TRIP A-1

DEVONIAN STRATIGRAPHY AND PALEOECOLOGY IN THE CHERRY VALLEY, NEW YORK REGION

by

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PROLOG

In the northern parts of Otsego and Schoharie Counties, New York and bordering the southern margin of the Mohawk Lowlands and the northern margin of the Allegheny Uplands, is an exceptionally well exposed Early and Medial Devonian (400-365 million years old) sequence. These flat-lying sedimentary rocks record a broad spectrum of paleoenvironments. It is my intention to introduce you to the physical and organic makeup of these Devonian strata and to show how their combined characteristics enable a reconstruction of past environments and their associated role in the events of geologic history.

ACKNOWLEDGEMENTS

Gwyneth Gillette and John B. Skiba, cartographers with the N.Y. Geological Survey, prepared Figures 1 and 2-3, respectively. For their contribution to the better understanding of Devonian geology in the Cherry Valley region, I am deeply grateful.

HISTORY OF PREVIOUS WORK

As early as the 1820's and 1830's, exquisite fossils were collected by the Gebhards, John Sr. and Jr., from the Devonian rocks of their native Schoharie Valley - a reference area bordering the Cherry Valley region to the southeast. The establishment of the Geological and Natural History Survey of New York on April 15, 1836 was a tremendous impetus toward learning more about the State's rocks. William W. Mather's First (eastern) District Report (1843) and Lardner Vanuxem's Third (central) District Report (1842), both classics in early American geology, covered Schoharie and Otsego Counties, respectively. The descriptions of the rocks with their entombed fossils are amazingly complete and a testimony to the meticulosity and perspicuity of these indefatigable pioneer field geologists.

The field geologists of the Seward Survey of 1836-41 were responsible for establishing the first formal stratigraphy of the Devonian rocks examined on this trip. Vanuxem, especially, was the perceptive observer who categorized the sub-divisions of the "Helderberg Division":

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Vanuxem's units	Modern name
Corniferous limestone (Selenurus limestone of Gebhard)	Moorehouse Member of Onondaga Limestone
Onondaga limestone (gray sparry limestone of Eaton)	Edgecliff Member of the Onondaga Limestone
Schoharie grit	Schoharie Formation
Cauda-galli grit (Cocktail grit of Dr. James Eights)	Carlisle Center Formation and Esopus Formation
Oriskany sandstone	Oriskany Sandstone
Upper Pentamerus limestone (Scutella ls.)	Becraft Limestone
Delthyris shaly limestone (Catskill shaly)	New Scotland Limestone
Lower Pentamerus limestone	Coeymans Limestone
Water Limestone (Tentaculite limestone and hydraulic limestone of Eaton)	Manlius Limestone and Rondout Formation
Pyritous shales	Brayman Shale

Note: Today, only the Manlius thru Port Ewen limestones (Becraft of this area) comprise the Helderberg Group.

Among the oldest reported fossils in New York is the crinoid *Melocrinus (Astrocrinites) pachydactylus* (Conrad) from Lasall Park, Schoharie. This was first illustrated in a Schenectady newspaper in 1835. Another early recognized unique fossil, is the interesting cystid *Lepocrinites gebhardii*, first distinguished by Timothy A. Conrad (1840, p. 207), paleontologist with the Seward Survey. Both of these pelmatozoans were found in strata referable to the Coeymans Limestone.

Following the dissolution of the Seward Survey of 1836-1841, James Hall, America's most colorful and prestigious invertebrate paleontologist, assumed the monumental task of describing New York's fossils and issuing monographs of them (Hall, 1861-1894). Using much of the Gebhard's collection and relying on younger John's field work for Mather's report, Hall described and illustrated hundreds of fossils from the Devonian strata of eastern New York State.

During the early 20th century, the splendid, well illustrated, monograph "Geology and Paleontology of the Schoharie Valley", by Amadeus W. Grabau (1906) excelled as the preeminent reference to the Devonian rocks of the area. The most exhaustive paleontologic and stratigraphic study of the Hamilton Group of New York was conducted by G. Arthur Cooper (1930, 1933); these accounts are but condensations of his voluminous Yale doctoral thesis. The Onondaga Limestone received intensive paleontologic and stratigraphic study by Oliver (1954), who applied subdivision names. Goldring and Flower (1942, 1944) rightly recognized that the Carlisle Center Formation should be separated from

the Esopus as a distinct formation. During the summer of 1953, Lawrence V. Rickard commenced his stratigraphic studies of the Helderberg Group. His field studies resulted in a comprehensive work on the Helderberg Group (1962) and, with Donald H. Zenger, in the mapping of the Stratigraphy and Paleontology of the Richfield Springs and Cooperstown Quadrangles, adjacent to Cherry Valley on the west (1964). Subsequent paleoecological studies of the Manlius and Coeymans Limestones were made by Laporte (1963, 1967) and Anderson (1967), respectively.

My involvement with Devonian rocks of eastern New York began in the summers of 1946 and 1947 while mapping the bedrock geology of the Fonda 15' Quadrangle for a master's thesis; subsequently, the Devonian strata of the westerly adjacent Canajoharie 15' quadrangle were mapped during the summers of 1952 and 1954 and updated in 1959, 1977, and 1978. The results are incorporated in a project covering fifteen 7½' quadrangles on the bedrock geology of the central Mohawk Valley,----to appear in the N.Y. State Museum, Map and Chart Series.

PHYSIOGRAPHY AND GEOLOGIC SETTING

The area to be examined occurs along the southern margin of the Mohawk Valley Lowlands and the northern margin of the Allegheny Uplands and forms a belt along U.S. 20 (Figure 1). The Mohawk Lowlands farmland is floored with Upper Cambrian, Lower Ordovician, and Middle Ordovician sandstones, dolostones, limestones, black shales, and gray shales and siltstones. Resting disconformably atop the siltstones and shales (Frankfort) is a thin representative of Upper Silurian pyritiferous and gypsiferous shales (Brayman), dolomitic limestones (Cobleskill), and argillaceous dolostones (Chrysler). A north-facing escarpment, the western extension of the more pronounced Helderberg Escarpment to the east, consists of Lower Devonian limestones (Helderberg Group), Lower Devonian sandstone and siliceous shales (Tristates Group), capped by another carbonate terrace of Onondaga Limestone. The prominent rounded hills south of the Cherry Valley-Sharon Springs region consist of shales and siltstones of the Middle Devonian Marcellus Formation of the Hamilton Group. These "Cherry Valley Hills" may be considered as foothills of the Catskill Mountains, a dissected plateau of flat-lying sedimentary rocks and the northeastern portion of the Allegheny Uplands.

North of the Mohawk Valley are the very maturely eroded Adirondack Mountains, consisting of Middle Proterozoic (Helikian) metamorphosed rocks, which unconformably underlie the flat-lying Upper Cambrian sandstones and dolostones. Block faulting has dissected the Mohawk Valley to create a horst and graben topography; these faults increase in throw to the north and hinge-out or disappear under the Silurian strata. No evidence is known that these faults cut the Silurian or Devonian strata. The Devonian escarpment is notched by many north-flowing streams. The positioning of some of these seems to be influenced by low anticlines with an amplitude to wave length ratio of greater than 1:50. The headwaters of Canajoharie Creek, occupying the valley upon which the village of Cherry Valley lies and over which Judd's Falls occurs, is carved into one of these low anticlines. Six miles to the east, Sharon Springs, too, seems to lie on one of these low, breached anticlines.

Karst topography, the chemical perforation of the limestones of the landscape by sink holes and widened joint crevasses, is prevalent in this region. Most of the sinks are developed in the Coeymans and Manlius Limestones.

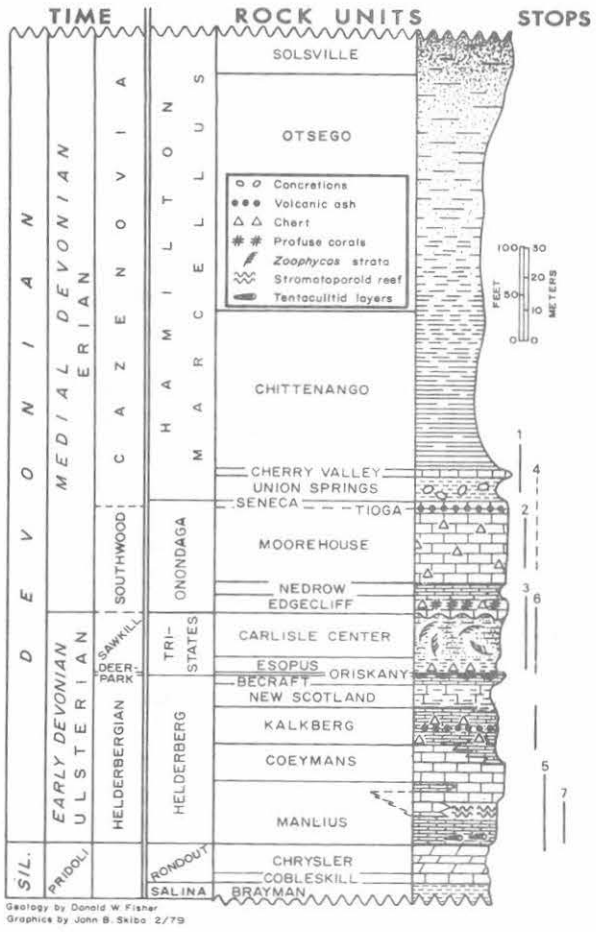

Figure 2
Stratigraphic column: Devonian and Silurian strata in Cherry Valley-Sharon region (Sprout Brook and Sharon Springs 7½' quadrangles).

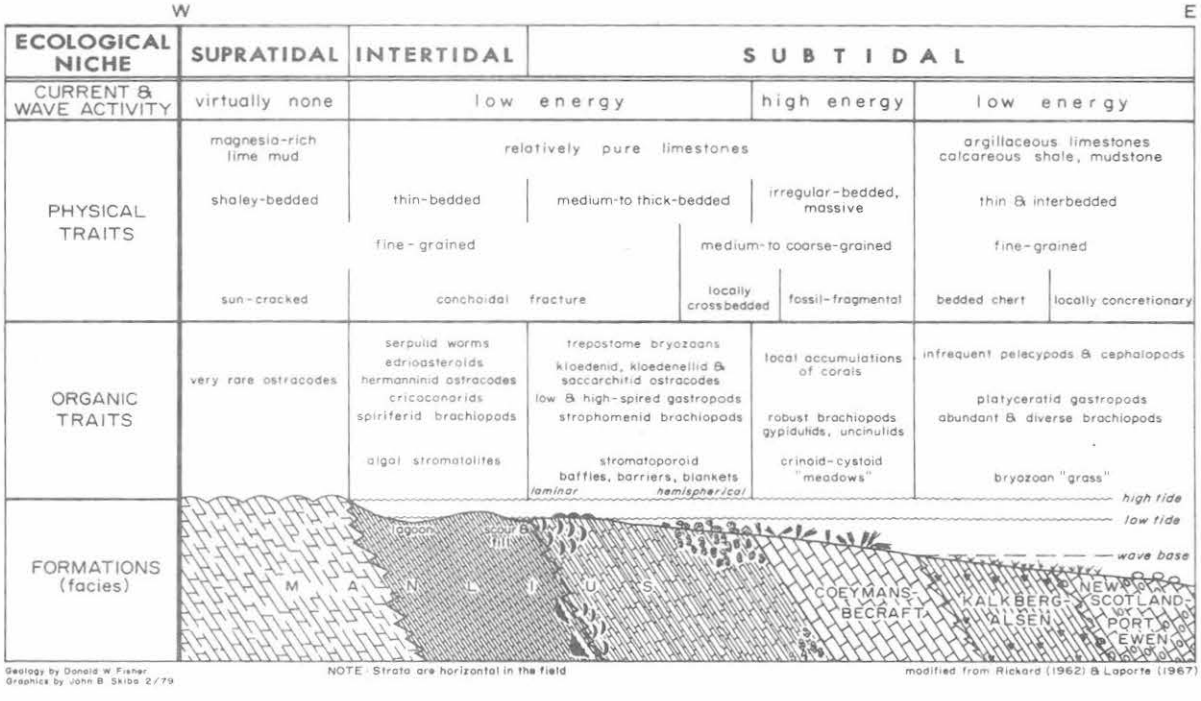

Figure 3. Paleoecology profile: Lower Devonian Helderberg facies in eastern New York State.

STRATIGRAPHY AND PALEOECOLOGY
(Figures 2 & 3)

PRE-DEVONIAN ROCKS

Directly beneath the Early Devonian Manlius strata of this region are the Late Silurian Rondout and Brayman Formations, respectively. The Rondout is divisible into an upper Chrysler Dolostone Member and a lower Cobleskill Limestone Member; the two are vertically gradational. The Cobleskill contains diagnostic Late Silurian fossils, foremost of which is the "chain" coral *Halysites*. The Chrysler has not yielded diagnostic fossils for age determination hence it is uncertain whether this thin unit should be classed as latest Silurian or earliest Devonian; I prefer to regard it as Silurian. The Brayman Shale has yielded Late Silurian fossils (Fisher and Rickard, 1953, p. 8) establishing a Pridolian age. Except for the subtidal coral-bearing rocks, these Upper Silurian units were formed in shallow hypersaline waters largely within the supratidal and intertidal zones.

In proceeding north from the Cherry Valley region, Upper Silurian strata rest unconformably on peneplained Upper Ordovician Frankfort gray shales and argillaceous siltstones which, in turn, rest on Utica black shale. Successively beneath the Utica are thin Middle Ordovician Trenton and Black River limestones. These limestones (not everywhere the same) rest, disconformably on Lower Ordovician Tribes Hill dolostones and dolomitic limestones and Upper Cambrian Little Falls Dolostone. Unconformably beneath these Early Paleozoic strata are Proterozoic rocks metamorphosed during the Grenville Orogeny of 1,100-975 million years ago. The Cambrian and Ordovician carbonates represent shallow water supratidal, intertidal, and subtidal deposits on an ancient continental shelf; the Ordovician pelites are basinal deposits formed some 450 million years ago, on this downwarped shelf during the Taconic Orogeny. About 450 m (≈1500 ft) of Ordovician and Cambrian strata lie between the Silurian and Proterozoic rocks.

DEVONIAN ROCKS

Helderberg Group (for details, see Rickard 1962)

Manlius Limestone (Vanuxem, 1840, p. 376) STOPS 5 & 7

The Manlius Formation consists of several members throughout its extent from Port Jervis to the Manlius region, Onondaga County. In the Cherry Valley area, the Thacher Member (Rickard, 1962, p. 43-54) enters from the east as a basal unit. At the west edge of the Sprout Brook Quadrangle the Thacher changes physically and organically to a thicker-bedded less fossiliferous unit termed Olney westward. Furthermore, between a lower Coeymans and upper Coeymans, there appears an intervening Manlius lithology (Elmwood Member).

The Thacher Limestone is a very light gray to white weathering, dark gray to black, thin to thick bedded, fine to medium grained limestone with rare calcareous shale interbeds and rare crossbedding in some few coarser

beds. The thinner bedded (ribbon limestones) and blocky medium bedded layers break with a conchoidal fracture and "ringing" sound. Fossils are abundant but only a few species are represented. Cabbage-like stromatoporoid reefs and baffles are locally present at the top of the Thacher. The tentaculitid *Tentaculites gyracanthus* and the ostracode *Hermannina alta* are ubiquitous in the ribbon strata, together with rare edrioasteroids *Postibula* n.sp., scarce bryozoans, and common spiriferid brachiopods *(Howellella vanuxemi)*; low-and high-spired gastropods are more common in the reefs and baffles.

The Thacher represents at least three different environments (Figure 3); each characterized by specific physical and organic traits; supratidal, intertidal, and proximal subtidal. Clearing of marine waters from the hypersaline Rondout sea permitted a more diverse and abundant life to pervade the Manlius sea.

Coeymans Limestone (Clarke and Schuchert, 1899, p. 874-875) STOP 5

The Coeymans is a medium to dark gray weathering, light to medium gray, medium to thick irregular bedded, medium to coarse grained, fossil-fragmental limestone. The formation is moderately fossiliferous, characterized by the pentamerid brachiopod *Gypidula coeymanensis*, meristellid and uncinulid brachiopods, and crinoidal and cystoidal debris. The westwardly thickening Coeymans (Ravena Member-Rickard, 1962, p. 65-68) splits along the Judd's Falls Valley into a lower Dayville (Rickard, 1962, p. 68-72) Limestone and an upper Deansboro (Rickard, 1962, p. 72-77) Limestone, separated by a tongue of Manlius lithology.

The Coeymans seems to have been deposited on the seaward side of fringing stromatoporoid barriers and baffles in agitated, clear, shallow water with crinoid and cystoid meadows fluorishing on the sea floor (Figure 3).

Kalkberg Limestone (Chadwick, 1908, p. 346-348) STOP 6

The Kalkberg is a light to medium gray weathering, medium to dark gray, thin to medium regularly bedded, fine to medium grained siliceous limestone with calcareous shale interbeds. Dark gray to black chert pods and beds are characteristic. A 2-3 cm bentonite (volcanic ash) occurs along the south side of U.S. 20 at the overpass for the abandoned Cherry Valley Railroad. This ash has been radiometrically dated (Miller and Senechal, 1965) as 395 million years old, using Rb-Sr isotopes.

The Kalkberg contains abundant and varied fossils, dominated by brachiopods, bryozoans, and crinoid columnals; The unit is believed to have formed in the proximal low energy subtidal zone below wave base (Figure 3).

New Scotland Limestone (Clarke and Schuchert, 1899, p. 874-878)

The New Scotland is a thin-bedded, dark gray to brown, argillaceous limestone interbedded with calcareous shales. Brown iron-oxide staining is common. The New Scotland is the most fossiliferous unit in the Helderberg Group; brachiopods and bryozoans were represented abundantly by many species. In this region, the New Scotland is poorly exposed beneath the overlying Becraft terrace. The most westerly exposure of the New Scotland is at the top of the

U.S. 20 roadcut at the west edge of Sharon Springs; the unit is absent at Cherry Valley. The New Scotland is believed to have formed on the distal continental shelf (Figure 3).

Becraft Limestone (Hall, 1893, p. 8-13)

The youngest division of the Helderberg Group in the southern portion of the Canajoharie 15' quadrangle is the Becraft Limestone. It is a medium gray weathering, light gray to tan, medium to thick bedded, coarse grained, fossil-fragmental limestone. It is replete with crinoid columnals and characterized by the crinoid base *Aspidocrinus scutteliformis*; these "scutellas" are convex upward and consist of well-cleaved tan to yellow calcite. Uncinulid brachiopods are also common. The Becraft is absent at Cherry Valley but makes its appearance at Sharon Center and forms a conspicuous ledge and terrace southeast of Sharon, continuing to the type Helderbergs at Thacher Park and thence southward to Kingston. Its lithologic and organic makeup is very similar to that of the older Coeymans and it is presumed to record the same kind of depositional environment (Figure 3).

Alsen (Grabau, 1919, p. 468-479) and Port Ewen ((Clarke, 1902, p. 666) Limestones

These younger divisions of the Helderberg Group are not present in the Cherry Valley or Sharon areas. The cherty Alsen makes its appearance in the Schoharie Valley and continues east and south along the Hudson Valley. The argillaceous Port Ewen appears near Coxsackie and is thickest in the Kingston area of the Hudson Valley. Their facies are similar, but not identical, to those of the Kalkberg and New Scotland, respectively (Figure 3).

Helderbergian time is recorded in New York as a period of quiescence reflected by stable shelf environments in which lime accumulated without benefit of very much detritus from adjacent peneplained source areas.

TRISTATES GROUP

Oriskany Sandstone (Vanuxem, 1839, p. 273)

In the Cherry Valley region, the Oriskany is actually a medium gray weathering, light bluish-gray limestone with relatively large spherical frosted quartz grains "floating" in a lime matrix. West of Cherry Valley, the Oriskany becomes a relatively pure quartz sandstone, although its distribution is patchy. East of Cherry Valley, the Oriskany becomes very quartzitic in the Schoharie Valley and in the Helderberg Mountains at Thacher State Park; south along the Hudson Valley in the Kingston Area, the stratigraphic position of the Oriskany is occupied by siliceous cherty limestone (Glenerie) or a pebble conglomerate (Connelly). The Oriskany contains very large, robust brachiopods such as *Acrospirifer, Costispirifer, Hipparionyx,* and *Rensselaeria;* large platyceratid gastropods are also common.

The source and environment of deposition of the Oriskany are puzzling. It is almost certain that the unit formed as a sand beach in a well agitated shallow sea but the source area for the quartz has not been determined; it may have been derived from a pre-existing quartz sandstone such as the older Cambrian Potsdam Sandstone. The virtual absence of clay minerals in the

Oriskany would seem to preclude derivation from a Proterozoic metamorphic terrane of feldspar-rich rocks. Radiometric dates in New England confirm that the initiation of the Acadian Orogeny occurred during Early Devonian (Deerpark) time.

Esopus Formation (Mather, 1840, p. 246-250) STOP 6

The Esopus is a dark brown weathering, dark gray to black, medium to thin bedded, compact, chertified argillite with dark gray shale intercalations and intervals. The blocky argillite displays conchoidal fracture and contains poorly preserved silicified brachiopods and gastropods.

A relatively large percentage of clay minerals in this unit signifies an abrupt increase in erosion of the source area, which lay to the east and southeast, and an intensity buildup during the Acadian Orogeny.

Carlisle Center Formation (Goldring and Flower, 1944, p. 340) STOPS 3 & 6

This is a buff weathering, light gray to tan, uniformly thin bedded, calcareous, argillaceous siltstone and silty shale; green glauconite is commonly present at the upper contact. Bedding planes are covered with "rooster-tail" markings presumed to be feeding trails of the worm *Zoophycos (Taonurus) caudagalli*. Strangely, no other fossils have been reported from this formation, other than trace fossils. There are abrupt lithologic contacts with both the Esopus below and Onondaga above.

The environment of deposition is a mystery! Certain it is that the sediment was thoroughly worked over by organisms; normal marine shelled forms were seemingly absent. Some have suggested very deep water whereas others have suggested an intertidal situation. There does not now seem to be adequate evidence with which to postulate the type of paleoenvironment which existed in the Carlisle Center sea.

Onondaga Limestone (Hall, 1839, p. 293-309) (for details, see Oliver, 1954 1956a, 1956b)

The Onondaga Limestone is divisible into the following subunits (in ascending order) with varying degrees of difficulty or ease of identification:

Edgecliff Limestone (Oliver, 1954, p. 626-627) STOP 3

This is a medium to dark gray weathering, light to medium gray, medium to coarse grained limestone characterized by nodules and nodular beds of light gray, tan, to cream-colored chert and profuse, often silicified, colonial and solitary rugose and tabulate corals. The lower 1 to 6 feet is finer grained, non-cherty, and less fossiliferous. Elsewhere in New York State, there may be a sandstone at the base which has been confused as Oriskany in the subsurface. Sink holes and terraces are often associated with the Edgecliff Limestone.

This unit formed in warm, agitated, shallow, clear subtidal water. In some areas the coral buildup was such that mounds were constructed and exceedingly coarse fossil-fragmental limestone accumulated as flank deposits.

Nedrow Limestone (Oliver, 1954, p. 627-628) STOP 2

This is a medium to dark gray weathering, dark to medium gray argillaceous limestone tending to be thinner bedded than the other Onondaga limestones. Fossils are scarcer, with platyceratid gastropods and phacopid trilobites diagnostic.

Moorehouse Limestone (Oliver, 1954, p. 628-629) STOPS 2 & 4

This is a light to medium gray weathering, medium to dark gray, medium bedded, fine to medium grained, slightly argillaceous limestone characterized by nodules and nodular beds of dark gray to black chert. Fossils uncommon, but brachiopods, gastropods, corals, trilobite fragments, and crinoid columnals may be locally abundant. The Moorehouse appears to be a more offshore subtidal shelf deposit in quieter water. Often, it forms a terrace.

Tioga Bentonite (Ebright, Fettke, and Ingham, 1949, p. 10)

This is a light gray to cream colored, sticky clay. Where exposed (rarely), a deep re-entrant marks its horizon. This volcanic ash forms the contact between the Moorehouse below the Seneca Limestone above. The Tioga is widespread in the eastern U.S. having been recognized as far away as West Virginia.

Seneca Limestone (Vanuxem, 1839, p. 377)

This is a very light gray weathering, dark gray to black, massive, fine grained argillaceous limestone. Fossils are scarce; brachiopods are most abundant, chiefly *Atrypa* and, west of here, *Chonetes*. The Seneca seems to be a distal shelf deposit in fairly quiet water below wave base.

The Onondaga Limestone environments (Southwood time) denote a period of quiescence between Phase 1 (Deerpark-Sawkill) and Phase 2 (Cazenovia and later Devonian time) of the Acadian Orogeny.

HAMILTON GROUP

Marcellus Formation (Hall, 1839, p. 295)

The Marcellus, is primarily black and gray shales and siltstones with scarce thin black limestones; normally the formation is sparsely fossiliferous with a limited mixture of benthonic and pelagic forms. The Marcellus is part of the Catskill Delta, a complex clastic wedge of erosional detritus, which extended into western New York and beyond. Members are (in ascending order):

Union Springs Shale (Cooper, 1930, p. 132, 218, 219) STOP 1

This is a slightly calcareous, black fissile shale with a few thin beds of hackly, bituminous limestone that are fossiliferous. The Union Springs holds a pelagic fauna of tentaculitids and styliolinids

in the shales and a benthonic fauna of corals, trilobites, and pelecypods in the limestones. There is an abrupt contact with the Seneca Limestone below. A deep water depositional site is postulated. Disrupted concretions (some with barite or siderite mineralization) and shale deformation ("pseudo-cleavage") may be contemporaneous with sedimentation. This may denote a response to Acadian thrusting via decollement, as evidenced in the Hudson Valley.

Cherry Valley Limestone (Clarke, 1903, chart) STOP 1

This is a cream to tan weathering, black, fine grained, massive, compact bituminous limestone which may create a terrace. The unit is characterized by the large coiled goniatite cephalopod *Agoniatites vanuxemi* and the straight nautiloid cephalopod *Striacoceras*, both of which are rare and exceedingly difficult to extract. The Cherry Valley is considered to be a deep water limestone; it is the youngest limestone in eastern New York. For details, see Rickard (1952).

Chittenango Shale (Cooper, 1930, p. 131, 219) STOP 1

This is a non-calcareous, black, grading upward through dark gray to medium gray, shale; locally, it may be slightly silty and micaceous. There is an abrupt contact with the Cherry Valley Limestone below, however, the contact with the Otsego Shale above is transitional. Except for occasional seams of pelagic tentaculitids and styliolinids, fossils are very rare in Chittenango Shale. The unit is obviously a basin deposit.

Otsego Shale (Cooper, 1933, p. 544, 548)

This is a light brown weathering, medium to light gray, slightly calcareous, silty mudstone and shale with a few argillaceous siltstones and fine grained sandstones near the top of the unit. The shales are virtually barren of fossils but a few brachiopods and pelecypods occur in the silty beds. This unit probably represents very rapidly deposited mud, whose source was the Taconic area, rejuvenated during the second and main pulse of the Acadian Orogeny. The Otsego makes up the slopes of the "Cherry Valley Hills".

Solsville Sandstone (Cooper, 1930, p. 133, 219)

This is a brown weathering, gray, fine to medium grained sandstone with interbedded argillaceous siltstone and silty argillite, all interbedded silty shale. The sandier and siltier layers predominate in the upper one-half of the unit. Brownish-orange iron oxide staining is locally common. Fossils are scarce; plant remains and pelecypods have been observed in the Cherry Valley region. This unit caps many of the "Cherry Valley Hills".

POST-DEVONIAN SEDIMENTS

Resting unconformably on the Devonian rocks of the Cherry Valley region are transported glacial gravels, sands, silts, and clays of Pleistocene age. Outwash and till are most common although there are notable west-east drumlins along the northern margin of the Devonian outcrop belt. These are products of a westward thrust of ice up the Mohawk Valley during the latter stages of glaciation.

NOTES

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TRIP A-1 (DEVONIAN STRATIGRAPHY & PALEOECOLOGY, ETC.)

ROAD LOG

I - Interstate Highway
US - Federal Highway
NY - New York State Highway
OC - Otsego County Highway
NOTE: Turn only where directions are underlined

TOTAL MILES	MILES FROM LAST POINT	DIRECTIONS & DESCRIPTIONS
0	0	Leave Rensselaer Polytechnic (R.P.I.) Houston Field House parking lot.
0.1	0.1	W(downhill) on Peoples Ave.
0.2	0.1	S(left) on Burdett St., at first signal.
0.2	0.1	SW(half-right) on Sherry Rd., Chapel and Cultural Center on right corner.
0.3	0.1	Join Sage Ave. and continue W(downhill) to intersection with 15th St. (student center on left) and continue straight ahead on Federal Ave. R.P.I. Buildings on left.
0.7	0.4	Deformed Taconic Sequence rocks at bend of hill on right.
1.1	0.4	Crossing "Emmon's or Logan's Line", the western limit of major Taconic gravity slides.
1.7	0.6	S(left) on River St., "Uncle Sam Mall" on left.
		Bear right on River St., join Congress St. (NY 7)
		Crossing Hudson River on NY 7.
2.0	0.3	Watervliet, intersection with NY 32, continue W (straight ahead) on NY 7.
5.3	3.3	Latham traffic circle; intersection with US 9.
5.9	0.6	S(left) on Adirondack Northway (I-87).
9.9	4.0	Intersection with NY 5.
11.1	1.2	Intersection with NY State Thruway (I-90).
12.1	1.0	W(right) on Western Turnpike (US 20).
14.5	2.4	Intersection with NY 155.

15.6	1.1	Guilderland; former site of glass manufacturing, using sand from dunes atop Lake Albany clays.
17.1	1.5	McCormick's Corners; intersection with NY 146 to Schenectady.
17.5-21.5	0.4	Helderberg Escarpment in view to S(left); note terraces caused by differing horizontal limestone formations.
19.6	2.1	Watervliet Reservoir; intersection with NY 158.
24.5	4.9	Climbing hill of eroded fault scarp; southern extension of easternmost of Mohawk Valley normal faults.
27.1	2.6	Crossing site of new I-88.
27.8	0.7	Duanesburg; intersection with NY 7 to Binghamton.
28.9	1.1	Middle Ordovician Schenectady sandstone and shale exposures scattered and small from here to Sloansville.
34.1	5.2	Crossing Schoharie Creek, Esperance; Schenectady-Schoharie County line.
34.7-35.3	0.6-1.2	Schoharie Creek parallels US 20 on S(left).
37.8	2.5	Sloansville; intersection with NY 30A and NY 162.
38.3-39.5	0.5-1.7	Several exposures of Schenectady sandstone and shale on hill at west end of Sloansville.
42.2	2.7	Passing from region underlain by Middle Ordovician strata to region underlain by Silurian and Devonian strata.
43.7	1.5	Carlisle.
44.8	1.1	Karst topography; sink holes on N & S of US 20 in Lower Devonian Manlius and Coeymans Limestones.
48.0	3.2	Sharon; intersection with NY 145 from S(Cobleskill) and Schoharie County 5A from N.
49.9	1.9	Long exposure of Onondaga Limestone on S(left), showing Moorehouse Member with 2 m of Nedrow Member at W end.
52.9	3.0	Sharon Springs; intersection with NY 10 to Canajoharie.

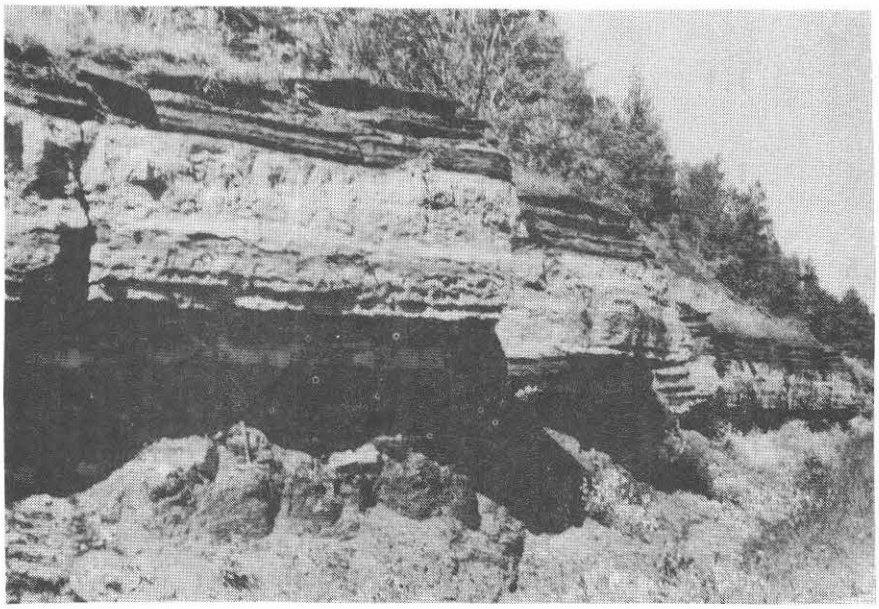

Figure 4. STOP 1. North-facing roadcut along OC 54, showing Chittenango Shale (top), Cherry Valley Limestone, and Union Springs Shale.

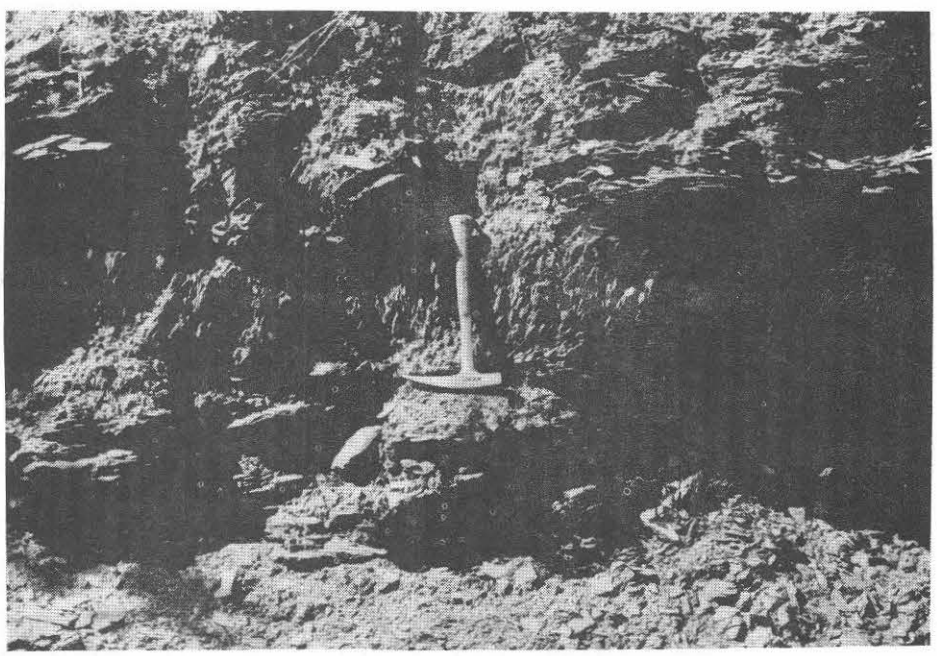

Figure 5. STOP 1. Closeup of "pseudocleavage" (shown at hammer level) in horizontally bedded Union Springs Shale.

53.3	0.4	Roadcuts on both sides of US 20 in Kalkberg Limestone; about 2m of New Scotland argillaceous limestone at top of exposure.
54.2	0.9	Leesville.
54.6	0.4	Roadcuts on both sides of US 20 in Kalkberg Limestone; forms conspicuous terrace.
55.0	0.4	Roadcut on S(left) of Esopus Shale, deformed by glacial shoving(?).
55.1	0.1	Otsego-Schoharie County Line; Cherry Valley hills to S(left).
55.3-57.1	0.2-2.0	Exceptional landscape view to N(right) across Mohawk Valley farmland floored with Ordovician and Upper Cambrian strata; Proterozoic gneisses of Adirondack Mountains in distance.
56.8	1.5	S(left) then immediate W(right) onto OC 54.

STOP 1 (35 minutes) - Parking area on right shoulder beyond W end of exposure. Roadcut on S (left) of road.

FIGURES 4 & 5

Three Middle Devonian units of Marcellus Formation of the Hamilton Group are well displayed here: Chittenango Shale (topmost), Cherry Valley Limestone, Union Springs Shale.

The dark gray-black Chittenango Shale contains the small, needle-like fossil *Styliolina fissurella* believed to have been pelagic in habit. No proven benthonic fossils have been found in the Chittenango. The hard, massive Cherry Valley limestone has yielded several species (Rickard, 1952) but they are scarce and exceedingly difficult to extract. Nautiloid and goniatite cephalopods are diagnostic, chief of which are *Striacoceras* and *Agoniatites vanuxemi*. The Union Springs Shale has a few thin limestone beds in its upper few feet which contain horn corals, trilobites, ostracodes, pelecypods, lingulid brachiopods, and the small goniatite *Werneroceras plebeiforme*, extremely useful for correlation purposes.

Of especial interest here are some unexplainable structural oddities in the Union Springs. One is the "pseudocleavage" and the other is the disrupted limestone concretions. These features may be manifestations of a large westward decollement', created during the Acadian Orogeny in Early Erian (Early Cazenovian) time as continental plate overriding (or underriding) produced a temporary basin on the site of the Devonian carbonate shelf in which black muds accumulated. Whatever their causes, these are anomalous structures in otherwise virtually structureless strata.

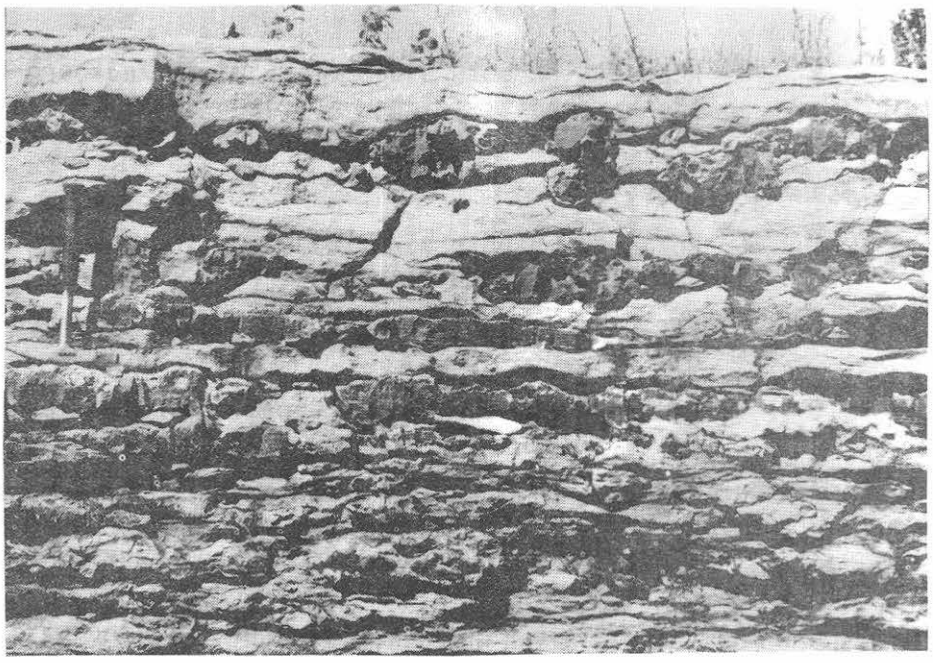

Figure 6. STOP 2. Nodular and bedded dark gray to black chert in Moorehouse Member of Onondaga Limestone.

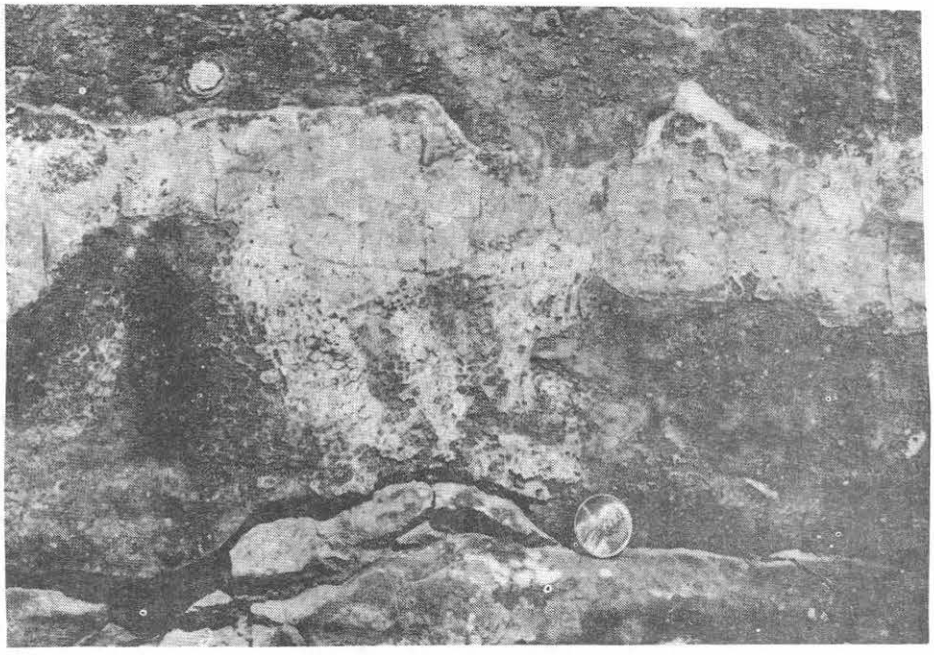

Figure 7. STOP 3. Nodular bedded tan to light gray chert in silicified coral-rich Edgecliff Member of Onondaga Limestone.

LEAVE Stop 1 and continue SW on OC 54.

58.2	1.4	Roadcut in Otsego Shale on N(right) side of road. Cherry Valley hills capped by younger Solsville sandstone and shale whereas Otsego forms slopes and Chittenango floors the intervening valleys.
58.4	0.2	Onondaga (Moorehouse) Limestone on S(left) of road.
58.5	0.1	N(right) on NY 166 at east edge of village of Cherry Valley.
59.8-60.0	0.3-0.5	Road ditch on W(left) shows Nedrow shaley limestone.
60.1-60.5	0.1-0.5	STOP 2 (25 minutes) - Park off highway on right shoulder. FIGURE 6

The roadcut on the E(right) shows the Moorehouse Member of the Onondaga Limestone; the Nedrow Member may be examined by walking back to the ditch exposure on the west side of NY 166.

A little over 60' of medium to thick bedded, dark to medium gray, fine to medium grained limestone with bedded and nodular dark gray to black chert is well shown. The unit is not overly fossiliferous although brachiopods, bryozoans, and pelmatozoan debris may be collected.

By contrast, the Nedrow is a thin to medium bedded, shaley, argillaceous limestone which weathers lighter. Platyceratid gastropods are diagnostic.

LEAVE Stop 2 and continue N on NY 166.

60.6	0.1	Roadcuts on both sides exhibiting Moorehouse Member.
60.7-60.8	0.1-0.2	STOP 3 (30 minutes) - Park off highway on right shoulder. FIGURES 7 & 8

The roadcut on the E(right) shows the Edgecliff Member of the Onondaga Limestone resting with sharp lithologic contact on the Carlisle Center calcareous, silty mudstone.

About 15' of massive, irregular bedded, light to medium gray, medium to coarse grained Edgecliff Limestone with tan to light gray nodular to bedded chert and with prolific corals (often silicified) and crinoidal debris is splendidly exhibited here. The lower 4' is non-cherty and finer grained and

		the basal few inches contains angular shale fragments. The contact with the subjacent Carlisle Center is abrupt and a marked lithologic change. LEAVE Stop 3 and continue N on NY 166.
60.8	60.9	Carlisle Center in sharp contact with Esopus Shale on E(right).
60.9	0.1	Kalkberg Limestone on E(right).
61.0	0.1	W(left) on access road to US 20 east.
61.2	0.2	Kalkberg limestone, chert, and shale on S(right).
61.3-62.1	0.1	Long, high roadcut on S(right) - Will be visited later as Stop 6.
62.1		S(right) on parking area road. STOP 4, LUNCH (40 minutes) Slope underlain by Union Springs Shale capped by terrace of Cherry Valley Limestone (now completely grassed over); excellent view to N across Mohawk Valley to Adirondack Mountains in distance.
62.3		LEAVE lunch stop, turn W(left) on westbound lane of US 20 by taking crossover at E end of parking area. USE EXTREME CAUTION!
62.5-62.7	0.2	Roadcut on N(right) in Onondaga (Moorehouse) Limestone.
62.8	0.1	Good view to N(right).
63.1	0.3	Overpass of abandoned railroad.
63.3	0.2	Turn right off US 20 and turn N(right) on OC 32. Note: NY 166 only goes S from here.
63.4	0.1	Roadcut on E(right) shows about 28' of Upper Coeymans (Deansboro) Limestone with great profusion of gypidulid brachiopods, often silicified, and crinoid debris. Few chert nodules signify stratigraphic nearness of overlying Kalkberg Limestone.
63.6	0.2	Roadcut on E(right), now largely concealed, of about 16' of upper Manlius Limestone.

STOP 5 (40 minutes) - Park on E(right) shoulder.

63.7-64.0	0.1	Long, high roadcut on E(right) in Lower Coeymans (Dayville), Manlius (Thacher), and Rondout (Chrysler). Thicknesses of each are 50', 44' and 12', respectively. Orange paint mark shows Coeymans-Manlius contact. Note that there is no reef rock in the uppermost Manlius nor *Tentaculites*- bearing ribbon limestones in lowermost Manlius in this section (compare with more easterly Manlius at Stop 7).
		Coeymans and Manlius are distinguished in that the former is lighter gray, thicker or irregularly bedded, coarser grained, and breaks with an irregular fracture; here, it is more fossiliferous than the underlying Manlius and has crinoidal debris and larger brachiopods. There is a 4' dolomitic shaley zone 25' from the base of the Manlius which is somewhat gradational into the subjacent Rondout Dolostone.
		The Manlius here is less fossiliferous than to the east and its environment may have been somewhat more saline so as to be less conducive to normal marine invertebrates.
64.5	0.5	LEAVE Stop 5 by proceeding N on OC 32 to first house on right and turn around in loop. Retrace
65.7	1.2	route to join NY 166 and pass under US 20 overpass.
65.8	0.1	Roadcuts on both sides of NY 166 in Kalkberg Limestone.
		W(right) on access road to US 20 and proceed east.
66.0	0.2	Roadcut on S(right) in Kalkberg Limestone.
66.1-66.7	0.1	Long, high roadcut on S(right) in Kalkberg, Oriskany, Esopus, Carlisle Center, and Onondaga Formations.
		STOP 6 (40 minutes) - Park off highway on right shoulder.
		FIGURES 8 & 9
		Beginning at the overpass for the abandoned Cherry Valley Railroad, and midway within the Kalkberg Limestone, is a 1-3 cm sticky clay bentonite (volcanic ash) which has been radiometrically dated (Miller and Senechal, 1965), using Rb-Sr isotopes, as 395 million years old. Note the regularity of the thin to medium bedded siliceous limestones, the shale intercalations, and the dark gray to black chert beds and nodules, as well as the great profusion and diversity of brachiopods and bryozoans.

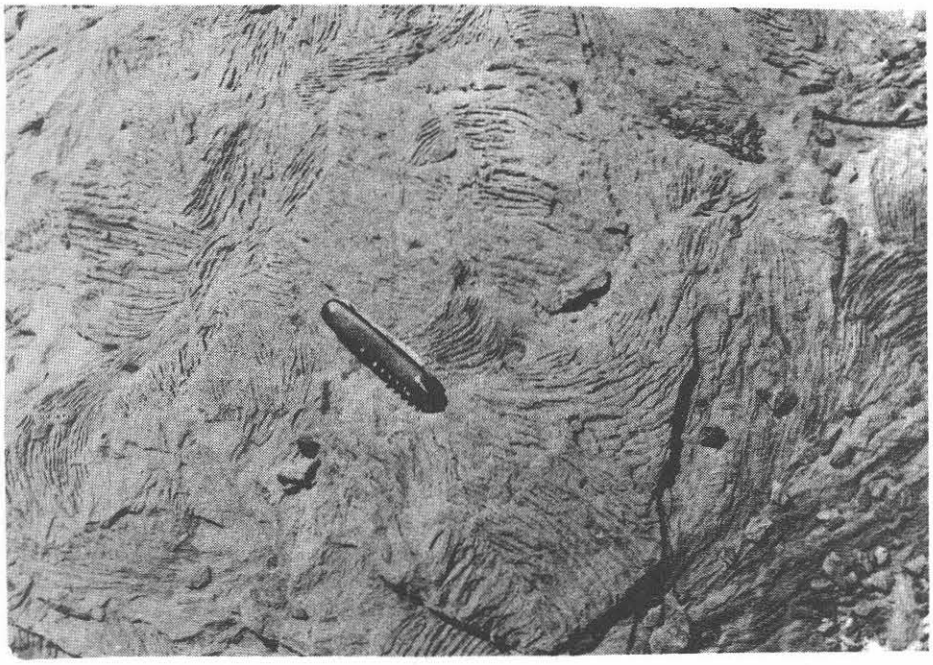

Figure 8. STOPS 3 & 6. Bedding plane exposure of "rooster-tail" markings, *Zoophycos (Taonurus) caudagalli*, in Carlisle Center Formation.

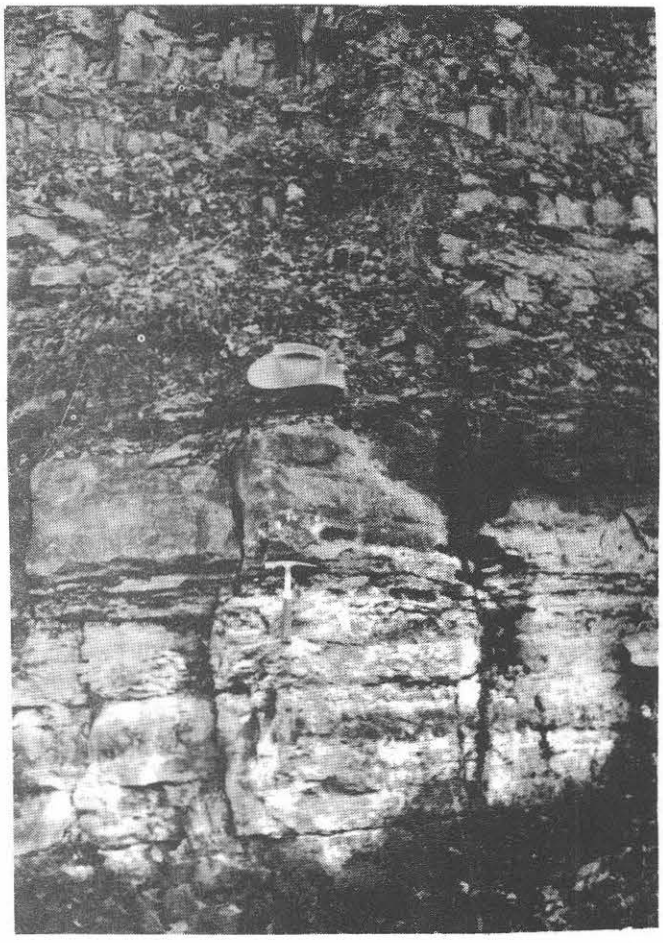

Figure 9.
STOP 6. Portion of stratigraphic sequence showing Esopus cherty shale (top), Oriskany "Sandstone" (hat at top, hammerhead at bottom), and Kalkberg Limestone.

The next overlying unit is a famous one in New York stratigraphy---the Oriskany Sandstone. Its fame as a gas producer has long been known in central and western New York. Here, however, it is a quartzose limestone with large, rounded, sand grains of quartz in a calcite matrix. The contact with the Kalkberg is a "welded" one.

Seventeen feet of chertified argillite, chert, and dark gray shale make up the overlying Esopus Formation, here. Eastward, in the Hudson Valley, the Esopus reaches a thickness of over 300'. In sharp contact is the next overlying Carlisle Center Formation. This is a curious unit lithologically and paleontologically. Physically, it consists of about 45-55% clay minerals, 25-30% quartz of silt size, and 25-30% calcium carbonate. Organically, it is replete with only one trace fossil, the worm feeding trail, *Zoophycos (Taonurus) caudagalli*. Its environment of deposition is a puzzle!

The Edgecliff Member of the Onondaga Limestone rests with a marked lithologic and paleontologic change on the Carlisle Center mudstone. This and other units of the Onondaga have been previously described and observed at Stops 2 and 3. Note the green mineral staining, attributed as glauconite, along the contact.

LEAVE Stop 6 and proceed E on US 20.

67.0	0.3	Roadcut in Seneca Limestone Member of Onondaga on N(left).
67.1	0.1	Roadcut in Seneca Limestone on S(right). During highway construction, this showed an abrupt lithologic contact with the overlying Union Springs black shale. Note the Cherry Valley Limestone terrace above.
67.3	0.2	Roadcut on S(right) in massive, dark gray Seneca Limestone with re-entrant at base showing 8-13 cm of sticky, light gray clay,--the Tioga Bentonite.
67.7-67.9	0.4	Long roadcut in Chittenango-Cherry Valley-Union Springs Members of the Marcellus Formation (STOP 1)
68.0	0.1	Intersection with OC 54 (to STOP 1). Continue E on US 20.
71.8	3.8	Sharon Springs; intersection with NY 10.

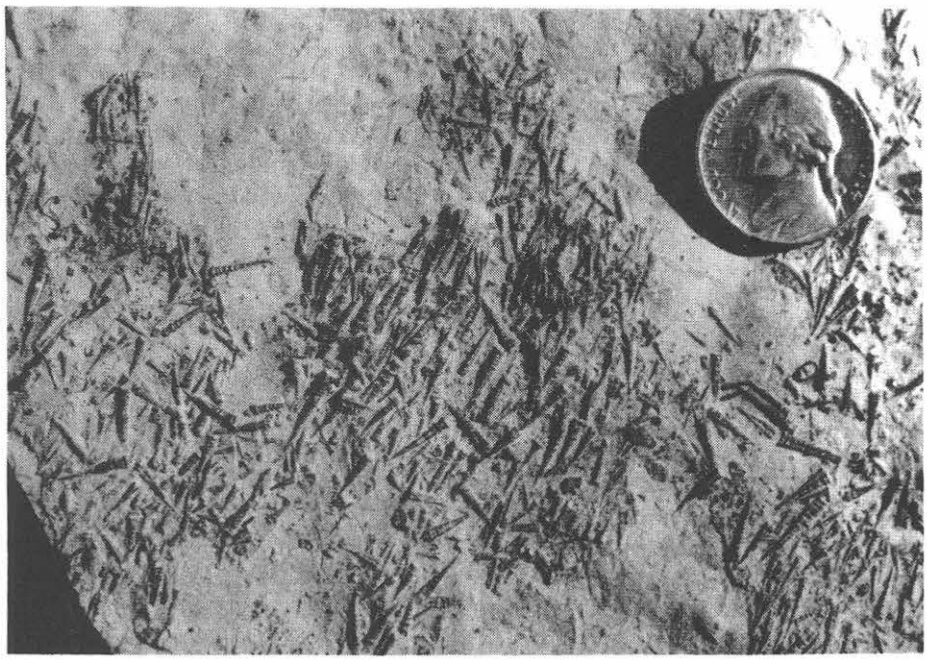

Figure 10. STOP 7. Bedding plane exposure of the extinct cricoconarid, *Tentaculites gyracanthus*, presumed to have been a mollusk. Thacher Member of the Manlius Limestone.

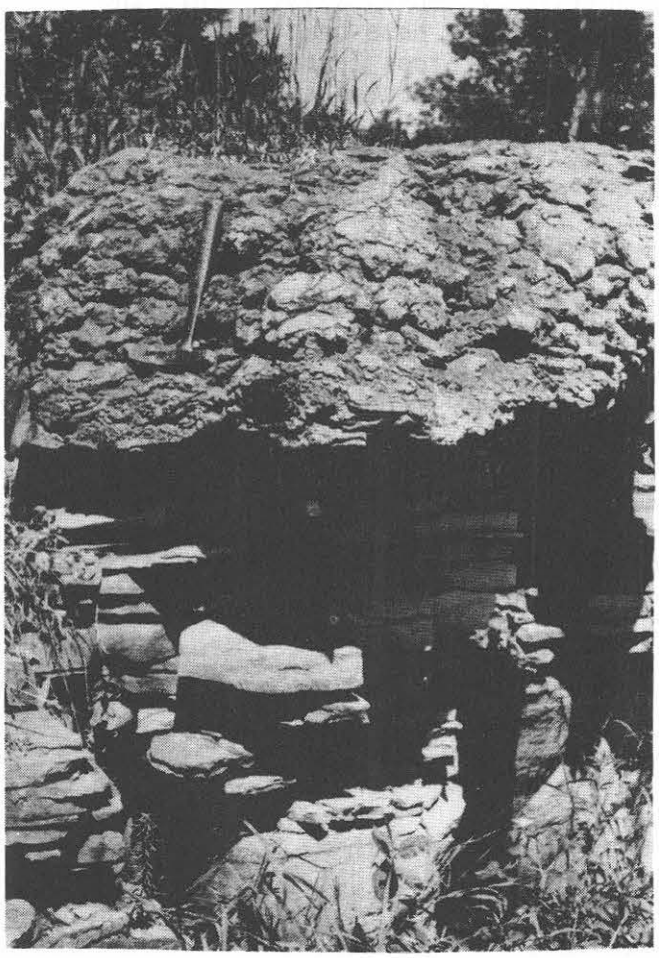

Figure 11.
STOP 7. Unbedded stromatoporoid biostromal reef resting on regular-bedded Thacher Limestone.

73.7	1.9	N(left) across westbound lane of US 20 onto town road. This intersection is termed Sharon Center on the topographic map.
74.1-74.4	0.4	Karst topography region; sink holes on W(left) about 400' from road.
74.7	0.3	E(right) on town road. Continuous ledge of lower Coeymans and upper Manlius limestones parallels road on S(right).
75.3	0.6	STOP 7 (45 minutes) - Buses will unload passengers on left shoulder opposite roadcut and load at right bend, 0.1 mile to the SE. FIGURES 10 & 11 Roadcut in Manlius (Thacher Member) Limestone on S(right) side. Thin-bedded (ribbon) limestone, fine grained, dark gray to black, weathers very light gray. Rock breaks with a "ringing" sound and conchoidal fracture. Numerous shale intercalations. Bedding planes covered with the extinct mollusk, the narrow conical *Tentaculites gyracanthus*, the ostracode *Hermannina alta*, and the small spiriferid brachiopod *Howellella vanuxemi*. Bryozoans and gastropods are occasionally found. In 1954 I was fortunate in discovering an horizon covered with the rare edrioasteroid *Postibula* n. sp. Walk SE past abandoned farmhouse to next limestone ledge. Here, crossbedded coarse grained limestone occurs in the upper 18" of the ledge; this is a rare sedimentary feature in the Helderberg Group. Proceed W across field to next limestone ledge. This is a stromatoporoid reef, marking the summit of the Manlius Formation. The "cabbage-looking" unbedded limestone rests on regular bedded Thacher Limestone. These stromatoporoids acted as barriers blankets, and baffles and caused waves to break offshore creating differing environments of quite protected areas and agitated open areas. LEAVE Stop 7 and proceed SE along town road.
78.2	2.9	Sharon; rejoin US 20, turn E(left) and retrace route to R.P.I. Field House.
101.7	23.5	Spectacular view ahead to the east, looking across Hudson River Valley to Taconic and Berkshire Mountains in distance. Albany's Empire State Plaza is visible in the Valley.
103.4	1.7	Another excellent view to the east, in case you missed the earlier one!

113.6	10.2	Passing over N.Y. State Thruway (I-90); BE PREPARED TO MAKE LEFT TURN!
113.7	0.1	N(left) on Adirondack Northway (unnumbered!).
119.9	6.2	E(right) on NY 7; continue on NY 7 thru Troy on Congress St.
123.8	3.9	N(left) on 15th St. (NY 7) thru R.P.I. Campus.
124.7	0.9	E(right) on Peoples Ave., past Samaritan Hospital to Field House.
125.2	0.5	END OF TRIP