SEDIMENTOLOGY AND PALEONTOLOGY OF PORTIONS OF THE HAMILTON GROUP IN CENTRAL NEW YORK

by

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INTRODUCTION

The richly fossiliferous marine sedimentary rocks of the Middle Devonian Hamilton Group of Central and Western New York (fig. 1) have been the object of paleontologic, sedimentologic and stratigraphic studies for nearly 150 years. The purpose of this field trip is to introduce participants to various lithofacies and faunal assemblages which characterize the upper portion of the Hamilton Group in the area of its type section. We further hope that observation and discussion of sedimentary structures, lithologies and fossil occurrences in field exposures will illustrate the excitement and frustration inherent in paleoenvironmental interpretation.

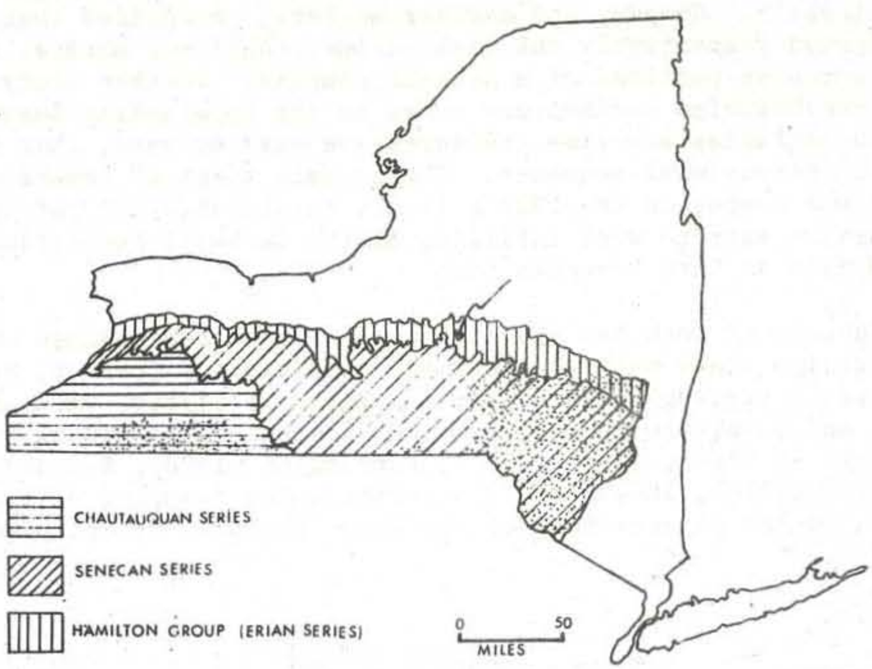

Fig. 1 - Distribution of Middle and Upper Devonian terrigenous clastic sedimentary rocks in New York State. Arrow indicates study area. (after Rickard 1975)

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PREVIOUS WORK

A list of early workers in Middle Devonian stratigraphy and paleontology of New York is graced by such eminent names as Hall, Clark, Prosser, Grabeau, and Cleland. These investigators recognized the major lithostratigraphic sequences of the Devonian and described the fauna, setting the stage for subsequent work. The studies of these men in the 1800's and early 1900's were carried out along strike of the major units. It was soon recognized that the faunal zones and prominent mappable strata that were easily recognizable in the western and central portions of the state were lost in less differentiable rocks to the east.

The work of G. Arthur Cooper in the late 1920's and early 1930's culminated in the definition of four formations which have since served as the basis for study of the Hamilton Group. Cooper (1930, 1933) based his subdivisions on three thin, but persistent limestone units which interrupted the terrigenous clastic sequence. Cooper further noted the existance of four major facies within the Hamilton Group: A "Marcellus" facies, consisting of dark shales with small, thin-shelled brachiopods and bivalves: a "Moscow" facies, consisting of blue-grey calcareous shales with an abundant and diverse marine fauna; a "Hamilton" facies, characterized by silty shales, siltstones and sandstones, bearing large brachiopods and bivalves; and a "Catskill" facies, consisting of red and green shales, siltstones and sandstones, often bearing non-marine plant fossils. Cooper, and earlier workers, recognized that these facies represented respectively the deep marine, shallower marine, transitional and non-marine portions of a deltaic complex. Further study of Middle and Upper Devonian sedimentary rocks in the Appalachian Basin revealed that these facies are time transgressive east to west, thus representing a large regressional sequence. The classic "facies" papers of Chadwick, Caster and Cooper in the 1920's firmly established the pattern of progressive east to west infilling of the Catskill depositional basin from Middle to Late Devonian time.

Subsequent work has shown that the faunal assemblages which characterize these major facies, and subdivisions thereof, are explicable in terms of varying water depth, turbidity, salinity, wave and current energy and substrate rheology in the original depositional environment. The works of Grasso (1970, 1973), Harrington (1970), Sutton, Bowen and McAlester (1970), Thayer (1973) are but a few examples of recent studies concerning the paleoecology of Mid-Upper Devonian deltaic sediments in New York.

TECTONIC SETTING

The paleotectonic regime of Mid-Upper Devonian time suggests that in the New York State region clastic sediments were shed from the rejuvenated Taconian mountains, uplifted during "Phase II" of the Acadian orogenic event. The miogeosynclinal basin which received these sediments was a rapidly subsiding downwarp on the edge of the continental crust. It is most probable that this basin formed as a result of isostatic adjustment to uplift to the east, in present-day New England. The

Catskill basin would therefore have formed via a "sea floor inversion" -- a process directly analogous to that described by Bird and Dewey (1970) for the Mid-Upper Ordovician of New York, resulting from the Taconian Orogenic event.

Devonian sedimentary rocks were deformed by the Alleghenian event in southeastern New York and adjacent Pennsylvania. This orogeny had only minor effect on the rocks of central New York. The only evidence of tectonic disturbance is a regional dip of 60-100 feet per mile (based on Skaneateles-Ludlowville contact) and a series of joints of unknown origin.

STRATIGRAPHY IN THE STUDY AREA

The Hamilton Group sediments in the Chenango Valley outcrop along the glaciated valley walls and in stream sections perpendicular to the north-south major valleys. More resistant sandstones and sandy limestones form caprocks of waterfalls in tributary streams. Excellent exposures of most of the units are also available in quarries and burrow pits excavated for road fill.

In all of New York State, the basal Hamilton Group sediments of the Marcellus Formation overly the Onondaga Limestone, apparently in a conformable fashion. In the study area the Marcellus formation consists of a basal black shale (Union Springs Member), succeeded by a black, cephalopod-bearing limestone (Cherry Valley Member), sandy shales (Bridgewater Member), sandy shales and siltstones (Solsville Member), and sandy shales, siltstones and sandstones (Pecksport Member).

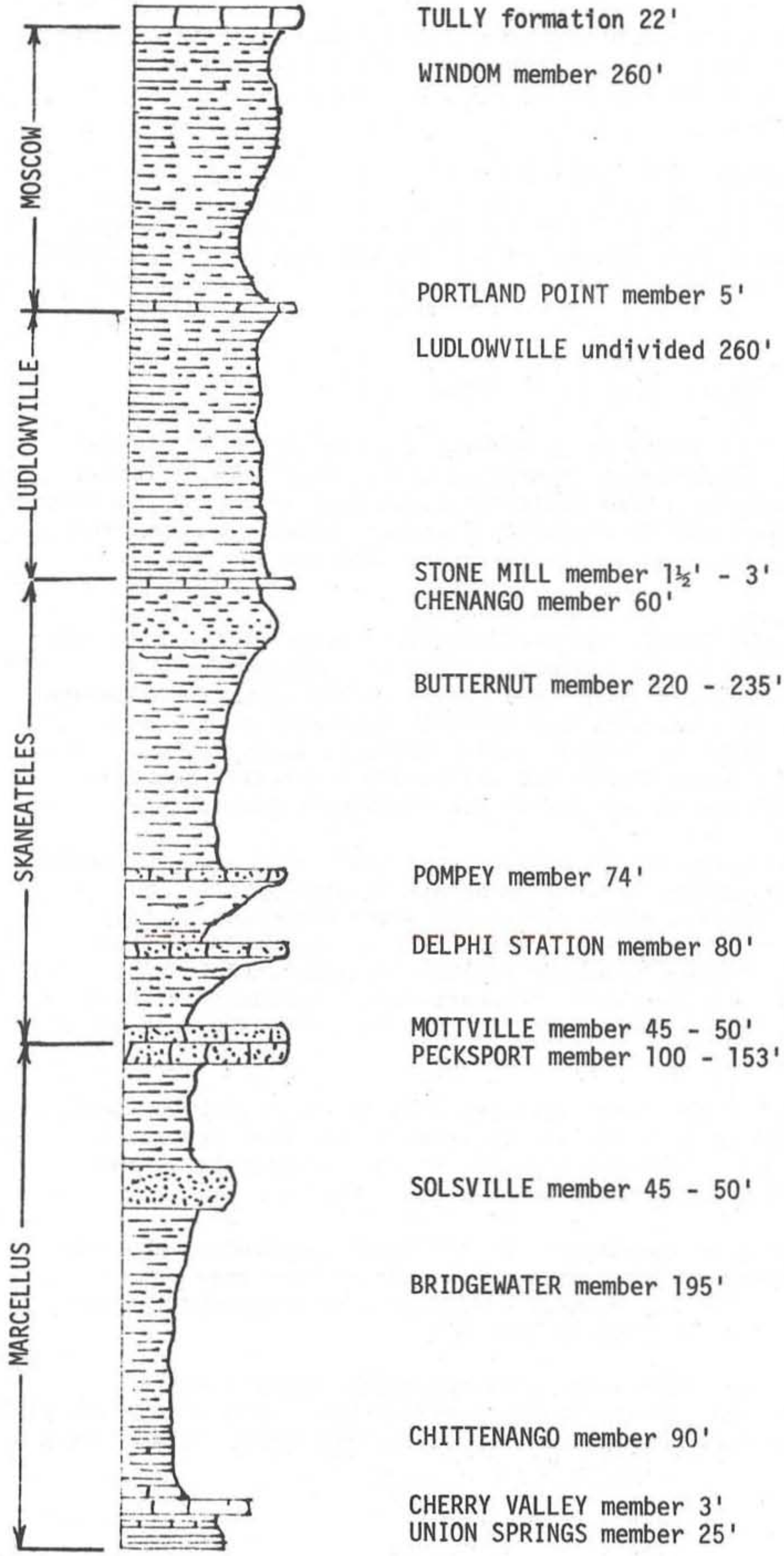
The Skaneateles formation is made up of a basal thin shaley limestone (Mottville = Stafford Member to west) overlain by sandy shales and sandstone (Delphi Member), black shales and sandy mudstones (Pompey Member), dark sandy shales (Berwyn Member), a fine grained sandstone with blue-gray sandy shales (Chenango Member - Colgate sandstone of Cooper (1930)), and a capping thin, discontinuous crinoidal limestone (Stone Mill Member, probably equivalent to the Centerfield Limestone further to the west).

The Ludlowville of the study area was undifferentiated by Cooper, consisting in general of grey shales and sandy shales with one thick (15-20') sandstone unit. The stratigraphy of the Ludlowville in the Chenango Valley is presently under study by the authors.

The Moscow formation consists of a thin basal calcareous sandstone (Portland Point Member) overlain by a thick unit of dark grey sandy shales and siltstones (Windom Member). A summary stratigraphic column for the Chenango Valley is shown in fig. 2.

The overlying Tully Limestone marks the Middle-Upper Devonian boundary in this region. In the Chenango Valley, the Tully is characterized by thin beds of limestone with interbedded silty and sandy shales. This

Fig. 2 - Stratigraphy of the Hamilton Group in the Chenango Valley



Adapted from G. A. Cooper (1930)

unit thickens into clastic correlatives to the east (Johnson and Friedman 1969), but thins and disappears into an erosional interval to the west (Rickard 1975).

SEDIMENTOLOGICAL FEATURES

To the casual observer, the shales, silstones, and fine-grained sandstones of the Hamilton Group in Central New York are a rather monotonous series of rocks. The more spectacular primary structures characteristic of shallow water limestone and coarse-grained sandstones are generally absent, and the fine-grained texture of most lithologies precludes simple thin-section examination. However, a number of useful primary and penecontemporaneous features can be discerned upon careful observation. These structures may often then be used for paleoenvironmental interpretation. A list of common features of interest to the sedimentologist follows.

Primary Structures

(1) Crossbedding - Many of the fine-grained sandstones of the Hamilton Group contain trough crossbedding and ripple laminations. These features indicate wave or current transport of the sediment and paleocurrent directions.

(2) Scour and Fill - Truncation of earlier bedding and subsequent filling of depressions with sediment indicates current activity.

(3) Graded Bedding - Single thin siltstone or sandstone beds often contain size gradation from coarse to fine upward. Such grading is usually caused by a single depositional event, related to storm surges or perhaps turbidity currents.

(4) Ripple Marks - These structures indicate wave or current activity on the substrate.

(5) Biogenic Structures - Tracks and trails left by burrowing organisms are common in many lithologies in the Hamilton Group. In general, intense bioturbation of sediment results in loss of primary stratification and indicates conditions suitable for infaunal benthos (sufficient oxygen, stable substrate). Single vertical burrows often indicate that animals lived below the sediment for protection from waves and currents, whereas horizontal trails may indicate quieter water conditions where grazing was possible. The paleoenvironmental requirements of the organism responsible for the common "rooster-tail" structure called Taonorus will be discussed in the field.

(6) Slumping, Load Casting, Ball and Pillow Structures - These features indicate post-depositional instability in sediments. Usually differences in density of various sediment layers promote the plastic flow of water-rich sediment following deposition. Large-scale soft-sediment deformation may indicate deposition on an initial slope or might be caused by outside disturbances such as storms or earthquakes.

(7) Parting Lineation - In the Hamilton Group, this feature is found only in the sandstones. These faint parallel structures on bedding surfaces are caused by unidirectional current flow over the substrate.

(8) Intraclasts, Mud Chips - Clasts of partially indurated sediment may be ripped-up from the substrate, transported and redeposited. These clasts are usually chips of grey or green shale in the Hamilton Group, and are confined to the coarser (sandstone) lithologies.

(9) Groove Casts and Tool Mark Casts - Sole markings indicating current activity and paleocurrent direction.

THE FAUNA

Paleoenvironmental reconstructions based only on the physical and chemical characteristics of sedimentary rocks are, of course, incomplete. The use of fossil assemblages as representative paleocommunities is an integral part of interpretation of sedimentary environments. However, the significance of paleocommunity data is dependent to a great degree on the knowledge of life habits and thus environmental requirements of groups of organisms. This knowledge stems in part from study of analogous living organisms, coupled with detailed morphological study of fossil groups. Care must be taken in paleocommunity studies, especially in assuring that samples are representative of a fossil assemblage, not simply specimens selected by a biased collector searching for large or impressive fossils.

With some degree of certainty, major faunal elements in the Hamilton can be assigned to certain habitat/feeding groups. Each group has certain habitat requirements which may then be used to infer characteristics of the depositional environment. The following feeding types are recognized for the purposes of this study.

(1) Vagrant Herbivores and Carnivores - These organisms were capable of directed motion on the sea floor. Some may have been swimmers (nektonic). They may have been herbivores, carnivores or detritus feeders, and their only common environmental requirement is oxygenated water and a food source. Because of a lack of more specific habitat requirements, these organisms are not highly diagnostic of any particular set of original environmental conditions. For many elements in this group, preservational happenstance appears to be the most important control over presence or absence. This group includes the following Hamilton genera:

Gastropods: Paleozygopleura, Bembexia, Ptomatis, Praematuratropis, Ruedemannia
Trilobites: Greenops, Phacops, Trimerus
Cephalopods: Orthoceras, Spyroceras, Tornoceras
Asterozoa: Devonaster

(2) Epifaunal Filter Feeders - Attached to the substrate, or lying sessile upon it, this group was dependent on constant wave or current action to supply micro-organisms and organic matter, which they subsequently

filtered from the water. In general, the presence of members of this group indicates oxygenated bottom waters and sufficient water movement to provide food. However, large influxes of sediment, or extremely active current/wave conditions might have prevented colonization. This group is represented in the Hamilton by large articulate brachiopods such as Spinocyrtia, Mucrospirifer, Tropidoleptus and Devonochonetes; the smaller articulate brachiopods Ambocoelia and Chonetes; and the epibyssate bivalves Leiopteria, Pterinopecten, and Pseudaviculopecten.

(3) Infaunal Filter Feeders - Members of this group lived buried or partially buried below the substrate and filtered food from the overlying bottom waters. Bivalves such as Cypricardella, Leptodesma, Actinopteria, Goniophora and Modiomorpha were probably attached to the sediment by byssus (endobyssate habit, Stanley 1968). Other members of this group, such as the bivalves Orthonota and Cimitaria were likely capable of burrowing, as was the inarticulate brachiopod Lingula. In general, this group had environmental requirements similar to the epifaunal filter feeders, although the infaunal group was undoubtedly more tolerant to fluctuations in turbidity, temperature and salinity.

(4) Infaunal Deposit Feeders - This group consists of those organisms which fed on organic material contained in the sediment. As such they are often found in fine-grained shales deposited under rather quiet water conditions, because fine muds generally contain high concentrations of organic material. The palp-feeding bivalves Nuculites, Nuculoidea and Paleoneilo characterize this group.

(5) Turbidity-Intolerant Filter Feeders - This group, although not functionally separable from the epifaunal filter feeders, are sufficiently different (by analogy with modern groups) in turbidity tolerance to warrant attention. The organisms in this group required clear, well-oxygenated water, and were highly susceptible to sediment-clogging of their filter-feeding mechanisms. They are thus indicative of rather low rates of sediment influx and agitated water conditions. Examples from the Hamilton of the study area include the corals Microcyclus and Favosites, the bryozoans Sulcoretepora and Taeniopora and various crinoids.

Substrate Requirements

The lack of, or limitations of, attachment mechanisms in various sessile benthonic organisms may restrict certain groups to specific substrate types. For instance, the larger peduculate articulates such as Mucrospirifer and Mediospirifer were likely limited to firm substrates or those where shell material was available for attachment. In contrast, the spinose chonetids were well-adapted to a soft mud substrate, living snow-shoe-like on the soft bottom. The apparent lack of attachment mechanisms in the chonetids would preclude their existance in wave- or current-churned environments.

Species Density and Diversity

The density of a given species (number/unit volume of rock) is a rough indicator of the suitability of a given environment for that organism. However, one must use caution in interpreting such data, because preservational bias may selectively concentrate individuals of a given species.

Diversity refers to the numbers of different species found. Low diversity often indicates rigorous conditions which prevented the growth of all but a few species. High diversity generally indicates more suitable or less variable environmental conditions. Again, preservational bias may drastically change the original species diversity.

Fossil Occurrence

Fossils in all lithofacies of the Hamilton are found in two different types of occurrences; coquinite and non-coquinite assemblages. Coquinite assemblages occur within shell-rich lenses or stringers, whereas non-coquinite assemblages are characterized by single fossils more or less surrounded by sediment. Sutton, Bowen and McAlester (1970) speculated that the coquinite lenses of the Upper Devonian Sonyea Group of south-western New York were formed by the winnowing of finer sediment from previously deposited material, leaving a lag concentrate of shell material. Such winnowing of the substrate would have taken place during storm, spring tide or flood season situations.

Coquinite assemblages of the Hamilton Group appear to be of two types. One is similar to those described by Sutton, Bowen and McAlester (1970). These coquinites are seen at the base of large scours or channels and contain numerous disarticulated and broken shells. A second type of coquinite is commonly found in the dark silty shales of the Ludlowville and Moscow Formations. This type is characterized by concentrations of whole and articulated shells, with abundant small phosphate nodules. We theorize that this second type of coquinite represents a period of little or no clastic influx and a substrate inhabited by a dense benthic shelly fauna, with the phosphate nodules forming penecontemporaneously during the depositional hiatus. This second type of coquinite often contains small specimens of the colonial coral Favosites perhaps indicating low rates of clastic influx.

Faunal Lists

The faunal lists which follow are included to assist the collector in identification of specimens from the four major collecting stops. They are partial and generally include only the more common species at each locality. More detailed discussions of faunal distribution and abundances are included in the stop descriptions contained in the road log.

Faunal Distribution

Faunal counts to date are included in the description of each stop in the road log. Hopefully, their inclusion will provide a basis for substantive discussion in the field.

PARTIAL FAUNAL LIST - BRIGGS ROAD

Brachiopods

Ambocoelia umbonata
Mucrospirifer mucronatus
Spinocyrtia granulosa
Devonochonetes coronatus
Chonetes scitula
Tropidoleptus carinatus
Athyris sp.
Rhipidomella penelope
Schuchertella peruersa
Elita fambriata
Pustulatia pustulosa
Protoleptostrophia perplana
Stropheodonta demissa
Camarotoechia congregata

Molluscs
Bivalves

Paleoneilo muta
P. emarginata
P. plana
P. maxima
Nuculoidea lirata
N. bellistriata
N. varicosa
Cimitaria recurva
C. corrugata
Cypricardella bellistriatus
Nuculites triqueter
Grammysia arguata
G. alueata
Grammysia sp.
Leiopteria deskayi
Leiopteria sp.
Actinopteria decussata
Sanguinolites solenoides
Limoptera macroptera
Goniophora rugosa
Pterinopecten vertumnus
Parallelodon hamiltonae

Gastropods

Bembexia sp.
Ptomatus patulus
Paleozygopleura hamiltonensis

Cephalopods

Spyroceras crotalum
Tornoceras sp.
"*Orthoceras*" sp.

Arthropods

Greenops boothi
Phacops rana
Trimeris dekayi

Bryozoa

Fenestella sp.
Taeniopora exigua
Sulcoretopora sp.

Miscellaneous

Pelmatozoan debris

PARTIAL FAUNAL LIST - GEER ROAD

Brachiopods

Spinocyrtia granulosa
Mucrospirifer mucronatus
M. consobrinus
Mediospirifer audaculus
Ambocoelis umbonata
Athyris subtilita
Athyris sp.
Tropidoleptus carinatus
Schuchertella cf. perversa
Chonetes scitula
Chonetes sp.
Rhipidomella penelope
R. oblata
Protoleptostrophia perplana
Leptaena sp.
Stropheodonta sp.

Molluscs
Bivalves

Grammysia secunda
G. arcuata
Modiomorpha concentrica
M. regularis
Cypricardella sp.
Mytilarca gibbosa
Paracyclas elliptica
Nuculoidea corbuliformis
N. lirata
N. varicosa
Paleoneilo maxima
Leiopteria conradi
Pholadella radiata
Parallelodon hamiltonae

Gastropods

Ruedemannia trilex
Ptomatis leda
Loxonema delphicola

Cephalopods

Spyroceras crotalum
"Orthoceras" sp.

Arthropods

Greenops boothi

Coelenterates

Favosites sp.
Aulopora tubaeformis

Bryozoa

Fenestella sp.

PARTIAL FAUNAL LIST - PIERCEVILLE QUARRY

LUDLOWVILLE FORMATION, HAMILTON GROUP

Coelenterata

Aulopora elleri
Favosites sp.

Bryozoa

Sulcoretepora incisurata

Brachiopods

Petrocrania hamiltoniae
Lingula punctata
Lindstroemella aspidium
Mucrospirifer mucronatus
Spinocyrtia granulosa
Mediospirifer audaculus
Ambocoelia umbonata
Athyris spiriferoides
Tropidoleptus carinatus
Rhipidomella penelope
Protoleptostrophia perplana
Devonochonetes coronatus
Longispina mucronatus
Devonchonetes syrtalis
Chonetes vicinus
Spinulicosta spinulicosta
Cyrtina hamiltonensis
Elita fimbriata

Molluscs
Bivalves

Solemya vetusta
Orthonota undulata
Grammysia bisulcata
G. arcuata
G. cuneata
G. globosa
Nuculoidea corbuliformis
N. opima
N. lirata
Nuculites oblongata
N. triqueter
Palaeoneilo constricta
P. emarinata
P. fecunda
P. muta
P. plana
Parallelodon hamiltoniae
Ptychopteria (Actinoptera) decussata
A. boydi
Ptychopteria (P.) flabellum
Leptodesma (Leiopteria) sayi
L. rafinesquii
Pseudaviculopecten fasciculatus
Lyriopecten macrodontus
Pterinopecten undosus
Modiomorpha cencentrica
M. mytiloides
Pholadella radiata
Cypricardella tenuistriata
Cimitaria recurva
Goniphora hamiltonensis

Gastropoda

Ptomatis rudis
Naticonema lineata
Palaeozygopleura hamiltoniae
Ruedemannia trilix
Platyceras sp.
Dictyotomaria capillaria

PIERCEVILLE QUARRY (continued)

Cephalopoda

Tornoceras discoidea
"Orthoceras" sp.
Spyroceras crotalum

Hyolithida

Hyolithes neapolis

Tentaculitida

Styliolina sp.

Arthropoda

Greenops boothi
Phacops rana
Dipleura dekayi
Echinocaris punctata
Rhinocaris columbina

Annelida

Taonurus

Plants

Protolepidodendron sp.

PARTIAL FAUNAL LIST - DEEP SPRING ROAD

Brachiopods

Mucrospirifer mucronatus
M. consobrinus
Chonetes scitula
Athyris subtilita
Athyris cora
Athyris sp.
Devonochonetes syrtalis
Protoleptostrophia perplana
Ambocoelis umbonata
Mediospirifer audaculus
Spinocyrtia granulosa
Tropidoleptus carinatus
Rhipidomella penelope
Camarotoechia sp.
Rensselandia sp.

Molluscs
Bivalves

Nuculoidea lirata
N. bellistriata
N. randalli
N. corbuliformis
Paleoneilo muta
P. constricta
P. emarginata
Cypricardella bellistriata
Prothyris lanceolata
Nuculites oblongatus
Pholadella radiata
Leiopteria dekayi
Actinopteria sp.
Parallelodon sp.
Tellinopsis subemarginata
Pterinopecten vertumnus
Modiomorpha mytiloides
Orthonata carinata
Actinodesma erectum
Modiella pygmaea
Goniophora hamiltonensis

Gastropods

Ptomatis leda
Praematuratropis ovatus
Ruedemannia trilex
Dictyomaria capillaria
Platyceras carinatum
Loxonema hydraulicum
Loxonema cf. laeviusculum
Loxonema sp.

Monoplacophorans

Cyrtonella pileolus

Cephalopods

Spyroceras crotalum
"Orthoceras" sp.

Arthropods

Greenops boothi

Bryozoa

Taeniopora exigua

DEEP SPRING ROAD (continued)

Incertae Sedis
Hyolithidae

Hyolithes aclis

Coleolidae

Coleolus tenuicinctum

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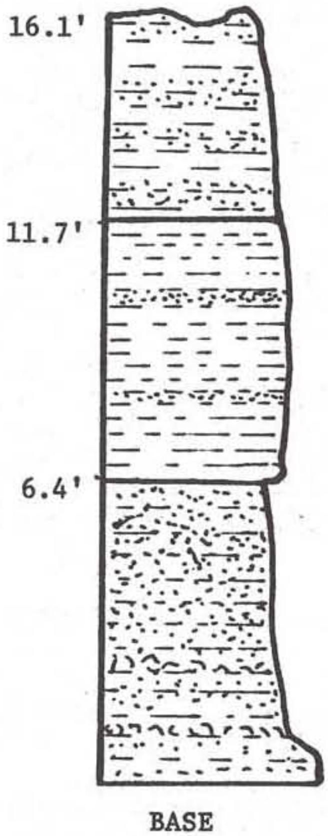
ROAD LOG

Cumulative Mileage	Mileage from last stop	Location
0.0	0.0	Entrance to village of Hamilton, NYS Route 12B, heading north.
0.20	0.20	College Street entrance to Colgate University campus, turn right (east).
0.55	0.35	Intersection by Administration Building; turn right (south). Proceed up hill.
0.80	0.25	Second right; turn right (southwest).
1.10	0.30	Circular drive, park on grass. Walk east up entrance road to Colgate University quarry (approx. 450 yards).
		Stop #1. Colgate Quarry - Chenango Sandstone (Upper Skaneateles Formation).
		Remarks: Most of the buildings of Colgate University are constructed of the thin- to medium-bedded, fine grained Chenango sandstone (= Colgate sandstone of Cooper, 1930) exposed here. A series of nearly perpendicular vertical joints made quarrying a rather simple process. Noteworthy feature, here are the large slump structures in the lower portion of the exposure. The fauna is largely dominated by Tropidoleptus, Mucrospirifer and numerous epifaunal and semi-infaunal bivalves. The asterozoan Devonaster has been reported, but is quite rare.
		Return to Cars.
1.10	0.0	Return to NYS Route 12B.
1.95	0.85	Intersection with NYS Route 12B - cross NYS Route 12B, proceed west on College Street.
2.50	0.55	Intersection with Lebanon Street (becomes Hamilton Road). Turn left (south).

Note: Field trip begins at southern village limits, Hamilton, New York, on NYS Route 12B, heading north. Mileage to nearest 0.05 odometer miles.

4.15	1.65	Hamlet of Randallsville - bear right (west) at intersection. Continue west on Hamilton Road.
4.40	0.25	Intersection with River Road - turn left (south).
4.90	0.50	Intersection with Briggs Road - turn right (west).
6.45	1.55	Stop #2. Briggs Road Quarry - upper portion of Ludlowville Formation. (Description on following page.)
6.45	0.00	Continue SW on Briggs Road.
7.00	0.55	Intersection with Lebanon Center Road - turn right (west).
7.70	0.70	Intersection with Bastian Road - turn right (north).
8.05	0.35	Intersection with Reservoir Road - continue north (bear right).
8.50	0.45	Intersection with Lebanon Hill Road - continue north (bear left).
9.15	0.65	Intersection with Geer Road - turn left (west).
10.10	0.95	Quarry entrance - small dirt road on right. Park on shoulder, walk north approximately 150 yards. Stop #3. Geer Road Quarry - upper portion of Ludlowville Formation. (Description on following page.) Remarks: This quarry provides an opportunity to observe and contrast the two types of coquinites which are characteristic of the Hamilton in this region. Approximately 2.1 feet from the base of the section a phosphate nodule-bearing coquinite is exposed. A similar bed is present at 14.2 feet. Other (storm lag ?) coquinites are scattered throughout the section, especially from 15.5 to 20 feet in the section.
10.90	0.80	Intersection with Bradley Brook Road - turn right (north).

STOP #2 -- BRIGGS ROAD QUARRY

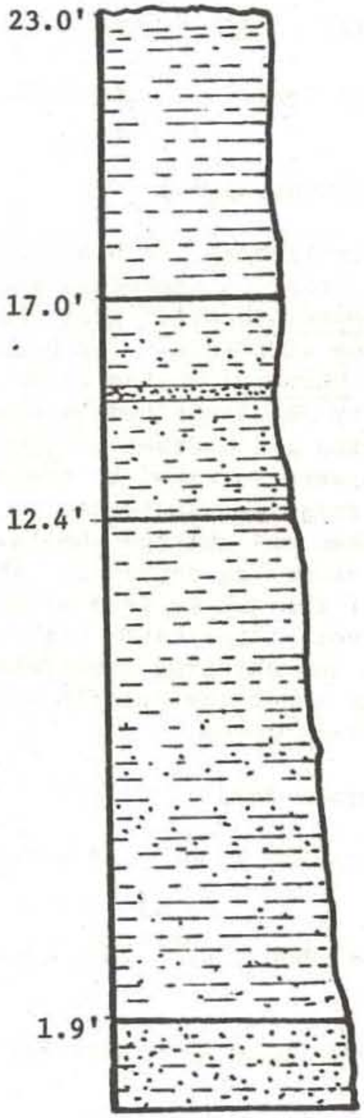


LITHOLOGY	FAUNA
Green-gray micaceous laminated siltstone with interbeds of gray calcareous shale.	Epifaunal F. F. - 78% Infaunal F. F. - 3% Infaunal D. F. - 15% Vagrant H.+C. - 2% Turbid-Int. F.F.- 2%
Gray silty shale with 1-3" thick beds of laminated and rippled siltstone.	Epifaunal F. F. - 77% Infaunal F. F. - 2% Infaunal D. F. - 12% Vagrant H.+C. - 4% Turbid-Int. F.F.- 5%
Gray micaceous siltstone	Epifaunal F. F. - 94% Infaunal F.F. - 2% Infaunal D.F. - 3% Vagrant H.+C. - 1% Turbid-Int. F.F.- 0%

DOMINANT GENERA

Upper siltstone:	Ambocoelia	- 20%
	Spinocyrtia	- 17%
	Elita	- 15%
	Nuculoidea	- 12%
Middle shale:	Ambocoelia	- 25%
	Chonetes	- 20%
	Spinocyrtia	- 17%
	Nuculoidea	- 8%
Lower siltstone:	Chonetes	- 37%
	Devonochonetes	- 19%
	Tropidoleptus	- 16%
	Mucrospirifer	- 9%

STOP #3 -- GEER ROAD QUARRY

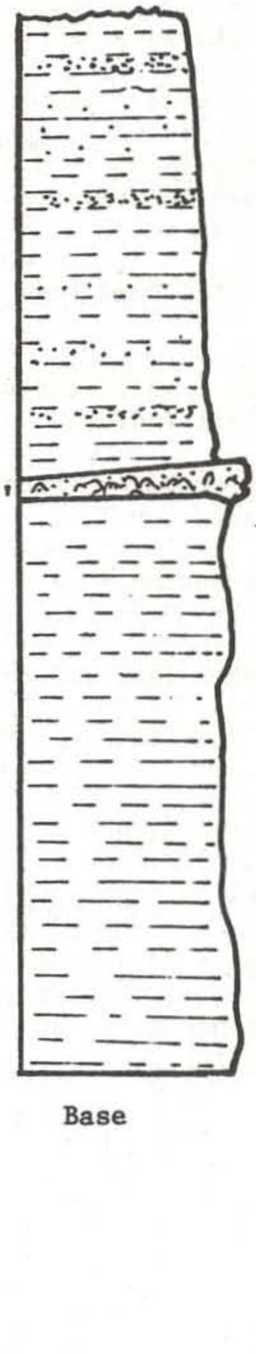


LITHOLOGY	FAUNA
Crumbly to fissile gray shale.	_Chonetes_ and _Ambocoelia_ dominant
Gray silty shale with light brown laminated and rippled thin beds of siltstone	
Dark gray fissile silty shale grading upward into crumbly dark gray shale.	_Chonetes_ and _Ambocoelia_ abundant
Dark brown silty calcareous shale.	Bivalves abundant

11.80	0.90	Intersection with Soule Road - turn left (west).
11.90	0.10	Quarry entrance on left. Park on shoulder.
		Stop #4. Pierceville Quarry - Ludlowville Formation.
		(Description on following page.)
		Remarks: Three major lithofacies/biofacies are exposed at this stop. A *Chonetes*-bearing dark shale, a *Spinocyrtia*-bearing grey shale and a bivalve-bearing siltstone. The patchy distribution of the *Chonetes* in the lower section of the quarry was described by Linsley, et al. (1972). Strips and patches of *Chonetes* on bedding surfaces were ascribed to areas of grass-covered and grass-free sediment. Coquinites with broken and abraded shells were thought to be storm lag deposits. The uppermost portion of the quarry is a siltstone with abundant bivalves. Apparently higher rates of deposition and shifting substrates precluded the domination of the sessile epifaunal articulate brachiopods.
11.90	0.0	Return to Bradley Brook Road.
12.00	0.10	Intersection with Bradley Brook Road - Turn right (south).
14.75	2.75	Intersection with Lebanon Road - turn right (west).
18.50	3.75	Intersection with NYS Route 26 - turn left (south).
20.30	1.80	Georgetown Village - intersection with East Hill Road - turn left (east).
21.10	0.80	Outcrop on right - park on shoulder.
		Stop #5. East Hill Road - Georgetown. Moscow-Tully Contact.
		Remarks: The silty shales and siltstones of the uppermost Moscow Formation are seen here overlain by the Upper Devonian Tully Formation. The Moscow here is dominated by large articulate brachiopods and bivalves, with numerous, well-preserved trilobites, particularly *Phacops*.

STOP #4 -- PIERCEVILLE QUARRY

27.5'



15.0'

Base

LITHOLOGY	FAUNA
Dark gray to brown shaley siltstone. Occassional rippled siltstone beds.	Various infaunal and epifaunal bivalves.
Gray calcareous shale	_Spinocyrtia_ dominant
Crumbly to fissile dark gray shale	_Chonetes_ dominant.

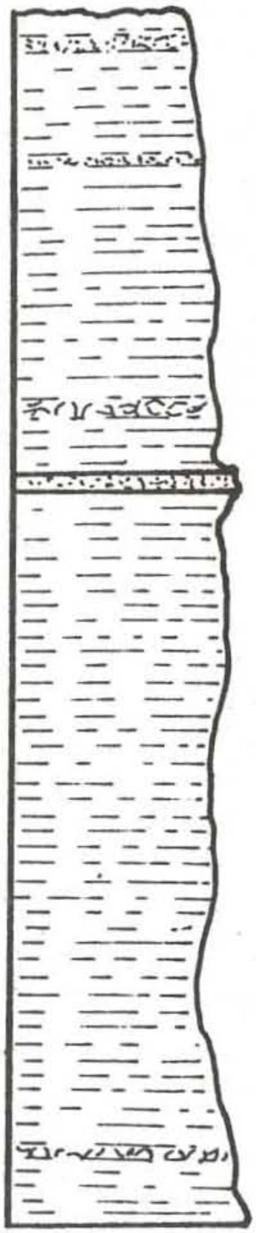
The contact is placed at the base of the first thin blue-grey limestone. Several thin (2-6") beds of limestone, separated by calcareous siltstone, characterize the Tully here. The Tully at this location is rather sparsely fossiliferous, with a few solitary argose corals and the colonial Favosites most prevalent. Hypothyridina, the diagnostic Upper Devonian Rhynconellid, has been reported in the Tully here, but is quite uncommon.

21.10	0.0	Continue east on East Hill Road (becomes South Lebanon Road).
24.75	3.65	Hamlet of South Lebanon - intersection with Campbell Road - turn left (north).
26.35	1.60	Hamlet of Lebanon - intersection with Lebanon Road - turn right (east).
28.00	1.65	Intersection with Deep Spring Road - turn right (south).
29.20	1.20	Quarry entrance on right - park on shoulder.
		Stop #6. Deep Spring Road Quarry - Moscow Formation.
		(Description on following page.)
29.20	0.0	Turn around - return to Lebanon Road.
30.40	1.2	Intersection with Lebanon Road - end of trip. (To return to NYS Route 12B, turn right (east) on Lebanon Road. Continue east approximately 4.5 miles to NYS Route 12B.)

End Road Log

STOP #6 -- DEEP SPRING ROAD QUARRY

38.0'



23.0'

BASE

LITHOLOGY	FAUNA
Fissile dark gray silty shale. Occassional thin siltstone beds. Prominent coquinite at 27'	Epifaunal F.F. - 92% Infaunal F. F. - 0% Infaunal D.F. - 6% Vagrant H.+C. - 2% Turbid-Int. F.F. - 0%
Brown siltstone with ripple laminations and groove casts.	Epifaunal F.F. - 77% Infaunal F.F. - 6% Infaunal D.F. - 8% Vagrant H.+C. - 9% Turbid-Int. F.F. - 0
Dark gray to light gray fissile slightly silty calcareous shale. Phosphate-bearing coquinite near base.	Epifaunal F.F. - 54% Infaunal F.F. - 10% Infaunal D.F. - 28% Vagrant H.+C. - 8% Turbid.-Int. F.F.- 0%

DOMINANT GENERA

Upper shale:	Chonetes	- 65%
	Spinocyrtia	- 14%
Middle Siltstone:	Chonetes	- 52%
	Mucrospirifer	- 20%
	Paleoneilo	- 8%
Lower shale:	Chonetes	-36%
	Nuculoidea	-20%
	Mucrospirifer	-11%
	Paleoneilo	- 8%