THE WHITEPORT DOLOSTONE OF THE LATE SILURIAN RONDOUT GROUP, VICINITY OF KINGSTON, ULSTER COUNTY, NEW YORK

Brian V. Fetterhoff
Department of Geological Sciences
State University of New York
College at New Paltz
New Paltz, New York 12561

Introduction

The term Whiteport was proposed by Rickard (1962) for a dolostone referred to by Hartnagel (1903) as the 'Rondout' in a rather restricted sense. Rickard suggested "that the name Rondout be applied to the dolomite strata subjacent to the Manlius everywhere in New York" (p. 30). Thus, according to Rickard, in the Rondout Formation the Whiteport is the uppermost of three members (Whiteport, Glasco, Rosendale), with a type section near Whiteport, New York.

Harper (1969) described the Whiteport as a "buff-weathering, light-gray to blue-gray on fresh, argillaceous silty dololutite. It is mudcracked, finely laminated, commonly burrowed, and very rarely fossiliferous" (p. 14). Harper's environmental interpretation is that of a mudflat facies.

Harper acknowledged that lime interbeds do exist within the Whiteport in the vicinity of Kingston:

> "One prominent interbed has been termed the "Twalfskill Bed" (Wanless, 1921; Van Ingen, local unpublished field term). Its thickness averages about one foot, and it is found to occur in the majority of sections in the Rosendale quadrangle... In this blue weathering, dolomitic limestone the fossils are commonly algal-coated, a fact which prompted Wanless to describe it as the "Algal Reef Limestone" (p. 14-15).

An additional limestone was recognized by Harper in the base of the Whiteport; a "two-foot interval of interbedded ostracod-rich calcarenites, calcilutites and calcareous silty dolomites" (p. 119).

Waines and Gomez (1977) divided the Whiteport (from Accord to Kingston) into five recognizable units (from top to bottom): Unit one, an argillaceous shaly dolostone (found south of Kingston); unit two, a massive weathering dolostone (unit one of this paper); unit three which can be subdivided into an upper, laminated portion and a lower, organic "reef" (unit two here); unit four, a massive dolostone (unit three here), and unit five, a somewhat fossiliferous lime unit (unit four here). This unit, which was often placed in the top of the Glasco, is actually a separate unit in the base of the Whiteport.

It is the presence of these limestone units which appear in the vicinity of Kingston that allows additional interpretations of environments and, due to their fossiliferous nature, a determination of age.

Stratigraphy and Environment of Deposition

In the Kingston area, four units of the Whiteport Dolostone have been recognized. See Figure 1 for sections.

Unit One

This unit is a buff-weathering, unfossiliferous laminated dolostone. It is occasionally burrowed, frequently and deeply mudcracked at the top where it is in apparent conformity with strata (limestone and shale) of the overlying Thacher limestone. The contact is drawn at the uppermost mudcrack (if present) or the first limestone or shales of the Thacher. The contact with unit two below is sharp, conformable to disconformable, and frequently limestone intraclasts of unit two can be noted within the lowermost strata of unit one. In East Kingston, where unit two pinches out, unit one rests disconformably upon unit three. Thicknesses of unit one range from over two feet (.61 m) in the Fly Mountain-Wilbur area, to one foot (.30 m) in the Kingston area.

Insoluble residues of unit one range from 25-30 percent. Unit one most probably formed within a shallow intertidal to supratidal environment.

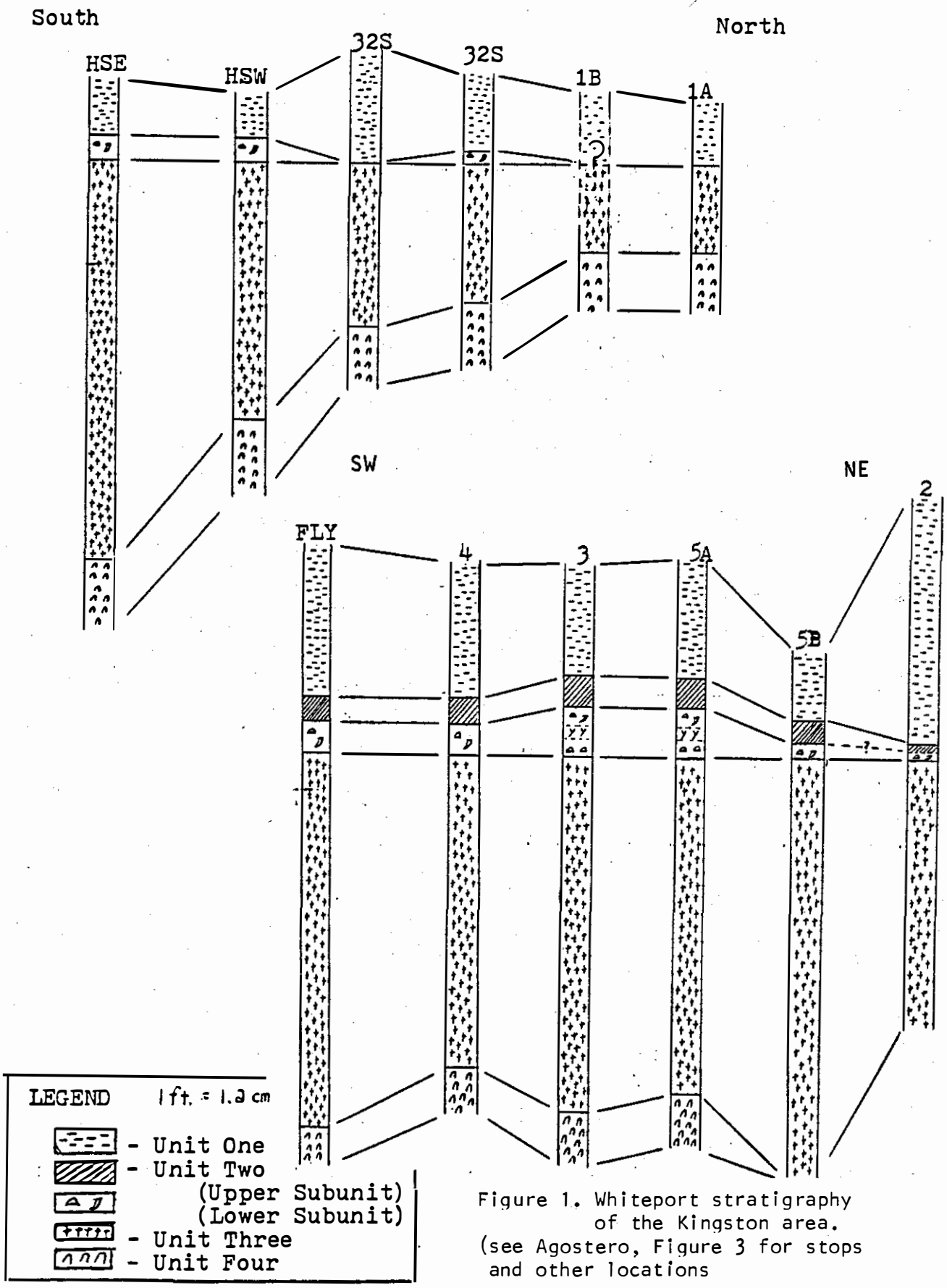


Figure 1. Whiteport stratigraphy of the Kingston area. (see Agostero, Figure 3 for stops and other locations

Unit Two

Unit two is a blue-gray weathering limestone, which may be subdivided into an upper, laminated calcilutite, and a lower organic 'reef' to 'offreef' unit (calcarenite to calcirudite), which contains a varied faunal assemblage.

The upper subunit is distinctly laminated, is not fossiliferous, and is frequently mudcracked with apparent intrusion of dolomitic muds from the unit above. This situation is similar to the mudcracks within unit one above, which are frequently filled with shale. Many of the laminated layers show evidence of being "ripped-up" (brecciation).

The lower subunit contains scattered fossils, which are notably abundant at Wilbur, and are recognizable in three distinct zones: 1) a basal stromatoporoid unit, 2) a solitary rugosa-tabulate-bryozoan unit, 3) and an upper stromatoporoid-solitary rugosa unit. At the western end of Callanan's quarry, at the base of this subunit, there is a quartz silt calcarenite unit, two to three inches (5-7 cm) thick. This thin unit is not fossiliferous and contains angular limestone fragments.

The upper subunit is disconformable on the lower subunit, and the entire unit is distinctly disconformable on unit three. It is possible that much of the lower subunit is missing, either as a result of erosion at the time of deposition, or by solutioning of limestone along the disconformity.

Thicknesses of unit two range from zero to one and a half feet (.46 m) through the Kingston area. In East Kingston, the unit pinches in and out. Where it is present, it averages four inches (10.2 cm) in thickness, and the upper subunit is generally eroded away, leaving a lower subunit with brachiopods, solitary rugose corals, and rare, hemispherical stromatoporoids. At Wilbur, the unit averages one and a half feet (.46 m), with each subunit six to eight inches (15.2 - 20.3 cm). At Fly Mountain the unit thins to one foot (.30 m), with each subunit half a foot (15.2 cm) in thickness. South of Fly Mountain unit two becomes dolomitized (late phase diagenesis?), although each subunit is retained. The lower subunit contains fossil 'ghosts'.

The upper subunit represents a relatively low (6-8 percent) insoluble residue, compared to the lower subunit (10-15 percent) or to unit one above. Although this subunit is limestone, it is in lack of fossils and has similar sedimentary structures to units one and three. It is likely that this calcilutite is intertidal to supratidal, representing similar conditions to the dolostone units, but lacking the requisite insolubles to enhance and early stage of diagenesis.

The lower subunit represents a return to subtidal conditions, and 'reef' to 'offreef' conditions. 'Offreef' conditions exist north and south of Wilbur, where fossils are less abundant and there are greater percentages of brachiopods. 'Reef' waters were well-circulated, relatively shallow and allowed a varied faunal assemblage.

Upper Stromatoporoid - Solitary Rugosa Zone

The hemispherical stromatoporoids are common in this zone, as are solitary rugose corals, while laminar stromatoporoids are not present. This suggests conditions involving relatively high water turbulence with moderate accumulation of fossil material.

Solitary Rugosa - Branching Tabulate Coral - Bryozoan Thickets

This most fossiliferous portion developed on a solid substrate and gentle water currents allowed the more delicate, branching forms of tabulates and bryozoans to develop. Laminar stromatoporoids are present in this zone in greater numbers than below, and there is a decrease in the percentage of hemispherical forms.

Basal Stromatoporoid Zone

This zone contains abundant hemispherical stromatoporoids (many in apparent growth position), rare (poorly developed) laminar stromatoporoids, and occasional solitary rugose corals. Turbulence was moderate, as was the accumulation of fossils.

Unit Three

This unit is a buff, massive-weathering dolostone (dolisiltite), occasionally laminated, occasionally burrowed, and rarely mudcracked. The contact with unit four is gradational, and is drawn at the initial fossils within the underlying unit. A major parting occuring toward the center of the unit is present throughout the Kingston area.

The thickness, ranging from four to seven feet (1.2 - 2.1 m), tends to decrease toward the north, and thicken to the south and east.

Mudcracks, burrowing, leaching, and the disconformity at the top of the unit suggest subaerial exposure indicative of the intertidal to supratidal zone. Unit three is similar in most aspects to unit one. Compared to unit two, unit three represents an increase in insolubles (25-30 percent in this unit).

Unit Four

At the base of the Whiteport, first appearing at Bloomington and extending northeast through Kingston is a dolomitic-calcarenitic limestone that exhibits cross-stratification, occasional ripple marks, intraclasts, and is variably fossiliferous sometimes containing lag deposits with ostracods, solitary rugose corals, and brachiopods. The contact with the underlying Glasco limestone is distinctly disconformable (the top of the Glasco is marked by a thin, black shale).

The thickness of unit four ranges from half a foot (15.2 cm) in the Bloomington-Fly Mountain area, to over a foot (30.5 cm) in the East Kingston area. At Wilbur, the unit becomes dolomitic, with limestone lenses. At the east end of Callanan's quarry the unit becomes entirely dolomitic, unfossiliferous, and is unrecognizable in the base of the Whiteport.

This unit exhibits features attributable to the shallow intertidal to supratidal zone. Ripple marks, cross-stratification, intraformational conglomerates as well as a high percentage of worn and fragmented shells suggest a relatively moderate energy environment. The ostracod shells are disarticulated, and concave down, indicative of the intertidal environment. Many of the brachiopod valves are concentrated in distinct horizons, suggesting storm activity.

The unit becomes very dolomitic around Wilbur, and the faunal assemblage becomes more diversified (now includes solitary rugose corals and hemispherical stromatoporoids). It is at these localities that cross-stratification and intraclasts can be noted. The percent of insoluble residues increases from 15-20 near Bloomington to around 25 near Wilbur.

Paleontology

The Whiteport has generally been considered unfossiliferous, and therefore, few paleontologic studies have been conducted on the formation. Wanless (1921, p. 258) noted 'stromatoporoid corals' and one species of brachiopod (Shuchertella woolworthana) within unit two. Grosvenor (1965) and Hoar and Bowen (1967) studied the brachiopoda of the Rondout Group, giving the most complete faunal listing to date. Within the Whiteport, Hoar noted "cup corals" and ostracods (presumably referring to unit four).

The limestone interbeds in the vicinity of Kingston, however, show a varied faunal assemblage. In unit four, are brachiopods, solitary rugosa, rare, small 'spheroidal' stromatopo-

roids, and numerous disarticulated ostracod shells which Harper (1969) reported as 'algal-coated'. Thin sections have revealed trilobite, tabulate, bryozoan, and pelmatozoan fragments. These fragments suggest a high degree of transport and/or reworking.

The lower portion of unit two contains hemispherical stromatoporoids (common), laminar stromatoporoids (rare), solitary rugosa, favositid and halysitid corals (rare), tabulate corals/bryozoans, brachiopods, pelmatozoan fragments, and trilobite debris. In the field many of the fossils appear algal-coated, which led Wanless to call this unit the "algal-reef" unit.

Four species of stromatoporoids representing three genera have been identified from unit two. These include Stictostroma pseudoconvictum (Stock), Parallelostroma constellatum (Hall), P. kaugatomicum (Riabinin), and Densastroma pexisum (Yavorsky). These species have been reported by Stock (1979) from the Glasco Limestone Member of the Rondout Formation and the Coble-skill Limestone in upstate New York. Only P. kaugatomicum and D. pexisum have been reported from the Upper Keyser (early Devonian) (Stock and Holmes, 1986).

Many of the stromatoporoid coenostea of unit two are in growth position, but some have been tumbled on their sides, and some are upside down.

The presence of halysitid corals has been reported by Adumkin (1976), Waines and Gomez (1977), Fetterhoff (1986), and Fetterhoff and Waines (1987).

Age

The Siluro-Devonian boundary in southeastern New York has been placed within the Rondout Formation (Fisher, 1960) and, more specifically, at the top of the Glasco Limestone Member (Rickard, 1962). This location is due to the presence of the 'chain' coral Cystihalysites, which is not thought to occur in the Devonian. According to Berry and Boucot (1971, p. 215) "the thin Glasco limestone in its median part contains Halysites. On this basis, the lower half of the Rondout Formation is assigned to the Late Pridoli and the upper, post-Halysites beds to the Devonian".

Recently, the placement of this boundary had come into question with discovery of halysitids within the Whiteport Dolostone. A halysitid 'ghost' was first noted by Adumkin (1976), and reported in unit two of Waines and Gomez (1977). Fetterhoff (1986) and Fetterhoff and Waines (1987) reported an unaltered halysitid from unit two.

Three genera representing four species of stromatoporoids have been identified from unit two. Each of these species has been reported from the Glasco limestone (Stock, 1979), and two of these as well from the Early Devonian Upper Keyser (Stock and Holmes 1986). However, Parallelostroma baretti (Girty), an upper Keyser form also occuring in early Devonian Thacher limestone, has not been recognized in unit two of the Whiteport.

It is believed that the foregoing evidence strongly supports a late Silurian age for the bottom three-fourths and, by lithologic association, the upper one-fourth of the Whiteport Dolostone.

Summary

The Rondout Group may well represent a series of nearshore environments which are mirrored in the Whiteport Dolostone with its tripart (dolostone, limestone, dolostone) sequence. Tidal flat deposits and shallow marine trough deposits with varied faunas protected from tidal destruction are well represented. Fossil evidence supports a Late Silurian (Pridoli) age for the Whiteport Dolostone.

LITHOLOGIC AND PALEOENVIRONMENTAL ANALYSIS OF THE LATE SILURIAN (PRIDOLI) GLASCO LIMESTONE IN THE MID-HUDSON VALLEY, VICINITY OF KINGSTON, NEW YORK.

by
Rosario Agostaro
Department of Geological Sciences
State University University of New York
College at New Paltz
New Paltz, New York

INTRODUCTION

In recent years the Glasco limestone has been studied in a broad to restrictive regional context by authors such as Rickard (1965), Grosvenor (1965), Grosvenor-Hoar and Bowen (1967), Waines and Hoar (1967), Harper (1969), and Rickard (1975). In this investigation the study area is limited to the vicinity of Kingston, New York and attempts to elucidate the intricate lithologic and paleontologic changes occurring within the Glasco sequence. The Glasco limestone within the Mid-Hudson Valley is Late Silurian (Pridolian) age according to Rickard (1975). It is disconformably overlain and underlain by the Whiteport and Rosendale Dolostones. The Glasco consists of a variety of carbonates including highly fossiliferous stromatoporoid and halysitid bearing limestones, dolomitic mudstones, and calcareous to dolomitic mudstones and floatstones. Thickness varies from 0.7 to 15.4 feet (0.2 to 4.7 meters). In the Kingston area the formation has been subdivided into three mappable stratigraphic units (here referred to in ascending order as units A, B, and C) (Figure 1).

Aside from the early work of Hartnagel (1903) the paleontology of this sequence has been most recently studied by Grosvenor (1965), Grosvenor-Hoar and Bowen (1967) who studied the brachiopods; and Stock (1979) who concentrated on the stromatoporoids.

CARBONATE ROCK CLASSIFICATION

For purposes of field description a classification was developed largely based on Cuffey's (1985) reef-rock scheme. He purposed that fossil and/or fossil fragments longer than 2mm (greatest dimension) where the most common elements of reef related carbonates. "When such textural elements constitute 10% or more of the rock's volume - versus fewer or none - they provide the most common logical means for initially subdividing these reef rocks" (Cuffey, 1985, p.307).

The field classification used in this study takes into account percent matrix, packing of fossils and/or fossil fragments, and growth types. Matrix in this sense includes sediment particles less than 2mm in size. The tripartite scheme used here is as follows: matrix greater than 75 percent, matrix 75-25 percent, and less than 25 percent. Floatstones, boundstones, and coverstones follow past usage, while lamstones, cupstones, stickstones, hemstones and chainstones reflect dominant fossil growth forms (Figure 2).

STRATIGRAPHY, LITHOLOGIES, AND PALEONTOLOGY

Three domains were used for mapping and correlation purposes (Figure 3). A northern domain includes the quarries and outcrops in the East Kingston area. The middle domain incorporates the outcrops and mines of the Vlightberg area. The southern domain includes the quarries, mines and outcrops of the Wilbur, New Salem, Fly Mountain and Bloomington areas.

Northern Domain

Here the thickness of the Glasco Formation is 9.5 feet (2.9 meters). The lower most sequence, unit A, averages 3.7 feet (1.1 meters) in thickness. Most sections consist of a basal hemstone or floatstone or lamstone, overlain in succession by a chert-rich coverstone, a calcareous to dolomitic floatstone or lamstone or hemstone, and an upper low matrix chainstone with abundant laminar stromatoporoids (Figure 4). Overall the unit is characterized by matrix poor lithologies (Figure 5). An insoluble residue of 4.2 percent was obtained from the chainstone. The fauna in decreasing order of abundance includes fragmented halysitids, laminar stromatoporoids, solitary rugosa, stick-like tabulates and/or bryozoa, hemispherical stromatoporoids, other tabulates (chiefly cladoporid-like forms), pelmatozoan oscicles, and entire halysitid coralla (Figures 6 and 7). Within the basal portions of the unit the dominant stromatoporoid form is hemispherical, while in the overlying coverstones and chainstones it is almost exclusively laminar.

Unit B is 4.8 feet (1.5 meters) on average and can be identified by several cyclic packages (floatstone or hemstone or lamstone overlain by cupstone or stickstone). This unit starts with a floatstone and ends with a stickstone or shale. The dominant lithology is floatstone, especially in the lower part (subunit 1, Figure 4) which exhibits a dramatic increase in matrix relative to unit (A)(Figures 4 & 5). Insoluble residues formed 4.3 percent of the upper stickstone lithologies (subunit 2, Figure 4) in this unit. The three dominant macro-invertebrates in the unit are solitary rugosa, cladoporid-like tabulates and stick-like tabulates and/or bryozoa (Figures 6 and 7).

Unit C averages 1.0 feet (0.3 meters) in thickness and is comprised of a clean lime calcarenite (subunit 1A) or a

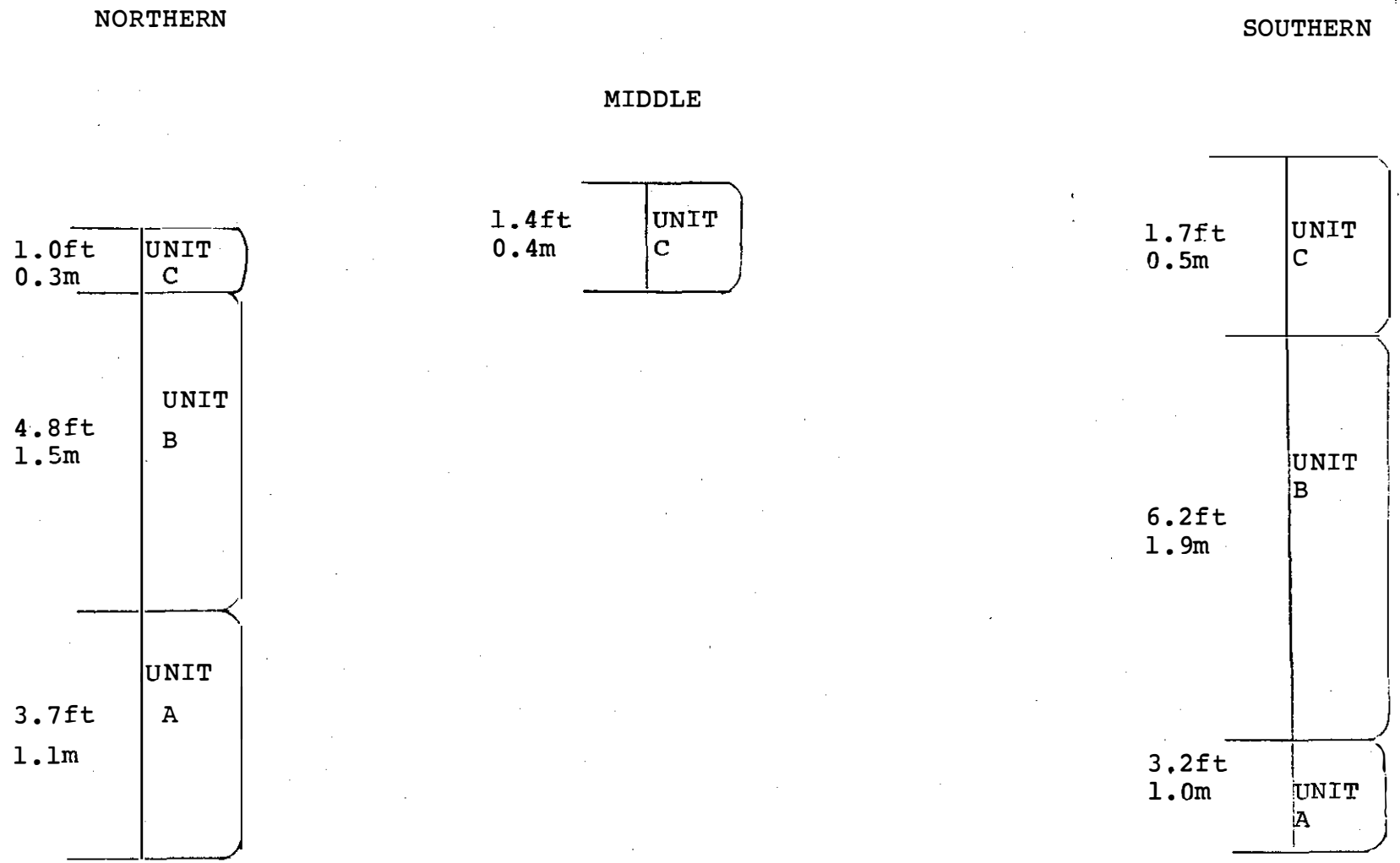


Figure 1 : General thickness relationships of three units in the northern, middle, and southern domains.

lamstone/coverstone (subunit 1B, Figure 4) overlain in one place by a mix of matrix-rich lithologies. Where present (Figure 4) the calcarenites occur above a bedding surface parting at the top of unit B. These calcarenites contain 2.5 percent insoluble residues and appear to be a facies of the lamstone/coverstone lithologies (Figure 4). The upper subunit (2), where it exists, contains floatstones, mudstones, rudstones and shales. Within the lamstone/coverstone package laminar and hemispherical stromatoporoids are equally abundant while solitary rugosa are rare. Although most of the material is fragmental, the calcarenites are characterized by equal proportions of solitary rugosa and cladoporid-like tabulates when identifiable.

Middle Domain

The Glasco in this domain as studied in two localities averages 1.4 feet (0.4 meters) in thickness. Only unit C occurs in this domain. The unit is characterized by dolomitic mudstone, floatstone, and quartz-rich rudstone (subunit 2). These lithologies contain stringers of fossil hash and are indistinctly laminated. Rare stromatoporoids were the only fossils identified.

Southern Domain

In the southern domain the Glasco limestone averages 11.1 feet (3.4 meters). Unit A is 1.7 feet (0.5 meters) thick on average. The basal lithologies are chert-rich boundstones with rare hemstones to the west (subunit 2, Figure 4)) and floatstones and mudstones to the east (subunit 1, Figure 4). Dolomitic to calcareous floatstones or lamstones or hemstones (subunit 3, Figure 4) that overly the boundstones contain 9.8 percent insoluble residues. The upper subunit (4) (Figure 4) is a dolomitic chainstone containing more matrix (50-75 percent) than that in the northern domain. Only fragmented halysitids, laminar and hemispherical stromatoporoids, and solitary rugosa occur in abundances greater than one percent (Figure 7).

Unit B is 6.2 feet (1.9 meters) thick on average. Two distinct subunits can be recognized (subunits 4-5, Figure 4). Dolomitic floatstone and/or lamstone, eastern facies, or a dolomitic floatstone and/or stickstone, western facies, (Figure 4)). The eastern facies may also contain hemstones and coverstones intercalated with matrix-rich (90 percent) floatstones. Some basal floatstones contain burrowed horizons that may be related to hardgrounds. The upper subunit (2, Figure 4)) is a dolomitic mudstone and/or floatstone. Two macro-invertebrates dominate this unit: cladoporid-like tabulates and fragmented halysitids. Solitary rugosa, laminar and irregular stromatoporoids are less abundant (Figures 6 and 7).

Unit C ranges from 1.2 to 9.0 feet (0.4 to 2.7 meters), averaging 3.2 feet (1.0 meters). Two subunits were identified:

CARBONATE CLASSIFICATION

MATRIX 90-75%	MATRIX 75-25%	MATRIX 25-0%
Floatstone -generally heterogeneous	Lamstone -laminar growth (i.e. stromatoporoids, favositids, Cupstone -cup shape growth (i.e. solitary rugosa) Stickstone -stick or branch growth (i.e. tabulates, bryozoans) Hemstone -hemispherical growth (i.e. stromatoporoids, favositlds Chainstone -chain or anastomozlng growth (i.e. halysltid corals)	Boundstone (less than 5% matrix) -always encrusting Coverstone -laminar growth, often encrusting Dense Cupstone Dense Stlckstone Dense Hemstone Dense Chainstone

Figure 2: Carbonate field classification (partly adapted from Cuffey, 1985)

lamstone/coverstone (1B) and floatstone, mudstone, and rudstone (subunit 2). In the west a thin shale overlies the lamstone/coverstone, while in the central portion of this domain deposition of floatstone and mudstone commences. Finally, to the east the lamstone/coverstone sequence is nonexistent while a floatstone/mudstone package becomes dominant. Rudstones and dolomitic mudstones near the top of this unit average 25 percent insoluble residues. The matrix-rich lithologies contain disarticulated ostracod valves, vertical burrows, rare solitary rugosa and brachiopods.

Summary

In terms of thicknesses unit A is thickest in the northern domain because subunit 1 (Figure 4) was probably eroded or not deposited in the southern domain prior to deposition of subunit 2. Unit B is thickest in the southern domain because there is an additional thickness of dolomitic mudstone/floatstone (subunit 2). The thinning of unit C in the northern domain is due to two possible causes. First, the lamstone/coverstone lithologies are much reduced. Second, the overlying matrix-rich package is rare or non-existent in the northern domain.

Faunally, the most significant trend was noted in the middle unit (B). Here solitary rugosa decrease in abundance from 38 percent in the north to 11 percent in the south. Laminar and irregular stromatoporoids increase in abundance from north to south.

Generally, insoluble residue percentage contrasted sharply in two domains: high insolubles in the southern domain versus low insolubles in the north.

DEPOSITIONAL ENVIRONMENTS

A number of relatively shallow water carbonate environments are recognized for the Glasco sequence. These include patch reef and backreef complexes, stromatoporoid knobs and low subtidal to intertidal flats.

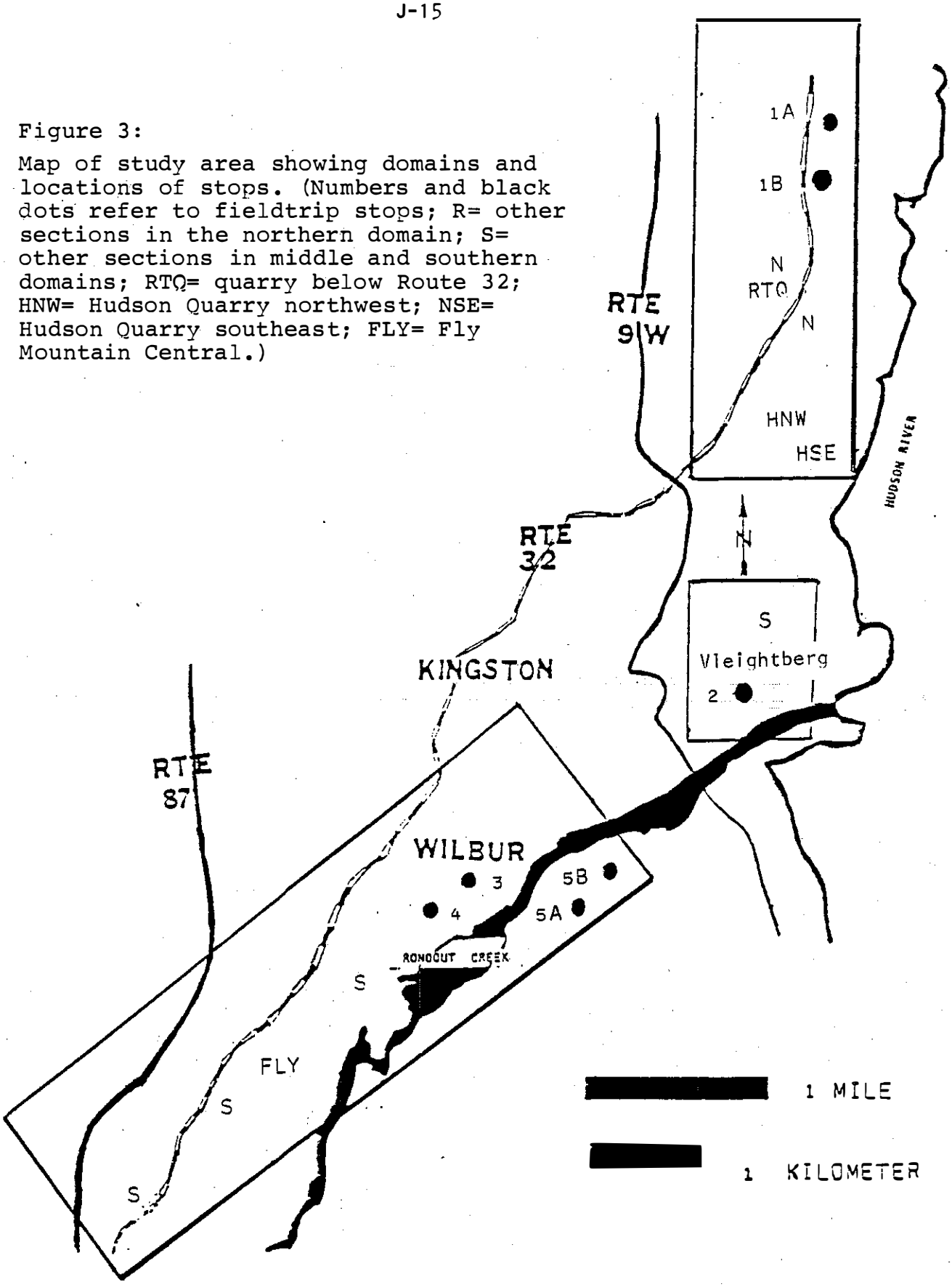
Unit A

Late Rosendale sedimentation probably occurred in a tidal flat environment (Harper, 1969). These flats may have been periodically exposed. Incursion of the sea during early Glasco time saw the development of a patch reef complex and associated halysitid coral thickets. Since the Rosendale substrate was probably well lithified, both stabilization and colonization stages in reef growth were omitted and a rather geologically 'quick' diversification stage progressed in the patch reef.

Hemispherical and laminar stromatoporoids, solitary rugosa,

Figure 3:

Map of study area showing domains and locations of stops. (Numbers and black dots refer to fieldtrip stops; R= other sections in the northern domain; S= other sections in middle and southern domains; RTQ= quarry below Route 32; HNW= Hudson Quarry northwest; NSE= Hudson Quarry southeast; FLY= Fly Mountain Central.)



stick-like tabulates and/or bryozoa, cladoporid-like tabulates, complete and fragmented halysitid corals, favositid corals and pelmatozoans debris have been recognized. The greatest species diversity among stromatoporoid was encountered in the patch reef and overlying reef flat environments. In thirty-seven coenostea sampled, three genera and five species were identified: Parallelostroma constellatum, P.kaugatomicum, P. rondoutense, Stromatopora clarkei, and Densastroma pexisum(Agostaro, 1987).

Sedimentation rates must have been relatively high since the dominant growth form is hemispherical to globular rather than laminar. The implication is that hemispherical stromatoporoids were able to keep pace with sedimentation while laminar forms were engulfed by the sediment. The patch reefs were likely destroyed catastrophically by an influx of fine-grained sediment and/or storm generated debris as indicated by the deposition of floatstones and mudstones in the upper portion of subunit 1.

A shallowing event(s) produced a significantly contrasting environment: high energy stromatoporoid flats probably similar to reef flats. With decreased sedimentation and increased turbulence, laminar encrusting stromatoporoids apparently thrived. One species, Stromatopora clarkei, dominated this assemblage. A domination stage in reef growth is postulated. Laminar stromatoporoids attained their greatest dimensions in this environment. These averaged 4.7 inches (11.9 cm) in breadth although some reached 23.6 inches (60 cm). The lack of matrix adds credence to the high energy, shallow water flat hypothesis.

Halysitid coral thickets developed on top of the stromatoporoid flats. The halysitid coralla may have been stabilized in the following manner. With an upright and open structure the halysitids could have baffled currents and trapped sediment in between corallites thus anchoring the bases of the coralla. During storm events most halysitids appear to have been dislodged, toppled, crushed and transported to form accumulations of flattened assemblages (chainstones). In the northern domain, large laminar stromatoporoids are sandwiched between such debris, either of which may been a favorable settling ground for stromatoporoid larvae as compared to calcareous muds. Stromatoporoids were eventually killed by an influx of fragmented halysitids washing on top of the coenostea. Complete halysitid coralla are exceedingly rare in a chainstone lithology.

In the south the chainstone is dolomitic, thins, and contains much more matrix while laminar stromatoporoids are rare. The coverstone is similarly dolomitic and, where it exists, thins. The environment was apparently less turbulent and possibly deeper than that to the north.

Unit B

Relative deepening of the sea during medial Glasco time

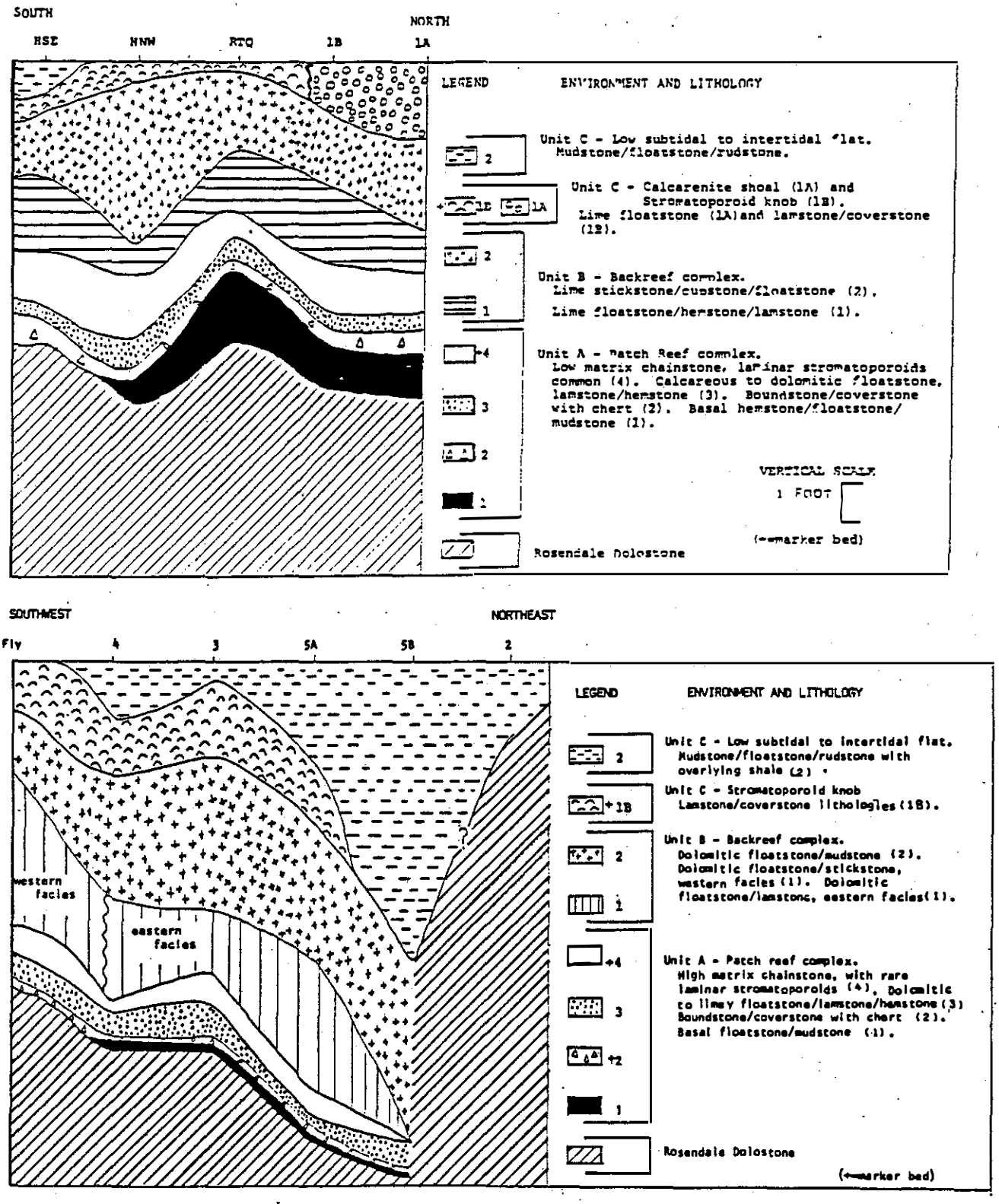
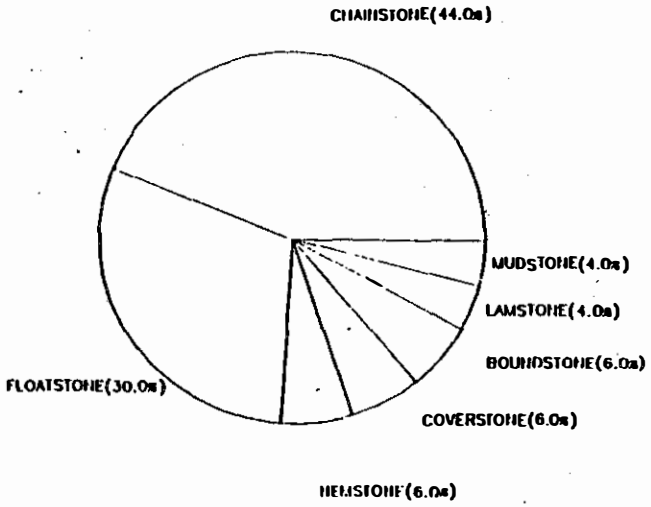


Figure 4: Stratigraphic correlation of sections along with associated environments and lithologies (refer to figure 1 for location of sections).

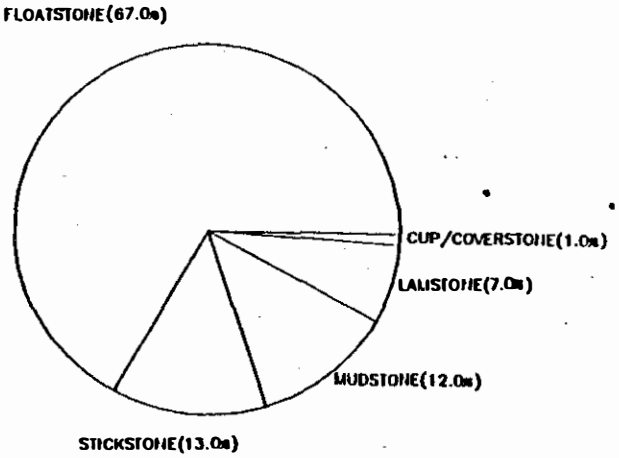
Unit A

Southern Domain



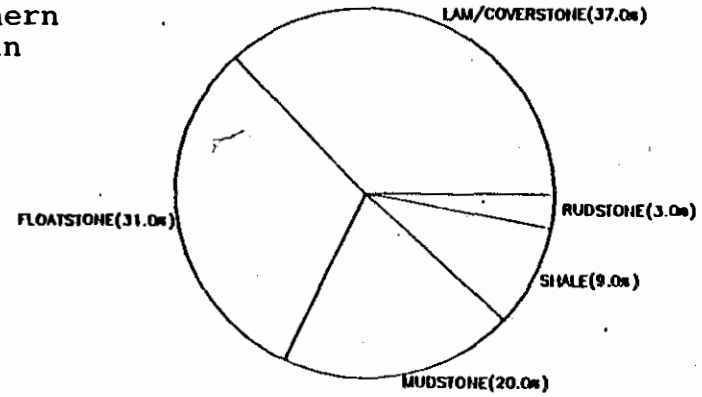
Unit B

Southern Domain



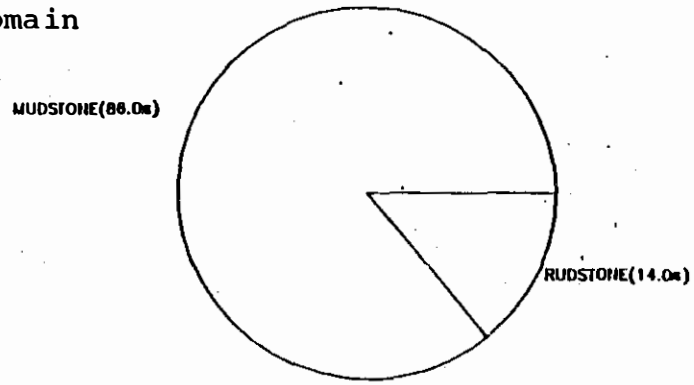
Unit C

Southern Domain



Unit C

Middle Domain



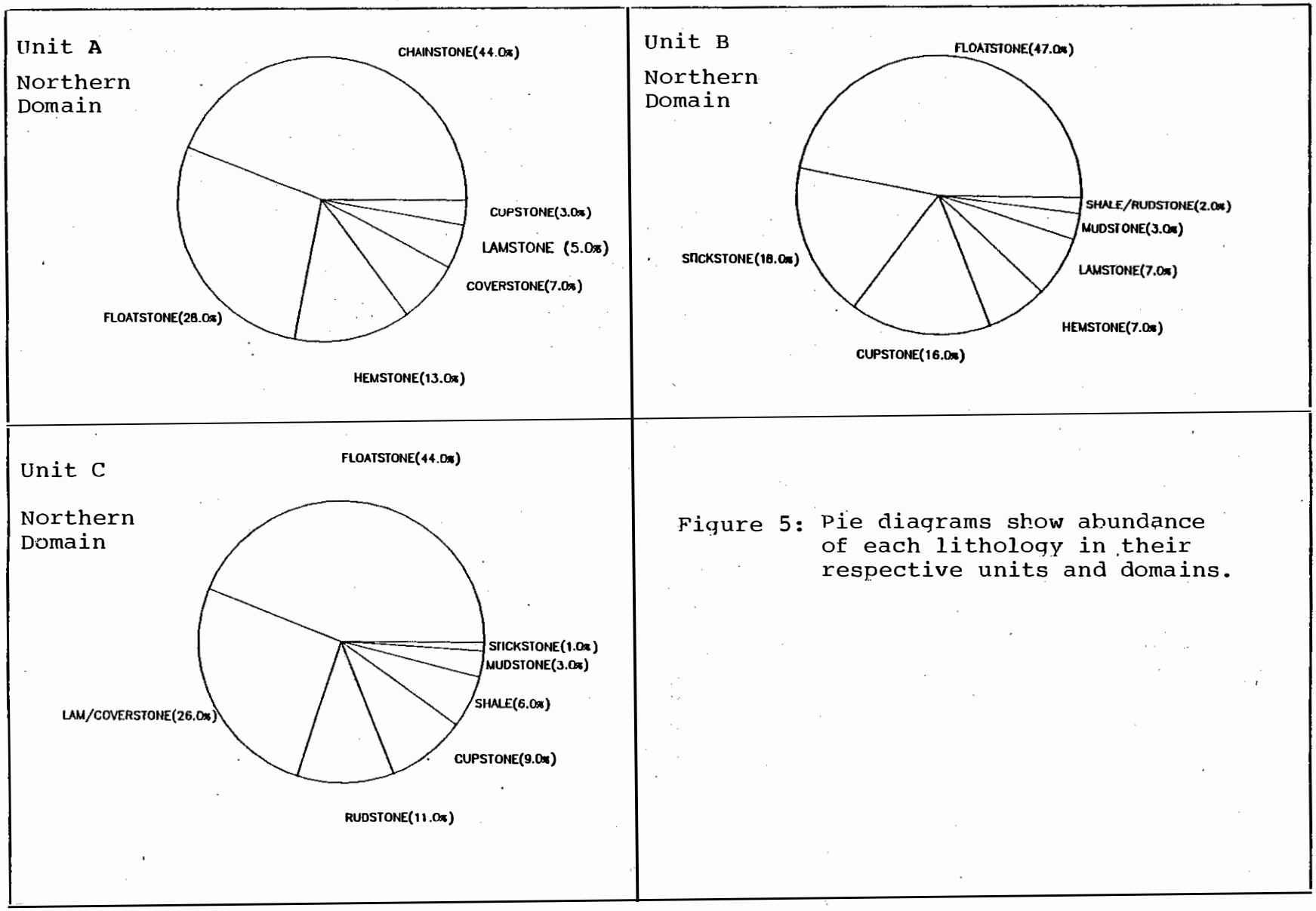


Figure 5: Pie diagrams show abundance of each lithology in their respective units and domains.

brought about a net decrease in water turbulence. Although the unit A patch reefs stood only a few feet above the seafloor (4-5 feet)(1.2 - 1.5 meters), they may have produced sufficient barriers to dissipate energy on a landward side. Matrix-rich packages accumulated in backreef complexes. A backreef complex probably consisted of the backreef environment and a shallower near-shore, subtidal environment.

Cyclic deposition of floatstones with stickstones, lamstones, hemstones or cupstones characterize Glasco backreef deposition. Cyclicity is a common component of European Devonian back-reef deposits (Burchette, 1981). Such cyclicity may suggest periodic attempts to re-establish reef growth; i.e. stabilization and colonization stages. Other evidence for back-reef deposition includes:

(1)abundant skeletal debris
(2)stickstone/cupstone/floatstone/mudstone/ with fine-grained matrix
(3)branching and small laminar growth forms

The delicate branching forms (cladoporid-like tabulates and stick-like tabulates and/or bryozoa) indicate high sedimentation and low energy rates. The water was probably more turbid than that in the patch reefs and thus precluded a more diverse fauna of filter and suspension feeders to develop. The macro-invertebrates most likely grew in thickets and served to baffle currents and allow matrix to accumulate. With the addition of abundant bryozoan, tabulate, and solitary rugosan skeletons the substrate became a muddy gravel. This substrate was colonized by small laminar stromatoporoids (averaging 2.9 inches or 7.3 centimeters in breadth) and fewer hemispherical or dendroid forms, until they were blanketed and killed off by fine-grained sediment. This cycle was repeated numerous times in some localities.

In the northeast the cycles are lime-rich and contain equal percentages of solitary rugosa, stick-like tabulates and/or bryozoa, and cladoporid-like tabulates. The situation suggests better circulation than that to the south. In the southwest the lithologies are dolomitic, more matrix rich and solitary rugosa are fewer relative to bryozoans and tabulates. Circulation was more restricted and the percentage of insolubles were higher.

In the southeast there is evidence for a shallow, quiet water, near shore, subtidal environment. Cyclicity decreases and is ultimately nonexistent. The dolomitic floatstone and mudstones are nearly devoid of epifauna with the exception of stringers of brachiopod and ostrocad valves. To the west the sequence becomes highly fossiliferous and cyclic. An infauna must have tolerated this environment since deep, wide, vertical burrows are common at the base of this unit. If this is a hardground it could imply a temporary stoppage in sedimentation

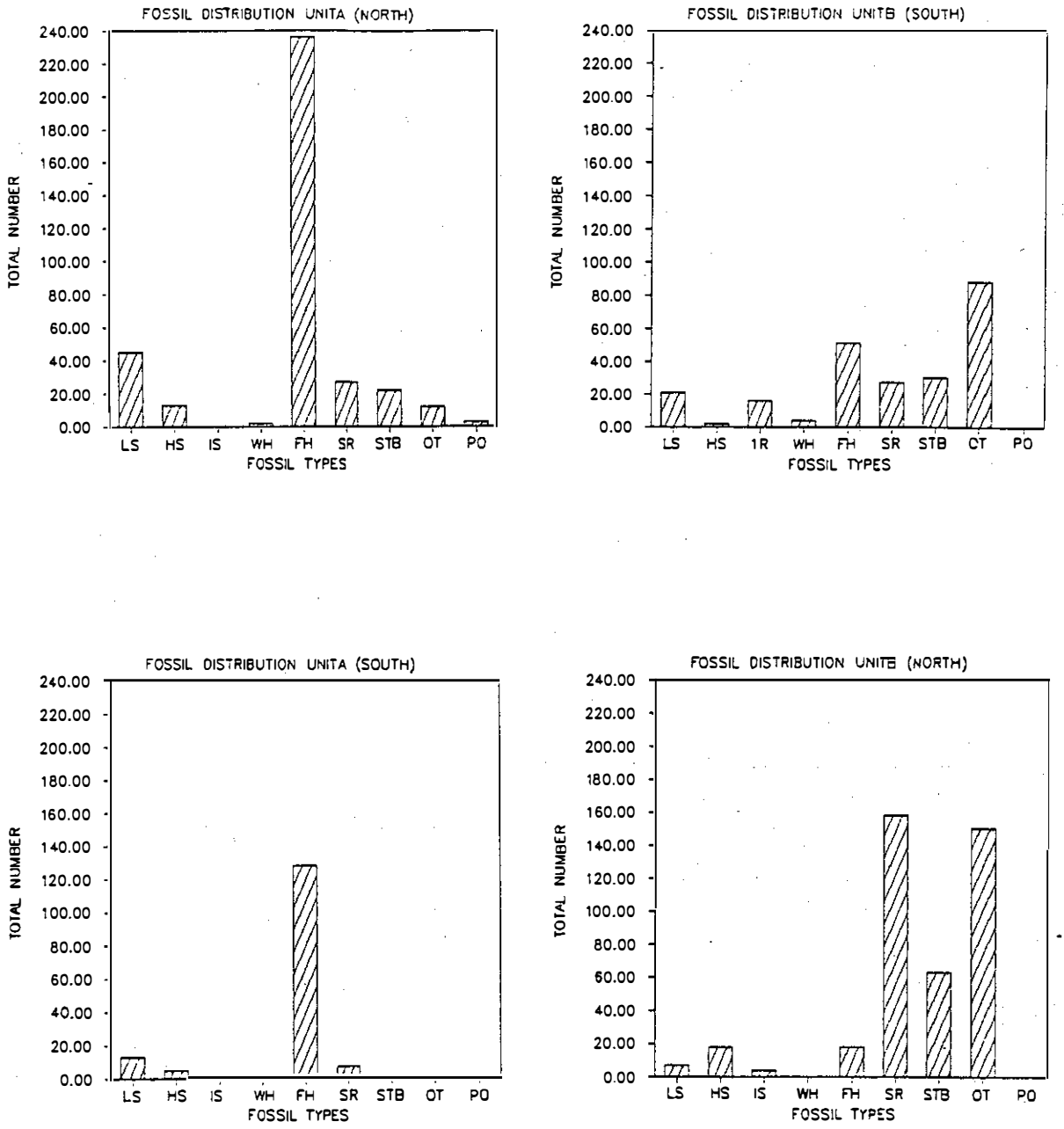


Figure 6: Distribution of macro-invertebrates for units A and B in the northern and southern domains. Histograms show total number of individuals. Strictly outcrop observations. (LS=laminar stromatoporoids; HS=hemispherical stromatoporoids; IS=irregular and dendroid stromatoporoids; WH= entire halysitids; FH=fragment halysitids; SR=solitary rugosa; STB=stick-like tabulate and/or bryozoa; OT=other tabulates ,chiefly cladoporid-like forms; and PO=pelmatozoan oscicles).

(Bathhurst, 1975). High salinity might have restricted the epifauna. It is notable that in one locality virtually the entire package of lithologies are dolomitized, indicative of high insolubles, possibly implying a terrigenous source for some of the sediment.

Unit C

Three distinct environments are recognized: stromatoporoid knobs, high energy calcarenite shoals, and low subtidal to intertidal(?) flats. A modern analog of the stromatoporoid knobs would be the coral knobs associated with patch reefs of Bermuda, which may be upto 5 meters (16.4 feet) across and rise 1 to 3 meters (3.3 to 9.9 feet) above the seafloor (James, 1983). The stromatoporoid knobs extend from the southern into the northern domain. When the knobs are exposed on bedding planes they are up to 15 feet across (4.6 meters) and rise 1-3 feet (0.3 - 0.9 meters) above the surrounding shales, calcareous shales, or dolomitic mudstones.

Although evidence for high energy scour is generally absent, rare small scale channeling has been observed at the base of this unit. Laminar stromatoporoids (Parallelostroma constellatum) have been seen to encrust a vertical channel wall and subsequent infillings (Agostaro and Waines, 1987). The implication here is that shallowing possibly occurred.

It is intriguing that laminar and hemispherical growth forms seem to co-exist at similar horizons within the stromatoporoid knobs. In a study of a Silurian biostrome of Gotland, Kershaw (1981, p.1288) noted that laminar and high domical stromatoporoids were found "adjacent to one another and therefore neighbors in the same environment". The author also suggested that intense competition under favorable conditions could lend to low diversity among reef organisms in modern reefs (p.1293). He presented a scenario that may be mirrored in the stromatoporoid knobs of the Glasco. "Laminar to low domical forms were possibly spreading sideways to rapidly increase their surface area for food collection, exclusion of other organisms and to offer a low profile to currents, thereby reducing stresses on the coenostea. High to extended forms developed the alternate solution of upward growth, possibly to take advantage of nutrient-rich currents or perhaps to produce a microenvironment of extra turbulence resulting in a constant supply of clean water" (Kershaw, 1981, p.1293).

Of twenty coenostea sampled from this horizon four species in one genus were identified (Parallelostroma) and two species (P.constellatum and P.kaugatomicum) constituted 80 percent of the population, indicating low species diversity. This has been interpreted as a colonization stage in reef growth (Agostaro, 1987). In general, growth forms were not unique to any particular species.

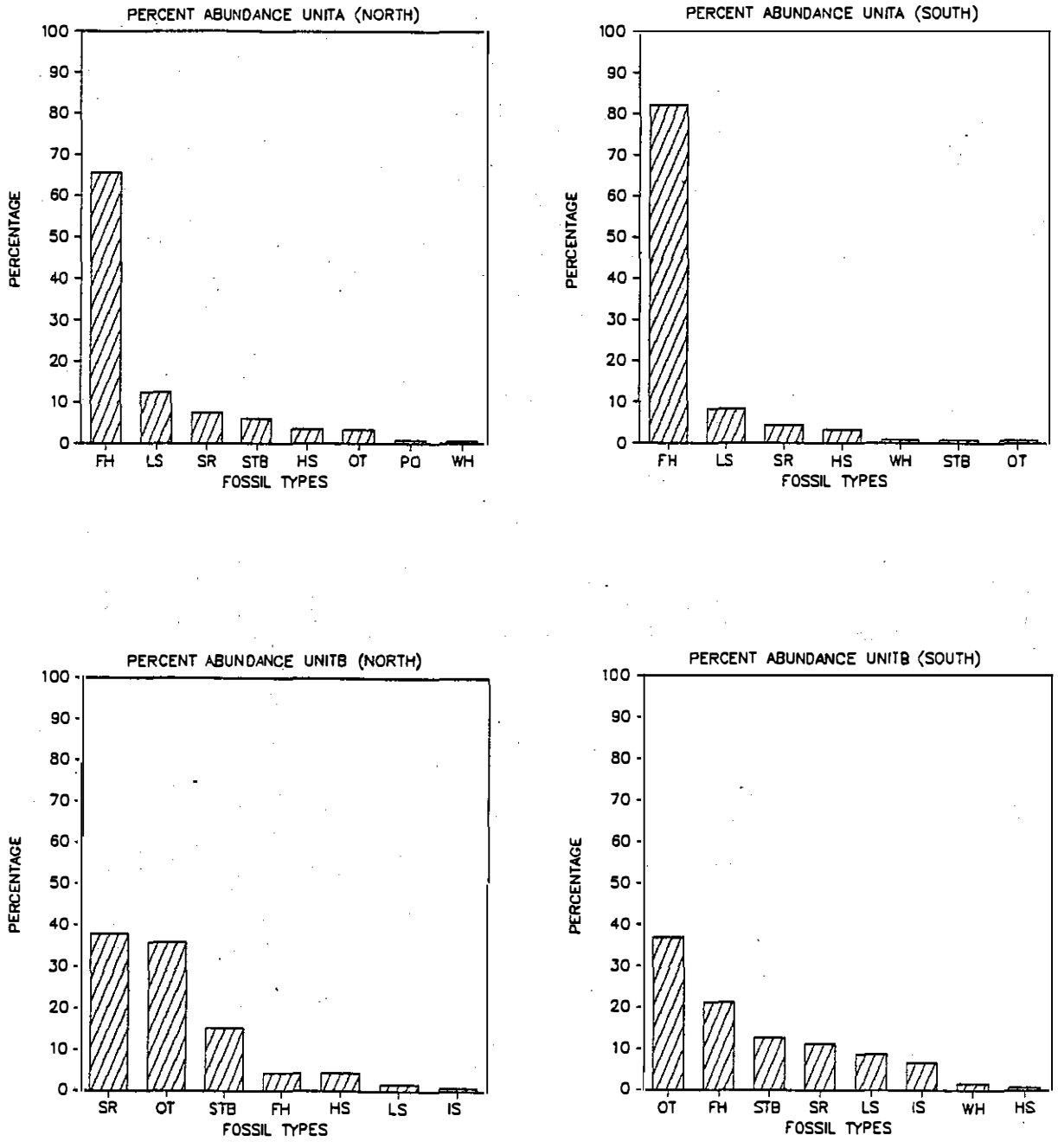


Figure 7: Percentage of fauna within units A and B in the northern and southern domains (see figure 6 key to symbols).

Although dolomitic mudstone and shales are a major component of this knob environment close examination suggests that hydrodynamic energy was sufficient to allow reef-like deposits to develop i.e.: (1) many stromatoporoids exhibit encrusting forms and (2) fragmented, repaired or healed coenostea. As the stromatoporoid knobs built upwards they produced topographic highs scattered over the sea bottom. Fine-grained sediment (shales and dolomitic mudstones) accumulated in the interareas.

With the exception of the unit A stromatoporoid flats, these knobs may represent the shallowest environment in which stromatoporoid activity could thrive. If the knobs were periodically exposed subaerially, this would account for the fragmented but healed coenostea. To the north and northeast the knobs disappear and high energy calcarenite shoals occur.

The high energy associated with the shoals transported the fine grain sediments out of this area. A significant color change occurs between the underlying dark gray to black back reef stickstone and cupstone deposits of unit B and the light gray to blue low insoluble residue lithologies of the shoal deposits. The latter contains the following macro-invertebrates, when identifiable (since most are fragmented): tabulates, bryozoans, solitary rugosa, and rare hemispherical stromatoporoids. The source for the fragments may well have been the backreef thickets of unit B. The shoals appear to represent a facies change from the stromatoporoid knobs since overall thicknesses are similar and both overly similar strata (in the northern domain)(Figure 4).

The most perplexing environment appears to be a low subtidal to intertidal flat environment which is represented in the central portion of the southern domain by dolomitic to calcareous laminated, sometimes rippled, floatstones and mudstones (subunit 2). Hemispherical and globular stromatoporoids are rare. Eastward this subunit thickens and rudstones begin to occur. At the eastern extreme of the southern domain the stromatoporoid knobs disappear and unit C is entirely a mixture of dolomitic mudstones, floatstones, and rudstones. Thin-sections reveal that the rudstones are rich in rounded, fine to medium size, quartz grains that often exhibit graded bedding. These are commonly associated with ostracod valves and 'pellets'. In addition the pellet-like structures have been observed in laminated, often bioturbated, lithologies.

The middle domain is represented by a low subtidal to intertidal flat environment. Unit C appears to be the only one present and it has thinned dramatically (Figure 4). The implication seems to be that this area is closer to the shoreline and salinities were sufficient to allow only ostrocads, rare brachiopods, and some infauna to exist on the tidal flat. Quartz grains from rudstones and fossil-hash floatstones/mudstones

suggest a terrigenous influx. The anomalously thin section (less than one foot) of Glasco in the middle domain may be explained by a topographic high (Rosendale Dolostone) on which only latest Glasco sediments accumulated.

Summary

Lithologic, paleontologic, and observational analysis of a marine carbonate sequence, the Late Silurian Glasco Formation in the vicinity of Kingston, New York, define the paleoenvironments within this stratigraphic sequence. The four environments recognized are patch reef complex, back reef complex, stromatoporoid knob and low subtidal to intertidal flat. Relative nearness to shore, water turbulence and turbidity, along with storm activity seem to be major parameters greatly affecting the nature and stability of environments.

Stromatoporoid growth within the patch reef complex appears influenced by depth and turbulence of water. Hemispherical forms occurred in moderately low turbulent waters of the patch reef. Laminar encrusting forms are dominant in shallower, more turbulent, stromatoporoid flats. Lack of good circulaton allowed matrix-rich sediments to accumulate in some of the back reef complexes of unit B. Hemispherical and laminar stromatoporoids were seemingly able to co-exist in the stromatoporoid knobs. High turbulence apparently removed fine-grained sediment and allowed calcarenite shoals to develop contemporaneously to the north. In the southeast, terrigenous input and possible high salinities eliminated nearly all biologic activity toward the end of Glasco time.

LATE SILURIAN (PRIDOLI) ROSENDALE DOLOSTONE AND WILBUR LIMESTONE, VICINITY OF KINGSTON, ULSTER COUNTY, NEW YORK

LORRAINE E. WARREN

Department of Geological Sciences
State University of New York College at New Paltz
New Paltz, New York, 12561

INTRODUCTION

The Rondout Group, of which the Rosendale Dolostone is part, has played an important part in Ulster County's past economic development. The Dolostone is comprised of Hydraulic limestone, which was crushed, reduced in kilns and used as a natural cement.

The term Rosendale was proposed by Hall (1893, p. 156) who gave as a location the southern exposure of a high escarpment at Rosendale where this dolostone was mined and manufactured into hydraulic cement. Some of the more recent investigations of the Rosendale in this century are those of Rickard, (1962), Hoar and Bowen, (1967), Harper, (1969) and Warren and Waines, (1986).

Based on field observations from nine different locations from just north of Kingston south to Maple Hill (just north of Rosendale), a four-fold subdivision is proposed for the Rosendale Dolostone. From top to bottom the Rosendale is comprised of Unit One: Limestone, Unit Two: Dolostone, Unit Three: Wilbur Limestone and Unit Four: Dolostone. Although not all subdivisions are present at all locations these units can be correlated laterally.

The term Wilbur Limestone was designated by Hartnagel (1903) based on a stratigraphic sequence of Mather (1843, p. 331). The outcrop referred to by Mather was located on the "right" (southeast) side of Rondout Creek opposite Wilbur. Hartnagel selected Mather's unit # 10 (limestone, dark colored impure and fossiliferous) and placed the Wilbur Limestone at the base of the Rosendale Dolostone. Most authors such as Van Ingen, (1903), Wanless, (1921), Rickard, (1962) and Harper, (1969) have followed this practice.

STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENT

It is suggested a four-fold subdivision of the Rosendale-Wilbur sequence is the best way to present the vertical and lateral variations observed in the Kingston area.

UNIT ONE:

This occurs as a mottled and some what dolomitized limestone that is slightly fossiliferous, and weathers light blue-gray.

At Wilbur Quarry the thickness is two feet (0.6m). In the vicinity of Wilbur the unit is disconformable with the overlying Glasco Limestone with a thin dark shale at the contact. The base of the unit grades into the unit below. To the south (Fly Mountain) the unit appears dolomitized (late phase diagenesis ?) and cannot be distinguish from the underlying dolostone. The unit does not appear to occur north of the southern Vlightberg and may have been removed by erosion prior to the deposition of the Glasco.

Unit one seems to represent a relatively near shore, high saline, 'deep water' trough deposit located between the tide flat and the shoreline. Fossils are not numerous and partial dolomitization may indicate proximity to tide flats deposition. This may account for the mottling of the limestone of the Wilbur area which appears to be in an early stage of diagenesis.

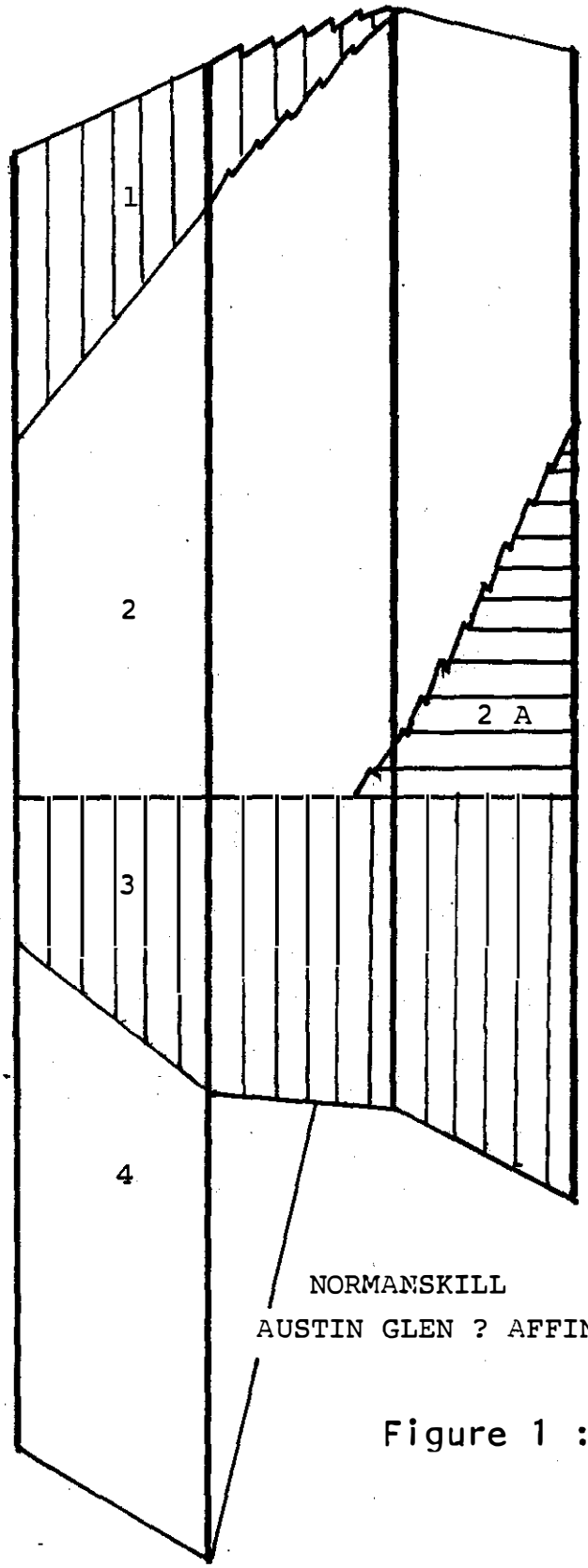
UNIT TWO:

This is a massive to laminated unfossiliferous dolostone which weathers orange-buff. In Wilbur Quarry this unit is 8.3 feet (2.5m) thick. The unit appears to equate with the bulk of Mather's (1843) unit # 9 (gray to black cement rock) and the 'dark cement rock' of many early 20th century authors. At Fly Mountain unit two grades downward into the dolostone below, but from the Vlightberg north the lower part of unit two appears to become interbedded with numerous to sparse slightly fossiliferous limestone stringers forming a subunit.

Unit two probably represents a hypersaline intertidal to tide flat environment. The limestone stringers found north from the Vlightberg and in the east side of Callanan's Quarry may have been derived from lime secreting organisms in a marine trough environment as in unit three and may represent organic debris outwash across tide flats.

UNIT THREE:

In the Wilbur area this unit occurs as a sparsly fossiliferous massive limestone that is somewhat mottled and slightly dolomitized. The unit weathers a light blue-gray. At Wilbur Quarry the limestone has a thickness of four feet (1.2m) and the upper and lower contacts are rapidly gradational to dolostone. This unit is the Wilbur Limestone of many authors and can be readily recognized as a stratigraphic unit below the Rosendale Dolostone from the Vlightberg north as far as West Camp, New York. However in the vicinity of Wilbur and south in Fly Mountain the Wilbur Limestone is an internal stratigraphic component of the Rosendale Dolostone. At the south end of Fly Mountain the Wilbur is a cherty and silicified fossil-bearing dolostone with occasional angular pebble-like structures of undolomitized limestone. The Wilbur can be traced as a thin insoluble resdue and a high Ca/Mg zone many miles to the southwest (Warren and Waines. 1986). Other limestones near or at the base



1 LIMESTONE

2 DOLOSTONE

2 A SUBUNIT 2 A

3 WILBUR LIMESTONE

4 DOLOSTONE

STOP 1B - WYGANT NORTH
STOP 2 - VLIGHTBERG
STOP 4 - WILBUR QUARRY

SEE AGOSTARO (FIGURE 3) THIS GUIDE BOOK

Figure 1 : suggested stratigraphic correlation within the Rosendale Formation

VERTICAL SCALE 1cm = 1ft

of the Rosendale Dolostone, such as those reported at High Falls, do not appear to be correlatable with Wilbur Limestone of the Wilbur area. Fossil content increases from the Vlightberg north and the base of this unit oversteps the underlying Ordovician sandstones and shales with angular unconformity.

The Wilbur exhibits a diverse fauna of brachiopods, bryozoa, tabulate (favositid and halysitid) and rugose corals, trilobites, ostracods, gastropods and pelmatozoan fragements (Hartnagel, 1903). Most recently, stromatoporoids identified by Stock (1979) include Stromatopora bekkeri, Parallelostroma constellatum, Parallelostroma kaugatomicum all from Wilbur strata just north of Kingston. Stromatopora bekkeri located at Accord, New York in the 'Wilbur member' comes from basal Rosendale strata which predate any of the Rosendale in the vicinity of Kingston.

Unit three represents a very fossiliferous limestone formed in a off shore trough-like environoment. Here a variety of fauna can be found ranging from brachiopods to stromatoporoids. The fossils found south at Fly Mountain may represent organic debris outwash across tide flats. Here again as in unit one the mottled limestone of the Wilbur vicinity appears to be in a early stage of diagenesis.

UNIT FOUR:

This unit is a massive dolostone which weathers orange-buff. At Wilbur Quarry the unit is 6.6 feet (2.0m) thick. In the vicinity of Wilbur the unit disconformably overlies the Binnewater Sandstone, and does not appear to extend northeast over Ordovician sediments. To the south at Fly Mountain this dolostone develops sparse chert nodules and occasional fossil ghosts. The unit is absent at the Vlightberg north. It is also absent at the east side of Callanan's Quarry.

Unit four probably represents a intertidal to tide flat environment. These flats most likely had a low energy environment, and perhaps were hypersaline.

CONCLUSION

The proposal of the Four-fold subdivision of the Rosendale Dolostone can be easly recognized in the field. All four units are distict enough to be readly recognized. At most locations all units are present except where removed by erosion, or have under gone facies change or were never deposited.

From the foregoing, it seems that the Wilbur Limestone would be best recognized as a facies and subunit of the Rosendale Dolostone.

REFERENCES

Adumkin, N.S., 1976, Halysitid Ghosts in the Whiteport Dolostone (Late Silurian), Town of Rosendale, Ulster County, New York; (Abs.): 7th Annual N.P.S.S.P.P., Program with Abstracts; 1976, p.2.

Agostaro, R., 1987, Stratigraphic Distribution of Stromatoporoids Within the Glasco Member (Late Silurian-Pridolian) Rondout Formation, Kingston Area, Ulster County, Southeastern New York; (Abs.): 15th Annual N.P.S.S.P.P., Program with Abstracts; 1987, p.2.

- and Waines, R.H., 1987, Atypical Growth Form in Laminar Stromatoporoid Coenostea, Glasco Limestone Member, Rondout Formation (Latest Silurian), Kingston, Southeastern New York; (Abs.): Geol. Soc. America, Programs with Abstracts, 22nd Annual Meeting, Northeast Section, Pittsburgh, Pennsylvania, p.1.

Bathhurst, R.G.C., 1975, Carbonate Sediments and Their Diagensis: Amsterdam, Elsevier, v.12, 658p.

Berry, W.B.N. and Boucot, A.J., Correlation of the North American Silurian Rocks: GSA Special Paper 102, 239p.

Burchette, T.P., 1981, European Devonian Reefs: A Review of Current Concepts and Models; in Toomey, D.F., ed.: European Fossil Reef Models, SEPM, Special Publication No.30.

Cuffey, R.S., 1985, Expanded Reef-Rock Textural Classification and the Geological History of Bryozoan Reefs: Geology, v.13, p.307-310.

Fetterhoff, B.V., 1986, Significance of a Halysitid Tabulate Coral in.the Whiteport Dolostone (Latest Silurian), Callanan's Quarry, Town of Esopus, Ulster County, New York; (Abs.): 14th Annual N.P.S.S.P.P., Program With Abstracts, 1986, p.7.

- and Waines, R.H., 1987, Stratigraphic Significance of a Halysitid Tabulate Coral in the Whiteport Member of the Rondout Formation (Latest Silurian), Town of Esopus, Ulster County, Southeastern New York; (Abs.): Geol. Soc. America, Programs With Abstracts, 22nd Annual Meeting, Northeast Section, Pittsburgh, Pennsylvania, p.14.

Fisher, D.W., 1960, Correlation of the Silurian Rocks in New York State: NY State Mus. and Sci. Service Bull., Map and Chart Series, No. 1.

Grosvenor, F.A., 1965, Brachiopoda and Stratigraphy of the Rondout Formation in the Rosendale Quadrangle, Southeastern New York: Unpublished M.Sc. Thesis, Univ. of Rochester, NY.

Grosvenor-Hoar, F.A. and Bowen, Z.P., 1967, Brachiopoda and Stratigraphy of the Rondout Formation in the Rosendale Quadrangle, southeastern New York: Jour. Paleo., Vol. 41, No.1, pp.1-30.

Hall, J., 1893, Twelth Annual Report of the State Geologist For the Year 1882, Vol. 46, pp.153-87.

Harper, J.D., 1969, Stratigraphy, Sedimentology, and Paleoecology of the Rondout Formation (Late Silurian) Eastern New York State: Unpublished Doctoral Thesis, Brown University, Rhode Island.

Hartnagel, C.A., 1903, Preliminary Observations On the Cobleskill ("Coralline") Limestone of New York: NY State Mus. Bull., Vol. 69, p.1109-1175.

James, N.P.,1983, Reef Environment: in Scholle, P.A., et al (Editors), Carbonate Depositional Environments, AAPG Memoir #33, 708p.

Kershaw, S., 1981, Stromatoporoid Growth Form and Taxonomy In A Silurian Biostrome, Gotland: Jour. Paleo., Vol. 55, No.6, pp. 1284-1295.

Mather, W.W., 1843, Geology of New York, Part I, Comprising the Geology of the First Geological District: Nat. Hist. pt. IV, Vol.1, 653p.

Rickard, L.V., 1962, Late Cayugan (Upper Silurian) and Helderbergian (Lower Devonian) Stratigraphy in New York: NY State Mus. and Sci. Service Bull., No.386.

- , 1975, Correlation of the Silurian and Devonian Rocks in New York State: NY State Mus. and Sci. Serv. Map and Chart Series No.24.

Stock, C.W., 1979, Upper Silurian (Pridoli) Stromatoporoidea of New York: Bull. Am. Paleontology, Vol. 76, No.308, pp.291-381.

- and Holmes, A.E., 1986, Upper Silurian/Lower Devonian Stromatoporoidea From the Keyser Formation at Mustoe, Highland County, West-Central Virginia: Jour. Paleo., Vol. 60, No. 3, p.555-580.

Van Ingen, G. and Clark, P.E., 1903, Disturbed Fossiliferous Rocks In the Vicinity of Rondout: NY State Mus. Bull., Vol. 69, p. 1176-1227.

Waines, R.H. and Grosvenor-Hoar, F.C., 1967, Upper Silurian-Lower Devonian Stratigraphic Sequence, Western Mid-Hudson Valley Region, Kingston Vicinity to Accord, Ulster County, New York: in NY State Geological Association, 39th Annual Meeting, May 5-7, 1967; Waines, R.H. (Editor).

- and Gomez, E., 1977, Stratigraphy of the Whiteport Dolostone, Rondout Formation (Late Silurian), Accord to Kingston, Ulster County, New York; (Abs.): Geol. Soc. America, Programs With Abstracts, 12th Annual Meeting, Northeast Section, p.328.

Wanless, H.R., 1921, Final Report On the Geology of the Rosendale Cement District: Unpublished M.A. Thesis, Princeton University, New Jersey.

Warren, L.E. and Waines, R.H., 1986, Relation of the Wilbur Limestone to the Rosendale Dolostone Member of the Rondout Formation (Late Silurian), Kingstone to Accord, Ulster County , Southeastern New York - A Revised Interpretation; (Abs.): Geol. Soc. America, Programs with Abstracts, 21st Annual Meeting, Northeast Section, Kiamesha Lake, New York, p.74.

ROADLOG FOR FIELDTRIP J:
STRATIGRAPHY OF THE LATE SILURIAN RONDOUT GROUP IN THE VICINITY OF KINGSTON, NEW YORK.

CO-LEADERS: AGOSTARO, R; FETTERHOFF, B.V.; WARREN, L.

Fieldtrip starts at the Ramada Inn parking lot.

MILES FROM LAST POINT

0	Turn right out of parking lot onto NY28 heading northwest.
0.1	Traffic light just past light bear right toward US209 bypass and Kingston-Rhinecliff Bridge.
0.2	North on US209. For the next 2.1 miles are extensive roadcuts in gently dipping siltstones and shales of Mt. Marion Formation (Middle Devonian).
2.0	Pass over Sawkill Road.
0.3	Pass over NYS Thruway.
0.3	Bridge over Esopus Creek.
0.7	End US209 bypass. Beginning of NY199. Continue east.
0.1	Pass over US 9W.
0.2	Roadcut shows Lower Devonian strata.
0.8	Exit at NY32. Bear right.
0.3	At stop sign turn left (south) onto NY32. Proceed south 0.5 miles and pull off to right.

STOP 1A: WYGANT NORTH. ROADCUT EXPOSING THACHER, WHITEPORT, GLASCO, AND ROSENDALE. (PLEASE DO NOT CROSS HIGHWAY. BEWARE OF FALLING ROCK - WEAR HARD HATS.)

Whiteport

Thickness of Whiteport is five feet. Unit two is not present in this section, and unit one rests disconformably upon unit three.

Glasco

Note lower disconformable contact with massive dolomitic mudstones of the Rosendale. Coverstone lithology of unit A (subunit 2) characterized by laminar

stromatoporoids, chiefly Stromatopora clarkei, intercalated with stick-like tabulates and/or bryozoa, and chert. Take note of the position of this unit in the stratigraphic sequence.

Distinct color change between unit B and C (dark blue vs. light gray). Bedding plane parting marks upper contact of unit C with overlying basal ostracod floatstones of the Whiteport. This unit in the lower Whiteport occurs in virtually all localities studied and serves as an excellent marker bed.

0.8 Pull off on right side of road.

STOP 1B: WYGANT SOUTH. PLEASE DO NOT CROSS HIGHWAY.

Whiteport

Unit four is well exposed at this stop. Note abundance of ostracods, and fragments of limestone (intraformational conglomerate) within this unit. Gradational contact with unit three. Unit one and two are not exposed at this stop.

Glasco

Hemispherical stromatoporoids and halysitids found in the basal hemstones are typical of the northern domain. Compare intact halysitid coralla with fragmented types in chainstone. Note laminar stromatoporoids in coverstone and chainstone lithologies of unit A. Pay particular attention to stromatoporoid/halysitid association in low matrix chainstone.

Dominant macro-invertebrates in unit B are solitary rugosa, cladoporid-like tabulates, and stick-like tabulates and/or bryozoa (especially in subunit 2). Unit C is characterized by fossil fragments. Note irregular disconformable upper contact and associated rip-up clasts.

Rosendale

At this location unit one is missing, probably due to erosion. Unit two is massive dolostone. Unit two subunit is a massive dolostone with discontinuous to continuous limestone stringers. Unit three, Wilbur is mottled and contains a fossil marker bed. The bottom

portion of this unit is a sandy limestone which rests on Ordovician sediments with angular unconformity. Most likely, unit four was never deposited.

1.7 Return to transportation and proceed south on NY32. There are intermittent outcrops and road cuts in a more or less regularly ascending stratigraphic order from Austin Glen (?) through Onondoga Formations. The overall structural picture is somewhat complicated. Turn left onto 9W south.

1.6 Stay in left lane at light make left turn into housing development. Cross under railrad bridge.

0.1 Turn right and proceed to dead end circle. Park here.

STOP 2: VLIGHTBERG HILL. (FOLLOW FIELDTRIP LEADERS UP HILL). PLEASE FOLLOW PINK RIBBON TRAIL AND DO NOT WANDER -ESPECIALLY DANGEROUS CLIFFS.

2A: VAN INGEN'S WILBUR

Rosendale

Unit three, Wilbur is massive but still has that mottled look. Here the limestone is in angular unconformity with underlying Middle Ordovician Normanskill (Austen Glen aspect) graywackes.

2B: SOUTH END OF THE VLIGHTBERG

Whiteport

Unit four is not present at this stop. Unit two is dolomitized, and the subunits are barely distinguishable.

Glasco

The Glasco is represented by unit C (subunit 2) which consists of dolomitic mudstones, indistinctly laminated dolomitic mudstone, and stringers of fossil

hash with quartz grains. Similar horizons occur at stops 3, 5A and 5B.

Rosendale

A small mottled portion of unit one is present.

0.1 Turn around make left and go back under railroad bridge. At traffic light go straight and cross US9W.

0.15 At next traffic light make a left turn onto Hasbrouck Ave.

0.1 Turn left on Abeel Street (two blocks down).

0.5 Proceed down Abeel Street and go past flashing red light.

0.75 Pass under NY Central Railroad.

0.05 Turn right at stop sign (Wilbur Ave).

0.05 Turn left on RT213 at flashing red light proceed back toward NY Central Railroad underpass (East).

0.15 Pull of road parallel to Rondout Creek just past stonehouse on right. Outcrop next to picket fence.

STOP 3: SWEENEY'S STONEYARD. (FOLLOW FIELD TRIP LEADERS) NO SAMPLING AT THIS OUTCROP - WHEN WE CROSS THE ROAD STAY ON SIDEWALK. DO NOT WALK ON THE FLOWER GARDEN.) OUTCROP DESCRIPTIONS WILL BE PRESENTED BY FIELDTRIP LEADERS ON OPPOSITE SIDE OF OUTCROP.

Whiteport

Best exposure for the Whiteport Dolostone in the Kingston area. Unit four is dolomitized at this stop. Unit two can be seen in its two subdivisions, the upper laminated subunit and lower 'reef' subunit. The three subzones within the lower subunit are best exposed here. Note disconformity at the base of units four, two, and at the top of unit two. At the top of of unit one, mudcracks mark the contact with the Thacher limestone.

Glasco

Cherty boundstone is found near the base of unit A (very thin subunit 1). Unit B contains a lower dolomitic floatstone/lamstone (subunit 1). The upper dolomitic mudstone may be indicative of quiet water in the back reef environment. Note the highs and lows within the stromatoporoid knobs along with laminar and hemispherical stromatoporoids located at similar horizons. Take a close look at the overlying subunit 2.

Rosendale

At this stop all four units in the four-fold proposal are present. The upper limestone of unit one can be seen with its mottled look and a minor parting at the base. Unit two is massive dolostone which has several partings present. Unit three and unit four are present but are hidden behind the fence. Once again do not step on the garden and no samples please.

0.1 Proceed east on Abeel Street. After underpass NY Central Railroad turn left on Dewitt to turn around and get back on Abeel Street going west.

0.3 Pass under NY Central Railroad.

0.2 Pass outcrop just examined.

0.05 Continuing down Abeel Street which also becomes NY213.

0.65 Traveling southwest parallel to Rondout Creek. Prepare to pull off road to right suddenly in 0.65 miles. Park in entrance to gravel pit road. If road is open do not block entrance.

STOP 4: CITY OF KINGSTON GRAVEL PIT (FOLLOW FIELDTRIP LEADERS). THE CLIFF TO THE NORTHWEST IS FORMED OF AN EXTENSIVE SEQUENCE OF UPPER SILURIAN AND LOWER DEVONIAN STRATA (MOSTLY CARBONATES) PARTLY REPEATED BY FAULTING.

Whiteport

Unit four is dolomitized at this outcrop. Fossiliferous horizons can be noted, with concave-down ostracod valves, brachiopods, and solitary rugose corals. Hemispherical stromatoporoids also present. Unit three is covered by talus; unit two can be seen in both subunits. Contact between unit one and overlying Thacher limestone is last mudcrack in unit one.

Glasco

The cherty coverstone marker bed essentially sits at the base of unit A. The chainstone lithology has thinned relative to the north, contains more matrix and few, if any, laminar stromatoporoids. The cyclic nature of floatstone and lamstone within unit B is best demonstrated at this locality. The base of unit C shows an unusual stromatoporoid growth form. A vertical channel wall and subsequent infillings are encrusted by stromatoporoid coenostea (Parallelostroma constellatum). Once again take note of of the laminar and hemispherical stormatoporoids that seem to co-exist at similar horizons.

Rosendale

This stop represents the standard reference for the Rondout Formation and the type section of the Wilbur member. Here all four units of the Rosendale dolostone can be seen. The cliff to the northeast shows an extensive sequence of all four units. Unit one can clearly be identified below the base of the Glasco. The massive limestone is mottled and the upper portion is darker than the bottom. The Wilbur, unit three, is sandwiched between the dolostone of unit two and unit four. Unit four lies with disconformity on the underlying Binnewater Sandstone.

0.9 Continue southwest on NY213. Cross over Rondout Creek Bridge.

0.1 After bridge turn left onto New Salem Road.

1.0 Proceed to Callanan's Quarry. Turn left into far entrance. Park in lot, keep roadway into pit open.

STOP 5: CALLANAN'S QUARRY. WAIVER FORMS MUST BE SIGNED RELEASING QUARRY AND ITS EMPLOYEES OF ANY LIABILITY, BEFORE ENTERING PREMISES. IT IS MANDATORY THAT HARD HATS AND FIELD BOOTS BE WORN - NO ONE ADMITTED WITHOUT SUCH SAFETY EQUIPMENT. FOLLOW FIELDTRIP LEADERS TO DESIGNATED LOCALITIES. DO NOT WANDER - EXTREMELY DANGEROUS OVERHANGS AND CLIFFS.

5A: CALLANAN'S WEST: FIELD ASSISTANTS WILL BE ON HAND TO ASSIST (ESPECIALLY KEEPING FIELDTRIP PARTICIPANTS AWARE OF DANGEROUS CLIFFS AND OVERHANGS). NO CLIMBING OF ANY SORT.

Whiteport

'Reef' subunit of unit two is present in this section. Undeformed halysitid coral found at this location. Unit four is almost completely dolomitized.

Glasco

Cherty boundstone marker bed is once again located near the base of unit A. Take a close look at the burrowed horizon and high matrix chainstone (rare entire halysitid coralla). Unit B is rather thick at this locality. Take some time to examine the stromatoporoid knobs and the overlying dolomitic mudstone and floatstone with occasional laminates, fossil debris and scattered hemispherical stromatoporoids. The latter was interpreted as a low subtidal to intertidal (?) flat environment.

Rosendale

At this outcrop all four units are present but due to faulting the beds are repeated several times. Unit one can be found sitting under the shale parting at the base of the Glasco. This mottled limestone has a parting at its base. Unit two massive dolostone has several partings. Unit three, Wilbur is mottled and also has several partings. The lower dolostone of unit four is massive with areas that are more calcareous. This dolostone lies disconformably on the underlying Binnewater Sandstone.

5B: CALLANAN'S EAST: ONCE AGAIN FOLLOW FIELDTRIP LEADERS. STAY AWAY FROM EDGE OF BENCH. DO NOT WANDER OR CLIMB!! FIELD ASSISTANTS ARE INSTRUCTED TO KEEP FIELD TRIP PARTICIPANTS AWAY FROM CLIFF. STAY AWAY FROM ROPED OFF AREA.

Whiteport

Unit four is no longer present; unit three is over seven feet in thickness. Unit two is much thinner in than the western side of the quarry, and, due to the less abundant fossils within the lower subunit, is now 'offreef'.

Glasco

This locality has been the most problematic to decipher due to its seemingly "unusual" character. With the help of marker beds in the Whiteport and Rosendale the intricate nature of this exposure appears to have been clarified. Unit A as usual contains a lower coverstone/boundstone but only fragments of the chainstone remain. Unit B does not contain subunit 1 but is represented by a thick subunit 2 (5.4 feet) consisting chiefly of dolomitic mudstones with fewer floatstones (somewhat cyclic). Some beds are laminated and burrowed. The base of the unit contains wide, deep, vertical burrows that appear related to a horizon on the west side. Unit C is represented by subunit 2 and its associated mixture of dolomitic mudstones and floatstones, rudstones, and black shale at the top. These lithologies contain more fossil debris and quartz grains. Only unit C, at other localities demonstrates these associations.

Rosendale

Unit one, the mottled limestone, is represented in the the cliffs (very dangerous do not climb up talus). Unit two and its subunit along with the Wilbur can be seen on several boulders lying near by. Unit two is massive dolostone which is somewhat calcareous. Again unit two subunit is present, a dolostone with continuous to discontinuous limestone stringers. Unit three, the Wilbur, is mottled, and fossiliferous along with clasts of sandstone present near the base. The Wilbur sits on top of Ordovician sediments at an angular unconformity . Most likely unit four was never deposited here.

END OF TRIP. HAVE A PLEASANT DRIVE HOME!