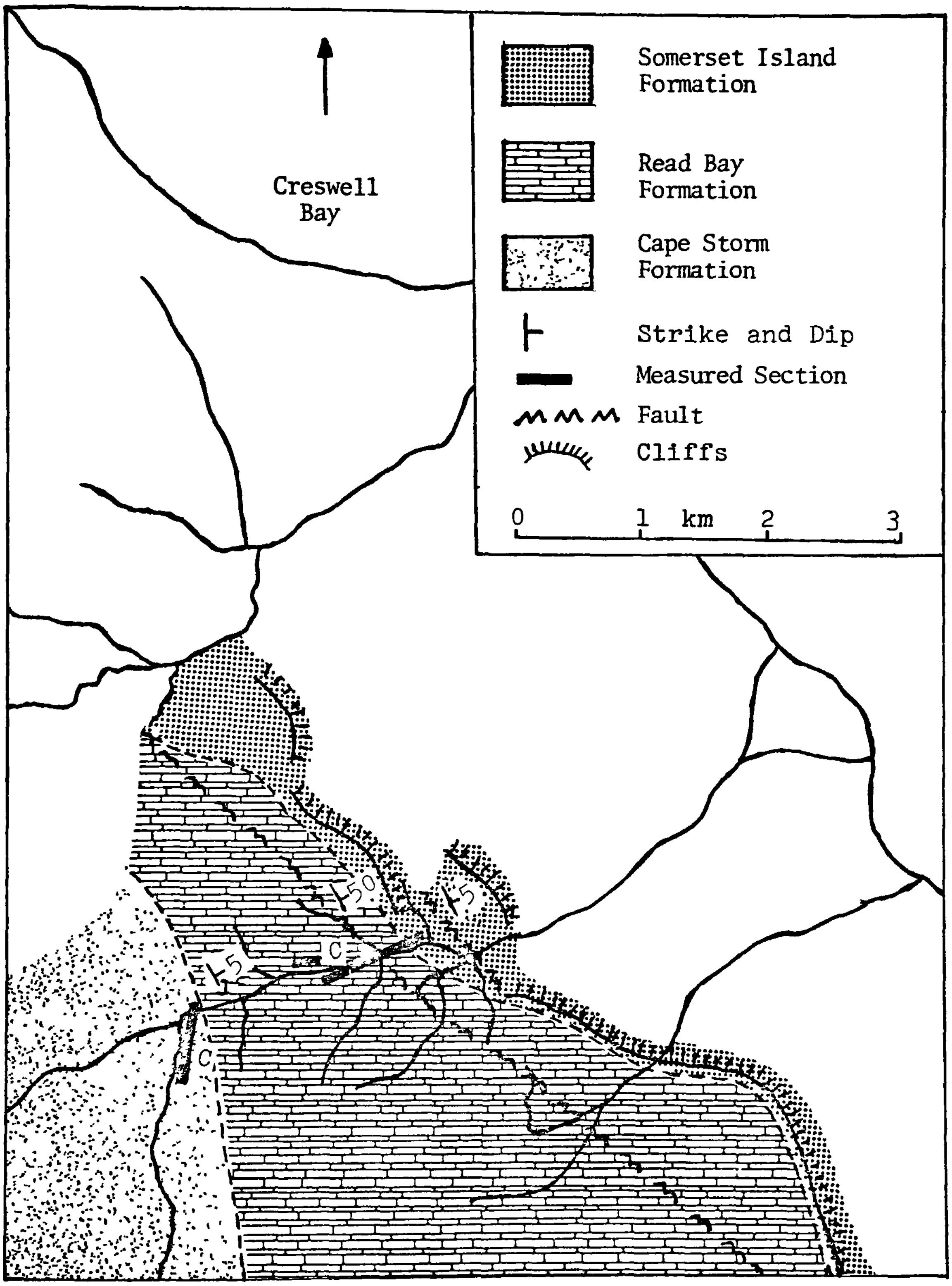
A composite section (section C) based on 5 individual sections was measured in an unnamed river gorge approximately 13 km north of Cape Garry (Text-fig. 18). The section contains approximately 23 m of Cape Storm Formation, 155 m of Read Bay Formation, and 30 m of very poor exposure of the Somerset Island Formation. The Cape Storm Formation and lower 30 m of the Read Bay Formation dip gently eastward (5°). The dip changes abruptly across a strike fault (Text-fig. 18), and the upper 120 m of the Read Bay Formation and overlying 30 m of the Somerset Island Formation dip relatively steeply (50°). Further east across a second strike fault (Text-fig. 18) the upper units of the Somerset Island Formation dip very gently eastward (5°). Several minor folds and dip faults with minor displacements occur in areas near the major faults.

Cape Storm Formation

Lithology

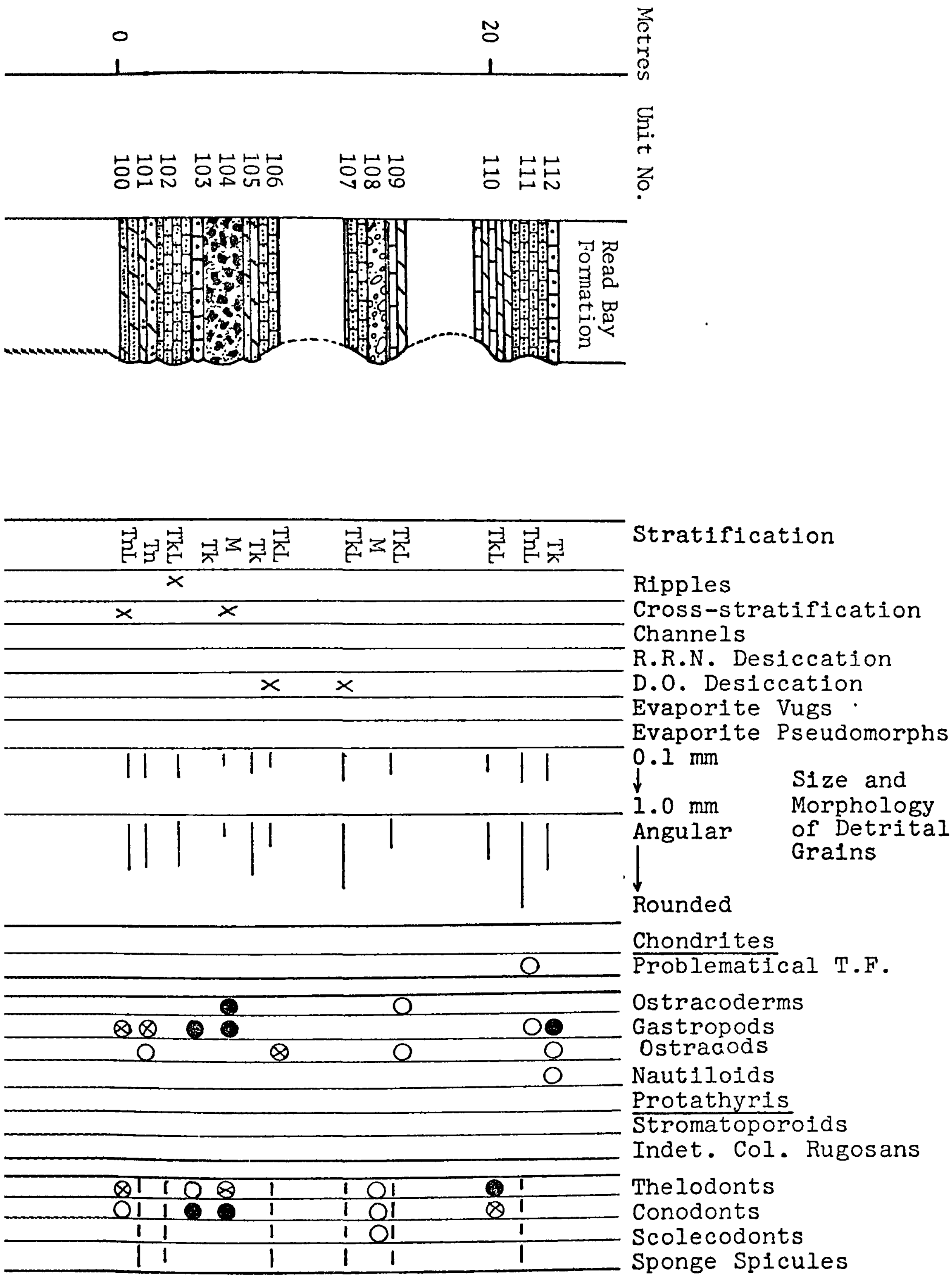
Details of the lithological succession are represented in Text-figure 19. The exposed Cape Storm Formation consists primarily of recessive, light- to medium-grey, planar-bedded, thinly- to thickly-interlaminated units of limestone with dolomite, limestone with sandstone, and dolomite with sandstone. Resistant, medium-bedded, light-grey to light-brown, peloidal limestone and intraclastic limestone are also present.

Angular to subrounded quartz grains, 0.05-0.3 mm in diameter, are the predominant detrital components. Muscovite blades up to 0.3 mm commonly constitute up to 2% of the rock.



Text-figure 18. Sketch map of area south of Creswell Bay showing the geology and location of measured section C.

Text-figure 19. Detailed stratigraphy of the Cape Storm Formation, section C. Lithological symbols as in Text-figure 7.



Metres
0
20
Unit No.
100
101
102
103
104
105
106
107
108
109
110
111
112
Read Bay Formation
Stratification
ThL
Th
TkL
Tk
M
Tk
TkL
TkL
M
TkL
TkL
ThL
Tk
Ripples
Cross-stratification
Channels
R.R.N. Desiccation
D.O. Desiccation
Evaporite Vugs
Evaporite Pseudomorphs
0.1 mm
1.0 mm
Angular
Rounded
Size and Morphology of Detrital Grains
Chondrites
Problematical T.F.
Ostracoderms
Gastropods
Ostracods
Nautiloids
Protathyris
Stromatoporoids
Indet. Col. Rugosans
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

The uppermost unit of the Cape Storm Formation is a 0.3 m thick, resistant, light-brown, planar-bedded, bioclastic limestone containing local concentrations of gastropods (unit C112) (Pl. 1, fig. 8).

Sedimentary Structures

Cross-lamination and ripples are relatively rare and restricted to the lower 8 m. Units C106 and C107 contain discontinuous oriented desiccation cracks up to 5 cm long. No other primary sedimentary structures were recognized.

Fauna

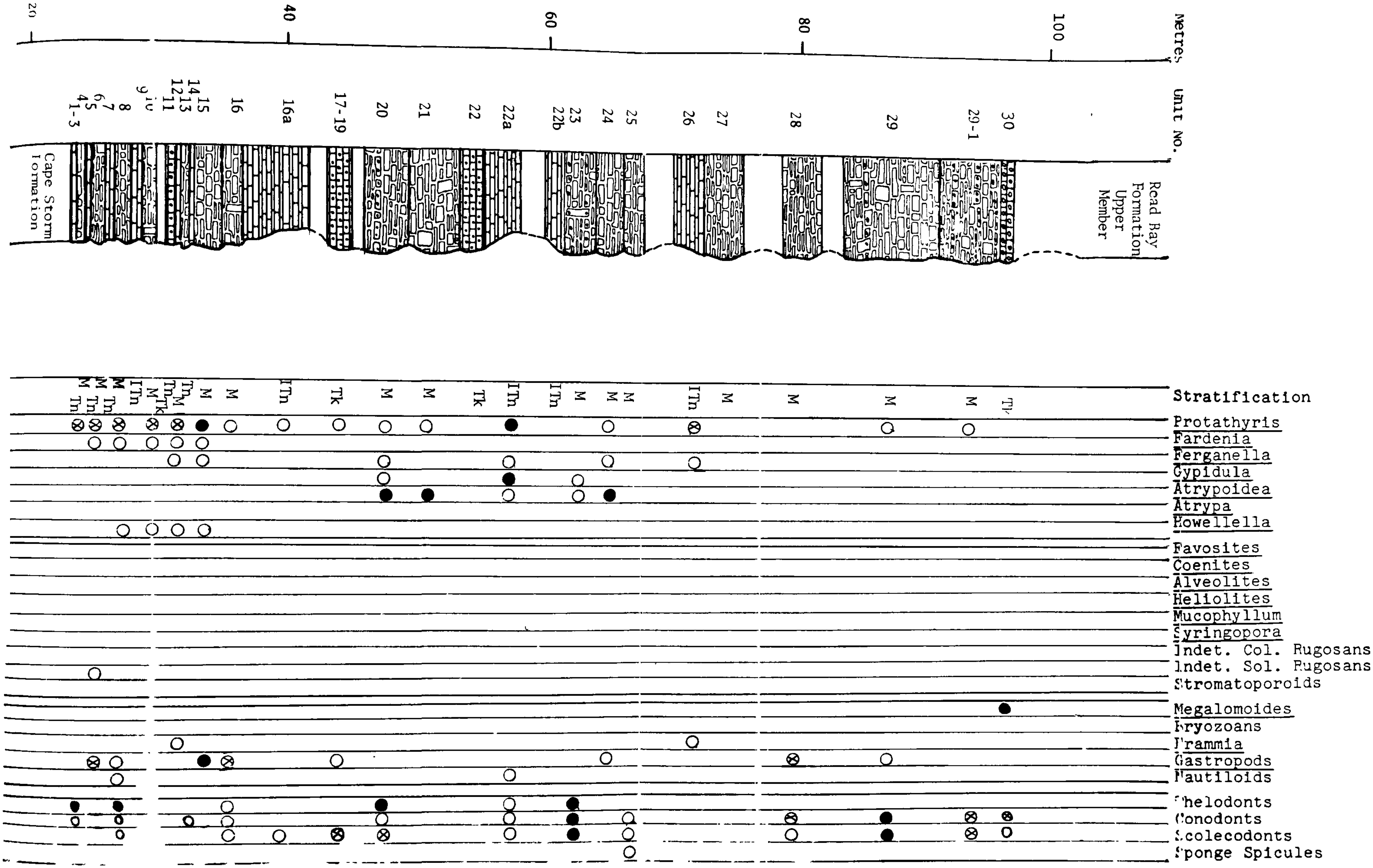
Gastropods, conodonts, and thelodonts are relatively abundant throughout the exposed strata. Unidentified ostracoderms are present in relatively large numbers at the top of unit C104, but rare in other units. Scolecodonts and nautiloids are present near the top of the formation. Unit C111 contains unidentified trace fossils similar to those found in section A, and measuring up to 15 x 5 cm. Although no ostracods were recognized in outcrop, they are common in thin section.

Read Bay Formation

Lithology

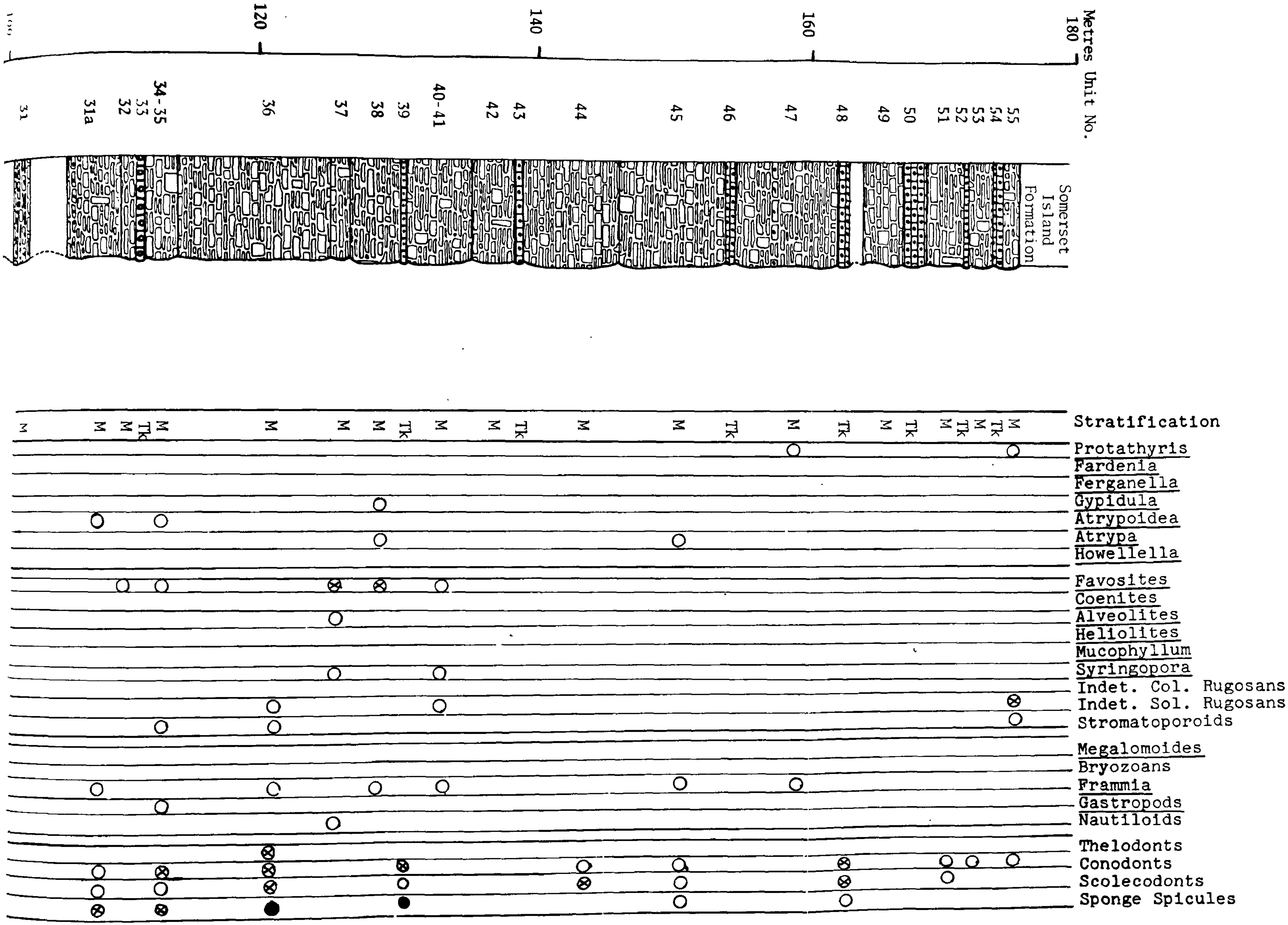
Details of the lithological succession are represented in Text-figures 20 and 21. The lower boundary of the Read Bay Formation is placed at the base of the first argillaceous limestone unit to occur in the section (unit C1). The lower 45 m consists of alternating units of thin- to medium-bedded mottled limestone and argillaceous limestone (Pl. 1, fig. 8) with minor thin- to thick-bedded oncolitic limestone, intraclastic limestone, and bioclastic limestone units. The upper 106 m is principally medium- to thick-bedded mottled limestone and bioclastic limestone. Crinoid, brachiopod, and gastropod fragments are relatively

Text-figure 20. Detailed stratigraphy of the lower member of the Read Bay Formation, section C. Lithological symbols as in Text-figure 7.



Metres
20
40
60
80
100
Unit No.
1-3
4
5
6
7
8
9
10
11
12
13
14
15
16
16a
17-19
20
21
22
22a
22b
23
24
25
26
27
28
29
29-1
30
Cape Storm Formation
Read Bay Formation Upper Member
Stratification
Protathyris
Fardenia
Ferganella
Gypidula
Atrypoidea
Atrypa
Howellella
Favosites
Coenites
Alveolites
Heliolites
Mucophyllum
Syringopora
Indet. Col. Rugosans
Indet. Sol. Rugosans
Stromatoporoids
Megalomoides
Bryozoans
Pramnia
Gastropods
Nautiloids
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

Text-figure 21. Detailed stratigraphy of the upper member of the Read Bay Formation, section C. Lithological symbols as in Text-figure 7.



Metres
120
140
160
180
Unit No.
31
31a
32
33
34-35
36
37
38
39
40-41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
Somerset Island Formation
Stratification
M
Tk
Protathyris
Fardenia
Ferganella
Gypidula
Atrypoidea
Atrypa
Howellella
Favosites
Coenites
Alveolites
Heliolites
Mucophyllum
Syringopora
Indet. Col. Rugosans
Indet. Sol. Rugosans
Stromatoporoids
Megalomoides
Bryozoans
Frammia
Gastropods
Nautiloids
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

common throughout the formation, whereas minor amounts of ostracod, bryozoan, trilobite, and coral fragments are present locally.

Although there is no fundamental lithological difference between the lower and upper parts of the formation, there is a distinct difference in the contained fossils, similar to that in section A. Brachiopods are the main faunal element in the lower member (units C1-C30) and corals the main faunal element in the upper member (units C31-C55). The boundary between these two informally designated members is drawn at the top of a 0.8 m thick, resistant, medium-brown, oncolitic limestone unit C30) containing large numbers of disarticulated, convex-up Megalomoides shells (Pl. 1, figs. 3 and 4).

Angular to subangular quartz grains, up to 0.1 mm in diameter, occur in relatively minor quantities (less than 5%) throughout the formation. Muscovite blades up to 0.3 mm long are present locally in trace quantities.

Sedimentary Structures

Except for wavy to irregular bedding, no primary sedimentary structures were recognized in the Read Bay Formation. Horizontal to inclined stylolites are common secondary structures.

Faunas in the Lower Member

As in section A, two assemblages can be distinguished: 1. Protathyris assemblages – ones in which Protathyris predominates; 2. Atrypoidea assemblages – ones in which Atrypoidea predominates.

Protathyris assemblages generally are present in thin units of alternating mottled limestone and argillaceous limestone, and in relatively thick rubbly argillaceous limestone units, whereas Atrypoidea assemblages tend to be restricted to relatively thick mottled limestone units. Howellella and Fardenia occur in Protathyris assemblages near the base of the lower member but are rare elsewhere. Ferganella occurs in both assemblages. Gypidula is abundant in unit C22A in a Protathyris assemblage, but is rare in other units.

Gastropods are common throughout the lower member, whereas Frammia, nautiloids, and stromatoporoids occur locally. Conodonts and scolecodonts are common to abundant in most units from which samples were etched, and siliceous sponge spicules rare. Thelodonts are generally abundant in lower units, but absent in upper units. Megalomoides is abundant in unit C30 but absent elsewhere.

Faunas in the Upper Member

Colonial corals, predominantly Favosites, are common in the lower and middle units, but rare in the upper units. They are isolated, discoid to subhemispherical colonies up to 55 cm in diameter. Only representative specimens were collected, and therefore statistical studies could not be performed, as for specimens from sections A and B.

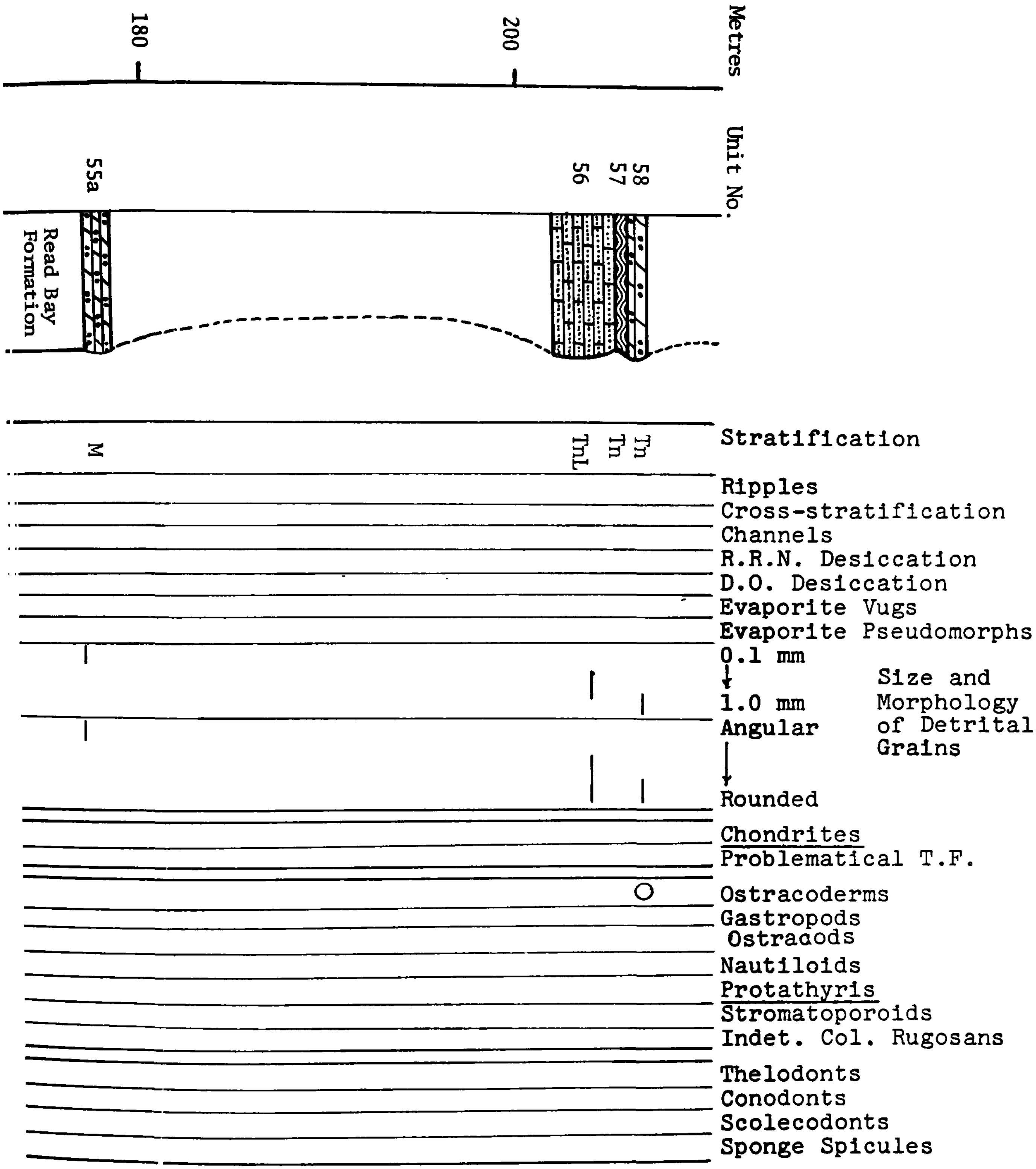
Stromatoporoids, nautiloids, gastropods, brachiopods, and Frammia are present locally. Atrypa, which is absent from the lower member, is present locally in the upper member. Siliceous sponge spicules are abundant in lower and middle units, but are rare to absent in the upper units. Conodonts and scolecodonts are generally common throughout the member. Thelodonts occur only in unit C36.

Somerset Island Formation

Lithology

The Somerset Island Formation in section C is very poorly exposed. Details of the lithological succession are represented in Text-figure 22. Planar, thin- to medium-bedded sandy dolomite comprises the lowermost

Text-figure 22. Detailed stratigraphy of the Somerset Island Formation, section C. Lithological symbols as in Text-figure 7.


Metres
180
200
Unit No.
55a
56
57
58
Read Bay Formation
M
TnL
Tn
Tn
Stratification
Ripples
Cross-stratification
Channels
R.R.N. Desiccation
D.O. Desiccation
Evaporite Vugs
Evaporite Pseudomorphs
0.1 mm
1.0 mm
Size and Morphology of Detrital Grains
Angular
Rounded
Chondrites
Problematical T.F.
Ostracoderms
Gastropods
Ostracods
Nautiloids
Protathyris
Stromatoporoids
Indet. Col. Rugosans
Thelodonts
Conodonts
Scolecodonts
Sponge Spicules

unit (C55A) and overlying scree material. The lower boundary of the formation is placed at the base of this unit. However, thin-interlaminated limestone and sandstone, a biolithite containing laterally linked hemispheroid stromatolites, and dolomitic sandstone (units C56-C58 respectively) are present in a small buttress 23 m stratigraphically higher, above an unexposed interval.

The quartz grains in the sandy dolomite at the base of the formation (unit C55A) are angular to subangular, and up to 0.1 mm in diameter, whereas the quartz grains in the sandy dolomite (unit C58) are well rounded, and up to 1.0 mm in diameter.

Sedimentary Structures

Except for planar bedding and lamination, sedimentary structures were not recognized in exposures of the Somerset Island Formation.

Fauna

Apart from ostracod fragments in thin sections of units C56-C58, the only fossils recognized were a few ostracoderm fragments in hand specimens and thin sections from unit C58.

CHAPTER 5

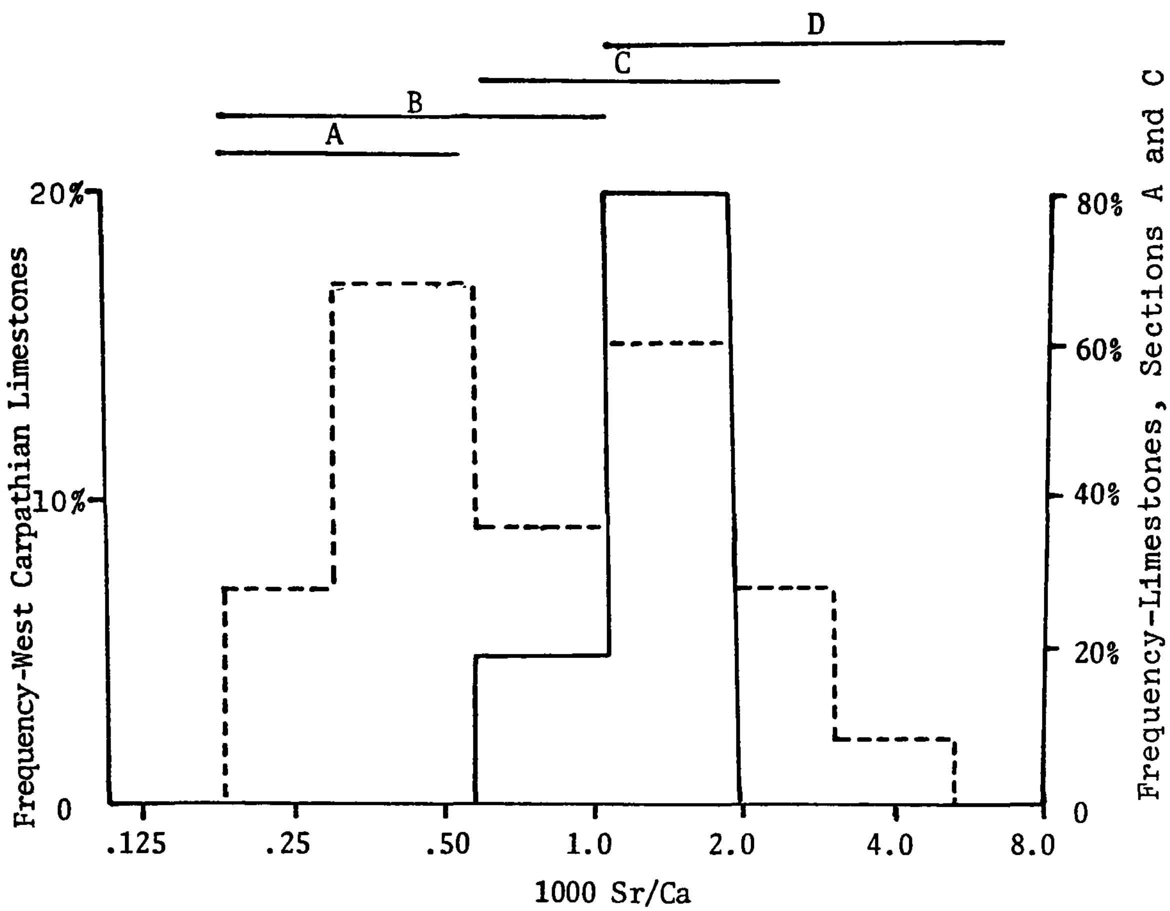
GEOCHEMISTRY OF LIMESTONES

Introduction

The distribution of trace elements in Recent carbonate sediments (eg. Siegel 1961; Billings and Ragland 1968; Bathurst 1971; Milliman 1974) and in recent organisms (eg. Lowenstam 1964; Dodd 1967) has been well documented. Trace element distribution in Phanerozoic sedimentary rocks has also been studied, but due to insufficient knowledge of sedimentary and diagenetic conditions, interpretation has commonly been difficult and ambiguous.

However, several models have been presented in which strontium distribution in carbonate rocks is used for interpretation of environmental and/or diagenetic histories of the rocks (eg. Flügel and Wedepohl 1967; Kinsman 1969; Wedepohl 1969; Veizer and Demovič 1973, 1974). Veizer and Demovič (op. cit.) found that the distribution of strontium in Mesozoic limestones is lognormal and distinguished two supergroups; one with limestones having 1000 Sr/Ca weight ratios of approximately 0.3 to 0.6 and another with limestones having 1000 Sr/Ca weight ratios of 1.0 to 2.0. The latter group includes limestones formed predominantly in environments with hypersaline tendencies, and hemipelagic to pelagic limestones formed in intermediate to deep waters. The former group includes hemipelagic limestones formed in shallow to intermediate depths, and littoral to neritic, mostly organodetrital limestones (Text-fig. 23).

According to Veizer and Demovič (1974), the bimodal distribution of strontium can be explained by original carbonate mineralogy. Since strontium distribution in Recent skeletons is bimodal (1000 Sr/Ca weight



Text-figure 23. Comparison of frequencies of 1000 Sr/Ca weight ratios between Mesozoic limestone populations (dotted lines) from the West Carpathians (after Veizer and Demovič, 1974, Fig. 6) and limestone populations from the Read Bay Formation in sections A and B (solid lines). (A) littoral to neritic, mostly organodetrital, limestones. (B) nodular hemipelagic limestones of shallow to intermediate bathyal depths. (C) hemipelagic to pelagic limestones deposited in intermediate to deep bathyal depths and dark limestones of practically any environmental milieu. (D) limestones formed in environments with hypersaline tendencies. (A-D after Veizer and Demovič, 1974, p. 104). Only groups A and D are applicable in comparing with Read Bay limestones.

ratios of approximately 21.0 and approximately 8.0), the strontium content in any carbonate sediment depends upon the proportion of particular skeletal components. Well documented examples of this dependence include the Heron Reef sediments (Maxwell *et al*. 1966) and the British Honduras coast sediments (Matthews 1966). Also, any precipitated cement in a marine environment will be either high magnesium calcite or aragonite, with strontium values in equilibrium with sea water values (1,000 ppm and 9,000 ppm respectively)(Kinsman 1969; Bathurst 1971; Milliman 1974). Strontium is more abundant in aragonite apparently because aragonite is isostructural with strontianite ($SrCO_3$).

Since aragonite and high magnesium calcite are metastable, they are diagenetically transformed into stable low magnesium calcite. This transformation is achieved primarily through a solution-precipitation process in the presence of meteoric waters (Friedman 1964). Consequently, the dissolution of aragonite in such waters will produce a solution supersaturated with respect to calcite. The low magnesium calcite in equilibrium with this solution should contain 600 to 1,000 ppm strontium (Veizer and Demovič 1973, p. 266). A similar dissolution of high magnesium calcite should produce low magnesium calcite containing approximately 200 ppm strontium (*op cit*., p. 266). If low magnesium calcite is the original mineralogical phase, then the strontium concentration (approximately 1000 ppm) should be only slightly altered (*op cit*., p. 266).

The increase in 1000 Sr/Ca weight ratios landward and seaward from an algal-bank facies can be explained in that apparently high magnesium calcite is the major carbonate constituent in open sea neritic and shallow pelagic environments and some reef facies, whereas aragonite is the major carbonate constituent in slightly hypersaline, littoral and sublittoral environments (Veizer and Demovič 1974, p. 105).

Diagenetic effects on original mineralogy and strontium concentrations are summarized in Text-figure 24.

Analytical Methods

Fifty-five samples from sections A and C were analyzed for calcium, magnesium, strontium and insoluble residue. Each sample was cut to a block approximately 3 cm cubed, and all weathered surfaces removed. Each sample was then crushed to a 200 mesh (74 micron) powder, using first a disc-grinder and then a ball mill. Approximately 1 g of each was dissolved for 3 hours in 50 ml of 6% HCl, and a further 5 ml of acid were added after this time to ensure complete reaction of the carbonate fraction. The samples were then filtered using ashless filter paper, and the solution made up to 100 ml. The insoluble residue was determined by gravimetric methods after ignition of the filter paper and residue at 1000°C for two hours (after prior ignition of the weighing crucible at 1000°C for two hours). Atomic absorption spectroscopy was used to determine the calcium, magnesium and strontium content of each sample, The multiple-standard method (Ramirez-Munoz 1968, p. 286) was used to determine calcium and magnesium, whereas the standard addition method (op. cit., p. 328) was used to determine strontium.

Two samples (A109, A115) were analyzed twice to determine precision of the results. The average reproducibility in relative percent was found to be 2.6% for calcium, 2.2% for magnesium, 4.5% for strontium and 1.8% for insoluble residue. A blank solution was found to contain 0.0 ppm calcium, 0.0 ppm magnesium, 3.0 ppm strontium and 0.0 grams of insoluble residue.

Original Mineralogy	Low-Mg Calcite	Aragonite	High-Mg Calcite
Original Strontium Concentration	1000-2000 ppm.	9000 ppm	1000-2000 ppm
Diagenesis	↓	↓	↓
Final Mineralogy	Low-Mg Calcite	Low-Mg Calcite	Low-Mg Calcite
Final Strontium Concentration	> 300 ppm (500-800)	>300 ppm (400-600)	< 300 ppm (200-300)

Text-figure 24. Diagenetic effects on original mineralogy and strontium concentrations of calcareous sediments.

Results and Discussion

Elemental compositions of the samples analyed are summarized in Tables 2 and 3. The 1000 Sr/Ca weight ratios, 100 Mg/Ca weight ratios and insoluble residues show considerable variation through each section (Text-figs. 25 and 26). As might be expected, the insoluble residue and 100 Mg/Ca weight ratios (reflecting amount of dolomitization) are highest in the Cape Storm and Somerset Island Formations. There is a sharp increase in insoluble residue, however, in the lower units of the upper member of the Read Bay Formation in both sections. Insoluble residues and 100 Mg/Ca weight ratios tend to show positive correlation in each section, and especially in the upper member of the Read Bay Formation.

The 1000 Sr/Ca weight ratios of the limestone samples have an apparent log-normal distribution, and when compared with Mesozoic limestone samples from the West Carpathians (Veizer and Demovič 1974), the population plots in the high 1000 Sr/Ca supergroup (Text-fig. 23).

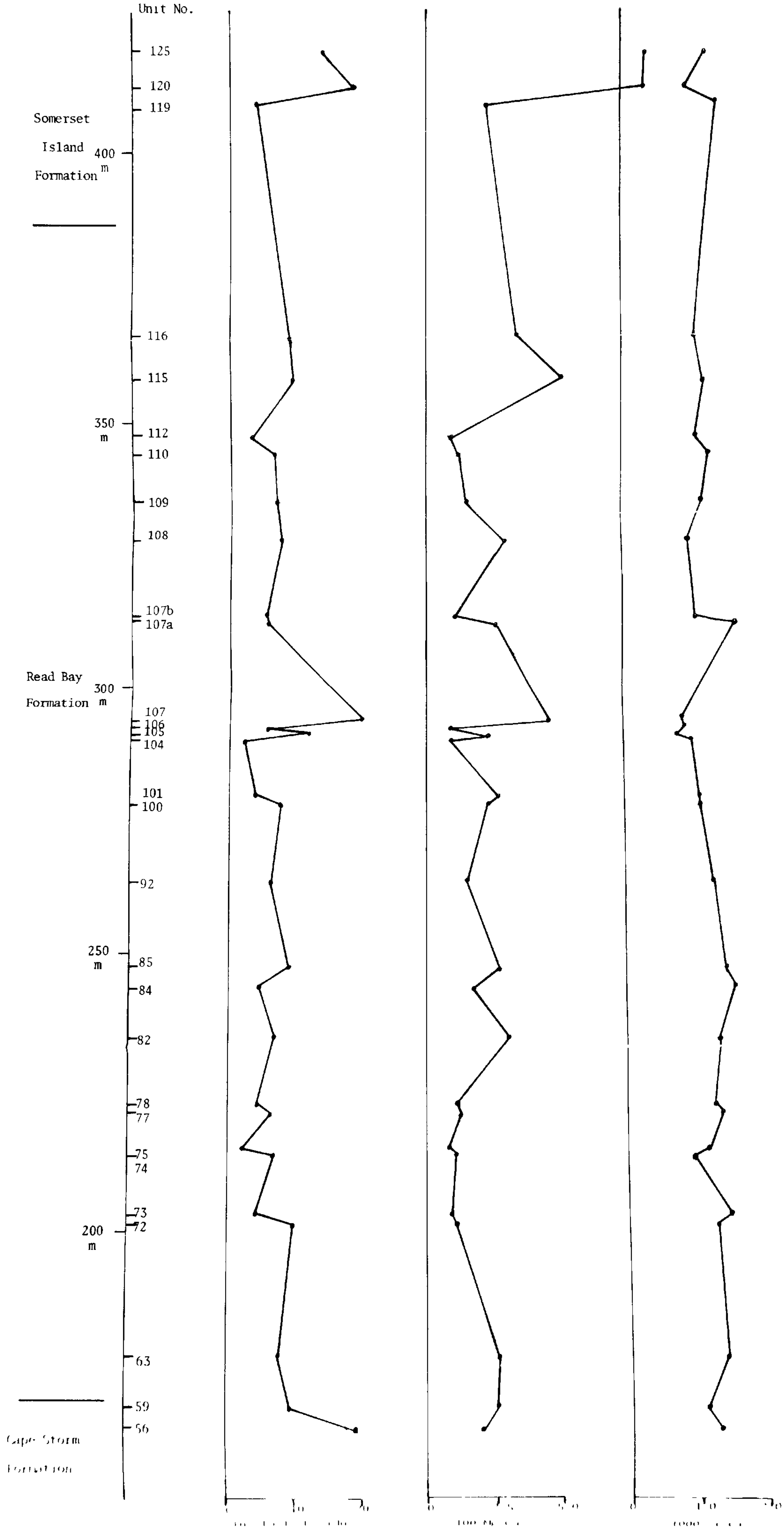
If only mottled limestone samples from the Read Bay Formation are considered, a positive correlation exists between the 100 Mg/Ca weight ratios and insoluble residue, and a negative correlation between 1000 Sr/Ca weight ratios and insoluble residue (Table 4). Since dolomites have lower 1000 Sr/Ca weight ratios than limestones, the increase in dolomite concentration will lower the 1000 Sr/Ca weight ratios of the total sample. The relationship between dolomitization and insoluble residue is to be expected, as the common association of higher amounts of early diagenetic dolomite with higher amounts of insoluble residue has been well established (Fairbridge 1957, p. 155; Veizer and Demovič 1973, p. 263), although the exact role of the insoluble residue is not clear (Veizer 1970, p. 1296; Engelhardt 1973, p. 331).

Unit No.	I.R. %	Ca^{++} ppt	Mg^{++} ppt	Sr^{++} ppm	100 Mg/Ca	1000 Sr/Ca
56	19.2	383	8.0	515	2.1	1.3
59	9.4	407	10.0	440	2.5	1.1
63	7.9	395	10.2	550	2.6	1.4
72	10.0	404	4.2	530	1.0	1.3
73	4.3	417	3.9	620	0.9	1.5
74	7.1	407	4.1	390	1.0	1.0
75	2.1	417	3.1	520	0.7	1.2
77	6.5	406	5.1	590	1.3	1.4
78	7.4	407	5.1	520	1.2	1.3
82	8.4	397	13.6	570	3.4	1.4
84	4.6	369	6.3	600	1.7	1.6
85	9.2	405	11.5	600	2.8	1.5
92	6.5	405	6.9	520	1.7	1.3
100	8.0	413	9.6	450	2.3	1.1
101	4.1	398	10.5	430	2.6	1.1
104	2.5	410	3.9	400	0.9	1.0
105	11.9	399	9.4	340	2.4	0.8
106	5.3	402	3.8	360	0.9	0.9
107	20.2	398	18.5	380	4.6	0.9
107a	6.1	371	2.6	640	2.6	1.7
107b	5.8	401	4.6	450	1.1	1.1
108	7.9	371	10.6	370	2.8	1.1
109	7.3	381	6.8	450	1.8	1.2
110	6.7	369	5.3	480	1.4	1.3
112	3.6	397	4.2	420	1.1	1.1
115	9.7	364	19.1	420	5.2	1.2
116	9.2	374	12.5	400	3.3	1.1
119	4.6	408	9.6	570	2.3	1.4
120	19.2	355	29.9	280	8.4	0.8
125	13.9	358	30.2	430	8.4	1.2

Table 2. Elemental composition and insoluble residues of limestones, section A.

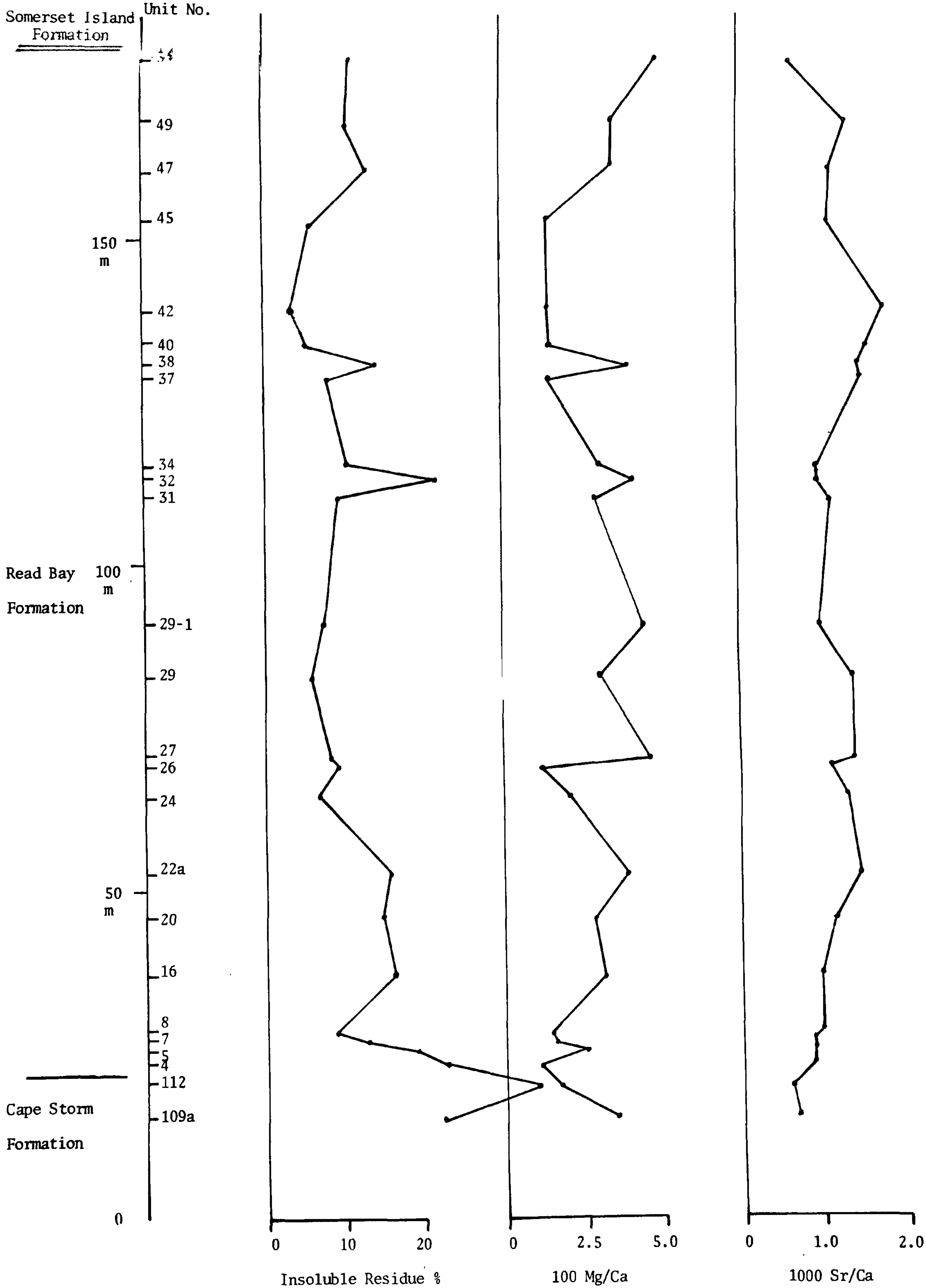
Unit No.	I.R. %	Ca^{++} ppt	Mg^{++} ppt	Sr^{++} ppm	100 Mg/Ca	1000 Sr/Ca
109	22.0	384	14.1	260	3.7	0.7
112	34.5	396	7.6	220	1.9	0.6
4	23.0	415	5.1	360	1.2	0.9
5	19.0	382	9.8	330	2.6	0.9
7	13.0	402	6.8	380	1.7	0.9
8	8.9	412	6.5	400	1.6	1.0
16a	16.4	394	13.1	400	3.3	1.0
20	14.8	399	11.7	500	2.9	1.2
22a	15.9	392	15.4	580	3.9	1.5
24	6.9	397	8.5	500	2.1	1.3
26	9.3	420	5.5	480	1.3	1.1
27	8.7	394	17.5	540	4.4	1.4
29	6.0	414	12.7	580	3.1	1.4
29-1	7.5	399	16.7	415	4.2	1.0
31	9.4	390	11.5	430	2.9	1.1
32	21.9	353	14.4	370	4.1	1.0
34	10.5	380	12.0	380	3.1	1.0
37	8.0	374	5.8	550	1.5	1.5
38	14.6	371	14.6	550	3.9	1.5
40	5.2	375	5.7	620	1.5	1.6
42	3.8	374	5.4	660	1.4	1.8
45	6.1	406	6.0	430	1.4	1.1
47	13.1	369	12.8	400	3.5	1.1
49	10.8	374	13.4	490	3.6	1.3
54	10.8	398	19.0	260	4.8	0.6

Table 3. Elemental composition and insoluble residues of limestones, section B.



Unit No.
125
120
119
Somerset Island Formation
400 m
116
115
350 m
112
110
109
108
107b
107a
Read Bay Formation
300 m
107
106
105
104
101
100
92
250 m
85
84
82
78
77
75
74
73
72
200 m
63
59
56

Text-figure 25. Stratigraphic position and corresponding elemental abundances and insoluble residues of limestone samples from the Cape Storm, Read Bay, and Somerset Island Formations, section A.



Somerset Island Formation
Unit No.
54
49
47
45
150 m
42
40
38
37
34
32
31
Read Bay Formation
100 m
29-1
29
27
26
24
22a
50 m
20
16
8
7
5
4
112
Cape Storm Formation
109a
0
0
10
20
Insoluble Residue %
0
2.5
5.0
100 Mg/Ca
0
1.0
2.0
1000 Sr/Ca

Text-figure 26. Stratigraphic position and corresponding elemental abundances and insoluble residues of limestone samples from the Cape Storm and Read Bay Formations, section C.

		I.R.	100 Mg/Ca	1000 Sr/Ca
	I.R.	1.0	0.524	-0.510
Sections A & C	100 Mg/Ca	-	1.0	0.108*
n=36	1000 Sr/Ca	-	-	1.0

		I.R.	100 Mg/Ca	1000 Sr/Ca
	I.R.	1.0	0.610	-0.536
Section A	100 Mg/Ca	-	1.0	-0.040*
n=21	1000 Sr/Ca	-	-	1.0

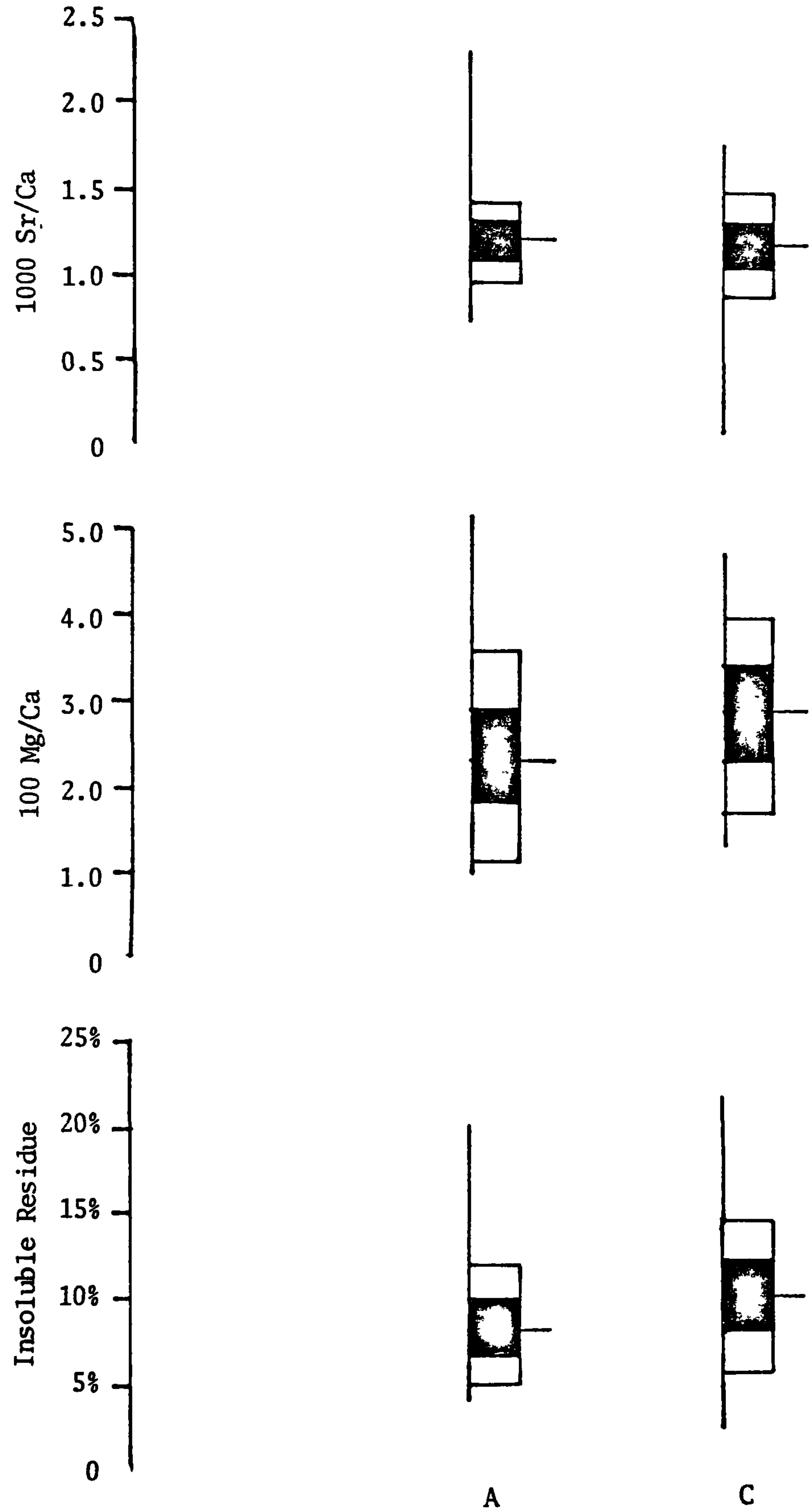
		I.R.	100 Mg/Ca	1000 Sr/Ca
	I.R.	1.0	0.410	-0.452
Section C	100 Mg/Ca	-	1.0	0.236*
n=15	1000 Sr/Ca	-	-	1.0

Table 4. Correlation coefficients for elemental compositions and insoluble residues of mottled limestones from sections A and C. *indicates no significant correlation at the 95% confidence level.

The above relationships between various parameters are similar if the mottled limestone samples from sections A and C are considered separately (Table 4). In addition, there is no significant difference at the 0.05% confidence levels in 1000 Sr/Ca weight ratios, 100 Mg/Ca weight ratios or insoluble residue between the two sections, (Text-fig. 27).

In conclusion, the strontium content of the limestone of the upper part of the Cape Storm Formation, the Read Bay Formation, and the lower part of the Somerset Island Formation suggests that these rocks were formed in environments with hypersaline tendencies. In addition, the amount of dolomite within mottled limestone appears to be related to the insoluble residue distribution.

Text-figure 27. Dice-diagrams comparing elemental abundances and insoluble residues of limestones from sections A and C.


2.5
2.0
1.5
1.0
0.5
0
1000 Sr/Ca
5.0
4.0
3.0
2.0
1.0
0
100 Mg/Ca
25%
20%
15%
10%
5%
0
Insoluble Residue
A
C

CHAPTER 6

DEPOSITIONAL ENVIRONMENTS

Introduction

General Statement

Any attempt to interpret the depositional environments of sedimentary rocks must take into account all available information, including physical, chemical and biological characteristics. The significance of these criteria depends primarily upon studies of modern sedimentary environments and identification of the most useful criteria for their recognition in the stratigraphic record.

Interpretation of environments from fossil evidence depends to a large degree upon studies of recent organisms. Generally, the unstable conditions in supratidal and intertidal environments result in low faunal diversity due to constant fluctuations of sedimentation, salinity, water depth, water turbulence and temperature. More stable subtidal environments tend to show higher faunal diversity. The modern environments of major preservable organisms have been extensively reviewed by Heckel (1972). However, many Paleozoic invertebrate groups have no modern counterparts, and their life environments can only be inferred from occurrences in other Paleozoic rocks and associations with extant groups. Also, certain groups which are of minor importance at present were much more abundant in the past, and undoubtedly inhabited more diverse environments than their modern counterparts.

Physical characteristics of principal value are such features as bedding character, cross lamination, ripples, desiccation structures and overall texture of the rock. The presence or absence of individual features cannot generally be used as an indicator of any particular depositional environment, since most features occur over a range of environments. However, the type and quantity of all features collectively may be used in conjunction with other evidence in recognizing particular sedimentary environments.

Chemical criteria include gross lithological composition of the rocks. In addition, ratios of major elements and trace elements may prove useful in determining depositional environments. Certain types of rocks in the stratigraphic record have sufficiently limited conditions of formation that they can be interpreted by direct analogy with their modern counterparts. However, the depositional environments of other rock types are not as limited and the mechanisms of formation of some are not completely understood. Such is the case with mottled limestone and rubbly argillaceous limestone, which, in view of their quantitative abundance in the Read Bay Formation, are discussed separately below.

Mottled Limestone

Mottled limestone appears to be relatively common in Paleozoic rocks in North America, and has been reported in the Ordovician (Wallace 1913; Birse 1928; Matter 1967; Braun and Friedman 1969), Silurian (Jones 1974) and Devonian Systems (Beales 1953; Osmond 1956).

Wallace (1913, p. 412) suggested that the dolomite mottling was best explained by penecontemporaneous alteration of the original limestone by seawater and selective dolomitization by fluids. Van Tuyl (1914, p. 345) suggested that the mottling was due to replacement of the original limestone by downward diffusion of magnesium salts derived from seawater that may at times have been hypersaline. Birse (1928, p. 220) thought that the mottling may have resulted from dolomitization around organically produced cavities which acted as centers for dolomitization.

The first truly comprehensive study of mottling was by Beales (1953), who, in examining the Devonian Palliser Formation, noted a sharp contact between dolomite and calcite, although patches of dolomite crystals were disseminated in the calcareous portion. He also noted (op. cit., p. 2285) that ". . . thick-shelled brachiopods and crinoid ossicles persist as recrystallized calcite. . ." and that ". . . limestone filling in shells is commonly altered even where the shell material itself remains as calcite." He described the mottling as irregular, consisting of seams and patches, some following bedding planes and others cutting primary structures to join other dolomite seams. He suggested (op. cit., p. 2287) that the mottling was relatively early diagenetic since dolomitization tended to follow primary structures such as bedding planes and early secondary structures such as compactional shears rather than late secondary features such as joints and fractures. Sea water was suggested as the likely source since mottling was uniform over a large area. Sea water penetrates most readily during and shortly after deposition of sediment. Cessation of dolomitization short of complete dolomitization could be due to an absence of excess $MgCO_3$, or to restriction of permeability by compaction.

In another comprehensive study, Osmond (1956, p. 39) suggested that, as in Beales' theory, dolomitization was relatively early diagenetic, since it preceded plastic deformation and followed patterns established at the time of deposition. Osmond (1956, p. 40) also suggested sea water as a source of magnesium, and that the rate of burial controlled the amount of dolomitization. Slow burial would result in complete dolomitization, whereas rapid burial would produce incomplete dolomitization. He suggested (op. cit., p. 40) that the mottled limestone was formed in semi-restricted shelf environments.

Braun and Friedman (1969, p. 124) suggested that mottling of limestone in the Ordovician Tribes Hill Formation was related to burrows and trails of organisms.

Matter (1967, p. 605) suggested that the mottled limestone of the Ordovician New Market Limestone resulted from desiccation polygons which had been disrupted and the resulting fragments transported, the degree of transportation indicated by the degree of rounding of the limestone clasts. The mud matrix was subsequently dolomitized.

Mottled limestone in the Read Bay Formation was extensively studied by Jones (1974) and was divided into two groups termed rubbly limestone types IV and V. Type IV consisted of lumps of micritic limestone, variable in size and shape, and distributed randomly in a dolomite matrix, whereas type V consisted of dolomite and limestone in well defined layers parallel to bedding. Rocks of type V were reported from the south bank of the West Creswell River. He suggested that type IV rubbly limestone was deposited in subtidal conditions and that dolomitizing fluids, derived from sea water of high salinity, would have selectively dolomitized zones of higher permeability. Type V rubbly limestone was apparently deposited in intertidal conditions. Jones (1974, p. 181) postulated that shrinkage cracks, produced during subaerial exposure of the sediment, would have been infilled by more permeable sediments, which would subsequently have been dolomitized due to evaporation and resulting increase in the Mg/Ca ratio of sea water during low tides.

From the above discussion, two fundamental conditions appear to be necessary for the formation of mottled limestone: 1. a source of magnesium sufficient to produce thick units of partly dolomitized rock, and 2. differences in permeability to account for the resulting mottled texture.

There is strong geochemical evidence for the first condition. All mottled limestone units analyzed from the Read Bay Formation plotted into the high strontium supergroup of Veizer and Demovič (1974). Therefore, if their scheme is accepted, it appears that the mottled limestone formed in environments with hypersaline tendencies. Additional evidence for a semi-restricted basin with hypersaline tendencies will be discussed subsequently (pp. 84 to 89).

The second condition appears to be the most difficult to explain. Modern analogues are notably lacking. Shinn (1968b) discussed a process of selective dolomitization on a supratidal mud flat in the lower Florida Keys. As the surface brines evaporated, marine brines were introduced by capillary action until the Mg/Ca ratio became sufficiently high to produce dolomite. Since the desiccation polygons are relatively impermeable, the brines pass into, and selectively dolomitize the more permeable crack-filling sediment. If the sediments remain in a supratidal environment, complete dolomitization will probably occur, whereas if there is relatively rapid subsidence then the selectively dolomitized structures will remain (Shinn 1968b, p. 615). Such a process seems unlikely for the formation of the mottled limestone in the Read Bay Formation, however, since intertidal and supratidal sedimentary structures are lacking and the faunas within the mottled limestone units are suggestive of relatively stable subtidal conditions.

One important factor, however, which may be of use in explaining the apparent early heterogeneity of the mottled limestone, is the presence of large numbers of stylolitic seams which are commonly laterally continuous with bedding planes. The association of dolomite seams and patches with stylolitic seams has been previously discussed (p. 18).

Three theories have been proposed to explain the origin of stylolites; the solution pressure theory (Stockdale 1943,), the contraction pressure theory (Schaub 1939) and the subaqueous solution theory (Prokopovich 1952). Apparently only the first two are accepted today (Park and Schot 1968, p. 187). Most stylolites are apparently of diagenetic, pre-lithification origin, although they may also develop in lithified rock (Park and Schot 1968, p. 187).

If there were periods of relatively slow sedimentation and/or minor influxes of detrital clay and silt, then shaly layers could be formed in the sediment. As initial compaction of the sediment took place, waters with high Mg/Ca ratios (derived from original brines with hypersaline tendencies) would be squeezed out of the highly porous clay seams and aragonite muds. The formation of stylolites through pressure solution would tend to further concentrate the insoluble residues. The insoluble residues in the stylolitic seams and on bedding planes would provide the path of least resistance to fluid movement (Engelhardt 1973, p. 331). The clay minerals might act as ionic membranes, trapping the magnesium ions present in the fluids, thus providing zones for dolomitization. The positive correlation between insoluble residue and Mg/Ca weight ratios in the mottled limestone has already been established (Chapter 5).

Vertical or inclined migration of dolomitizing fluids would take place along stylolitic seams and may explain the common association of stylolites and dolomite. Dolomitization would proceed to a point where the porosity of the sediment had decreased sufficiently to significantly curtail fluid movement, or when the magnesium concentrations in the fluids became insufficient to allow further dolomitization.

Rubbly Argillaceous Limestone

As in mottled limestone, the major problem is in explaining the heterogeneity within the rock, that is, the limestone nodules in an argillaceous matrix. The formation of rubbly argillaceous limestone on Somerset Island was extensively investigated by Jones (1974), who suggested that the rocks were originally heterogeneous, as such textures produced in an originally homogeneous sediment would be even more difficult to explain. He suggested that the limestone nodules may originally have been calcareous sponges, algae or stromatoporoids, which would have been rigid prior to lithification, while the less rigid argillaceous matrix would have been compressed around the calcareous organisms. However, the rubbly argillaceous limestone units examined in the study area showed no evidence for this mode of formation. Jones (1974, p. 154) suggested that rubbly argillaceous limestone was formed in subtidal environments.

In a study of nodular limestones in the Silurian of New Brunswick, Noble and Howells (1974) suggested that the nodules were formed in subtidal environments by early lithification of calcium carbonate near the sediment-water interface, and that later compaction was responsible for the argillaceous matrix surrounding the nodules. The nodular limestone was apparently formed in an outer shelf environment where rates of sedimentation were moderate.

The close association of rubbly argillaceous limestone and mottled limestone, and the presence of small patches of dolomite in some rubbly argillaceous limestone units, tend to suggest a mechanism related to the formation of mottled limestone. The relatively higher content of argillaceous material might be explained by proximity to a detrital source area, periodic increases in detrital sedimentation, slower carbonate sedimentation rates, or combinations of these factors. Since the rubbly argillaceous limestone units were probably formed in environments with hypersaline tendencies (chapter 5) they might also have contained interstitial brines with relatively high Mg/Ca ratios.

However, the general absence of dolomite in the argillaceous zones must be explained. If lithification took place before compaction, as suggested by Noble and Howells (1974), the argillaceous material would have been selectively segregated. The brines would be expelled during compaction, and, if close enough to the sediment-water interface, would be reintroduced to the sea water, rather than remain as interstitial fluids. The interstitial fluids remaining may have produced the minor degree of dolomitization.

Environments of Deposition of the Cape Storm Formation

In section A, the lower 130 m of the Cape Storm Formation contain evidence suggestive of deposition in supratidal and high intertidal environments. Beds of dolomite and sandy dolomite predominate and form typically in such environments. Although various processes have been proposed to explain dolomitization in areas such as the Persian Gulf and the Caribbean, the overall association of penecontemporaneous dolomitization with supratidal and high intertidal environments is consistent (eg. Adams and Rhodes 1960; Deffeyes et al. 1965; Illing et al. 1965; Shinn et al. 1965; Butler 1969).

Sedimentary structures in the lower Cape Storm Formation which particularly support supratidal or high intertidal environments are regular random nonorthogonal desiccation cracks, calcite pseudomorphs and molds after gypsum, and vugs (Illing et al. 1965, p. 95; Summerson 1966, p. 223; Shinn 1968a; Kahle and Floyd 1971, p. 2092; Lucia 1972, p. 161). These structures are associated with crossbedding, ripples, and small channels, which also commonly occur in such environments (Kahle and Floyd 1971, p. 2092). The restricted and sparse fauna, principally of ostracoderms also tends to confirm this interpretation (Denison 1956; Heckel 1972, p. 234). Intraclastic dolomite beds, common in supratidal environments (Laporte 1969, p. 728), indicate occasional periods of high energy.

The upper 40 m of the Cape Storm Formation show evidence of change to lower intertidal and shallow subtidal conditions. This is suggested by the progressively greater calcareous content of the younger dolomite, the presence of bioclastic and peloidal limesone (Folk 1962, p. 69; 1968, p. 163; McKee and Gutschick 1969, p. 555-556), and the less common occurrences of vugs and calcite pseudomorphs after gypsum. The very thinly interlaminated dolomite and limestone units in the upper part of the formation strongly resemble algal laminae described by Gebelein and Hoffman (1973) who considered them indicative of intertidal or shallow subtidal environments. In addition, discontinuous oriented desiccation cracks occur rather than regular nonorthogonal desiccation cracks. Similar desiccation cracks have been produced experimentally in subaqueous conditions by White (1961), Burst (1965) and Donovan and Foster (1972).

The relatively abundant though restricted fauna of gastropods, brachiopods, ostracods and ostracoderms is further evidence of low intertidal and shallow subtidal conditions (Heckel 1972, p. 234).

Environments of Deposition of the Read Bay Formation

Lower Member

The relatively diverse, typically marine fauna, dominated by brachiopods, gastropods, trilobites and stromatoporoids, the scarcity of sedimentary structures, and the predominance of various types of limestone in the lower member of the Read Bay Formation suggest deposition in subtidal environments. Strong current or wave action appears to have been absent during deposition of much of the lower member. The predominance of micrite in the limestone is generally considered indicative of deposition on shallow carbonate banks in conditions of relatively low energy (Folk 1962, p. 69; Cloud 1962; Stockman *et al*. 1967). Occasional periods of high energy are suggested, however, by the presence of units of bioclastic limestone and peloidal limestone.

The variety of growth forms (lamellar to hemispherical) and the fragmental and overturned nature of many of the stromatoporoids at the base of the lower member (unit A60) indicate a relatively high energy environment (Klovan 1964; Mountjoy 1965). The large numbers of *Vicunostachyodes* Sokolov present in the unit above (unit A61) suggest a lesser degree of agitation, since ramose colonies are generally indicative of relatively calm waters (Jansa and Fischbuch 1974; Kobluk 1975). The stromatoporoids do not appear to have formed anything more than a mildly positive feature, as no biohermal structures are apparent. The highly argillaceous nature of the limestone at the base of the lower member in section C may have prevented colonization by stromatoporoids at this locality, as such conditions were apparently unfavourable for stromatoporoids (Tasch 1973, p. 121).

The presence of Protathyris assemblages in many bioclastic limestone units and in sequences of thin units of mottled limestone alternating with bioclastic limestone suggest that they favoured relatively unstable conditions, whereas the presence of Atrypoidea assemblages primarily in thicker mottled limestone units suggests that such assemblages favoured more stable conditons. A similar association occurs on northern Somerset Island (Jones and Dixon 1976). Although the presence of brachiopod faunas is evidence of subtidal conditions, the restricted number of benthonic taxa appears to indicate some abnormality in the environment, since many Silurian brachiopod faunas are notable for their great diversity (Ziegler et al. 1968; Calef and Hancock 1974; Lawson 1975). In addition, there appears to be an association within the brachiopod assemblages of particular genera with particular environments.

In section A in the uppermost units of the Cape Storm Formation, in sections A and C in the lowermost Read Bay Formation units, and in bioclastic and peloidal limestone units throughout the lower member, Protathyris occurs alone. These units have been demonstrated above to have formed in unstable, high energy environments. With decreasing energy and a corresponding increase in stability, Fardenia, or Fardenia and Howellella, are associated with Protathyris. With a further increase in environmental stability, Ferganella and finally Atrypoidea occur in the assemblage. However, Protathyris and Atrypoidea rarely occur in the same assemblage in equal abundance. Usually if Atrypoidea is common or abundant, Protathyris is rare or absent. In addition, the amount of argillaceous material appears to have had some control on the composition of the brachiopod assemblages, as Gypidula is found in abundance only in a rubbly argillaceous limestone unit in section C (C22A).A model for the succession of assemblages showing variation due to environmental stability and amount of argillaceous material in the sediment is presented in Text-figure 28.

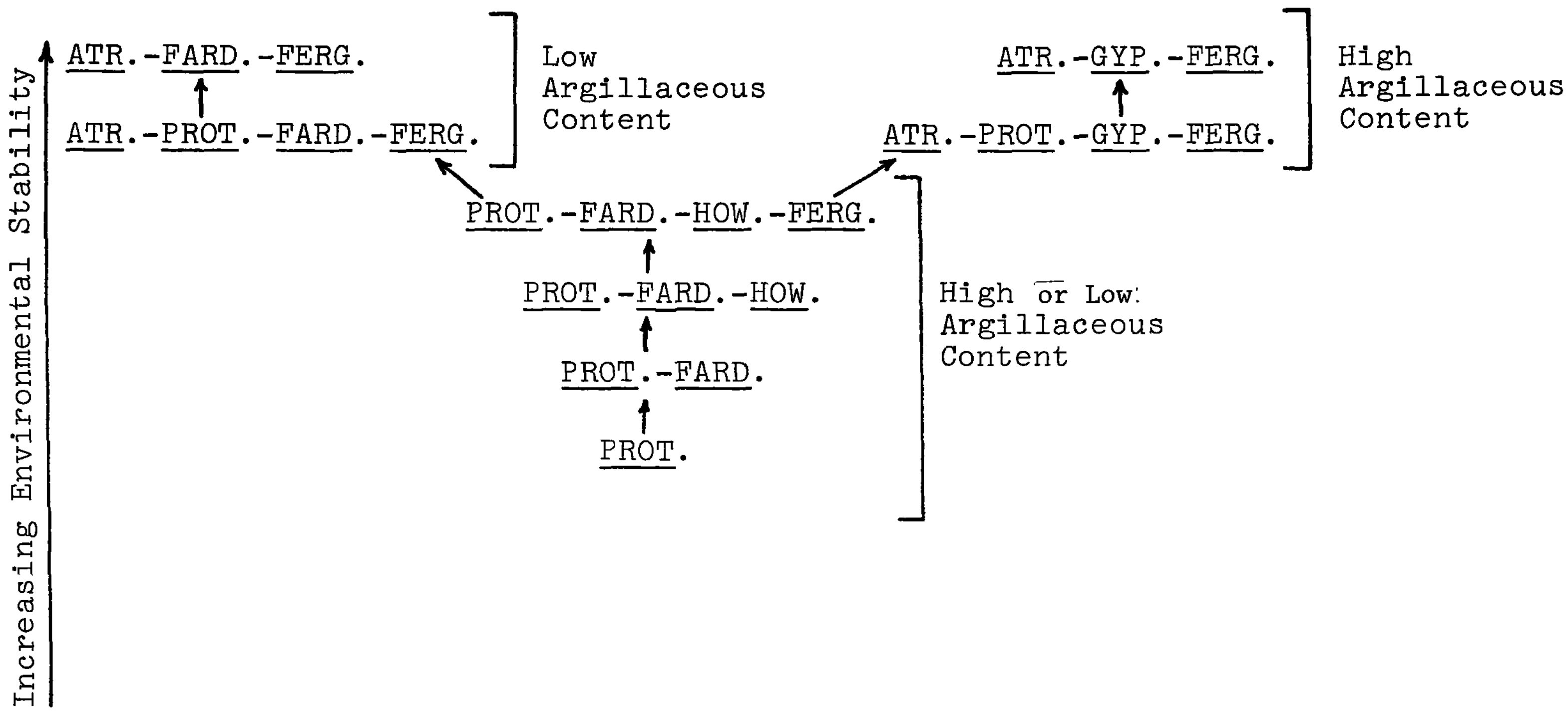
The relative abundance of thelodonts in the lower units of the lower member suggests that these strata represent nearshore, possibly restricted conditions, since Silurian thelodonts apparently favoured such habitats (Turner and Dixon 1971; Turner and Turner 1974).

Depositional environments in the upper 23 m of the lower member appear to have been considerably more turbulent and probably shallower, as suggested by the presence of units of intraclastic limestone, oncolitic limestone, and stromatolitic biolithite (compare Laporte 1967; Logan et al. 1964). The presence of large numbers of disarticulated convex-up Megalomoides valves only in the oncolitic limestone units suggests that they inhabited only shallow, highly agitated environments.

The greater frequency and abundance of scolecodonts in the lower member in section C may be due to the higher insoluble residue, as Paleozoic polychaetes apparently preferred soft, muddy substrates (Howell 1957).

Upper Member

The similarity of rock types in the upper member to those in the lower member, the scarcity of sedimentary structures, and the relative abundance of taxa such as corals, brachiopods, trilobites and nautiloids typically associated with marine environments, indicate deposition in subtidal conditions.



Text-figure 28. Idealized succession of brachiopod assemblages in the lower member of the Read Bay Formation near Creswell Bay. PROT. = *Protathyris*; FARD. = *Fardenia*; HOW. = *Howellella*; FERG. = *Ferganella*; ATR. = *Atrypoidea*; GYP. = *Gypidula*.

In marked contrast to the brachiopod assemblages which predominate in the lower member, coral assemblages predominate in the upper member. Although the predominance of micrite in the rocks again appears to indicate conditions of relatively low energy, occasional periods of greater turbulence are indicated by the presence of bioclastic and peloidal limestones. Most of the bioclastic units contain relatively high proportions of crinoid debris, which may indicate the presence of crinoidal 'meadows' at the time of deposition. These bioclastic deposits may in some instances have provided firm substrates on which corals could develop, since many units containing abundant corals occur immediately above bioclastic limestone units.

The apparent restriction of Frammia to the upper member, especially in the lower units where coral development is greatest, suggests favourable habitats in these environments only.

Siliceous sponge spicules, rare in samples etched from coralliferous units in section A, are abundant in similar units in section C. The reason sponges should be closely associated with corals in section C but not in section A is not clear, but may be related to the higher insoluble residue in section C. This may also explain the lesser numbers of corals in section C, but the greater frequency and number of scolecodonts.

The decrease in coral colony diameter, taxonomic diversity and abundance in the uppermost units in sections A and B and the scarcity of corals in the uppermost units in section C suggest deterioration of conditions conducive to coral development. Unfavourable conditions for other organisms (including microorganisms) are also suggested by the successive decrease in their diversity and abundance.

Environments favourable for thelodonts appear to have been lacking during deposition of the entire upper member, as they occur in only one sample etched from the units in sections A and C.

Environments of Deposition of the Somerset Island Formation

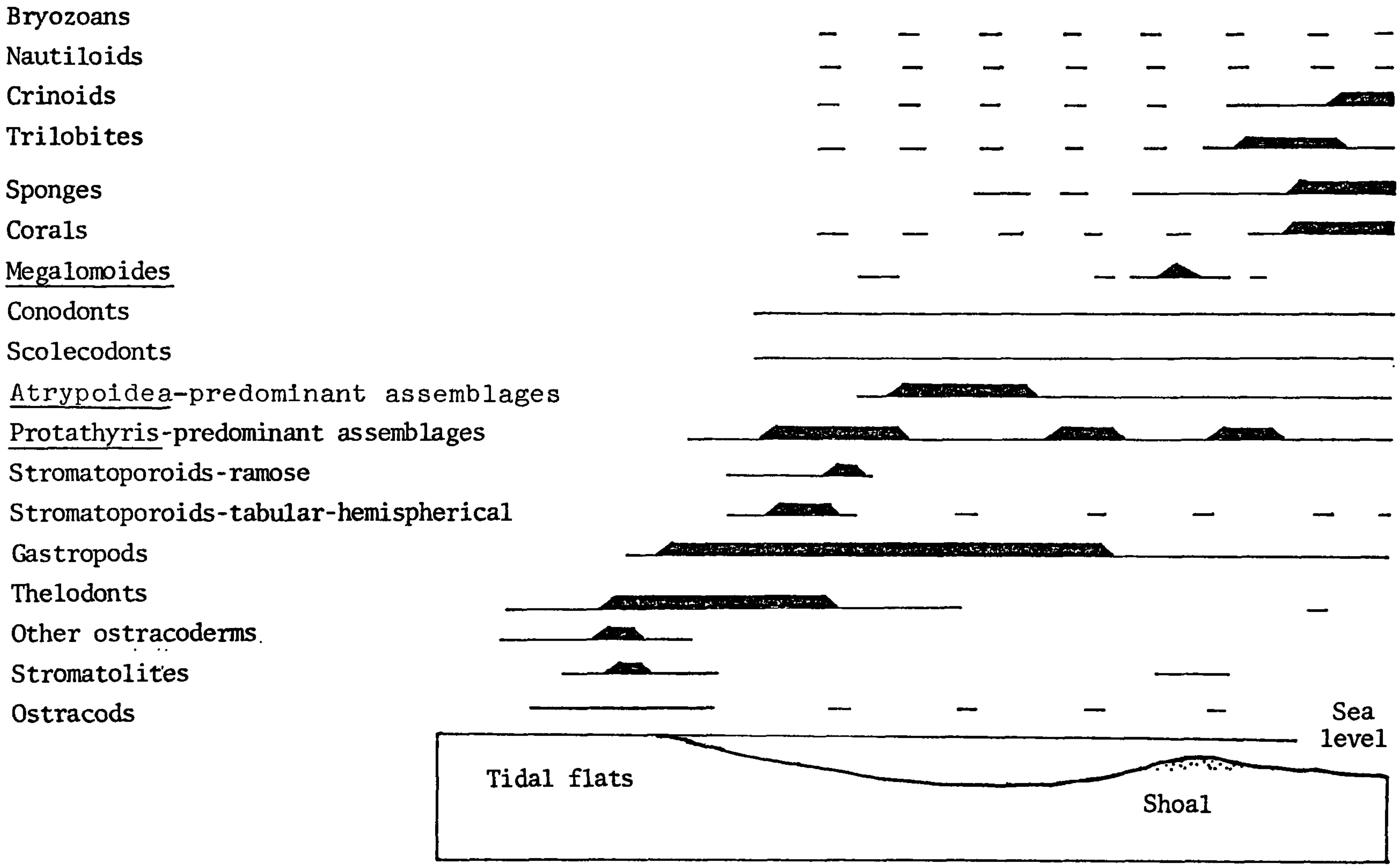
A return to relatively unstable, shallow subtidal and intertidal environments is suggested by the occurrence of peloidal limestone, dolomite, sandy dolomite and sandstone (Laporte 1967; Lucia 1972), and of LLH-type stromatolites (Logan *et al*. 1964). The restricted fauna, predominantly of ostracods and gastropods, the presence of desiccation cracks, and of vugs similar to birds-eye structures (Shinn 1968a) support this interpretation. In addition, the red staining in some of the sandstone units is hematite, which characteristically forms in supratidal environments from weathering and dehydration of iron-rich minerals (Walker 1967).

Dolomite and sandstone units which contain coarse, well rounded quartz grains, which lack invertebrate faunas normally associated with marine environments, and which locally contain desiccation cracks and vugs, alternate with limestone units containing usually minor quantities of fine to very fine grained quartz and marine invertebrate faunas and conodonts. This suggests fluctuations between shallow subtidal and intertidal/supratidal conditions resulting from the first episodes of uplift of the Boothia Uplift in the Upper Silurian. The abundant, well rounded, coarse quartz grains were probably derived from older sedimentary rock overlying the Boothia Uplift. Seven such alternations were observed in section A in 30 m of strata measured; others may be present in covered intervals which constitute approximately 60% of the thickness of the Somerset Island Formation in the section.

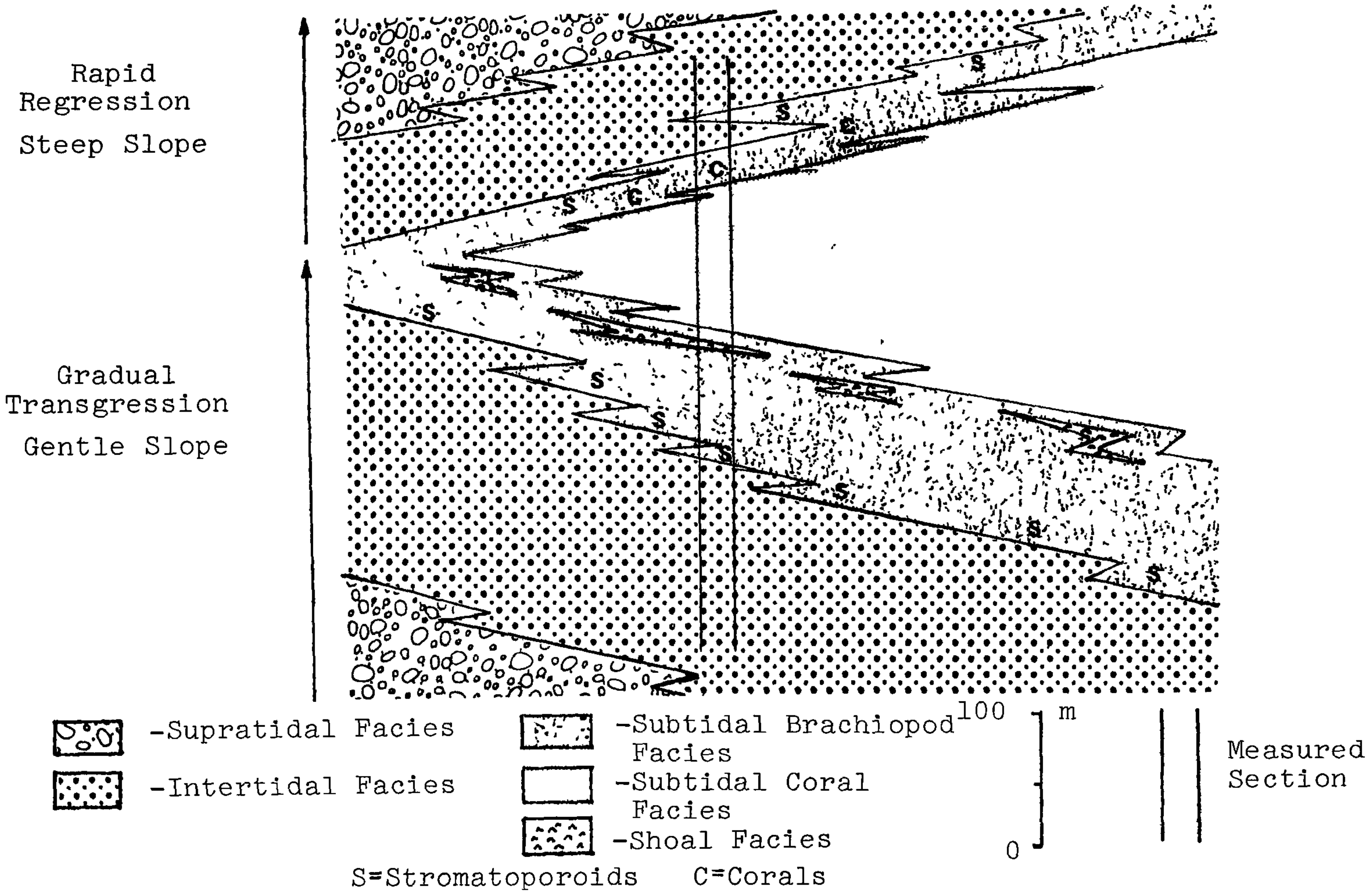
Paleoenvironmental Models

It is apparent that two major environmental regimes are represented in the sections studied: the predominantly intertidal/supratidal environments of the Cape Storm and Somerset Island Formations and the subtidal environments of the Read Bay Formation. However, the sequence does not appear to be a simple transgressive-regressive cycle since the upper and lower members of the Read Bay Formation exhibit two distinct faunal facies (brachiopod facies and coral facies respectively). Any interpretation of the succession of environments of the Read Bay Formation must take this into consideration.

The rocks of the entire Read Bay Formation appear to have been deposited in relatively shallow marine, carbonate-forming environments. However, oncolitic units in all three sections measured and a stromatolite unit in section B, occur at the top of the lower member, as well as other rock types indicative of shallow, high energy environments. If the Boothia Uplift during the Middle and Upper Silurian was a mildly positive topographic feature as suggested by Brown *et al*. (1969, p. 539) and Dineley (1971, p. 436), the stratigraphic interval at the top of the lower member may represent submerged offshore shoals, similar to modern oolitic shoals in the Bahamas (Purdy 1963) and in the Persian Gulf (Kendall and Skipworth 1968). Accordingly, the lower member would represent deposition in relatively shallow, protected lagoonal areas between the shoreline and offshore shoals, while most of the upper member would represent deposition in more open areas seaward of the shoals. The suggested local paleogeographic profile and interpreted faunal distribution are represented in Text-figure 29, and a facies model derived from it in Text-figure 30.



Text-figure 29. Idealized local profile and interpreted faunal distribution in study area during the late Ludlovian.



Text-figure 30. Preferred model of facies distribution at locality A.

For example, in section A, the tidal flat area is represented by the Cape Storm Formation, characterized by a restricted fauna, and various dolomites, sandstones, and sedimentary structures typically associated with such environments. Nearshore, shallow subtidal, high energy environments are represented by the stromatoporoid-rich bioclastic units (A60-A61), and high energy environments immediately seaward by predominantly bioclastic limestone units and mottled limestone units containing Protathyris assemblages (units A62-A63 and A68-A81). The least agitated, deepest lagoonal environments are represented by the relatively thick mottled limestone units containing Atrypoidea assemblages (units A64-A67 and A82-A84). This is consistent with Smith's (1976) study, in which Atrypoidea asemblages were considered to inhabit quiet, subtidal, semi-restricted environments. The actual shoal area is represented by the Megalomoides-rich oncolitic unit (A96) and the shallow areas on either side by bioclastic and intraclastic limestone units containing Protathyris assemblages (units A85-A95 and A97-A104). Increasing depths seaward of the shoal areas are represented by thick mottled limestone units containing an abundant and diverse coral fauna (units A105-A108). Brachiopods are also present in these units, but are considerably less abundant than in the lower member. Throughout this time a relatively gentle depositional slope would have favoured the development and persistence of offshore shoals or barriers.

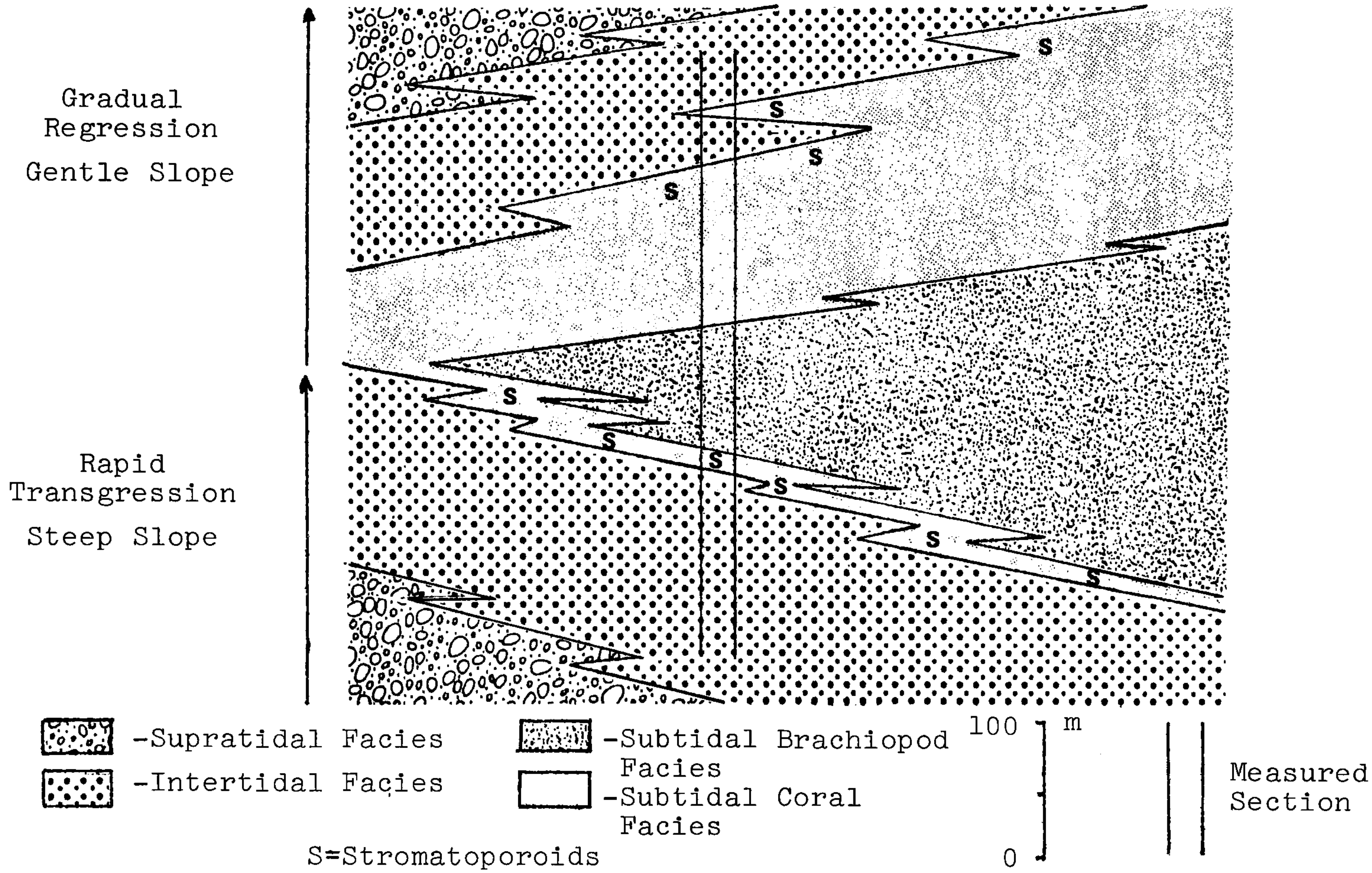
Following maximum transgression, a regression resulted from uplift of the Boothia Uplift. This caused the decreasing coral size and diversity in mottled limestone units (A110-A116). Offshore shoals are not represented in the regressive sequence, which, according to Anderson (1972) and Makurath (1977), is not an uncommon situation, and apparently results when lagoons are filled in and 'capped' during progradation. The absence of the shoals may also be explained by steeper offshore gradients, a distinct possibility following uplift of the Boothia Uplift. Relatively high energy environments continued through the regression, with the result that Atrypoidea assemblages did not redevelop to any great extent. However, Protathyris assemblages, which might be expected to flourish in the shallow, nearshore environments, are also poorly developed during the regressive sequence. This may be due to higher sedimentation rates, which are apparently unfavourable to articulate brachiopods (Heckel 1972, p. 281). In addition, the change in coral morphology (from large discoidal to small bulbous) and the increasing relative abundance of solitary rugosans during the interpreted regressive sequence may also reflect increasing sedimentation rates.

Although the top of the upper member in section A is not exposed, large hemispherical stromatoporoids are present in scree material near the top of the member, suggesting that a stromatoporoid unit similar to that at the base of the formation is present under the covered interval.

An alternative model to that presented above is that the faunal differences may reflect differences in depths of deposition of the two members. Shallow subtidal, high energy environments would be represented by the stromatoporoid-rich bioclastic unit at the base of the Read Bay Formation and by the coral-rich upper member, and relatively deeper, low energy environments by the brachiopod-rich lower member. In this model, maximum transgression would coincide with Atrypoidea assemblages. The transgression would have been relatively rapid, since the stromatoporoid-coral 'zone' is represented by only 3 m of strata in section A, and maximum transgression occurs after 65 m in the succession. By contrast, the regressive phase, initially represented by the Protathyris assemblages in the upper units of the lower member, would have been gradual, as it is represented by 155 m, including 100 m of the nearshore, high energy, stromatoporoid-coral 'zone'. A suggested facies model for this interpretation is presented in Text-figure 31.

Of the above two models, which best seem to explain the sequence, the former model (offshore shoals) is favoured, primarily for the following reasons:

1. The occurrence of oncolitic limestone, stromatolitic biolithite, and associated intraclastic limestone and bioclastic limestone in the upper units of the lower member suggests high energy environments. If they occur during the regressive phase as suggested by the latter model, then mottled limestone containing an abundant coral fauna represents an even shallower, high energy environment. The predominance of micrite in the mottled limestone and the in situ nature of most of the corals suggests that this was not the case.
2. The stromatoporoids near the base of the Read Bay Formation and in the Somerset Island Formation are predominantly fragmented and overturned, and occur in bioclastic limestone, which contrasts sharply with the in situ nature of corals in the micritic mottled limestone. In the latter model, these would represent equivalent environments (shallow, high energy).



Text-figure 31. Alternative model of facies distribution at locality A.

CHAPTER 7

AGE AND CORRELATION

Introduction

The Silurian System was first described in the British Isles by Murchison (1839, 1854), and was originally divided into three series, Llandovery, Wenlock, and Ludlow. It was subsequently divided by Lapworth (1879-1880) into 11 graptolite zones, and by Elles and Woods (1901-1918) into 21 graptolite zones, the youngest of which is the *Monograptus leintwardinensis* zone. The Silurian-Devonian boundary (Ludlovian-Downtonian) in England was originally placed at the Ludlow Bone Bed (White 1950), which coincides with a major faunal change from marine to chiefly continental rocks. A result of this was that traditionally no graptolites were considered to be younger than Ludlovian in age. In the Belgian type section of the Devonian, the lowest strata of the Gedinnian (lowest series of the Devonian) consist of marine rocks and rest unconformably on older strata. White (1950) suggested that the base of the Gedinnian was approximately equivalent to the base of the Downtonian.

Subsequent studies of graptolites in other parts of the world revealed graptolite sequences younger than the *Monograptus leintwardinensis* zone, but older than the Gedinnian. Boucot and Pankiwskyj (1962) studied the Podolia area of Russia and suggested that the post-Ludlovian-pre-Gedinnian series be named the Skalian. In Bohemia, Boucek *et al.* (1966, 1968) recognized a post-Ludlovian-pre-Gedinnian graptolite sequence which was designated the Pridolian Series, and suggested that the Silurian-Devonian boundary be relocated at the top of the Pridolian (base of *Monograptus uniformis* zone). Berry and Boucot

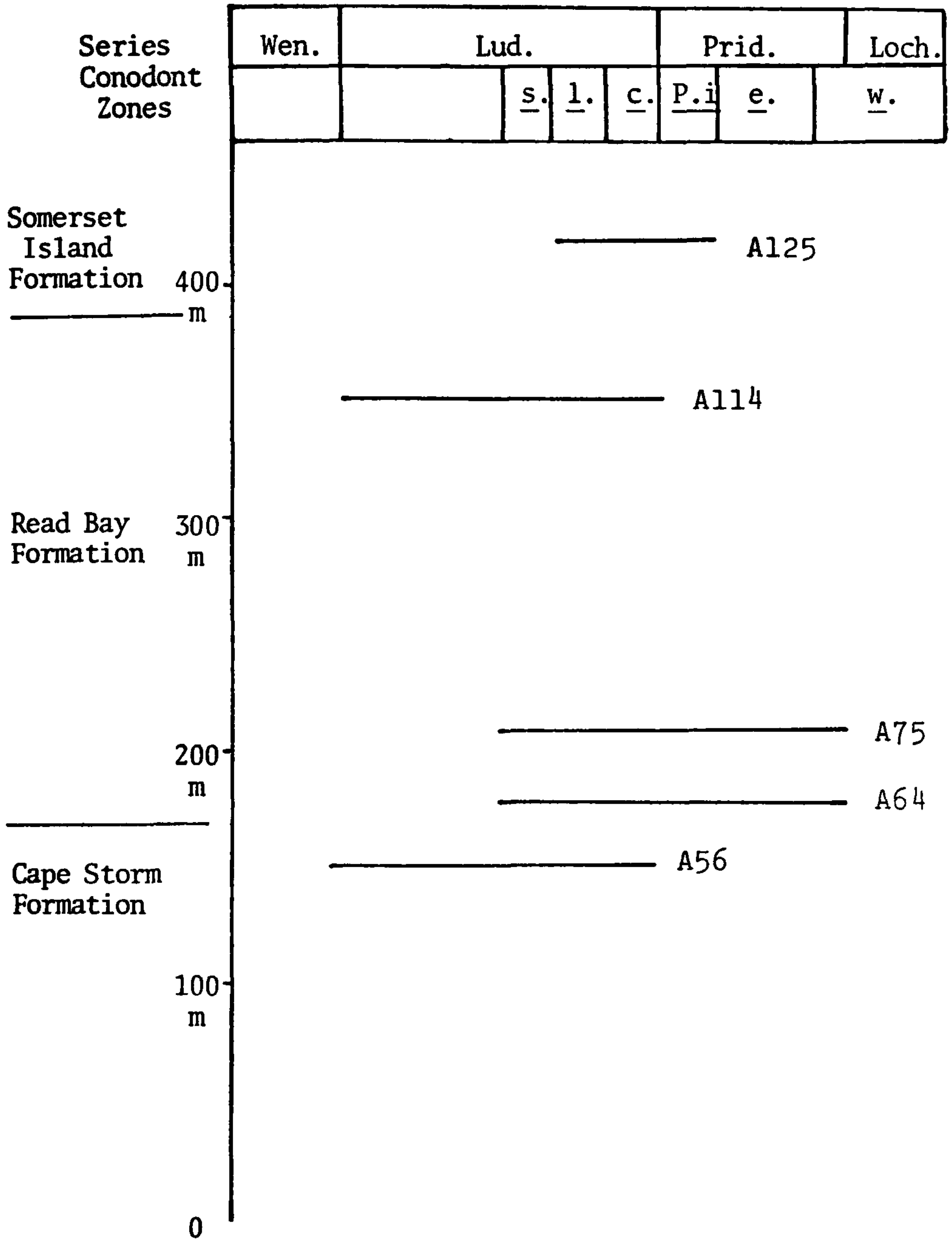
(1970) agreed with this relocation and in addition suggested that the Ludlovian-Pridolian boundary be placed at the base of the *Monograptus ultimus* zone. The Committee on the Silurian-Devonian Boundary (McLaren 1973) recommended that the Siluro-Devonian boundary be placed at the base of the *Monograptus uniformis* zone in the Barrandian area of Czechoslovakia.

Since the Pridolian Series was established after many of the formational boundaries in the arctic had been dated along traditional lines, it is probable that many strata previously considered Upper Ludlovian or Lower Devonian are in fact Pridolian in age.

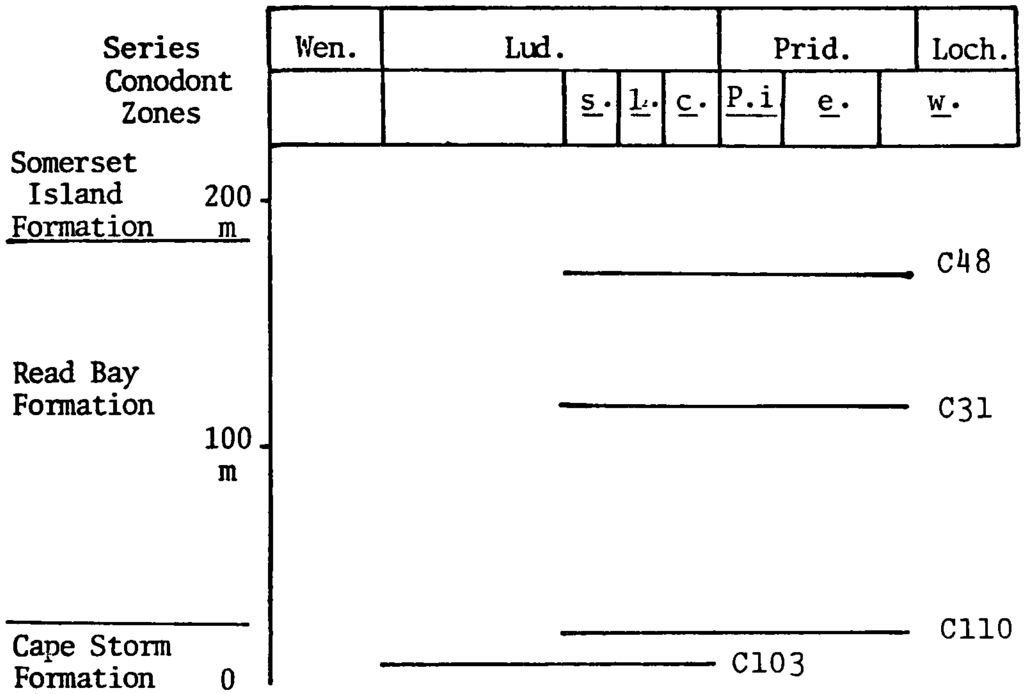
On Somerset Island, the determination of the age of Silurian strata has been further complicated by the lack of reliable index fossils. Graptolites and ostracoderms have been used as the principal age indicators for the Read Bay Formation elsewhere in the Arctic, but are absent from the Read Bay Formation on Somerset Island. The abundant invertebrate fauna is generally of limited use, since most forms are long ranging and their stratigraphic distribution is poorly known. However, most recent studies have relied heavily on conodonts as age indicators (eg. Jones and Dixon 1975, 1977; Loeffler and Jones 1976, 1977; Miall *et al*. 1978), and a conodont sequence has been established for the type section of the Read Bay Formation on Cornwallis Island (Uyeno 1977). Age ranges for conodonts obtained from sections A and C are presented in Text-figures 32 and 33 respectively.

Lithostratigraphical Correlation

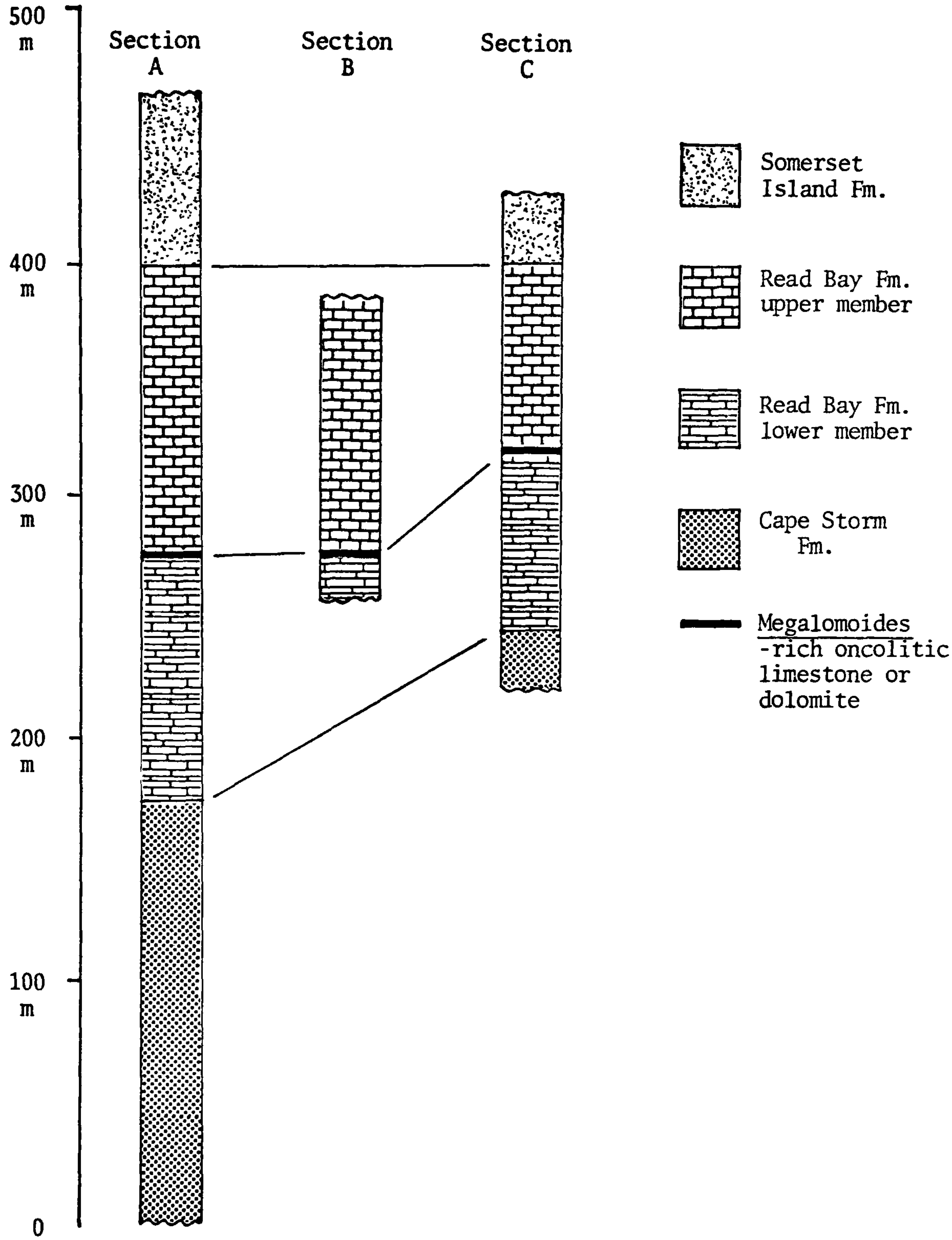
Lithostratigraphical correlation of sections A, B, and C is presented in Text-figure 34. The upper and lower boundaries of the Read Bay Formation are readily correlated using the lithological relationships



Text-figure 32. Age ranges indicated by conodonts from the Upper Silurian rocks in section A. Conodont zones from Klapper and Murphy (1974, Fig. 1): s = siluricus; l. = latialata; c. = crispa; P.i. = Pelekysgnathus index fauna; e. = eosteinhornensis; w. = woschmidti. Conodont identifications by T.T. Uyeno. Wen. = Wenlockian; Lud. = Ludlovian; Prid. = Pridolian; Loch. = Lochkovian.



Text-figure 33. Age ranges indicated by conodonts from the Upper Silurian rocks in section C. Conodont zones from Klapper and Murphy (1974, Fig. 1): s. = siluricus; l. = latialata; c. = crispa; P.i. = Pelekysgnathus index fauna; e. = eosteinhornensis; w. = woschmidti. Conodont identifications by T.T. Uyeno. Wen. = Wenlockian; Lud. = Ludlovian; Prid. = Pridolian; Loch. = Lochkovian.



Text-figure 34. Suggested lithostratigraphic correlation of sections A and B, north of Creswell Bay and section C, south of Creswell Bay.

with the underlying Cape Storm Formation and the overlying Somerset Island Formation. In addition, the lower and upper members of the Read Bay Formation are correlated using the Megalomoides-rich oncolitic limestone units in sections A and C, and the Megalomoides-rich dolomite unit in section B, which serve as useful marker horizons.

Age of the Cape Storm Formation

The conodont Ozarkodina n. sp. B of Klapper (in Klapper and Murphy 1974) occurs 10 m below the top of the Cape Storm Formation (unit A56) in section A and 17 m below the top of the Cape Storm Formation (unit C103) in section C and is considered by T.T. Uyeno (1976 written communication) to range from Lower to Upper Ludlovian. In addition, Ozarkodina confluens (Branson and Mehl) occurs 3 m below the top of the Cape Storm Formation (unit C110) in section C and is considered by T.T. Uyeno (1976 written communication) to range from mid-Ludlovian to Pridolian. However, since this is not a late form, the age is probably restricted to middle and late Ludlovian. The presence of Ozarkodina n. sp. B 180 m above the base of the Read Bay Formation (unit A119) suggests that most if not all of the Read Bay Formation is restricted to the Ludlovian. Therefore, the upper part of the Cape Storm Formation is probably middle Ludlovian in age. An age for the lower boundary of the Cape Storm Formation is not possible to determine, since the boundary is not exposed in any of the sections measured. However, based on the age of the lower boundary elsewhere in the Arctic (see Regional Correlation) it is tentatively considered to be early Wenlockian in age.

Although other diagnostic fossils are lacking in the Cape Storm Formation in the sections measured, thelodonts etched from as low as 145 m below the top of the formation (unit A16) were considered by S. Turner (1974 written communication) to be 'Wenlockian broadly' in age.

Age of the Read Bay Formation

The conodont *Ozarkodina confluens* (Branson and Mehl) occurs in section A 8 m and 40 m above the base of the Read Bay Formation (units A64 and A75 respectively) and in section C 88 m and 140 m above the base of the Read Bay Formation (units C31 and C48 respectively) and is considered by T.T. Uyeno (1976 written communication) to range from mid-Ludlovian to Pridolian. In addition, *Ozarkodina* n. sp. B of Klapper (*in* Klapper and Murphy 1974) occurs 180 m above the base of the Read Bay Formation (unit A114) in section A, and is considered by T.T. Uyeno (1976 written communication) to range from Lower to Upper Ludlovian. This would suggest that the Read Bay Formation in the study area ranges from middle to late Ludlovian.

Invertebrate fossils which support an Upper Silurian age include *Atrypoidea* (*Atrypella* in Berry and Boucot 1970, p. 202) and *Plexodictyon katriense* (Nestor 1966, p. 21).

Age of the Somerset Island Formation

The conodont *Ozarkodina* n. sp. D? occurs 33 m above the base of the Somerset Island Formation (unit A125) and is considered by T.T. Uyeno (1976 written communication) to range from late Ludlovian to early Pridolian. Since the Read Bay Formation is considered to be middle to late Ludlovian in age, the lower part of the Somerset Island Formation may be late Ludlovian or early Pridolian in age. The upper part of the formation was not examined in the study area, but according to Miall *et al*. (1978), the upper part is as young as late Pridolian on Somerset Island.

Regional Correlation

The Cape Storm Formation at the type section on Ellesmere Island, and at sections on Devon and Cornwallis Islands, was considered by Kerr (1975) to range from late Llandoverian to early Ludlovian. The early Ludlovian upper age limit was based on the occurrence of *Atrypoidea*, *Encrinurus*, and *?Coenites* in the overlying Douro Formation, considered to indicate an early Ludlovian or late Wenlockian age. However, the same fauna occurs in rocks on Somerset Island which contain conodonts of late Ludlovian age (Jones and Dixon 1975, 1977). Uyeno (1977) suggested that the upper part of the formation on Cornwallis Island was middle Ludlovian in age, based on conodont evidence. On Prince of Wales Island, strata of the Cape Storm Formation were termed the 'transition beds' by Dixon *et al*. (1972), the upper part being considered late Wenlockian or early Ludlovian in age. On northwestern Somerset Island, the Cape Storm Formation was considered by Jones and Dixon (1977) to range from early Wenlockian to early Ludlovian. The formation is not present on northeastern Somerset Island, but is apparently represented by part of the Cape Crauford-Leopold Formations succession (*op. cit*.)

The Read Bay Formation at the type section on Cornwallis Island was originally assigned a late Wenlockian to late Ludlovian age (Thorsteinsson 1958), which was later extended to the Lower Devonian (Thorsteinsson and Tozer 1970). On the basis of conodont studies, Uyeno (1977) suggested that members A and B were middle Ludlovian, member C late Ludlovian to Pridolian, and member D Lochkovian (Lower Devonian). However, Gibling and Narbonne (1977) have recently suggested that the entire Read Bay Formation on Somerset Island is lithologically equivalent to Member A only. On Ellesmere and Devon Islands, strata laterally equivalent to the Read Bay Formation include the Douro.Formation and overlying Devon Island Formation (Berry and Boucot 1970). On Prince of Wales Island, the uppermost part of the Read Bay Formation was considered to be early Pridolian in age (Berry and Boucot 1970) and the lower part, based on the probable age of the Cape Storm Formation, early Ludlovian in age. On northern Somerset Island, the Read Bay Formation is markedly diachronous, and according to Jones and Dixon (1977) ranges from early to late Ludlovian in the northwest and from middle to late Pridolian in the northeast, where it is underlain by the Leopold Formation, considered to be early to middle Pridolian in age.

On Somerset Island, the Somerset Island Formation is ". . . predominantly Pridolian in age, but may also include some strata of Ludlovian or Gedinnian age." (Miall et al. 1978, p. 181), and is approximately laterally equivalent to the lower member of the Peel Sound Formation on Prince of Wales Island and to member C of the Read Bay Formation on Cornwallis Island. The Somerset Island Formation may be laterally equivalent in part to the Leopold Formation and lower part of the Read Bay Formation on northeastern Somerset Island (Jones and Dixon 1977).

The proposed regional correlation is represented in Text-figure 35.

Data from Jones and Dixon (1977), Miall *et al.* (1978), and this study.					Data from Berry and Boucot (1970), Kerr (1975), and Uyeno (1977).			
	Island / Series	Prince of Wales	Somerset West	Somerset N.E.	Cornwallis South	Cornwallis North	Devon	Ellesmere
Devonian	Gedinnian				Snowblind Bay Fm.; D	D.B. Fm.	Sutherland River Fm.	Unnamed Carbonates
Silurian	Pridolian	Peel Sound Fm.	P.S.Fm; S.I.Fm	R.B.Fm; Leopold Fm.	R.B. Fm.; C	Cape Phillips Fm.	Devon Is. Fm.	Devon Is. Fm.
	Ludlovian	Read Bay Fm.	R.B.Fm		A,B		Douro Fm.	Douro Fm.
	Wenlockian	Cape Storm Fm.	Cape Storm Fm.	Cape Crauford Fm.	Cape Storm Fm.		Cape Storm Fm.	Cape Storm Fm.
	Llandoverian	Allen Bay Fm.	Allen Bay Fm.		Allen Bay Fm.		Allen Bay Fm.	Allen Bay Fm.

Text-figure 35. Suggested time correlation of Silurian-Devonian Formations of the central Canadian Arctic. P.S.=Peel Sound Formation. S.I.=Somerset Island Formation. R.B.=Read Bay Formation. D.B.=Disappointment Bay Formation.

CHAPTER 8

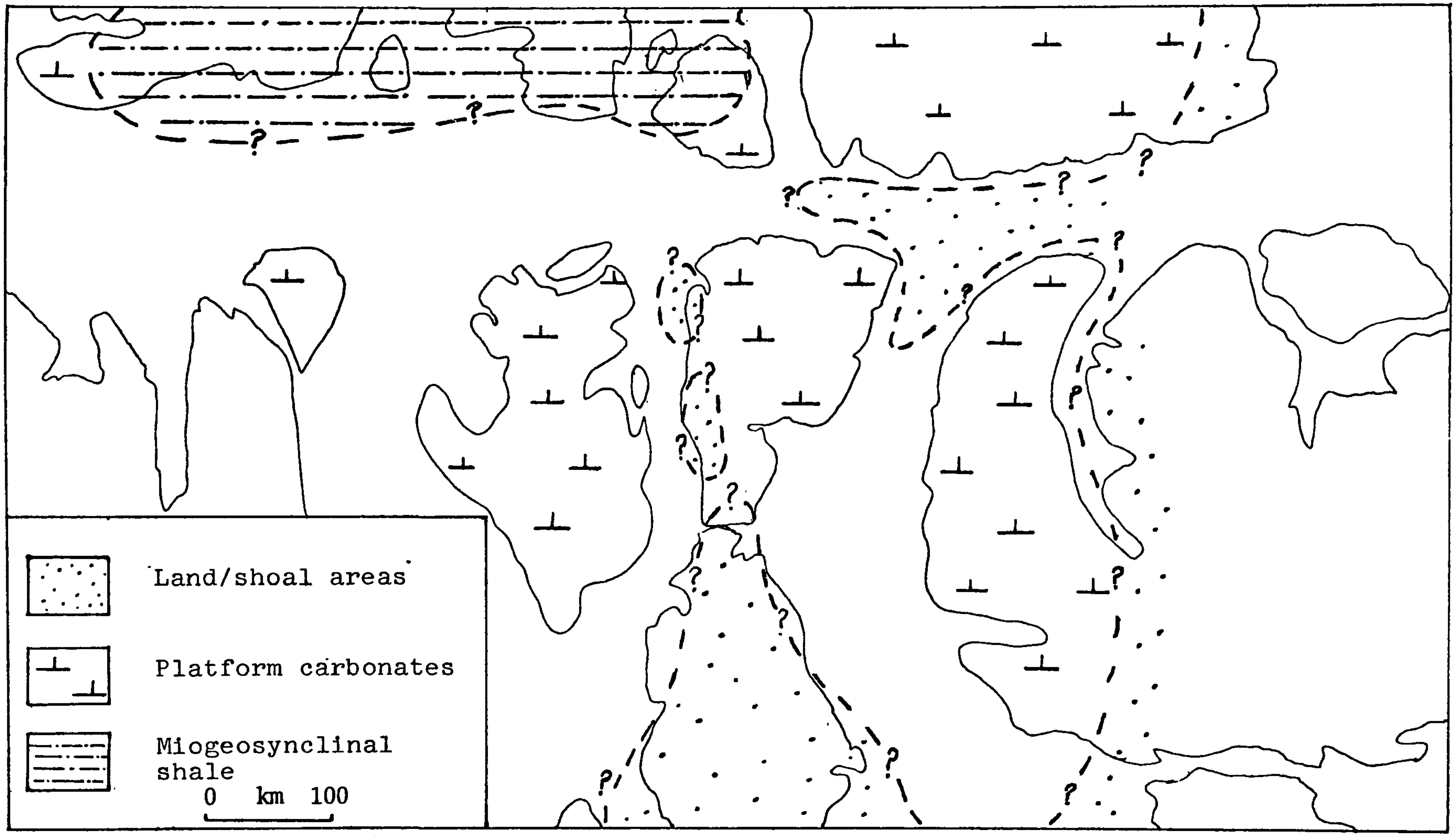
HISTORY OF DEPOSITION

Although the depositional history presented below is based primarily on data from the study area, consideration of data from other areas on Somerset Island is necessary in order to form a more complete picture of depositional events.

Throughout the Llandoverian, Wenlockian, and lower and mid-Ludlovian, sedimentation on Somerset Island was essentially supratidal and intertidal. This produced the predominantly dolomitic succession of the Allen Bay Formation and lower units of the Cape Storm Formation in the west (Dixon 1974a, p. 137; this study) and the predominantly dolomitic and evaporitic succession of the Cape Crauford Formation in the east (Reinson 1978). The detrital material being supplied in the study area in the west was probably derived from the Boothia Uplift, either directly from the metamorphic basement rocks, or possibly from overlying sedimentary rocks. Although Paleozoic carbonate clasts are present in the Peel Sound Formation (Brown _et al_. 1969; Gibling 1978), this does not necessarily imply that the entire Boothia Uplift was covered by Paleozoic rocks; exposed basement rocks may have continued to supply detrital material throughout the early and middle Silurian (see Brown _et al_. 1969, Fig. 9).

To the east the detrital material was probably derived from a metamorphic and/or igneous land mass to the north and east of Port Leopold (Jones and Dixon 1975, p. 409). A middle Ludlovian transgression introduced low intertidal and subtidal environments to the study area, producing the dolostone, sandstone and limestone of the upper part of the Cape Storm Formation and the various limestones of the lower member of the Read Bay Formation. To the northeast, predominantly supratidal sedimentation persisted (Jones and Dixon 1977, p. 1450). Detrital material continued to be supplied in the west from the Boothia Arch and in the east from the inferred land mass to the north and east of Port Leopold (Text-fig. 36). Land masses in this configuration could have restricted sea water circulation sufficiently for slightly hypersaline conditions to develop, as suggested by the geochemical evidence.

In the study area, tidal flat and very shallow subtidal environments were inhabited by thelodonts and other ostracoderms, as well as a restricted fauna of ostracods, gastropods, and Protathyris. Concentrations of lamellar to hemispherical stromatoporoids developed locally in high energy nearshore environments, while ramose stromatoporoids developed immediately seaward in relatively deeper, less agitated environments. Stromatoporoid development was restricted or entirely prohibited in the southern part of the study area, possibly due to the higher detrital sedimentation, which, conversely, appears to have provided favourable habitats for scolecodont-bearing annelids. The higher detrital sedimentation in the southern part of the study area probably reflects greater proximity to the Boothia Uplift of this area. In the subtidal environments seaward of the generally stromatoporoid-rich nearshore environments, various brachiopod assemblages developed in what were probably semi-restricted areas sheltered by local offshore shoals which may have developed parallel to the Boothia Uplift. Those in which Protathyris predominated developed in shallow high energy environments. The assemblages were increasingly diverse with depth and decreasing energy level, until Atrypoidea became predominant in the least agitated environments. In the highly argillaceous sediments in the south of the



Text-figure 36. Suggested regional paleogeography during the middle and late Ludlovian. The diagram incorporates the results of this study with information from surrounding areas from Brown et al. (1969), Dineley (1971), Jones (1974), and Jones and Dixon (1975).

study area, *Gypidula* replaced *Fardenia* in the *Atrypoidea* assemblages. Gastropods and conodont-bearing organisms were commonly associated fauna, as were thelodonts in nearshore environments.

The hypothesized offshore shoals consisted primarily of oncolites and locally stromatolites, and were inhabited almost exclusively by *Megalomoides*. The shallow, high energy environments immediately adjacent to the shoal areas were inhabited by *Protathyris* assemblages, while in open areas seaward of the shoals coral faunas developed, with local concentrations of trilobites (especially in nearshoal, seaward environments), gastropods, conodont-bearing organisms, and brachiopods (including *Atrypa*). While corals were generally profuse and diverse in the northern part of the study area, they were less so to the south, where they were commonly associated with sponges, possibly a result of the higher detrital sedimentation.

The transgression had apparently reached its maximum extent by the late Ludlovian, at which time regression resulting from the uplift of the Boothia Uplift began. The decreasing size and diversity of the corals, the decrease in the diversity of the associated faunas, and a corresponding increase in detrital material, are the first indications of the regression. As the uplift proceeded, intertidal and supratidal environments returned in the study area, and alternated with shallow subtidal environments, which were inhabited by a limited fauna of ostracods, gastropods, and stromatoporoids and *Protathyris*. These environments are represented by the alternating sequences of limestone, dolomite, and sandstone of the Somerset Island Formation, which contain well rounded, sand-sized quartz grains apparently derived from the Boothia Uplift. With further uplift, fluvial red sandstone and conglomerate of the Peel Sound Formation were deposited in the study area.

CHAPTER 9

STROMATOPOROID FAUNAS

Introduction

Silurian stromatoporoids in the Canadian Arctic have been largely neglected in studies in the area to date. Apart from Petryk's (1967) study of Lower and Middle Silurian forms from Baffin Island, the only other stromatoporoids studied have been several specimens from Beechey Island and Southampton Island (Parks 1909).

Stromatoporoids are abundant in the basal units of the Read Bay Formation in section A and in a distinctive bioclastic unit in the Somerset Island Formation in section A. Since these units are important stratigraphic horizons in the study area, stromatoporoids from these horizons and any other specimens collected from the study area were examined in detail.

Systematic Paleontology

PHYLUM Porifera

SUBPHYLUM Stromatoporata Stearn 1972

FAMILY Clathrodictyidae Kuhn 1939

GENUS Plexodictyon Nestor 1966

Type species — Plexodictyon katriense Nestor 1966

Diagnosis — Skeletal elements composed of zig-zag shaped, strongly crumpled laminae alternating with thin, straight, continuous or coalescing laminae (paralaminae). Apices of strongly crumpled laminae commonly joined, producing irregular horizontal series of small subcircular cells. Astrorhizae absent or weakly developed. Tissue compact.

Remarks — Plexodictyon is similar to Ecclimadictyon Nestor except that in the latter genus the thin straight laminae are absent. The interlaminar skeletal elements were considered by Nestor (1966, p. 80) to be abruptly bent skeletal plates, by Stearn (1969, p. 761) to be pillars intertwining in zig-zag form, and by Mori (1970, p. 99) to be zig-zag shaped, strongly crumpled laminae.

Plexodictyon katriense Nestor 1966

Pl. 2, figs. 1-3

Diagnosis — Paralaminae 0.01 to 0.04 mm thick and spaced 1 to 2 mm apart. Paralaminae rarely continuous, commonly coalescing to form lenses. Strongly crumpled laminae 0.08 to 0.10 mm thick, form regular zig-zag patterns. 5 to 6 strongly crumpled laminae in 1 mm. Galleries circular to elongate. Tissue compact.

Remarks — The specimens closely resemble those described by Nestor (1966) but lack astrorhizal cylinders.

Material — Four complete hemispherical to domal specimens. Hypotypes GSC 54153-GSC 54156 are in the repository of the Geological Survey of Canada.

Horizon and age — All specimens were collected from the basal unit (A60) of the Read Bay Formation in section A. Middle to late Ludlovian.

Plexodictyon heclae n.sp.

Pl. 2, figs. 4-8

Diagnosis — Paralaminae 0.01 to 0.03 mm thick, number 1 to 2 per mm, generally continuous, rarely coalesce to form lenses. Strongly crumpled laminae 0.10 to 0.15 mm thick, number 3 to 4 in 1 mm. Galleries tend to be circular or slightly elongate. Astrorhizae absent. Tissue compact.

Remarks – *P. heclae* differs from *P. katriense* in the presence of generally continuous paralaminae and fewer crumpled laminae per mm, and from *P. waparksi* Stearn, from Upper Silurian rocks on Beechey Island in the Canadian Arctic, by having much thinner paralaminae (0.01-0.03 vs 0.06-0.09 mm), and thicker strongly crumpled laminae (0.10-0.15 vs 0.05-0.06 mm).

Material – Five hemispherical, fragmented specimens. Holotype GSC 54157 and paratypes GSC 54158-GSC 54161 are in the repository of the Geological Survey of Canada.

Horizon and age – All five specimens were collected from unit A137 approximately 68 m above the base of the Somerset Island Formation. Late Ludlovian or early Pridolian.

Derivation of name – The species is named after H.M.S. Hecla, one of two ships used by W.E. Parry when he explored Somerset Island in 1824-1825.

GENUS *Diplostroma* Nestor 1966

Type species – *Clathrodictyon pseudobilaminatum* Khalfina 1961

Diagnosis – Horizontal elements consist of regular sets of two closely spaced laminae, fused locally. Pillars simple, developed in wider alternate interlaminar spaces. Dissepiments present or absent.

Remarks – Nestor (1966, p. 27) considered the horizontal elements of *Diplostroma* to be thick bipartite single laminae with variable median split thickness, whereas Mori (1969, p. 70) revised the original concept and considered them to be regular sets of two laminae. Evidence presented by Mori (*op. cit.*) that the horizontal elements are in fact regular sets of two laminae is very strong, in that the median split in some specimens is infilled by fine sediment or contains commensal organisms. Specimens described by Mori (1969; 1970) contain two types of microstructure; compact in the lower lamina and vacuolate in the upper lamina of each set. Only compact tissue is present in the single specimen examined from Somerset Island.

Diplostroma sp.

Pl. 4, figs. 1, 2

Description — The laminae are straight and continuous, and form regular sets of two laminae, each set 0.15 to 0.20 mm thick, and spaced 2 to 3 per mm apart. The interlaminar space within each set is up to 0.1 mm thick, although it is commonly lacking due to fusion of the laminae. The pillars are spool-shaped, 0.1 to 0.2 mm in width and number 3 to 6 in 1 mm. In tangential section the pillars are circular, 0.1 to 0.2 mm in diameter. The tissue is compact. Astrorhizae are absent.

Remarks — The single specimen available is insufficient material on which to base a species identification.

Material — One hemispherical, encrusting specimen (GSC 54162) was collected and is in the repository of the Geological Survey of Canada.

Horizon and age — The specimen was collected from unit A105 approximately 125 m above the base of the Read Bay Formation in section A. Middle to late Ludlovian.

FAMILY Actinostromatidae Nicholson 1886

GENUS *Actinostroma* Nicholson 1886

Type species — *Actinostroma clathratum* Nicholson 1886

Diagnosis — Vertical elements consist of continuous pillars. Horizontal elements consist of rod-like processes developed at even levels on the pillars, forming more or less continuous laminae. Astrorhizae present or absent.

Remarks — Flügel (1959), in a major revision of the genus, divided Actinostroma into two subgenera; Actinostroma (Actinostroma) and Actinostroma (Densastroma). Mori (1970, p. 109) considered Actinostroma (Densastroma) an independant genus. Nestor (1964) divided Actinostroma (Actinostroma) into the genera Actinostroma and Plectostroma. In the former genus the radial processes project from the pillars at the same level, while in the latter the radial processes project from the pillars at different levels.

Actinostroma furyi n. sp.

Pl. 3, figs. 1-8

Diagnosis — Laminae consist of radial processes projecting from pillars at the same level, forming astral mesh-work in tangential section. Laminae greatly undulatory, rising into well developed mamelons. Laminae 0.01 to 0.04 mm thick, and number 5 to 7 in 1 mm. Pillars long, round, passing through many laminae, 0.03 to 0.06 mm in diameter, and number 7 to 10 in 1 mm. Galleries vertically rectangular. Astrorhizal canals well developed, radiating outwards from mamelon centers, vary in width from 0.1 to 0.3 mm and are up to at least 2.0 mm in length in tangential section.

Remarks — Actinostroma has been extensively reviewed by Flügel (1959) and Flügel and Flügel-Kahler (1968). Although Actinostroma sensu Nestor (1964) is common in the Devonian, it is rare in the Silurian. Of the closest related Silurian species, A. furyi differs from A. botvaldavikense Mori from Gotland and A. tenuipalum Yavorsky from Siberia by the presence of less well defined laminae and thicker pillars, form A. inflectum Parks from the Hudson Bay Lowlands, Northern Ontario by the absence of sharply folded laminae, from A. tenuifilatum Parks from Michigan by the presence of well defined astrorhizae and more closely spaced laminae, and from *A. whiteavesi niagarense* Parks from southern Ontario by the absence of an "indistinct latilaminar structure" due to bent pillars, which results in a characteristic areolated appearance in tangential section (Parks 1908, p. 13). *A. franklinense* Parks from the Silurian of Beechey Island in the Canadian Arctic was considered synonomous with *A. intertextum* Nicholson by Flügel (1959, p. 108), the latter species being subsequently designated the type species of *Plectostroma* (Nestor 1964, p. 109).

Material — Twenty-six lamellar to hemispherical specimens, many of which are fragmental. The holotype (GSC 54163) and paratypes (GSC 54164-GSC 54169) are in the repository of the Geological Survey of Canada.

Horizon and age — All twenty-six specimens were collected from the basal unit (A60) of the Read Bay Formation in section A. Middle to late Ludlovian.

Derivation of name — The species is named after H.M.S. Fury, one of two ships used by W.E. Parry when he explored Somerset Island in 1824-1825.

FAMILY Uncertain

GENUS *Actinodictyon* Parks 1909

Type species — *Actinodictyon canadense* Parks 1909

Diagnosis — Skeleton composed of continuous or discontinuous laminae inflected into chevron-like folds, and vertical continuous pillars. Astrorhizae present or absent. Tissue compact.

Remarks — Galloway (1957), Galloway and St. Jean (1957), and Flügel (1959) considered the horizontal elements to be dissepiments, whereas Parks (1909), Stearn and Hubert (1966), and Petryk (1967) suggested the horizontal elements were laminae. Mori (1969) also considered the horizontal elements to be dissepiments, but later described forms from Gotland in which the dissepiments change laterally into laminae (Mori 1970, p. 144). In the specimens examined from Somerset Island, the horizontal elements are more closely allied to laminae than to dissepiments. The genus Neoclathrodictyon erected by Lessovaya (1971, p. 116) is considered synonomous with Actinodictyon if the horizontal elements of the latter genus are laminae rather than dissepiments.

Actinodictyon netsiliki n. sp.

Pl. 4, figs. 3-6

Diagnosis — Laminae more or less continuous and inflected into chevron-like folds. Laminae 0.03 to 0.05 mm thick and number 6 to 8 in 1 mm. Pillars long, continuous, passing through many laminae, 0.08 to 0.10 mm in diameter and number 5 to 6 in 1 mm. Astrorhizae absent. Tissue compact.

Remark — The specimens closely resemble those designated Neoclathrodictyon kimi by Lessovaya (1971, Plate 32, fig. 2) except that the latter possess astrorhizal canals. The specimens differ from A. quebecense Stearn and Hubert from the Silurian of Quebec, in that they possess longer pillars and more closely spaced skeletal elements, and from A. canadense Parks, from the Silurian of Southampton Island, by the presence of more regular laminae.

Material — Two hemispherical encrusting specimens, one fragmental. The holotype (GSC 54170) and paratype (GSC54171) are in the repository of the Geological Survey of Canada.

Horizon and age — Both specimens were collected from unit A137 approximately 68 m above the base of the Somerset Island Formation in section A. Late Ludlovian or early Pridolian.

Derivation of name — The species is named after the last group of Inuit to permanently inhabit Somerset Island.

GENUS Vicunostachyodes Yavorsky 1961

Type species — Vicunostachyodes mirabilis Yavorsky 1961

Diagnosis — Skeletal elements amalgamated, neither laminae nor pillars distinct. Galleries generally in the form of irregular vermiform network. Axial canal lacking. Microstructure finely porous or compact.

Remarks — Vicunostachyodes differs from Amphipora in the lack of an axial canal, and from Clavidictyon, erected by Sugiyama (1939) in the lack of genuine laminae in the Peripheral portion of the coenosteum.

Vicunostachyodes sokolovi (Riabinin)

Pl. 4, figs. 7, 8

Description — The skeletal elements are amalgamated, and the pillars and laminae indistinct. Galleries are vermiform, 0.1 to 0.3 mm in diameter, and are generally elongate in longitudinal section and circular in cross section. Outer galleries tend to curve toward periphery. Microstructure is obscure.

Remarks — The specimens from Somerset Island are very similar to those described by Yavorsky (1967), although the microstructure is obscure, whereas in the latter specimens it is finely porous. They differ from V. riabinini in that the galleries are not arranged in a distinct radial pattern.

Material — Numerous poorly preserved, dendroid and isolate, fragmented specimens. Hypotypes (GSC 54172, GSC 54173) are in the repository of the Geological Survey of Canada.

Horizon and age — The specimens were collected from the uppermost unit of the Cape Storm Formation (unit A59) and lowermost units of the Read Bay Formation (units A60 and A61) in section A. Middle to late Ludlovian.

CHAPTER 10

CONCLUSIONS

1) The Upper Silurian (mid-late Ludlovian) Read Bay Formation near Creswell Bay, Somerset Island can be divided into two members on the basis of contained faunas; a brachiopod-rich lower member and a coral-rich upper member. The two members are separated by a characteristic oncolitic or coarse dolomite unit containing abundant *Megalomoides* which is interpreted as representing offshore shoal areas adjacent to the Boothia Uplift. Various depth-dependant brachiopod assemblages apparently inhabited areas between the Boothia Uplift and the offshore shoals, while coral faunas inhabited environments seaward of the shoals.

2) Sedimentological and geochemical evidence suggests that mottled limestone and argillaceous limestone, the two predominant rock types of the Read Bay Formation, were formed in environments with hypersaline tendencies. These hypersaline tendencies may have resulted from restricted conditions due to the presence of land masses and/or shoal areas to the west (Boothia Uplift) and to the northeast of the study area.

3) Six species of stromatoporoids are present in the Read Bay Formation and overlying Somerset Island Formation in the study area. These taxa include *Plexodictyon katriense*, *Diplostroma* sp. and *Vicunostachyodes sokolovi*, and three new species, *Plexodictyon heclae*, *Actinostroma furyi*, and *Actinodictyon netsiliki*.

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PLATE 1

Field Photographs from the study area

Fig. 1. Mottled limestone. Unit C15, section C. Hammer handle is approximately 0.3 m long.

Fig. 2. Rubbly argillaceous limestone. Unit C22A, section C. Hammer handle is approximately 0.3 m long.

Fig. 3. Oncolitic limestone. Unit C30, section C. Hammer handle is approximately 0.3 m long.

Fig. 4. Oncolitic limestone showing abundant moulds of convex-up *Megalomoides* valves. Unit C30, section C. Part of pen visible is 6 cm long.

Fig. 5. View northward from the West Creswell River, showing the prominent flat-topped ridge formed by the resistent Read Bay Formation (RB) flanked by the generally recessive underlying Cape Storm Formation (CS) and overlying Somerset Island Formation (SI). Scale is approximately 100 m. Photograph by B. Jones.

Fig. 6. View northward from section A, showing the resistant stromatoporoid-rich unit at the base of the Read Bay Formation (RB) above the Cape Storm Formation=CS. Scale is approximately 10 m long.

Fig. 7. View southward at section A, showing the boundary between the Read Bay Formation (RB) and the overlying Somerset Island Formation (SI). Scale is approximately 10 m long.

Fig. 8. Boundary between the Cape Storm Formation (CS) and overlying Read Bay Formation (RB) at section C. Scale is approximately 5 m long.

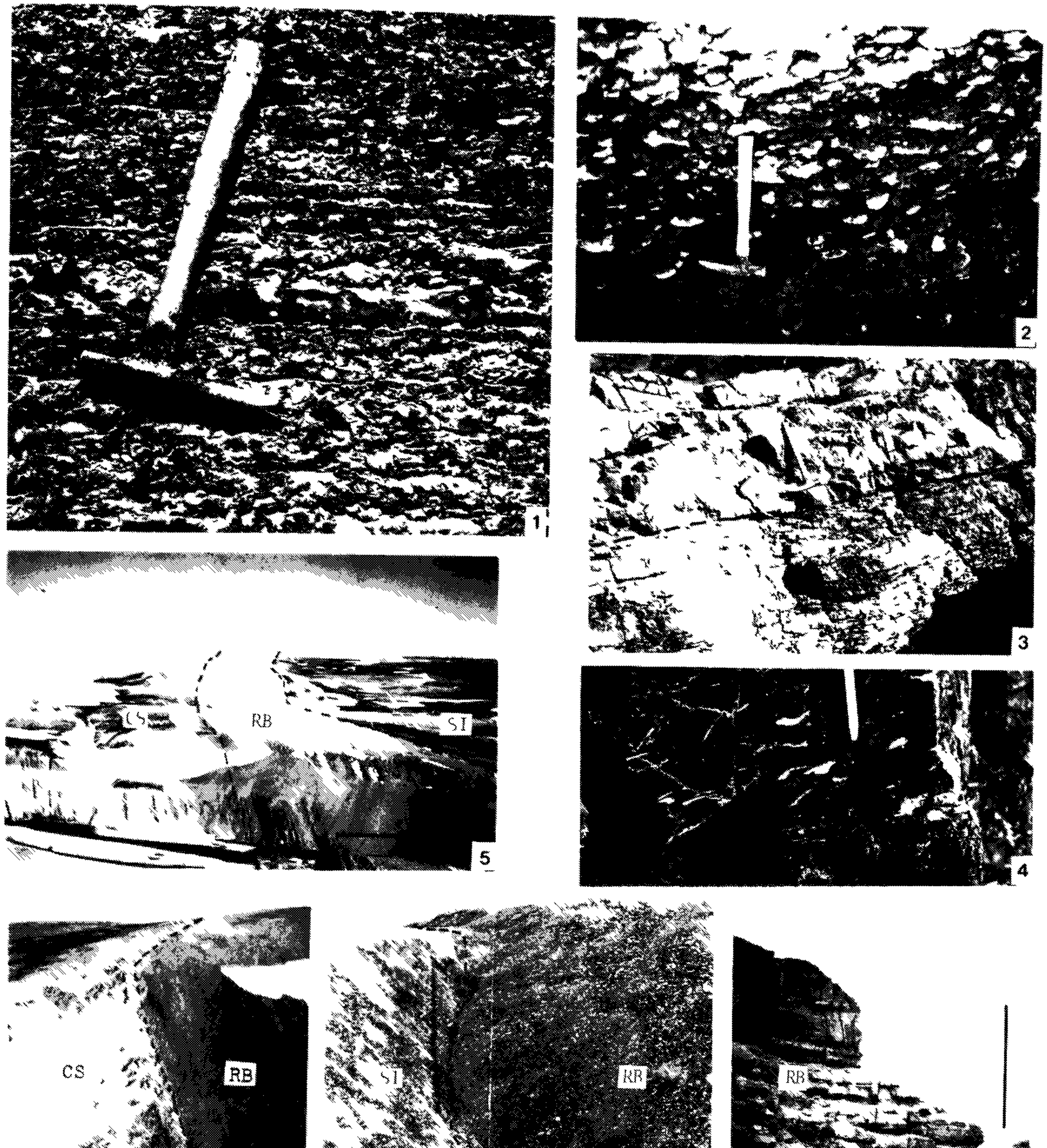
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PLATE 2

Stromatoporoids

Bar scales: 1 mm

Figs. 1-3. Plexodictyon katriense Nestor. 1: vertical section, hypotype GSC 54153, showing regular zig-zag pattern of strongly crumpled laminae. 2: tangential section, hypotype GSC 54153. 3: vertical section, plesiotype GSC 54154, showing coalescing paralaminae.

Figs. 4-8. Plexodictyon heclae n.sp. 4: vertical section, holotype GSC 54157, showing generally continuous thin paralaminae. 5,6: vertical and tangential sections, paratype GSC 54158. 7,8: vertical and tangential sections, paratype GSC 54161.

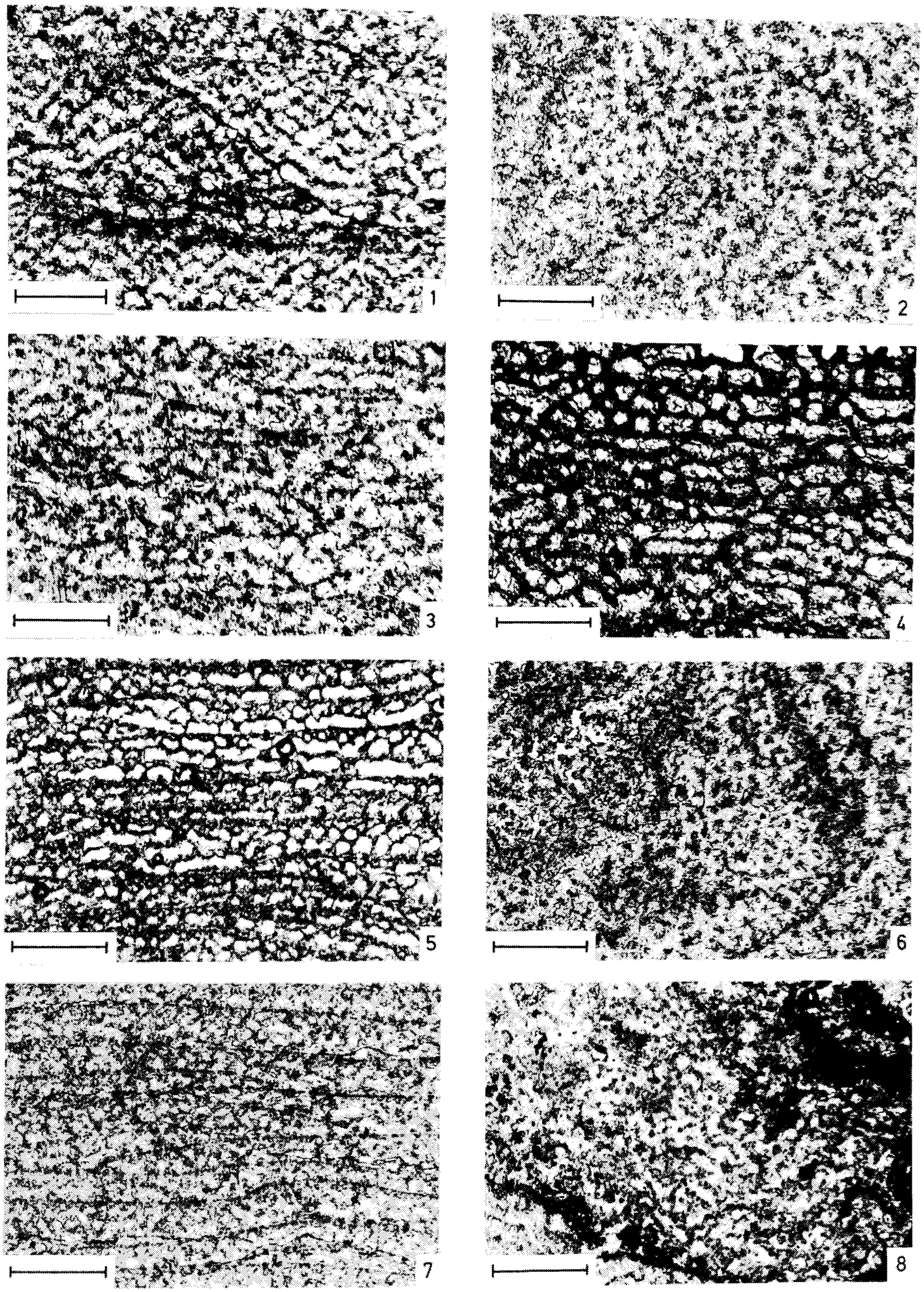
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PLATE 3

Stromatoporoids

Bar scales: Figs. 1, 2-1 cm; Figs. 3-8-1 mm

Figs. 1-8. *Actinostroma furyi* n.sp. 1: vertical section, paratype GSC 54168, showing continuous laminae and well developed mamelons. 2: tangential section, holotype GSC 54163, showing well developed mamelons and astrorhizal canals. 3,4: vertical and tangential sections, holotype GSC 54163. 5: vertical section, paratype GSC 54166. 6: tangential section, paratype GSC 54165, showing astral meshwork formed by radial processes. 7: vertical section, paratype GSC 54169, showing inflection of laminae due to mamelon development. 8: tangential section, paratype GSC 54168, showing astrorhizal canals.

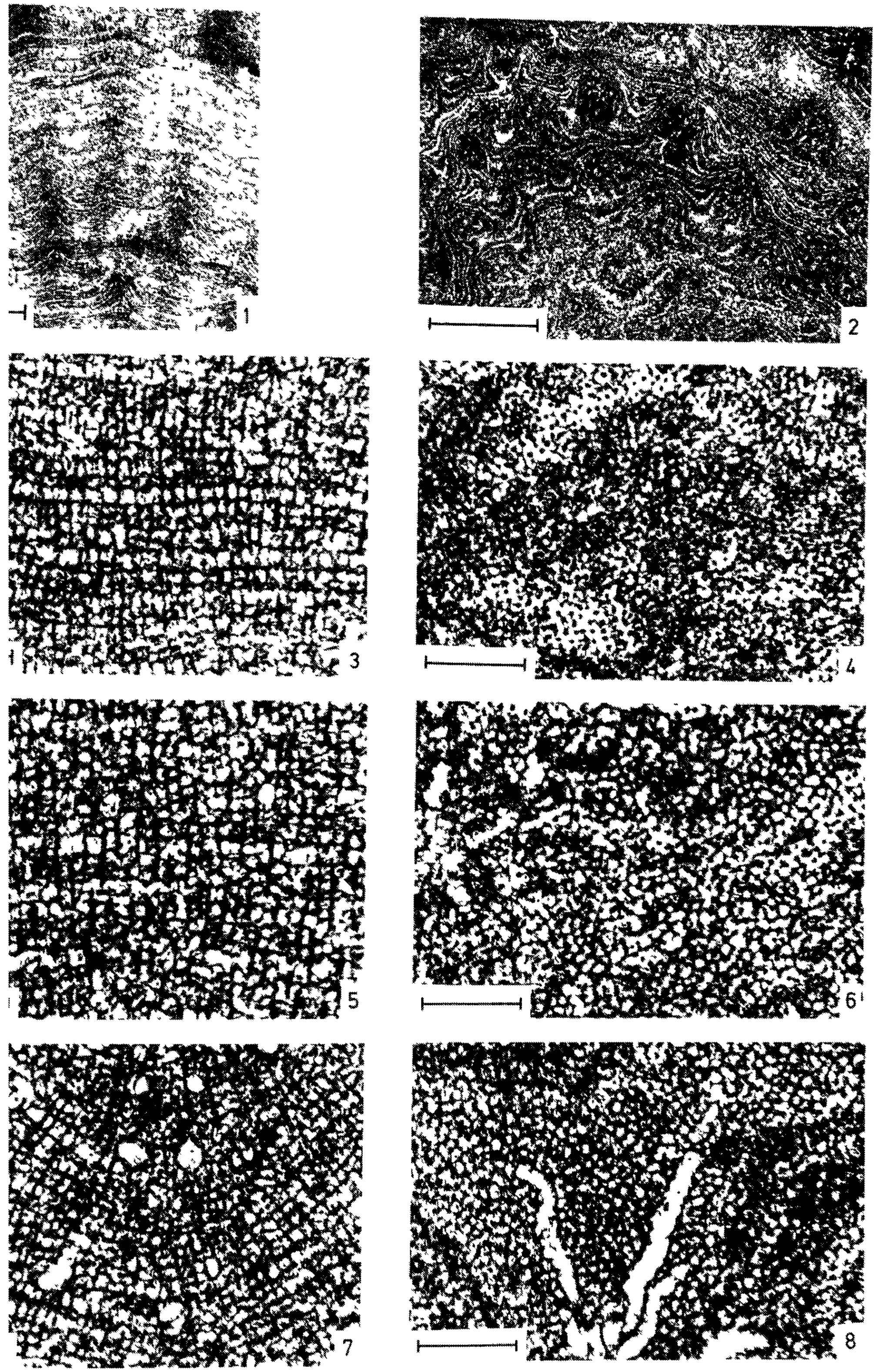
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PLATE 4

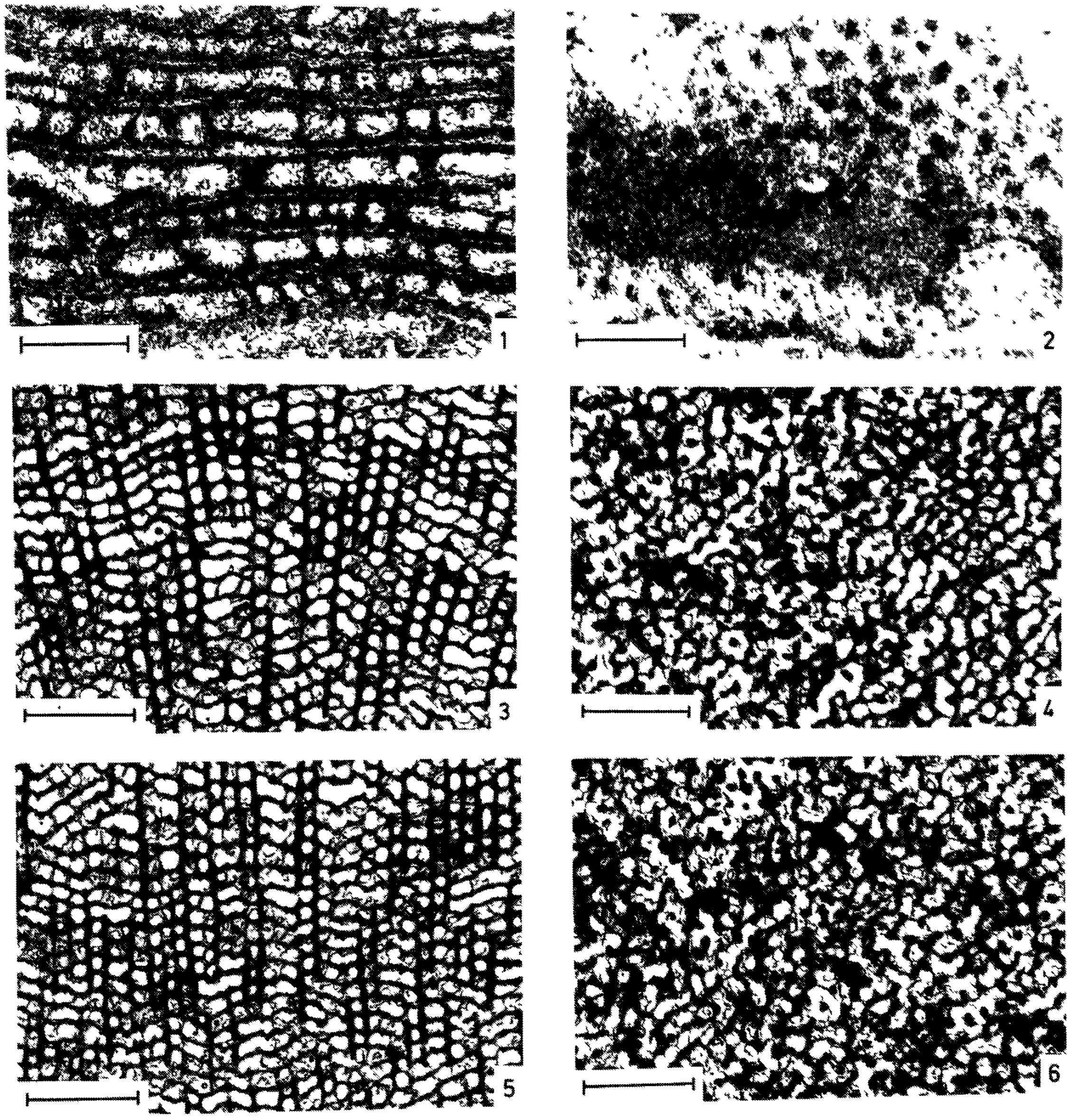
Stromatoporoids

Bar scales: 1 mm

Figs. 1,2. *Diplostroma* sp. 1: vertical section, GSC 54162, showing regular sets of two laminae and spool-shaped pillars. 2: tangential section, GSC 54162.

Figs. 3,6. *Actinodictyon netsiliki* n.sp. 3,5: vertical sections, holotype GSC 54170, showing long continuous pillars, and chevron-like folds in continuous laminae. 4,6: tangential sections, holotype GSC 54170.

Figs. 7,8. *Vicinostachyodes sokolovi* (Riabinin). 7: longitudinal section (center), and cross section (lower right), hypotype GSC 54172, showing vermiform galleries. 8: cross section, hypotype GSC 54173.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