ANATOMY OF A COMPOSITE SEQUENCE BOUNDARY: THE SILURIAN-DEVONIAN CONTACT IN WESTERN NEW YORK STATE

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INTRODUCTION

Unconformities form the basis for sequence stratigraphy (Vail et al., 1977, 1991; Wilgus et al., 1988; Van Wagoner et al., 1988; Emery and Meyers, 1996). Widespread disconformities have long been recognized and Sloss (1963) used such major gaps – which typically expand cratonward – to delineate six major intervals, now termed supersequences, in the Phanerozoic record of North America. The boundary between the middle Ordovician – Lower Devonian – Mississippian Kaskaskia sequence was drawn at a major, if cryptic, disconformity that was later named the "Wallbridge Unconformity" (Sloss, 1963; Dennison and Head, 1975). The temporal significance of unconformities stems from a key assumption – fundamental to relating sequence stratigraphy and chronostratigraphy – all strata below an unconformity are everywhere older than all strata above the surface.

In addition to their importance in sequence stratigraphy, unconformities may have other far-reaching implications. Topographic features of the surfaces may provide insight into processes active during the hiatus in which the surfaces formed. Presence of early jointing may signify tectonic regimes. Sinkholes and collapse breccias may point to karstification, and paleosols may provide some hints as to climatic regimes. Three-dimensional study of unconformities – the production of paleogeologic maps along these key surfaces may yield very important insights, as to paleotopography and aid in defining the positions of relative highs (domes, arches) and lows (local basins).

Correlation of unconformities involves outcrop to outcrop tracing and/or independent data on biostratigraphy, event beds, etc. Such correlations may point to significant widespread lowering of relative sea level. Ultimately, intercontinental correlations may aid in identification of eustatic lowstands. Conversely, the localization of unconformities in otherwise continuous successions may lead to recognition of local tectonic effects (e.g., Ver Straeten and Brett, 2000). Commonly, two or more disconformities may merge laterally to form a much larger unconformity. This to may point to localized diastrophic or far field tectonic effects (Ettensohn, 1991).

Finally, as erosion surfaces are later onlapped by shallow seas they become transformed temporarily into rocky shorelines and rockground seafloors that may exhibit distinctive morphologies and faunas that typify the intertidal to shallow subtidal zone. Such rocky shorelines have received considerable attention of late (see Kobluk et al., 1977; Johnson, 1988, 1992; Johnson and Baarli, 1999).

In this paper we document details of widespread sub – Middle Devonian (Onondaga Formation) unconformities in western to west-central New York (map, Figure 1). We recognize up to three disconformity surfaces (sequence boundaries) in western to central New York that locally merge to form one. The true Wallbridge Unconformity may erosionally truncate three older, post-Bertie sequences.

These results point to widespread erosion in the Late Silurian – Early Devonian west of Cayuga Lake. This surface was subsequently transgressed in the middle Early Devonian (Pragian) and draped with basal quartz sands of the Kaskaskia transgression (Oriskany Formation). A subsequent period of erosion removed much of the Oriskany and probably all of the overlying Esopus Formation during mid-Emsian time. This erosion surface was transgressed by late Emsian (Schoharie-Bois Blanc) shallow seas, which reworked sand and clasts of older units. Finally, another period of erosion, immediately preceding the deposition of latest Emsian-early Eifelian Onondaga Limestone removed much of the Bois Blanc and further modified the exhumed erosion surface.

Finally, we describe what appears to be a rocky shoreline with small sea stacks, submarine cavities, and fissures in Silurian dolostones, which are draped and filled with Devonian bioclastic sediment.

STRATIGRAPHY

In the following section we briefly discuss each of the stratigraphic units synjacent to the Devonian unconformities, commencing with the oldest. An overview of the stratigraphy of the uppermost Silurian and Lower Devonian, presenting preliminary modifications of Rickard (1975), is displayed in Figure 2.

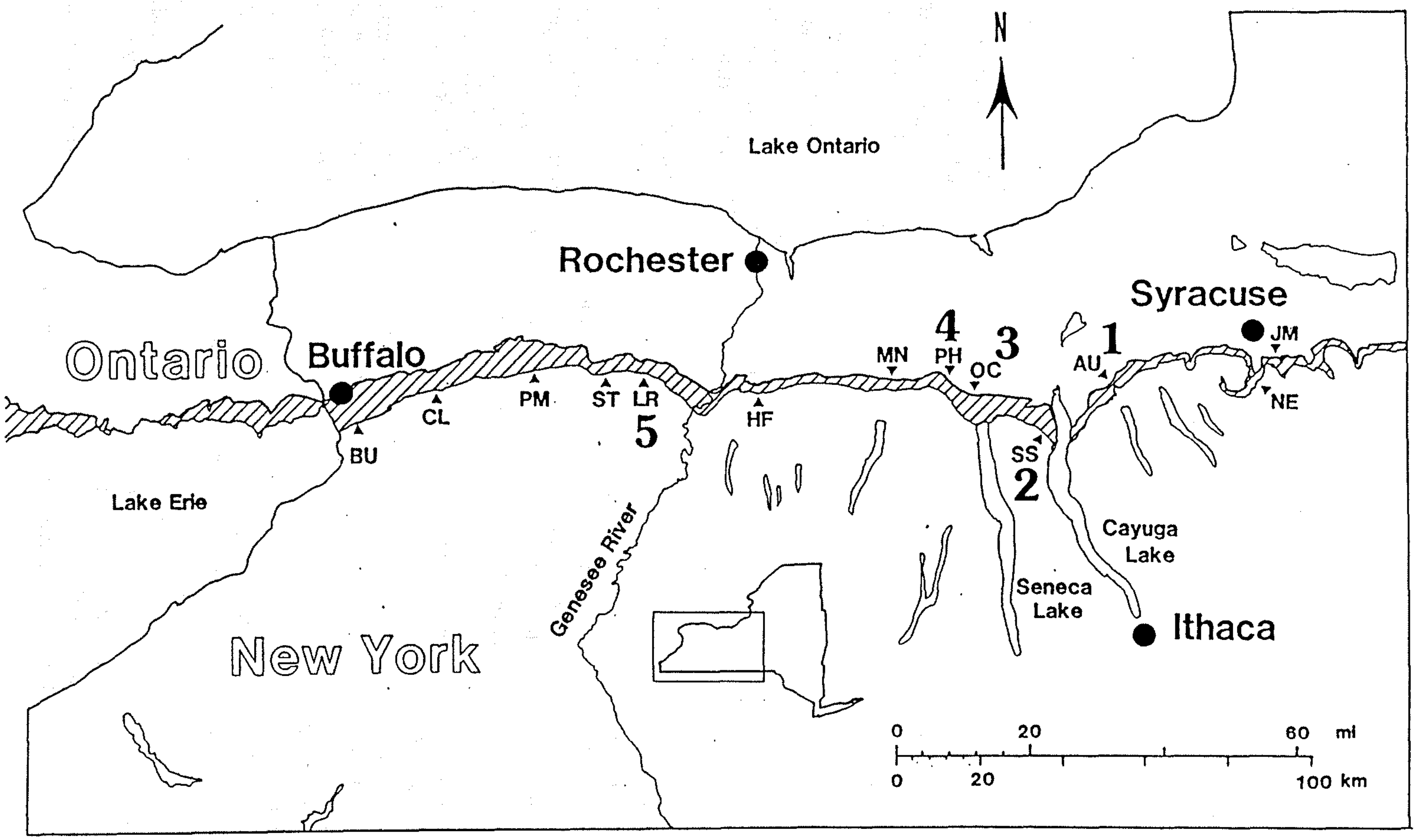

Figure 1. Outcrop map of the Onondaga Formation in west-central to western New York (modified after Rogers et al., 1990). Unconformities interval at and below Onondaga Formation examined on fieldtrip occur at north side of outcrop belt. Key localities include (east to west): JM=Jamesville, NE=Nedrow and Onondaga Indian Nation, AU=Auburn (Stop 1 of fieldtrip), SS=Seneca Stone quarry (Stop 2 of fieldtrip), OC=Oaks Corners (Stop 3 of fieldtrip), PH=Phelps (Stop 4 of fieldtrip), MN=Manchester, HF=Honeoye Falls, LR=LeRoy (Stop 5 of fieldtrip), ST=Stafford, PM=Pembroke, CL=Clarence, BU=Buffalo.

Silurian and Devonian Units below the Wallbridge Unconformity

Upper Silurian (Pridolian) Bertie Group. The oldest strata, below the lower or Wallbridge Unconformity are dolostone and dolomitic shales of the Upper Silurian (Pridoli) Bertie Group. The Bertie has long been famous for its eurypterid fauna and details of Bertie stratigraphy have been documented by Clarke and Ruedemann, 1912; O'Connell, 1913, 1916; Ruedemann, 1916; Alling and Briggs, 1961; Leutze, 1961; Rickard, 1962, 1969, 1975; Kjellesvig-Waering and Heubusch, 1962; Kjellesvig-Waering, 1963, 1964; Craft, 1964; Treesh, 1972; Ciurca, 1973, 1978, 1982, 1990; Hamell and Ciurca, 1986; Ciurca and Hamell, 1994; Belak, 1980; Tollerton and Muskatt, 1984). The details of Bertie stratigraphy will only be briefly summarized here. In broadest outline, the Bertie comprises three shallowing - deepening cycles.

Oatka Formation. Lowest Bertie strata have been assigned to the Oatka Formation. The Oatka comprises approximately three meters of medium – dark gray dolomitic shale and shaly dolostone. It is unfossiliferous and probably represents sabhka-type dolomitic mudstone-shale facies.

Fiddlers Green Formation. The overlying Fiddlers Green Formation (ca. 10 m-thick) has been subdivided into a series of members by Ciurca (1973, 1990). Lowest strata are assigned to the Morgansville Member, which consists of approximately 1.5 m of buff-weathering, conchoidally-fracturing, massive dolostone. This is the first unit referable to as a "waterlime", a fine-grained dolostone, formerly used as a naturally-setting cement rock.

The Morganville Member carries rare eurypterids and sedimentary structures such as vaguely crinkly laminae (cryptalgal?), ripples, and salt hoppers, indicative of shallow subtidal (lagoonal?) to intertidal deposition. Here the Oatka – Morganville succession is inferred to represent a deepening – shallowing peritidal succession.

The upper surface of the Morganville Member is an irregular discontinuity surface with relief of up to 0.5 m; it is well displayed in cuts along the New York State Thruway at Phelps. It is interpreted as a flooding surface, a minor discontinuity at which the irregular upper contact of the Morganville hosts thrombolitic mounds. These mounds extend upward into thin bedded, light gray- to white-weathering, 6 m-thick Victor Limestone Member of the Fiddlers Green Formation. This is the most strongly marine-influenced part of the Bertie; the Victor A submember (ca. 0.6 m-thick) typically contains articulate brachiopods (*Whitfieldella*). It is overlain by the thick Victor B (brownish gray, thinly-bedded, vuggy and bioturbated dolostone) and thin Victor C (limestone, 0.6 m-thick) submembers.

The upper portion of the Fiddlers Green Formation displays a series of facies that resemble the Morganville Dolostone and comprises the second shallowing upward cycle of the Bertie Group. It commences with pale brownish-gray, conchoidally-fracturing, finely-laminated dolostone of the Phelps Member (1 m-thick). This unit is noted for its finely preserved eurypterids, especially *Eurypterus remipes remipes*, most notably at Passage Gulf, Herkimer County, New York. The upper portion of the Phelps Member contains a suite of sedimentary structures including crinkly cryptalgal laminae, ripples, salt hopper casts, and desiccation cracks, that, again, point to an inter– to supratidal depositional setting. The highest unit of the Fiddlers Green Formation is the 1-2.5 m-thick, stromatolitic Ellicott Creek Breccia Member. Ciurca and Hamell (1994) proposed that the breccia may represent a tsunamite deposit that tore up stromatolitic-bound sediments. The member is interpreted as evidence for further shallowing, associated with the transition into the Scajaquada Formation.

Scajaquada Formation. The succeeding Scajaquada Formation (ca. 3 m-thick) consists of dark gray, greenish-gray, and rarely reddish-streaked shaly dolostone and thin-bedded platy dolostone. Desiccation cracks and small halite crystal molds are present. Fossils are lacking; chert nodules occur locally. The unit is very similar to the Oatka Member and is likewise interpreted as a muddy sabkha facies.

Williamsville Formation. The Williamsville Formation constitutes pale gray, fine-grained, slightly argillaceous dolostone, or waterlime, similar to the Phelps Member of the Fiddlers Green (though grayer in color rather than brownish-gray). This unit is approximately 2 m-thick and has been subdivided into four subunits by Ciurca (1990). The first and third units (A and C) comprise conchoidally-fracturing waterlimes; the B unit features the articulate brachiopod *Eccentricosta*. Unit D is also a waterlime, transitional into the overlying Cobleskill/Akron Formation. The Williamsville Formation contains a moderately diverse assemblage of fossils, including molluscs, lingulid brachiopods, ostracodes, and the eurypterid *Eurypterus remipes lacustris*.

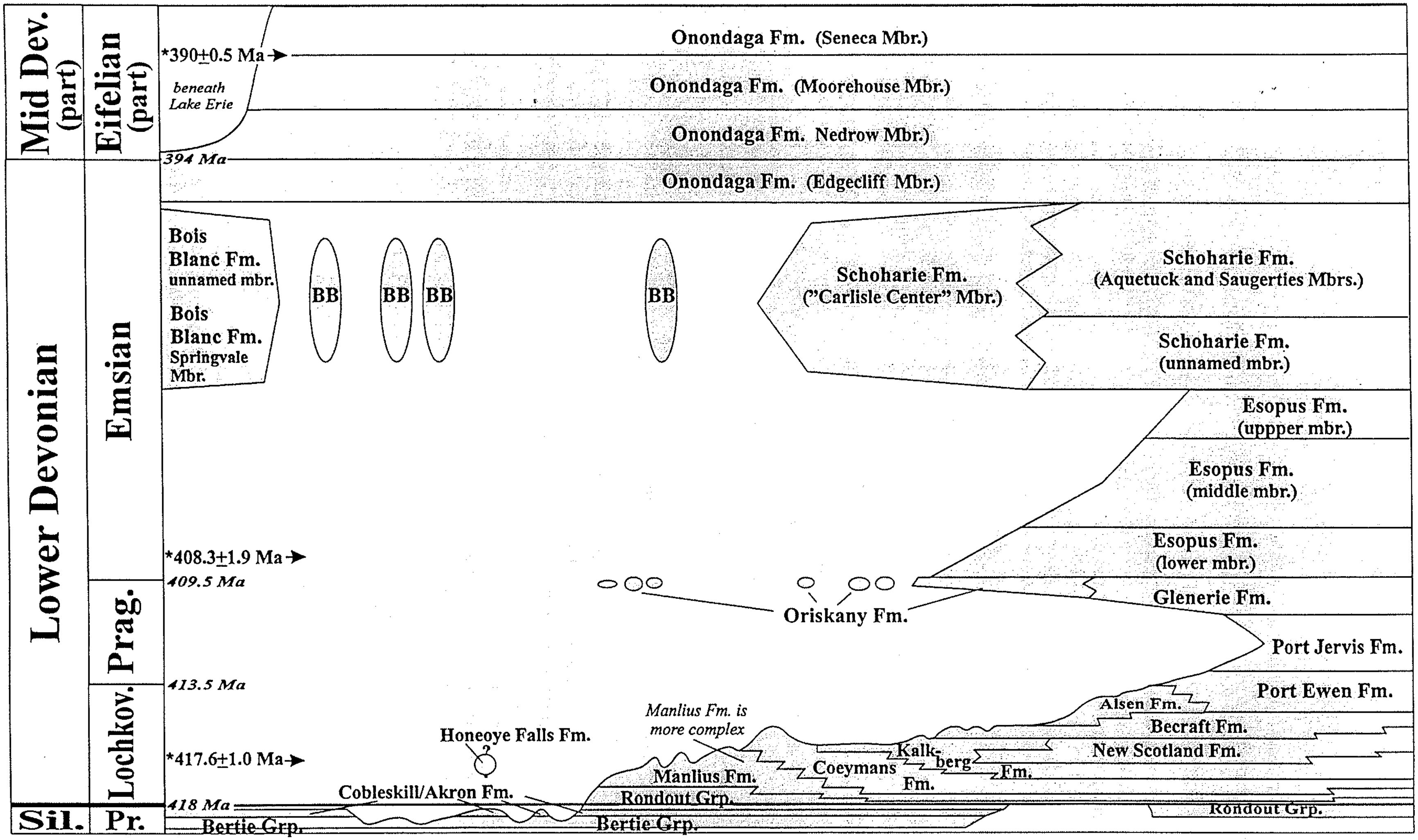

Figure 2. Revision by C.A. Ver Straeten (in process) of the Lower Devonian portion of Rickard's (1975) Stratigraphic Chart of the Devonian. One of the significant components of this revision is the adaption of the revised Devonian time scale of Tucker et al. (1998), wherein the Late Silurian Pridolian Stage comprises one million years, and the Lochkovian, Pragian, and Emsian stages of the Lower Devonian comprise 4.5, 4.0, and 15.5 million years respectively. The revised, longer estimate for duration of the Emsian (previously estimated between 3.6 to 8 m.y. by previous time scales) is reflected in the expanded vertical dimension of the Emsian age Esopus and Schoharie formations. Recent geochronologic dates from Tucker et al. (1998) in bold, regular letters to left in figure; their estimates for dates of the stage boundaries in bold italic lettering. Zircons from the two older dated horizons come from K-bentonites in the Kalkberg and Esopus formations at Cherry Valley, NY. The upper dated K-bentonite is the Tioga B (=Onondaga Indian Nation Ash) at the base of the Seneca Member of the Onondaga Formation, dated from samples in central Pennsylvania.

Upper Silurian (Pridolian) - Lower Devonian (Lochkovian) Rondout Formation.

Cobleskill/Akron Formation/Member. The Cobleskill (or Akron) Formation (Member of Rickard, 1975) is the highest Silurian formation fully exposed in western and central New York. It is a massive, vuggy, and heavily-bioturbated dolostone and dolomitic limestone. The latter has been referred to as Cobleskill, while more fully dolomitized facies have been identified as Akron. Belak (1980), showed that the units are merely diagenetic facies of one another, and Ciurca (1990) advocated the use of Cobleskill Formation throughout New York and southwestern Ontario. He also suggested inclusion of the Cobleskill within the Bertie Group. Herein we follow Rickard (1975) and keep the Cobleskill/Akron Formation in the Silurian-Devonian Rondout Formation. Rare rugose and tabulate corals and a few species of brachiopods (including *Eccentricosta*) have been identified from this unit in western New York. This interval probably represents a return to more open subtidal and less saline conditions.

Moran Corner Waterlime Member. Capping the Cobleskill Formation is a 1 m-thick unit fine-grained, conchoidally-fracturing waterlime described by Ciurca (1982, 1990). The unit features a eurypterid (Eurypteris sp.), and postulates an unconformity marked by distinct mudcracked upper contact. The Moran Corner Waterlime appears to represent a small outlier of the Chrysler Member (Rondout Formation) recognized by Rickard (1975).

Chrysler Member. The Lower Devonian (Lochkovian to lower Pragian) Helderberg Group is represented in central New York by strata assigned to the upper part of the Rondout Formation and the Manlius Formation. Basal strata of the Chrysler Member are comprised of conchoidally-fracturing, buff dolostones interpreted to represent supratidal facies.

Ciurca (1973) recognized massive and thin-bedded dolostones and waterlimes at one locality in western New York, which he termed the Honeoye Falls Formation. The formation features the eurypterid *Erieopterus microphthalmus*, otherwise known from the Manlius Formation of central New York. The unit appears to represent a local outlier of Chrysler Member. Ciurca (1982) correlates the Honeoye Falls with Lochkovian strata in southwestern Ontario assigned to the Clanbrassil Formation. The unit is characterized by approximately 7.6 meters of fine-grained dolostone and also features *Erieopterus*. The Clanbrassil Formation has been correlated with the Chrysler Member and part or all of the overlying Manlius Formation (Ciurca, 1982, 1990; Ciurca and Hamell, 1994). Ciurca (1990) also projects an unconformity between the Upper Silurian Moran Corner and Honeoye Falls formations.

Manlius Formation. The Manlius Formation of the Lower Devonian Helderberg Group comprises a mixture of thinly-laminated, stromatolitic to mudcracked micrites, fossiliferous thin-bedded packstones with low-diversity normal-marine faunas, and stromatoporoid-rich bioturbated wackestones. The Manlius Formation is the highest unit exposed below the Wallbridge Unconformity in central to western New York; it is considered to be of Early Devonian, Lochkovian-age. Six members are recognized, including five in the central New York region. These five units are considered to be lateral, shallow water equivalents of the Coeymans, Kalkberg, and New Scotland formations to the east (Rickard, 1962, 1975; see Figure 2of this paper). Rickard (1962, 1975; Figure 2 of this paper) also shows the Chrysler Member of the Rondout Formation as correlative with the Manlius (Thacher Mbr.), Coeymans, and lower Kalkberg formations of eastern New York.

These correlations suggest that the westward thinning and eventual loss of the Helderberg Group (Figures 3, 4) is in part attributable to depositional pinchout onto the craton. We might further suggest that the westward extension of the Chrysler/Honeoye Falls/Clanbrassil formations is laterally equivalent to the maximum transgressive part of the lower Helderberg depositional sequence (i.e., New Scotland Fm.) of eastern New York.

Rickard (1975) shows the Olney and Elmwood members of the Manlius Formation underlying the major Wallbridge Unconformity in the eastern Finger Lakes area (Localities 1-2 of this field trip). The Olney Member comprises lowest strata of the Manlius Formation west of the Syracuse area. The unit consists of blue-colored, fine-grained, even-, thin- to thick- or massive-bedded limestones, sometimes internally laminated, with minor, thin grainstone beds (Rickard, 1962). Excepting stromatoporoids, which are widespread, fossils are uncommon in the Olney Member. The succeeding Elmwood Member in the study area is composed of non-fossiliferous, drab yellow-weathering, thin-bedded waterlimes with desiccation cracks (Rickard, 1962).

Southeastward of the study area, successively higher units of the Helderberg Group appear beneath the Wallbridge Unconformity (Figures 2, 3). These units comprise two large deepening upward cycles; A) Rondout, Manlius, Coeymans, Kalkberg, New Scotland, and lower Becraft; and B) upper Becraft, Alsen, Port Ewen, and Port Jervis formations. Closure of the unconformity occurs in the Tristates area of New York, New Jersey, and Pennsylvania (i.e., Port Jervis, NY; Figure 2).

Devonian Units above the Wallbridge Unconformity

Oriskany Sandstone. The oldest unit exposed above the major Wallbridge Unconformity in New York is the Oriskany Sandstone, tentatively dated as late Pragian age (Oliver and Hecht, 1994). The Oriskany Formation is a pale gray to white weathering quartz arenite. Locally, this sandstone is highly fossiliferous with a moderate diversity fauna, including thick-shelled brachiopods (i.e., *Costispirifer arenosus, Acrospirifier murchisoni, Megastrophia, Hipparionyx,* and *Rensselaeria* ("Big Shell" or *Hipparionyx* Community; see Boucot, 1975). At the Seneca Stone quarry south of Seneca Falls (Stop 2), a thin lens of the Oriskany Sandstone contains abundant brachiopods, spheroidal *Favosites (Emmonsia)* sp. and very rare rugose corals (Oliver and Hecht, 1994).

Although the Oriskany locally attains a thickness of 3 m at the type section (Oriskany Falls; Baker, 1983), it has a very patchy distribution in central New York and generally absent in the western part of the state (Figures 2, 3. 4). As noted, the unit is up to 60 cm thick in Seneca Stone quarry (Stop 2) but pinches out within the quarry.

Across much of the west-central to western New York outcrop belt the Oriskany Formation is missing, although neptunian dikes and cracks filled with quartz grains that may represent Oriskany sands occur just below the Wallbridge unconformity at several localities (e.g., Stops 3 and 5).

Bois Blanc Formation. At several localities through central to western New York State, the Oriskany Formation, or the Wallbridge Unconformity where the Oriskany is missing, is unconformably overlain by a thin, highly condensed interval that has been variously termed "Bois Blanc Limestone" or "Springvale Sandstone" (Figures 2, 3).

Ehlers (1945) originally defined the Bois Blanc as approximately 30 meters of cherty and arenaceous to shaly chert-rich limestone on Bois Blanc Island, Mackinac Straits area of Michigan. Sanford and Brady (1955) traced the unit eastward through southern Ontario where it thins from 30 m near Woodstock to less than 2 m near Buffalo, where small erosional remnants of the unit were identified by Oliver (1954). Near Hagerstown, Ontario, where the Bois Blanc is approximately 6.0 m-thick, the lower 2.5 m are massive sandstones assigned to the Springvale Sandstone of Stauffer (1913).

In New York the unit ranges in thickness from zero to approximately five meters, and is preserved as localized lenses. Apparently, the unit has been removed across most of the western to central New York region by a period of late Emsian erosion, prior to deposition of the Onondaga Formation.

The stratigraphy and faunas of the Bois Blanc Formation in the western New York area have been described by Oliver (1967, 1976), Oliver and Sorauf (1981), and Boucot and Johnson (1968). Coral and conodont biostratigraphy indicate a late Emsian age (probably *serotinus* zone) for the Bois Blanc (Oliver and Pedder, 1979; Oliver, 1967; Oliver and Sorauf, 1981; Klapper, 1981). This unit is a lateral equivalent of the Schoharie Formation of the eastern New York and perhaps also of sandy beds rich in *Meristina* and small *Amphigenia*, informally termed "Springvale" near Syracuse.

The term "Springvale" was proposed by Stauffer (1913) for a thin (<1 m) fossiliferous, glauconitic and phosphatic sandstone that locally overlies the true Oriskany Sandstone. The Springvale fauna was found to post-date the Oriskany and to have affinities with that of the Schoharie Formation of eastern New York State. The Springvale is presently considered to be the basal member of the upper Emsian Bois Blanc Formation in Ontario (Chadwick, 1919; Oliver, 1967).

Use of "Springvale" for basal Bois Blanc glauconitic sandstones in Ontario and western New York follows Oliver (1967), Boucot and Johnson (1968), and Oliver and Hecht (1994). As thus construed, Springvale represents the lower member of the Bois Blanc Formation, and is overlain by a presently unnamed carbonate-rich member, the main thickness of the Bois Blanc.

Near Buffalo, NY, Oliver (1966, 1967) recognized lenses of the carbonate-rich unit, which he described as a dark gray, fine-grained limestone with a brachiopod-dominated fauna. Small lenses of Bois Blanc have also been recognized near LeRoy. The furthest eastward outcrop at which the typical Bois Blanc carbonate lithology has been recognized is at Phelps (Stop 4).

At the Neid Road quarry near LeRoy (Stop 5), the Bois Blanc is a two-part succession up to about 1.4 m thick. A thin (ca. 0- 25 cm) interval of dark brownish-gray, glauconitic and phosphatic sand and sandy mudstone, attributed

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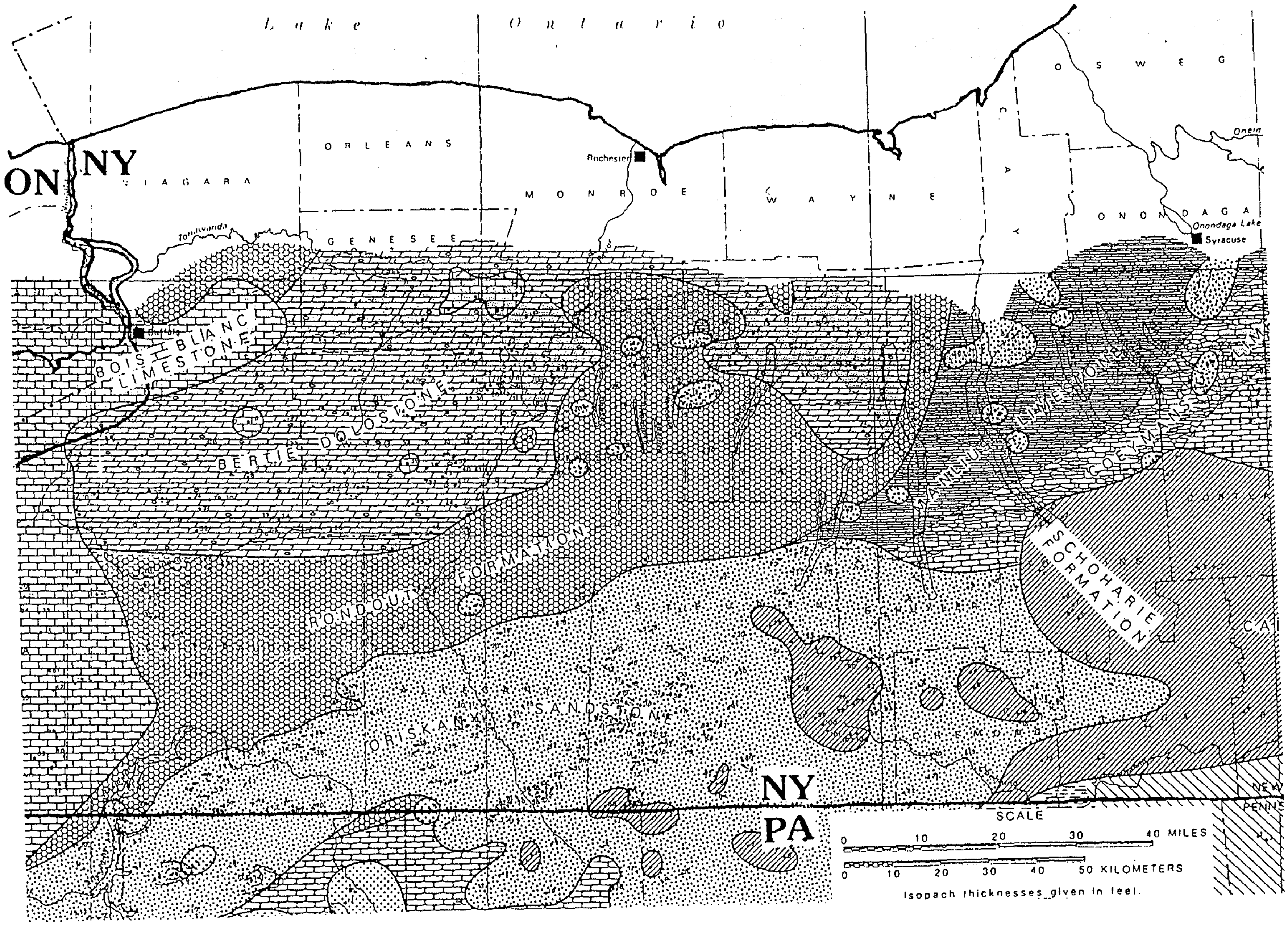
Figure 3. Paleogeologic map of Silurian and Devonian strata below the sub-Onondaga unconformity, northern Appalachian Basin (from Rickard, 1989). Note the progressively older strata exposed below the unconformity into western New York, from the west and especially from the southeast. Recent work discussed in this paper indicates a greater amount of Schoharie-Bois Blanc (sandstone facies), previously interpreted as basal Onondaga, underlies the unconformity in central New York.



Lake Ontario
ON
NY
ORLEANS
MONROE
WAYNE
GENESEE
ONONDAGA
Onondaga Lake
Syracuse
Rochester
Tonawanda
BOIS BLANC LIMESTONE
BERTIE DOLOSTONE
RONDOUT FORMATION
SCHOHARIE FORMATION
ORISKANY SANDSTONE
NY
PA
SCALE
0 10 20 30 40 MILES
0 10 20 30 40 50 KILOMETERS
Isopach thicknesses given in feet.

to the Springvale Member, is present below carbonates of the unnamed upper limestone member. The sandstone features meristellid and spiriferid brachiopods and small rugose and favositid corals that resemble forms in the overlying Bois Blanc carbonate beds. A pebbly bed about 10 cm above the base contains rounded clasts of brown dolostone and chert, apparently derived from underlying Bertie Group strata, as well as small, sandy phosphatic nodules. The upper third of the 25 cm interval features two to five centimeters of thin lensing beds of wackestones and shales. This lower "Springvale" interval in turn is sharply overlain by two or three ledge-forming, light gray limestone beds, totaling about one meter in thickness. The lower one or two beds are fossiliferous, bioturbated wackestones with thin layers of brachiopod rich packstones. The upper bed is a wackestone with scattered solitary rugose corals (*Heterophrentis*, cystiphyllids and other forms). Adjacent to knobs of Cobleskill Formation that extend upward along the Wallbridge unconformity surface the Bois Blanc appears to form a single bed of highly fossiliferous, medium gray, iron stained pack- and grainstone. (See further details below).

At the roadcut on NY Rt. 88 just west of Phelps, NY (Stop 3), the Bois Blanc is a little less than 5 m thick (see Oliver, 1967, for discussion of nearby outcrop along the NY State Thruway). It still exhibits a basal sandy zone (ca. 1.6 m-thick at Phelps) that, at its base, contains phosphatic clasts of Bertie and sandstone; this apparently represents the Springvale Member. The upper member, about 2.9 m thick locally, consists predominantly of fine-grained, brownish-gray, cherty, dolomitic, limestone (sparse biomicrite or lime mudstone). The unit shows some tendency toward upward coarsening, with grains of crinoidal debris and small corals becoming more common toward the top. This unit is overlain by a pale pinkish gray crinoidal grainstone that represents the basal Edgecliff Member, but the contact is poorly exposed. As previously noted, this is the farthest east lens of typical Bois Blanc strata. The formation is absent altogether at the next major locality to the east at Oaks Corners Quarry (Stop 3).

Undifferentiated Bois Blanc/Schoharie Strata in Central New York. East of Phelps, typical carbonate facies of the Bois Blanc Formation are absent. Farther east, in the Auburn to Syracuse area and eastward, the equivalent of Bois Blanc and Schoharie is represented by a thin (centimeters to over 3 m), two part succession. A thin, lower, dark-gray muddy sandstone (Springvale Member), is overlain by calcareous, yellow- to white-weathering quartz arenite, locally greenish-gray to reddish and argillaceous, with large spheroidal (2-10 cm in diameter) bluish-white-weathering, black phosphatic sandstone concretions ("cannonballs"). Near its top, this unit becomes a sandy limestone that is locally hematitic, and contains fairly abundant large brachiopods, bryozoans and other fossils. We suggest that the main upper body of sandstone may be equivalent to the unnamed carbonate member of the Bois Blanc formation to the west. At its thickest, along Rt. I-81 south of Syracuse, the interval is almost 3.5 m-thick. To the east of Syracuse the phosphatic sandstone extends at least Oriskany Falls, where it overlies typical Oriskany Sandstone (Baker, 1983). Beyond there it thickens, and is continuous with what been called the Carlisle Center Formation, now informally recognized as a member of Schoharie Formation, laterally equivalent to the whole of the Schoharie Formation in the Hudson Valley of eastern New York (Ver Straeten, 1996, in prep.). West of and even near Syracuse, however, its thickness and presence/absence is very localized, and the white quartz arenite-cannonball facies is absent west of Cayuga Lake. In many places where it is absent, reworked phosphatic sandstone clasts, apparently derived from the unnamed member, indicate its widespread occurrence previous to erosional truncation below the Onondaga Formation.

Onondaga Formation. The highest stratigraphic unit involved in the unconformable contacts in western to central New York is the Edgecliff Member of the (Onondaga Formation Figure 2). Brett and Ver Straeten (1994) recognized two predominant facies in the Edgecliff Member: crinoidal, commonly coral-rich grainstones (Jamesville Quarry facies) and cherty, finer-grained wackestone to mudstone (Clarence facies). In nearly all outcrops from Fort Erie, Ontario eastward to past Syracuse, New York the basal Onondaga is formed by a 0.3 to 1.5 m thick interval of non-cherty crinoidal pack- to grainstone. This interval is locally developed as a series of small bioherms. In the study area the basal Edgecliff grainstones variably overlie the Bois Blanc/Springvale, Oriskany, Manlius (Olney or Elmwood mbrs.), Chrysler, or various units of the Upper Silurian Bertie Group (Figures 3, 4).

West of the Syracuse area, and especially from the Oaks Corners quarry west, the higher parts of the Edgecliff Member are generally developed in Clarence facies, a cherty micrite (lime mudstone to wackestone) that displays common light gray to bluish gray chert. In places, the Clarence facies may comprise up to eighty percent chert, with minimal carbonate. The cherty unit rests directly on sub-Onondaga strata in a very few, localized occurrences (e.g., Stop 5, Neid Rd. quarry).

The age of the Edgecliff Member of the Onondaga Formation remains poorly constrained, as it has at present only yielded non-diagnostic conodonts of shallow water icriodid biofacies. The overlying Nedrow Member, however, has yielded forms diagnostic of the *partitus* zone and the overlying P. *costatus costatus* zone, representative of lower

Eifelian age (Klapper, 1971, 1981). In the absence of further data, the Edgecliff is tentatively placed within the latest Emsian *patulus* conodont zone (Klapper, 1971, 1981).

UNCONFORMITIES

At least three unconformities intervene between the uppermost Emsian (Lower Devonian) Edgecliff Member and the Pridolian (Late Silurian) Bertie Group. Each of these is described in some detail below, and are presented in Figures 3, 4, and 5.

Sub-Oriskany (Wallbridge) Unconformity

The most significant of the unconformities is the sub-Oriskany Wallbridge Unconformity, which marks the base of Sloss' (1963) North American-wide Kaskaskia Supersequence. Evidence for the unconformity across the region can be found in many sections where Oriskany Sandstone (or sand grains) overlie an erosion surface. Careful studies in central New York to southwestern Ontario by Ciurca (1973, 1982, 1990), Ciurca and Hamell (1994), and Kobluk et al. (1977) indicate that this unconformity is complex and regionally variable.

Ciurca (1973, 1982, 1990) carefully traced out the stratigraphy of the top Silurian – Lower Devonian erosion surface in Ontario and western New York. His cross-sections (combined into Figure 5 of this paper) show substantial regional relief on this surface. A maximum of 18 meters of stratigraphic separation is redognized from highest areas that expose Lower Devonian Honeoye Falls and Clanbrassil Formations to lowest depressions exposing Silurian Bertie Dolostone units downward to the Victor Member of the Fiddlers Green Formation. Because it is overlain by Pragian-age Oriskany Sandstone, the Wallbridge erosion is bracketed between Lochkovian and upper Pragian. At a smaller scale the unconformity shows a relief of up to three meters in a single quarry (e.g., Stop 5, Neid Rd. quarry), but, in these cases, the erosion surface is actually the combination of two or more unconformity-forming episodes.

At Seneca Stone quarry (Stop 2) the Wallbridge Unconformity is a nearly planar, slightly irregular contact of Oriskany Sandstone on older Lower Devonian (Lochkovian) Manlius Formation. The contact displays small clastic dikes and what appear to be large (up to 1 cm in diameter) organism boreholes. In places angular clasts of the Manlius occur as much as twenty centimeters up into the Oriskany and a few have been encrusted with corals. Rarely, *Favosites* directly encrust the unconformity itself.

Kobluk et al. (1977) describe an irregular sub-Oriskany unconformity in southern Ontario that features sand-filled, solution widened joints, and a *Trypanites* bored rock ground. The widened joints ("klufkarren" or grikes) were interpreted to have formed under subaerial conditions; however, a lack of vugs suggested insufficient meteoric water circulation in contrast to later pre-Bois Blanc conditions. Borings were produced during initial transgression of shallow seas over the eroded surface (Pemberton et al, 1980).

Sub-Bois Blanc / Springvale Unconformity

In most localities where the Bois Blanc Formation (or equivalent sandstone) is present (Figure 6), it rests directly upon the Silurian – Lower Devonian erosion surface with at most only a few sand grains in fractures below. However, in certain localities from the Seneca Stone quarry eastward to Syracuse the Bois Blanc/Springvale can be seen to rest unconformably upon the Oriskany Formation, thereby demonstrating the existence of an Emsian unconformity, distinct from the Wallbridge (see also Oliver, 1966, 1967; Hodgson, 1970, Baker, 1983). This erosion surface was characterized by phosphatized clasts of subjacent units, including Bertie dolostone, Manlius, and sandstones with thick-shelled brachiopods resembling those in the Oriskany Formation.

In those areas where the Oriskany Sandstone is absent and the Bois Blanc/Springvale is present, a combined Wallbridge – sub-Schoharie unconformity exists. This contact is generally flat to slightly undulose. However, at the Neid Road quarry near LeRoy, New York, Bois Blanc strata locally mantle a highly irregular surface on the Silurian Bertie dolostones. The sub-Bois Blanc surface is commonly irregularly pitted, bored, and impregnated with glauconite. In a few places along the quarry walls the Bois Blanc overlaps neptunian dikes filled with clean quartz sands. These are presumably remnants of the Oriskany that were not exhumed during the pre-Bois Blanc/ Schoharie erosional interval. In other cases phosphate- and glauconite-rich quartz sands fill crevices and dikes, and appear to represent later Emsian-age ("Springvale") deposits. Fossiliferous upper Bois Blanc sediment fills karstic hollows up to several meters across, as well as thin cracks, fissures, and even horizontal crevices within the eroded Silurian. We interpret this contact as the exhumed and slightly modified Wallbridge Unconformity.

In southern Ontario Kobluk et al. (1977) described a bored rock ground surface immediately below the Bois Blanc. They also noted the development of solution pits, vugs, and a second generation of joints containing clasts of Oriskany Sandstone. Minute solution pitting was inferred to indicate the presence of algae, lichens and/or mosses, while dendritic etchings on this surface were interpreted as land plant rhizome etchings. *Trypanites* borings below

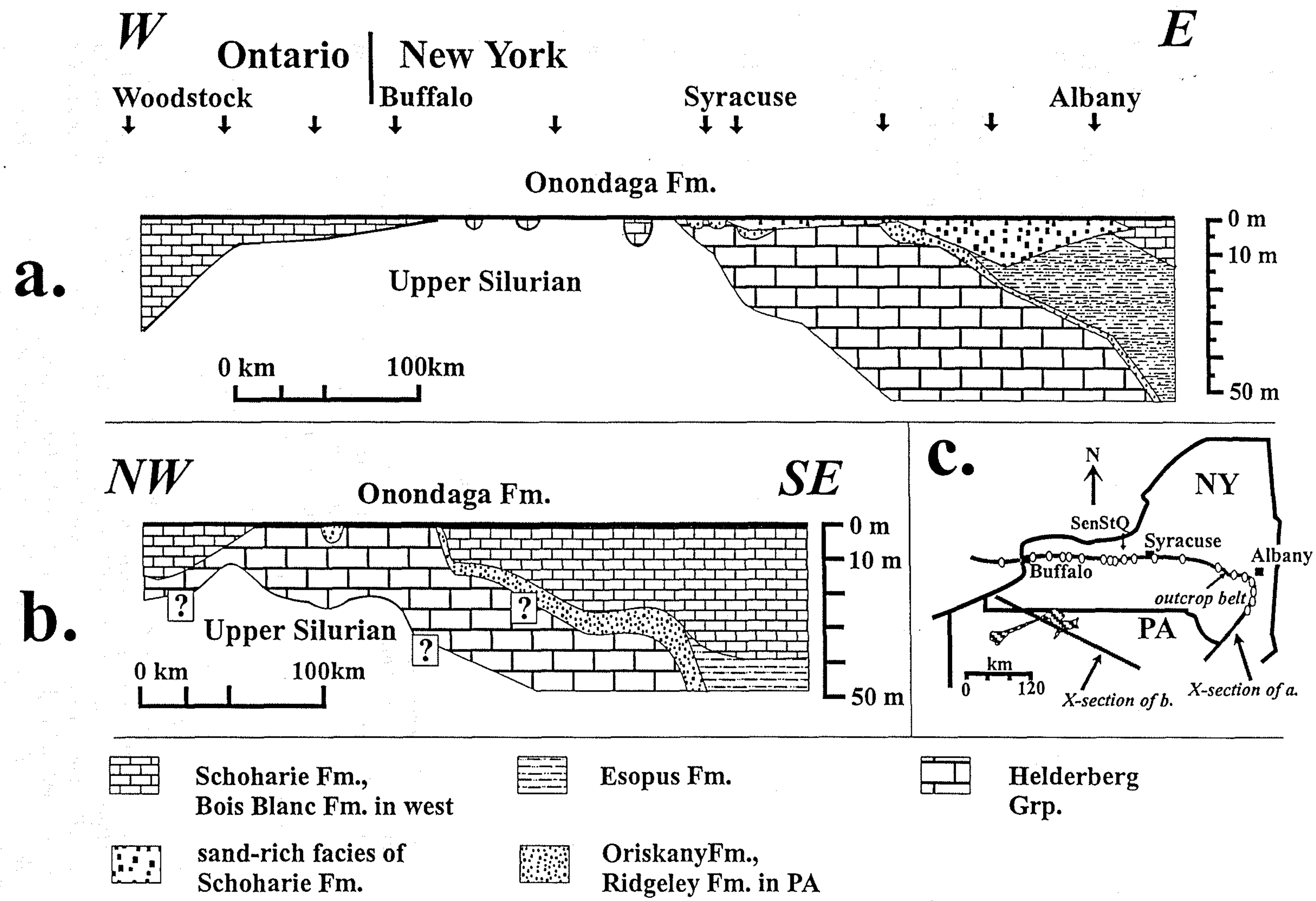
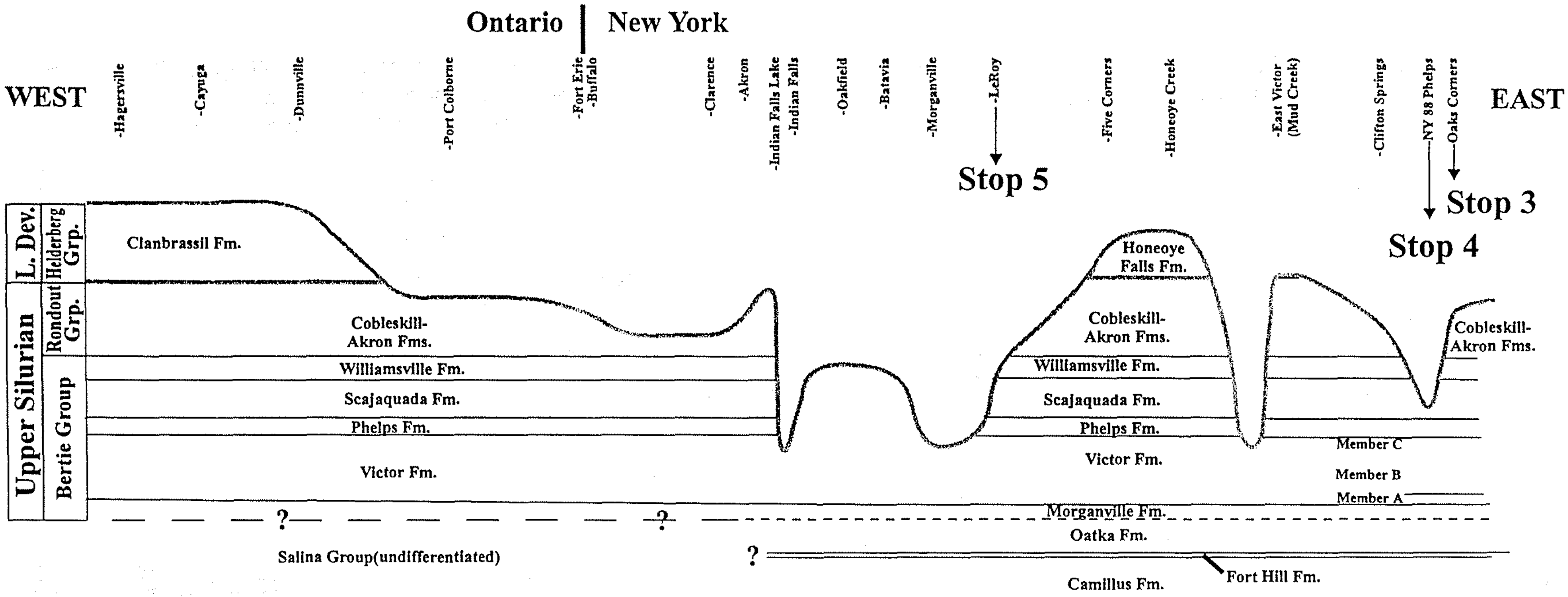


Figure 4. Cross section of Devonian strata below the sub-Onondaga unconformity along the New York outcrop belt (a) and in the subsurface of southwestern New York and northwestern to central Pennsylvania (b). Map (c) shows distribution of cross-sections. From Ver Straeten and Brett, 2000; data for cross-section b from Rickard (1989).



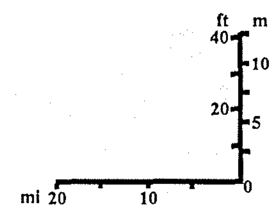


Figure 5. Cross section after Ciurca (1973, 1982) showing distribution of Wallbridge Unconformity along outcrop belt from Hagersville, Ontario to Oaks Corners, New York (Stop 3). Additional uncomformity separates Lochkovian (Lower Devonian) Clanbrassil and Honeoye Falls formations from underlying Pridolian strata (Rondout "Group" and Bertie Group Note set of deep, generally narrow incisions into Silurian, interpreted as possible incised valleys.

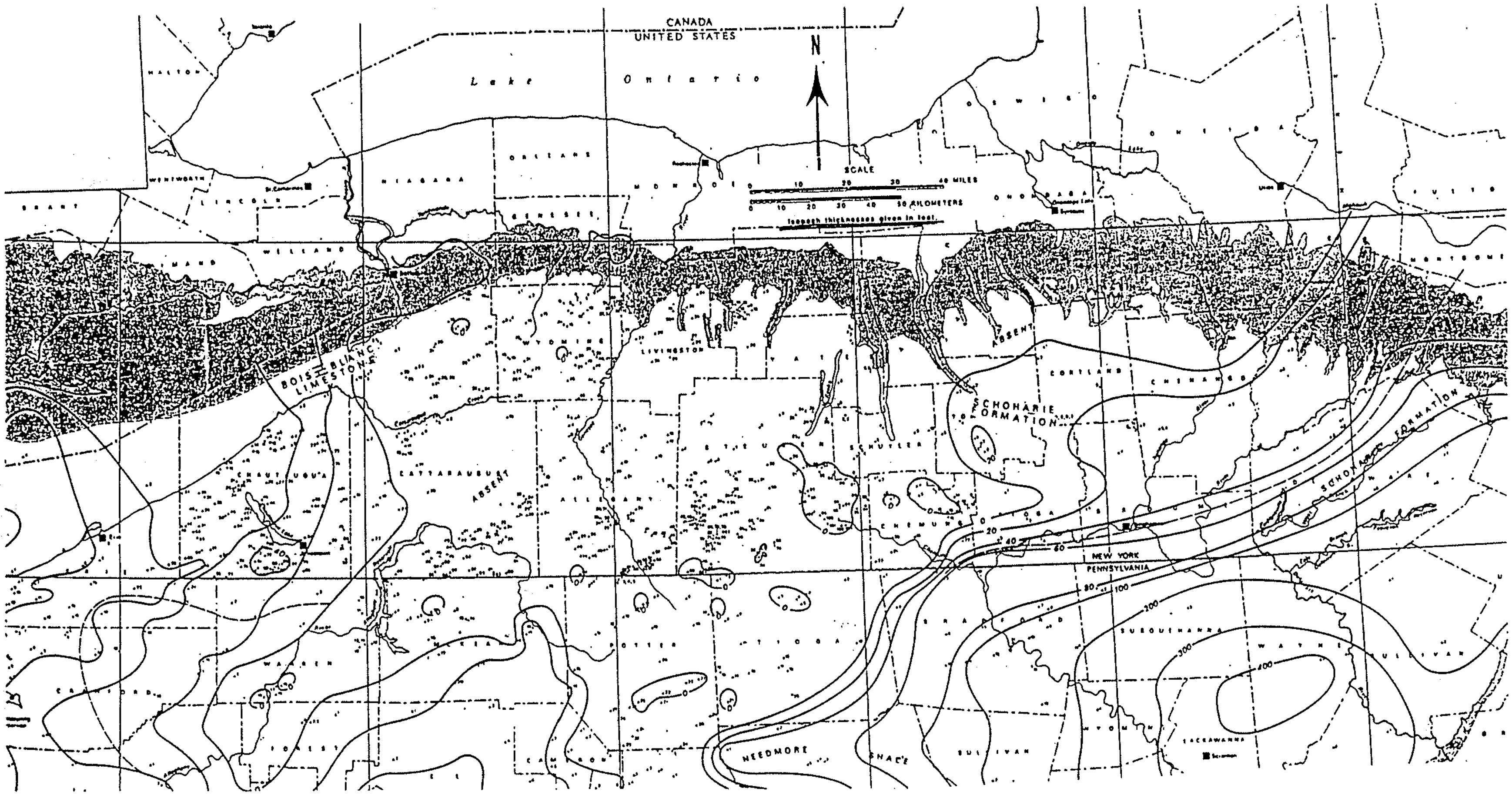


Figure 6. Isopach map of Bois Blanc and Schoharie formations in northern Appalachian Basin (after Rickard, 1989). Note broad pinchout of strata across western to central New York, with isolated lenses preserved across the area. Outcrop-based recognition of Bois Blanc-Schoharie sands across central New York (east of Cayuga Lake) indicates a greater, though locally spotty, distribution of these strata occurs over the area. Isopach thickness given in feet.

the Bois Blanc were infilled with quartz silt/sand and glauconite (Pemberton et al., 1980). We have similarly observed glauconite and silt-filled borings beneath and above Bois Blanc in cavities at Neid Road quarry and the NY Route 88 roadcut near Phelps (see below).

Sub-Onondaga Unconformity

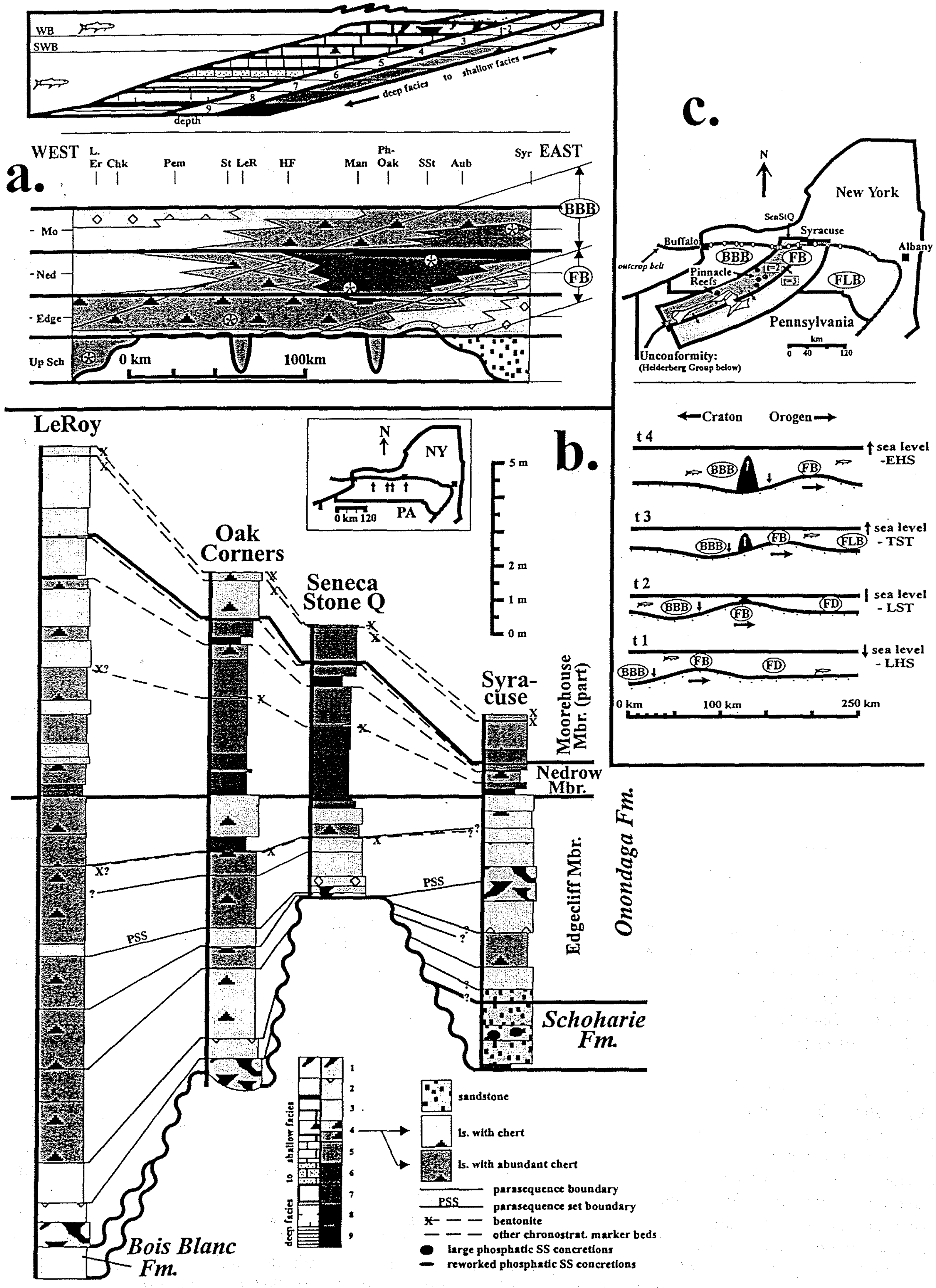
Oliver (1966) and Oliver and Sorauf (1981) noted a faunal break between the Bois Blanc and Onondaga formations that he interpreted to result from a significant unconformity. The contact of the Onondaga (Edgecliff Member) and underlying Bois Blanc formations is also marked by a thin lag of quartz sand, glauconite, and phosphate grains, further suggesting the presence of an unconformity (Hodgson, 1970; Oliver and Hecht, 1994).

In outcrops where the Bois Blanc is present, such as the Neid Road quarry (Stop 5, near LeRoy), it is separated from the overlying Edgecliff grainstones by a sharp, typically planar to gently undulating contact. This unconformity is set off by rust staining at or closely below the contact. It is immediately overlain in some sections by a thin layer of sticky clay that may be a K-bentonite or residual soil. In some outcrops (e.g. Neid Road Quarry, northeast wall [Stop 5], and Goodrich Road near Clarence, NY) the Bois Blanc occurs as a series of lenses. This indicates preservation only in patches. Presumably, the unit has been removed in intervening areas. At both the Auburn and Seneca Stone quarries (Stops 1 and 2), the basal bed of the Edgecliff Member at the base of the Onondaga, shows a flat and seemingly conformable contact with underlying beds. However, it also contains clasts of older units, including phosphatic sandstone nodules (apparently reworked from the older Emsian-age, Schoharie- and Bois Blanc-equivalent "Springvale Sandstone", as well as oxidized (subaerially-weathered?) clasts of the Lochkovian-age Manlius Limestone. Some phosphate-impregnated clasts also contain valves of thick-shelled brachiopods, resembling those of the underlying Oriskany Sandstone. These clasts were reworked during deposition of the first Onondaga sediments (latest Emsian?) as they are associated with (and rarely encrusted by) Onondaga, rather than Schoharie, rugose corals (W. Oliver, 1981, pers. commun.). Ver Straeten and Brett (2000) infer that a number of these clasts were locally derived from previously deposited "Springvale" strata that were eroded over the crest of a migrating topographic high (Figure 7; see further discussion below).

Combined Wallbridge, Sub-Bois Blanc, Sub-Onondaga unconformities.

At many localities in western New York the Onondaga Formation rests directly on eroded upper Silurian strata. In such cases, the crinoidal grainstone of basal Edgecliff tends to fill hollows on the irregular karstic surface. This surface appears to have been "inherited" from the karstification episode of the Wallbridge unconformity (i.e. Late Silurian to earliest Devonian erosion interval). We suspect that during the intervening time interval the surfaces may have been mantled with thin deposits of Oriskany, probably Esopus, and Bois Blanc, but that these beds were subsequently removed by the pre-Onondaga erosion.

Figure 7. Composite figure of facies and time-rock relationships, high resolution correlations, and model for bulge and back-bulge basin migration across central to western New York, Bois Blanc-Schoharie and Onondaga formations (from Ver Straeten and Brett, 2000). 7a) Facies and time-rock relationships in Bois Blanc-Schoharie and Onondaga formations, Buffalo to Syracuse area. Upper part of figure 7a displays an idealized onshore-offshore transect for Onondaga facies across the Appalachian Basin (1 = shallow coral biostromal facies, 9=basinal black shales). Lower part of 7a is a chronostratigraphic facies transect across western to central New York. Vertical axis represents time. Note unconformity at base. FB and BBB areas outline envelopes of eastward migrating bands of relatively shallower and deeper facies through time, interpreted to represent a flexural bulge and back-bulge basin. 7b) High resolution correlations of Bois Blanc-Schoharie strata and Edgecliff, Nedrow, and Moorehouse members of the Onondaga Formation, western to central New York (including Stops 2, 3, and 5 of this fieldtrip). Correlated units include bentonites, a widely recognized pair of black shale beds, and small- to media-scale cycles. Note absence of entire lower medial-scale cycle (parasequence set) at Seneca Stone quarry. 7c) Map and cross section of interpreted peripheral bulge,showing eastward motion of bulge and model of pinnacle reef development in deeper facies in southern New York and northwestern Pennsylvania. BBB = back-bulge basin, FB = forebulge, and FLB = foredeep of Appalachian Basin at that time. LHS = late highstand, LST = lowstand, TST = transgressive, and EHS = early highstand systems tracts of sequence stratigraphic terminology; arrows indicate relative sea level fall to rise. Reef development model shown for upper Bois Blanc-Schoharie (t1) through middle Onondaga (t4).



WB
SWB
deep facies to shallow facies
depth
a.
WEST
EAST
L. Er
Chk
Pem
St
LeR
HF
Man
Ph-Oak
SSt
Aub
Syr
BBB
FB
- Mo
- Ned
- Edge
Up Sch
0 km
100km
c.
N
New York
SenStQ
Syracuse
Buffalo
Albany
outcrop belt
Pinnacle Reefs
BBB
FB
FLB
Pennsylvania
km
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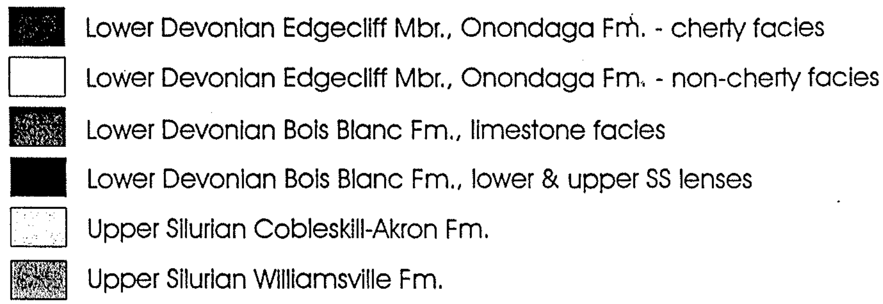
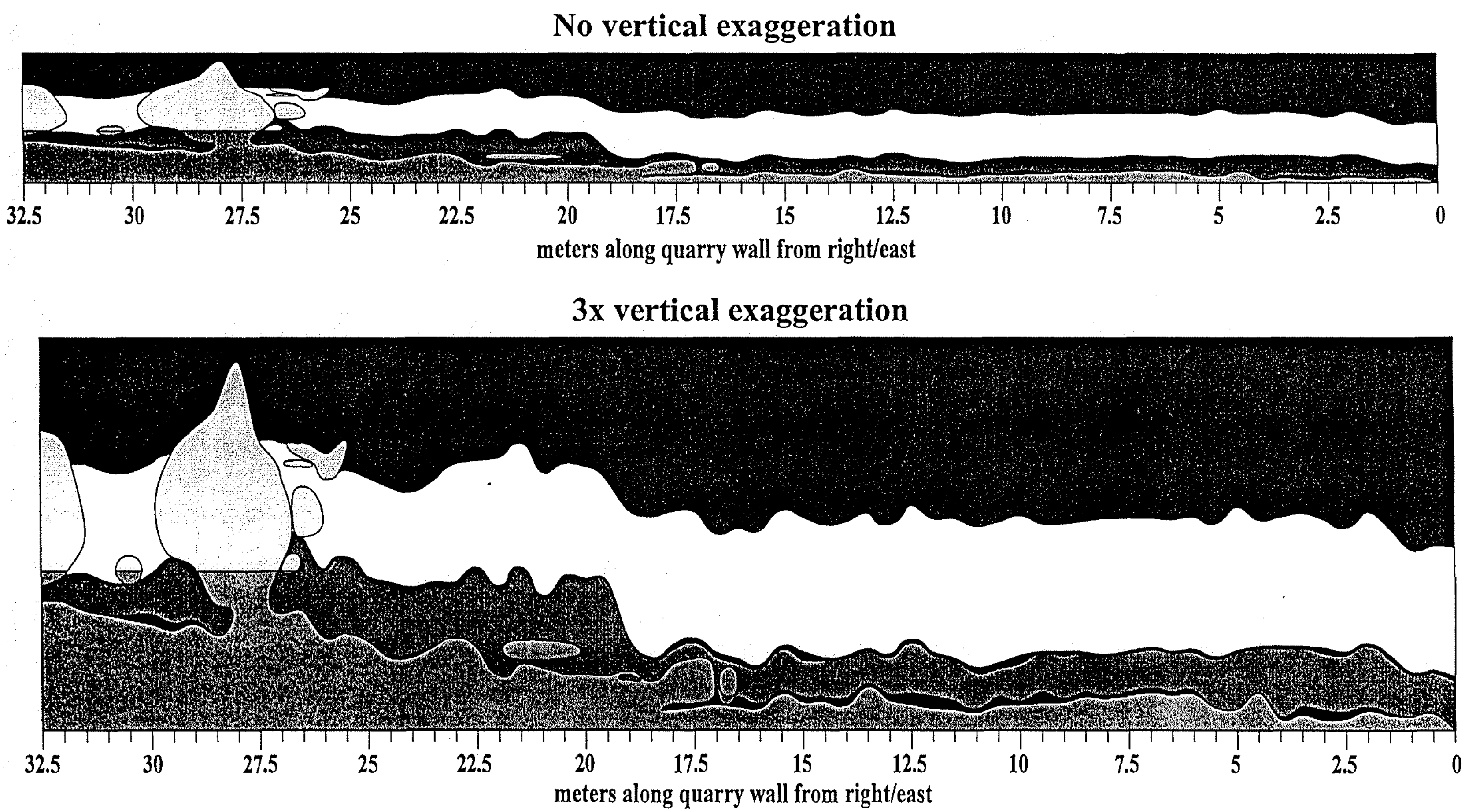
Unconformity:
(Helderberg Group below)
Craton
Orogen
t 4
sea level -EHS
t 3
sea level - TST
t 2
sea level - LST
t 1
sea level - LHS
FD
0 km
100 km
250 km
LeRoy
Oak Corners
Seneca Stone Q
Syra-cuse
b.
NY
PA
0 km 120
5 m
2 m
1 m
0 m
Moorehouse Mbr. (part)
Nedrow Mbr.
Edgecliff Mbr.
Onondaga Fm.
Schoharie Fm.
Bois Blanc Fm.
PSS
X?
deep facies to shallow facies
sandstone
ls. with chert
ls. with abundant chert
parasequence boundary
PSS parasequence set boundary
bentonite
other chronostrat. marker beds
large phosphatic SS concretions
reworked phosphatic SS concretions

Figure 8. Partial cross-section of northeast wall of Neid Road quarry, LeRoy, New York, showing complex stratigraphic relationships over remnant Silurian bedrock highs. Relief on Silurian = three meters. Note prominent knobs and undercut cavities in Silurian strata, progressively filled in, around, and over by Bois Blanc Formation (coral-crinoid rudstones), basal Edgecliff Member (chert-free grainstones), and middle Edgecliff Member (cherty wacke- to packstones). Two significant disconformities present: 1) an amalgamated Wallbridge & sub-Bois Blanc unconformity; and 2) a sub-Onondaga unconformity.





The Silurian – Devonian contact at Neid Road Quarry: A Possible Rocky Shoreline.

Restudy of an abandoned limestone quarry north of Gulf Road and west of Neid Road in the town of LeRoy (Stop 5) has yielded evidence for a complex, irregular rock ground with possible sea stacks.

The contact between the Silurian Bertie Group and Devonian carbonates is exposed almost continuously around the eastern and northern rim of this quarry. At most stations along the eastern and northwestern quarry walls a thin (ca. 0.8 to 1.4 m-thick) interval of the Bois Blanc Formation rests on beds of the Williamsville Formation. About 10-30 cm of dark gray, glauconitic/phosphatic pebble-rich sandy mudstone (Springvale Mbr.) is overlain by about a meter of brachiopod, coral and gastropod-rich wackestone to packstone (unnamed upper Bois Blanc mbr.). Oriskany Sandstone is absent except for minor fracture fillings in the Bertie that are visible down to at least 0.9 m below the unconformity. Additional fracture fills of, quartz sand with phosphate, glauconite, and abundant fossil hash appear to be Emsian-age. A slight amount of channeling and positive relief of at least 50 cm is observed at this contact. The Bois Blanc, in turn, is sharply overlain by a 70 to 110 cm interval of fine- to medium-grained crinoidal grainstone – the basal Edgecliff Member. This contact also displays a very minor amount of relief, is stained orange from the leaching of sulfides and is, at least locally, overlain by a thin clay layer. The higher beds of the Onondaga are developed in chert-rich Clarence facies of the Edgecliff Member (Figure).

Particularly interesting features occur at the northeast corner of the quarry (Figures 8, 9). Here the normal, nearly horizontal basal contact of the Bois Blanc is greatly modified. First, obvious mounds to pinnacles of Upper Silurian Williamsville and Cobleskill dolostone rise up to three meters above the normal, sub-horizontal contact. These knobs are variously draped by coarse coral- and crinoid-rich Bois Blanc strata, or the lower Edgecliff Member. However, in places, the Bois Blanc and basal beds of the Edgecliff terminate abruptly against the Silurian paleobedrock knobs. Thus, over highest parts of the Silurian knobs the contact is overlapped by cherty Clarence facies (Figures 8, 9).

The knobs themselves are composed of medium-bedded dolostone of the Williamsville Dolostone (Bertie Group), and locally the overlying burrow-mottled, coral-bearing Cobleskill-Akron Formation. They stand above the main "peneplane" surface in the Bertie Group. We infer that these knobs are erosional remnants and possibly sea stacks that were elevated on the Devonian sea floor.

The most intriguing feature of these erosional masses is that they have been undercut near their bases. Subhorizontal notches as much as 1.5 m deep and 5-50 cm high occur near the base of at least one such a mound. Erosion may have been focused along the contact between the softer, thinner bedded Williamsville and overlying, harder Cobleskill dolostone (Figures 8, 9).

In one particularly intriguing situation, along the northeast wall the vertical succession of beds at the edge of one of the pinnacles is as follows: Williamsville (Upper Silurian) – Bois Blanc (Lower Devonian) –Cobleskill (Upper Silurian) – Edgecliff (Lower Devonian). The Bois Blanc here is filling in an undercut notch (possible karstic cavity); where this filling has crumbled away on a single area the ceiling and sidewall of the crevice are visible. They have been extensively bored by *Trypanites*, the dwelling sites of probable sipunculid worms (Pemberton et al., 1980) in the cavity ceiling (Figure 9).

This and other cavities and adjacent areas are infilled by coarse, coral-rubble rudstone to grainstone facies (Figures 9,10) that are directly traceable along the outcrop into the normal, brachiopod-rich mudstones to wackestones of the Bois Blanc Formation. The coarse material is exceptionally rich in solitary and colonial rugose corals (many of them overturned, highly corroded remnants) as well as tabulates and echinoderm debris. The coral content of the Bois Blanc gradually decreases and grades into that typical of the fossiliferous wackestone-packstone facies of the Bois Blanc within 100 to 150 meters from the knobs.

DISCUSSION: IMPLICATIONS OF THE SILURIAN-DEVONIAN UNCONFORMITIES FOR REGIONAL GEOLOGIC HISTORY

The unconformity capping Upper Silurian (Pridolian)/Lower Devonian (Lochkovian) strata in western New York is a complex surface, in places representing the superposition of two to three or more major disconformities, each with distinctive geometries and characteristics. Details of the geometry and topography of these erosion surfaces, together with the sediments that overlap them aid in reconstructing the broad outline of a regional history during the Early Devonian, a history characterized more by erosion than deposition.

Latest Silurian- Earliest Devonian Background

It should be noted that a significant unconformity may also exist between the uppermost Silurian Cobleskill-Akron dolostones and overlying Lower Devonian Clanbrassil-Honeoye Falls Formation (Ciurca, 1990; Ciurca and Hamell, 1994). This unconformity is poorly known due to the fact that it is poorly exposed and overstepped in many areas by the subsequent Wallbridge Unconformity. As far as known, it is a nearly planar paraconformity.

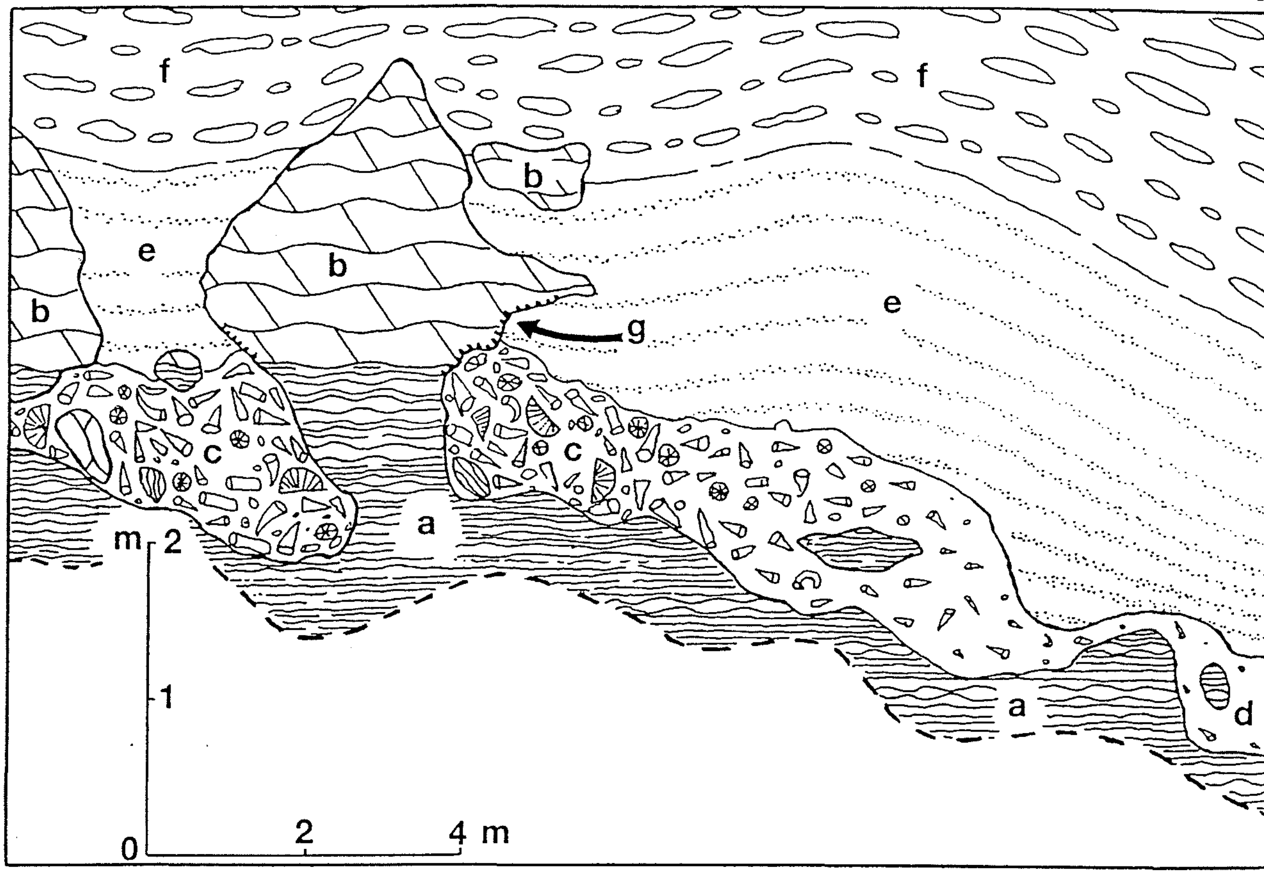
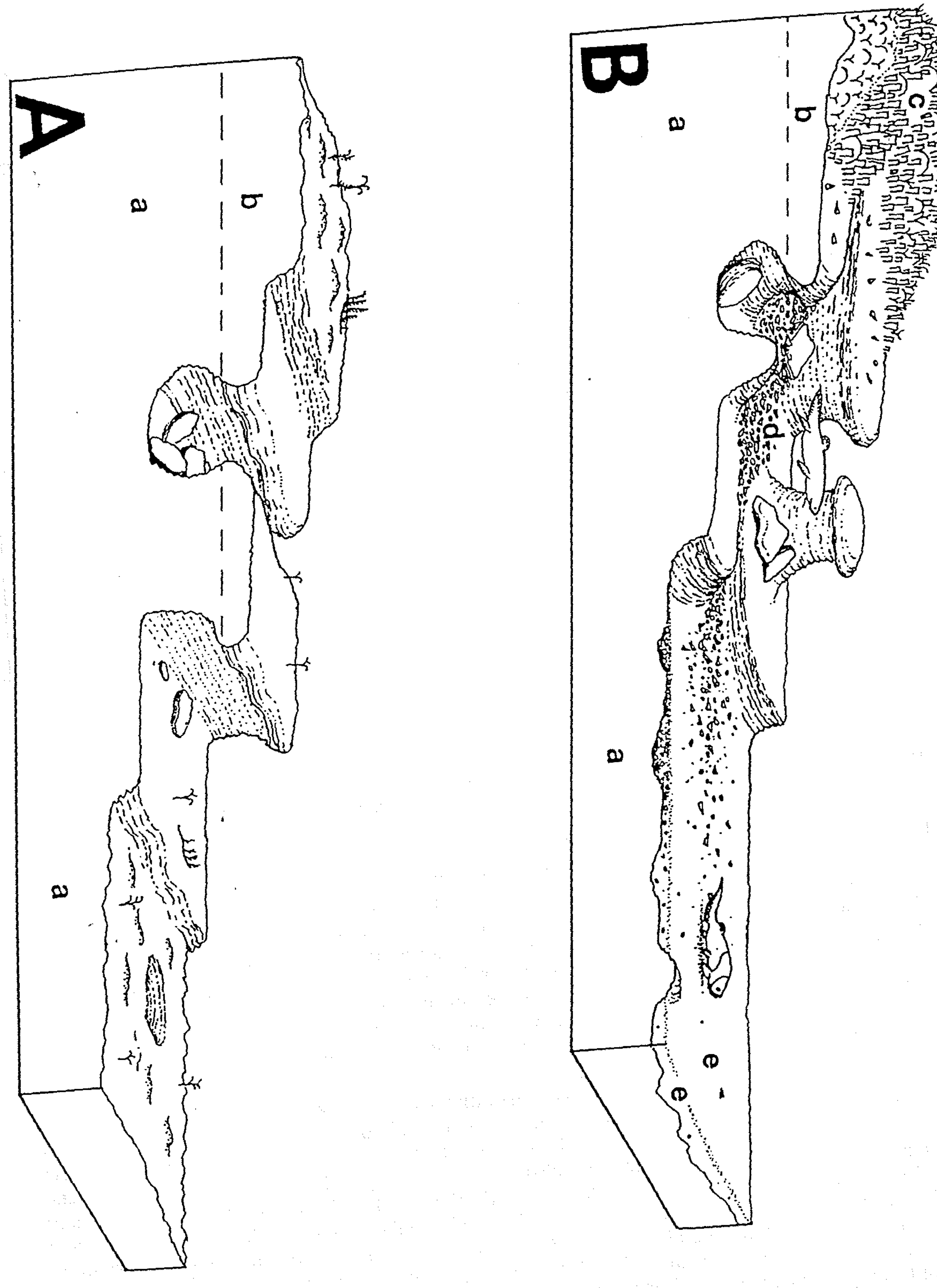


Figure 9. Diagrammatic view of irregular erosional contact (Wallbridge Unconformity) of Silurian Bertie-Cobleskill dolostone and Devonian Bois Blanc and Onondaga limestones, at Neid Road Quarry, LeRoy, Livingston County, New York. Note irregular knob ("sea stack") of dolostone and onlapping relationship of the overlying Devonian skeletal carbonate sediments; also note Devonian skeletal debris filling in pockets below projecting ledges of Silurian dolostone. Lettered features include: a) Williamsville Dolostone (Upper Silurian, Pridoli, Bertie Group): rhythmically laminated, light gray dolostone("waterlime"); b) Cobleskill/Akron Formation (Upper Silurian); massive, mottled dolostone with rare corals; c) Bois Blanc Limestone (Lower Devonian, Emsian) note coarse, coral-rich packstone and grainstone, with some dolostone clasts near bedrock knob; note that this unit terminates against Silurian bedrock and grades laterally into d) finer grained packstone-wackestone typical of Bois Blanc in surrounding exposure; e, f) Edgecliff Member (Lower to lowest Middle Devonian; Emsian-Eifelian; Onondaga Limestone); e) lower submember; medium grained, well sorted pinkish gray crinoidal grainstone; note that this unit also terminates against bedrock knob; f) upper submember, "Clarence" facies, light gray, bioturbated lime mudstone with abundant dark, bluish gray chert nodules; note that this unit drapes the bedrock knob; g) *Trypanites* borings in ceiling of overhanging ledge.

Figure 10. (See next pages)Series of schematic diagrams illustrating sequential development of the composite Wallbridge-sub-Onondaga unconformity, as exposed at the Neid Road quarry near LeRoy, New York. A) Early Pragian: development of the sub-Oriskany (Wallbridge) karstic unconformity; subaerial conditions, note development of small sink holes and solution hollows, also small tracheophyte plants on the surface (evidenced by rhizome etchings on the unconformity in Ontario; see Kobluk et al., 1977). B) middle-late Emsian: deposition of Bois Blanc sediments on old erosion surface flooded by shallow seas; note hypothetical growth of corals on elevated bedrock knob and coral rubble in adjacent hollows. C) latest Emsian: eroded surface of Silurian and veneer of Bois Blanc skeletal rich sediment during relative lowstand associated with the sub-Onondaga unconformity; again, note small vascular plants growing on subaerially exposed carbonate surface. D) latest Emsian-earliest Eifelian: composite erosion surface reflooded and accumulating crinoidal sand and gravel during initial Onondaga transgression. Letters: a) Williamsville Dolostone, Bertie Group; b) Cobleskill/Akron Dolostone; c, d) Bois Blanc Limestone coarse facies and fine facies; e) basal Edgecliff sediments.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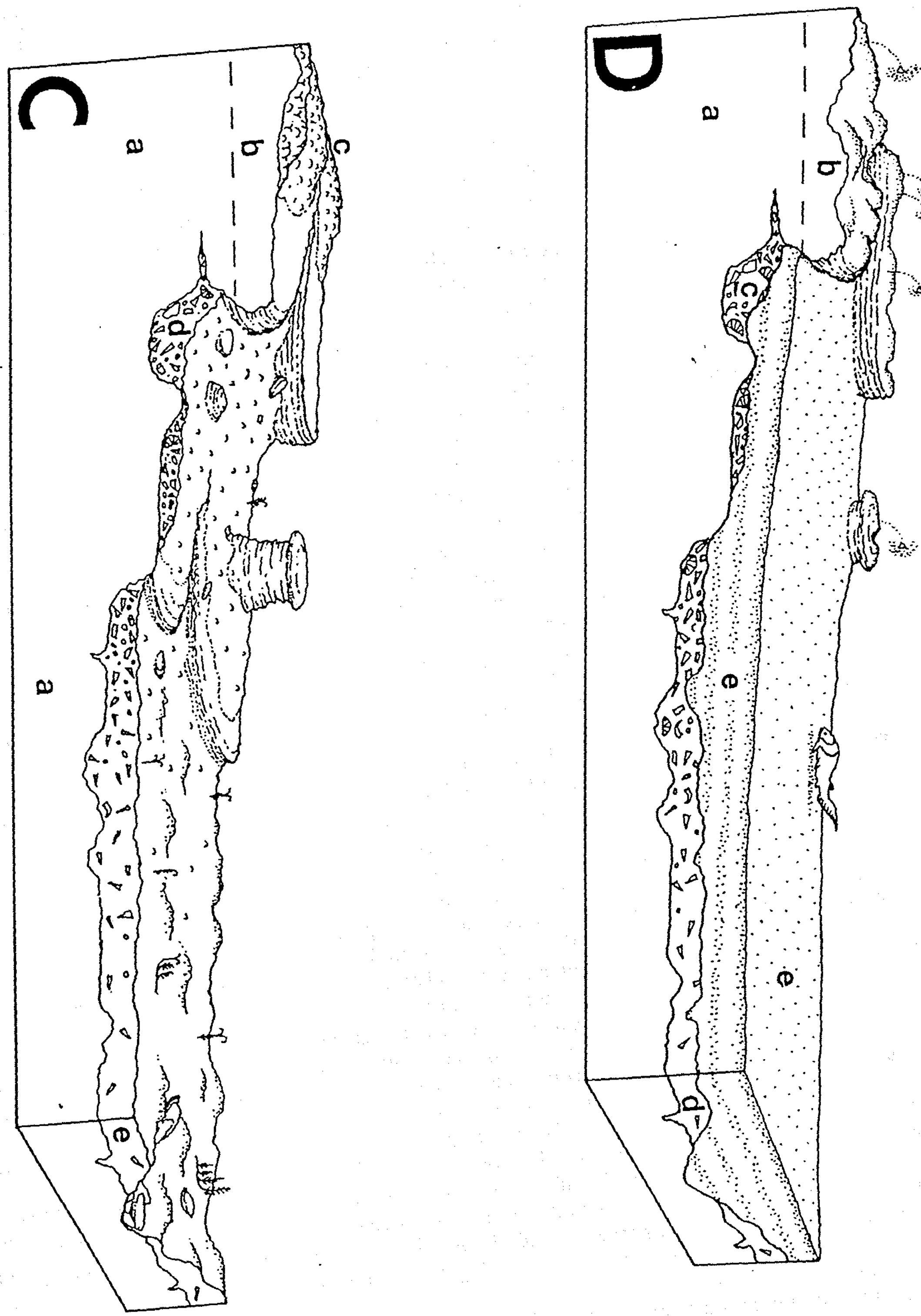
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We infer that it developed in areas west of the northwestern shoreline of the eastwardly-restricted foreland basin during relative sea level lowstand in latest Silurian to earliest Devonian time, probably coeval with deposition of peritidal Rondout (Chrysler) and Thacher carbonates in south eastern to central New York. We suggest, but can not prove that the shallow water Clanbrassil and Honeoye Falls carbonates are slightly younger deposits that accumulated during an Early Devonian highstand, perhaps coeval with the deposition of shallow subtidal upper Manlius limestones in central New York and deeper water Kalkberg-New Scotland strata to the east (Hudson Valley; see Figure 2).

Pre-Oriskany Events

The most significant unconformity is the sub-Oriskany (Wallbridge) disconformity. This unconformity appears to emanate from the contact between the Glenerie-Oriskany and the underlying Port Jervis Formation in southeastern New York (Figure 2), where the Glenerie (or Oriskany in nearby eastern Pennsylvania) is approximately 50 m-thick. Preliminary investigation across the basin indicates that the Wallbridge Unconformity in central New York may already represent an amalgamation of two sequence-bounding discontinuities; a lower one, locally underlying the thick Oriskany-Ridgeley sandstones in the deeper central portion of the basin (e.g., central Pennsylvania and adjacent areas), and an upper one underlying the New York Oriskany. More work is pending on this.

To the northwest across New York the sub-Oriskany Wallbridge Unconformity bevels successively lower Helderberg units and eventually cuts downward into the underlying Bertie Group west of the Cayuga Lake meridian. Only very minor remnants of Lower Devonian Helderberg Group rocks remain in western New York, but studies by Ciurca (1973, 1982; see Figure 5) indicate that a more continuous preservation of the Lower Devonian Clanbrassil Formation occurs west of Hagersville, Ontario. The unconformity shows maximal relief and cuts most deeply into the Silurian (Victor Member of Fiddlers Green Formation) at localities in Genesee and Livingston Counties in western New York. The overall pattern of greatest cutout in western New York and decreasing hiatus both to the east and west suggests that the lowstand erosion may have been focused on a relatively high area, possibly a broad arch or dome lying partly in western New York. It should be noted that erosion is even more extensive to the southwest of New York. For example, in south-central Ohio the base of the Columbus Limestone, tentatively correlated with the upper Emsian Bois Blanc or lower Onondaga limestones, rests on medial Silurian dolostones.

The detailed cross section of the unconformity surface in Ontario-western New York delineated by Ciurca (1973, 1982; Figure 5 herein) shows a series of four "deep" incisions along the Wallbridge unconformity , separated by highs on the Silurian-Lowest Devonian paleobedrock surface. The cross section has a high degree of vertical exaggeration. In fact, the lows are relatively broad (5 to 15 miles) and shallow (15-20 m deep). We suggest that these represent a series of incised paleovalleys that may have been cut by a combination of solution and erosion during a mid Early Devonian (late Lochkovian to Pragian) lowstand. It is tempting to speculate that these were temporarily occupied by broad, low gradient rivers that emptied into the Appalachian foreland basin to the southeast. Unfortunately, data at present are insufficient to constrain the orientation of the lows. It is also noteworthy that the unconformity becomes more nearly planar (lacking in distinct highs and lows) both east and west of the study area where it is developed on Lower Devonian Helderberg carbonates. This too may indicate that those areas were not subject to so prolonged a period of subaerial exposure.

A further interesting fact is that these paleovalleys do not contain thick fills of Oriskany Sandstone. However, in each of these areas at least minor veneers, neptunian dikes, and crack fillings of clean, white quartz sand, possibly attributable to the Oriskany, indicate that the irregular unconformity was cut prior to deposition of the latter unit (i.e. by no later than late Pragian time). If the lows or putative paleovalleys were ever filled by Oriskany Sandstone it has subsequently been removed almost completely. Strangely, thicker areas of clean quartz arenite, with typical Oriskany faunas occur both to the west (in southern Ontario) and to the east (in central New York State) of the area of maximal erosional incisement as depicted in Figures 3 and 5.

This observation and the pattern of onlap of the Helderberg Group into central New York suggests that the region of incisement in western New York may have been locally elevated during early to mid Early Devonian (Lochkovian to Pragian) time. The fact that the sub-Oriskany unconformity in Ontario (Kobluk et al., 1977) and in western New York (Oliver, 1966; personal observation) shows solution enlarged joints with sandstone "dikes" indicates that the Silurian rocks had undergone a period of fracturing in the pre-Oriskany interval. Possibly, this early jointing episode was related to stresses associated with gentle arching of the crust. Such joints, in turn, may have focused later erosive incision.

Details of the unconformity in some areas, as at the Neid Road quarry (Stop 5), also suggest that it may have had a more intricate topography (Figures 9, 10). However, the degree to which that topography was modified by later erosive and transgressive events is presently unknown (but see below).

Oriskany-Schoharie Interval

In eastern New York up to 100 m of dark gray silty to siliceous shale and fine-grained sandstones, the Esopus Formation, intervene between the Oriskany Sandstone and the overlying Schoharie Formation. If this unit was ever deposited in the west it has been removed by sub-Schoharie/Bois Blanc erosion. The fine-grained, dark gray, deep-water nature of middle Esopus strata in westernmost outcrops (e.g., Cherry Valley), indicate that the Esopus should have originally extended far to the west, but was later erosionally truncated below the sub-Schoharie sequence-bounding unconformity. That erosional episode has also stripped away Oriskany Sandstone across west-central to western New York except in some local lenses. These may represent pockets of sand that were preserved in low spots on the unconformity. We do note, however, that the Oriskany is not always present in the lowest depressions in local quarry sections.

The fact that Oriskany Sandstone (and overlying Esopus mudstone, if ever present) has been removed, except in local lenses and pods throughout western and west central New York indicates a period of post-Oriskany erosion. Moreover, Kobluk et al. (1977) found evidence for a second episode of jointing beneath the Bois Blanc, indicating possible renewed tectonic stresses during this time.

At Cherry Valley, in east central New York, the Esopus Formation is sharply and erosionally overlain by argillaceous siltstones to fine-grained sandstones of the Carlisle Center Member (Schoharie Fm.; Figure 2). This sequence-bounding unconformity, which can be traced beyond Catskill in the Hudson Valley, contains some reworked phosphatic clasts and firmground burrows indicative of erosional truncation down into overcompacted muds (Miller and Rehmer, 1982; Ver Straeten, 1996). We surmise that this is the leading edge of the unconformity that underlies the Bois Blanc/Springvale Sandstone in western New York.

As noted, the "lows" or paleovalleys on the Wallbridge Unconformity generally lack thick Oriskany deposits and only fissure fillings point to the former existence of the sand in these areas. We suggest that the incised areas may have been re-occupied by streams during the pre-Schoharie lowstand and their sands flushed out. Alternatively, all accommodation space in the older paleovalleys may have been filled during the Oriskany-Esopus sequence, and new paleovalleys cut during the sub-Schoharie/Bois Blanc lowstand. If so, then the fissure fillings are actually from later, Emsian-age sands.

It is certainly noteworthy that the lower part of the Schoharie Formation throughout the Hudson Valley, and westward to Cherry Valley, shows layers of large quartz grains near its base. Perhaps these are, in part, cannibalized Oriskany sands. It does appear, however, that minor amounts of sand remained on the unconformity surface and were reworked along with terrigenous muds (reworked Esopus?) during the initial Schoharie-Bois Blanc transgression to form the so-called Springvale sands.

In contrast to the Oriskany, the Bois Blanc/Schoharie does appear to be preferentially preserved in lows or paleovalleys. A notable example is the outlying lens of Bois Blanc Formation at Phelps, NY (Stop 5). Here as much as 4.5 m of phosphatic, cherty sandstones and fine-grained, somewhat cherty, sparsely fossiliferous limestone overlies the Scajaquada Shales (Bertie Group). As elsewhere, the basal beds are sandy and contain reworked phosphatic nodules and clasts. Conversely, nearby at the Oaks Corners Quarry (Stop 3) no hint of the Bois Blanc is present; and here a relative high ("interfluve") brings Cobleskill (Akron) Formation into direct contact with lower Onondaga Limestone.

However, it is also notable that Bois Blanc in intervening lenses, most notably in the sections near LeRoy, 45 miles west of Phelps, and again near Buffalo, have a distinctly coarser texture (wackestones to grainstones at Neid Road Quarry). These areas also display more diverse, brachiopod, bryozoan, and even coral-rich biotas. Hence, the Bois Blanc facies at the farthest east outcrop presently recognized are distinctly deeper water in aspect and more comparable to Canadian Bois Blanc in southern Ontario than these intermediate sections. It is notable that the Phelps exposures lie in one of the deeper low areas or "paleovalleys" on the Wallbridge Unconformity (Figure 5). We suggest that Bois Blanc thicknesses and facies were controlled by the local irregular topography of the seafloor. Near Phelps (Stop 4) a relatively thick succession of deeper water aspect accumulated as part of a paleovalley fill, whereas near LeRoy (Stop 5) the seafloor was shallower over a relative high on the unconformity and thinner, shallower water facies accumulated.

Termination of the Bois Blanc onto local highs is directly observable in a single outcrop at the Neid Road quarry (Stop 5; Figures 9, 10). Here the Bois Blanc forms a semi-continuous band 60 centimeters to about 1.4 meter thick around most of the quarry. The bed thins and drapes the inclined erosion surface near a knob and thin pinches out for a distance of five meters. The first beds of the overlying basal Edgecliff Member likewise wedge out against the bedrock high (Figures 9, 10). This evidence demonstrates that the Bertie bedrock high persisted through deposition of the Bois Blanc and beyond (see below) through the time of the pre-Onondaga hiatus and remained a high during the initial deposition of Onondaga transgressive grainstones. We suggest that this pinnacle of rock represents a sea stack or small bedrock island on the Bois Blanc-Schoharie seafloor.

Notches near the base of this and other bedrock knobs in the Neid Road quarry are filled with coarse skeletal debris that grades laterally into the lower (Springvale) and upper (unnamed) members of the Bois Blanc Formation (Figures 9,10). The undercut areas were thus in existence during Bois Blanc-Schoharie deposition. We suggest that they mark the position of a wave cut (or bioerosional) notch, comparable to those seen on many present day carbonate rock coast lines. It would mark a temporary stand of sea level during the Bois Blanc-Schoharie transgression. The notch and the knob itself were probably "drowned" during subsequent sea level rise (Figure 10b). Relict crevices (some probably enlarged joints) and notches then became infilled with debris of normal marine biotas that infiltrated from higher ground (Figure 10). As noted, the coarseness of debris and the anomalously high abundance and diversity of corals relative to normal Bois Blanc near the bedrock knobs at the Neid Road quarry, may indicate that the bedrock high provided an elevated substrate for colonization of shallow water coral-dominated biotas that were normally excluded from the surrounding slightly deeper (~3 m deeper) and more muddy Bois Blanc sea floor (Figure 10b). Unfortunately, thus far, we found no direct evidence of corals cemented in place nor any holdfasts or other encrusters on more elevated portions of the knob. This is not surprising in view of the fact that the knob was probably re-exposed and subjected to an abrasive environment during the later Onondaga transgression.

The phosphatic-glauconitic, bioturbated, locally muddy sandstones that characterize the "Springvale" in central New York, represent a highly condensed Bois Blanc/Schoharie-equivalent that accumulated in a moderate energy sandy to muddy shelf setting. Fossil brachiopods and bryozoans are found in this unit. It is not entirely clear whether this biofacies represents deeper or shallower conditions than those of the western Bois Blanc. The extraordinarily high concentration of phosphatic nodules and coated clasts may suggest that nutrient-rich waters upwelled onto the margin of the eastern shelf during this time, or may alternatively be related to very low sedimentation rates across a starved, sandy shelf-type environment across central New York.

Schoharie-Bois Blanc to Edgecliff Events

In the Hudson Valley, the basal Edgecliff Member of the Onondaga Limestone overlies upper strata of the Schoharie Formation (Figure 2). The abrupt contact and upward change to coarser-grained facies are the only hints of a minor sequence-bounding disconformity. Likewise, in southern Ontario, Canada, the contact between the Bois Blanc and Onondaga is abrupt but seemingly nearly conformable. This contact in Ontario and at least one western New York outcrop (Neid Road quarry) is marked by a thin, recessive weathering, sticky greenish gray clay that may represent a K-bentonite. However, over most of western New York, the Edgecliff grainstones rest directly on Oriskany Sandstone or Bertie Group strata. The fact that rather typical cherty facies of the Bois Blanc are found as far east as Phelps (some 120 km east of the last continuous outcrop of Bois Blanc in southern Ontario, indicates that these deposits were at one time relatively widespread. Evidently, they have been removed over much of the area by a short-lived erosive episode, prior to deposition of initial Edgecliff sediments. The erosion was not too severe, so that remnants of Bois Blanc were preserved in hollows or paleovalleys. It is noteworthy that, with the exception of these depression fillings, the Bois Blanc is absent over western New York. The incorporation of reworked phosphatic concretions and other clasts derived from Schoharie-Bois Blanc into the base of Onondaga indicates that a short period of pre-Onondaga erosion took place in this area, even as deposition continued almost unbroken to the west and east.

A significant factor in the development of the sub-Onondaga unconformity across western to central New York has recently been discussed by Ver Straeten and Brett (2000). Detailed litho- and biofacies trends (Figure 7a), the correlation of small scale cycles/parasequences and marker beds through the lower to middle Onondaga (Figure 7b), and the distribution of the unconformity (Figure 4) point to anomalous lateral migration of adjacent shallower- and deeper-water facies belts through upper Bois Blanc-Schoharie and Onondaga time. A fall and rise of sea level through the interval should have resulted in predictable vertical changes of facies, in which all areas of central to western New York showed the same relative trends as is seen across the rest of the Appalachian Basin for that time. However, the pinchout and absence of lower Edgecliff cycles into the central Finger Lakes area (focused at Seneca Stone quarry, Stop 2; Figure 7b), differing water depth trends for individual localities across the area, and the eastward shift of distinct, adjacent bands of shallow and deep-water facies through time (Figure 7a) can be tied to the migration of a bulge-like feature and an adjacent, cratonward back-bulge basin across western to central New York during the Late Emsian to early Eifelian (Figure 7c).

This interpretation is supported by, and appears to provide an explanation for, the distribution of Onondaga pinnacle reefs within the deeper water facies in the subsurface of south-central New York and northwestern Pennsylvania (Figure 7c; see Ver Straeten and Brett, 2000 for further discussion). The migration of the bulge, combined with a eustatic sea level lowstand at the base of the Onondaga Limestone, resulted in the cutout or non-deposition of progressively younger Edgecliff strata into the area of Seneca Stone quarry (Figure 7b).

What this means relative to the development of the sub-Onondaga unconformity is that there was additional time during the latest Emsian to modify the pre-existing landscape over a broad topographic high across west-central to central New York. This, in part, must account for the very patchy distribution of at least the late Emsian Bois Blanc Formation and its equivalents, if not progressively older strata of the Esopus and Oriskany Formations and the underlying Helderberg and Bertie Groups.

This strongly suggests a period of tectonically-induced arching during or following final phases of Bois Blanc-Schoharie deposition. This broad truncation surface, spanning over 150 km, may be due regional erosion of a gently uplifted arch. Such an arch might have resulted from tectonic thrust loading during a late part of the first tectophase of the Acadian Orogeny; this notion is supported by the appearance of a probable K-bentonite locally, along the unconformity. This bentonite is only one of many bentonites in the Onondaga and might seem to herald the onset on increased magmatism previous to the onset of Acadian Tectophase II. Alternatively, following flexural models of Quinlan and Beaumont (1984) and Beaumont et al. (1988) the arching might represent thrust load relaxation and accentuation of the basin and forebulge. But that should have occurred earlier than approximately 15 million years after the early, tectonically-active stage at the onset of Tectophase I. Indeed the pattern of deep truncation of lower Emsian Esopus clastics might lead to speculation that the sub-Schoharie unconformity is more associated with relaxation and uplift of a flexural forebulge. Nonetheless, the sub-Onondaga unconformity has the aspect of a tectonically generated sequence boundary in that it fades both west and east of the erosive area in western New York. However, erosion was also concentrated at the sub-Onondaga unconformity during a widespread, apparently eustatic lowstand interval immediately prior to Onondaga deposition.

It may be that the sub-Onondaga unconformity represents the one that finally levels out the basin topography that was initiated with the onset of tectonism in the early Emsian. Initial thrust load-induced subsidence of the proximal foredeep at that time resulted in deposition of relatively deep water muds and sands of the Esopus Formation. Subsequent uplift of a flexural bulge in central New York by Schoharie time, and possibly even during mid to upper Esopus time, and a top Esopus/basal Schoharie sea level lowstand, began the process of eroding and leveling the high, accompanied by infilling available accommodation space in the foredeep with predominantly orogen-derived sediments. The following Bois Blanc-Schoharie transgression resulted in widespread deposition over the high. Ensuing lowstand conditions resulted in another erosive beveling over the bulge, followed by the eventual complete blanketing of the region with the Onondaga carbonates.

The Edgecliff sandy grainstones seem to record a basal transgressive lag of phosphatic clasts, and sand reworked from the Springvale or possibly Oriskany Sandstone, together with crinoidal and coralline sand and gravel. This material spread as a sheet-like unit and appears to have nearly leveled out any residual topography. Locally, as at Oaks Corners quarry (Stop 5), this sandy, crinoidal grainstone thickens by tens of centimeters into low erosional hollows on the Silurian unconformable surface. The first beds of the basal Edgecliff Member actually wedge out against the bedrock highs at Neid Road quarry, as do the underlying Bois Blanc beds (Figures 8, 9, 10c,d). This evidence demonstrates that the Bertie bedrock highs persisted through deposition of the Bois Blanc and beyond through the time of the pre-Onondaga hiatus. If any residual Bois Blanc sediments mantled the bedrock highs, it was removed during this time. The highest knobs remained exposed during deposition of the initial Onondaga transgressive grainstones and were finally overlapped by cherty Clarence facies of the second Edgecliff cycle (Figure 10c,d). At this point the legacy of the Wallbridge Unconformity was completed and the irregularities of the old contact finally ceased to have any influence upon sedimentation patterns.

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ROADLOG AND STOP DESCRIPTIONS

0.0	0.0	Start field trip at the junction of U.S. Rte. 20/NY Rte. 5 with NY Rte. 14 south. Proceed ahead on U.S. Rte. 20/NY Rte. 5
0.6	0.6	Junction with NY Rte. 14 north. Continue ahead on U.S. Rte. 20/NY Rte. 5.
2.6	2.0	Junction with NY Rte. 96A. Continue east on U.S. Rte. 20/NY Rte. 5.
7.3	4.7	Cross NY Rte. 96 in city of Waterloo.
8.7	1.4	Proceed straight through intersection with NY Rte. 414, which joins with U.S. Rte. 20/NY Rte. 5 into the village of Seneca Falls. We will later pass through this intersection going from Stop 3 to Stop 4. Enter the village of Seneca Falls approximately 1.5 miles ahead, and pass by Women's Rights National Park.
14.0	5.3	Cross NY Rte. 89. We will later drive south on this road to get to Stop 3.
15.8	1.8	Cross over Seneca River. Enter Cayuga County.
16.0	0.2	Intersection with NY Rte. 90.
23.6	7.6	Low cuts of Manlius on left (south) side of highway, Manlius and Onondaga Fms. on right (north) side of highway. Reworked concretions of phosphate-cemented sands of the "Springvale Sandstone" of Schoharie age occur in the base of the Edgecliff Member.
23.7	0.1	Entrance to Finger Lakes Mall on right.
24.3	0.6	Junction with Cayuga Co. Rte. 326.
25.2	0.9	Cross Washington St.
25.6	0.4	NY Rte. 38 turns north.
25.8	0.2	Turn left (north) onto NY Rte. 34
26.9	1.1	Cross railroad tracks
27.2	0.3	South entrance to abandoned "Schooley" Quarry.
27.3	0.1	Leave city of Auburn.
27.4	0.1	Turn right (east) into entrance of NFR Northeast Inc.

27.5	0.1	Turn right and proceed a short distance to the abandoned "Schooley" Quarry in Manlius to Onondaga Fms. Park car and walk in.

STOP 1. ABANDONED QUARRY ("SCHOOLEY QUARRY"), NORTH OF AUBURN.

This abandoned quarry pit and a larger one to the east expose Lower to Middle Devonian strata of the Manlius, "Springvale Sandstone," and Onondaga (Edgecliff, Nedrow, and Moorehouse members) formations. The regional complexity of multiple unconformities is reflected at the small scale here by the local thickening and thinning, including pinchout, of the "Springvale" Sandstone along the quarry walls.

The lower walls of the quarry feature buff to gray, fine-grained limestones to dolostones, with local stromatoporoid buildups, assigned to the Manlius Formation. Two members appear present in the quarry; upper buff-weathering, mud-cracked dolomites to limestones of the Elmwood Member, and lower, gray weathering limestones with local stromatoporoid buildups of the Olney Member. Ciurca (1978), however, shows Olney at the contact in the area of Auburn. The upper contact of the Manlius Formation appears sharp.

A photograph (Figure 11) shows the succession through the units in the northwest corner of the "Schooley" quarry, along a ramp road. The top surface of the Manlius appears irregular and knobby. The overlying approximately 0.7 m consists of dark, argillaceous, phosphate-rich and locally glauconitic sandstone, with phosphatic concretions. A gray- to buff- to blue-colored resistant ledge of sandstone caps the "Springvale." Medium- to large-sized sandy phosphatic concretions occur at two horizons within; similar and smaller concretions in the upper part of the bed appear fragmented and reworked, possibly indicative of a time of erosion and unconformity between "Springvale and basal Onondaga strata.

The overlying 3.7 m-thick Edgecliff Member (Onondaga Fm.) is characterized by a lower non-cherty interval (0.3 m-thick) with common corals; the corals are mostly restricted to the lower 0.8 m of the member. Three cherty intervals (Clarence facies) occur up through the Edgecliff in the "Schooley" quarry.

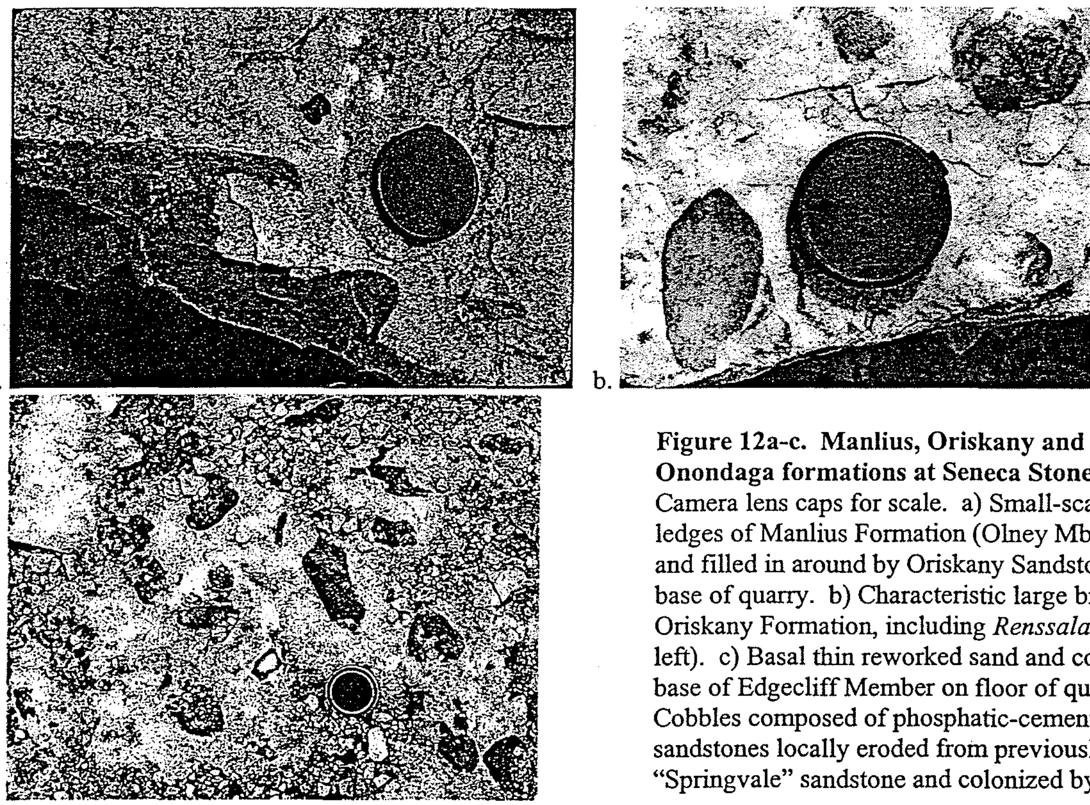
Examination around the walls of the quarry indicates local pinching and swelling of the "Springvale" sandstones. In at least one area on the south wall, the Springvale is absent for a distance; sandy phosphatic concretions from the unit are seen reworked into the base of the Edgecliff Member.

27.6	0.1	Proceed back to NY Rte. 34 and turn left (south), proceeding back through Auburn to U.S. Rte. 20/NY Rte. 5.
27.7	0.1	Enter city of Auburn.
28.1	0.4	Cross railroad tracks.
29.1	1.0	Turn right (west) onto U.S. Rte. 20.
29.7	0.6	Cross Washington St.
30.6	0.9	Junction with Cayuga Co. Rte. 326.
31.2	0.6	Entrance to Finger Lakes Mall on right.
31.3	0.1	Low cuts of Manlius on left (south) side of highway, Manlius and Onondaga Fms. on right (north) side of highway. Reworked concretions of phosphate-cemented sands of the "Springvale Sandstone" of Schoharie age occur in the base of the Edgecliff Member.
38.9	7.6	Intersection with NY Rte. 90. A short distance ahead cross into Seneca County and pass through Montezuma National Wildlife Refuge, at head of Cayuga Lake, in valley ahead.
40.9	2.0	Turn left (south) onto NY Rte. 89.
41.7	0.8	Cross Seneca River.
44.8	3.1	Entrance to Cayuga Lake State Park.
45.0	0.2	Fayette town line.
46.6	1.6	Enter village of Canoga.
46.8	0.2	Turn right (west) onto Canoga St.
47.0	0.2	Verge right onto Seneca Co. Rte. 121.
47.7	0.7	Sharp left bend on Seneca Co. Rte. 121.
47.9	0.2	Sharp right bend on Seneca Co. Rte. 121.
48.8	0.9	Entrance and office of Seneca Stone Corporation quarry. Check in at the office, and then proceed straight (north) into quarry.
49.2	0.4	<u>Fork left</u> onto ramp road, beyond sheds on left. Proceed to lower level.

Figure 11. Top Manlius, "Springvale", and Onondaga strata at abandoned ("Schooley") quarry, Auburn. Note resistant top ledge of Manlius (Elmwood Mbr.) low in photo, overlain by phosphate-rich, relatively friable sands, which are in turn succeeded by resistant top ledge of "Springvale" sandstones. Medium to large phosphatic sandstone concretions in top Springvale bed. Basal Edgecliff Member at top of photo.

a.

b.



c.

Figure 12a-c. Manlius, Oriskany and basal Onondaga formations at Seneca Stone quarry. Camera lens caps for scale. a) Small-scale bedrock ledges of Manlius Formation (Olney Mbr.) overlain and filled in around by Oriskany Sandstone, from base of quarry. b) Characteristic large brachiopods of Oriskany Formation, including *Renssalaeria* (lower left). c) Basal thin reworked sand and cobble bed at base of Edgecliff Member on floor of quarry. Cobbles composed of phosphatic-cemented sandstones locally eroded from previously deposited "Springvale" sandstone and colonized by corals.

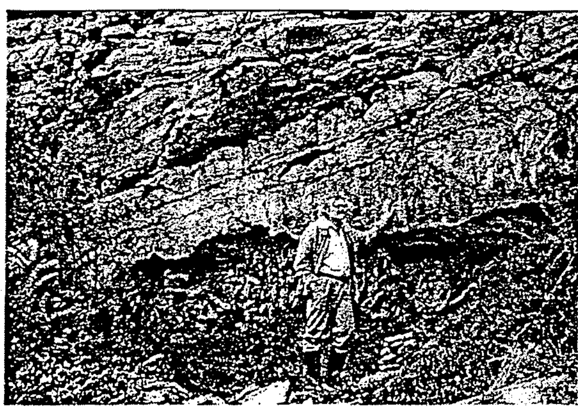


Figure 13. Irregular topography on sub-Onondaga Unconformity, overlying Upper Silurian Cobleskill-Akron Formation at Oaks Corners Quarry (south wall).

STOP 2. SENECA STONE QUARRY.

The classic Seneca Stone quarry exposes a succession of Lower to Middle Devonian strata from the upper part of the Manlius Limestone to the top of the Cherry Valley Member of the Oatka Creek Formation (Marcellus subgroup of Brett and Ver Straeten, 1994). Two prominent, north-directed thrust faults occur in the upper part of the Onondaga Formation within the quarry. One of the faults has been long known, and is visible in the east and west walls toward the south end of the quarry. An additional, recently exposed fault occurs in the northwest wall. The section at Seneca Stone is otherwise relatively undisturbed.

Fine-grained, micritic limestones of the Lower Devonian Manlius Formation (Olney Mbr.) of the Lochkovian Helderberg Group are found in a small sump pit in the bottom of the quarry, overlain unconformably by quartz arenites of the Lower Devonian Oriskany Formation (Pragian Tristates Group). The intervening break between the Olney, which is mid-Lochkovian, and the Oriskany, interpreted to be late Pragian represents on the order of four to six million years (based on Rickard, 1975 and new geochronologic dating by Tucker et al., 1998). This break represents the true Wallbridge Unconformity at the base of the Sloss's (1963) Kaskaskia Supersequence. Clasts of the older Manlius Limestone occur in the base of the Oriskany, sometimes overgrown by tabulate coral colonies. Small (cm-scale) undercut ledges of the Manlius may also be found at the unconformity, with the intervening space filled by quartz arenite (Figure 12a).

The Oriskany Formation is characterized by white quartz arenites that occur locally as pods or lenses across central New York. The spottiness of these occurrences is shown well within the base of the Seneca Stone quarry. Approximately 0.6 m of quartz sandstone is found near the central sump pit of the quarry; however, the whole unit pinches out a short distance to the south (visible in the quarry walls). The classic "big brachiopod community" of the Oriskany Formation is well shown in the sandstones at Seneca Stone quarry (Figure12b), with numerous large, robust brachiopods (including *Costispirifer arenosus*, *Rensselaeria*, and *Hipparionyx*), platyceratid gastropods, and favositid and rare rugose corals (Oliver and Hecht, 1994).

The Emsian-age, phosphate- and locally glauconite-rich sandstone strata noted at Auburn during the previous stop are absent at Seneca Stone quarry. They do appear, however, to be represented, as phosphatic-cemented sandstone clasts in a lag of reworked conglomeratic sands in the base of the Onondaga Formation (Figure 12c; sourced from the Springvale Mbr., as seen in situ at Stop 1). Based on the recent Devonian time scale revision of Tucker et al. (1998), the gap between basal Onondaga strata (uppermost Emsian) and the Oriskany Formation (upper Pragian) represents approximately 15 million years.

49.6	0.4	Return to the office of Seneca Stone Corporation and turn right (west) onto Seneca Co. Rte 121.49.90.3 Sharp right bend on Seneca Co. Rte. 121.
50.1	0.2	Sharp left bend on Seneca Co. Rte. 121.
50.7	0.6	Cross NY Rte. 414 and continue west.
51.4	0.7	Turn right (north) onto Disinger Rd.
53.3	1.9	Intersection with County House Rd. Jog slightly left (west) and proceed north on Kingdom Rd.
55.0	1.7	Turn left (west) onto Seneca Co. Rtes. 116/119.
55.6	0.6	Turn right (north) and cross over Seneca River.
55.7	0.1	Junction with NY Rtes. 5 and 414 and U.S. Rte. 20. Proceed straight through stoplight onto NY Rte. 414.
56.1	0.4	Turn left (west) onto Ballsley Rd.
56.4	0.3	Cross railroad tracks.
57.0	0.6	Intersection with Swift Rd. Proceed ahead on Ballsley Rd.
57.5	0.5	Intersection with Virginia Rd./NY Rte. 96. Proceed straight ahead onto Rte. 96.
61.7	4.2	Vegetable stand on left.
62.4	0.7	Fork left (almost straight ahead) onto Cross Road at right bend of NY Rte. 96.
62.8	0.4	Cross Town Line Rd. and enter Ontario Co.
63.4	0.6	Cross railroad tracks.
63.5	0.1	Cross NY Rte. 14.
64.5	1.0	Elderlee Sand and Gravel operation on right and 0.6 miles ahead.
65.3	0.8	Turn right onto Pre-Emption Rd./Ontario Co. Rte. 6.
65.4	0.1	Entrance to Oak Corners Quarry (owned and operated by Hanson Aggregates). Check in at office.
65.7	0.3	Proceed to the old south wall of the quarry

STOP 3: OAKS CORNERS QUARRY

The walls of the Oaks Corners quarry displays strata of the upper Silurian Akron Formation and the Lower to Middle Devonian Edgecliff, Nedrow, and part of the Moorehouse Members of the Onondaga Formation. The unconformity between Silurian and Devonian strata is well exposed in the quarry walls (Figure13), and commonly exhibits an irregular topography of small mounds and adjacent lows that are filled with basal Onondaga limestones or locally-occurring patches of quartz sandstone.

On the south wall at Oaks Corners, basal Onondaga strata of the Edgecliff Member generally rest directly on beds of the Upper Silurian Akron Formation, a massive, dark brownish buff-weathering saccharoidal dolostone. Thin, locally-occurring quartz arenite lenses occur in the quarry, as well as quartz-sandstone filled karstic cavities that extend down as far as the quarry floor (D. Woodrow, pers. commun.). The age of the sandstones (Oriskany, Bois Blanc, or reworked at the base of the Onondaga) is presently unresolved. In the absence of the sandstones, weathered pyritic crusts leave distinct rusty stains along the Akron-Onondaga contact. The unconformity is approximately six meters lower in the Silurian section four miles to the northwest (Rte. 88-Phelps cuts, Stop 4), where the unconformity surface is cut down to the level of the older Scajaquada Shale. At the Oaks Corners quarry, large channel-like depressions, up to several meters across and with a relief of up to one meter, occur along the unconformity.

Basal, chert-free beds of the Jamesville Quarry facies of the Edgecliff Member (Brett and Ver Straeten, 1994) occur within hollows on the combined Wallbridge, sub-Bois Blanc-Schoharie (?), and sub-Onondaga unconformities. These lowest Edgecliff strata comprise fine- to medium-grained crinoidal grainstone, typically pinkish-weathering, which range from 40 to 120 centimeters in thickness as a result of the irregular topography over the unconformity. Immediately overlying chert-rich strata (Clarence facies) consist of cherty, crinoidal pack- to wackestones. The remainder of the approximately 8.5 m-thick Edgecliff Member at the Oaks Corners quarry is dominated by the Clarence cherty facies, and consists predominantly of pale gray-weathering, micritic limestone with 20 to 30% dark gray chert.

66.0	0.3	Return to the quarry entrance and turn left (north) onto Pre-Emption Rd./Ontario Co. Rte. 6.
66.3	0.3	Town picnic park on left. **LUNCH STOP.**
66.4	0.1	After lunch, continue north on Pre-Emption Rd./Ontario Co. Rte. 6.
66.9	0.5	Turn left (west) onto NY Rte. 96.
68.9	2.0	Enter village of Phelps.
69.5	0.6	Cross over Flint Creek.
70.3	0.8	Turn right (north) onto NY Rte. 88.
70.7	0.4	Outcrops on both side of road of Edgecliff Mbr., Bois Blanc Fm., "Springvale Sandstone," Oriskany Fm., and Upper Silurian Scajaquada and Fiddlers Green Fms. Park along side of road.

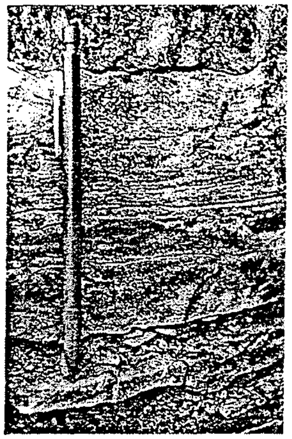
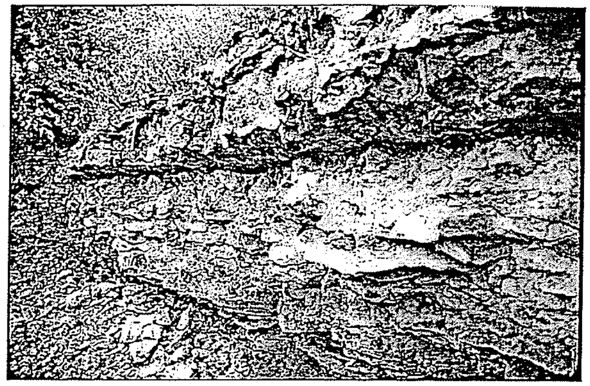
STOP 4: ROADCUTS ALONG NEW YORK RTE. 88, NORTH OF PHELPS.

Roadcuts along NY Route 88, immediately south of the New York State Thruway, display Upper Silurian strata of the Bertie Group (Pridolian, Scajaquada Formation) and Lower Devonian rocks interpreted here to represent the Emsian Bois Blanc Formation, a lateral equivalent of the Schoharie Formation of eastern New York.

Medium to slightly reddish-gray shales and argillaceous dolostones of the Scajaquada Formation characterize the lower part of the succession here and to the east along the Thruway. Small salt crystal casts may be found in the formation.

The Wallbridge Unconformity lies at the top of the Scajaquada Formation. The new Devonian time scale of Tucker et al. (1998) indicates that the unconformity between the Bois Blanc and the Scajaquada represents on the order of 16 million years.

The contact of the Scajaquada Formation with overlying Devonian strata is sharp. However, a record of unconformity-related processes is visible in the upper part of the Silurian strata. Thin fissure fillings of Oriskany quartz sand are seen to extend 30 to 40 centimeters downward below the upper surface of the Scajaquada Shale. The upper 10 -20 cm also show an indistinct mottled texture (Figure 14a), and the upper surface of the dolostone features common *Trypanites* hardground borings, infilled with quartz sands. The contact is overlain by a conglomeratic sandstone bed with pebbles to cobbles of dolostone, sandstone or phosphate (Figure 14b). Some of the clasts even show an interior core of dolostone that may be up to 2-3 cm thick, surrounded by 2-3 additional centimeters of lithified sandstone that may also feature a thin exterior rind of phosphate.

a.  b.  c. 

d. 

Figure 14a-d. Upper Silurian Scajaquada Formation and Lower Devonian (Emsian) Bois Blanc Formation, NY Rte. 88 cut at Phelps. a) Fine-grained dolostones of uppermost Scajaquada Formation capped by coarser sandstones of Bois Blanc (Springvale Mbr.). Note mottled texture of Scajaquada, with increasing disruption of primary layering up to the contact. b) Irregular contact of Scajaquada and Springvale, at pen on right and descending to left. Note reworked phosphatized pebble in sandstone bed. c) Strata of 1.45 m-thick Springvale Member above Scajaquada Formation. Contact on top of small ledge at bottom center of photo. d) Knobby, cherty, wacke- to packstones of upper carbonates of Bois Blanc Formation at Phelps roadcut.

Recent study of the Devonian strata at the Phelps cut indicates a distinct two-part lithologic subdivision: a lower, only slightly calcareous sand-rich unit (1.6 m-thick) and an upper carbonate interval above (4.2 m-thick). The character of the much of the outcrop, including lithology and fauna, appears strikingly different from the Edgecliff Member of the Onondaga Formation across the region. We interpret the outcrop to represent the easternmost known outlier of the Emsian-age Bois Blanc Formation in New York State. This is supported by Oliver's (1963) report of low exposures of cherty, micritic Bois Blanc limestones along the New York State Thruway near Phelps, 1.7 miles west of the Rte. 88 cut. Pending a revision of Emsian strata across the region, we assign the lower sand-rich unit to the "Springvale Member" of the Bois Blanc Formation, and the lower 2.9 m of the upper carbonates to an unnamed, upper member of the Bois Blanc.

The lower part of the Bois Blanc Formation ("Springvale Member") here is relatively sand-rich. Three subdivisions can be recognized, consisting of a lower coarse sandstone unit with a basal conglomerate-rich bed, overlain by finer-grained, knobby-bedded/nodular strata, with thin shaly drapes between layers (Figure 14c). Local lenses of "salt and pepper" quartz and phosphate sandstones occur at the contact of the lower and middle units. The upper unit is coarser-grained again, although still knobby-bedded. Irregular nodules of apparent phosphatic and/or cherty composition occur in both the middle and upper subunits of the sand-rich interval. Phosphate appears to be especially common in the middle, finer-grained unit, although it also commonly occurs as reworked concretions in the basal lag bed.

The upper sand-rich subunit features common fossils, including medium- to large-sized brachiopods, uncommon small rugose corals (one larger rugosan seen), cephalopods, and a conularid. Little to no crinoidal material is visible. Of interest is the appearance of large brachiopods, including a spiriferid, in the sand-rich facies of the Springvale. Similar large brachiopod assemblages are seen in the apparent Bois Blanc-Schoharie-age sandstone facies across central New York (e.g., Jamesville and vicinity).

Limestones comprise the succeeding 4.2 m of the section at Phelps. Much of the interval is characterized by relatively fine-grained, knobby-bedded, cherty limestones (Figure14d), with coarser-grained beds noted near the base and especially about a meter below the top. The lower to middle beds generally appear poorly- to non-fossiliferous, again excepting the basal bed and another approximately 1.2 m above the base of the carbonate section. Of note, the topmost bed on the east side of the road at Phelps is a relatively coarse limestone bed with scattered rugose corals. The presence of the corals, and the relative coarseness of the bed is similar to the lower part of the Edgecliff Member of the overlying Onondaga Formation across New York, and across the Appalachian Basin. On the west side of the road, it is overlain by two additional limestone beds. The upper of these features small, light gray chert nodules, analogous to the lowest occurrence of chert in the Edgecliff Member. We interpret the coral bed to represent the base of the Edgecliff Member. The horizon of the Bois Blanc-Edgecliff contact is not exposed well in the cuts; following the regional trends, we could project it to be unconformable.

Four miles to the southeast, at the previous stop (Oaks Corners quarry), basal strata of the Edgecliff Member directly overlie the Cobleskill-Akron Formation of the Upper Silurian. This is in sharp contrast to the cuts here at Route 88. Regional study shows an additional six meters of erosional truncation of Silurian strata here relative to Oaks Corners. This local topographic low appears to have provided accommodation space for deposition of the Bois Blanc, in addition to providing a shield against erosional truncation of Bois Blanc preserved in the low. The unconformity is approximately four to five meters higher in the Silurian section than at the Rte. 88 exposures (Stop 3), where the unconformity surface is cut down to the level of the older Scajaquada Shale. The geographic extent of the area of the low is not known, but Oliver's (1963) report of additional local exposure of the Bois Blanc indicates a feature of some extent. We project that the relatively deeper water, cherty non-fossiliferous carbonates and the finer-grained sand-rich unit of the Bois Blanc, along with the additional strata were deposited in a locally incised valley that developed during one or more of the sea level lowstands associated with the Wallbridge and sub-Bois Blanc unconformities.

70.7	0.0	Proceed ahead (north) on NY Rte. 88.
70.8	0.1	Overpass of New York State Thruway.
71.1	0.3	Turn around at broad driveway on right, just before McBurney Rd. Return south on NY Rte. 88.
71.8	0.7	Turn right and continue west on NY Rte. 96.
72.4	0.6	Outcrop of Nedrow Mbr. of Onondaga Fm. in bed and bank of Flint Creek, to left (south) of NY Rte. 96 (opposite ice cream shop).
72.9	0.5	Cross NY Rte. 448.
79.9	7.0	Turn right (north) onto NY Rte. 21.
80.0	0.1	Turn left and proceed to toll booth of NY State Thruway/I-90.
80.2	0.2	Fork to left and take NY State Thruway west towards Buffalo.
81.0	0.8	Merge onto NY State Thruway.
90.2	9.2	Seneca Service Area on NY State Thruway.
91.6	1.4	Exit ramp for I-490 to Rochester. Proceed ahead (west) on Thruway. Cross into Monroe Co. approximately 2.5 miles ahead.
102.9	11.3	Exit ramp for I-390 to Rochester. Proceed ahead (west) on Thruway.
107.0	4.1	Cross over Genesee River.
116.1	9.1	Ontario Service Area on NY State Thruway. Cross into Genesee County
119.0	2.9	Exit from of NY State Thruway at Exit 47/LeRoy.
119.4	0.4	Exit 47 toll booth. Pay toll and proceed ahead.
119.7	0.3	Exit to right to get to NY Rte. 19 and LeRoy.
120.1	0.4	Intersection with NY Rte. 19. Proceed straight ahead onto Rte. 19.
120.6	0.5	Cross over NY State Thruway.
121.0	0.4	Turn left (east) onto Parmalee Rd. Road will bend to right (south).
121.4	0.4	Turn left (east) on Oatka Trail Rd.
122.3	0.9	Turn right (south) onto Circular Hill Rd.
122.4	0.1	Cross over Oatka Creek.

122.6	0.2	Base of the Onondaga escarpment. Exposures of Upper Silurian strata on left (east) bank of road toward top of escarpment.
122.9	0.3	Top of Onondaga Escarpment.
123.7	0.8	Dolomite Products Corporation, Rochester Asphalt Products plant.
124.0	0.3	Turn left (east) onto Gulf Rd.
124.4	0.4	Pullover and view of abandoned quarry in Onondaga Fm. Top of Edgecliff Mbr. exposed in quarry floor; Nedrow and lower Moorehouse mbrs. form the quarry walls.
124.6	0.2	Bridge over abandoned quarry road. Upper part of Edgecliff Mbr. and Nedrow Mbr. exposed below bridge.
124.9	0.3	Dolomite Products Corporation quarry entrance on right; old quarry scoop shovel seen on left.
125.1	0.2	Front entrance to Neid Rd. quarry on left. Proceed ahead on Gulf Rd.
125.4	0.3	Turn left (north) onto Neid Rd.
125.7	0.3	Turn left (west) onto extension of Neid Rd.
125.8	0.1	Proceed to gate of abandoned Neid Rd. quarry and park. Walk ahead, following old quarry road and proceed down the ramp to the quarry road.

STOP 5. ABANDONED NEID ROAD QUARRY, EAST OF LEROY

This large abandoned quarry exposes Upper Silurian (Pridolian) strata of the Bertie Group and Cobleskill-Akron member of the Rondout Formation, and Lower Devonian (Emsian) strata of the Bois Blanc Formation and Edgecliff Member of the Onondaga Formation. Adjoining quarries along Gulf Road expose additional strata of the Edgecliff, Nedrow, and Moorehouse members of the Onondaga Limestone. At this stop we will focus our attention to the northeast corner of the quarry, examining relationships between the top Silurian, Bois Blanc, and basal Onondaga units.

One of the most significant features of the Neid Road quarry is the locally complex topography of Upper Silurian strata, which in one area features prominent knobby pinnacles and undercut cavities through the fine-grained dolostones. The overlying Devonian units are variously draped over the highs and settled into the cavities below. In addition, the Bois Blanc undergoes dramatic lithologic changes between a relatively low, level background topography and the adjacent highs, from relatively fine-grained, brachiopod wacke- to packstones to coarse, rubbly, coral- and crinoid-rich rudstones and grainstones.

The quarry is floored by thinly bedded dolostones of the Fiddlers Green Formation of the Bertie Group. Characteristic salt hopper casts are locally common in the formation. The overlying Scajaquada Formation is poorly exposed in the lower sides of the quarry walls and extends up into fine-grained waterlimes of the overlying Williamsville Formation. Across most of the quarry the Williamsville is erosionally truncated by a composite Wallbridge Unconformity; generally about 0.8 m of the unit remains below the erosional surface. The surface of the unconformity along most of the quarry wall is generally relatively planar, with local humps up to approximately a half meter high and a couple meters across. The uppermost dolostone layers show subtle features associated with unconformity development, including a weathered, spongy appearing appearance in the upper few centimeters, and sand-filled *Trypanites* hardground/rockground borings. Quartz sand-filled neptunian dikes are visible down to at least 0.7 m below the Silurian-Devonian contact locally.

Along the quarry walls on the east and west, the unconformity is overlain by the late Emsian (upper Lower Devonian) Bois Blanc Formation. Two divisions are recognizable in the Bois Blanc along the east wall (Figure 15a): a lower, recessive-weathering interval of argillaceous sandstone with reworked clasts, phosphate, and glauconite, and lensing, nodular limestones ("Springvale" Member); and a more resistant ledge of fossiliferous, fine- to medium-grained limestones (unnamed member).

The "Springvale" Member at the Neid Road quarry consists primarily of approximately 30 cm of argillaceous siltstone to sandstone (Figure 15b); the unit locally thins over low mounds on the Silurian and thickens in topographic lows. A yellow clay occurs locally at the contact. Different layers internal to the Springvale may feature reworked clasts of dolostone or phosphate, or even chertified favositid corals. Glauconite is present in some beds, along with a few meristellid and other brachiopods. A transitional cap to the Springvale comprises alternating lenses of fossiliferous micritic limestones and thin shales.

The upper (unnamed) limestone member of the Bois Blanc along the eastern wall (Figure 15a) consists of a ledge, approximately 0.8 to one meter thick, of relatively tabular, gray wacke- to packstones. The lower interval, generally weathering as two beds (ca. 30 cm-thick each) show a fauna of predominantly small to medium-size brachiopods with ambocoelids and a meristellid, along with platyceratid gastropods, and some small rugose corals. The upper bed features scattered medium-sized rugosans (*Heterophrentis* and a cystiphyllid) and medium to large brachiopods.

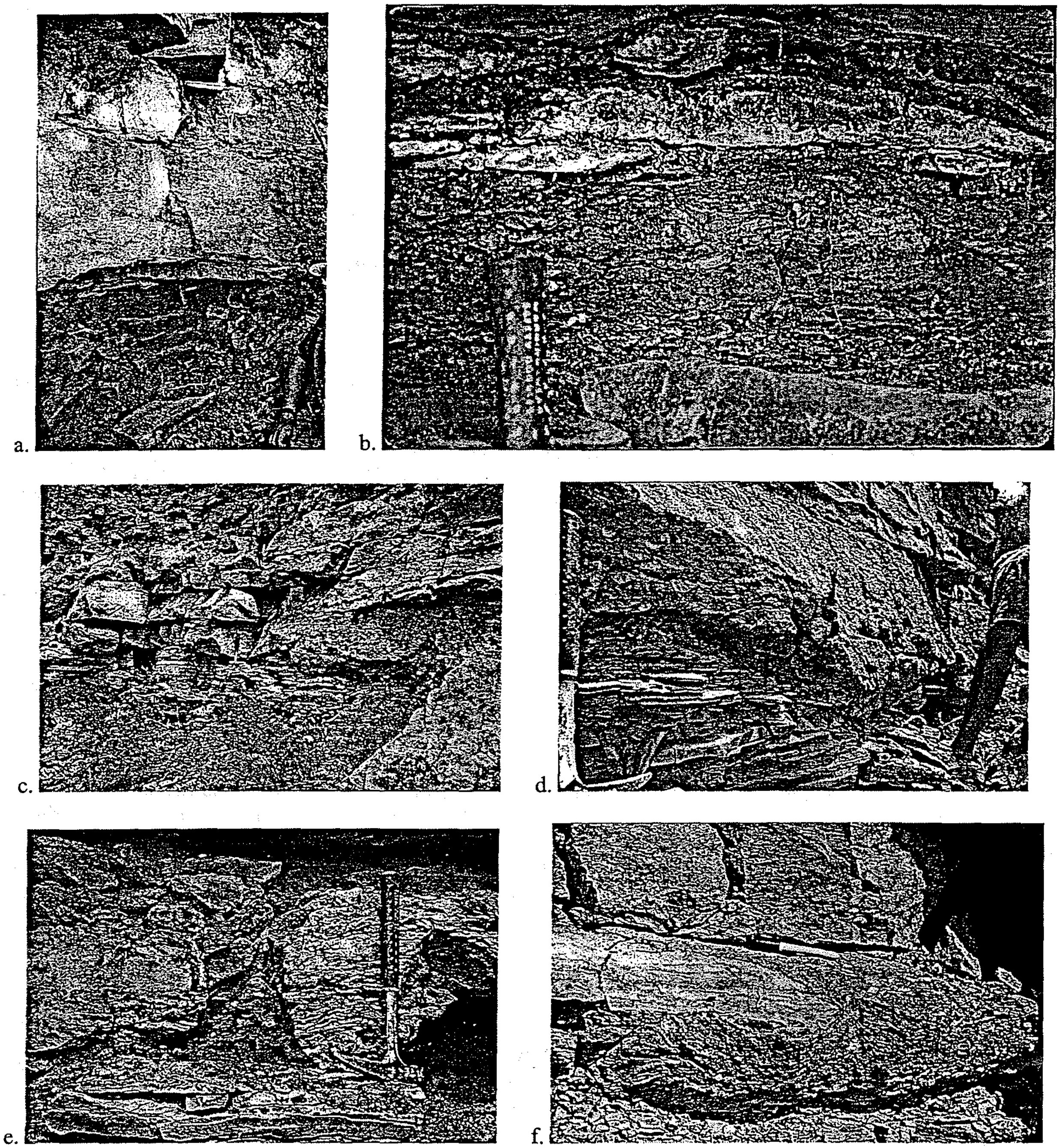


Figure 15a-f. Silurian-Devonian unconformities interval, Neid Road quarry, LeRoy. a) Topmost Bertie Group (Williamsville Fm.), Bois Blanc, and basal Onondaga formations on east wall of quarry. Hammers on sub-Bois Blanc unconformity, overlain by argillaceous, phosphatic Springvale Member. Upper Bois Blanc limestones extend up to horizontal field book (upper center). b) Detail of sub-Bois Blanc unconformity and Springvale Member on east wall. c) Mid-distance view of north quarry wall (east end), showing Williamsville, Bois Blanc, and Onondaga formations. Note irregular topography on sub-Bois Blanc unconformity. d) Close-up photo of center of previous photo, showing truncation of Silurian strata below Bois Blanc Formation. Note rough, coarse-grained rudstones of Bois Blanc carbonates on north wall relative to smoother-textured grainstones of basal Onondaga above (upper right). e) Close up of north wall at 17 meters of cross-section (Figure X of this paper), showing karstic cavity fill of apparent terra rosa soil within Silurian bedrock. f) Karstic fill of coarse-grained Bois Blanc limestone into cavities within fine-grained Williamsville dolostones, overlain by basal Edgecliff Member above pen.

Faunally and lithologically, the Bois Blanc limestones appear to represent relatively offshore, shelf-like facies, with a general coarsening-up/shallowing-up trend into the upper bed.

The top of the Bois Blanc is marked by an irregular topography and a thin crevice, which features a yellowish clay (< 1 cm-thick); the clay may represent a bentonite bed. A similar clay has been seen at the Bois Blanc-Onondaga contact in Ontario.

The contact is overlain by approximately 0.9 m of relatively coarse non-cherty grainstones (Jamesville Quarry facies) of the Edgecliff Member. The contact is relatively horizontal along the eastern wall, although it can be seen to rise subtly above the crests of the low paleobedrock mounds on the Silurian. The basal Jamesville Quarry facies of the Edgecliff is succeeded by a thick succession of Clarence chert-rich facies. The Edgecliff Member totals 12.9 m and is fully exposed in the Neid Road and adjacent Gulf Road quarries.

These patterns are representative of the Silurian and Lower Devonian transition zone around much of the Neid Road Quarry. However, immediately adjacent to the ramp road, in the northeast corner of the quarry, the stratigraphy becomes much more complex.

On the northeast wall we find some remnant topographic highs on the Silurian bedrock; localized knobs, or pinnacles, that extend at least 3 meters up above the normal, background topography of the Silurian bedrock (cross-section, Figure 8). In places the full 2.9 m of the Williamsville are preserved, with overlying Cobleskill/Akron Formation visible with its small, recrystallized corals. The paleotopographic highs, which may have functionally been "seastacks" along the Bois Blanc to Edgecliff coastlines, are locally undercut by cavities. The pinnacles, and isolated chunks of the Williamsville and Cobleskill/Akron that apparently attached back into the wall, stand surrounded by a matrix of Devonian strata. In a few places, thin, continuous fill of Bois Blanc is observed in elongate narrow cavities that are open at both ends. These various features may be due to karstification, or possibly be related to widening of joints (grikes) and physical cutting/erosion during sea level advance over a rocky coastline. Kobluk et al. (1977) reported etching over the Silurian bedrock that they interpreted to be associated with land plants, indicating subaerial exposure of the bedrock during lowstand events. They also reported indications of marine erosion processes, including bioerosive activity associated with *Trypanites* rockground borings. We have not at present identified plant related etchings. No borings were noted on the top surface of the Williamsville along the outcrop, away from the pinnacles. However, on some of the isolated pods that would have been standing above the sea floor and on the adjacent pinnacles, *Trypanites* borings are notable. In addition, to the west of the measured section, toward the far end of the "pinnacles outcrop (away from the ramp), a channel-like feature also occurs, infilled with Bois Blanc limestones.

Draped over this topography, across the lower parts of it, are coarse coral- and crinoid-rich rudstones with some grainstones (Figures 15c, 15d). This facies, which might generally be associated with the basal Edgecliff in New York, can be seen to grade laterally to the northwest and the southeast into the normal, generally brachiopod-rich wacke- to packstones, and even the basal muddy phosphatic sands and lenticular carbonates, of the Bois Blanc Formation. The coarse facies features a relatively diverse fauna, including a number of different solitary and colonial rugose corals, and *Pleurodictyum* and *Favosites* , along with abundant echinoderm debris, medium to large brachiopods, and rostroconchs. In places there is a finer-grained unit at the top, that locally even becomes shaly. A thin recessed interval of muddy, phosphatic sandstone to shales with glauconite also occurs locally at the bottom of the Bois Blanc on the northeast wall, and locally infills cavities, as seen at 17 m on the cross-section (cross-section Figure 8 and photo Figure 15e). The coarser, coral- and crinoid-rich facies can also be seen to infill around knobs and cavities in the underlying Silurian strata (Figure15f). The Bois Blanc ranges in thickness along the northeast wall from 0 to 72 cm, and terminates against the highest Silurian pinnacles/knobs.

Where the knobs stand above the top of the Bois Blanc, they are typically draped by the chert-free basal Edgecliff strata (Jamesville Quarry facies). However, in a few places the knobs stand up over the basal Edgecliff unit and are draped by cherty strata of the overlying Clarence facies of the Edgecliff. A distant view of the outcrop shows that the various lower Edgecliff layers appear to rise locally over the pinnacles.

Development of the coral-rich facies over the topographic high appears to be varied. Across the ramp road, approximately 100 m to the southeast, two thin wedges of coral-crinoidal rudstones pinch out locally into the thin limestones interval at the top of the lower, recessive Springvale unit. The lower part of the upper limestone ledge appears coarser than the upper part locally also. In the opposite direction, across a covered distance of more than 100 m, there appear to be three intervals of coarser, coral-rich facies, separated by finer-grained, almost calcisilt-type facies. So it appears that development of the coralline communities occurred repeatedly during deposition of the Bois Blanc Formation.

The abrupt changes in litho- and biofacies between the relatively deeper shelf, brachiopod-rich wacke- to packstones along the sidewalls of the quarry and the coarse rudstones of corals echinoderm debris of the pinnacles area imply a sharp ecological gradient locally during deposition of the Bois Blanc. A visible relief of approximately three meters in the quarry walls would not appear to account for enough depth change to support this gradient. It may be that the coral rudstone facies was developed either during relative lowstands of sea level, or that the positive topographic relief exposed in the quarry is only the margin of a more elevated feature that is developed back of the wall, or was destroyed during quarrying. The presence of tongues of rudstone to grainstone facies through a significant portion of the upper limestone ledge in the first outcrop to the northwest, and its presence in the top of the lower (Springvale) unit across the ramp road implies that a coral-rich community was developed locally during deposition of much of Bois Blanc. This appears to support a suggestion that a greater topographic high, not seen in the quarry wall, existed locally, and that coral bioherm communities, reflected here in off-reef debris aprons draping the topography, may have existed locally over the high during much of Bois Blanc deposition. Curiously, reef development did not continue above the sub-Onondaga unconformity, as reflected by the relative finer-grained and coral-poor grainstones of the basal Onondaga, which is well known for its local biohermal buildups.

This is also very interesting in light of recent work by Wolosz (1992) and Wolosz and Paquette (1988, 1994) on the nearby LeRoy Bioherm. They provide evidence that the lower core of the bioherm was subjected to extensive erosion prior to deposition of the upper cap of the feature. Recent regional to basinwide study of the Onondaga Formation indicates that the Edgecliff Member comprises two and a half medial-scale sea level cycles (parasequence sets). The erosion over the core could have occurred during one of the relative lowstands of sea level within the Edgecliff. However, in light of the discovery of Bois Blanc biohermal facies locally, another possibility is that the dark-colored, fine-grained, *Cladopora*-rich core of the reef also could be Bois Blanc. Oliver (pers. commun., 8/00) states that Cladopora is a long-ranging Silurian-Devonian form; its presence in the lower part of the bioherm does not necessarily indicate an Edgecliff age. The diagenetic character of the partially-silicified Cladoporids, unique among Edgecliff reefs (Wolosz and Paquette, 1994), is also consistent with the high degree of silicification of fossils in the Bois Blanc in western New York (Boucot and Johnson, 1968). Reworked clasts of Cladoporid mound facies and otherwise absent lithologies in the base of the overlying biohermal unit and in fissure fills cut down into the inner reef core reported by Wolosz and Paquette (1994) appear to indicate a relatively significant break, consistent with exposure and erosion at a sequence-bounding unconformity. It is possible, then, that the erosion surface within the LeRoy Bioherm may actually represent the sub-Onondaga unconformity, and that the inner reef core is Bois Blanc in age, as tentatively suggested by Wolosz (1988).

END OF TRIP. To return to Hobart and William Smith Colleges, backtrack to the NY State Thruway and follow it eastward toward Albany. Get off at Exit 42 and proceed south on NY Rte. 14 to Geneva. Follow signs to Hobart and William Smith Colleges.