Hudson Valley Stratigraphy

Ordovician Strata

The **Martinsburg Formation**, in the Rondout and Walkill Valleys southwest of Kingston, represents a Middle Ordovician Taconic foreland basin. The thickness of the Martinsburg clastic wedge is as much as 3,000 – 4,000 m but it may have been locally thickened by the stacking of thrust slices. The section of the Martinsburg exposed in the Rondout and Walkill Valleys is commonly referred to as the Bushkill Shale and is probably correlative with the lower part of the Martinsburg Formation in Pennsylvania and New Jersey.

Silurian Strata

Middle- to Late-Silurian strata of the Hudson and Rondout Valleys lie in angular unconformity on the Middle to Late Ordovician shales. These strata consist, in ascending order, of the Shawangunk (pronounced "shon-gum") Conglomerate, High Falls Shale, Binnewater Sandstone, and Rondout Formation – all of which represent the northeast transgression of a Late Silurian sea.

The **Shawangunk Conglomerate** is a well-indurated quartz-pebble conglomerate with minor amounts of quartz arenite and thin red- and green-shale laminae, are correlative with the Tuscarora Sandstone in Pennsylvania, and are thought to represent the deposition of a clastic wedge derived from a southeastern source uplifted during the Taconic orogeny. The Shawangunk increases in thickness southward from its pinch-out just south of Kingston to approximately 100 m in the Shawangunk Mountains at Ellenville and the conglomerate lies in angular unconformity on Ordovician shales of the Martinsburg Formation.

The **High Falls Shale** is composed of finely-laminated silty red shale, with occassional thin laminae of green shale and argillaceous carbonate, indicating alternation of subtidal, intertidal, and supratidal enviroments. The shale is exposed in the Rondout Valley between Accord and Binnewater, is absent north of Binnewater due to non-deposition, and reaches its maximum thickness of 24 m near its type section in High Falls. The High Falls and overlying Binnewater Formations are probably correlative with the Poxono Island Formation of Eastern Pennsylvania.

The **Binnewater Sandstone** is a well-indurated, cross-bedded, dolomitic quartz arenite exposed in the Rondout Valley. Its thickness increases from its pinch-out just south of Kingston to approximately 18 m in the subsurface at Accord. The Binnewater represents repeatedly shifting subtidal, beach, and supratidal facies. The general lack of fossils and presence of dolomite in the unit indicate a restricted hypersaline environment.

The **Rondout Formation** is composed of argillaceous carbonates and calcareous sandstones cropping out along a narrow belt along the Helderberg escarpment from Albany south to Kingston and then southwest into the Rondout Valley. In the Hudson and Rondout Valleys, the Rondout may be subdivided into four distinct members – in ascending order the Wilbur Limestone, Rosendale Dolostone, Glasco Limestone, and Whiteport Dolostone – representing two separate transgressive-regressive marine sequences.

The **Wilbur Limestone** is a massive, blue-gray weathering biostromal limestone occurring only in the vicinity of Kingston. The Wilbur Member reaches maximum thickness of 4 m at the Wilbur Quarry, lies conformably over

the Binnewater Sandstone to the south, and lies in angular unconformity with the Austin Glen Formation to the north. A diverse invertebrate fauna indicates that it was deposited in a subtidal marine environment.

The **Rosendale Dolostone** is an orange-buff weathering argillaceous non-fossiliferous dolostone representing a hypersaline tidal-flat environment. The Rosendale Member conformably overlies the Wilbur Limestone where present but otherwise disconformably overlies the Binnewater Sandstone to the south, where the Rosendale is approximately 9 m thick, and unconformably overlies the Austin Glen Formation to the north, where the Rosendale is approximately 2 m thick.

The **Glasco Limestone** is a highly-fossiliferous biostromal limestone which conformably overlies the Rosendale dolostone and represents a shallow marine reef environment. The Glasco is thinnest (1 m) at Kingston and thickens to the north and south to approximately 3 m. A distinctive Silurian fossil, the tabulate chain coral *Halysites catenularia*, is common throughout the Glasco.

The **Whiteport Dolomite** is a buff-weathering, non-fossiliferous calcareous dolostone, with occasional dessication cracks, representing a tidal-flat environment of deposition. The Whiteport conformably overlies the Glaso and thickens from 1 m, north of Kingston, to approximately 5 m at Accord.

The Rosendale and Whiteport magnesian limestones ("waterlimes") of the Rondout Formation were extensively mined in the 19th and early 20th centuries for use as a natural cement. The rock was quarried, burned in local kilns to remove CO_2 gas, and the remaining powder, when mixed with water, produced a strong hydraulic cement. Cement production was a major industry in Rosendale with quarries in the region producing up to 4,000,000 barrels of cement per year. This cement was extensively used for the construction of the New York State canal system (*e.g*. the Erie Canal) as well as being incorporated into such notable landmarks as the Brooklyn Bridge and the foundations of the wings of the United States Capital Building in Washington, D.C. Many abandoned quarries and roof-and-pillar cement mines in the Rondout and Hudson Valleys provide unique three-dimensional exposures of geologic structures within these rock units.

Devonian Strata

The Devonian strata of the Hudson Valley crop out along a narrow belt along the Helderberg escarpment south from Albany along the western Hudson Valley to Kingston and then southwest into the Rondout Valley. The strata affected by Hudson Valley deformation consist of the Helderberg Group, Tristates Group, Onondaga Limestone, and Hamilton Group.

The Helderberg Group

The Late-Silurian to Early-Devonian Helderberg Group (Figure 2.8) is composed of seven laterally-extensive formations which record two successive epeiric sea transgressive sequences, separated by a minor regression. Each of the transgressive sequences is characterized by the deposition of an initial shallow-water limestone followed by the deposition of increasingly argillaceous carbonates. The Helderberg sea existed in a shallow trough, open to the Iapetus Ocean, between a subaerial Taconic landmass to the east and the North American craton to the west. The Helderberg Group is comprised, in ascending order, of the Manlius, Coeymans, Kalkberg, New Scotland, Becraft, Alsen, and Port Ewen Formations.

The **Manlius Formation** is a dark gray, thin- to thick-bedded, calcilutite with thin laminae of micrites ("ribbon beds") predominant near the base. Two distinctive fossils distinguish the Manlius from the overlying Coeymans Formation – the tentaculitid *Tentaculites gyracanthus* and the bean-shaped ostracode *Leperditia alta*. The Manlius within the Hudson Valley consists of the Thacher Member which has a thickness of approximately 15 m and represents deposition within a lagoonal environment.

A definitive placement of the Silurian-Devonian boundary in New York State has been problematic. Some workers have placed the boundary within the uppermost Rondout Formation, between the Glasco and Whiteport Members in the Hudson Valley, based upon the stratigraphic position of the Silurian tabulate coral *Halysites catenularia*. With the discovery of halycitid corals within the Whiteport, the boundary was moved upward to the base of the Helderberg Group. More recent work has used the graptolite *Monograptus ultimus* to place the Silurian-Devonian boundary within a 1.38 meter interval in the Manlius Limestone immediately below the Manlius-Coeymans formational contact.

The **Coeymans Formation** is bluish-gray, medium- to coarse-grained fossiliferous calcarenite with irregular to indistinct bedding. The Coeymans Formation gradationally overlies the Manlius and may be distinguished by the presence of the pentamerid brachiopod *Gypidula coeymanensis*. The Coeymans within the Hudson Valley is known as the Ravena Member and has a thickness of 5 – 10 m. The Ravena represents deposition in a subtidal reef environment above the wave base.

The **Kalkberg Formation** is a thin- to medium-bedded, fine- to medium-grained fossiliferous limestone gradationally overlying the Coeymans. The Kalkberg is distinguished in the field by the presence of nodules and beds of black chert and approaches 15 m in thickness in the Hudson Valley. The Kalkberg represents a subtidal environment near the wave base. Two members are recognized, a lower Hannacroix and an upper Broncks Lake. Zircon crystals from a bentonite layer within the Kalkberg at Cherry Valley, west of Albany, yielded an age of 395 ± 5 Ma for the deposition of the original volcanic ash, definitively placing it within the early Devonian Period.

The **New Scotland Formation** is an extremely fossiliferous (> 300 species reported) argillaceous limestone with distinctive interbeds of rusty-brown weathering layers. The New Scotland conformably overlies the Kalkberg, varies between 20 – 30 m in the Hudson Valley, and also appears to represent a subtidal environment near the wave base. A common distinctive fossil within the New Scotland is the strophomenid brachiopod *Leptaena rhomboidalis*.

The **Becraft Limestone** is a very coarse-grained, massive, gray to pink limestone (grainstone) with abundant pelmatozoan columnals and occassional green shale partings. The thickness of the Becraft varies from 4 m in the northern Hudson Valley to over 20 m southwest of Kingston and appears to represent a subtidal high-energy "crinoid bank". A ubiquitous fossil within the Becraft is the crinoid holdfast *Aspidocrinus scutelliformis*.

The **Alsen Formation** is a dark gray, thin-bedded, argillaceous fossiliferous limestone, cherty in places, conformably overlying the Becraft Limestone. The Alsen is up to 9 meters thick in the central Hudson Valley and represents an open marine shelf environment.

The **Port Ewen Formation** gradationally overlies the Alsen and consists of dark gray, thin-bedded, sparsely-fossiliferous argillaceous limestones and calcareous mudstones. The Port Ewen averages 24 m near Catskill thickening to as much as 38 m at Accord. A distinctive feature of the Port Ewen is the presence of numerous ellipsoidal calcareous nodules up to 1.0 x 0.25 x 0.25 m in size which appear to be diagenetic in origin.

The Tristates Group

The Tristates Group, which lies unconformably on top of the Helderberg Group in the Hudson Valley, represents a marine transgression. It consists of four formations – the Connelly, Glenerie, Esopus, and Schoharie.

The **Connelly Formation** unconformably overlies the Port Ewen Formation as is comprised of a mixed lithology of interbedded quartz pebble conglomerates, quartz arenites, black shales, and chert beds representing alternation of supratidal to subtidal environments. The Connelly is present from Kingston south to Rosendale and is 6 m or less in thickness.

The **Glenerie Formation** consists of subtidal cherty fossiliferous limestones with thin shale partings. This unit locally conformably overlies the Connelly. The Glenerie is present throughout the southern Hudson Valley and varies in thickness between 15 and 25 m. The Connelly and Glenerie Formations are believed to correlate with the Oriskany Sandstone exposed just above the Helderberg Group west of Albany in the Mohawk Valley.

The Esopus Shale consists of dark-gray to black, non-calcareous silty shales and siltstones gradationally overlying the Glenerie. The Esopus is exposed throughout the central and southern Hudson Valley, reaches a thickness of 60 m in the Kingston area, and represents deposition below the wave base. While relatively unfossiliferous, Esopus bedding planes occassionally contain the distinctive trace fossil *Zoophycos caudagalli* representing the infaunal feeding burrows of an unknown annelid. The Esopus has a well-developed slaty cleavage within the Hudson Valley and the fairly high clay content within the Esopus shales is thought to reflect the weathering of source areas to the east uplifted during the earliest part of the Acadian orogeny.

The **Schoharie Formation** conformably overlies the Esopus shales and is composed of fossiliferous muddy limestones and calcareous mudstones which are subdived into three members in the Kingston area. The thickness of the Schoharie at Kingston is slightly over 50 m and thickens slightly to the southwest toward Accord. The Schoharie within the Hudson Valley commonly displays a well-developed anastamosing, spaced cleavage.

The Onondaga Limestone

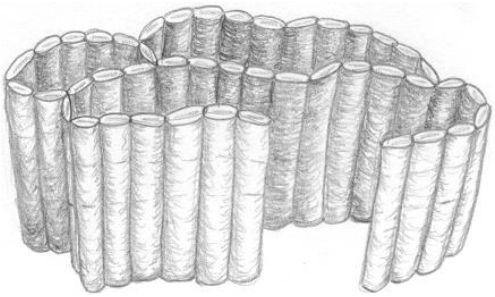
The Middle Devonian **Onondaga Limestone** gradationally overlies the Schoharie Formation and is well-exposed in outcrops throughout the entire length of the Hudson Valley. While the Onondaga has been subdivided in New York State into five members, only the Edgecliff, Nedrow, and Moorehouse Members occur in the Hudson Valley and these vary in total thickness from 35 m in the northern Hudson Valley to slightly over 50 m near Kingston. The Edgecliff Member is a crinoidal limestone with occassional coral bioherms, the Nedrow Member is a thin-bedded, fine-grained argillaceous limestone, and the Moorehouse Member is a very-fine-grained limestone with numerous shaly partings all thought to be deposited in a westward-transgressing, shallow, subsiding epicontinental sea. The Edgecliff Member is quite distinctive in that it often contains abundant nodular and bedded chert which weathers into a characteristically "knobby" appearance. The Onondaga is fossiliferous throughout and contains a large and diverse faunal assemblage.

The Hamilton Group

Two formations within the Middle Devonian Hamilton Group have also been affected by Hudson Valley deformation. The **Bakeoven Shale** is a thinly-laminated calcareous black marine shale with a thickness of approximately 60 m near

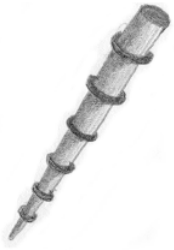
Kingston. The high organic content, presence of pyrite, lack of bioturbation, and sparse pelagic fauna suggest deposition in a strongly reducing anerobic basin.

The **Mount Marion Formation**, with a thickness approaching 250 m near Kingston, consists of non-calcareous, thinly-bedded marine siltstones and shales characteristic of a subtidal shelf. The Mount Marion is the youngest Devonian unit in which Hudson Valley structures have been recognized. The rest of the Hamilton Group, above the Mount Marion Formation, belong to the non-marine sediments of the Catskill clastic wedge.

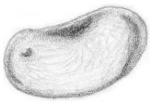


Halysites

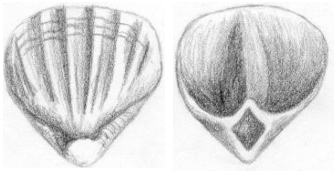
Monograptus



Tentaculites



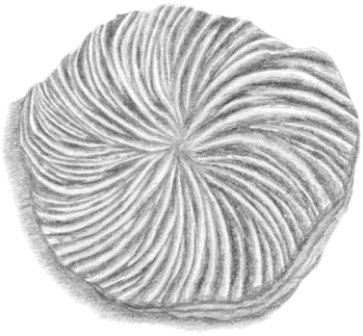
Leperditia



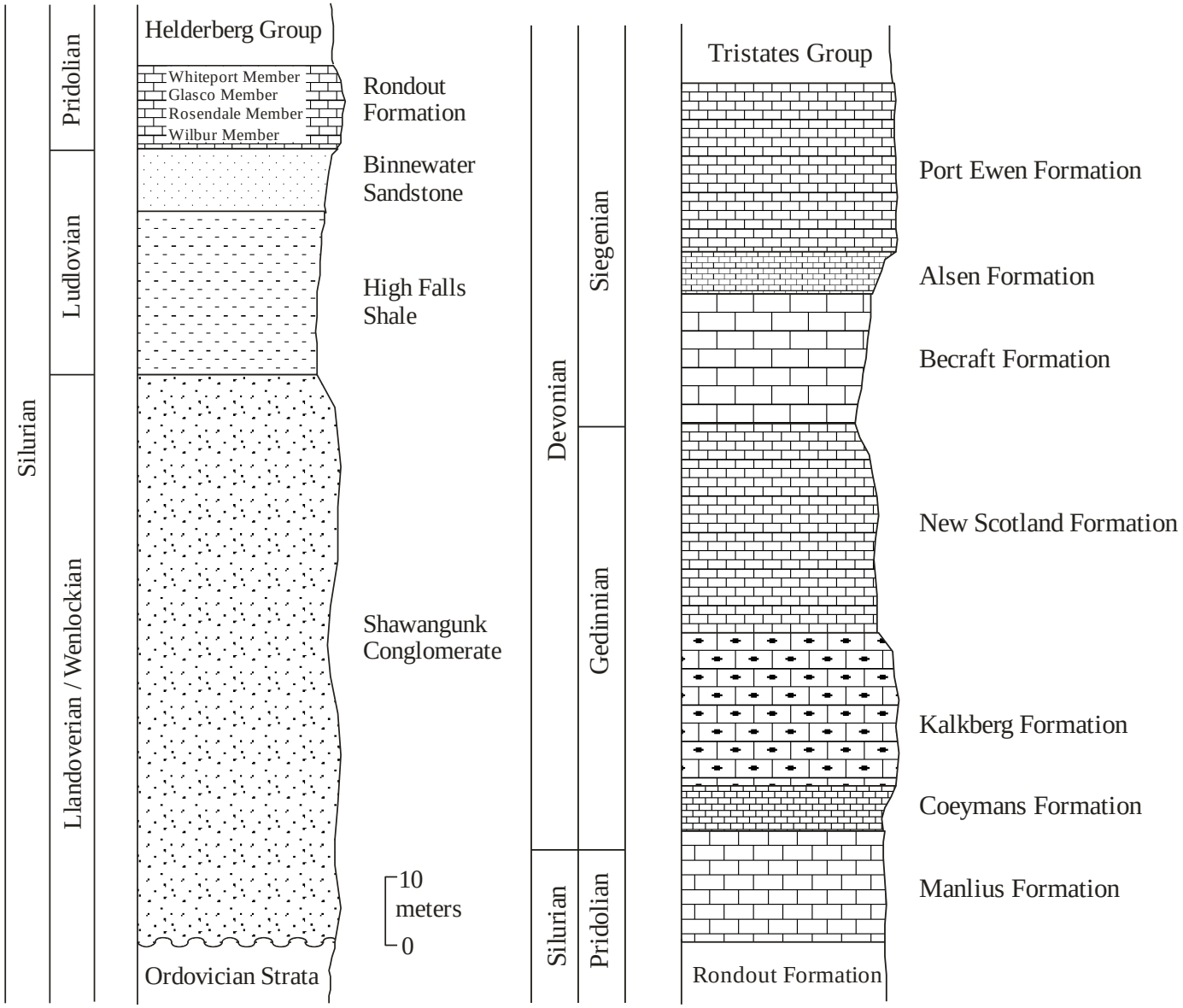
Gypidula

Aspidocrinus

Leptaena



Zoophycos


Silurian
Pridolian
Ludlovian
Llandoverian / Wenlockian
Helderberg Group
Whiteport Member
Glasco Member
Rosendale Member
Wilbur Member
Rondout Formation
Binnewater Sandstone
High Falls Shale
Shawangunk Conglomerate
10
meters
0
Ordovician Strata
Devonian
Siegenian
Gedinnian
Silurian
Pridolian
Tristates Group
Port Ewen Formation
Alsen Formation
Becraft Formation
New Scotland Formation
Kalkberg Formation
Coeymans Formation
Manlius Formation
Rondout Formation