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CARBONATE-EVAPORITE CYCLES IN THE SILURIAN ROCKS OF SOMERSET ISLAND, ARCTIC CANADA

G.E. REINSON

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CARBONATE-EVAPORITE CYCLES IN THE SILURIAN ROCKS OF SOMERSET ISLAND, ARCTIC CANADA

ABSTRACT

The east coast of Somerset Island is characterized by spectacular cliffs, as much as 365 m high, consisting of Silurian strata which are nearly horizontal or dip westerly at a low angle. A cyclic sequence of carbonate-evaporite rocks forms the lower exposures, but the upper two thirds of the cliff are composed primarily of carbonate rocks. The upper carbonate succession has been studied in detail and designated as the Leopold Formation. The lower cyclic carbonate-evaporite sequence is described in this paper.

The carbonate-evaporite sequence is considered to be Wenlockian in age, and correlative with the upper Cape Crauford Formation on northwestern Baffin Island and the lower Cape Storm Formation on Devon Island. It crops out only in the vertical cliffs of northeastern Somerset Island and, thus, cannot be mapped on a regional scale. This cyclic carbonate-evaporite succession has a maximum exposure of 125 m in the coastal cliffs 18 km south of Elwyn Bay, and it is there that a detailed section was measured. The lower boundary of the sequence lies below sea level, and the upper boundary was placed at the top of the last continuous evaporite bed, which marks the base of the Leopold Formation.

Twenty-three carbonate-evaporite cycles were recognized in the measured section. Each cycle is considered to represent deposition during progradation of a lagoonal-sabkha shoreline. Three lithofacies make up the complete cycles; subtidal, intertidal, and supratidal. Three rock types constitute the subtidal or lagoonal lithofacies; pelletoidal wackestone, finely laminated mudstone, and massive to laminated mudstone. Rocks interpreted to be algal stromatolites constitute the intertidal lithofacies. Two stromatolite forms are recognized - digitate stromatolites and cryptalgalaminite. The supratidal lithofacies is characterized by birds-eye laminated mudstone, interlaminated gypsum and carbonate mudstone, and by bedded gypsum deposits.

Not all the cycles contain all three lithofacies; in some, the subtidal lithofacies is absent, and in others the supratidal lithofacies is absent. The middle of the measured section commonly contains subtidal-intertidal cycles, whereas in the upper and lower parts, intertidal-supratidal cycles are prevalent. Where the lagoonal or subtidal facies of the cycles is absent, the carbonate is dolomite but, where subtidal rocks are present in the cycles, calcitic carbonate prevails. This dolomite distribution is consistent with that observed in the modern sabkha of the Trucial Coast, Persian Gulf, in that the dolomitization occurs as a diagenetic front which progresses seaward in the prograding supratidal zone.

The Silurian stratigraphic succession of northeastern Somerset Island, from the basal carbonate-evaporite sequence, through the Leopold Formation to the overlying Read Bay Formation, records a sequence of deposition in a shoreline-shelf environment that was subsiding continually. During the evaporite depositional phase, conditions were restricted and hypersaline; these conditions changed gradually to a shallow, more open marine environment during deposition of the subtidal fossiliferous carbonates of the Read Bay Formation.

RÉSUMÉ

La côte orientale de l'île Somerset est caractérisée par des falaises impressionnantes qui atteignent 365 m de hauteur, et sont constituées de strates siluriennes presque horizontales ou faiblement inclinées vers l'ouest. Une succession cyclique de carbonates et évaporites forme les affleurements inférieurs, tandis que les deux-tiers supérieurs de la falaise sont constitués essentiellement de roches carbonatées. La succession carbonatée supérieure a fait l'objet d'études détaillées à la suite desquelles elle a pris le nom de formation de Leopold. La présente étude décrit la succession cyclique inférieure de carbonates et évaporites.

L'auteur considère que cette succession appartient au Wenlockien et qu'elle peut être mise en corrélation avec la partie supérieure de la formation de Cape Crauford (au nord-ouest de l'île Baffin) et la partie inférieure de la formation de Cape Storm (dans l'île Devon). Comme elle n'affleure que dans les falaises verticales du nord-est de l'île Somerset, il est très difficile d'en dresser la carte a l'échelle régionale. Cette succession cyclique de carbonates et évaporites présente un affleurement maximal de 125 m dans la falaise littorale située à 18 km au sud de la baie d'Elwyn, à l'endroit même où l'on a mesuré une coupe détaillée. La limite inférieure de la succession se trouve au-dessous du niveau de la mer tandis que la limite supérieure a été située au sommet de la dernière couche continue d'évaporites, que marque en même temps la base de la formation de Leopold.

Vingt-trois cycles de carbonates et évaporites ont été identifiés dans la coupe mesurée. On estime que chacun des cycles représente une sédimentation qui s'est effectuée au cours de la progression d'un rivage de type lagunaire ou de sabkha. Les cycles complets comprennent trois genres de lithofaciès: subtidal, intertidal et supratidal. Trois types de roches forment le lithofaciès subtidal ou lagunaire; une wackestone riche en granules, une pélite finement laminée et une pélite massive passant progressivement à une forme laminée. On a interprété comme étant des stromatolites les roches de lithofaciès intertidal. Deux formes de stromatolites ont été identifiées, des stromatolites digitées et des laminites cryptalgales. Le lithofaciès supratidal est caractérisé par de la pélite à concrétions calcaires, des couches alternées de gypse et de pélite carbonatée, ainsi que par des dépôts de gypse stratifiés.

Certains cycles ne contiennent pas les trois lithofaciès; chez certains d'entre eux, on ne trouve pas le lithofaciès subtidal, tandis que chez d'autres c'est le lithofaciès supratidal qui est absent. Le centre de la section mesurée contient généralement des cycles subtidaux et intertidaux, tandis que dans les parties supérieures et inférieures, les cycles intertidaux et supratidaux dominent. Lorsque le faciès lagunaire ou subtidal des cycles est absent, le carbonate est dolomitique, mais lorsqu'on trouve des roches subtidales dans les cycles, il y a prépondérance du carbonate cristallisé en calcite. Cette répartition du caractère dolomitique correspond à celle observée dans la sabkha actuelle de la côte des Pirates (golfe Persique), la dolomitixation s'effectuant suivant un front de diagénèse qui progresse vers le large dans la zone supratidale d'accumulation.

A partir de la succession basale de carbonates et évaporites, en passant par la formation de Leopold jusqu'à la formation sus-jacente de Read Bay, la succession stratigraphique silurienne du nord-est de l'île Somerset indique une succession de dépôts dans un milieu littoral et de plate-forme continentale soumis à un mouvement continu de subsidence. Au cours de la phase de dépôt par évaporation, le milieu était limité et hypersalin, mais au cours du dépôt des carbonates fossilifères subtidaux de la formation de Read Bay, il s'est modifié progressivement pour constituer un milieu marin peu profond et ouvert.

CARBONATE-EVAPORITE CYCLES IN THE SILURIAN ROCKS OF SOMERSET ISLAND, ARCTIC CANADA

INTRODUCTION

Stratigraphic field studies of Paleozoic rocks on northern Somerset Island, Arctic Canada (Fig. 1), were made in 1975 (Reinson *et al.*, 1976) as part of a regional geological mapping program of Somerset Island and Boothia Peninsula (Kerr, 1976). This mapping program is continuing at the time of writing, hence regional geological findings are not available yet for incorporation in this paper. This report deals specifically with the sedimentological documentation and the interpretation of depositional environments of a Silurian carbonate-evaporite cyclic succession which crops out on the east coast of Somerset Island.

The east coast of Somerset Island, from Batty Bay northward to Port Leopold, is characterized by spectacular cliffs up to 365 m high (Figs. 2, 3). These cliffs consist of Silurian strata which are either nearly horizontal or which dip westward at a small angle. A cyclic sequence of carbonate-evaporite rocks forms the lower exposures, but the upper two thirds of the cliff are dominated by carbonates. The occurrence of evaporites on the east coast of Somerset Island was recorded first by Parry (1826) and M'Clintock (1857). Norris (1963) described a section at Elwin Bay, and Jones and Dixon (1975) referred briefly to the underlying carbonate-evaporite sequence while describing thoroughly the overlying carbonate strata.

FIGURE 1. Map of eastern Sommerset Island showing measured section locality (Lat. 73°42'N, Long. 90°35'W) indicated by black dot

ACKNOWLEDGMENTS

The field work for this study was done in the summer of 1975, when the writer participated in the first phase of Operation Boothia with J. Wm. Kerr. Many fruitful discussions were held with J. Wm. Kerr, U. Mayr and, in particular, with R. Thorsteinsson, all of the Geological Survey of Canada, Calgary, regarding Silurian stratigraphy of the Somerset Island region. Thanks are due also to O. Dixon, University of Ottawa, and B. Jones, University of Calgary, both of whom freely discussed their stratigraphic studies of Somerset Island and with whom the writer had the pleasure to share camps at the locality discussed in this paper, and in other parts of Somerset Island. W.D. Stewart, student at the University of Calgary, ably assisted in the field.

Thanks are extended to G.R. Davies and U. Mayr, Geological Survey of Canada, Calgary, for critically reviewing the manuscript, and making helpful suggestions for improving it.

STRATIGRAPHIC SETTING

McMillan (1963) recognized three main units in some 335 m of nearly flat-lying strata in the vicinity of Port Leopold: 1) a lower unit (55 m thick) of thick-bedded, grey, dolomitic limestone with subordinate gypsum lenses averaging 30 cm in thickness; 2) a middle unit (76 m thick) of thick-bedded, grey limestone with minor amounts of chocolate-brown beds; 3) an upper unit (214 m thick), consisting of thin-bedded, ostracode-bearing, argillaceous, sandy, varicoloured yellow-grey to brown limestone, with interbeds of shale and calcareous sandstone. McMillan observed ripple marks, mudcracks, graded beds, and brecciation in this unit. He correlated these strata with part of the Upper Silurian Read Bay Formation on Cornwallis Island as described by Thorsteinsson and Fortier (1954) and Thorsteinsson (1958).

Norris (1963) also considered the strata at Elwin Bay to be correlative with the Read Bay Formation on Cornwallis Island. He recognized two members at Elwin Bay: 1) a lower evaporite member consisting of 21 m of interbedded anhydrite, gypsum and cherty-limestone; and 2) an upper limestone member (244 m thick) consisting of interbedded, medium regularly bedded limestone, thin irregularly bedded "stromatolitic" limestone, and thin, platy, silty limestone, all weathering medium to dark grey-brown. Norris also observed ripple marks, mudcracks, cross-laminae, and intraformational breccias in the upper limestone member.

Recently, Jones and Dixon (1975) examined in detail the strata at Port Leopold, and recognized two major lithological units (just as Norris, 1963, did at Elwin Bay): a lower evaporitic member comprising interbedded anhydrite and carbonate, about 30 m thick, and an upper carbonate member about 305 m thick. According to Jones and Dixon (1975), the upper carbonate member consists of interbedded dolostone, dolomitic limestone, sandy limestone and dolostone, with minor amounts of evaporite, and shelly, oncolitic limestone. Large

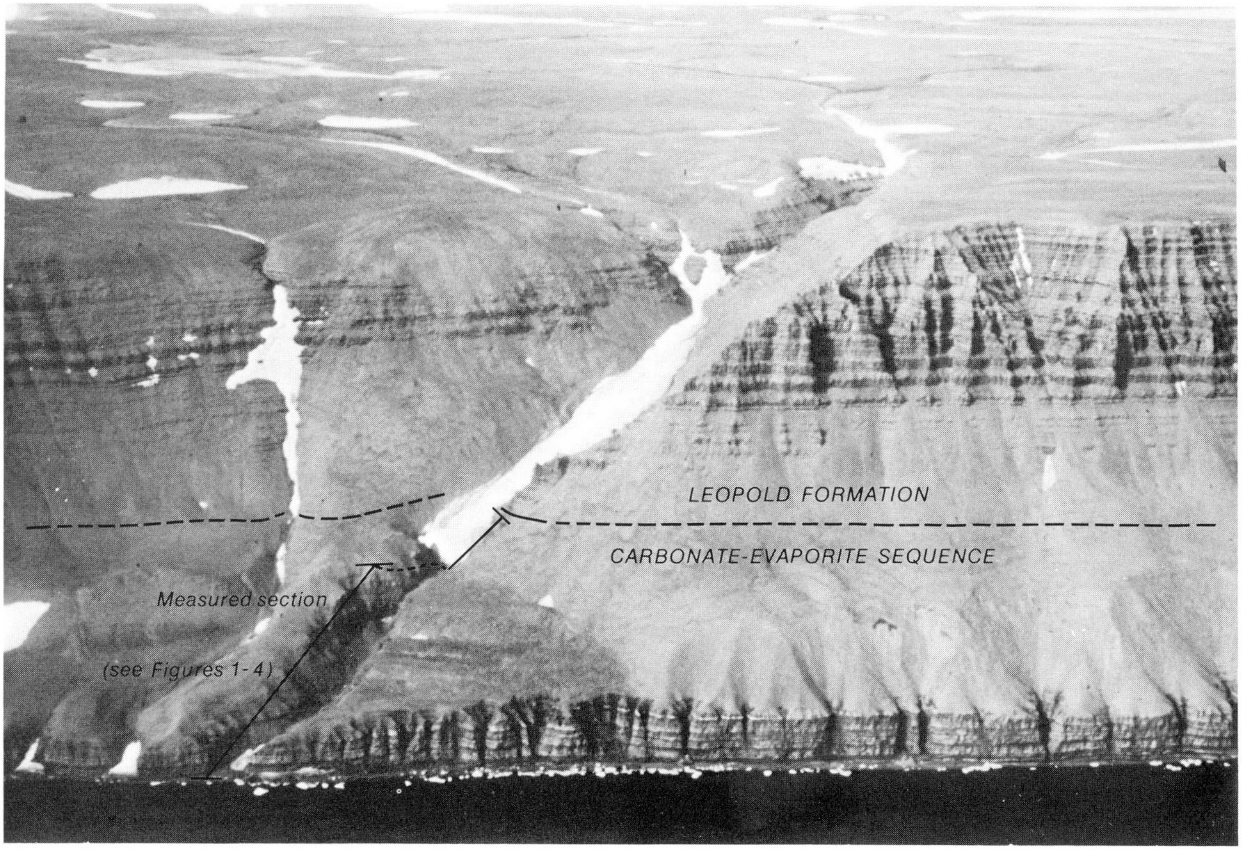


FIGURE 2. Coastal cliffs of eastern Somerset Island showing location of measured section. Contact between the Leopold Formation and underlying carbonate-evaporite sequence is indicated by dashed line. Top of cliff is more than 300 m above sea level (photo courtesy of Dr. B. Jones). GSC 199238

stromatolitic units are common in the upper member, as are eurypterids, ostracodes, gastropods and ostracoderms (Jones and Dixon, 1975). Intraformational conglomerate beds, current lineations and other depositional features, combined with the relatively restricted faunal assemblage, indicated to Jones and Dixon that these strata were deposited in a tidal-flat environment. The same authors considered these rocks to be different from those typical of the Read Bay Formation at its type locality on Cornwallis Island, and at other localities on the north coast of Somerset Island. Consequently, they designated the upper carbonate member as the Leopold Formation. The lower boundary of the Leopold Formation was drawn arbitrarily at the top of the uppermost continuous evaporite bed.

The contact between the Leopold Formation and the underlying unnamed evaporitic sequence can be traced continuously as far south as Batty Bay (Jones and Dixon, 1975). The underlying evaporitic sequence has been reported at Port Leopold (Jones and Dixon, 1975; McMillan, 1963), Elwin Bay (Norris, 1963), and Batty Bay (Blackadar, 1963), and the writer has followed this contact southward during aerial reconnaissance flights.

Jones and Dixon (1975) considered that contained vertebrate and invertebrate faunas indicate a Pridolian age for the Leopold Formation, although Reinson *et al.* (1976) imply that the Leopold may be of middle to late Ludlovian age and correlative with the upper Cape Storm Formation on the west side of Somerset Island. Jones and Dixon (1975) and Mayr (1975) correlate the underlying carbonate-evaporite sequence with the evaporitic upper Cape Crauford Formation of northwestern Baffin Island (Trettin, 1969). Mayr (in press) considers this carbonate-evaporite sequence to be correlative also with the lower member of the Cape Storm Formation on Devon Island and, therefore, of mid-Wenlockian or older age.

The carbonate-evaporite sequence, underlying the Leopold Formation, has a maximum exposure of 125 m in the coastal cliffs 18 km north of Elwin Bay. A stratigraphic section was measured in detail at this locality (Figs. 1, 2), and the cyclic nature of the sequence clearly is evident from the litholog (Fig. 4). The lower boundary of the sequence lies below sea level, and the upper boundary was placed at the top of the last continuous evaporite bed, which marks the base of the Leopold Formation (Figs. 5, 6).

The carbonate-evaporite sequence is exposed only in the vertical cliffs of northeastern Somerset Island. Because of this limited exposure, formational status for this sequence is not warranted, and it is correlated with the Middle Silurian Upper Cape Crauford Formation on Baffin Island (Trettin, 1969; Jones and Dixon, 1975; Mayr, 1975, in press).

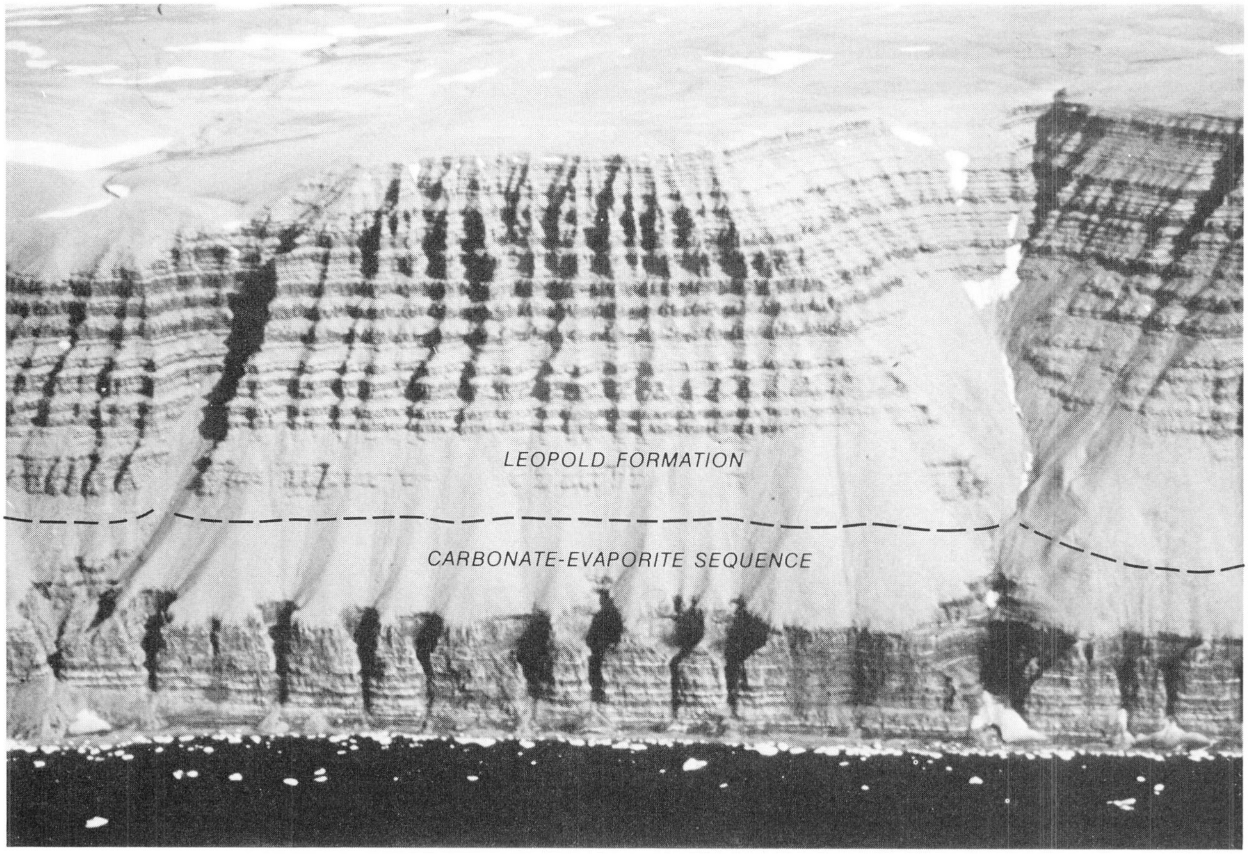


FIGURE 3. Coastal cliffs of eastern Somerset Island between Port Leopold and the measured section locality (photo courtesy of Dr. B. Jones). GSC 199239

CARBONATE-EVAPORITE CYCLES

The lagoonal-sabkha model for carbonate-evaporite deposition has developed from the study of the Recent shoreline sediments on the Trucial Coast, Persian Gulf, by Shearman (1963, 1966), Evans (1966), Evans *et al.* (1969), Kinsman (1966), Butler (1969), and others. A bibliography of these studies is given in Purser (1973). Some ancient carbonate-evaporite cyclic sequences, which have been interpreted as repetitive lagoonal-sabkha cycles, are described by Macqueen and Price (1967), Wood and Wolfe (1969), Bosellini and Hardie (1973), and Mossop (1973).

Twenty-three carbonate-evaporite cycles were recognized in the section measured in this study (Fig. 4). Each cycle represents deposition during progradation of a lagoonal-sabkha shoreline. The generalized cycle is presented in Figure 7. The lithofacies that make up the generalized cycle are not present necessarily in each cycle. In some, the lagoonal or subtidal lithofacies is poorly represented or absent, and in others the supratidal lithofacies is poorly represented or absent. In fact, the section measured contains essentially intertidal-supratidal cycles in the lower and upper parts, and lagoonal-intertidal cycles in the middle part. Where the lagoonal or subtidal facies of the cycles is absent, the carbonate is predominantly dolomite, but where subtidal rocks are present in the cycle, calcitic carbonate is more prevalent. Contacts between individual cycles are sharp and concordant (Fig. 8), though many display evidence of erosive or depositional breaks.

Various rock types of the three lithofacies are described in the following sections using the carbonate classification of Dunham (1962).

SUBTIDAL OR LAGOONAL LITHOFACIES

Three rock types make up the subtidal-lagoonal lithofacies. These are: pelletoidal wackestone, finely laminated mudstone, and massive to laminated mudstone.

Pelletoidal wackestones are, for the most part, dark brown and colour banded or colour mottled with light buff-grey (Fig. 9). Stylolites, ostracodes and thin-shelled brachiopods are common features of this rock type. These pellet wackestones probably represent deposition under quiet, lagoonal conditions.

Finely laminated, light grey mudstones are characterized by distinct laminae marked by thin partings of clay and organic material (Fig. 10). Although planar laminations prevail, ripple marks, micro-cross-laminae, wavy laminae, and disrupted laminae are common. Quartz silt occurs in some laminae, along with disseminated carbonaceous grains. This rock type is considered to represent deposition in the high subtidal to low intertidal zone.

Massive to laminated mudstones are variably structureless to laminated; when laminated, the laminations are much thicker than those of the finely laminated mudstones (Fig. 11). They are characterized by buff-grey, earthy appearance, vugular porosity, and the frequent presence of

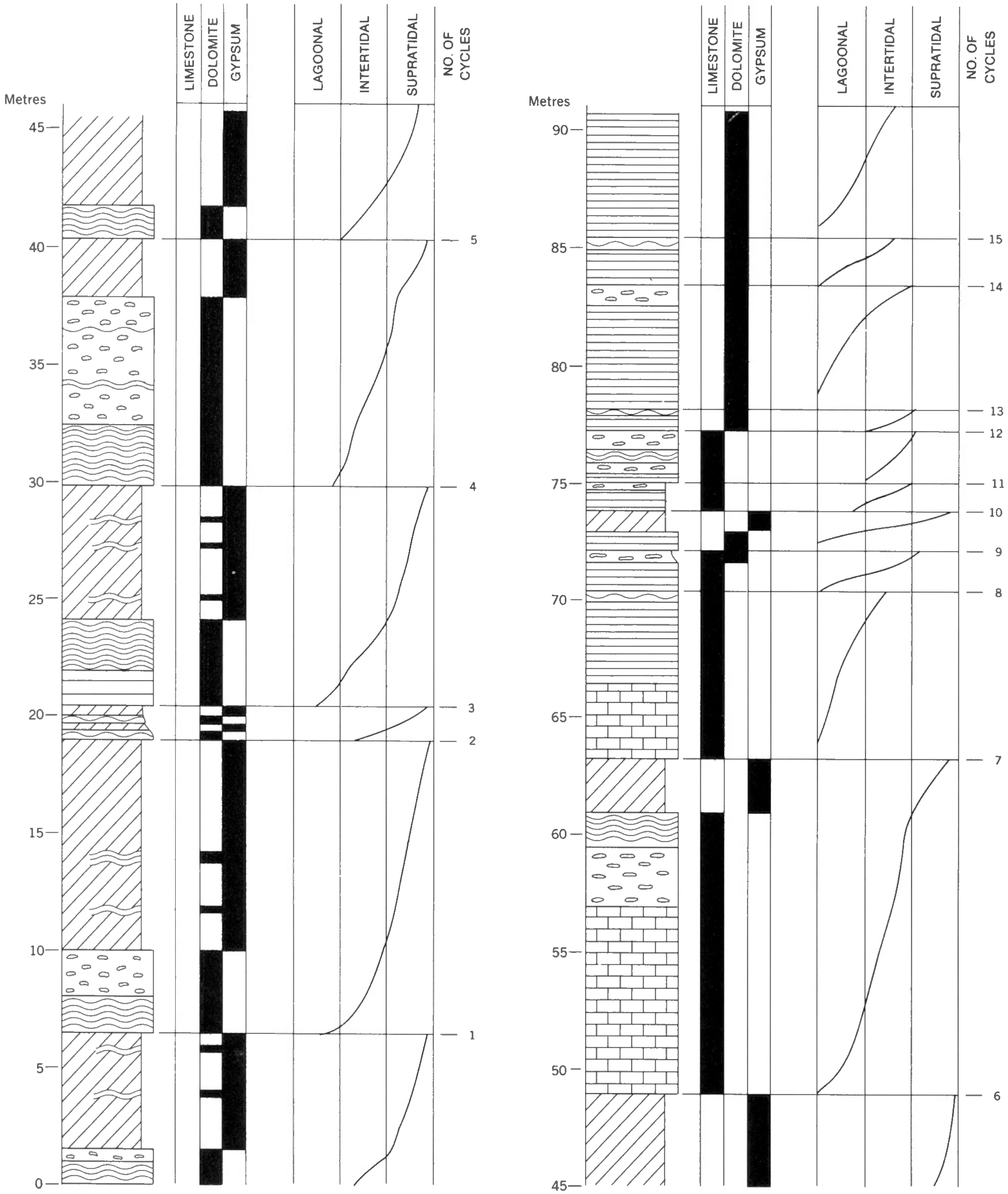
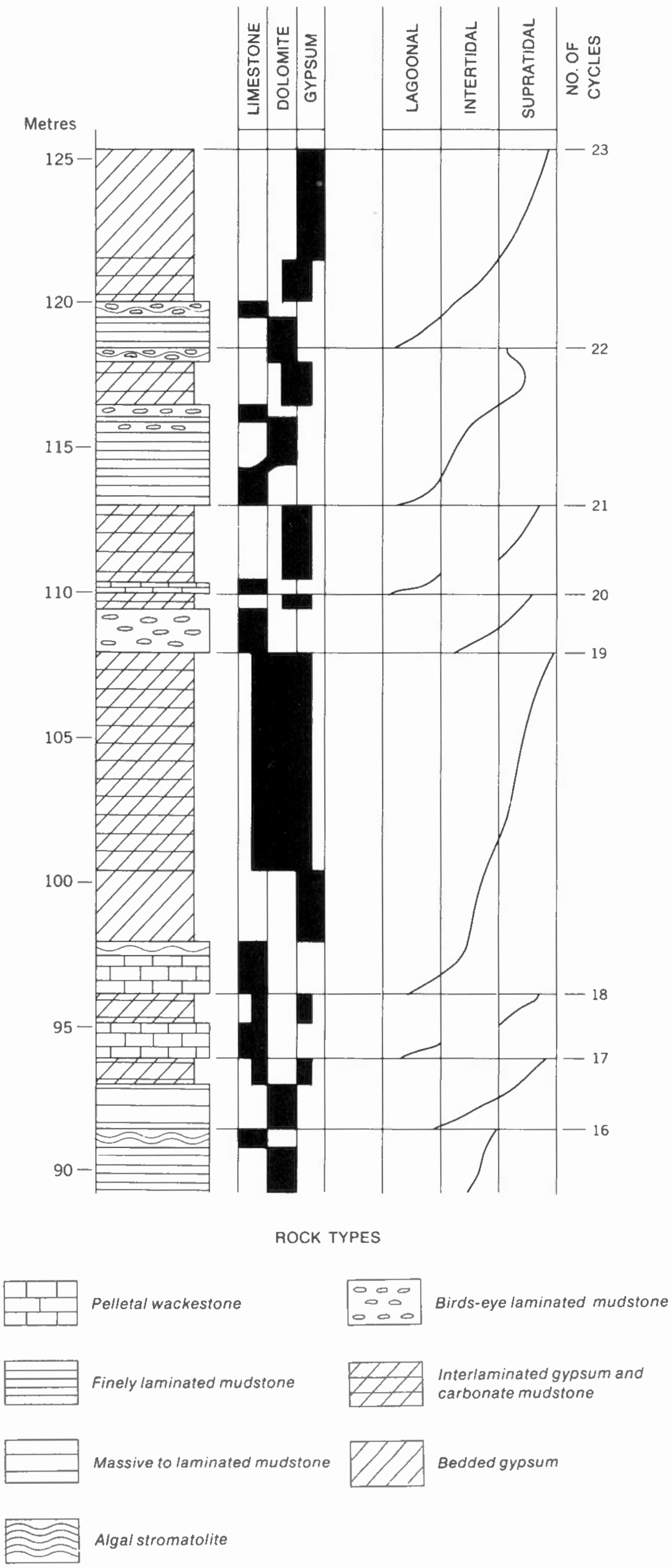


FIGURE 4. Detailed litholog of measured section, showing cyclicity of the carbonate-evaporite succession, the distribution of dolomite and limestone in the section, and an environmental interpretation of each rock-unit

FIGURE 4. Continued



contorted laminae. These soft-sediment deformation fabrics usually occur in the upper parts of units of this rock type and are marked by partings rich in carbonaceous material. Quartz silt is rare. These rocks probably indicate deposition in the shallow subtidal environment.

The three rock-types of this lithofacies grade into one another where two or more of them are present. The pellet wackestones are considered to be the basal rock-type of the subtidal cycle, and strictly sublittoral, whereas the other two rock-types may record periods of deposition near or across the subtidal-intertidal boundary.

INTERTIDAL LITHOFACIES

Rocks interpreted as algal stromatolite constitute this lithofacies. They are dense, dark brown mudstone with internal laminar structures marked by an organic residuum. Two external stromatolite forms were observed; digitate stromatolites and cryptalgalaminite (Figs. 12, 13). Digitate stromatolites, according to Logan *et al.* (1964) and Aitken (1967), form in the low intertidal zone. "Cryptalgalaminite" is the term proposed by Aitken (1967) for planar-laminated carbonates bearing evidence of algal mat activity. These rocks are considered to be of intertidal origin and analogous to the intertidal algal-mat laminite of the Trucial Coast, Persian Gulf (Shearman, 1966). Gypsum crystals and crystal casts are common in cryptalgal laminite of this lithofacies (Fig. 13), as are laminated fenestral fabrics and birds-eye structure porosity.

This lithofacies displays evidence of desiccation in some places, especially in the cycles that are truncated, and rip-up clasts occur in the basal parts of succeeding cycles (Fig. 14).

SUPRATIDAL LITHOFACIES

The supratidal lithofacies is characterized by birds-eye laminated mudstone, interlaminated gypsum and carbonate mudstone, and by bedded gypsum with rare wispy laminations and very thin beds of micritic carbonate.

Birds-eye laminated mudstones overlie algal stromatolite and are interpreted to be of high intertidal to supratidal origin. There is generally a gradational contact between algal stromatolite and birds-eye laminated mudstone, indicating that both subaerial drying of high tidal algal mats and shrinkage and gas escape from supratidal muds may have caused the birds-eye features (Fig. 15). In some units, the birds-eye structures are filled with carbonate mud or gypsum but, in others, vugular porosity, which is a function of the birds-eye structures, is a common occurrence. Shinn (1968) considers that birds-eye structures and associated porosity are indicative of supratidal and, in some places, intertidal sediments.

In the rock units characterized by evaporitic minerals, gypsum is dominant. It is entirely secondary, and considered to be the hydrated form of pre-existing anhydrite. Because of this intense hydration, it is suggested that nodular structures

FIGURE 5. Base of carbonate-evaporite sequence at section locality. Vertical part of cliff is about 12 m high. GSC 199236

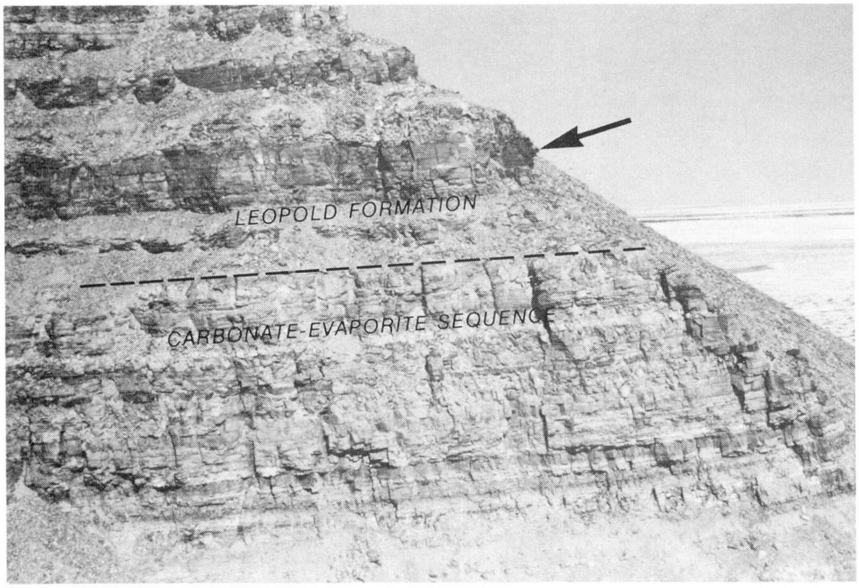


FIGURE 6. Contact between the carbonate-evaporite sequence (light colour) and overlying Leopold Formation (dark colour). Thick resistant unit (arrow) in Leopold Formation is about 5 m thick. GSC 19935

typical of sabkha deposits may have been obliterated. Alabastrine gypsum, which is considered to be a late diagenetic weathering product (Holliday, 1970), is the dominant type of gypsum (Figs. 16, 17). Porphyroblastic gypsum also occurs, with included traces of relict anhydrite. This type is probably a secondary product of anhydrite that formed at an early diagenetic stage. Fibrous gypsum satin-spar veins, which are considered to be by-products of gypsum-anhydrite volume-for-volume replacements (Holliday, 1970), are a third form of the mineral observed in these rocks (Figs. 16, 17).

The carbonate beds, which occur in subordinate amounts in the bedded gypsum rock units, may be algal laminites (Fig. 18). Close examination reveals that they are laminated distinctly, the laminations being marked by organic films. These carbonate layers are predominantly dolomitic and, in places, display evidence of layered enterolithic structures, such as those that occur in the sabkha sediments of the Trucial Coast, Persian Gulf (Shearman, 1966; Shearman and Fuller, 1969). It is suggested that early dolomitization of enterolithic anhydrite has occurred, preserving these original early diagenetic evaporitic structures which are so characteristic of the supratidal facies in the Recent sabkha setting of the Trucial Coast. Chert nodules are present scattered throughout the rocks of this lithofacies.

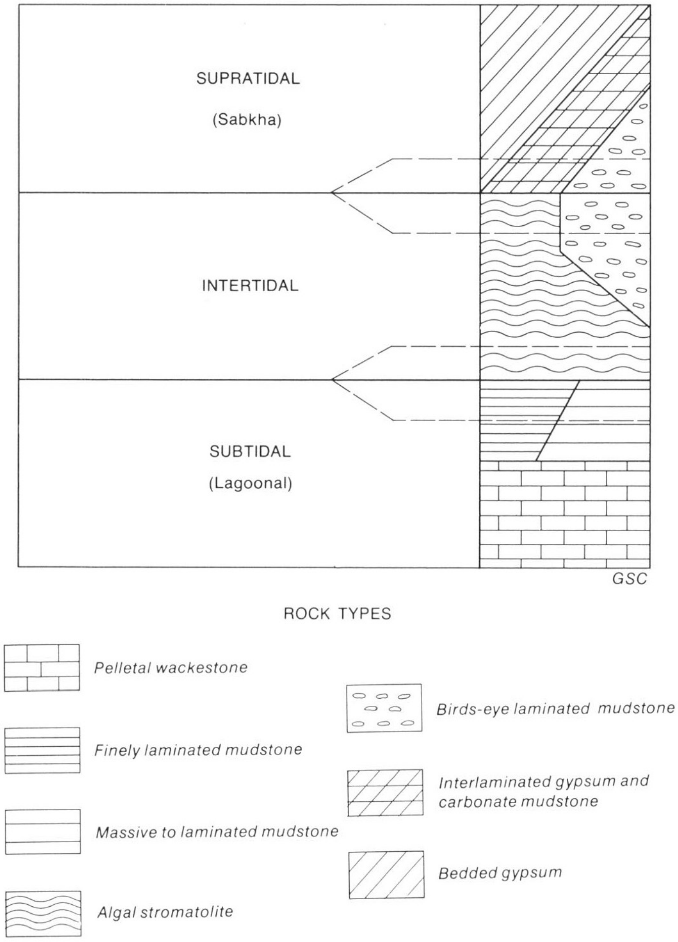


FIGURE 7. Generalized model of the lagoonal-Sabkha cycle in the Silurian carbonate-evaporite sequence of Somerset Island. Dashed lines indicate that some of the rock types may represent transitional sequences between major lithofacies.

DISCUSSION

Studies of modern environments have shown that saline supratidal-tidal flats are progradational, and that sediment accumulation in a sabkha cycle occurs during the regressive and stable phases. With this framework in mind, the Silurian carbonate-evaporite sequence discussed in this paper is considered to represent a series of lagoonal-sabkha cycles. The main drawbacks to justifying such a model are: the relatively thin sequence of the modern sabkha cycle of the Trucial Coast [60 cm intertidal algal mat, 60 cm supratidal evaporite, Shearman (1966)], compared with some of the thick cycles in the Silurian sequence (in particular the thick carbonate and evaporite units); the preponderance of sediment accumulation during the regressive phase; and the apparent absence of sediment accumulation during the transgressive phase.

According to Mossop (1973), steady and uninterrupted subsidence could lead to the generation of stacked rhythmic sabkha cycles. He argues that, at the start of the regressive cycle, deposition is rapid and, as the sabkha front progrades seaward, sediment accretion rate decreases relative to subsidence rate, to the point where progradation cannot keep up with continuing subsidence. At this point, the flat sabkha surface will be inundated rapidly, and a new prograding cycle will be initiated.

Mossop (1973) further considers that fluctuations in subsidence are responsible for the thickened carbonate and anhydrite units in the Ordovician Baumann Fiord Formation of Ellesmere Island. He contends that thick carbonate units may represent more than one subtidal sequence, or rather two or more incomplete cycles composed of stacked subtidal lithofacies. This could come about by increased subsidence rate before the sabkha surface could prograde over the lagoonal sediments. To account for thick intertidal stromatolite accumulations, accretion would have to be balanced exactly by regional subsidence.

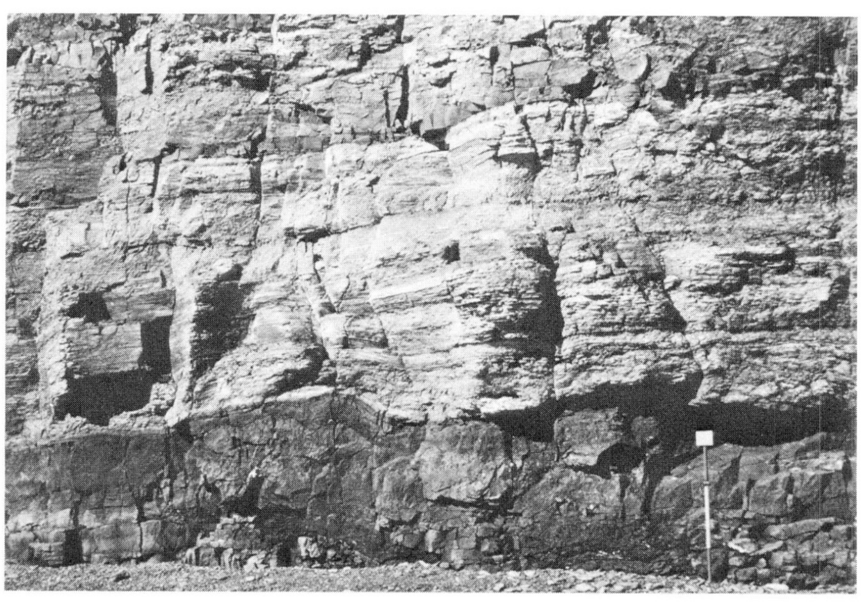


FIGURE 8. Basal units of the measured section, showing the sharp contact between the lowest carbonate unit and the overlying gypsum unit. (Pogo stick is 1.5 m). GSC 199237

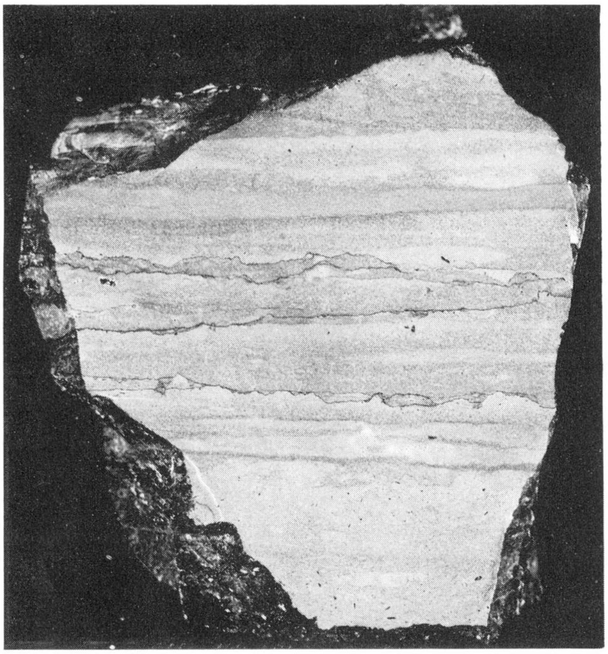


FIGURE 9. Pelletoidal wackestone, dark brown, colour-banded with light greyish buff. Note numerous stylolites. Subtidal lithofacies (Bar scale is 2 cm)

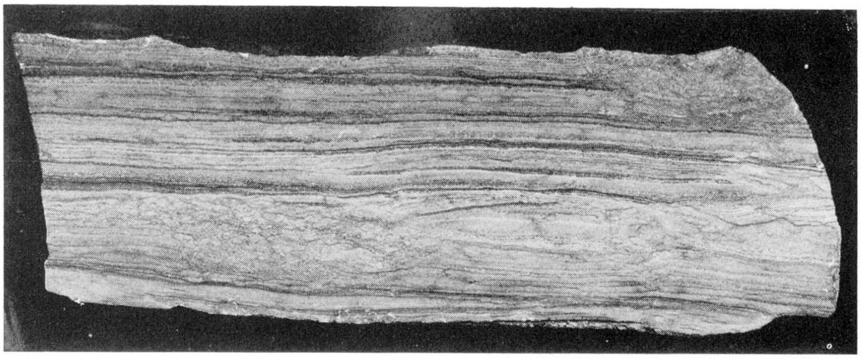


FIGURE 10. Light grey, finely laminated mudstone of the subtidal facies. Note wavy and disrupted laminae in lower part of specimen. (Bar scale is 2 cm)

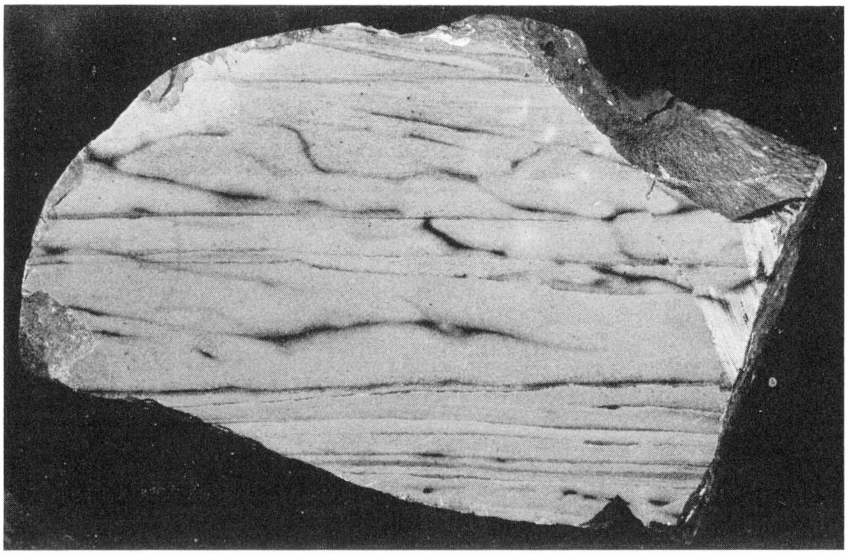


FIGURE 11. Buff-grey, earthy, massive to laminated mudstone of the subtidal lithofacies. Note contorted layers marked by black carbonaceous residuum. (Bar scale is 2 cm)

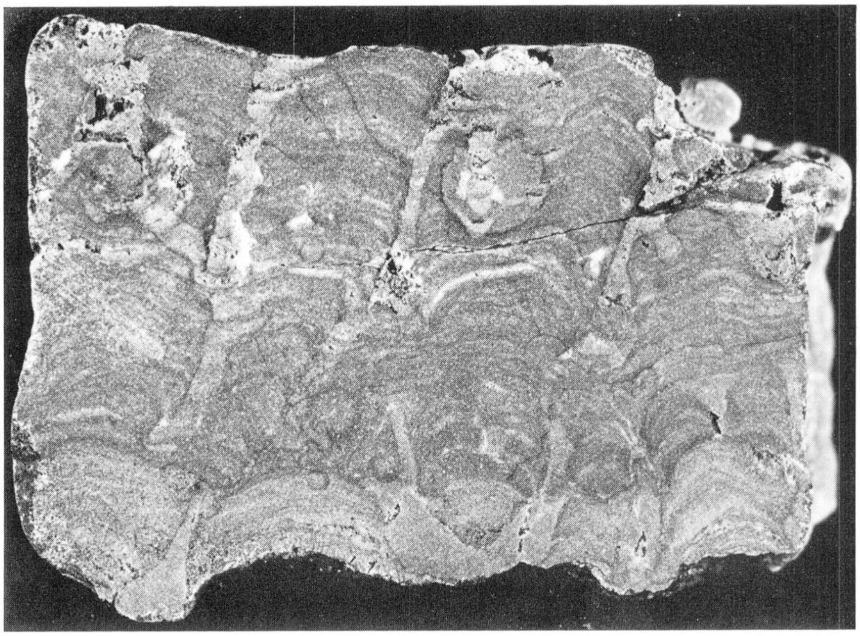


FIGURE 12. Digitate stromatolites of the intertidal lithofacies. (Bar scale is 2 cm)

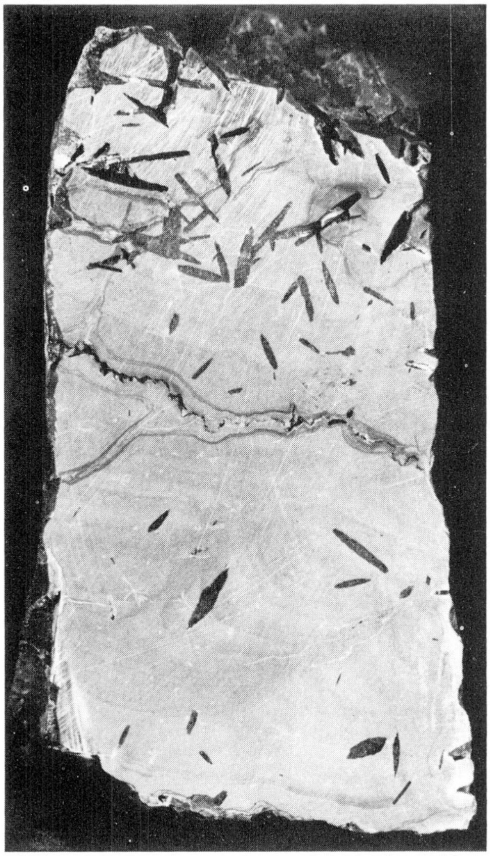


FIGURE 13. Algal laminite of the intertidal lithofacies. Note the crystallotopic gypsum crystals and crystal casts in the upper part of the specimen. (Bar scale is 2 cm)

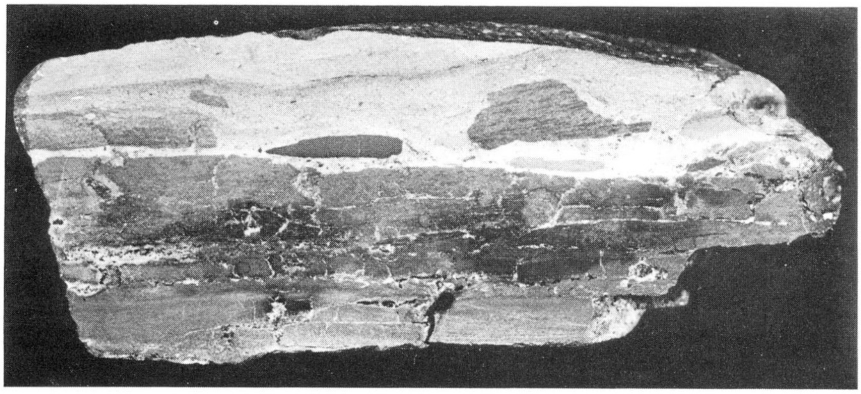


FIGURE 14. Contact between algal laminite and overlying finely laminated, silty mudstone. Note the laminite clasts of the intertidal unit incorporated in the basal part of the overlying subtidal unit. (Bar scale is 2 cm)

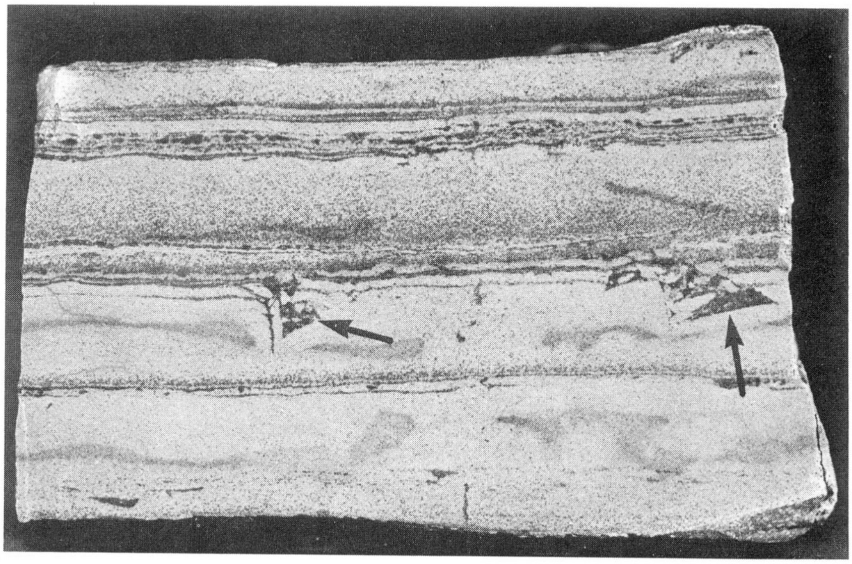


FIGURE 15. Birds-eye laminated mudstone of the supratidal lithofacies. Note the faint birds-eye structures in the lower two layers, and the pin-point pores in the upper half of the specimen. The two angular breccia-filled structures (arrows) are suggestive of halite-crystal casts. (Bar scale is 1 cm)

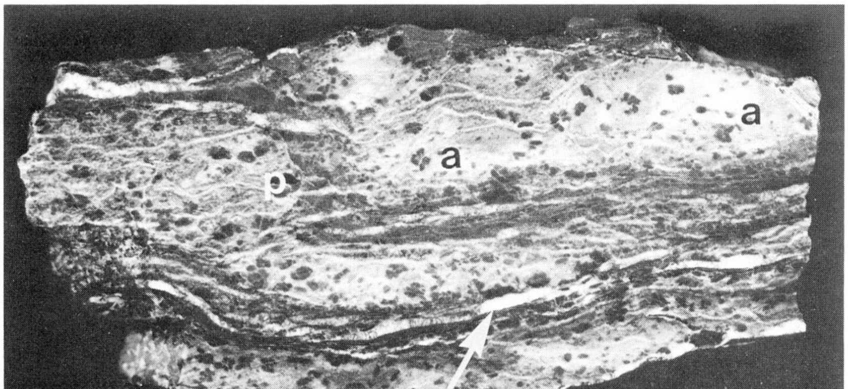


FIGURE 16. Specimen of gypsum rock from an evaporite unit. Alabastrine gypsum (a) forms part of the rock, but abundant porphyroblastic gypsum (p) is present also. The arrow points to a gypsum satin-spar vein. (Bar scale is 2 cm)

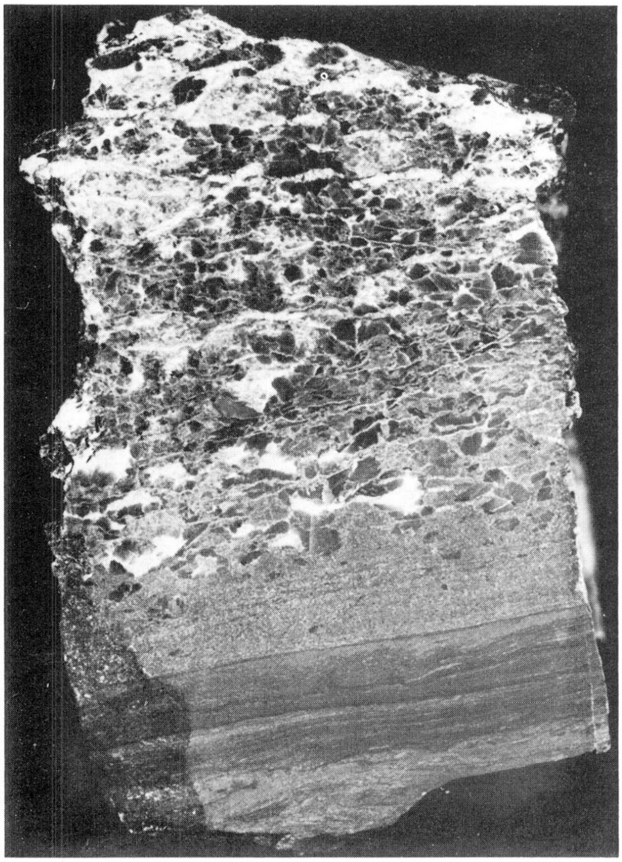


FIGURE 17. Abundant porphyroblastic gypsum with an increasing amount of alabastrine gypsum in the upper part of the specimen, along with some satin-spar veins. Note the gradational contact between porphyroblastic gypsum and the underlying laminated dolomite (algal laminite?). (Bar scale is 1 cm)

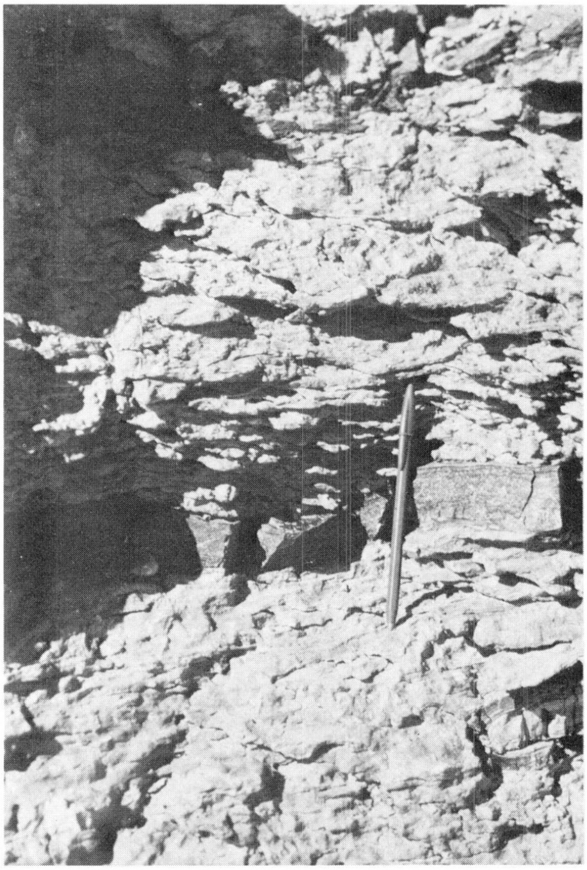


FIGURE 18. Thin (algal-laminated?) dolomite bed in extremely weathered alabastrine gypsum unit. GSC 199234

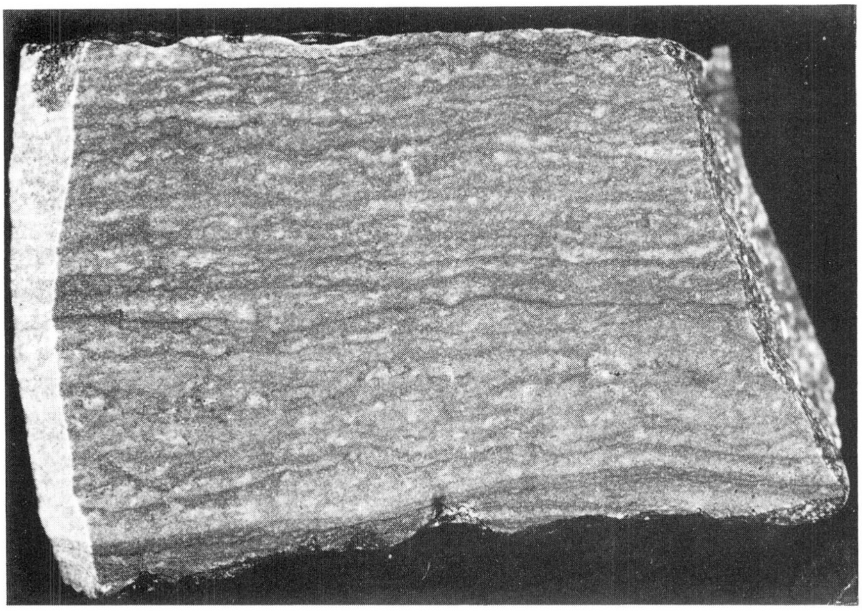


FIGURE 19. Rock specimen from one of the thin dolomite beds illustrated in Figure 18. Note the dark, wavy laminations and the faint, light-coloured, contorted laminae suggestive of enterolithic-type layering. (Bar scale is 1 cm)

In the Silurian section studied, the lack of evaporitic facies in the middle of the section (Fig. 4) may indicate that, locally, subsidence increased for a time. The prograding sabkha cycles never reached completion because the progradational front was inundated repeatedly before evaporite accumulation could occur.

The thicker gypsum units in the Silurian sequence (Fig. 4) could be attributed to local or temporal decrease in subsidence rate (if the opposite mechanism accounts for thick composite carbonate units). The thick gypsum sequences could represent composite cycles composed of stacked supratidal evaporitic lithofacies. Further evidence for such an interpretation is indicated by the presence of thin algal laminite units (attenuated intertidal lithofacies) in some of the thick, bedded gypsum units (Fig. 18). Another explanation for the thickened gypsum units may be the diagenetic, vertical jacking mechanism (increasing thickness of evaporite due to hydration) proposed by Mossop (1973).

In the modern sabkha cycle of the Trucial Coast, the prograding algal mat front is succeeded by supratidal carbonate accumulation. A series of diagenetic fronts follow which include the dolomitization front, succeeded by the displacive anhydrite-growth front, which is largely responsible for the evaporitic lithofacies of the typical sabkha cycle (Mossop, 1973).

It is notable in the Silurian sequence illustrated here (Fig. 4) that, in the cycles where thick gypsum units or any rock-type of the supratidal facies occurs, the carbonate is usually dolomite but, where gypsum units and birds-eye laminites are thin or absent and subtidal rocks are present, limestone is the predominant carbonate. The decrease of dolomitic carbonate in a large part of the section where evaporites are thin or absent would seem to substantiate an increased subsidence rate during deposition of these evaporite-free sediments, thereby suppressing the formation of dolomite, and of complete sabkha cycles.

The stratigraphic succession of northeastern Somerset Island, from the basal carbonate-evaporite sequence through the Leopold Formation (Jones and Dixon, 1975) to the overlying Read Bay Formation (Reinson *et al.*, 1976) is a sequence representative of deposition in a shoreline-shelf environment which, on a regional scale, was continually subsiding. The basal carbonate-evaporite cycles represent deposition along the shoreline of a shallow restricted shelf sea, under arid and hypersaline conditions. The lithological sequence of the overlying Leopold Formation (Jones and Dixon, 1975) indicates that the nearshore depositional environment became influenced by more open marine conditions during Leopold time than during the preceding evaporitic depositional episode. The environment was still arid and somewhat restricted, but tidal and wave-energy conditions were sufficiently strong to provide a significant amount of littoral clastics to the carbonate strandline deposits, and to allow for the growth of large columnar stromatolites. Both of these sedimentological features are common components in the lithological sequence of the Leopold Formation. Further subsidence led to the deposition of marine carbonate sediments of the Read Bay Formation. The environment was now shallow, open marine, and completely subtidal. This is indicated by the presence of numerous brachiopods, and corals, and the general lack of clastics, evaporites, and stromatolites in the Read Bay lithological succession.

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