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

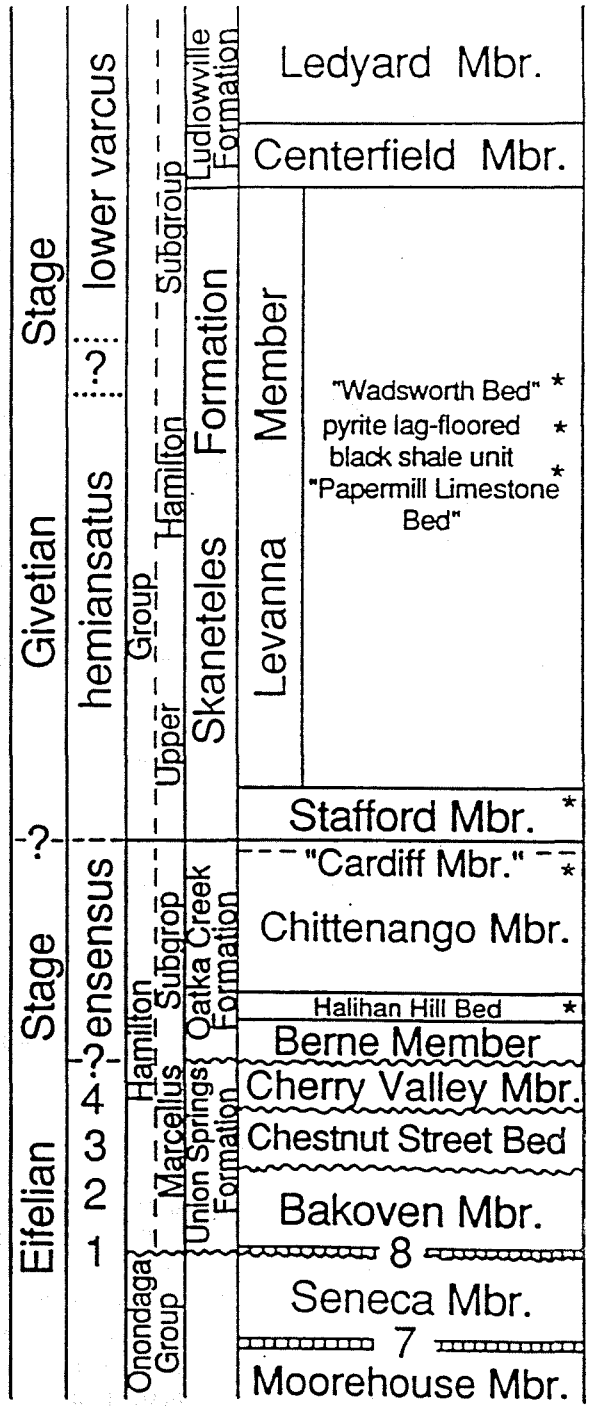

Figure 1. Generalized succession of lithologic and zonal units in the uppermost Onondaga Formation-through-basal Ludlowville Formation interval in western New York. Numbers denote: 1, base-Bakoven Member discontinuity; 2, *Cabrieroceras plebieforme* zone; *Haplocrinites* zone; 4, *Agoniatites vanuxemi*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

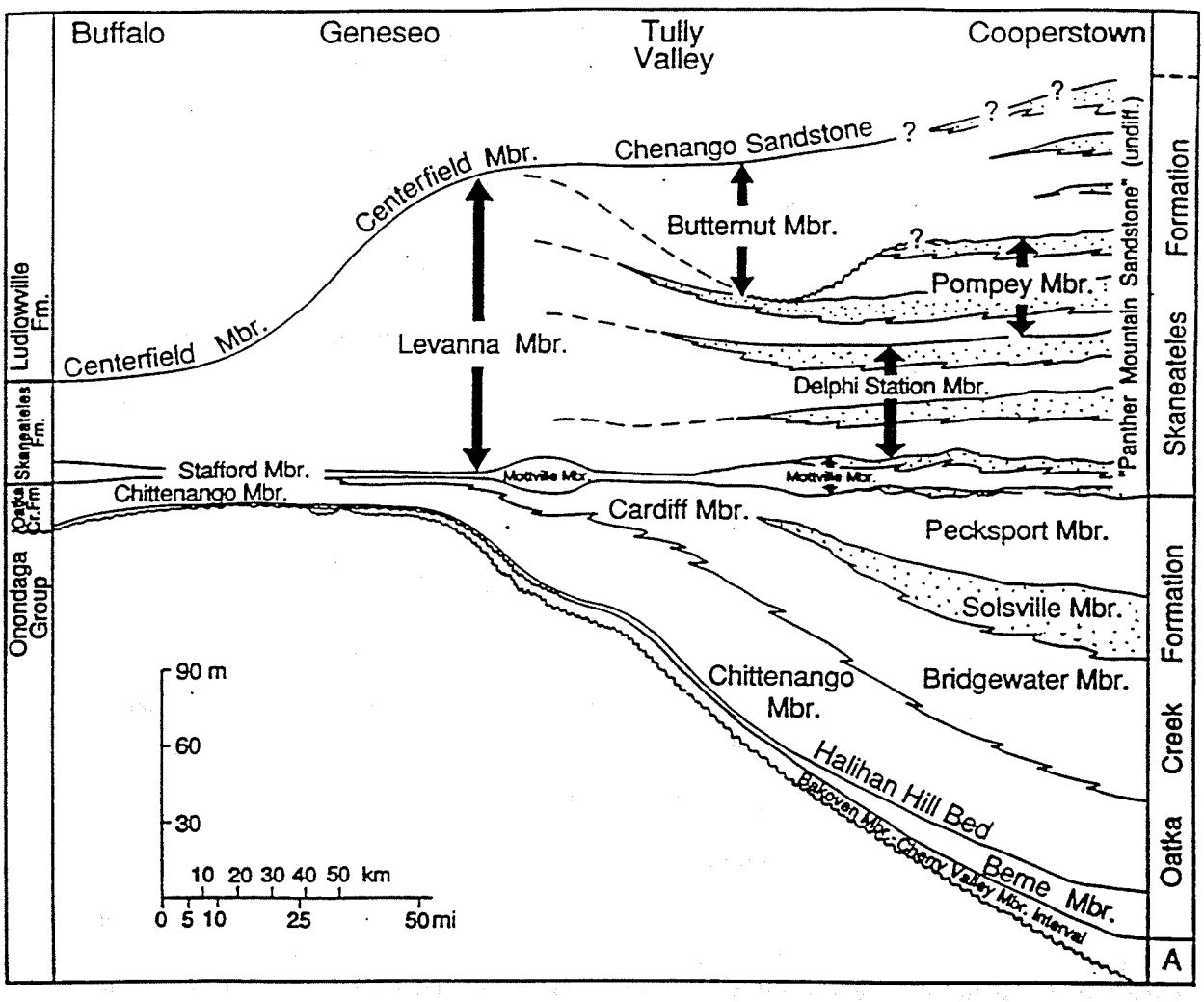

Figure 2. Generalized stratigraphy and unit relationships in the lower part of the Hamilton Group along the east-west outcrop belt across New York State. Conspicuous eastward thickening of units reflects clastic influxes associated with the second tectophase of the Acadian Orogeny and coincident deepening 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

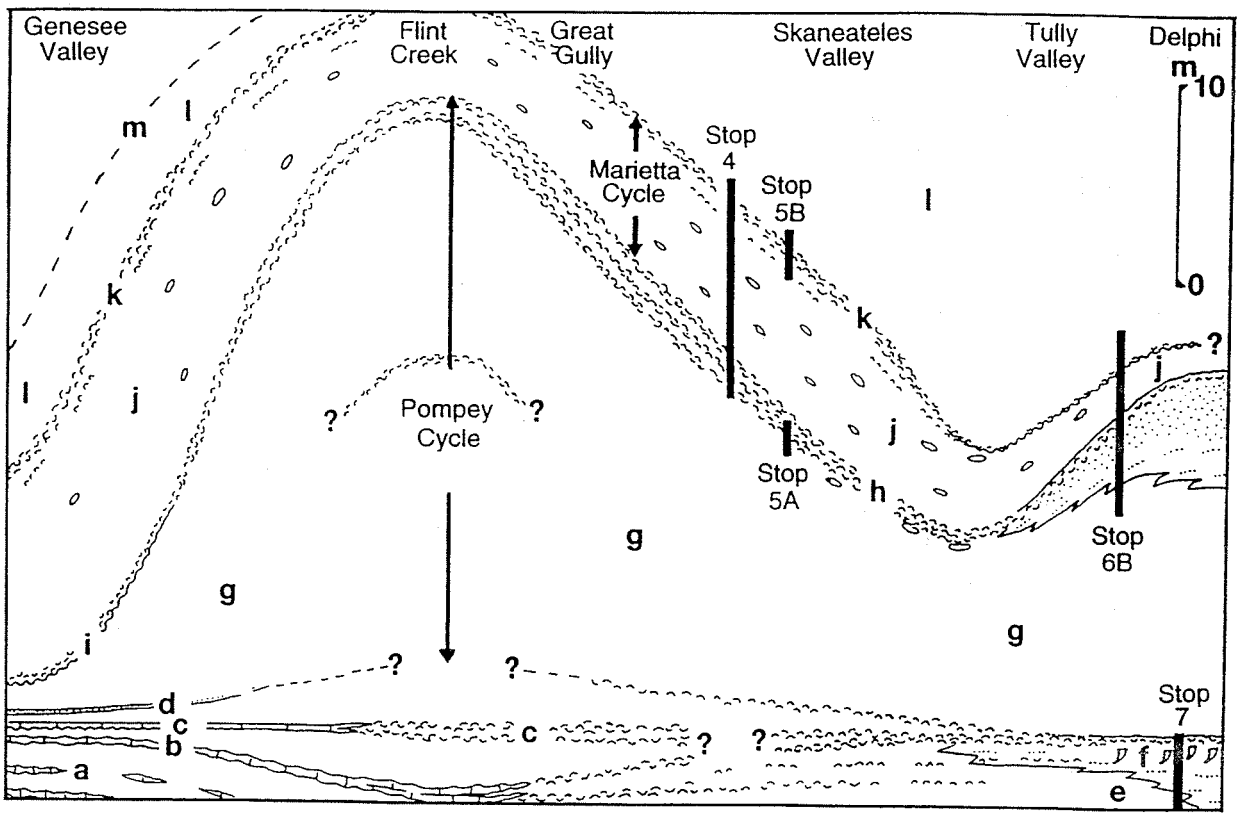

Figure 3. Medial Skaneateles Formation correlations across the Finger Lakes region. Divisions shown include: the upper Delphi Station cycle, Pompey-Marietta cycle interval and the Butternut Shale interval. Lettered units include; a, calcareous shale and limestone facies comprising the upper part of the 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.

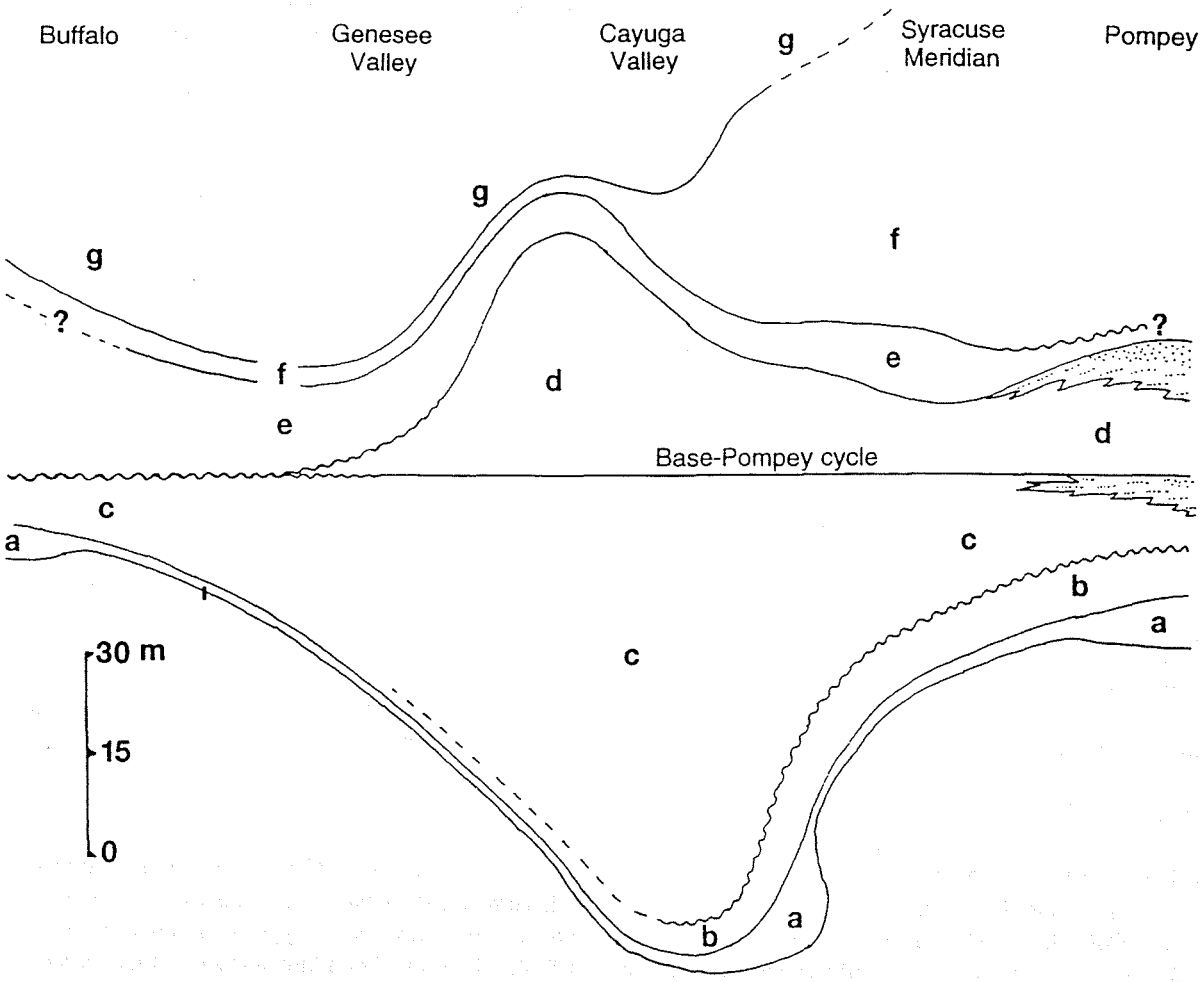

Figure 4. Dynamic pattern of shifting depocenters observed in the Skaneateles Formation. Divisions shown include: a, Stafford-Mottville interval; b, Cole Hill cycle; c, upper Delphi Station cycle; d, Pompey cycle; e, Marietta cycle; f, Butternut Member and Butternut Member-equivalent Levanna Member strata;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

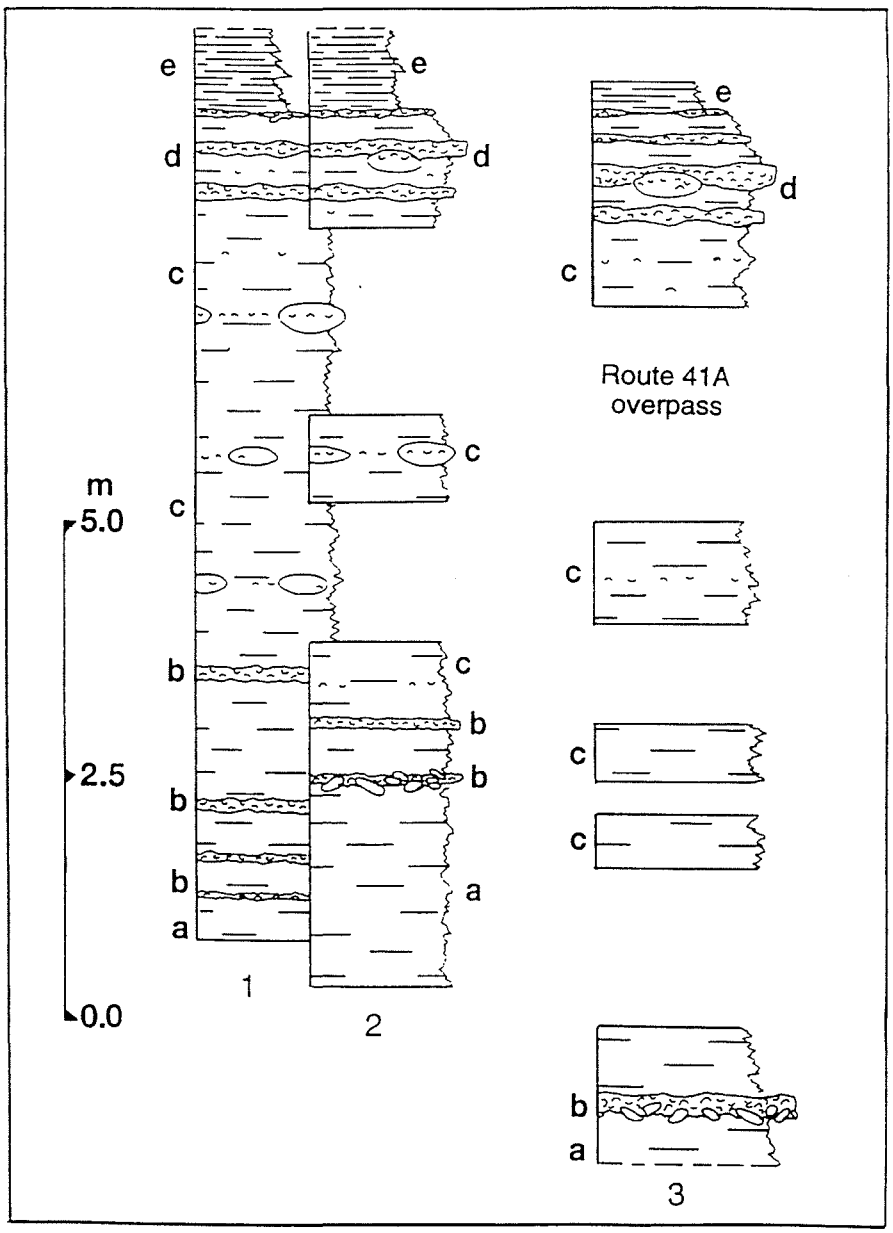

Figure 5. Marietta cycle succession and adjacent divisions exposed near Auburn and Skaneateles. Sections shown include: 1, roadcut exposed on Rockefeller Road east of Koenig Point on the east side of Owasco Lake (STOP 4); 2, Section in ravine east of Long Point on the east side of Owasco Lake; 3, section 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, Buttermut Member-equivalent dark shale facies of upper Levanna Member succession.

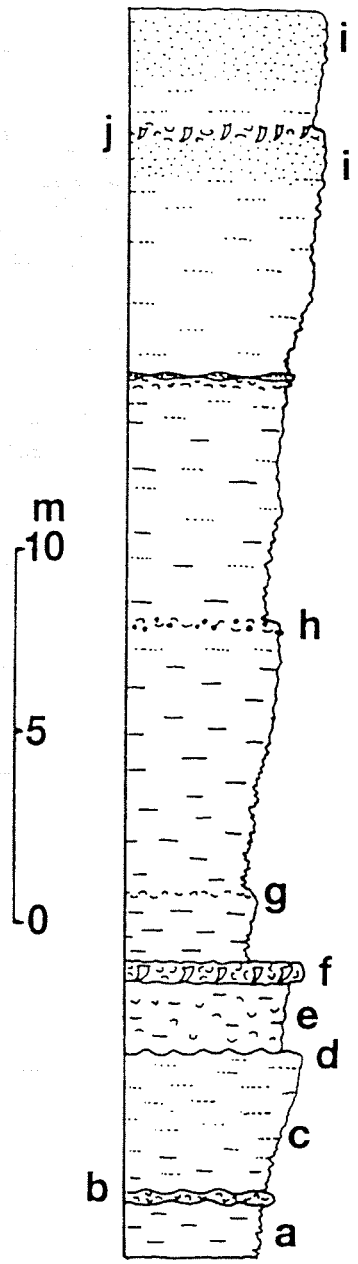

Figure 6. Roadcut section on US Route 20 west of Pompey Hollow (STOP 7). Lettered units include: a, uppermost part of Cardiff Member; b, Mason Hill Bed; c, calcareous muddy siltstone interval marking prominent regression in lower Mottville Member; d, reentrant marking probable position of the Cedarvale 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.

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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