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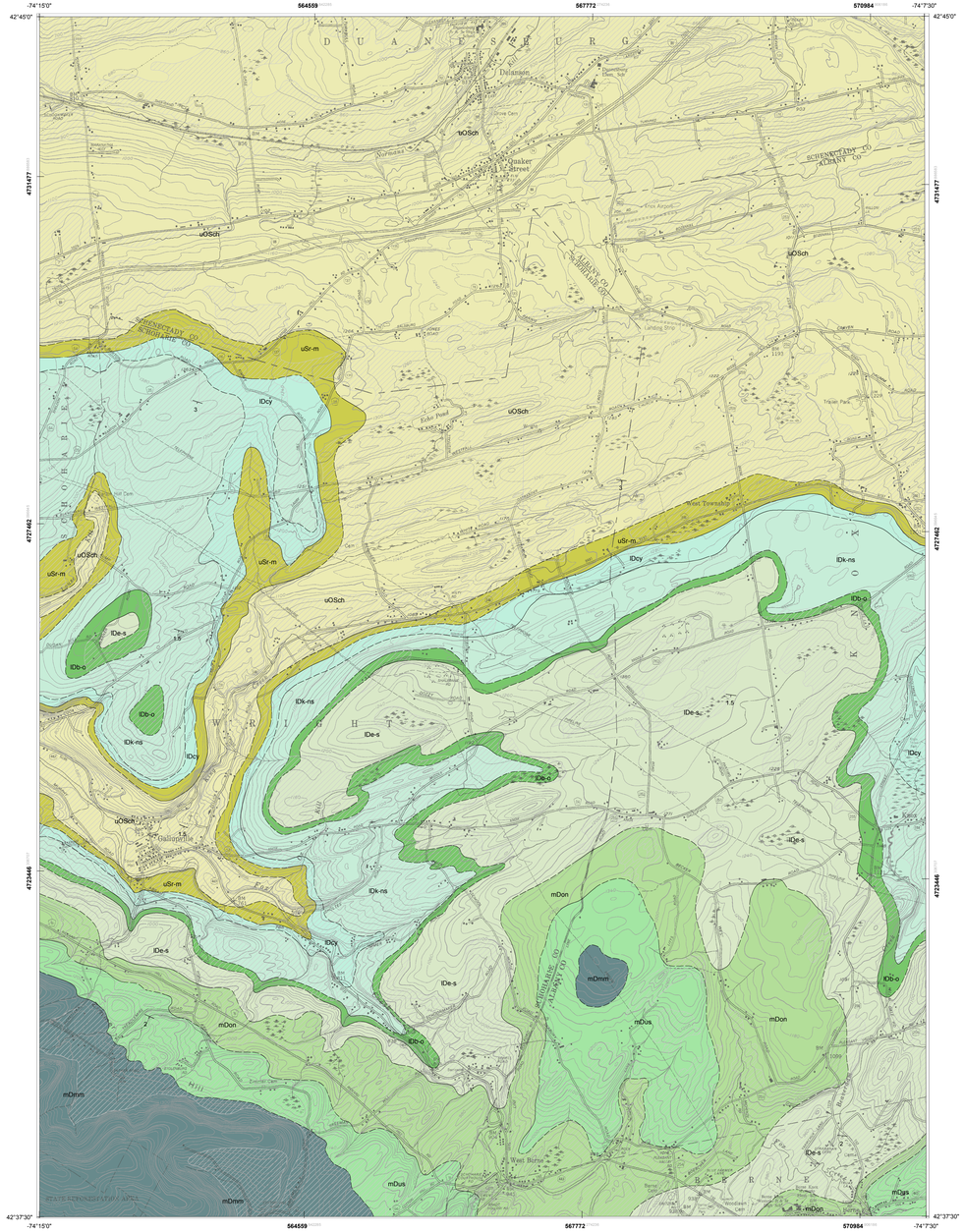
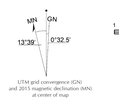
New York State Geological Survey



Universal Transverse Mercator, Zone 18 N
North American Datum of 1983

Hygrology and planimetry layers from the New York State DOT Raster Quadrangle separates for Gallupville 7½ minute quad; DOT edition date 1993, USGS contour date 1944

Topographic map symbols can be found at http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf
Magnetic declination from the NOAA online Declination Calculator: http://www.ngdc.noaa.gov/geomag-web/#declination



UTM grid convergence (GN) and 2015 magnetic declination (MN) at center of map

Scale 1:24 000
1 0 1 Miles
1 0.5 0 1 Kilometers
Contour interval 20 feet

Geologic mapping by Stander, E.J., Ver Straeten, C., Engel, T.D., and Stander, J. 2014
Digital data and cartography, B. Bird, 2015

BEDROCK GEOLOGY OF THE GALLUPVILLE QUADRANGLE, ALBANY, SCHOHARIE and SCHENECTADY COUNTIES, NEW YORK

Edward J. Stander, Charles Ver Straeten, Thomas D. Engel and Jonathan Stander

2014

BEDROCK GEOLOGY OF THE ALTAMONT 7.5 MINUTE QUADRANGLE: AN OVERVIEW

Bedrock on the Gallupville 7.5 minute quadrangle is represented by diverse sedimentary rocks of Ordovician, Silurian and Devonian age. A total of sixteen distinct rock formations stretch across the quadrangle in three major east-west trending belts – a central belt largely composed of limestone bounded to the north and south by a mix of shale and sandstone.

The rock strata on the Gallupville quadrangle formed over a period of approximately 60 million years, extending from approximately 450 to 388 million years before the present (i.e. the Ordovician, Silurian and Devonian Periods). They were deposited in a relatively shallow marine sea that flooded New York and, at times, much of eastern North America. While some units (such as the Rondout - Manlius sequence) display features indicative of deposition within the range of low to high tides, others suggest a maximum depth of deposition on the order of a few hundred feet. Most were deposited in environments similar to the modern continental shelf, from a few to several tens of feet deep. On two occasions, marine waters withdrew from the region for several millions years, leading to the formation of major erosion surfaces (or disconformities). The longer of these erosional breaks occurs between the Ordovician Schenectady Formation and overlying Silurian strata; the lesser break occurs at the contact of the Lower Devonian Becraft or Alsen and Oriskany formations.

Fossil shells of marine life occur in varying abundance and diversity in the rocks on the Gallupville Quadrangle. They are more common in the limestones, and in the Oriskany Sandstone. Common fossils include brachiopod shells and crinoid fragments, with occasional corals and gastropods (snails), and rare trilobite pieces. The types of fossils present in the rock units provide information about the environments they lived in (including water depth, salinity, climate).

Various bedrock units were quarried on the Gallupville Quadrangle in the past, and some continue to provide useful materials today. Small, abandoned quarries occur scattered across the limestone belt. Uses included stone blocks for building homes and chimneys and for foundations for homes and barns. At least two old lime kilns were found during mapping, along the northern edge of the limestone belt. Historically, these provided the raw materials needed to produce masonry cement and agricultural lime. The Esopus Formation continues to be mined locally for crushed rock gravel on roads and driveways.

Previous geological studies of the Gallupville 7.5' quadrangle include Goldring (1935), Johnsen (1958), and Rickard (1962).

QUATERNARY

Q

Quaternary (Q) material
Undifferentiated Quaternary material of variable thickness. Estimated distribution is based upon examination of digital elevation models (DEMs), topographic lines and field examination. Determination north to east of line on shaded relief map based on DEM with 2 meter resolution and field data. Determination south and west of the line (area of "10 meter resolution") based on topographic lines and field data. This difference in resolution affects the accuracy of the cover distribution. Note that bedrock may locally occur in areas mapped as predominantly Quaternary sediment cover, and visa versa.

MARCELLUS SUBGROUP
In eastern New York, strata sometimes known as the Marcellus "shale" are divided into two formations; a lower Union Springs and upper Mount Marion Formations. Classic black to dark gray shales, typical of the Marcellus subgroup in central to western New York, only occur in the lower part of the Marcellus strata in eastern New York (Bakoven Member of the Union Springs Formation). Succeeding higher Marcellus strata are composed largely of dark gray shales, siltstones and sandstones, with an overall increase in sandstone upward.

mDmm

MOUNT MARION FORMATION (mDmm: = upper part of Marcellus subgroup)
Dark-gray to gray shales and mudstones, and gray to brown siltstones and sandstones, with a few thin limestones (Hurley and Cherry Valley Members) at the base. Marine fossils often occur in distinct layers separated by of poorly- to non-fossiliferous strata. Overall, the percentage of sand in the rocks increases upward through the formation. An unknown amount of the formation occurs in the southwest corner of the Gallupville quadrangle. The Mount Marion Formation represents intermediate depth to shallow marine environments (from perhaps a few hundred feet at most, to the shoreline at sea level).

Five members of the Mount Marion Formation occur on the Gallupville quadrangle. From low to high, they are the Hurley, Cherry Valley, East Berne, Otsego and unnamed upper members.
Hurley Member. Limestone, shale and minor silt- to sandstone. Approximately one to two feet thick (0.3 to 0.6 meters). Thin, fossiliferous limestones and a thin sandstone separated by shales of varying thicknesses.
East Berne Member. Dark-gray shale and mudstone, with minor thin sandstone beds through the member and a thick sandstone at the top. Member marked by distinct basal and top contacts, above Cherry Valley Limestone, and below the overlying Halihan Hill Bed (see below). The unit is found only in the southwest corner of the Gallupville quadrangle. Its thickness is unknown.
Otsego Member. Shale and sandstone, with an overall increase in the percent sandstone upward through the member. The base of the Otsego, which was not located in the field, is a distinct, relatively fossiliferous bed with rugose ("horn") corals, brachiopods and other fauna (Halihan Hill Bed of Ver Straeten, 1994).
Unnamed upper member. Undifferentiated sandstone-dominated strata. These strata occur in the upper elevations in the southwest corner of the Gallupville Quadrangle

mDus

UNION SPRINGS FORMATION (mDus: = lower part of Marcellus subgroup)
Dominantly black to dark-gray shales and mudstones, with some thin impure limestone layers. Strata are generally non-fossiliferous to poorly fossiliferous, with straight and coiled cephalopods, very small conical shells (styliolinids, dacryoconarids), and some small brachiopods and bivalves. The base of the Union Springs Formation, at the contact with the underlying Onondaga Limestone, was not found on the quadrangle. During the Middle Devonian, Union Springs sediments are interpreted to have been deposited in deeper, more basinal environments, perhaps a couple to few hundred feet deep.

Only one member of the Union Springs Formation is found on the Gallupville quadrangle, the Bakoven Member.
Bakoven Member: Organic-rich black to dark-gray shales and mudstones, with thin, minor limestone beds and limestone concretions. Generally non-fossiliferous to poorly fossiliferous; fossils consist largely of shelled animals that lived up in the water column, not on the sea floor (e.g., straight and coiled cephalopods, and styliolinids/dacryoconarids). The Bakoven Member is approximately 90 feet (27 meters) thick south of Gallupville, near the southwest corner of the quadrangle. This represents a thinning of roughly 30 feet (9 meters) from the eastern edge of the adjacent Altamont quadrangle, perhaps in part associated with facies change from less compacted, calcareous strata of the Stony Hollow Member there. Thinning could also be related to decreased sedimentation toward the basin center, and/or less repetition of Bakoven strata associated with deformational thrust faulting, perhaps more prevalent to the east.

mDon

ONONDAGA FORMATION (mDon)
Light-colored, fossiliferous, coarse- to fine-grained limestones (grainstones, packstones and wackestones), with chert in some intervals. The relatively hard, resistant limestones of the Onondaga Formation commonly form ledges and sometimes cliffs and escarpments (as on the Altamont quadrangle to the east). The formation forms the bedrock across a broad area the southern portion of the Gallupville quad. On the east, it from Becker Road, then extends northwestward to the south side of Knox-Gallupville Road before heading south-southwestward across Line Road, extending southward to the village of Berne and the area south of Rickard Hill Road, where it then is overlain by black shales of the Union Springs Formation (Bakoven Member). The base of the formation is indicated by limestone directly overlying fossiliferous sandstone of the Schoharie Formation.

A nearly complete section of the Onondaga Limestone is found in a creek bed south of Gallupville indicates a total thickness of 90 to 100 feet. On the adjacent Altamont Quadrangle to the east, Oliver (1956) reported a minimum thickness of 110 feet (33.5 meters) for the Onondaga Limestone locally, in contrast with Goldring and Cook's (1935) report of 85 to 100 feet (26 to 30 meters).

Chert (sometimes called "flint") is common in some parts of Onondaga Formation, absent in others. It occurs as layers or irregularly-shaped nodules. In lower parts of the formation the chert is light gray, but dark gray in upper strata. Three members of the Onondaga (Edgecliff, Nedrow and Moorehouse Members, low to high) occur in the Helderbergs region, but are not distinguished on the map. Common corals in basal limestones locally developed into a reef mound with abundant corals. Thin clay layers at some levels are the altered remnants of volcanic ash, erupted from Middle Devonian volcanoes in the Appalachians. One of these altered volcanic ash layers in the upper Onondaga Limestone, absent in the Helderbergs, has been dated at 390.0 +/- 0.5 million years old (Roden et al., 1990). Sediments of the Onondaga Formation were deposited in a variety of water depths in a shallow sea (e.g., mid-ramp to shoal type environments), similar to depths found on today's mid-continental shelf to a shallow shoal, where day-to-day waves crash against the sea floor.

MIDDLE DEVONIAN

lDe-s

ESOPUS and SCHOHARIE FORMATIONS (lDe-s)
On the Gallupville quadrangle, the Esopus and Schoharie formations (below and above, respectively) were mapped as one unit. Poor exposure of the formations did not permit measuring their total thickness. Two coarse measurements south of Gallupville, based on GPS barometric pressure-derived changes in elevation, yielded estimated thicknesses of approximately 90 and 105 feet (approximately 27 and 32 meters). On the Altamont quadrangle to the east, combined thickness of the two formations is approximately 120 feet thick (37 meters), at sites where the strata do not appear strongly deformed.
Schoharie Formation. Clayey sandstones, siliceous shales and highly fossiliferous sandstones characterize the Schoharie Formation in the Helderbergs. In contrast with the formation in the Hudson Valley, only the upper part of the Schoharie Formation in the Helderbergs is calcareous. Strata in some intervals are deformed by folds and thrust faults. Water depths varied some during deposition of the Schoharie Formation, largely in mid- to inner shelf type settings, but shallowing to shoal type environments at the top of the formation.
Esopus Formation. Clayey siltstones and sandstones, and dark gray shale to mudstones compose most of the Esopus Formation. Minor chert and thin clay layers occur low in the formation. Layering (bedding) is generally difficult to distinguish, due to extensive burrowing of the sediment by animals (e.g., worms, clams). Shelly fossils are rare. Strata are not uncommonly deformed by folds and thrust faults. Up to 15 thin clay layers in lowest strata of the Esopus Formation (Sprout Brook K-bentonites) are the altered remnants of volcanic ash, erupted from Lower Devonian volcanoes in the Appalachians. Two of these altered volcanic ash layers have been dated at 408.3 +/-1.9 million years old (Tucker et al., 1998). Water depths varied some during deposition of the Esopus Formation, in mid- to outer shelf-type environments.

EARLY DEVONIAN

ORISKANY, ALSEN AND BECRAFT FORMATIONS (lDk-o)

lDk-o

Oriskany Formation. Quartz sandstone, often fossiliferous, and cemented by silica (quartz). The unit is quickly recognized by abundant, large brachiopod shell fossils in some parts of the unit; the shells themselves are sometimes dissolved away. In the Helderberg region, the attractiveness of the highly fossiliferous rock has long made it a prized building stone, seen in fireplaces, chimneys, and other decorative stonework.

The Oriskany Sandstone is a thin unit (measured locally at 2.5 feet-0.7 meters-thick), often fossiliferous, and very hard and resistant. The top of the Oriskany sometimes forms a wide flat surface across the landscape, where overall softer, less resistant strata of the lower part of the Esopus Formation was stripped away by glacial ice prior to about 16,000 years ago.

Few outcrops of the Oriskany Sandstone were located on the Gallupville quadrangle. South of Gallupville, 2.5 feet of Oriskany was measure; the contact with the overlying Esopus formation was covered. On the adjacent Altamont quadrangle the thickness of the Oriskany Sandstone varied, between one and four feet (1.2 to 0.3 meters). The Oriskany Sandstone unconformably overlies older strata of the Alsen or Becraft Limestone Formations, formed during a major drop in sea level, and withdrawal of marine waters, for a few to several million years.

Fossils in the formation include numerous brachiopods and other shelly forms of the Oriskany "big brachiopod" fauna. The sandy sediments of the Oriskany Formation were originally deposited in shallow marine, shoal-type environments, where waves contacted the sea floor on a day-to-day basis.
Alsen Formation. Fossiliferous, gray, medium-grained, bedded cherty limestones, present locally on the western half of the Gallupville quadrangle. This unit, found extensively in outcrops from central Albany to Ulster counties and beyond to Port Jervis (Orange Co.), is present to absent across western Albany and eastern Schoharie counties, below a sub-Oriskany erosion surface (Rickard, 1962). Thickness on the quadrangle ranges from zero to eight feet (0 to 2.4 meters). The Alsen Formation is not found west of the Cobleskill area. Overall, the character of the rock is similar to the older Kalkberg Formation (see below). The Alsen Formation was originally deposited in shallow ramp environments similar to the inner continental shelf.
Becraft Formation. Light-colored, relatively coarse-grained limestone, composed largely of complete to broken shell material, chiefly fragments of crinoids. Rickard (1962) reported 12 to 18 feet (3.7 to 5.5 meters) of Becraft Limestone on the Gallupville Quadrangle; Goldring (1935) reported 15 feet (4.6 meters) along Fox Creek and a roadside quarry along New York Route 443 northwest of West Berne. These thickness agree with general trends found during mapping across the Gallupville quad.

The lower contact of the Becraft Formation with the underlying New Scotland Formation is gradational. The number of different fossil species in the Becraft is much less than in the New Scotland; however, the Becraft is often a relatively pure mass of whole and fragmented fossil shells, unlike the underlying New Scotland Formation. Fossils in the Becraft Formation largely consist of abundant crinoid fragments and several different species of brachiopods. The most diagnostic fossil of the Becraft Limestone is a shallow bowl-like fossil on the order of an inch (2 cm) across. Similar to the Coeymans Limestone below and the Oriskany Sandstone above, sediments of the Becraft Limestone were deposited in shallow, shoal type environments, where day-to-day waves brushed the sea floor, but also where at times tidal currents moved sediments about.

While not pervasive through the unit, some outcrops of Becraft Limestone in the Helderbergs feature chert. Chert is not generally found in the Becraft Formation in eastern New York. The chert may occur in paleokarst cavities, which formed when sea level fell and the region became land for a time.

lDk-ns

KALKBERG AND NEW SCOTLAND FORMATIONS (lDk-ns)
The Kalkberg and New Scotland formations (lower and higher, respectively) are mapped together on the Gallupville quadrangle, in part because their contact is both gradational and often covered by surficial sediments. On the western edge of the quadrangle, south of Gallupville, the two formations total about 110 feet (33.5 meters; Rickard, 1962). At Thacher State Park, on the adjacent Altamont quadrangle to the east, Rickard measured about 115 feet (35 meters). Several thin clay layers in the two formations are altered remnants of volcanic ash deposits (Bald Hill K-bentonites), erupted from Lower Devonian volcanoes in the Appalachians. One of these altered volcanic ash layers was dated at 417.6 +/-1.0 million years old (Tucker et al., 1998).
New Scotland Formation. Fine-grained limestones and calcareous shales and mudstones, with occasional chert nodules. Strata are generally thin-bedded; limestones and shales commonly interlayered. Limestones are generally have a high clay content. Strata are often fossiliferous, with relatively high diversity of varied types of fossils. The lower contact of the New Scotland with the underlying Kalkberg is gradational; the New Scotland is distinguished from the latter by more shaly strata, and a more diverse group of fossils. The contact of the New Scotland with the overlying Becraft Limestone is also gradational. Upper New Scotland strata are less muddy, and the limestone layers become thicker and coarser-grained upward, appearing increasingly like the Becraft Limestone above. Fossils in the New Scotland (over 100 species reported in the region) include diverse brachiopods, along with bryozoans, corals, gastropods, and other fossils including rare trilobites. Rickard (1962) reports a thickness of 65 feet (19.8 meters) south of Gallupville, and 66 feet (20 meters) for the New Scotland Formation eastward off the quadrangle at Thacher State Park. At Thacher Park, the unit is locally deformed by folds and thrust faults. No faults were noted on the Gallupville quadrangle; however much of the unit is rarely exposed here, and some structure may be present. Sediments of the New Scotland were deposited in deep ramp-type environments, roughly similar to environments on the mid- to outer continental shelf.
Kalkberg Formation. Fossiliferous, medium-grained limestones, with coarser- and finer-grained beds and minor shale/mudstone. Thin- to medium-bedded layering. On fresh surfaces, the Kalkberg Limestone appears darker gray than the underlying Coeymans Limestone, but often weathers to a buff-tan color. Some dark gray chert also present, generally as nodules. The lower contact with the Coeymans Formation is somewhat gradational, indicated by a change to finer-grained strata and more diverse and abundant fossils. These include various brachiopods, bryozoans, and small rugose corals. Rickard (1962) reports 45 feet (15 meters) for the Kalkberg Limestone at on the Gallupville quadrangle. The Kalkberg Formation was originally deposited in shallow ramp environments similar to the inner continental shelf.

lDcy

COEYMANS FORMATION (lDcy)
Bluish-gray to light gray, coarse-grained limestones (grainstones to packstones). Thick to massive-bedded, with poorly developed layering. The Coeymans Limestone commonly forms a very resistant ledge, best seen capping the cliffs along the Helderberg Escarpment at John Boyd Thacher State Park. Though less pronounced, it also forms ledges and waterfalls across the Gallupville quadrangle. The lower contact with the Manlius Limestone is marked by a change to coarser-grained limestone, and is erosional. The Coeymans Formation is relatively fossiliferous, including common crinoid fragments, with brachiopods and scattered mound-like colonial "honeycomb" corals (*Favosites helderbergiae*). The brachiopod *Costispirifer coeymansensis* is an index fossil for the Coeymans Limestone; it does, however, also extend up into lower strata of the Kalkberg Formation above. Rickard (1962) reported 50 feet (15.2 meters) of Coeymans Limestone near Gallupville, thinning to45 feet (13.6 meters) eastward across the Gallupville quadrangle. The rocks were originally deposited in 'shoal'-type environments, where day-to-day waves continually impacted against the sea floor.

uSm

LATE SILURIAN PERIOD
MANLIUS AND RONDOUT FORMATIONS (uSr-m)

Manlius Formation (Thacher, Green Vedder and Dayville Members)
Generally light gray-colored, fine-grained limestones (micrite, wackestone), with buff to yellow weathering dolostone intervals, and reef layers of stromatoporoid sponges. The Manlius Formation forms the bulk of the lower portion of the Helderberg escarpment cliffs, well seen along the Indian Ladder Trail at Thacher State Park. The thinly-laminated dolostones are most notable in the recessed "upper bear path" in the cliffs at Thacher State Park. No complete section of the Manlius Limestone was measured on the Gallupville quadrangle. Rickard (1962) estimates about 45 feet (13.7 meters) for the formation around Gallupville, thickening slightly eastward. Over the quadrangle boundary to the east, the Manlius Limestone is 52 feet (15.8 meters) thick at Thacher State Park (Rickard, 1962). West of the Gallupville quadrangle, along Interstate I-88 west of the Scholharie exit, Dr. James Ebert (pers. commun., 9/9/14) interprets the Manlius to total 45.5 to 48.2 feet (13.9 to 14.7 meters) in thickness; with three members of the Manlius present (Thacher, Green Vedder and Dayville members, low to high).

The Manlius Formation was deposited in tidal environments on the margin of the Devonian seaway, between just above to a little below low tides. Stromatoporoid reefs, indicated by chaotic-appearing layering in the middle to upper Manlius Formation, formed in shallow depths slightly below low tide.
Rondout Formation (Chrysler and Cobleskill Members: +/- Brayman Formation)
Late Silurian dolostones, limestones and shales, approaching 50 feet (15.2 meters) in thickness on the west margin of the Gallupville quadrangle. The Rondout Formation thins to approximately 5 feet (1.5 meters) on the eastern edge of the adjacent Altamont quadrangle, due to progressive pinching out of lower strata, which also takes away the entire underlying Brayman Formation (Rickard 1962). Rickard also reported an exposure of the lower Chrysler, complete Cobleskill, and uppermost Brayman members south of Gallupville. During fieldwork in 2014, loose cobbles and boulders of Rondout were visible in Kings Creek northeast of Gallupville. But only one outcrop, partially exposing the strata, was found on the Gallupville Quadrangle in 2014. This outcrop is the same one reported by Rickard (1962), on the west side of NY Rte. 146, ca. 0.5 miles northeast of Gallupville (on private property). The exposure is in the bed of a small stream that issues from close to the base of the Manlius Formation.
Rondout Formation, Chrysler Member. Non-fossiliferous, fine-grained, blue to yellowish-brown dolostone, limestone and shale, locally with greenish-gray sandy, pyritic shale in its lower part. Rickard (1962) reported 20 to 25 feet (6.1 to 7.6 meters) of Chrysler Member on the Gallupville quadrangle. Much of the Chrysler Member is exposed in the outcrop northeast of Gallupville. The Chrysler Member was chiefly deposited in supratidal environments, just above high tides.
Rondout Formation, Cobleskill Member. Fossiliferous thick to thin bedded limestone, with a diverse group of fossil brachiopods, gastropods, stromatoporoid sponges, corals, estracodes, and others. Uppermost beds become somewhat dolomitic (Rickard 1962). The upper contact, with the Rondout Formation, was placed by Rickard (1962) at the disappearance of fossils and a change to more shaly, dolomitic strata. Rickard reports nine feet (2.7 meters) of Cobleskill Limestone on the Schoharie Quadrangle immediately to the west; His Figure 2 indicates a similar thickness on the west side of the Gallupville quadrangle, pinching out to zero on the east margin of the quadrangle. A slightly tilted, out of place block of the Cobleskill was seen at the outcrop northeast of Gallupville. It appeared to have slid downslope perhaps 10 -15 feet (3.0 to 4.6 meters), possibly over the Brayman Shale (covered at this locality). A layer of black chert occurred with the other rock lithologies listed above. The Cobleskill Limestone was deposited in shallow, subtidal marine waters.
Brayman Formation. Non-fossiliferous, very pyrite-rich greenish-gray shales to dolostones, interpreted by Rickard (1962) to be absent east of Gallupville. At Gallupville, Rickard (1962) reported 17 feet (5.2 meters) of Brayman Formation. He reported no other outcrops of Brayman Shale on the Gallupville quadrangle, and none were found by the authors in 2014. Older reports of shale termed Brayman Formation east of this quadrangle (e.g., Ruedemann, 1912; Goldring, 1933, 1935) were discounted by Rickard (1962), and placed in the Rondout Formation. New investigations are examining this issue.

LATE SILURIAN

uOSch

LATE ORDOVICIAN PERIOD
SCHENECTADY FORMATION (uOsch)
Sandstones and black to gray sandy to clay-rich shales, thin to massive layered, and commonly interbedded. The proportion of sandstone to shale varies vertically through the formation. Goldring (1935) estimated 1800 to 2000 feet (548 to 610 meters) for the Schenectady Formation on the adjacent Altamont quadrangle, succeeded by 410 feet (125 meters) of strata assigned to the "Indian Ladder Beds", for a total of up to nearly 2400 feet (731 meters). Goldring, however, only reported the Indian Ladder Beds on the Altamont Quadrangle, to the east of this map. The Schenectady Formation is interpreted to represent relatively deep water, foreland basin turbidite slope-type environments.

LATE ORDOVICIAN

EXPLANATION

OVERVIEW: STRUCTURAL GEOLOGY OF THE GALLUPVILLE QUADRANGLE

Structurally, the sedimentary rocks of the Gallupville quadrangle dip gently to the south-southwest. Dip angle is on the order of 2-4 degrees, with the steepest dips found at the edges of the central limestone belt. The units of the quadrangle are further deformed by an extremely broad anticlinal structure across the mapped area which plunges shallowly to the south. This structure is most likely of Late Paleozoic age, and probably formed during the closing stages of the Appalachian Orogen.

Large scale brittle deformational features, such as faults, were noticeably rarer here than on the adjacent Altamont Quadrangle to the east. A thrust fault is reported at depth within Schoharie Caverns, near the west edge of the quadrangle, with a strike approximating west-northwest. Additional thrust faults occur in black shales of the Bakoven Member (Union Springs Formation) in the southern part of the Gallupville Quadrangle.

Smaller scale fractures, commonly referred to as joints, were observed over the entire quadrangle, and generally share a roughly south-southwest to north-northeast orientation. In the limestone belt, these joints are often solutionally widened by slightly acidic surficial waters, leading to the formation of caves and surficial karst features.

OVERVIEW: KARST ON THE GALLUPVILLE QUADRANGLE

Karst is a landform created by the dissolving of the underlying bedrock, generally limestone. Evidence of karst includes the presence of caves, sinkholes, disappearing streams, solutionally-enlarged joints, and springs; and by the general absence of surface streams.

On the Gallupville quadrangle karst is found in the Kalkberg, Coeymans, and Manlius Limestones; the Becraft Limestone; and the Onondaga Limestone. The longest caves are found in the Coeymans and Manlius, but considerable karst is found in all listed limestone units.

The longest known cave on the quadrangle is about five miles long. Other caves include Knox Cave, open only by written permission, and Schoharie Caverns, a former commercial cave. (Check with the landowner before visiting.) The most easily visible sinkhole is Lodens Sink next to Middle Rd. Water sinking here has been dye-traced to Bogardus Spring, about 1.6 miles (2.6 km) to the south-southeast, near Fox Creek.

Due to valley infilling with quaternary sediments (e.g., glacial and stream sediments; = QAL), some caves in the eastern part of the quad show maze development from back flooding as the result of inefficient drains.

Flowstone deposits from Schoharie Caverns exceeded the limits of the U-Th dating method at 350,000 year BP. This suggests a minimum age for the down-cutting of the Fox & Schoharie Creek valleys.

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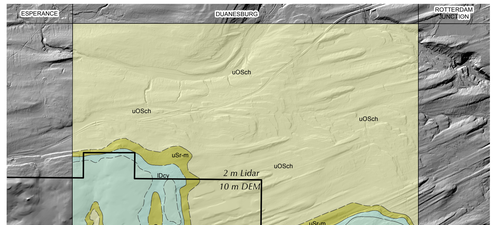
[1] NOTE: Older New York State Museum publications are available as free downloads at http://www.nysm.nysed.gov/publications/bulletin/index.html.

GEOLOGIC SYMBOLS

Contact, definite
Contact, inferred
Contact, approximate
Limit of Quaternary cover

SHADED TERRAIN MAP AND SURROUNDING QUADRANGLES



1:62 500 scale; 2x vertical exaggeration

Shaded relief generated from National Elevation Dataset 1/3 arc-second data from the US Geological Survey.

QUADRANGLE LOCATION

New York State Museum Map & Chart No. 81
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