A BRIEF DESCRIPTION OF UPPER DEVONIAN UNITS TO BE OBSERVED ON CHAUTAUQUA COUNTY FIELD TRIP

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PREVIOUS WORK

The first major work related to the geology of Chautauqua County appears in James Hall's (1843) Survey of the Fourth Geologic District. Chautauqua County stratigraphy was later studied in greater detail and modified by such workers as Clarke (1903), Chadwick (1923; 1924), Caster (1934), Pepper and de Witt (1950; 1951) and de Witt and Colton (1953). New York State Museum Bulletin 391 (Tesmer, 1963) describes the stratigraphy and paleontology of Chautauqua County.

Devonian stratigraphic nomenclature pertinent to this region his been subject to various interpretations (e.g., Rickard, 1964 and Oliver et al., 1969). In this guidebook, the present author follows the stratigraphic terminology used in his other publications (Tesmer 1963; 1966; 1967; 1974; Buehler and Tesmer 1963).

DESCRIPTION OF UNITS

Hanover Shale Member of the Java Formation

Only a few feet of the uppermost portion of the Hanover Shale can be observed on this field trip (STOP 2). The Hanover Shale was named by Hartnagel (1912, p. 76) for exposures that occur in Hanover Township, northeastern Chautauqua County. This unit is about 90 ft. thick and consists mostly of gray shales with some interbedded dark-gray shales and thin limestones as well as several zones of calcareous nodules (Tesmer 1966, p. 48). The unit contains some pyritized algae, conodonts and a few cephalopods. The Hanover has been traced from the Lake Erie shore at Dunkirk eastward across Cattaraugus Creek between Irving and Versailles through Pipe Creek Glen in Colden Township, Erie County to exposures in Beaver Meadow Creek at Java village, Wyoming County and eastward (Pepper and de Witt 1950; de Witt 1960).

Dunkirk Shale Member of the Canadaway Formation

An excellent view of this unit may be seen at STOP 2 which is the type locality for the Dunkirk Shale named by Clarke (1903, p. 24). Here, one may observe most of the unit which is composed of about 40 ft. of black shale (Tesmer 1963, p. 15) containing some pyrite nodules and septaria that vary from 1 to 5

ft. in diameter. The sharp contact between the light-gray Hanover beds and the overlying black shales of the Dunkirk makes a well-defined base for the Canadaway Formation. Pepper and de Witt (1951) assigned the Dunkirk, South Wales and Gowanda Members to a Perrysburg Formation which the present author does not recognize as it has an ill-defined top to the east in southern Erie and northern Cattaraugus Counties. Instead, Tesmer (1963, p. 14) considers the Dunkirk as the basal member of the Canadaway of Chadwick (1933, p. 355) and Caster (1934, p. 136). The Dunkirk has been traced from Lake Erie exposures in Dunkirk (Stop 2) across Cattaraugus Creek at Versailles, eastward to Pipe Creek Glen in Colden Township, Erie County, and beyond. Fossils include pyritized algae, higher plant fragments and conodonts.

South Wales Shale Member of the Canadaway Formation

Overlying the black Dunkirk Shale is a sequence of interbedded light- and dark-gray shales which vary from about 60 to 80 ft. in thickness (Tesmer 1963, p. 15). The South Wales was named by Pepper and de Witt (1951) for exposures in a small tributary to the East Branch of Cazenovia Creek, three miles south of South Wales in southern Erie County. South Wales strata contain some algae and conodonts. This member has been traced from the Lake Erie shore near Van Buren Point across Chautauqua Creek between Versailles and Gowanda eastward to Pope Creek Glen in Colden Township, Erie County, and beyond.

Gowanda Shale Member of the Canadaway Formation

The Gowanda Shale, originally named by Chadwick (1919, p. 157) after exposures at the village of Gowanda, was later redefined by Pepper and de Witt (1951), who selected outcrops along Walnut Creek in Hanover Township, Chautauqua County, as a standard reference section. The original Gowanda of Chadwick (1919, p. 157) is now divided into an older South Wales Member and a younger Gowanda Member (restricted sense). Thus, the Gowanda Member as now defined, contains interbedded gray to black shales, silty shales and light-gray siltstones, as well as many zones of calcareous concretions and septaria. The thickness varies considerably, ranging from about 120 ft. to well over 200 ft., generally increasing to the east (Tesmer 1963, pp. 18-22). Many of the strata seem quite barren but the Gowanda Member contains some fossiliferous zones such as the Corell's Point Goniatite Bed of House (1967, p. 1066). This will be seen at STOP 3 and is described by Kirchgasser in this guidebook. In addition to cephalopods, several pelecypods and some gastropods are present (Clarke 1904) and conodonts have been collected from dark shale bands near the top of the unit. The Gowanda occurs in Lake Erie cliffs in Portland Township, Chautauqua County, and has been followed eastward across Walnut Creek and Big Indian Creek (Pepper and de Witt 1951). This member cannot be easily

differentiated in most of southern Erie and northern Cattaraugus Counties as the younger Laona Siltstone Member pinches out making the contact between the similar Gowanda and Westfield Shale Members indistinct east of the village of Perrysburg (Tesmer 1974).

Laona Siltstone Member of the Canadaway Formation

This unit was named by Beck (1840, p. 57) for strata that occur along Canadaway Creek at Laona, Chautauqua County. It has been traced across Chautauqua County from Lake Erie cliffs at Barcelona into western Cattaraugus County where it apparently pinches out in the vicinity of the village of Perrysburg (Tesmer 1963, pp. 25-27; 1974). The Laona attains a maximum thickness of about 25 ft. and consists principally of light-gray, quartzose siltstones up to one foot thick, with increasing interbedded gray shales toward the top of the unit. Usually barren, at one locality near Nashville, eastern Chautauqua County, this member contains a basal coquinite comprised primarily of brachiopods and pelecypods, several species of which first occur in the Laona but continue upward into younger units such as the Northeast Shale Member.

Westfield Shale Member of the Canadaway Formation

Overlying the siltstones of the Laona is a sequence of gray shales 100 to 220 ft. thick with a few interbedded siltstones. Chadwick (1923, p. 69) named it the Westfield Shale for exposures along Chautauqua Creek at the village of Westfield. This member can be traced from the Lake Eire shore near the New York - Pennsylvania line across Chautauqua County to the east branch of Big Indian Creek in northwestern Cattaraugus County (Tesmer 1963, pp. 27-29). As both the underlying Laona Siltstone Member and overlying Shumla Siltstone Member apparently pinch out a short distance east of here, the intervening Westfield Shale Member merges with the similar older Gowanda and younger Norteast Shale Members and is not recognized as a distinctive unit eastward in southern Erie and northern Cattaraugus Counties (Buehler and Tesmer 1963, pp. 93-94; Tesmer 1974). Most strata appear to be relatively barren although a few brachiopods and several conodonts have been reported (Hass 1958, p. 767).

Shumla Siltstone Member of the Canadaway Formation

This member was named by Clarke (1903, p. 25) for siltstone beds exposed along Canadaway Creek at Shumla (STOP 1). Lithologically, the Shumla is similar to the older Laona Siltstone Member of the Canadaway, consisting of up to about 35 ft. mainly of light-gray, quartzose siltstone with beds seldom more than a few inches in thickness. Various sedimentary structures may be observed at our field stop. An increasing percentage of interbedded shales occurs toward the top of the unit. Strata assigned to the Shumla are usually quite barren, but Hass (1958, p. 767) collected and identified conodonts from the type locality. This lens-like member has been traced from Lake Erie shore exposures near the New York - Pennsylvania line across Chautauqua County into Perrysburg Township, northwestern Cattaraugus County, where it apparently pinches out.

Northeast Shale Member of the Canadaway Formation

The Northeast Shale, named by Chadwick (1923, p. 69) for excellent exposures in Northeast Township, Erie County, Pennsylvania, is the youngest member of the Canadaway Formation. This unit, which varies in thickness from about 400 to 600 ft., is exposed in a band across northern Chautauqua County, particularly along Chautauqua Creek south of Westfield and in Canadaway Creek upstream from Shumla. With the pinching out of the Laona and Shumla Siltstone Members in northwestern Cattaraugus County, the Gowanda, Westfield and Northeast Shale Members merge into a single unit east of Persia Township, Cattaraugus County, and are treated as undifferentiated Canadaway by Tesmer (1974). Lithologically, the Northeast is a sequence of mostly medium-gray shales with some light-gray siltstones from 1 to 4 in. in thickness. The percentage of interbedded siltstones varies within the unit as well as geographically. The Northeast is quite barren in many places but the upper Northeast becomes quite fossiliferous in easternmost Chautauqua and northwestern Cattaraugus Counties. Bryozoans, brachiopods and pelecypods are typical forms (Tesmer 1963, pp. 31-35; 1974).

Dexterville Member of the Chadakoin Formation

This unit was proposed by Caster (1934, p. 63) for the fossiliferous, gray siltstones and shales of which about 100 ft. are exposed in quarries at Dexterville (now part of the city of Jamestown). They form a subdivision of the Chadakoin, previously named by Chadwick (1923, p. 69) for the same exposures which are adjacent to the Chadakoin River (STOP 6). The brachiopod "Pugnoides" duplicatus is confined to the Dexterville and has been collected in various parts of Chautauqua County as well as near the village of Randloph in southwestern Cattaraugus County. The Dexterville fauna contains many examples of brachiopods and pelecypods as well as numerous bryozoans. Exposures of this member occur in many part of central and eastern Chautauqua County (Tesmer 1963, pp. 37-38) where the member is usually less than 100 ft. in thickness. East of Randloph, the distinctive Dexterville brachiopod "Pugnoides" duplicatus is absent and Tesmer (1974) considers the Chadakoin Formation as a single unit here.

Ellicott Member of the Chadakoin Formation

Above the Dexterville is a sequence of fossiliferous, gray shales and interbedded siltstones which overlie much of central and southern Chautauqua County (Tesmer 1963, pp. 39-41). These strata are assigned to the Ellicott Member, proposed by Caster (1934, p. 66) for exposures in Ellicott Township, near Jamestown. An excellent locality for collecting Ellicott fossils occurs along the Erie-Lackawanna railroad cut (STOP 5) near Lakewood where Late Devonian brachiopods and pelecypods may be found. Murphy (1973) collected the alga Protosalvinia (Foerstia) near the base of the

Ellicott at Belsons Run in northwestern Chautauqua County as well as westward into northwestern Pennsylvania and northeastern Ohio. The Ellicott Member averages about 150 ft. in thickness in Chautauqua County, although complete sections are seldom exposed. In Cattaraugus County, to the east, the Dexterville and Ellicott Members are not differentiated, but are considered collectively as undifferentiated Chadakoin (Tesmer 1974).

Panama Conglomerate Member of the Cattaraugus Formation

The youngest unit to be observed on this field trip is the Panama Conglomerate lens that locally forms the base of the Cattaraugus Formation of Clarke (1902, p. 525). The Panama Conglomerate was proposed by Carll (1880, p. 58) for about 70 feet of conglomerate and buff sandstone exposed at the village of Panama is southern Chautauqua County (STOP 4). The Cattaraugus Formation contains a great variety of lithologies including red shales, several similar conglomerate lenses, as well as sequences of interbedded, gray siltstones and shales. Miller (1974) studied the petrology of the Panama and various other Cattaraugus conglomerate lenses in an attempt to differentiate them with regard to environment of deposition, provenance and dispersal.

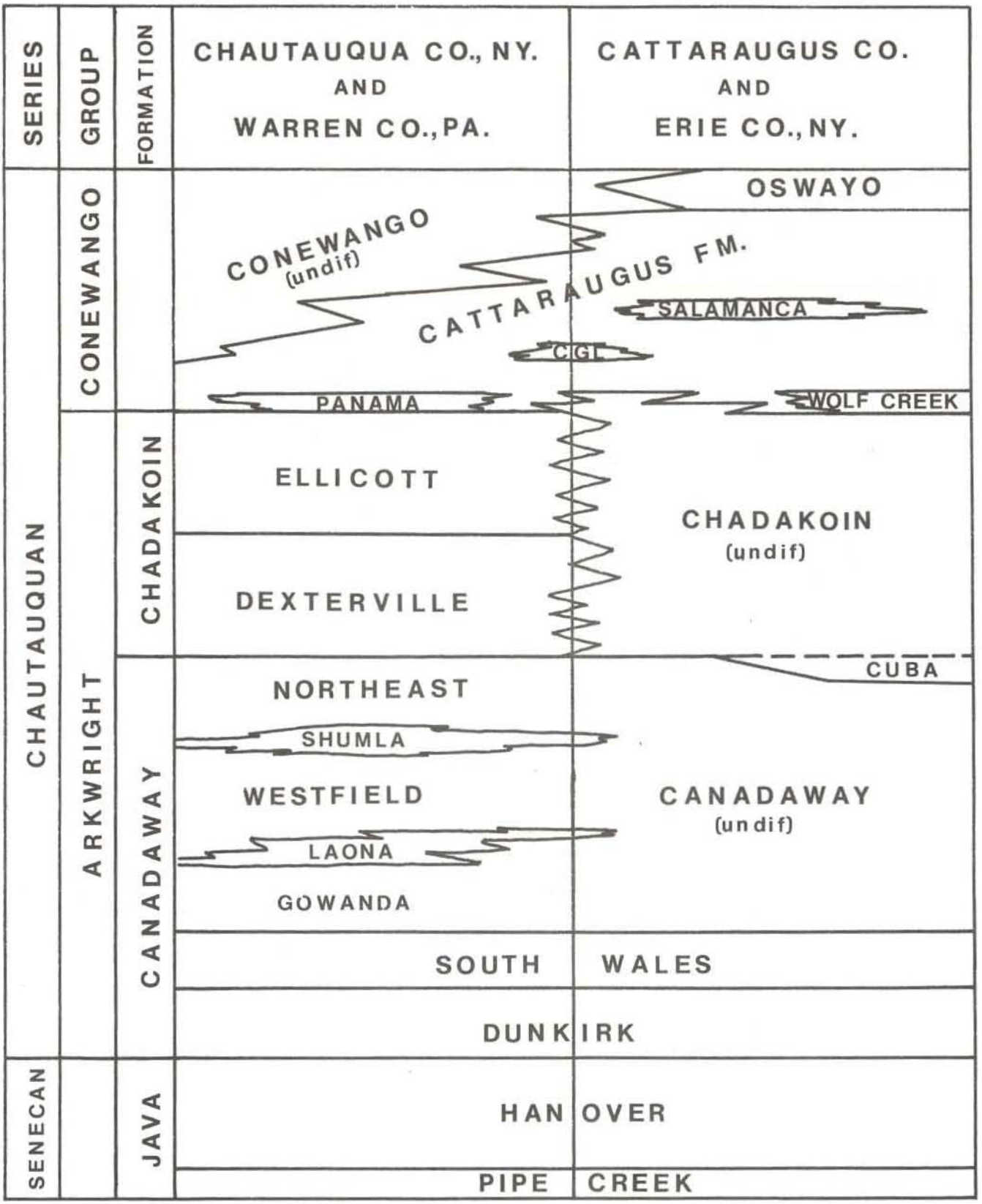

Plate 1. Correlation of the stratigraphic units exposed in Chautauqua, Cattaraugus and Erie Counties, NY and Warren Co., PA. The Chautauqua County column is modified from Tesmer (1963) and the Cattaraugus County column is modified from Tesmer (1974).

REFERENCES CITED

Beck, Lewis C., 1840, Report on the mineralogical and chemical department of the survey of New York: N. Y. Geol. Surv. Ann. Rpt. 4, p. 57-58.

Buehler, Edward J. and Tesmer, Irving H., 1963, Geology of Erie County, New York: Buffalo Soc. Nat. Sci. Bull. 21, no. 3.

Carll, John F., 1880, The geology of the oil regions of Warren, Venango, Clarion and Butler Counties: 2nd Pa. Geol. Surv. Rpt. 13, 58 p.

Caster, Kenneth E., 1934, The stratigraphy and paleontology of northwestern Pennsylvania; Part 1, Stratigraphy: Bull. Amer. Paleon. 21, no. 71.

Chadwick, George H., 1919, Portage stratigraphy in western New York (abstract): Geol. Soc. Amer. Bull. 20, 157 p.

_____, 1923, Chemung stratigraphy in western New York (abstract): Geol. Soc. Amer. Bull. 34, p 68-69.

_____, 1924, The stratigraphy of the Chemung Group in western New York: N.Y. State Mus. Bull. 251, 149-157.

_____, 1933, Great Catskill Delta: Pan-Amer. Geol. 60, 355.

Clarke, John M., 1902, Preliminary statement of the paleontological results of the areal survey of the Olean Quadrangle, NY: State Mus. Bull. 52, 524-528.

_____, 1903, Classification of New York Series of geologic formations: Univ. State N.Y. Hdbk. 19, 1st ed.

_____, 1904, Naples fauna of western New York: Part 2, N.Y. State Mus. Mem. 6, 199-454.

de Witt, Wallace, Jr., 1960, Java formation of late devonian age in western and central New York: Amer. Assoc. Petrol. Geol. Bull. 44, 1933-1936.

_____ and Colton, George, 1953, Bedrock geology of the Silver Creek quadrangle, New York: U. S. Geol. Surv. Geol. Quad. Map GQ30.

Hall, James, 1843, Geology of New York: Part IV, comprising the survey of the Fourth Geological District.

Hartnagel, Chris, A., 1912, Classification of the geologic formations of the state of New York: N.Y. State Mus. Hdbk. 19, 2nd ed.

Hass, Wilbert H., 1958, Upper devonian conodonts of New York, Pennsylvania and interior states: Jour. Paleon. 32, 765-769.

House, Michael R., 1967, Devonian ammonoid zonation and correlations between North America and Europe: Int. Symposium on the Devonian System 2, 1061-1068. Clagary, Alberta, Alberta Society of Petroleum Geologists.

Miller, William H., 1974, Petrology of Devonian Cattaraugus formation and related conglomerates, Cattaraugus and Chautauqua Counties, New York: Unpublished M.A. Thesis, State Univ. of N.Y. at Buffalo.

Murphy, James L., 1973, Protosalvinia (Foerstia) Zone in the Upper Devonian sequence of eastern Ohio, northwestern Pennsylvania, and western New York: Geol. Soc. Amer. Bull. 84, 3405-3410.

Oliver, William A., Jr. et al., 1969, Correlation of Devonian rock units in the Appalachian basin: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-64.

Pepper, James F. and de Witt, Wallace, Jr., 1950, Stratigraphy of the Upper Devonian Wiscoy Sandstone and the equivalent Hanover Shale in western and central New York: U. S. Geol. Surv. Oil and Gas Invest. Chart 37.

_____ and _____, 1951, Stratigraphy of the Late Devonian Perrysburg Formation in western and west-central New York: U. S. Geol. Surv. Oil and Gas Invest. Chart OC-45.

Rickard, Lawrence V., 1964, Correlation of the Devonian rocks in New York State: N. Y. State Mus. Map and Chart Ser., no. 4.

Tesmer, Irving H., 1963, Geology of Chautauqua County, New York, Part I - Stratigraphy and paleontology: N. Y. State Mus. Bull. 391.

_____, 1966, Upper Devonian stratigraphy and paleontology of southwestern New York State (Erie, Chautauqua and Cattaraugus Counties) from Geology of Western New York, Guidebook for 38th Ann. Meeting of the N.Y. State Geol. Assoc., 47-52.

_____, 1967, Upper Devonian stratigraphy and paleontology of southwestern New York State: Int. Symposium on the Devonian System 2, 259-269, Calgary, Alberta, Alberta Society of Petroleum Geologists.

_____, 1974, Geology of Cattaraugus County, New York: Buffalo Soc. Nat. Sci. Bull. (in press).

NOTES ON THE AMMONOID AND CONODONT ZONATIONS OF THE UPPER DEVONIAN OF SOUTHWESTERN NEW YORK

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INTRODUCTION

The sequence of zones currently recognized for the upper part of the Upper Devonian of New York is based on research by House (1962, et seq.) on the ammonoid (goniatite) cephalopods and by Hass (1958) and Huddle (in Oliver and others, 1968 and Klapper and others, 1971) on conodonts. During the course of their studies of the succession in southwestern New York the author has had the opportunity to work with Michael House and John Huddle and the notes which follow summarize their reports to date. The zonations and the horizons from which biostratigraphically important faunas have been recorded are shown in Figure 1. Although the New York record for the upper part of the Upper Devonian is far from complete, correlations have been made at several levels with the standard zonal sequences of Europe.

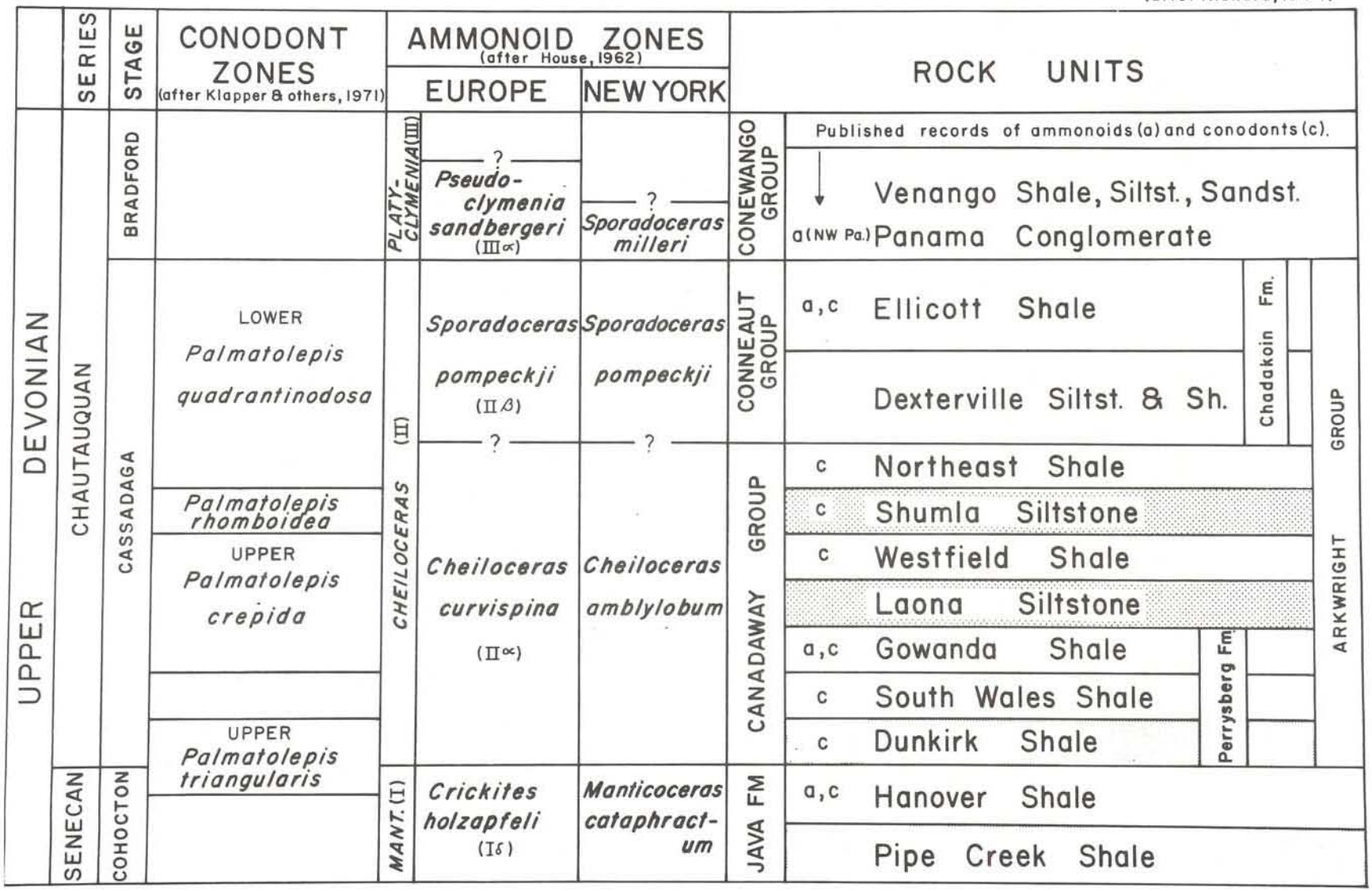
Above the Dunkirk Shale, horizons yielding determinable ammonoid and conodont faunas decrease in frequency as the offshore shales wtih calcareous horizons and pelagic faunas interfinger with and are overlain by thick sequences of silty shales, siltstones and sandstone with benthonic faunas, and non-marine units in the upper part. The Dunkirk is the highest major black shale in the succession and above this level the subdivision and regional correlation of the rocks have proved to be more difficult than lower down in the section where black shale horizons provide stratigraphic control. Because key faunal horizons are scattered and difficult to trace, the positions of many zonal boundaries are not known with certainty.

Ammonoids are rare in New York above the Gowanda Shale and, in this part of the succession, conodonts would seem to offer the most promise for further zonal refinement. As shown in Figure 1, the European conodont zones are named for species of the distinctive platform genus Palmatolepis. Illustrations of some of these species are found in the Treatise (Muller, 1962, fig. 47); see Klapper and others (1971) for additional references. Illustrations of ammonoid zone-fossils are found in the Treatise (Miller and others, 1957), Miller (1938), and House (1962).

Java Formation

The ammonoids of the Java Formation mark the last occurrences of manticoceratids (Zone of Manticoceras (I) in New York, but there are as yet no reports from sections in the fieldtrip area.

FIGURE I. UPPER DEVONIAN ZONES- SOUTHWESTERN NEW YORK (after Rickard, 1964)



Manticoceras cataphractum occurs in the lower part of the Hanover Shale Member at Java, N.Y. (Wyoming County) and a form of the Crickites holzapfeli-type occurs in the upper part of the member in a nearby section (House, 1968, p. 1066). Conodonts reported from the upper Hanover include Palmatolepis triangularis and indicate the Upper P. triangularis Zone (Klapper and others, 1971, fig. 4).

Canadaway Group

No ammonoids have been reported from the Dunkirk Shale or succeeding South Wales Shale, but in the Gowanda Shale the Cheiloceras fauna (Zone of Cheiloceras (II)) is well developed in the Corell's Point Goniatite Bed (House, 1962, 1966, 1968). At the type locality at Corell's Point on Lake Erie (STOP 3), the cephalopods occur as small pyritic molds in a ledge of concretions up to eighteen inches thick, outcropping at lake level, and also in the overlying fifteen feet of shale. The fauna (Figure 2) includes Cheiloceras amblylobum (subglobular shell with broad, relatively flat suture across well rounded venter), Tornoceras concentricum (suture with steep dorsal face of lateral lobe concentric with the umbilicus) and Aulatornoceras bicostatum (prominent ventro-lateral furrow); the latter two species are the highest known tornoceratids in the Devonian of New York (House, 1965, p. 84, 1966, p. 55).

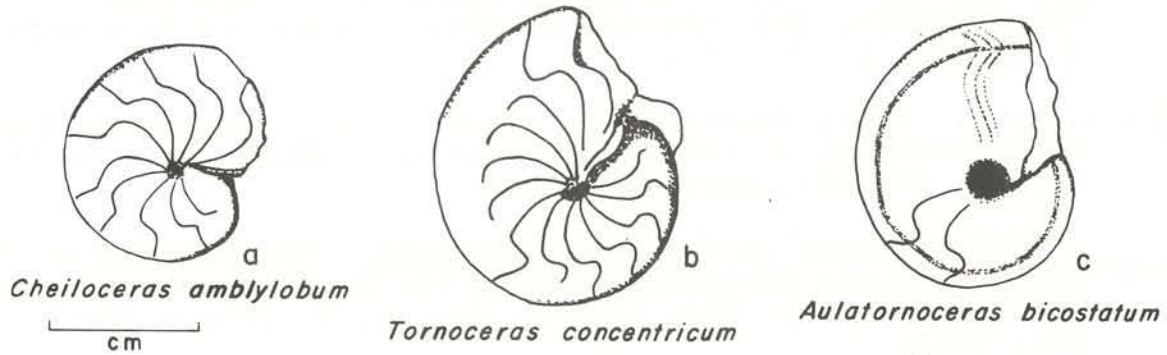


Figure 2. Ammonoids from Corell's Point Goniatite Bed (Gowanda Shale) at Corell's Point, Lake Erie (STOP 3). a: figured House (1962, pl. 46, fig. 4). b: figured House (1965, pl. 9, fig. 88). c: figured House (1965, pl. 11, fig. 128).

The Corell's Point Goniatite Bed has been traced inland through several sections as far as Holland, N.Y., in eastern Erie County. Localities near Fredonia include Little Canadaway Creek below Lamberton and Walnut Creek at Forestville (see House, 1966, 1968, for locality details). Faunal lists and locality data for the conodont faunas of the Canadaway Group and higher units are found in Hass (1958), Tesmer (1963), Oliver and others (1968) and Klapper and others (1971).

Conneaut and Conewango Groups

Few ammonoids have been found in the highest part of the New York succession and the biostratigraphically important clymenids are apparently missing. The only ammonoid identified from the Conneaut Group is Sporadoceras cf. pompeckji (S. pompeckji Zone) from the Ellicott Shale in Porter's Creek, Summerdale, N.Y. (Chautauqua County) (House, 1962, p. 277). No higher ammonoids have been reported in New York but S. milleri (Pseudoclymenia sandbergeri Zone) is known from near the Panama Conglomerate (Conewango Group) in northwestern Pennsylvania (Miller, 1938, House, 1962). There are six higher ammonoid zones recognized in the Upper Devonian of Europe (House, 1962, Table 3).

The highest conodont fauna reported from New York is also from the Ellicott Shale and represents the Lower Palmatolepis quadrantinodosa Zone (Klapper and others, 1971). There are eleven higher zones recognized by Ziegler (1971, Chart 4) in the standard sequence in Europe and many of these are recorded elsewhere in North America (Kapper and others, 1971, fig. 4).

REFERENCES CITED

Hass, W. H., 1958. Upper Devonian Conodonts of New York, Pennsylvania, and Interior States. Journal of Paleontology, V. 32 (4), p. 765-769.

House, M. R., 1962, Observations on the ammonoid succession of the North American Devonian. Journal of Paleontology, V. 36 (2), p. 247-284, pls. 43-48.

_____, 1965, A study in the Tornoceratidae: The succession of Tornoceras and related genera in the North American Devonian. Phil. Trans. Roy. Soc. London, Ser. B, V. 250, p. 79-130, pls. 5-11.

_____, 1966, Goniatite Zonation of the New York State Devonian. in Geology of Western New York, Guidebook, New York State Geological Association, Buehler, E. J., ed., 38th Annual Meeting. p. 53-57.

_____, 1968. Devonian Ammonoid Zonation and Correlation between North America and Europe. in International Symposium on the Devonian System, Calgary, Alberta, Sept. 1967. Alberta Soc. Petroleum Geologists, V. II, p. 1061-1068.

Klapper, Gilbert, Sandberg, C. A., Collinson, Charles, Huddle, J. W., Orr, R. W., Rickard, L. V., Schumacher, Dietmar, Seddon, George, Uyeno, T. T. 1971. North American Devonian Conodont Biostratigraphy, in Sweet, W. C. and Bergstrom, S. M., eds. Symposium on Conodont Biostratigraphy. Geol. Soc. America, Memoir 127, p. 285-316.

Miller, A. K., 1938, Devonian Ammonoids of America. Geol. Soc. America, Special Paper 14, 262, p., 39 pls.

_____, Furnish, W. M., and Schindewolf, O. H., 1957. Paleozoic Ammonoidea, in Treatise on Invertebrate Paleontology, Part L, Mollusca 4, Cephalopoda Ammonoidea, R. C. Moore, ed., Geol. Soc. America and Univ. Kansas Press, p. L12-L472.

Muller, K. J. 1962. Taxonomy, evolution, and ecology of conodonts. in Treatise on Invertebrate Paleontology, Part W, Miscellanea, R. C. Moore, ed., Geol. Soc. America and Univ. Kansas Press., p. W83-W91.

Oliver, W. A., Jr., DeWitt, Wallace, Jr., Dennison, J. M., Hoskins, D. M. and Huddle, J. W. 1968. Devonian of the Appalachian Basin, United States. in International Symposium on the Devonian System, Calgary, Alberta, Sept. 1967: Alberta Soc. Petroleum Geologists, V. 1, p. 1001-1040.

Rickard, L. V. 1964. Correlation of the Devonian Rocks in New York State. N. Y. State Museum Map and Chart Ser., No. 4.

Tesmer, I. H. 1963. Geology of Chautauqua County, New Yor;, Part I, Stratigraphy and Paleontology (Upper Devonian). New York State Museum Bull. 391, 65 p.

Ziegler, W. 1971. Conodont stratigraphy of the European Devonian. in Sweet, W. C. and Bergstrom, S. M., eds., Symposium on Conodont Biostratigraphy. Geol. Soc. America, Memoir 127, p. 227-284.

TRIP B - UPPER DEVONIAN STRATIGRAPHY OF CHAUTAUQUA COUNTY, NEW YORK

William J. Metzger, Irving Tesmer, and William Kirchgasser

Total Miles	Miles from last point	Route description
0.0	0.0	Leave the Fredonia campus at the Temple Street Exit.
		Turn left (S) onto Temple Street.
0.7	0.7	Intersection with Route 20. Proceed straight ahead on Water Street.
0.8	0.1	Cross Canadaway Creek.
0.9	0.1	Bear left at intersection of Water and Liberty Streets.
1.3	0.4	Several levels of river terraces are exposed on each side of the bus at this point associated with higher stages of Lake Erie.
1.8	0.5	Cross Canadaway Creek Bridge. Good exposures of the Gowanda shale at this point continue upstream to Laona, NY.
2.2	0.4	Cross Railroad tracks.
2.4	0.2	Enter Laona, NY.
		Well-defined stream terraces can be seen on the right side of the bus. An abandoned oxbow lake can be observed 25 feet above the present level of the creek.
2.6	0.2	Intersection with Webster Road; continue straight ahead. 100 feet to the right (west) of this intersection is the type section of the Laona Siltstone exposed in a small waterfall.
3.0	0.4	Intersection with Route 60. Turn right (S)

Total Miles	Miles from last point	Route description
4.1	1.1	Road cut through semi-stabilized landslides on left of bus. Hill is composed of till overlying proglacial lake deposits. The creek flows in bedrock 200 feet to the right (W).
4.3	0.2	Exposures of the Westfield Shale are seen on the right side of the bus.
4.4	0.1	Junction with Shumla Road. Turn left (E).
4.9	0.5	Pull off onto shoulder before the bridge. Walk down to the Canadaway Creek downstream from the bridge.
		STOP 1. Shumla Siltstone: Exposures examined here are the type section of this unit. The lower contact is exposed downstream from the bridge. The underlying Westfield shale includes interbedded siltstones and shales. The base of the Shumla is marked by a massive siltstone which grades upward into increasingly thinner bedded units. These strata in turn grade upward into interbedded siltstones and shales which characterize the overlying Northeast shale. Trace fossils are abundant in several zones in these outcrops as are sedimentary structures including ripple marks, flute casts, and soft sediment deformation. Dunkirk, NY, 7½' quad.
		Turn around and return to Route 60.
5.4	0.5	Junction with Route 60. Turn right (N).
8.7	3.3	Passing the crest of the Pleistocene beach ridge of Glacial Lake Whittlesey.
9.2	0.5	Intersection with Route 20. Proceed straight ahead. The bus will pass over the Lake Warren beach complex in the next 0.3 miles.

Total Miles	Miles from last point	Route description
9.5	0.3	Mobil station on the right is near the crest of Warren II beach and it displays the best topographic expression of all the beaches along this traverse. Dunkirk Ready-Mix plant is located in the beach deposit.
10.0	0.5	Thruway overpass.
11.0	1.0	Entering Dunkirk, NY
11.1	0.1	Cross Norfolk and Western Railroad Tracks.
11.5	0.4	Junction Route 60 and Main Street. Turn right (N) and proceed to Lake Shore Drive. (Route 5).
12.1	0.6	Intersection of Main Street (Route 60) and Lake Shore Drive (Route 5). Turn left (SW).
13.2	1.1	Turn right (N) onto Point Drive North.
13.6	0.4	Turn right into Cedar Beach Parking area.
13.7	0.1	STOP 2. Hanover Shale and Dunkirk Shale: Exposures allow the examination of the contact between the grey-green Hanover Shale and the black, fissile Dunkirk Shale. Numerous pyritized worm burrows and carbonized plant stems are seen at this locality. Rare specimens of the inarticulate brachiopod Barroisella compbelli have also been collected. Exposures of a "bedded" till are also exposed along the eastern side of the headland overlying a striated surface of Dunkirk Shale. Dunkirk, NY 7½' quad. Leave parking lot. Turn left (S) onto Point Drive North.
14.1	0.4	Intersection with Route 5. Turn right (SW).

Total Miles	Miles from last point	Route description
19.8	5.7	On left is gas wellhead, one of approximately 60 wells drilled during the past 2 years in Chautauqua County. Production comes from the Silurian Medina Sandstone.
20.0	0.2	Bridge over Little Canadaway Creek. Exposures are in the South Wales Shale.
21.1	1.1	Entrance to Lake Erie State Park.
23.1	2.0	Bridge over Slippery Rock Creek. Exposures include the South Wales at the lake shore and Gowanda Shale at the bridge and upstream.
24.0	0.9	Bridge over Corell Creek. Exposures are the Gowanda Shale.
25.1	1.1	Park on shoulder beyond the entrance to the trailer park on the right (N) side of the road. Walk down to the beach turn to the left (SW) and proceed approximately 100 yards. STOP 3. Gowanda Shale, Corell's Point Fauna: Exposures at about lake level continue for approximately 100 yards. Cephalopods are pyritized and concentrated in bands, the most prominent of which is approximately 2 feet below a conspicuous zone of very large septarian concretions. This exposure is also notable for the bedrock-till contact which includes till injected along bedding planes and the incorporation of large blocks of bedrock in the till. Brocton, NY, 7½' quad. Return to the bus. Continue straight ahead on Route 5 towards Barcelona, NY.
26.3	1.2	On the left of the bus (S) observe the elongate glacial landforms which characterize this specific portion of the lake plain. These deposits may represent reworked sand deposits of higher lake stages.
26.8	0.5	Bridge over unnamed creek. Exposures of Gowanda Shale include a 15 foot waterfall at the lake.

Total Miles	Miles from last point	Route description
28.8	2.0	Bridge over Bournes Creek. Exposures of Gowanda Shale and Laona Siltstone.
31.0	2.2	Entering Barcelona.
31.2	0.2	First Lighthouse illuminated by natural gas in U.S.A.
31.3	0.1	Intersection of Route 5 and 17. Turn left (S) onto Route 17.
31.6	0.3	Pass Thruway entrance on left.
31.9	0.3	Entering Westfield.
32.9	1.0	Intersection of Route 17 and 20. Continue straight towards Mayville.
	?	Crossing Glacial Lake Whittlesey beach crest.
34.0	1.1	Bridge over Little Chautauqua Creek gorge.
35.4	1.4	Pull off road onto shoulder for overview. Stop is located on the lake escarpment moraine. Optional lake plain overview.
38.5	3.1	Entering Mayville, NY
38.9	0.4	Intersection of Route 17, 430, and 394. Proceed straight ahead on Route 394 East.
39.7	0.8	Chautauqua Lake. Field trip route will traverse over Pleistocene and Recent Alluvial sand and silt for the next several miles.
42.6	2.9	Junction of Route 394 and Road to Panama, NY. Bear right. Route now travels over Kent ground moraine.
44.5	1.9	Cross Prendergast Creek and drive onto Kent end moraine.
46.4	1.9	Elm Tree Y intersection. Bear right towards Panama, NY.

Total Miles	Miles from last point	Route description
51.3	4.9	Enter Panama, NY
52.0	0.7	Intersection with Route 474. Turn right (W).
52.2	0.2	Junction with Rock Hill Road. Bear left up the hill.
52.4	0.2	Enter Panama Rocks Park on left.
		STOP 4. Panama Conglomerate Member of the Cattaraugus Formation: Exposures examined here constitute the type section of this unit. A thickness of approximately 70 feet is exposed. The conglomerate is crossbedded in part and consists predominantly of milky quartz with occasional jasper pebbles averaging less than one inch in diameter. Localized weathering and erosion along joints account for the various "dens", "alleys", and special shapes which characterize Panama Rocks Park. Panama, NY, 7½' quad.
		LUNCH STOP
		Leave parking lot and turn right onto Rock Hill Road.
52.6	0.2	Junction with Route 474, turn right (E) Continue on 474 towards Jamestown, NY Route between Panama, NY and Ashville traverses over a Kent end moraine which is somewhat older than the one observed at mile 44.5.
56.2	3.6	Entering Blockville, NY.
58.5	2.3	Entering Ashville, NY.
58.9	0.4	At flashing yellow light turn right (S) onto Maple Road.
59.2	0.3	Junction with Hunt Road, turn left (E)
60.2	1.0	Pull off on shoulder east of the Erie Lackawana Railroad tracks.

Total Miles	Miles from last point	Route description
		STOP 5. Ellicott Member of the Chadakoin Formation: Exposures in this Erie-Lackawana railroad cut are very fossiliferous. The fauna includes brachiopods Camarotoechia, Cyrtospirifer and Productella and pelecypods Leptodesma and Mytilarca. Lakewood, NY, 7½ quad.
		Proceed straight ahead on Hunt Road to Jamestown, NY
64.7	4.5	Entering Jamestown, Bear right on Hunt Ave.
64.8	0.1	Y intersection of Hunt Ave. and Third Street. Bear right onto Third Street and proceed through downtown Jamestown.
66.2	1.4	Turn right onto Prendergast Street.
66.3	0.1	Turn left onto Second Street.
67.5	1.2	Turn right onto Buffalo Street.
67.8	0.3	Turn back sharply to the right onto Allen Street.
68.0	0.2	Turn left into parking area of abandoned shale quarry.
		STOP 6. Dexterville and Ellicott Members of the Chadakoin Formation: The exposures in this inactive quarry represent the type section of both members. The lower unit, the Dexterville, is predominantly shale. Good fossil collecting is possible from both members at this location. Pugnoides duplicatus is restricted to the Dexterville strata and has been used as an index fossil for that unit. Rare specimens of very poorly-preserved glass sponges have been collected from these exposures. Jamestown, NY, 7½' quad.
		Leave parking lot and turn right onto Allen Street.
68.2	0.2	Turn back sharply to the left onto Buffalo Street.
68.5	0.3	Intersection with Second Street. Turn left.

Total Miles	Miles from last point	Route description
69.3	0.8	Bear right onto E. Fourth Street (Route 394 West).
69.6	0.3	Turn right on Prendergast Street.
69.7	0.1	Turn left onto Sixth Street.
69.9	0.2	Turn right onto Route 60 North.
71.4	1.5	Junction Route 17. Continue North on Route 60.
73.8	2.4	Airport overview. Panoramic view of the glaciated terrain. Uplands are predominately Kent ground moraine. Glacial streamlining is very obvious.
76.0	2.2	Entering Gary, NY.
76.6	0.6	Flashing stop sign. Turn left and continue on Route 60.
		Between Gary, NY and Sinclairville, Route 60 traverses a series of Kent stratified drift deposits. The flood plain of Cassadaga Creek observed on the left (W) of the bus is recent alluvium and stream gravels.
		Between Sincliarbille and Cassadaga the route traverses primarily Kent ground moraine.
87.8	11.2	Entering Cassadaga, NY.
88.5	0.7	Outwash plain of lake escarpment moraine complex.
88.8	0.3	Bedded sands and gravels in pits behind trailers.
89.2	0.4	Lake escarpment moraine front.
90.1	0.9	Typical morainal topography.
90.9	0.8	Landslides in complex glacial deposits which include varved clays deposited in a proglacial lake as well as till of Lake escarpment age.

PLATE I