MASTODON ROAD LOG

John Chiment, Cornell University

Actual directions are in boldface, points of interest in regular typeface. These are **not** stops!

Geneva to Demonstration site via P.R.I.

0.0 Hobart and William Smith Colleges. The corner of Pulteney and Rts. 5 and 20. **Turn right on Rts. 5/20.**

0.5 Ramada Inn. **Follow Rts. 5/20 east.**

0.8 Lakeshore Park. "The Geneva" lake tour boat on the right. To the left, the Fingerlakes Railroad (a privately owned railroad with 100 miles of track).

2.5 **Take Rt. 96a right to Ovid/Ithaca. Proceed south on Rt. 96a.**

3.3 Crows Nest Restaurant

3.8 Rose Hill Mansion. Greek revival style mansion. Built in the early 1800s. Site of many early agricultural experimental plantings.

4.1 Historical Marker commemorating the Clinton-Sullivan Campaign of the Revolutionary War. In August 1779 four thousand soldiers of the Continental Army marched out of Pennsylvania against the Iroquois. The Drain Tile Museum, just behind the marker, commemorates the introduction of drain tiles to the western hemisphere.

7.6 New Land Winery

9.1 The white plastic tanks are connected to natural gas wells.

9.9 Seneca Army Depot. Decommissioned, former home of nuclear warhead missiles. Now the home of Kids Peace organization and N.Y. State Correctional Facility. Home to a herd of albino deer.

13.8 Sampson State Park. Former Navy and Air Force training area.

14.2 Old Seneca Army Airbase. Reported to have the longest runway on the East Coast.

15.2.1 Kendai-i, site of an Iroquois village destroyed by the Clinton-Sullivan Campaign.

17.5 Willard. Originally a hospital during the Civil War (War of Northern Aggression). In 1864 it became the first N.Y. State Land Grant University. Later it was a psychiatric hospital and is now a prison for drug offenders (don't pick up hitchhikers).

19.9 **Ovid. Turn right at the flashing red light/stop sign. IGNORE the Ithaca sign. Go straight ahead to Ovid. Stay on Rt. 96a to Watkins Glen.**

20.2 Look at the cute County Buildings on the left. The courthouse, Sheriff's office and library are known as "the three bears".

20.5 **Continue south on Rts. 96a/414.** Keep an eye out for horse-drawn Amish conveyances.

24.5 **Lodi. Turn left on Rt. 96a at the Eagle Hotel.**

26.1 Drainage divide between Seneca and Cayuga Lakes. Notice the flat horizon of the Devonian seabeds.

29.1 Interlaken. Summer home of the Westinghouse family and Rod Serling. Site of the infamous sponge fossil find at Mike Potts' service station (see exhibit at PRI).

29.5 **Turn right on Rt. 96 south.**

31.1 Interlaken. Across the lake is Milliken Power Plant. Coal-fired plant supplied by a train from Pennsylvania.

33.3 Hamlet of Covert. Covert Bed & Breakfast.

35.5 Trumansburg. Tompkins County Line.

37.5 Smith Woods. Large trees in an old-growth forest.

37.7 **Turn left at Taughannock Falls State Park onto Taughannock Park Road.** See Taughannock creek on the right.

38.3 Former home of Ithaca College Professor Moog. Father of the Moog Synthesizer, used by the Beatles on the Abbey Road album.

38.5 Kimberlite dikes intersect the creek bedrock. These were discovered following the flood of 1935. Diamond mine opened in 1935-36. Sorry folks, no diamonds.

38.8 Follow the road to the right noting how the creek's path is joint-controlled.

38.9 **Turn left into Taughannock State Park.**

39.5 Taughannock Falls overlook on the right (restrooms, water fountain). The bumper-stops are concretions from the Tully Limestone. **Continue downhill.**

40.3 **Turn right on Rt. 89 south.**

40.4 Taughannock Creek Delta.

Quick! Look right to see

40.5 Lower Taughannock Falls, spilling over the Tully Limestone.

SHARP RIGHT, NOW!

40.6 **Turn right on Gorge Road.** As you climb, be sure to notice the precipitous drop into the gorge on your right.

42.3 **Turn left onto Jacksonville Road at the stop sign.** This area was settled by Quakers in the 1820s.

43.7 **Turn left onto Rt. 96S.** The houses on your left were temporarily abandoned because of well contamination.

45.6 Spikes BBQ. Best BBQ in the area. Pick up a bumper sticker that says, "You Can't Beat Spike's Meat".

46.0 Bellwether Hard Cider (you can stop for a sample…)

46.7 ISA Babcock Chicken Hatcheries. Currently owned by a French company, this small hatchery produces a large portion of the world's laying hens.

STOP #1 PRI

48.6 **Turn Left onto road IMMEDIATELY after the traffic light at the hospital.** Park at the first brick and stone building. This is the Paleontological Research Institution, a former International Order of Odd Fellows orphanage, where you will meet such odd fellows as Cornell's Big Red Mastodon (aka the Chemung Gilbert Mastodon), PRI's Hyde Park Mastodon, and the skeleton of a Right Whale.
Continue south on Rt. 96.

49.2 View of Cornell University on Ithaca's East Hill.

49.9 View of Ithaca College on Ithaca's South Hill.

50.7 Welcome to the Octopus! **Proceed to the junction of Rt. 13 (Fulton St.) and Rt. 96. Turn right onto Rt. 13.**

51.0 **Follow Rt. 13 south- bear right.** During the flood of '94 the Tops/Wegman's parking lot to your right was a fishing and water-skiing paradise for about a day and a half.

52.5 To the right it the proposed site of a "big box" store.

52.7 To the left is the entrance to Buttermilk Falls State Park

53.2 To the right is the site of a Tutelo Indian village. The Tutelo were subject to the Iroquois, and were granted a sort of "reservation" here. The Clinton-Sullivan Campaign wiped out the village in 1779.

54.1 The entrance to R.A. Treman State Park. **Stay in the right lane; follow Rt. 13 south toward Elmira.**

54.4 On the left, the building with the amazing color and architecture is the Gables Inn. It was originally called "Sunny Sides" and was the home of the founder of The Agway and P&C stores. It has survived several reincarnations as a restaurant.

57.4 Town of Newfield. Devonian shale exposed in road cuts.

58.7 On the right Arnot Forest, Cornell research facility.

60.2 On the right, Connecticut Hill, highest point in Tompkins County. In the 1780s the subject of a land dispute between New York, Pennsylvania and Connecticut.

63.9 On the left- almost anything you can imagine in plaster or concrete for your lawn!

65.7 On the right is old-growth forest that has never been logged.

66.7 **Continue south on Rt. 13 at the traffic light, BUT BE PREPARED TO TURN RIGHT SOON!** New Harley-Davidson dealership on your left.

66.8 **Turn right on Schuyler County Road 14.** This is the old Hinman Turnpike. Don't worry- they don't charge anymore.

70.2 This 3-WAY intersection is known as "The Corners". It marks the boundary of the Watkins-Flint purchases of 1795. **Continue south on C.R. 14.**

73.9 **Go left at the stop sign onto Rt. 14.**

74.4 On the right is Catherine Creek, a world famous trout stream. It used to be the Chemung Canal, the only canal in this area to cross the Susquehanna/St. Lawrence drainage divide.

STOP #2 DEMONSTRATION SITE

Look for sign and Cornell Van (dark blue van)

76.4 **Turn left and park at the Demonstration Site for GPR, GPS, and Coring Demonstrations.** This is an open grassy area on the left.

This is the official southern end of the field trip. If you continue south on Rt. 14, you will reach Elmira/Horseheads. If you go north on Rt. 14, you will reach Watkins Glen and eventually, Geneva.

To go back to Watkins Glen and Geneva (Hobart-William Smith)

7.64 Proceed north on Rt. 14

78.9 Montour Falls. **Do not turn right. Continue on Rt. 14.**

79.1 To the right is Havana Glen.

79.2 Crossing Catherine Creek.

79.4 The Fire Academy. Formerly Cook's Academy, one of Cornell's competitors for land grant university in 1864.

79.9 **Turn left at the traffic light and follow the business district signs.** Straight ahead is She-Qua-Ga falls.

80.2 On the right are two unusual all-brick Greek Revival buildings. **Turn left (south on Genesee st.), park and visit She-Qua-Ga Tumbling Waters. Go north on Genesee St. to Catherine St. Follow Catherine and turn left at the intersection with Rt. 14.**

80.7 On the left, Devonian shale in the road cuts and waterfalls. On the right, Queen Catherine Marsh.

81.2 Chef's Restaurant.

82.1 Watkins Glen. **Stay on Rt. 14 north.**

82.3 Pizza Hut.

82.6 Entrance to Watkins Glen State Park.

82.7 The original finish line for the Watkins Glen Grand Prix.

83.0 On the right, Glen Mountain Market and the Watkins

Hotel. Start the Seneca Lake Wine Trail.

85.4 Cascada Winery. **Stay on Rt. 14 north to Geneva.**

86.6 Lakewood Vineyards.

87.2 Arcadian Winery.

89.0 Yates/Schuyler County line. Earliest European settlement in the Seneca Lake Area. Jemima Wilkins religious sect settled in the late 1700s.

91.2 Fulkerson Winery.

91.8 Glenora Winery.

92.9 Freedom Village.

93.3 Barrel People Winery

96.9 Weimar Winery

98.3 Meadery (F. Y. I. if you've never attended a Renaissance Fair: mead is a drink made from fermented honey).

101.0 Torrey Ridge Winery

101.5 Prejean Winery.

101.6 River cobble house

102.5 Longpoint. Salvation Army camp.

103.0 Look out in the lake. The U.S. Navy's Underwater Sonar Testing Research Facility.

104.5 Dresden Power Plant. Coal-fired plant supplied by Pennsylvania Coal.

106.8 Anthony Road Winery

107.6 Seneca Shore Wine Cellar

108.6 Fox Run Winery

108.9 Cobblestone house

111.1 Historical Marker. Clinton-Sullivan Campaign.

104.7 Spinnakers (Seafood- good food, good view).

106.1 Bellhurst Castle (hotel & restaurant).

106.8 Geneva on the Lake (hotel & 4 star restaurant).

107.5 Hobart and William Smith Colleges.

FACIES AND FOSSILS OF THE LOWER HAMILTON GROUP (MIDDLE DEVONIAN) IN THE LIVINGSTON COUNTY-ONONDAGA COUNTY REGION.

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INTRODUCTION

The stratigraphic interval between the top of the Late Eifelian Onondaga Limestone and the base of the Givetian Ludlowville Formation (Union Springs, Oatka Creek, Skaneateles formations) has traditionally received less attention from stratigraphers and paleontologists than overlying Hamilton Group formations. This is due partly to poor exposure of these units in the western New York region, but also to the general impression (largely correct) that this overall succession consists of sparsely fossiliferous and unfossiliferous dark gray to black shale facies. Discovery of widespread fossil-rich condensed limestone beds within the Union Springs and Oatka Creek formations and associated corrosional discontinuities in these same formations (Baird and Brett, 1986, 1991; Griffing and Ver Straeten, 1991; Ver Straeten et al., 1994) has served to enhance our understanding of foreland basin dynamics during a key pulse of the Acadian Orogeny. Study of fossil-rich levels in the Skaneateles Formation in central New York induced the present authors to trace known key beds westward across New York into the undivided shale succession of the Levanna Member (Baird et al., 1999).

The present paper continues from the theme of last year's NYSGA paper and field log (Baird et al., 1999) which reviewed lower Hamilton facies and key beds between Buffalo and the Genesee Valley. This paper and excursion examines the same divisions in the region from the Genesee Valley eastward to the Cazenovia meridian in central New York. Because the stratigraphy and issues surrounding units in the Union Springs and Oatka Creek formations have been covered extensively in the Baird et al. (1999) field trip and comprehensively in Griffing and Ver Straeten, (1991); Ver Straeten et al., (1994), these units are treated more synoptically in this paper. However, a brief review of key issues pertaining to these formations is provided below and in the stop description for the Seneca Stone Quarry (STOP 1). The present paper focuses on correlational connections within the Skaneateles Formation, most notably the relationships of key Levanna Member markers (top-Cole Hill discontinuity, Papermill Bed, Roanoke Bed, Pole Bridge Bed, Wadsworth Bed, Slate Rock beds), described in Baird et al. (1999), to recognized member-capping divisions in the central New York Skaneateles section.

UNION SPRINGS FORMATION

Across central and western New York the Union Springs Formation is a thin, significantly truncated division composed of two very widespread units (Figs. 1, 2). The lower unit, called the Bakoven Shale, is a basinal bituminous shale that typically overlies a corrosional discontinuity and associated bone bed developed on the topmost carbonate unit (Seneca Member) of the Onondaga Limestone (STOP 1). The Bakoven records combined eustatic and tectonic deepening probably associated with thrust loading during the second tectophase of the Acadian Orogeny (see Ettensohn, 1987). Above the Bakoven a thin, fossiliferous limestone unit, the Chestnut Street submember of the Hurley Member is observed. In western New York the Chestnut Street submember, yields a moderate diversity of fossils including the brachiopod *Variatrypa*, small rugosans, numerous exuviae of the proetid *Dechenella* and a small crinoid *Haplocrinites*. It records oxic conditions and a significant shallowing from the basinal setting of the Bakoven. The Bakoven correlates eastward to the vastly thicker siltstone and calcareous siltstone succession of the Stony Hollow Member in the Hudson Valley (Griffing and Ver Straeten, 1991).

OATKA CREEK FORMATION

In western New York, the Oatka Creek Formation consists, in ascending order, of the Cherry Valley Member, Berne Member, Halihan Hill Bed, and the Chittenango Member (Ver Straeten et al., 1994). The Cherry Valley

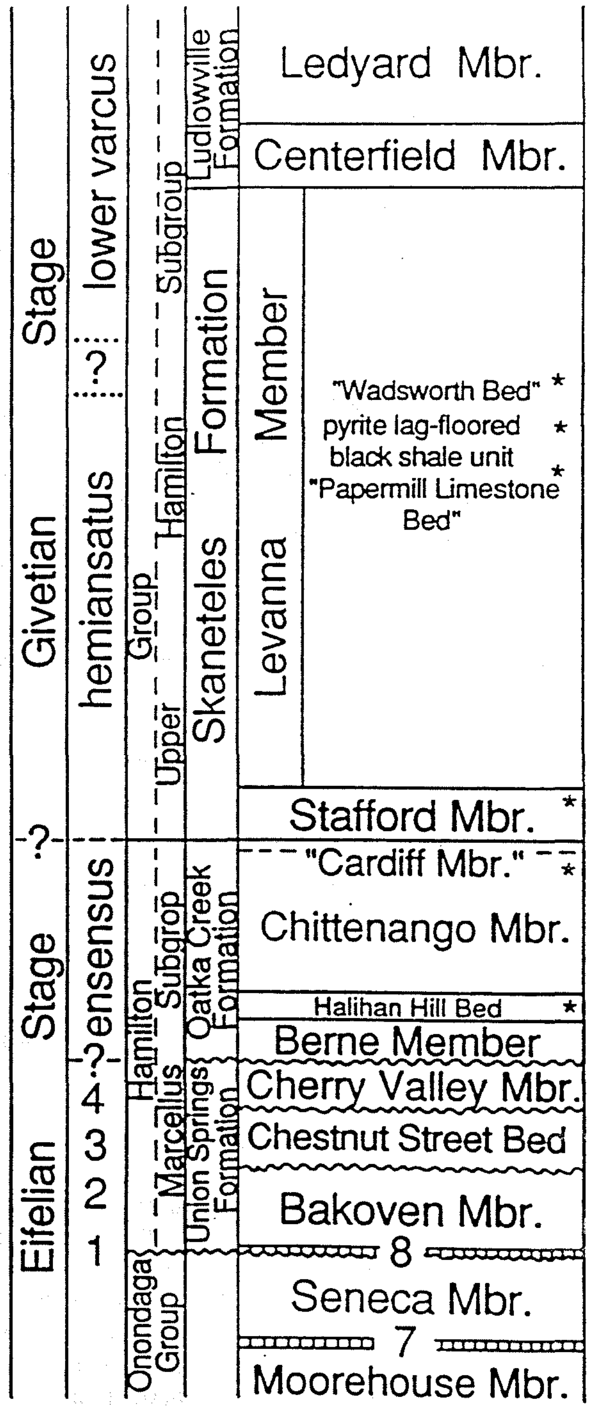

Figure 1. Generalized succession of lithologic and zonal units in the uppermost Onondaga Formation-through-basal Ludlowville Formation interval in western New York. Numbers denote: 1, base-Bakoven Member discontinuity; 2, *Cabrieroceras plebieforme* zone; *Haplocrinites* zone; 4, *Agoniatites vanuxemi* zone; 7, Onondaga Indian Nation (OIN) K-bentonite; 8, Tioga "F" K-bentonite (from Baird et al., 1999).

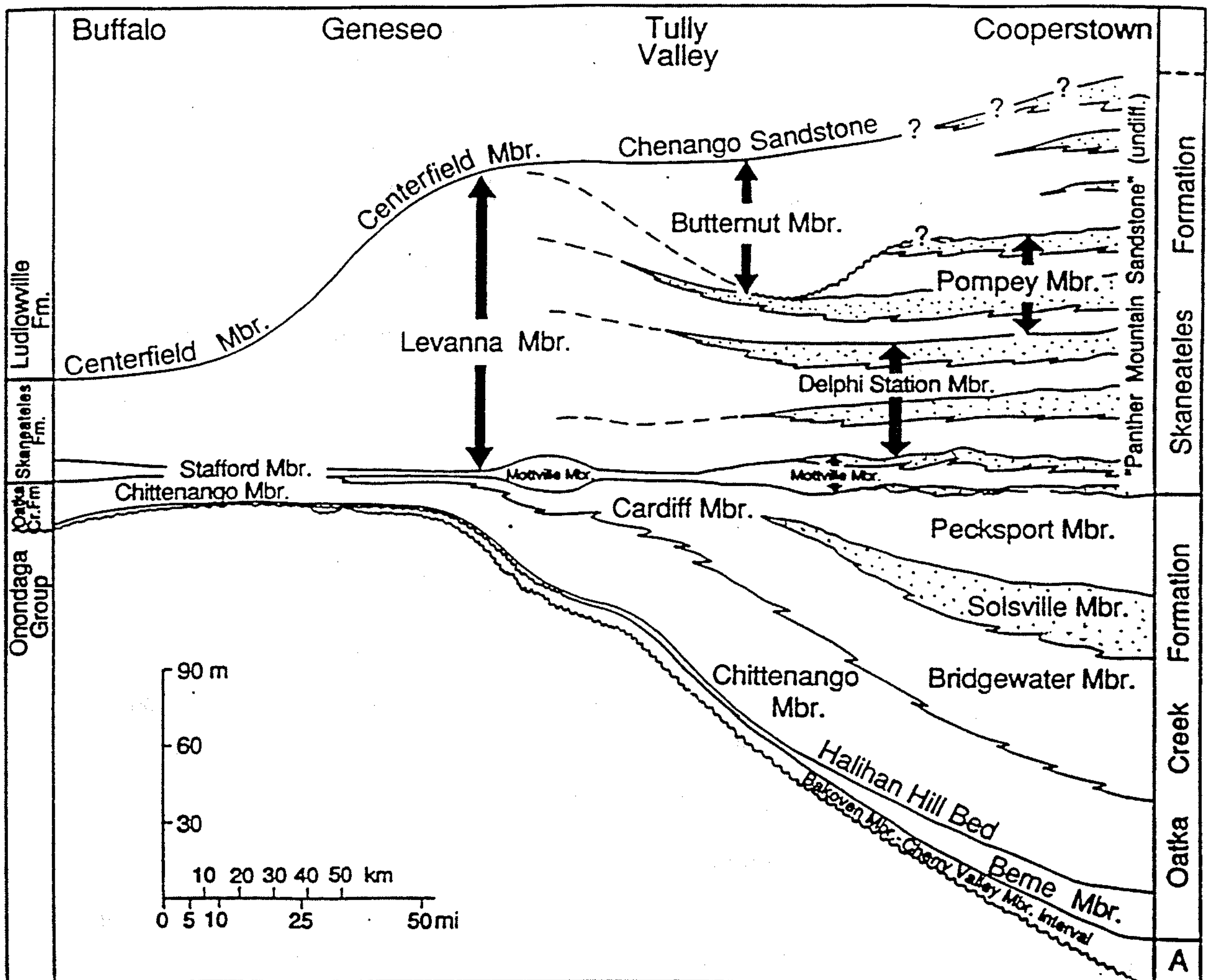

Figure 2. Generalized stratigraphy and unit relationships in the lower part of the Hamilton Group along the east-west outcrop belt across New York State. Conspicuous eastward thickening of units reflects clastic influxes associated with the second tectophase of the Acadian Orogeny and coincident deepening of the Devonian foreland basin (from Baird et al., 1999).

Limestone is a distinctive brown petroliferous and nodular, thin carbonate layer that is extremely widespread (Fig. 2). At STOP 1 it shows its typical condensed character and distinctive fauna. Key fossils in this unit include styliolines, thickets of auloporid corals, and large cephalopod conchs. Orthoconic cephalopods and the zonally important goniatite *Agoniatites vanuxemi* are particularly abundant in the upper part of the unit; these were exposed by the hundreds, until recently, on the top-Cherry Valley discontinuity surface at the Seneca Stone Quarry (STOP 1). The Cherry Valley truncates the upper part of the Union Springs Formation across western New York and it is overlain, in turn, by a corrosional discontinuity beneath the Berne Member from Cayuga Lake westward. West of the Genesee Valley both the Cherry Valley and the underlying Union Springs Formation appear to be absent due, in part, to erosional (corrosional) beveling beneath the Berne Member (Baird and Brett, 1986, 1991; Baird et al., 1999; Fig. 2). The fauna of the Cherry Valley and that of the underlying Chestnut Street Bed-Stony Hollow interval differs significantly from that of the Onondaga fauna and that of the overlying Hamilton fauna. This reflects the global Kacak-otomari evolutionary-ecological biotic succession and faunal disturbance that is recognized by many workers (Chlupac and Kukal, 1986; Trylos-Massoni et al., 1990).

The Cherry Valley Limestone is succeeded by a black, fissile highstand shale unit known as the Berne Member (Griffing and Ver Straeten, 1991; Ver Straeten et al., 1994; Fig. 1). From Syracuse westward to LeRoy the Berne is represented, at best, by only a meter or less of section in outcrop, although this unit is vastly thicker in the Hudson Valley. Above the Berne Member is 0.3 - 1.0 meter-thick interval of profusely fossiliferous gray shale that is designated the Halihan Hill Bed (see Griffing and Ver Straeten, 1991; Baird et al., 1999). This unit is unusual both for the fact that it remains thin from the mid-Hudson Valley region all the way to LeRoy in western New York and for the first appearance of the Hamilton fauna, an evolutionary-ecological biota that would persist almost to the end of the Givetian (Brett and Baird, 1995). Key fossils in this bed include the brachiopods *Tropidoleptus*, *Pseudoatrypa*, *Athyris*, *Mediospirifer* chonetids, and ambocoeliids. Small corals, bryozoans, diverse bivalves and the trilobite *Phacops* are also present. The widespread, thin and condensed nature of this unit is problematic considering that it records a major regression at this time. Typically, Hamilton regressive units (Mottville Member, Chenango Member, Ivy Point and Owasco sandstones) record significant influxes of coarse sediment into the study area (Baird et al., 1999).

The Halihan Hill Bed is succeeded by an interval of black, organic-rich shale (Chittenango Member) that marks resumption of anoxic highstand conditions comparable to those recorded by the Berne Member. From Cayuga Lake westward this unit is less than 17 meters-thick, but to the east, it thickens to greater than 33 meters in the vicinity of Syracuse (Fig. 2). Moreover, the upper part of the Chittenango Member grades eastward into gray shale facies beginning at the Skaneateles Valley meridian. This gray shale interval, known as the Cardiff Member, thickens significantly to the east across Onondaga County (Fig. 2).

SKANEATELES FORMATION

STAFFORD MEMBER-MOTTVILLE MEMBER INTERVAL

The Stafford Member and stratigraphically correlative Mottville Member comprise the basal divisions of the Skaneateles Formation (Fig. 1). In sections west of Auburn, New York the Stafford Member consists of a 0.5 to 4 meter-thick interval of impure limestone beds yielding a low to moderate diversity biota. In Erie County the Stafford is 3 to 4 meters-thick and is characterized by a lower limestone bed yielding abundant *Devonochonetes* and *Emanuella* (Stafford "A" Bed) followed by an interval of thin bedded impure limestone which is succeeded, in turn, by a massive, nodular, cherty limestone unit yielding auloporid corals and a few other fossils (Stafford "B" Bed). From Stafford east to the meridian of Waterloo, the Stafford Member is a 0.3 - 1.0 meter-thick interval marked by a thin shell-rich shale unit at the base yielding *Emanuella*, auloporids rare *Dipleura* exuviae as well as flattened gastropods and orthocones (Meyer, 1985; Baird et al., 1999). Above the fossiliferous shale is a 0.25 - 0.7 meter-thick limestone ledge, or double ledge displaying a wackestone texture. Key fossils in the limestone include: *Bembexia* and orthoconic nautiloid conchs displaying black calcite preservation, the brachiopod *Cupulrostrum sappho*, *Phacops* exuviae and auloporid corals. At Great Gully south of Union Springs and at the roadcut and farm section (STOP 3) south of Half Acre, the Stafford again thickens to 3 - 3.5 meters and takes on the lithologic appearance of the Stafford in eastern Erie County, though with fewer fossils (Baird et al., 1999; see STOP 3). The basal *Emanuella*-rich limestone bed at STOP 3 probably corresponds to the "A" bed in Como Park at Lancaster. The

0.7 meter-thick nodular, and slightly cherty bed at the top of the STOP 3 section corresponds to the "B" bed in Erie County and to the Case Hill Coral Bed of the upper part of the Mottville in Onondaga County sections (Meyer, 1985; Baird et al., 1999). Fossil-rich calcareous shale deposits below the *Emanuella*-rich limestone layer at STOP 3 appears to correspond to a *Mediospirifer* and *Dipleura*-bearing calcareous mudstone unit at the base of the Mottville sections in Onondaga County that we herein name the Mason Hill Bed (see discussion below).

East of STOP 3, the middle and upper parts of the Stafford abruptly balloon in thickness as one crosses the Auburn meridian (Fig. 2). At Smiths Falls and at the type Mottville section north of Skaneateles, this interval exceeds 7 meters in thickness and is expressed as monotonous hard calcareous mudstone yielding *Zoophycos* and rare body fossils. The term Mottville applies to sections from Smiths Falls eastward, although sections east of Mottville are much thinner and are different in character. We believe, however, that lower Mottville units remain condensed and distinctive through the region. East of the Skaneateles meridian the Mottville thins and is quite condensed in sections south and west of Marcellus. However, only a short distance further east in the Marcellus quadrangle, the Mottville thickens slightly and develops the well known "two-limestone" motif of central New York sections (Grasso, 1986).

The Central New York Mottville Member is characterized by five mappable internal divisions; these are, in ascending order: a, a basal shell-rich calcareous mudstone or impure limestone layer yielding small brachiopods and mollusks as well as abundant *Mediospirifer*, large *Aulocystis* and the trilobite *Dipleura dekayi*; b, a calcareous siltstone interval (present mainly at and east of STOP 7); c, a hard, falls-capping crinoidal unit; d, a calcareous mudstone unit rich in *Mediospirifer*, *Tropidoleptus*, *Rhipidomella* and diverse associated fossils; d, a hard muddy limestone unit (Case Hill Coral Bed) yielding abundant rugose and tabulate corals; e, an interval of soft, gray shale yielding abundant *Ambocoelia* and small bivalves. Units b and d are the two limestone markers that make for easy identification of the Mottville Member across Onondaga County.

The lowest Mottville division is a 0.4 - 0.8 meter-thick shell-rich calcareous mudstone unit that caps the long mudstone succession of the Cardiff Member. We herein name this unit the Mason Hill Bed for exposures on an unnamed ravine paralleling Eager Road southwest of Mason Hill in the Jamesville 7.5' quadrangle. This layer typically yields large *Aulocystis*, *Mediospirifer audaculus*, *Emanuella*, as well as numerous bivalves and orthoconic cephalopods. *Mediospirifer* is rare in this bed west of the Otisco Valley meridian and the bivalve fraction is increasingly dominated by nuculoids in the same direction. This unit is confidently recognized in sections from Pompey Hollow (STOP 7) west to Smiths' Falls near Auburn.

Above the Mason Hill Bed at Pompey Hollow (STOP 7) is a 3.7 meter-thick interval of calcareous siltstone that is characteristically *Zoophycos*-churned. This unit is missing further to the west where the Mottville crinoidal limestone is juxtaposed onto the Mason Hill Bed. We believe that this siltstone unit thickens eastward and becomes a major regressive marker unit in the lower Mottville in the Chenango-Sangerfield valley region.

Above the unnamed calcareous siltstone interval is a 0.3 - 0.45 meter-thick calcarenitic limestone bed that typically caps waterfalls across the Onondaga County region. Herein, we name this ledge the Cedarvale Bed for waterfalls-capping exposures in three small gullies located 2.0 - 4.2 kilometers southwest of Cedarvale near the east edge of the Marcellus 7.5' quadrangle. The Cedarvale Bed is a crinoidal packstone to grainstone that unit occasionally yields large corals. At its base are minor channels and hydraulically enlarged burrows. This basal contact appears to mark a discontinuity; westward pinchout of the underlying calcareous siltstone unit is believed to reflect westward erosional overstep of this unit by the Cedarvale Bed. The Cedarvale Bed is an analog of the Stone Mill and Tichenor limestones, both of which are encrinite beds resting on sequence boundary unconformities (Brett and Baird, 1996). We believe that the sub-Cedarvale contact marks a eustatic lowstand and is a sequence boundary as well. At Pompey Hollow (STOP 7) the Cedarvale Bed is absent and its position is marked by a reentrant (Fig. 6). Moreover, the eastward appearance of the unnamed calcareous siltstone between the Mason Hill and the Cedarvale reentrant level at STOP 7 is consistent with our belief that the Mason Hill is a precursor bed followed by a regressive progradational clastic unit associated with a major lower Mottville lowstand event (Brett and Baird, 1996).

Above the Cedarvale Bed is a 0.7 - 2.0 meter-thick interval of calcareous mudstone yielding a diverse fauna. This unit, as yet unnamed, yields abundant *Tropidoleptus*, *Mediospirifer*, *Nucleospira* and *Rhipidomella*. Other fossils

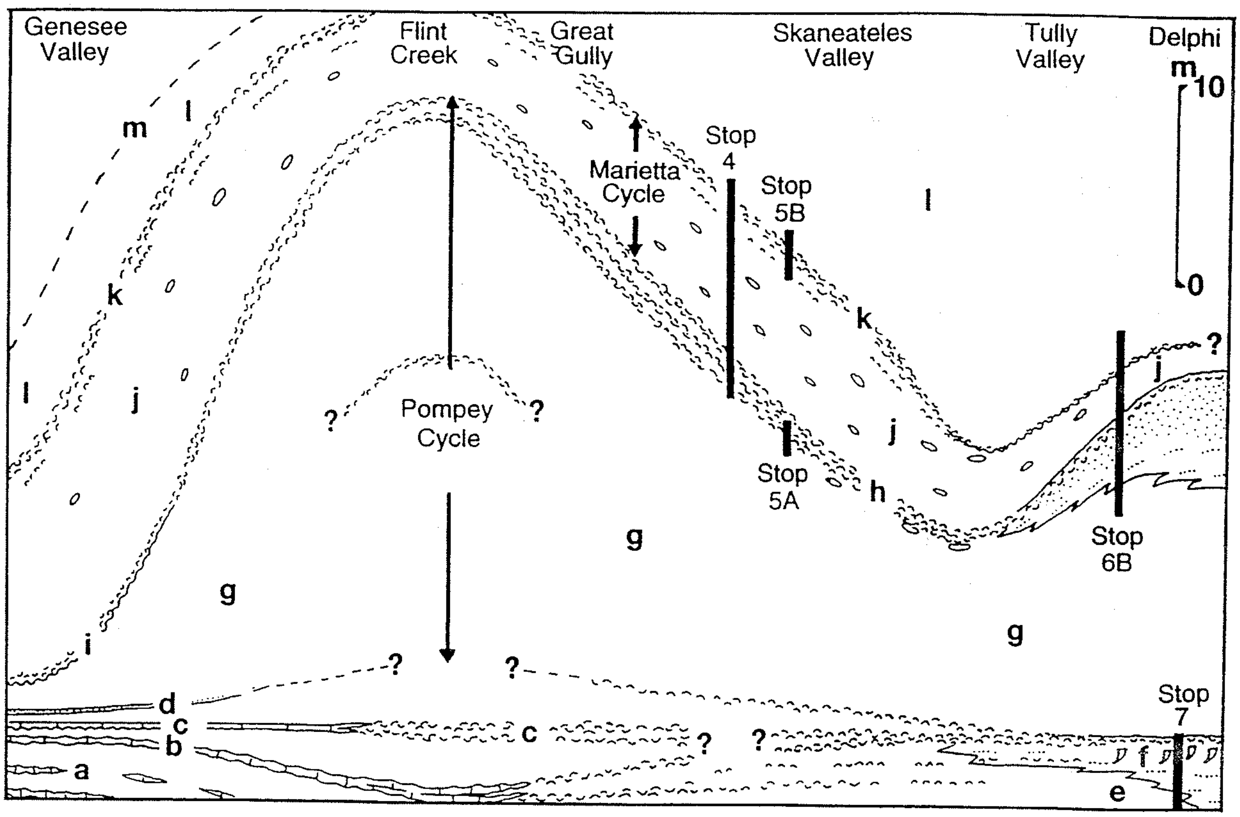

Figure 3. Medial Skaneateles Formation correlations across the Finger Lakes region. Divisions shown include: the upper Delphi Station cycle, Pompey-Marietta cycle interval and the Butternut Shale interval. Lettered units include; a, calcareous shale and limestone facies comprising the upper part of the upper Delphi Station cycle in western New York; b, Papermill Limestone Bed; c, Pole Bridge Limestone Bed and equivalent *Crurispina nana*-rich shell bed; d, *Tasmanites*-rich bed flooring Pompey cycle; e, silty shale of Delphi Station Member; f, siltstone-fine sandstone facies of uppermost Delphi Station Member; g, Pompey cycle shale succession; h, top-Pompey *Nyassa-arguata*-rich shell bed bundle; i, Wadsworth Bed; j, Marietta cycle shale succession; k, Slate Rock bundle of shell beds; l, dark gray to black highstand shale facies of Butternut succession, m, Centerfield Member.

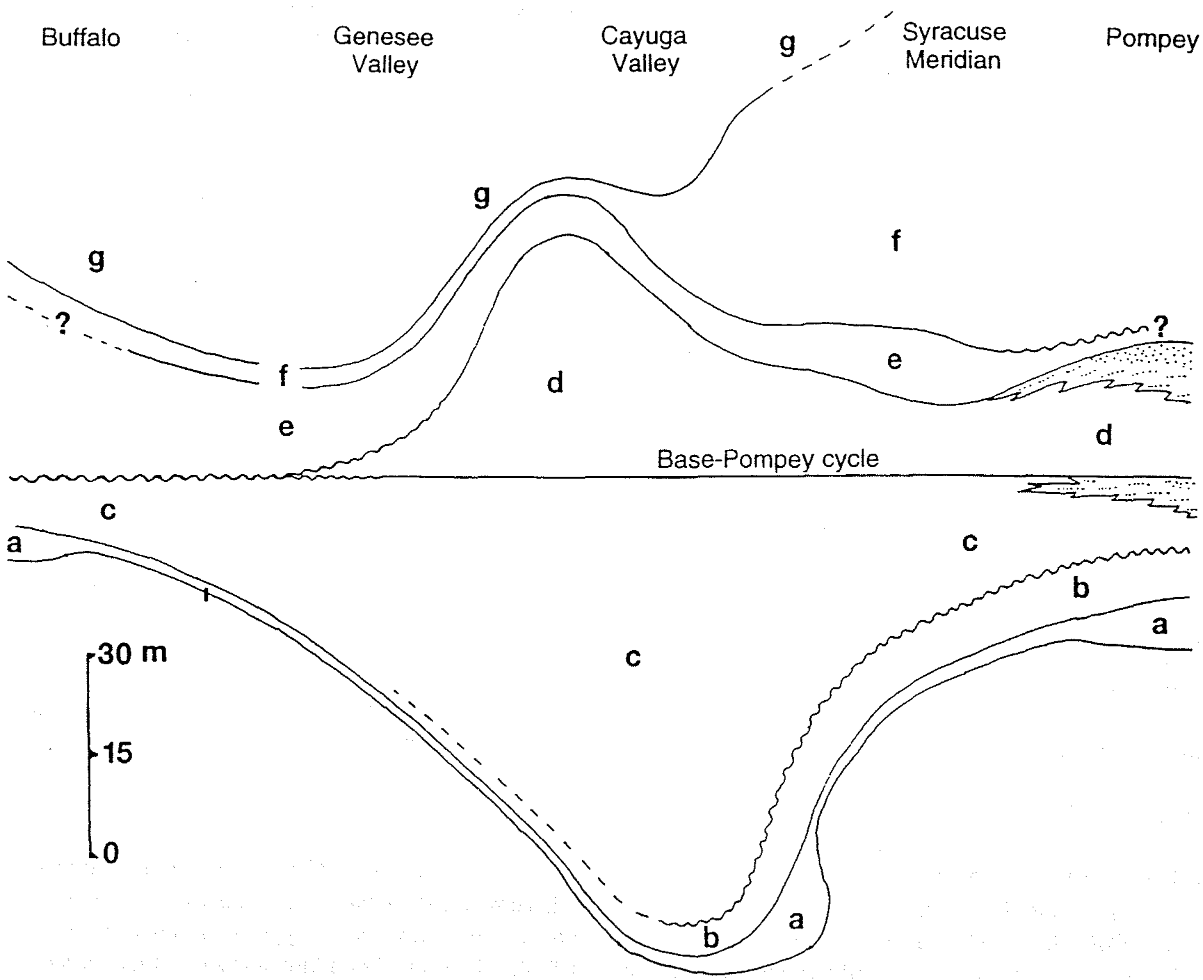

Figure 4. Dynamic pattern of shifting depocenters observed in the Skaneateles Formation. Divisions shown include: a, Stafford-Mottville interval; b, Cole Hill cycle; c, upper Delphi Station cycle; d, Pompey cycle; e, Marietta cycle; f, Butternut Member and Butternut Member-equivalent Levanna Member strata; g, Centerfield Member.

include abundant bryozoans and diverse bivalves. At STOP 7, this division is represented by two meters of fossil-rich strata between the Cedarvale reentrant and the overlying Case Hill Coral Bed (Fig. 6). The Case Hill Bed is the second regional carbonate marker of the central New York Mottville section (Grasso, 1996). This layer is typically 0.3 - 0.6 meters-thick and is typically represented by a muddy limestone ledge that holds up a secondary higher falls lip in Mottville sections. Key fossils include large corals such as *Heliophyllum*, *Heterophrentis* and *Favosites* which are often abundant and distinctive to this level. Other fossils include *Mediospirifer*, *Rhipidomella*, bryozoans and large bivalves. Above the Case Hill Coral Bed is a thin calcareous shale unit rich in the small rugose coral *Stereolasma* and the trilobite *Phacops rana*. Other fossils include the brachiopods *Rhipidomella* and *Pholidostrophia*. This unit is overlain by a 2 - 3.3 meter-thick softer gray shale interval rich in *Ambocoelia* and small bivalves. At the top of the soft shale unit, one typically observes a pavement of *Ambocoelia* in association with numerous gastropods and cephalopods displaying black calcite preservation. This horizon underlies somewhat more silty, monotonous gray to dark gray shale deposits of the basal Delphi Station Member.

We believe that the overall facies trend from the Chittenango Member up to the base of the Cedarvale Bed is a regressive systems tract culminating in a sequence boundary unconformity at the base of the Cedarvale ledge. From the Cedarvale ledge up to the shell pavement at the base of the Delphi Station the section has the overall aspect of a transgressive systems tract culminating in a maximum flooding surface. Within this transgressive interval, the Case Hill Coral Bed can be viewed as a regressive culmination of a second, more minor, Mottville cycle.

LEVANNA MEMBER AND COEVAL DELPHI STATION, POMPEY, "MARIETTA" AND BUTTERNUT MEMBERS

OVERVIEW.

The balance of the Skaneateles Formation above the Stafford-Mottville interval is represented by the shale-dominated Levanna Member west of Skaneateles Lake and coeval siltstone-sandstone capped cyclic units (Delphi Station, Pompey, "Marietta" and Butternut members) to the east of there (Figs. 2 – 4). This picture is complicated by the fact that the Delphi Station Member actually includes two sedimentary cycles (Cole Hill and upper Delphi Station cycles) and the "Marietta Member" is, as yet, an unofficial unit. As such, the post-Mottville succession encompasses five significant cyclic divisions capped by siltstone or sandstones; these are, in ascending order: the Cole Hill, upper Delphi Station, Pompey, Marietta, and Butternut-Centerfield cycles (Figs. 3 – 5). Notice that the last cycle includes the lowest division of the Ludlowville Formation. In the ensuing description we use cycles rather than member names as headers for ease of visualization of the correlation scheme.

LOWER DELPHI STATION CYCLE (COLE HILL CYCLE).

This lowest of the post-Mottville cycles develops a sandstone cap largely east of the Cazenovia meridian, hence it has been lumped into the Delphi Station Member to the west of there where the Delphi Station is essentially all shale. The Cole Hill Siltstone is named for Cole Hill Road east of Sangerfield where its type section is heavily worked by collectors for trilobites and large bivalves (Grasso, 1986). The upper bounding surface of this division can be traced westward from Delphi Falls, the type section of the Delphi Station Member, to the Genesee Valley. In the Genesee Valley and at Flint Creek near Phelps it is a thin shell bed 3.3 meters above the Stafford Member (Figs. 4, 6). At Great Gully, near Union Springs, it is expressed as a bed of reworked concretions encrusted by auloporid corals that occurs 7 meters above the top of the Stafford. From the vicinity of Marcellus east to Lord's Corners the layer of reworked concretions is well developed and typically associated with thickets of auloporid corals. Southeast of Lord's Corners reworked concretions become scarcer at this level but are replaced by small phosphatic pebbles and a greater abundance of associated shells. At the Pompey Hollow cut on US Route 20, this bed occurs 7 meters above the top of the Mottville and it yields phosphatic pebbles in association with small bivalves and numerous valves of *Athyris cora* (Fig. 6). At Delphi Falls the siltstone bed below this shell bed yields numerous *Dipleura dekayi*. This is particularly significant because the type Cole Hill Siltstone is famous for these fossils.

UPPER DELPHI STATION CYCLE.

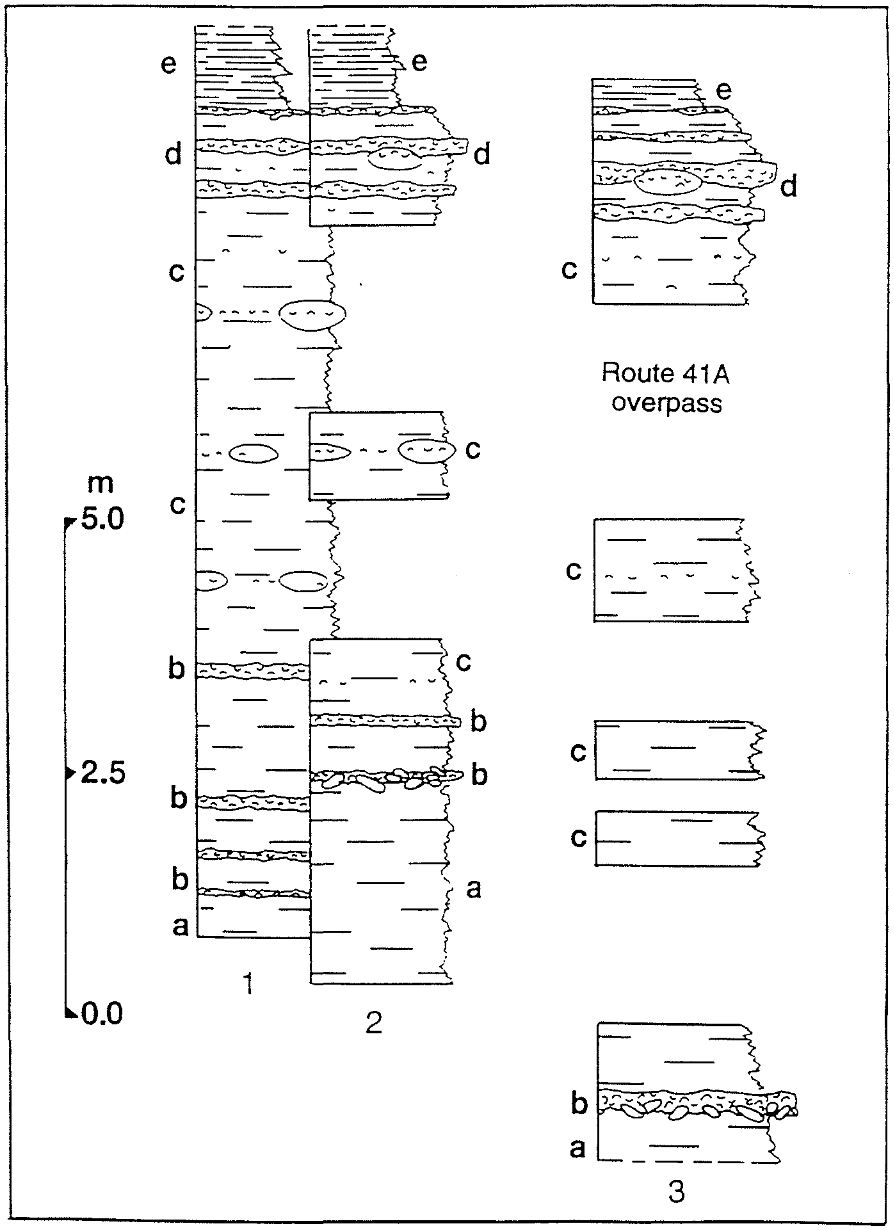

Figure 5. Marietta cycle succession and adjacent divisions exposed near Auburn and Skaneateles. Sections shown include: 1, roadcut exposed on Rockefeller Road east of Koenig Point on the east side of Owasco Lake (STOP 4); 2, Section in ravine east of Long Point on the east side of Owasco Lake; 3, section in ravine between Skaneateles Lake west shore and Skaneateles Aerodrome (STOP 5A, 5B). Lettered units include: a, shale of Pompey cycle; b, top-Pompey cycle shell bed bundle yielding *Nyassa arguata* and locally yielding reworked concretions; c, fossiliferous shale of Marietta cycle; d, top-Marietta cycle shell bed bundle (Slate Rock beds interval); e, Butternut Member-equivalent dark shale facies of upper Levanna Member succession.

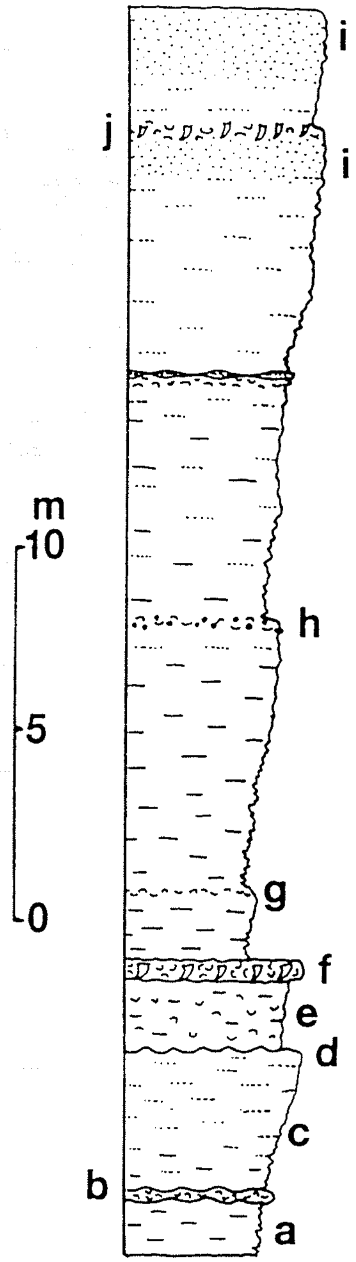

Figure 6. Roadcut section on US Route 20 west of Pompey Hollow (STOP 7). Lettered units include: a, uppermost part of Cardiff Member; b, Mason Hill Bed; c, calcareous muddy siltstone interval marking prominent regression in lower Mottville Member; d, reentrant marking probable position of the Cedarvale Bed which is missing here; e, *Tropidoleptus* and *Mediospirifer*-rich shale interval; f, Case Hill Coral Bed of upper Mottville Member; g, Mottville-Delphi Station Member-contact (maximum flooding surface shell pavement-level); h, top-Cole Hill cycle discontinuity bed yielding phosphatic pebbles; i, siltstone-fine sandstone facies of upper part of Delphi Station Member; j, bed of large corals and *Spinocyrtia* that is probably correlative to Papermill Bed-Roanoke Bed interval in Genesee Valley region sections.

Between the top of the Cole Hill cycle and the base of the Pompey Member is 20 - 50 meters of section that includes numerous concretionary limestone beds west of the Rochester meridian, a thick monotonous shale succession in the central Finger Lakes region, and a regressive, upward-coarsening facies succession east of the Syracuse meridian (Figs. 3, 4). In western New York, the top of the upper Delphi Station cycle is marked by distinctive beds (Papermill Limestone Bed, Roanoke Bed, Pole Bridge Bed) listed in ascending order (Baird et al., 1999). The resistant Papermill Bed can be traced from Oatka Creek eastward to the east side of Seneca Lake (Fig. 3). The Pole Bridge Bed, characterized by abundant *Ambocoelia* is believed to be traceable as far east as Great Gully near Union Springs (Fig. 3). Although the top-Delphi Station markers lose their calcareous character as they are traced eastward to the Cayuga Valley, the top of the upper Delphi Station cycle remains characterized by several closely-spaced shell beds indicative of sediment slow-down within the transgressive uppermost part of the Delphi Station cycle. This bundle of shell beds is again seen at Clintonville Ravine near Otisco Lake where it overlies silty regressive shales. At Rattlesnake Ravine in the Tully Valley, the upper part of the upper Delphi Station cycle has changed to a hard, silty, falls-forming succession and the shell beds are reduced in number (Fig. 3). Larger brachiopods such as *Tropidoleptus* and *Spinocyrtia* have replaced the mix of *Eumetabolotoechia* and nuculoids that characterize these shell beds in the central Finger Lakes region. At STOP 7 the culminating lithofacies of the cycle is siltstone and fine sandstone (Grasso, 1986; Linsley, 1991). *Spinocyrtia* occurs in this interval as do numerous medium to large bivalves including *Nyassa arguata*. A band of large corals observed at STOP 7 and adjacent sections marks a regression maximum within the uppermost part of this cycle; this level may be equivalent to the Papermill Bed-Roanoke Bed interval in western New York sections (Figs. 3, 6).

POMPEY CYCLE.

The type Pompey Member section at Pratts Falls (STOP 6B) includes 12 meters of silty shale followed by 5 meters of regressive siltstone and fine sandstone (Cooper, 1930). This unit grades westward to a 11 - 12 meter-thick shale succession bracketed by the top-Delphi Station shell-bed bundle at the base and by a shell-bed bundle (*Nyassa arguata*-rich shell bed interval) at its top in sections between the Tully and Otisco valleys. West of Skaneateles Lake where Pompey-equivalent strata occur in the Levanna Member, the top and bottom of this unit is delimited by these shell-bed bundles (Figs. 3, 5). The Pompey Member-equivalent shale interval reaches a maximum thickness of 33+ meters at Flint Creek near Phelps before thinning to about 3 meters in the Genesee Valley (Figs. 3, 4). At Conesus Outlet near Avon, this interval includes 3 meters of black shale underlain by a 25 centimeter-thick bed containing dense concentrations of *Tasmanites*. The spore-rich zone appears to mark a maximum flooding surface at the base of a near-anoxic early highstand Pompey interval (Baird et al., 1999). West of the Genesee Valley the Pompey Member-equivalent shale is believed to be absent due to erosive beveling (Figs. 3, 4).

In the Tully Valley-Skaneateles Valley region, the *Nyassa arguata*-rich zone at the top of the Pompey typically consists of two to three closely spaced shell beds typically yielding *Nyassa* and other mollusks that are three-dimensionally preserved and retaining shells of black calcite (see STOP 5A). The lowest of the shell beds is observed to locally exhume concretions (see STOP 5A). In the Levanna Member these shell beds persist as key markers, at least, as far west as Seneca Lake. We believe that the shell-bed bundle at the top of the Pompey Member-equivalent shale interval connects to a clearly erosive layer designated the Wadsworth Bed in Genesee Valley sections (Baird et al., 1999; Figs. 1, 3). This bed, occurring above a thin Pompey Member-equivalent black shale interval near Avon, is believed to truncate successively lower marker beds towards the west (Figs. 3, 4). At Oatka Creek the Wadsworth Bed is juxtaposed onto upper Delphi Station strata with the uppermost Delphi Station interval and overlying Pompey-equivalent *Tasmanites*-rich interval removed by erosion at this meridian. At Buffalo Creek, the undulatory disconformity contact observed at Union Road (see Baird et al., 1999) may correlate to this erosional bed.

MARIETTA CYCLE.

Above the type Pompey section on the west tributary at Pratts Falls (STOP 6B) and below the Butternut Member succession upstream is a 2.3 meter-thick sequence of soft fossil-rich gray shale capped by siltstone that appears to be a stand-alone sedimentary cycle. Traced westward this division thickens to 4 meters in the Tully Valley and 8 - 10 meters in the Otisco and Skaneateles valleys (Figs. 3 - 5). This interval typically consists of soft gray shale with minor shell beds and several levels of discoidal concretions in the lower and middle parts. The upper 0.8 - 1.7 meters is characterized by a bundle of closely spaced shell beds in association with discoidal concretions (Fig. 5). This succession, referred to as the "Slate Rock beds" interval (Baird et al., 1999) is traceable from the Tully Valley west to the Batavia meridian (Fig. 3). We herein informally name this unit the "Marietta Member" for excellent exposures of this interval at Willow Dale Glen on the west side of Otisco Lake south of Marietta, New York.

Fossils in the gray shale part of the "Marietta Member" include abundant ambocoeliids including the newly described form *Microclypeus* (Goldman and Mitchell, 1990) and occasional *Mucrospirifer*. Auloporid corals occur in the shell beds and dispersed nuculoid bivalves and orthoconic cephalopods are common in the shale. An interval of pyrite nodules and pyritic fossil steinkerns is present near the middle of the shale interval within the Tully Valley-Skaneateles Valley area. Nuculoid bivalves, orthoconic cephalopods and the goniatite *Tornoceras* are key steinkern elements. The Slate Rock beds yield abundant ambocoeliids as well as numerous *Devonochonetes* and *Mucrospirifer*. Auloporids are common and *Stereolasma* is also present. Small bivalves and pelmatozoan hash round out the mix of fossils. As with the underlying *Nyassa arguata*-rich shell beds below the Marietta, black calcite preservation is typical for many bivalves and orthocones in the Tully Valley-Skaneateles Valley region (see STOP 5B). West of the Skaneateles Valley, these fossils are preserved as flattened composite molds (see STOP 4).

In the Owasco-Seneca Valley region the Marietta cycle is 4 - 8 meter-thick. However, this interval thickens to 9 meters in the Genesee Valley and approximately 15 meters on Oatka Creek (Fig. 4). West of the Genesee Valley Marietta Shale facies begins to darken as the interval thickens (Baird et al., 1999). Although the Slate Rock beds interval is concealed west of the Batavia meridian, rendering correlations uncertain in this part of the section, we believe that the Marietta Member includes at least 23 meters of black and near-black shale on Buffalo Creek in Erie County (Fig. 4). This black shale caps the spectacular undulatory disconformity exposed below Union Road on that creek (Baird et al., 1999). Eastward thinning of the Marietta cycle from the Tully Valley eastward to Pratts Falls probably reflects combined internal condensation and erosive beveling.

BUTTERNUT-CENTERFIELD CYCLE.

The Slate Rock beds interval is abruptly overlain by black and dark gray, fissile to platy shale from the Batavia area east to the Cazenovia meridian (Figs. 4, 5). From the Batavia meridian to the west edge of the South Onondaga 7.5' Quadrangle, the top of the Butternut is marked by a discontinuity lag bed (Peppermill Gulf Bed) associated with the base of the Centerfield. From the Tully Valley eastward the Butternut spectrally grades upward from basinal shale facies into proximal cross-bedded sandstone facies of the Chenango Member without a discernible break (Gray, 1984, 1991). Hence, the interval between the top of the Slate Rock beds and the sequence boundary between the Chenango Sandstone and the Stone Mill Limestone appears to be part of one and the same upward-coarsening aggradational event (see below).

Across much of western New York, the Butternut Member is only 2.5 - 5 meter-thick (Fig. 4). However, this unit balloons from 2.5 meters of thickness at STOP 2 west of Cayuga Lake to 23 meters on the east side of Cayuga Lake (Fig. 4). At the Cazenovia meridian the Butternut is about 75 meters-thick and is characterized by interbedded dark shale and tabular siltstone beds. In this region the Butternut actually resembles parts of the Penn Yan-Sherburne succession of the highest Givetian. Of all the Skaneateles divisions, the Butternut clearly records the greatest transgression event.

SKANEATELES FORMATION DEPOSITIONAL PATTERNS

The upper part of the Oatka Creek Formation, Skaneateles Formation and lower Ludlowville Formation-interval encompasses seven transgressive-regressive cycles; these include in ascending order: a cycle commencing below the Cardiff Member and culminating at the base of the Cedarvale Limestone Bed, an upper Mottville cycle centered on the Case Hill Coral Bed; the Cole Hill cycle; the upper Delphi Station cycle; the Marietta cycle and the Butternut-Centerfield cycle centered on the Chenango Member-Stone Mill Bed contact (Figs. 3, 4). As such, the first and last cycles are of the greatest magnitude. In fact, it is a moot question as to whether the Butternut and Centerfield members should be combined as a distinct new formation owing to their internal genetic continuity. We view the shell-bed bundles within the Levanna and coeval members to be the expressions of transgressive systems tract intervals above variably monotonous regressive aggradational shale-siltstone successions.

As with the higher Ludlowville and Moscow formations, the Skaneateles interval shows a pattern of laterally shifting depocenters (Fig. 4). The depocenter for the Cardiff-lower Mottville cycle is located east of the Cazenovia meridian. The depocenter for the upper Mottville cycle is localized in the region north and west of Skaneateles. The Cole Hill cycle has no well defined depocenter as yet, but it may exist somewhere east of the Cazenovia meridian. The upper Delphi Station cycle interval appears to be thickest in the Cayuga Valley and the Pompey cycle is thickest at Flint Creek near Phelps. The Marietta cycle is clearly thickest and most basinal in aspect in Erie County. However, the Butternut Member interval is thickest and most basinal in aspect in central New York. Some of this thickness variation may be influenced by erosional processes associated with discontinuity development but some of it clearly reflects flexural crustal processes presumably linked to the Acadian Orogeny. The abrupt change from westward depocenter migration to eastward (retrograde) depocenter migration during Butternut Member deposition may signal a pulse of renewed thrust loading.

ACKNOWLEDGEMENTS

We thank the managers of the Seneca Stone Quarry, Ray Lockwood, David Robinson and James Garrison for kind permission for our group to enter their properties. Our work on the Skaneateles Formation was supported by grants from the Petroleum Research Fund and NSF EAR 9219807 and the joint New York State-Federally supported STATEMAP mapping program.

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ROAD LOG FOR FACIES AND FOSSILS OF THE LOWER HAMILTON GROUP

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0.0	Junction of Route 14 with US Route 5 & 20 in Geneva; proceed east on US Route 5 & 20.
2.5	2.5	Junction of US Route 96A; proceed straight (east) on US Route 5 & 20

8.6	6.1	Junction of US Route 5 & 20 with Route 414 west of Seneca Falls; turn right (south) onto Waterfalls Bridge Road crossing the NYS Barge Canal in order to bypass downtown Seneca Falls.
8.7	0.1	Junction of Waterfalls Bridge Road with River Road. Turn left (east) onto River Road.
10.55	1.85	Intersection with red light. River Road becomes West Bayard Road; proceed straight (east) on West Bayard Road.
10.7	0.15	Intersection of West Bayard Road with Route 414. Turn right (south) onto Route 414.
14.6	3.9	Junction of Route 414 with Yellow Tavern Road; turn left (east) onto Yellow Tavern Road.
16.7	2.1	Turn left (north) into entrance of Seneca Stone Quarry. Stop to sign release forms and continue into quarry.
16.9	0.2	Turn left onto dirt road south of main pit and park vehicles.

STOP 1. ONONDAGA LIMESTONE-BASAL OATKA CREEK FORMATION-SUCCESSION IN SENECA STONE QUARRY

Seneca Stone Quarry has been written up in many previous reports (see Ver Straeten et al., 1994) particularly with respect to the stratigraphy of the Oriskany sandstone and overlying Onondaga Limestone. On this trip we focus on the post-Onondaga succession exposed on the top-riser at the south end of the quarry.

The Seneca Member of the Onondaga Limestone, forming the highest wall below the riser, is bracketed by the Onondaga Indian Nation K-bentonite at its base and dark post-Onondaga shales at its top. Units belonging to the Union Springs Formation are represented by the Bakoven Member, represented here by black, bituminous shale and ribbon limestone facies and by the thin overlying Chestnut Street Limestone submember which is gray in color and rich in fossils. The Bakoven records lower dysoxic to near-anoxic highstand conditions and is marked by a maximum flooding surface at its base. A prominent bone bed rich in *Onychodus* teeth is present at the base as are several K-bentonites which are developed in the vicinity of the bone bed. Higher Bakoven strata yield *Camarotoechia*, styiolinids and the large bivalve *Panenka*. Bitumen ("dead oil") is conspicuous along fractures and bounding surfaces associated with the limestones. The Chestnut Street submember occurs amalgamated to the base of the overlying Cherry Valley Limestone and is partly overstepped by the unit at this locality. Key fossils in the unit include the proetid trilobite *Dechenella* and a very small inadunate crinoid *Haplocrinites*. The Chestnut Street submember displays an erosional disjunct contact with the underlying Bakoven Member.

The Oatka Creek Formation overlying the Union Springs Formation is represented in the quarry by the Cherry Valley Member, Berne Member and Halihan Hill Bed, all of which are highly condensed and/or erosionally truncated. The Cherry Valley is represented by 0.7 meters of friable brown limestone which is distinctly nodular and petroliferous. It is rich in styliolinids, auloporid corals and distinctive for large cephalopod conchs. Orthoconic cephalopods and the early goniatite *Agoniatites vanuxemi* occur in the uppermost bed of the unit; these were spectacularly exposed along the top-Cherry Valley discontinuity surface in this quarry for a number of years. The Cherry Valley is part of the transgressive systems tract succession above the Stony Hollow-Chestnut Street submember regression maximum; it is highly condensed, contains internal discontinuities and yields a largely pelagic fauna.

Post-Cherry Valley strata at this locality are represented by the 0.7 meter-thick black shale interval of the Berne Member and by the fossil-rich Halihan Hill Bed which is occasionally seen in the quarry scrapings. The Berne represents basinal early highstand deposits over a wide region and it overlies a regional corrosional discontinuity surface on the Cherry Valley in western New York. The somewhat enigmatic Halihan Hill Bed, by contrast, yields the greatest diversity of fossils observed in the lower Hamilton Group.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPION
17.1	0.2	Return to vehicles and retrace route to quarry entrance. Turn right (west) onto Canoga Springs-Yellow Tavern Road.
19.2	2.1	Junction of Canoga Springs-Yellow Tavern Road with Route 414; turn left (south) onto Route 414.
21.6	2.4	Junction of Route 414 with Poormon Road in Village of Fayette;

		turn right (west) onto Poormon. Road.
21.9	0.3	Fayette Town Quarry on south side of Poormon Road; turn left (south) into quarry and park vehicles

STOP 2. UPPER SKANEATELES-THROUGH-BASAL LUDLOWVILLE FORMATION SUCCESSION IN FAYETTE TOWN QUARRY

The Fayette Town Quarry exposes the uppermost part of the Skaneateles Formation and the overlying Centerfield Member of the basal Ludlowville Formation. Skaneateles Formation deposits comprise gray and dark gray shale of the Levanna Member which are exposed in the lower 7.5 meters of the quarry section. Two prominent shell beds rich in *Ambocoelia*, *Devonochonetes*, *Mucrospirifer*, nuculoid bivalves and orthoconic cephalopods cap a bench in this quarry. These layers, designated the Slate Rock beds (Baird et al., 1999), mark the uppermost part of a shale-dominated interval that we believe correlates to a unit that we designate the Marietta Cycle in central New York localities (see text; Fig. 3). Shale deposits below the Slate Rock beds yield several levels rich in the distinctive ambocoeliid brachiopod *Microclypeus* (Goldman and Mitchell, 1990) and auloporid corals often in association with discoidal concretions.

The top 2.5 meters of the Levanna Member below the Centerfield is a dark gray to near –black shale unit yielding *Eumetabolotoechia* ("*Leiorhynchus*"), *Styliolina* and few other fossils. We believe that this is a major highstand unit that is correlative with the Butternut Member in central New York sections. The top of the dark shale interval is abruptly overlain by richly fossiliferous, calcareous shale deposits of the Centerfield Member.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTIOM
		Return to vehicles. Exit Fayette Town Quarry turning right (east onto Poormon Road.
22.2	0.3	Junction of Poormon Road with Route 414; turn left (north) onto Route 414.
28.5	6.3	Junction Route 414 with US Route 5 & 20 in downtown Seneca Falls. Proceed straight (north) onto US Route 5 & 20.
33.35	4.85	US Route 5 & 20 bridge over Cayuga Outlet near entrance to Montezuma Wildlife Refuge. Continue east on US Route 5& 20.
33.55	0.2	Junction of US Route 5 & 20 with Route 90 just east of Cayuga Outlet overpass. Continue east on US Route 5 & 20.
39.9	6.35	Junction of US Route 5 & 20 with Half Acre Road; turn right (south) onto Half Acre Road. Small Onondaga Limestone exposure to right south of the intersection.
40.55	0.65	Junction of Half Acre Road with Route 326 at intersection in Half Acre. Proceed straight (south) on Route 326.
41.8	1.25	Outcrop of Mottville Member of Skaneateles Formation to left on the southeast side of Route 326
42.0	0.2	Turn right from Route 326 onto driveway of Dairy Farm. Park vehicles.

STOP 3. STAFFORD MEMBER, CAYUGA VALLEY MERIDIAN

This newly discovered shale pit on the Ray Lockwood Dairy Farm and the nearby roadcut section on Route 326 display essentially a complete section of the Stafford Member as well as 2 - 3 meters of the underlying Oatka Creek Formation. The Stafford at this locality, though expressed as a ridge-forming impure carbonate unit, is surprisingly depauperate in fossils at most levels. Most fossils, including the brachiopods *Cupulorastrum*, *Emanuella*, and *Devonochonetes*, auloporid corals, the gastropod *Bembexia* and orthoconic cephalopods, are found near the base of the unit. We believe that this fossiliferous condensed interval correlates to the Mason Hill and Cedarvale beds in the equivalent Mottville Member. Above the *Emanuella*-rich "A" limestone at this locality is a 1.7 meter-thick interval of thin-bedded lenticular limestone layers yielding sparse fossils. At the top of the section is a 0.7 meter-thick massive limestone bed yielding hard, dolomitic? nodules and occasional chert. This unit, yielding *Zoophycos* and sparse body fossils, is designated the "B" limestone bed of the Stafford (Meyer, 1985; Baird et al., 1999). It is well developed between Erie County and Cayuga Lake. This bed dramatically thickens eastward to approximately 8 meters at Smiths Falls on the other side of Auburn (Figs. 2, 4) before rapidly thinning again to form the fossil-rich

Case Hill Coral Bed in Onondaga County sections. The low fossil diversity of limestone beds at this locality is believed to reflect the "double whammy" of low oxygen conditions coupled with soft, turbid substrate conditions.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Exit farm and retrace route to US Route 5 & 20.
44.1	2.1	Junction of Half Acre Road and US Route 5 & 20; turn right (east) onto US Route 5 & 20.
46.1	2.0	Enter city of Auburn.
47.5	1.4	Intersection in downtown Auburn where US Route 5 splits off from US Route 20; turn right (south) on US Route 20.
47.65	0.15	Intersection where US Route 20 turns left (east); proceed straight (southeast) on Route 38A.
49.8	2.15	Northern end of Owasco Lake; continue straight (southeast) on Route 38A.
53.6	3.8	Junction of Route 38A with Rockefeller Road; turn right (south) onto Rockefeller Road.
54.9	1.3	Small shale exposure on east side of Rockefeller Road; park vehicles on wide shoulder area opposite outcrop.

STOP 4. MEDIAL-UPPER DIVISIONS OF LEVANNA MEMBER, OWASCO VALLEY MERIDIAN.

Visible in this roadcut are two shell bed bundles respectively capping Pompey Member-equivalent Levanna strata and "Marietta Member"-equivalent Levanna beds (Fig. 5). The lower shell bed bundle; visible in the lower end of this cut is represented by two main shell beds which are 1.2 meters apart and minor lower beds which are now concealed. These correlate eastward to the *Nyassa arguata* shell-rich zone which we will see at STOP 5A. In this cut the shell layers yield *Devonochonetes*, occasional *Protoleptostrophia* and *Mucrospirifer*, pelmatozoan debris, *Phacops*, auloporid corals and nuculoid bivalves. The small rugosan *Stereolasma* occurs in both shell beds. Reworked concretions are observed at the level of the lower shell bed in the nearby gully above Long Point signifying localized erosion below this layer (Fig. 5). Above the lower shell bed bundle is a 4.6 meter-thick fissile shale interval yielding minor shell-rich layers, dispersed ambocoeliid brachiopods and discoidal concretions. We believe that this unit is equivalent to the lower and middle parts of the "Marietta Member" in the Otisco Valley-Cazenovia region (Fig. 3).

The upper bundle of shell beds includes three subequal fossil-rich layers in a 0.8 meter-thick interval near the upper end of this roadcut. This bundle corresponds to the "Slate Rock beds" interval that caps the Marietta cycle across western and central New York. Key Slate Rock fossils include ambocoeliids, *Mucrosirifer*, pelmatozoan debris, auloporid corals, occasional *Stereolasma* and nuculoid bivalves. As with the lower shell bed bundle mollusks are typically preserved as flattened composite molds. This condition changes to the east of this locality where Levanna shell beds begin to yield mollusk fossils preserved as shells of black calcite (see text; STOP 5).

Above the Slate Rock beds shell bundle is an abrupt change into dark gray, highly fissile shale yielding few fossils. This part of the Levanna corresponds to the Butternut Member at localities east of here. The Butternut records a major transgression with development of near-anoxia during late Skaneateles time. Less than a meter of the dark shale can be seen here.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Return to vehicles and retrace route back to Route 38A via Rockefeller Road.
56.2	1.3	Junction of Rockefeller Road and Route 38A; turn right (southeast) onto Route 38A.
60.35	4.15	Junction of Route 38A with Route 359, turn left (north) onto Route 359.
62.0	1.65	Junction of Route 359 with Route 41A in Mandana. Turn left (north) onto Route 41A.
65.2	3.2	Turn right (east) onto private lane immediately south of New York State boat launch entrance. Lane parallels small creek southeast of the

		Skaneateles Aerodrome.
65.55	0.25	Turn vehicles around at driveway loop of David Robinson residence at end of lane and park along lane part way back from loop.

STOP 5A *NYASSA ARGUATA*-RICH LAG BED AT TOP OF POMPEY CYCLE.

Although the section of this creek is generally discontinuous and sloughy, the top of the Pompey Member-equivalent part of the Levanna Member, marked by *Nyassa arguata*-rich shell beds is fortuitously well exposed near the private lane. Similarly, the Slate Rock beds interval is well exposed 10 meters higher along this creek above the Route 41A overpass (see STOP 5B; Fig. 5).

At this locality the base of the *Nyassa arguata*-rich shell bed interval is a 14 - 18 centimeter-thick shell layer which is profusely fossiliferous. Brachiopods including *Devonochonetes*, *Protoleptostrophia*, ambocoeliids and occasional *Mucrospirifer* are present. *Stereolasma* and auloporid corals, *Phacops*, nuculoid bivalves and orthoconic cephalopods are also common. Both at and east of the Skaneateles Valley meridian, molluscan fossils are preserved as shells of black calcite, a condition that we will also see in the lower Delphi Station Member at STOP 7. The bivalve *Nyassa arguata*, a rare component of this interval west of the Skaneateles Valley is present and conspicuous at this level from Skaneateles Lake eastward. Typically the anterior of this clam is beautifully reinforced by thick black calcite while the posterior displays only a thin, often corroded, veneer of the carbonate. Reworked concretions are abundant in this bed at this locality; these are heavily bored and may yield a variety of encrustors (see Baird, 1981; Baird and Brett, 1981 for detailed study of this phenomenon). Exhumation of nodules below this bed in the Owasco and Skaneateles Valley region is consistent with our belief that this layer is correlative with the erosive Wadsworth Bed in western New York (see text; Baird et al., 1999; Fig. 3).

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Return to vehicles and return along private lane to Route 41A.
65.8	0.3	Junction of private lane and Route 41A; proceed straight (west) across Route 41A into private driveway of James Garrison residence on the west side of Route 41A. Park vehicles near barn and proceed on foot to outcrop upstream from previous stop.

STOP 5B "SLATE ROCK BEDS'-INTERVAL. TOP OF MARIETTA CYCLE.

The creek bed just above the Route 41A overpass exposes the upper part of the "Marietta Member"-equivalent part of the Levanna, including the Slate Rock beds, as well as the base of the Butternut Member-equivalent part of the Levanna (Fig. 5). The Slate Rock beds interval is represented by a bundle of closely-spaced shell beds in association with discoidal concretions. The shell beds contain abundant ambocoeliid brachiopods, numerous *Mucrospirifer* and occasional *Protoleptostrophia* and *Rhipidomella*. Other fossils include auloporids and occasional *Stereolasma*, nuculoid bivalves and orthoconic cephalopods. As with the *Nyassa arguata* bed downstream, mollusks in the Slate Rock interval display black calcite preservation.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Return to vehicles.
65.8	0.0	Driveway entrance on Route 41A. Turn left (north) onto Route 41A.
68.2	2.4	Junction of Route 41A and US Route 20 in Skaneateles; turn right (east) onto US Route 20.
68.65	0.45	Center of Skaneateles. View of Skaneateles Lake to the right. Continue east on US Route 20.
69.4	0.75	Leave village of Skaneateles. Continue east on US Route 20.
73.55	4.15	Junction of US Route 20 with Route 174 in axis of Otisco Valley. Continue east on US Route 20.
79.55	6.0	Junction of US Route 20 and Route 80 at Lords' Corners; continue east on US Route 20.
82.95	3.4	Junction of US Route 20 and Tully Farms Road in axis of the

		deep glacially scoured Tully Valley. The recent Tully Valley landslide (see Fakundiny and Brett, 1997; Negussy et al., 1997) occurred south of this road junction.
85.25	2.3	McDonalds' Restaurant to the left (rest stop for trip participants). Butternut Member of Skaneateles Formation visible on I-81 entrance ramp across US Route 20 from restaurant.
85.35	0.1	Junction of US Route 20 and Interstate 81; continue straight (east) on US Route 20.
87.55	2.2	Junction of US Route 20 with Apulia Road in Butternut Creek Valley.
91.35	3.8	Enter village of Pompey Hill.
91.55	0.2	Junction of Hennaberry Road and US Route 20. Turn left (north) onto Hennaberry Road.
93.55	2.0	Junction of Hennaberry Road and Pratts Falls Road; turn right (east) onto Pratts Falls Road.
94.05	0.5	Entrance to Pratts Falls County Park from Pratts Falls Road; turn left (north) into Pratts Falls Park.
94.4	0.35	Continue to large parking area by Pratts Falls. Park vehicles and proceed on foot to falls overlook.

STOP 6A MEDIAL SKANEATELES FORMATION SUCCESSION EXPOSED AT PRATTS FALLS

The east and west forks of this creek display almost a complete view of the Skaneateles Formation. Pratts Falls itself provides a view of the upper part of the Delphi Station Member which is exposed in the lower part of the falls and the Pompey Member which makes up the upper part of the falls face and falls cap. Although strata are inaccessible from the overlook, one can clearly see that the upper part of the Pompey succession has coarsened to resistant siltstone and fine sandstone. This part of the succession is best viewed on the west fork of this creek (see STOP 6B).

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Return to vehicles and proceed west in park to pull off just past the smaller west fork of the creek.
94.8	0.4	Park vehicles at parking area by small bridge over the creek west fork within the park.

STOP 6B DELPHI STATION, POMPEY, "MARIETTA" AND BUTTERNUT MEMBERS OF SKANEATELLES FORMATION

Strata on the west branch include the Delphi Station, Pompey, "Marietta" and Butternut members. However, the Delphi Station and lower part of the Pompey members are difficult to observe here; we will focus on the capping sandstone beds of the Pompey Member between the road and the footbridge, the "Marietta Member" upstream from the road and the basal Butternut Member in the upstream waterfall.

Fossil-rich sandstone and siltstone beds yielding abundant moldic *Nyassa arguata* and spirifers can be viewed below the park road overpass; these most likely correspond, in part, to the *Nyassa arguata*-rich shell bed observed at STOP 5A and the lower shell bed bundle at STOP 4 (Fig. 3). This coarse facies represents the regressive capping part of the Pompey Member (and Pompey coarsening-up cycle). At Delphi Falls, south of this locality, the corresponding sandstone is 6.5 meter-thick attesting to coarse sediment progradation from the east or southeast. The underlying regressive top-Delphi Station interval at this locality, by contrast, is mainly a muddy siltstone suggesting that the Pompey cycle contains more proximal facies in this area.

Above the road is a short covered interval where the Pompey Member-"Marietta Member" contact is concealed. However, above this gap is a three and 1.3 meter-thick interval of soft gray fossiliferous shale succeeded by a 0.7 meter-thick falls-capping siltstone bed; this is the visible part of the 2.3 meter-thick "Marietta Member" succession at this locality. The soft shale below the siltstone bed is rich in ambocoeliids and an alate form of *Mucrosirifer* resembling *M. arkonensis* as well as many other taxa. The soft shale is much finer than corresponding shales in the basal part of the Pompey Member, suggesting that the Marietta cycle is part of a backstepping transgressive systems tract succession. Eastward thinning of the "Marietta Member" across this area, noted earlier, may reflect erosion and/or section condensation.

Above the small falls held up by the top-Marietta siltstone bed is a large falls displaying fissile dark gray shale and thin siltstone beds of the Butternut Member. In this region the Butternut has thickened to 75 meters and numerous tabular, flaggy siltstone beds are present in the middle and upper parts of the succession (Figs. 2, 4). The base of the Butternut is sharp and possibly erosional upon the top-Marietta siltstone; this contact is a classical maximum flooding surface associated with a major transgressive event.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
		Return to vehicles and retrace route back to park entrance.
95.3	0.5	Turn left (east) onto Pratts Falls Road.
96.2	0.9	Junction of Pratts Falls Road with Waterville Road; turn right (south) onto Waterville Road.
96.75	0.55	Junction of Waterville Road with US Route 20; turn left (east) onto US Route 20.
98.05	1.3	Intersection in Pompey Center; continue straight (east) on US Route 20.
99.05	1.0	Large roadcut on US Route 20 that begins at upper end of long descending grade into the Limestone Creek Valley. Vehicles will park on level ground on west (upper) end of this roadcut. Participants will exit vehicles and proceed on foot to lower end of exposure.

STOP 7 MOTTVILLE AND DELPHI STATION MEMBERS, POMPEY HOLLOW SECTION

This is a roadcut that has served as an important section for viewing lower Hamilton Group facies and collecting fossils. Recent widening of the road has both enlarged and lengthen the section (Fig. 6). Moreover, a year of exposure of the fresh rock face to the elements has served to loosen and release an enormous number of fossils.

The Mottville Member is now exposed in its entirety as well as 1.0 meter of underlying rock assignable to the Cardiff Member of the Oatka Creek Formation (Fig. 6). Above the 8 meter-thick Mottville succession is a 23 meter section including almost the entire succession of the Delphi Station Member. This latter interval includes 7 meters assignable to the Cole Hill cycle within the lower part of the Delphi Station Member and 10 meters comprising most of the main Delphi Station cycle succession within the middle and upper parts of the Delphi Station Member (Fig. 6).

The Mottville Member, at this locality, is marked by two prominent fossil-rich layers, the Mason Hill and Case Hill beds (see text). Between these markers is a 7.5 meter succession of calcareous silty mudstone marked by a prominent parting about 3.7 meters above the Mason Hill Bed(Fig. 6). Between the parting and the Case Hill Bed is mudstone rich in *Tropidoleptus*, *Nucleospira* and *Mediospirifer*. Above the Case Hill Bed is 2 more meters of softer mudstone rich in *Ambocoelia* and small mollusks.

The Mason Hill Bed yields abundant brachiopods including *Mediospirifer* as well as associated bryozoan debris and exuviae of *Dipleura*. The 0.3 meter-thick shell-coral-rich bed in the upper Mottville is clearly the Case Hill Coral Bed of Grasso (1986) and it corresponds to the Mottville "B" bed of Meyer (1985). We believe that a third key marker, the Cedarvale Bed is poorly developed in this section and corresponds to the bank reentrant below the *Tropidoleptus*-rich interval (Fig. 6). In sections within the Marcellus, South Onondaga and Jamesville 7.5' quadrangles, the Cedarvale Bed is a packstone-grainstone encrinite layer comparable to the higher Stone Mill and Tichenor limestones. It probably overlies a sequence boundary regionally; at this section the sequence boundary unconformity is probably represented by the reentrant below the *Tropidoleptus* interval.

The Case Hill Coral Bed yields large rugose and tabulate corals as well as diverse brachiopods. The upward change from the unit into soft, *Ambocoelia*-rich shale marks a significant deepening event within a larger transgressive systems tract succession above the sequence boundary reentrant. The top of the Mottville is typically marked by a bedding plane covered by small brachiopods as well as gastropods and orthoconic cephalopods displaying black calcite preservation. This maximum flooding surface, unfortunately, is poorly exposed in this section.

Above the Mottville interval is a 7 meter-thick interval of gray shale and gray silty shale that is bounded at the top by a shell bed yielding abundant phosphatic nodules associated with numerous *Athyris cora* and other fossils (Fig. 6). This shell bed marks a discontinuity that can be traced westward into the Levanna Member as far as Cayuga Lake (Fig. 4). Between Cayuga Lake and the Tully Valley, this layer is typically characterized by reworked concretions encrusted by auloporid corals in association with molluscan debris. East of the Tully Valley the reworked concretions are replaced by small phosphatic pebbles and a somewhat more diverse associated biota. We believe that this shell-phosphate layer projects to the top of the Cole Hill Sandstone bed near Sangerfield.

Between the top of the Mottville and the top-Cole Hill cycle shell-phosphate bed is an interval of shale yielding abundant clams, snails and cephalopods displaying black calcite preservation. Gastropods, including *Bembexia* and *Palaeozygopleura,* as well as nuculoid bivalves and cephalopods, are typically preserved three-dimensionally.

Above the shell-phosphate bed is a 16 meter-thick interval of silty shale grading upward to fine sandstone at the upper (west) end of the outcrop. This part of the section corresponds to the upper Delphi Station upward-coarsening cycle. The uppermost beds in this interval are considerably coarser than equivalent strata at Pratts Falls suggesting a trend to greater facies proximality towards the southeast. The coarse beds at the top of the section contain abundant bivalves and occasional large brachiopods such as *Spinocyrtia*. Three meters below the top of this section is a band of medium-size corals that is also observed at Pratts Falls and at a section near Delphi Station; this bed may correlate to the Papermill Bed-Roanoke Bed interval in western New York (Fig. 3).

End of Road Log.

JAVA SOFTWARE FOR EARTH SCIENCE EDUCATION

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INTRODUCTION

The Earth Science Educational Resource Center (ESERC). which is based at SUNY Stony Brook. conducts four programs through which students have created software designed for Earth Science education and research. This workshop is designed to introduce high school teachers and college-level faculty to these programs. which are: 1) Project Java. 2) GEO 327: Computerized Modeling of Geological Phenomena. 3) GEO 511: Computer Programming for the Geosciences. and 4) Summer Educational Interns. Software produced under these programs is used in high school educational enrichment programs and undergraduate and graduate courses conducted at SUNY Stony Brook. In addition. it is disseminated on the World Wide Web and in teacher enrichment programs and courses. During the present workshop. participants will have an opportunity to use some of the software developed through these programs. and will be given an opportunity to create some simple Java programs called applets.

Participants in the workshop are invited to form a network of people who are interested in fostering the development of additional interactive educational material that will be created and posted on the Web. High school teachers and college faculty would be especially valuable in this network as sources of ideas for new applets that can be used for education in their area of interest. Selected ideas put forth by the group will be implemented as software by SUNY Stony Brook Project Java students. with periodic evaluations from the network members. Some of the attending college faculty or high school teachers may wish either to learn to program themselves. or to assemble a group of students who can create applets at their own institutions. Means of accomplishing this will be discussed.

ESERC EDUCATIONAL PROGRAMS THAT CREATE SOFTWARE

ESERC. which is funded by the National Science Foundation. offers several programs that generate software designed for use in Earth Science education and research. These programs. the types of software they have created. and selected examples of this software are listed in table 1.

	Model natural phenomena	Model analytical techniques	Present hypothetical scenarios for analysis by students	Access data to present it graphically	Present data formatted for processing
Project Java	Lake Applet (figure 1). Chemical Charge Applet (figure 5)	Bragg's Law Applet (figure 2)	Plume Finder (figure 3)	Tr660 Applet	Future work
GEO 327: Computerized Modeling of Geological Phenomena	Geyser Applets				
GEO 511: Computer Programming for the Geosciences	Littoral Drift Applet	Impedance Applet		MgO Analyzer Application	Future work
Summer Educational Interns	Future work	Future work	Future work	Earthquake Distance Applet (figure 4)	Future work

Table 1. Summary of ESERC programs that create software for use as educational and research tools

password. and is assigned a scenario chosen by the server from among a set of possibilities. During the spring. 2000 semester. the Plume Finder applet was used as the basis of an extra credit project for GEO 101: Environmental Geology.

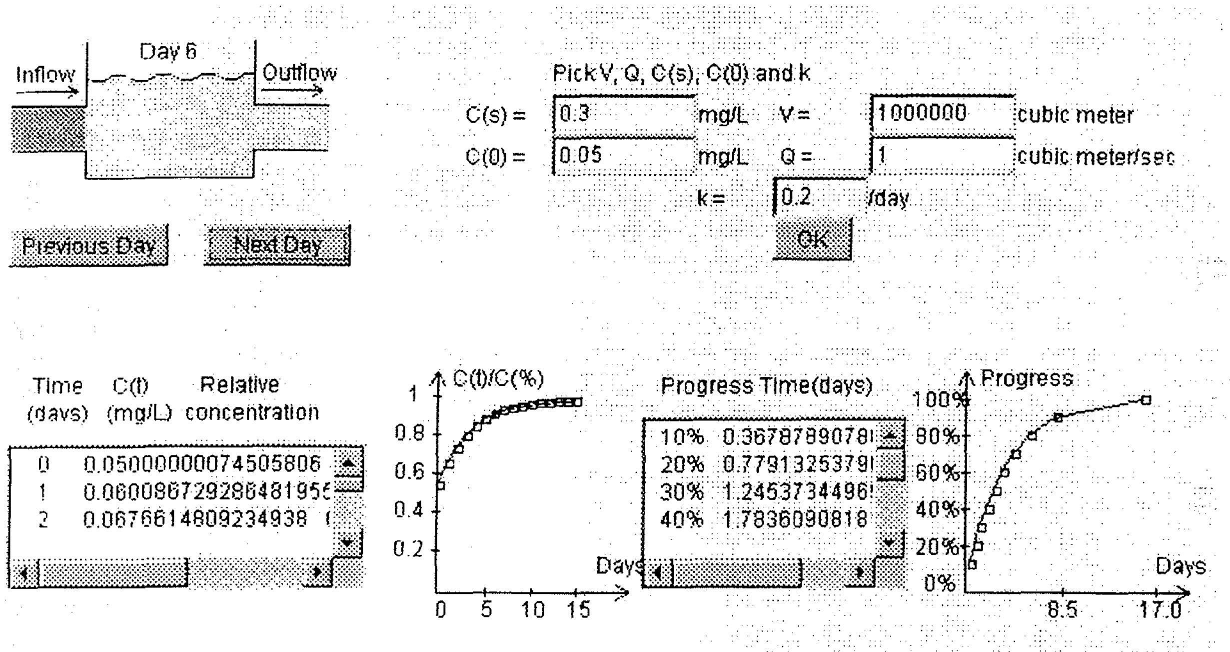

Figure 1. The Lake Applet

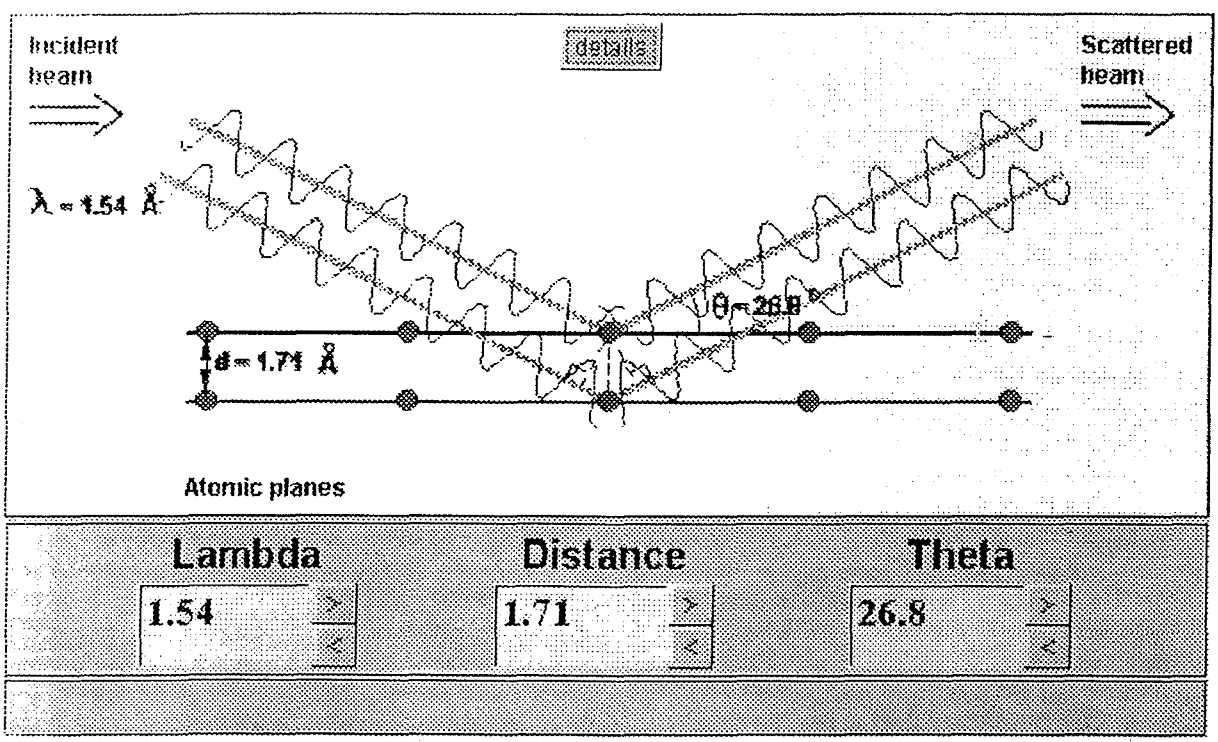

Figure 2. The Bragg's Law Applet

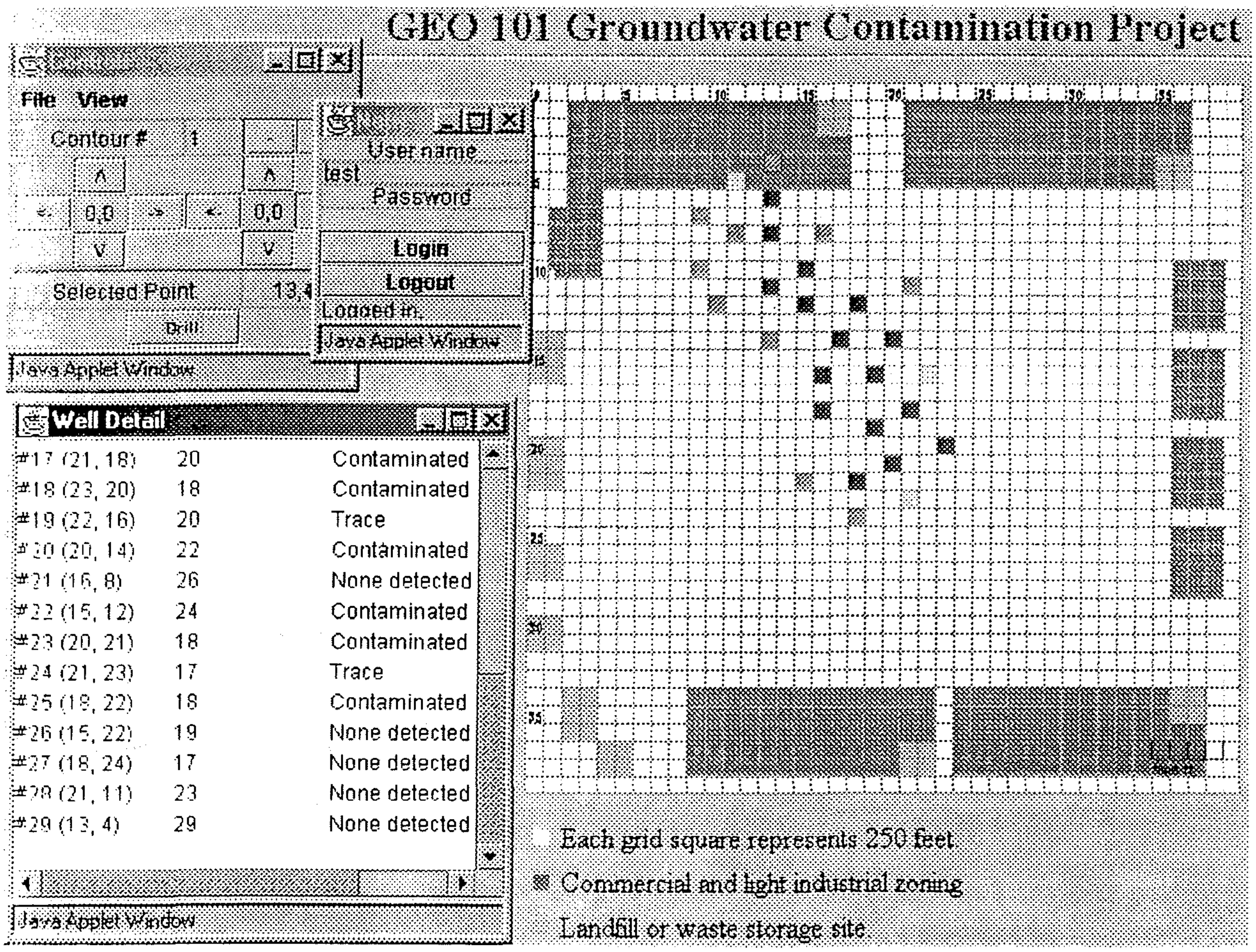

Figure 3. The Plume Finder Applet

Access data to present it graphically

This software collects data and presents it in a form that can be easily interpreted by humans. The software may perform numerical analysis prior to graphical presentation. The Earthquake Distance Applet (figure 4) was developed by Vincent Ugenti, a former Project Java student, while he was participating in the Summer Educational Interns program. It enables users to pick P and S wave arrival times in order to view earthquake event distances represented on a map. Possible epicenter locations are represented by a circle that expands or contracts with the time interval between the P and S wave arrivals. This applet is currently being refined for use in education programs.

Li Li, a student in GEO 511, developed a program designed to analyze images of materials under pressure in order to calculate strain rates. The first set of images she used represented magnesium oxide, which contained thin sheets of gold foil as reference features. The gold foil appears as diffuse vertical dark lines in the images. The mouse is used to select areas for the software to compare within the images. After the areas are chosen, the software uses various mathematical strategies to compute the locations of the lines and their displacements within a series of images. An inner difference method, which computes the displacement that results in the minimum sum for the differences in gray scale values for corresponding pixels when the two images are compared, was one of the numerical analysis techniques used. Least squares and other schemes were subsequently employed, ultimately resulting in resolution on the scale of a fraction of a pixel.

Present data formatted for processing

A fifth category of software will be designed that retrieves data from digital libraries and presents it to students in a format that is convenient for saving and opening later as a file or copying into software for analysis. For example, seismic data can be copied and pasted into spreadsheets. ESERC is beginning to explore strategies for implementing this type of software. and programming of these modules will be performed by Project Java students during the 2000 to 2001 academic year.

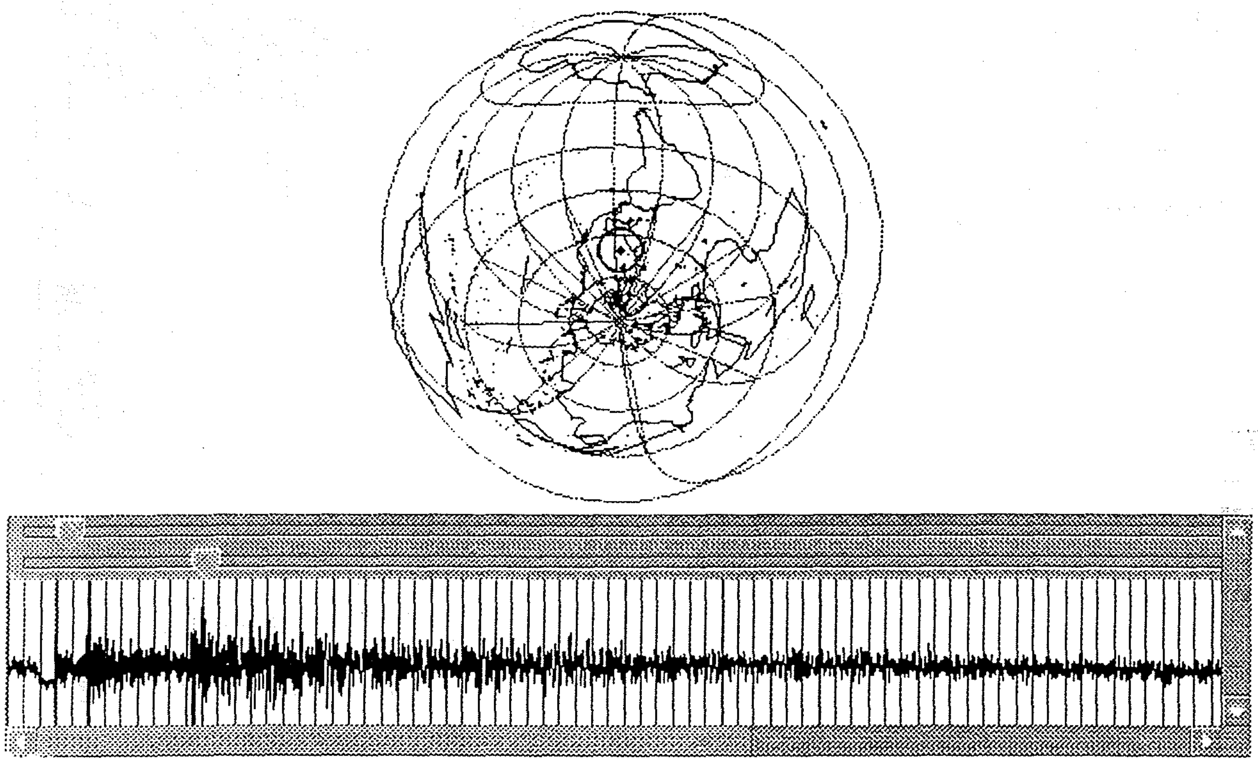

Figure 4. The Earthquake Distance Applet

SOFTWARE DEVELOPMENT BY EARTH SCIENCE EDUCATORS

Educators who learn Java can develop their own software. with the advantage that they can efficiently design and create it according to their own specifications. Janet Kaczmarek, Educational Specialist at ESERC, joined Project Java and learned how to program during the summer of 2000. Subsequently, she was able to create the Chemical Charge Applet (Figure 5). and post it with background information and instructions for educational activities. The applet enables students to either choose cations and anions at random or select them from pull-down lists. The user can then use buttons to vary the quantity of each ion in order to generate a compound with a neutral charge and a proper empirical formula. Although this applet is aimed primarily at chemistry students. the interdisciplinary nature of Earth Science dictates that a knowledge of all the sciences contributes to its understanding.

INITIATING SOFTWARE DEVELOPMENT PROJECTS SIMILAR TO PROJECT JAVA

A software development project similar to Project Java can be initiated at institutions of higher learning. provided that at least one person who is knowledgeable about Java is prepared to conduct the program. that there is a source of student programmers available for participation, and that a group of scientists is prepared to offer content. develop specifications. and assess the resulting software. The software also needs to be evaluated by representatives of its intended audience.

It is extremely important to build a system for student accountability into this type of project. Students have many competing academic demands. and a program such as this one. which is less structured than a formal course. suffers the danger of being viewed as a low priority responsibility. A system of accountability can be implemented by requiring participants to deliver periodic presentations of their work in progress. to carefully comment their source code. and to document the revision process. The students should be offered pay or academic credit for their work.

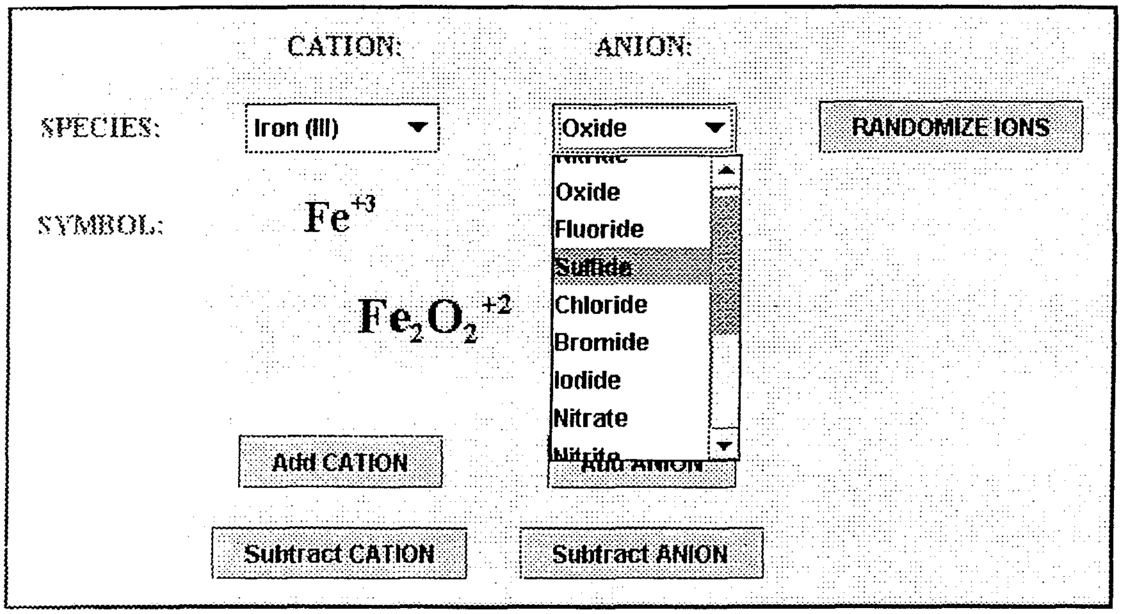

Figure 5. The Chemical Charge Applet with an open pull-down list of anions.

The Java 2 SDK version 1.3.0 is free as a download (Sun Microsystems) and easy to install on systems running Solaris. Linux. or Windows. Macintosh systems can be used as well. but as of this writing. version 1.1 is the most recent release available for that platform. However Apple plans to integrate Java 2 into Mac OS X (Mac OS X). The first step in establishing a mentored software development program is to speak at length with a person with experience in conducting this type of project. This type of activity has tremendous potential for creating software for education and research. and for providing students with a working knowledge of programming and an opportunity for analytical creativity of a very intricate nature (Richard and Kaczmarek. 2000).

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Stratigraphic Logs to Accompany NYSGA 2000 Field Trip Guidebook, Trip B1: The Late Devonian Clastic Wedge in Central New York and Pennsylvania by D.L. Woodrow.

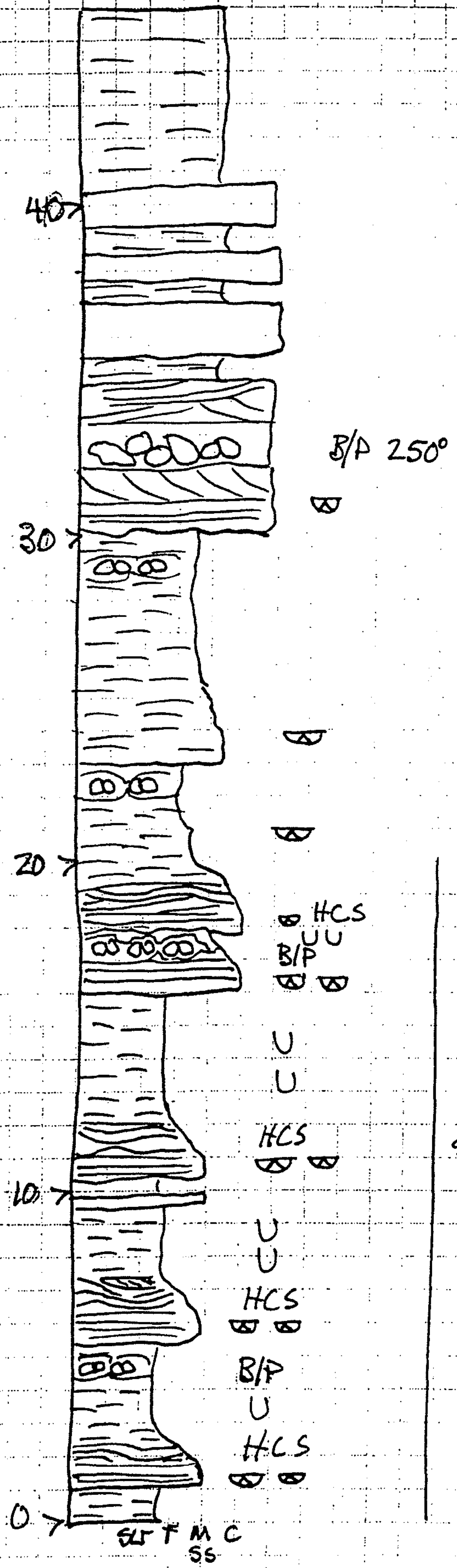
Log I. Cowanesque Dam spillway and roadcut on PA Rte. 49 south of the spillway and west of the village of Lawrenceville, PA.

Log II. Roadcut on PA Rte. 287, west of the village of Tioga, PA.

Log III. Strata in and around the channel connecting the Tioga-Hammond Dams at Tioga, PA and in the roadcut on US Rte 15 overlooking Tioga, PA. From: Brett, C.E. and Ver Straeten, C.A., eds, 1997, Devonian Cyclicity and Sequence Stratigraphy in New York State, Field Trip guidebook for meeting of International Commission on Devonian Stratigraphy, University of Rochester, 369 p.

Log IV. Roadcut on realigned US Rte 15 at Blossburg, PA. Section starts at the most northerly point of the road cut and proceeds uphill along the ramp to old US Rte 15.

LOG I



RTE 49 CLIFF

TEICHICHNUS

B/P: 16 AXES MEASURED. MEAN ≅ 270/280°

SPILLWAY, SOUTH END OF COWANESQUE DAM

RIPPLES: 232°, 238° CHAN. 265°
CHAN. 260°, 265°, 225°

RIPPLES: 242°, 243° CHAN - 253°, 217°

B/P: 255°, 310°, 318° CHAN - 278°, 281°

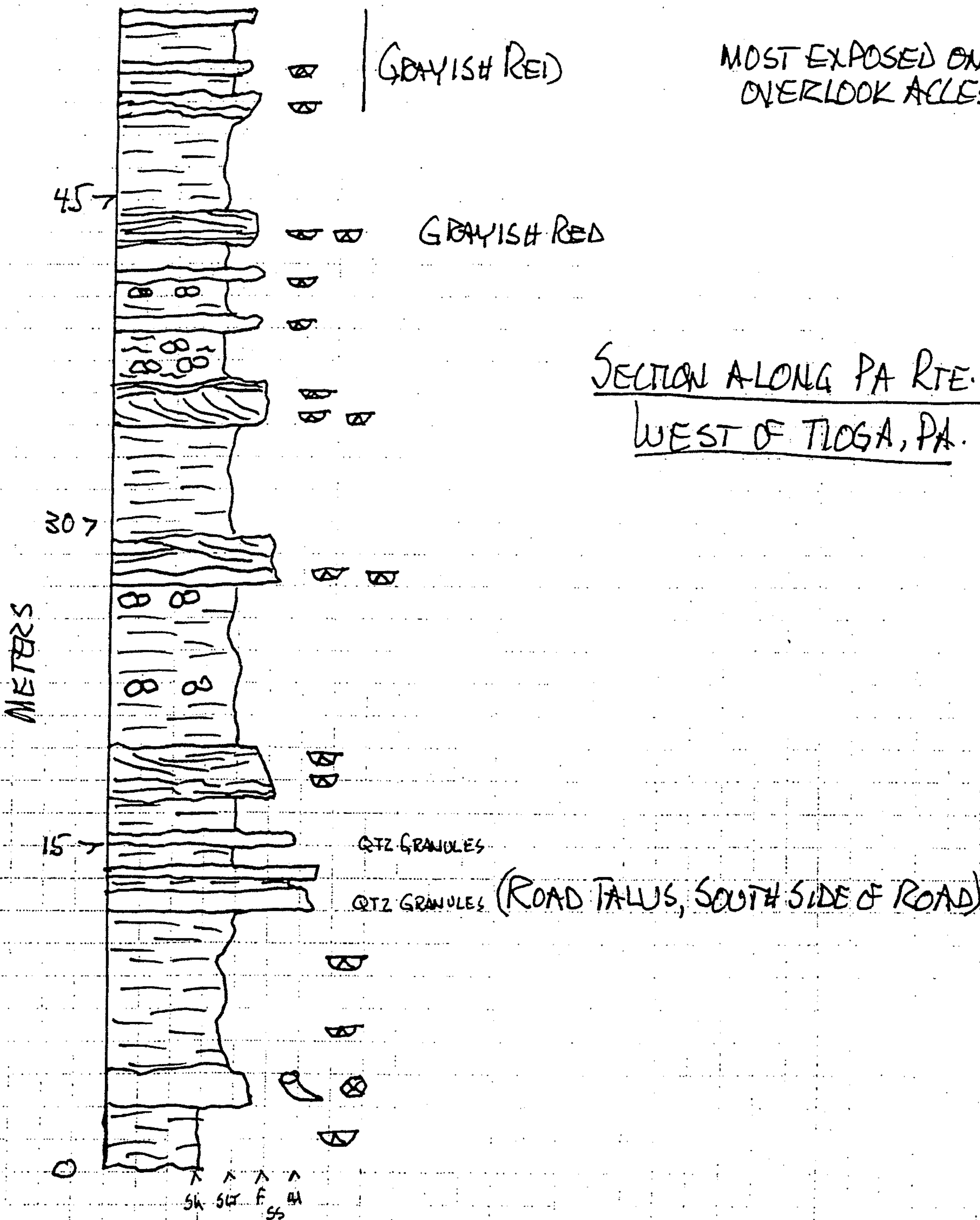
CHAN 280°, 240°, 230°

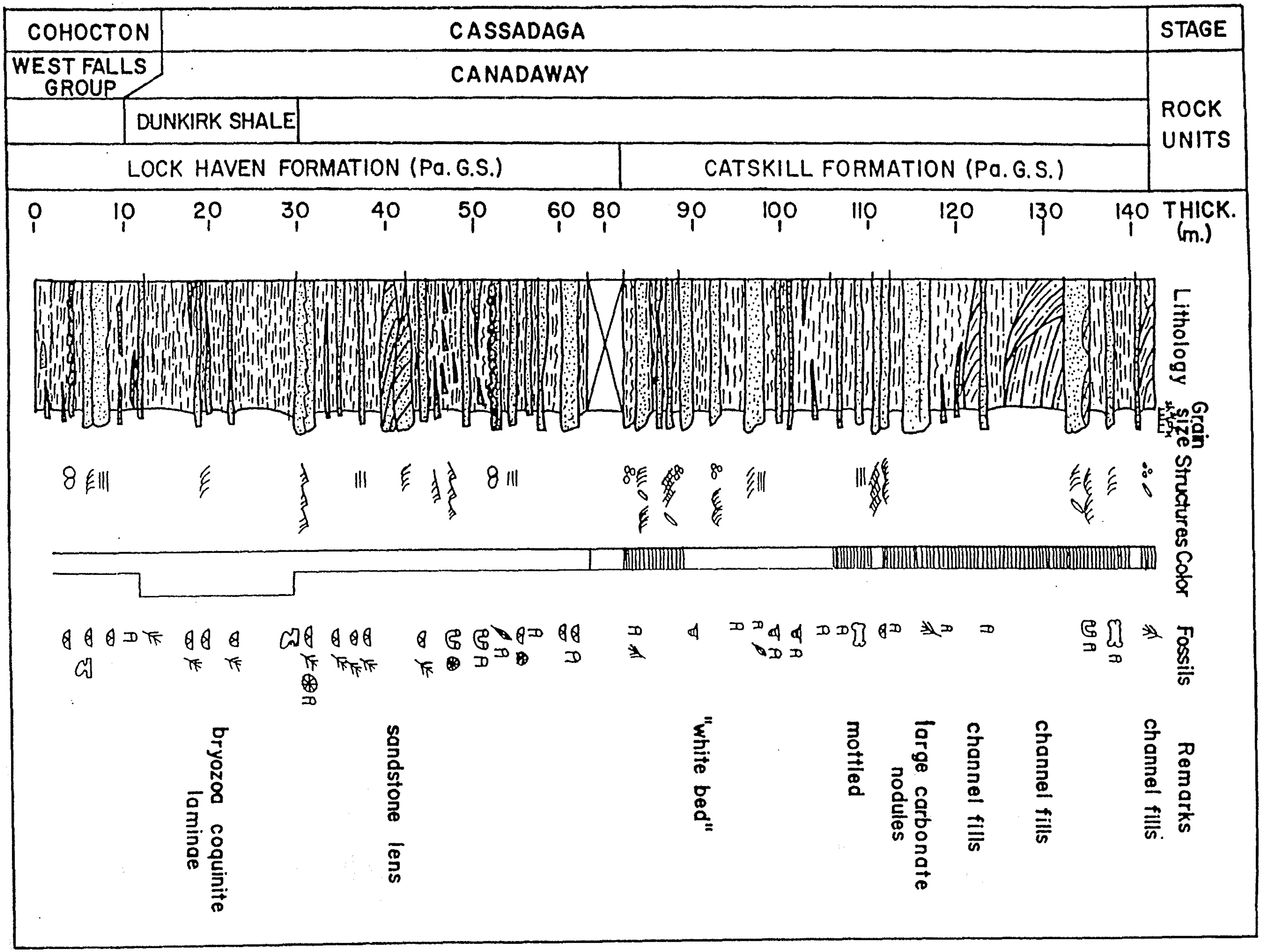
TEICHICHNUS, CHONDRITES

LOG II.

SECTION ALONG PA RTE. 287
WEST OF TIOGA, PA.

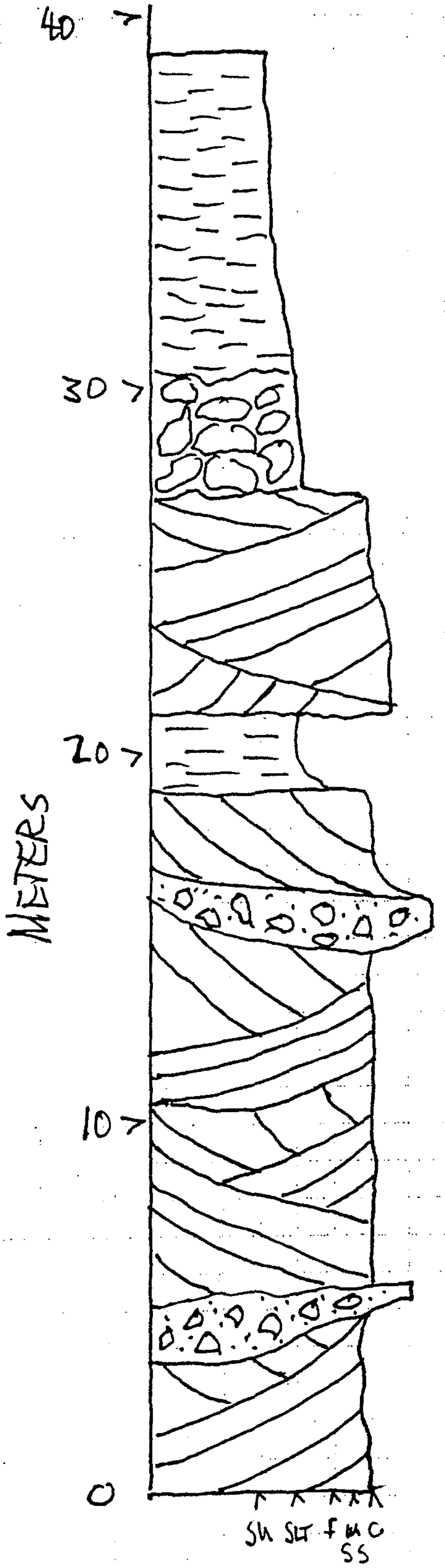
MOST EXPOSED ON OVERLOOK ACCESS ROAD




COHOCTON
CASSADAGA
STAGE
WEST FALLS GROUP
CANADAWAY
DUNKIRK SHALE
ROCK UNITS
LOCK HAVEN FORMATION (Pa. G.S.)
CATSKILL FORMATION (Pa. G.S.)
0 10 20 30 40 50 60 80 90 100 110 120 130 140
THICK. (m.)
Lithology
Grain size
Structures
Color
Fossils
Remarks
bryozoa coquinite laminae
sandstone lens
"white bed"
mottled
large carbonate nodules
channel fills
channel fills
channel fills

LOG III.

LOG IV.



SECTION AT BLOSSBURG. PA. BASE OF NEW ROAD. CUT.