A Helderberg Escarpment Tour at John Boyd Thatcher State Park, New York

by John J. Gara

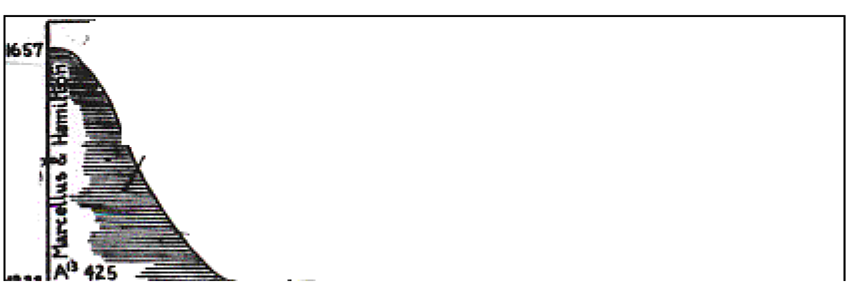
Helderberg Escarpment visible in the background of this photo of Albany, NY.

A popular destination for an Earth Science field trip is John Boyd Thatcher State Park just south of Albany, New York. This virtual tour highlights some of the rock strata that can be seen and discussed during a visit to the Helderberg Escarpment.

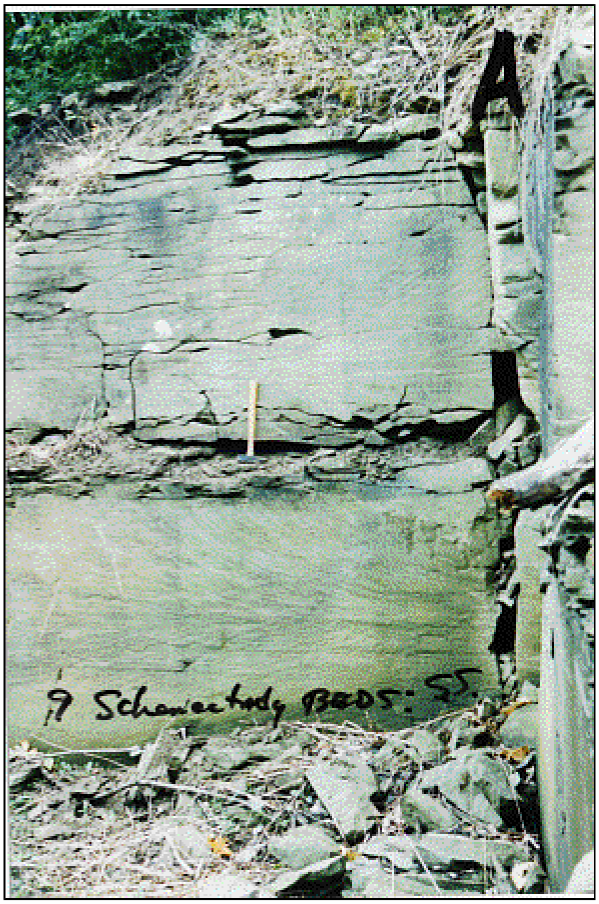
New York's Capital Region is geologically rich with one billion years of time recorded in the rocks within a one hundred mile radius of Albany. Evidence of deposition under the sea and three orogenies of mountain building are within easy reach.

One billion years ago, the New York area was part of a supercontinent formed by the Grenville Orogeny. Some of this Grenvillian basement material can be seen in the Adirondacks. Then,"remnants of the ancestral North American continental margin were thrust westward out of the present day New England area by the collision of northeastern Proto North America with a volcanic island arc during the Middle Ordovician Taconic Orogeny. Allochthonous (transported) rocks from this mountain building episode lie along the eastern side of the Hudson River (Landing, 1986)."

In another direction, "Younger Late Silurian and Devonian marine sequences overlook Albany from the Helderbergs and Blackhead Mountains to the southwest (Landing,1986)." This is an interesting area to study since "Helderberg stratigraphy appears to be divisible into meter scale, sharply bounded, shoaling upward cycles due to geologically instantaneous deepening followed by aggradation to base level (Anderson, 1986)." The clastics eroding from the Taconic Orogeny filled the Catskill basin with sediments, thus the 'parent' giving birth to the sediments that eventually became the Catskill plateau. Each layer tells a story of what was happening to the land around and under the sea that was Eastern New York.



Profile of the Helderberg Escarpment as seen in the Goldring guidebook of Thatcher Park published in 1933.



A: Schenectady Beds

In the Ordovician Period, 460 million years ago, the Taconic Orogeny was in progress. This period of mountain building east of the Albany area produced vast amounts of clastic material as these rising mountains eroded into what was then a basin area that was sinking with the advance of the Taconic volcanic island arc.

The Schenectady beds are alternating beds of sandstone and shale laid down in shallow seas with shifting currents changing the source materials from sand to clay and back again. The formation is 2000 feet thick in places, indicative of the availability of clastics and how quickly the Catskill basin was sinking. These rocks characteristically have only sparse fossil remains, mainly seaweeds and a few graptolites (Goldring, 1933).

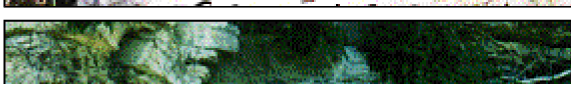
The Schenectady beds are now found at the base of the Helderberg escarpment and the floor of the western capital district valley. They are easily eroded making them a contributor in the development of the escarpment topography of the area. The valley beds are generally covered in glacial till transported by the glaciers that covered the area 11,000 years ago.

B: Indian Ladder Beds

The Indian Ladder beds were deposited on top of the Schenectady Beds. These are light colored sandstones in thick beds of clayey shales. The bed is not widespread indicating deposition by a narrow arm of the sea from the south (Goldring,1933). These rocks are no longer found in the lower elevations of the Hudson-Mohawk Valley.

These examples were found at the base of the Thatcher park escarpment, at an outcrop in New Salem and also in Feura Bush. Note the dolostone and fossiliferous limestone overlaying both outcrops. This is the Rondout waterlime often found atop the Indian ladder beds and Brayman shale.

These easily eroded shales and sandstones are the principle reason for the undercutting of the escarpment of harder limestone in the Helderbergs.



C: Brayman Shale

In the immediate Capital District area, much of the rock records from the late Ordovician period to the late Silurian has been eroded away. To see rocks of this period at the surface, you must travel into the western Mohawk valley. Indications are that the land of eastern NY was exposed to erosional forces possibly due to lower sea levels during a glacial period in the early Silurian or an uplift at the end of the Taconic Orogeny (Isachsen,1991). This created an unconformity in the rock record locally.

The last remnants of the Upper Silurian age is represented in thin bed of Brayman shale. Thicker in the Schoharie region, it is thought by some to be a residual soil atop the Ordovician rocks laid down 40 million years prior (Goldring, 1933). Brayman shale, like the Rondout dolostone above it, occasionally but rarely yields Upper Silurian fossils formed in shallow hypersaline waters within a supratidal and intertidal zone (Anderson, 1986).

This example shows the shale beds over the sandstone of the Indian Ladder bed in New Salem.

D: Rondout "Waterlime" or dolostone.

A relatively thin layer of rock of Upper Silurian age, Rondout waterlime erodes very quickly forming the undercut of the Lower Bear Path of the Indian Ladder trail at John Boyd Thatcher Park. The Rondout, as mentioned in caption C, has fossils of Upper Silurian through early Devonian time that include chain corals (Anderson,1986) It is thickest in Cobleskill, where it is mined for cement manufacture at Howe's Cave. Pentagonal mud-crack structures indicate this rock was formed by a fine lime mud that was probably exposed to the sun at low tide (Goldring, 1933).

Photo shows the undercut of the Lower Bear Path at Thatcher Park. The floor of the path is the remains of Indian Ladder sandstone and Brayman Shale.

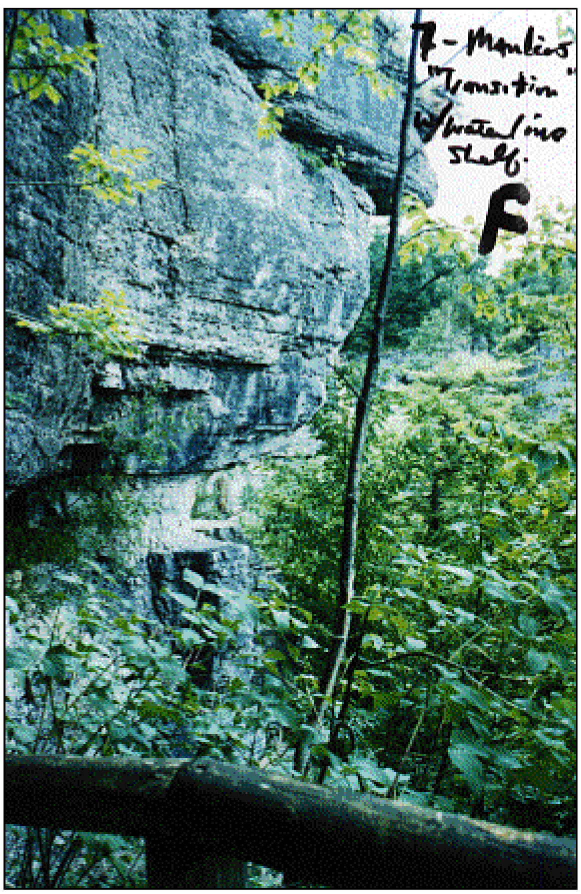
E: Manlius Limestone

410 million years ago, much of New York was flooded by the sea water of the Appalachian Basin. The Helderberg Group of rocks was deposited in a shallow

sea surrounded by a low, flat landscape evidenced by the lack of mud and sand that would be present if the area had high ground (Isachsen, 1991). This indicates the mountains of the Taconic Orogen must have been eroded down considerably in the time leading to the Devonian. The Manlius Limestone was laid in an intertidal zone resulting in thin, three inch beds of limestone interbedded with very thin films of shale. Mud cracks and ripple marks further indicate a tidal flat, lagoon environment. Compared to the Rondout, the seas of the Manlius were clearer and supported more marine life such as coral reefs and mollusks (Anderson, 1986) and Stromatoporas globular masses (Goldring, 1933).

The 40 foot exposure of the Manlius above the Lower Bear Path shows indications of ever deepening seas as you progress to the upper part of the formation.

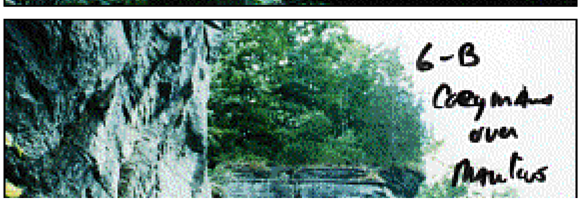
Pictured is the Manlius with respect to surrounding bed, the interbedding of the very hard limestone with the shale films and shale interbeds.



F: Upper Manlius "Transition" Beds

The deepening of the Appalachian Basin is evident in the thicker, purer limestone of the upper part of the Manlius. A softer dolostone layer of about four feet constitutes the Upper Bear Path. Sometimes called Tentaculite Limestone because of the abundance of fossils of these conical, carrot shaped organisms, the "waterlime" of the Upper Bear Path erodes away from the face of Helderberg Cliff quicker than the limestone above and below. This creates a suspended shelf on the face of the cliff. (Goldring, 1933)

Pictured is the shelf as seen on the face of the cliff.



G: Coeymans Limestone

The sea continued to deepen as the early Devonian progressed. The effects of tides become less evident in the Helderberg rocks as layers begin to show the less frequent variations caused by storm waves of deeper seas. This results in a purer mass of limestone with fewer interbeds of contaminating particles.

Coeymans Limestone thickens westward where the seas were deeper. Fresh breaks show a blue-gray color and a semi-crystalline character (Goldring, 1933). Diverse fauna of brachiopods, mollusks and honeycomb corals can be found. The Coeymans was deposited on the seaward side of coral barriers in agitated, clear water with abundant fauna (Anderson, 1986).

Its hardness is responsible for the "battlements" of the Helderberg Escarpment. These rocks protrude beyond the Manlius and fracture vertically, resulting in massive blocks that break away from the face of the cliff on occasion ... usually early spring.

Picture shows the battlements of the Coeymans over the Manlius.

H: The New Scotland Beds

The waters of the Appalachian Basin reached their deepest during the deposition of the New Scotland beds. These beds were below the motion of fair weather seas and only agitated by storms. These are the most fossiliferous of all the limestones of the Helderberg group. The New Scotland is a thick as 100 feet in places and easily erodes into fertile slopes used for grazing and farming in the Helderbergs

The characteristics of the New Scotland formation are interbeds of impure limestone and shale that weather to a gray-brown color, occasional thicker beds of purer limestone, yielding to a black, cherty layer near the top (Goldring, 1933). Also described as thin bedded limestone interbedded with calcareous shales with a high pyrite content responsible for its brown weathering (Anderson,1986).

Abundant fossils include brachiopods, bryozoans and trilobites. This represents a more distal, deeper water environment.

The shaley character of the New Scotland is evident in the picture. Occasional purer limestone sections can be found. Samples show the abundant sea life.

I: Becraft Limestone

After the New Scotland was

formed, the seas began to recede. The upper New Scotland shows a purer limestone which transitions almost seamlessly into the Becraft Limestone which is very pure like the Coeymans, formed by a high energy shoal. The formation is less than nine feet in the Helderbergs and thickens to 45 feet to the south. Its similarity to the Coeymans also manifests itself as conspicuous cliffs. Its hardness creates a small step in the profile of the Helderbergs.

The Becraft is a coarse grained echinoderm grainstone with brachiopods and sea-lily-like crinoids (Anderson, 1986). Port Ewen Limestone is not found atop the Becraft at this location since the later deposits were eroded by a further recession of the seas. This unconformity is evidenced by the contact of Oriskany Sandstone on the Becraft in the Helderbergs.

Pictured is a large road cut of the Becraft which has the limestone of the top of the New Scotland at its base and Oriskany Sandstone capping it. The top of the outcrop is extremely fossiliferous, almost to the point of seeming like a seashell dump.

J: Oriskany Sandstone

After a period of erosion, the land began to subside and again the sea overrode the land. When the shore reached the vicinity of the present day Helderbergs, a sandy beach formed. The sandy offshore produced patterns of vigorous wave action. The sands were rich in quartz grains, many that were large and spherical.

Oriskany Sandstone is unusual in that Paleozoic corals are more commonly found in limestone and calcareous shales and are very rare in coarse sandstone like this bed. Oriskany sandstone has such corals indicating turbulent near shore depositional environment (Oliver, 1994).

Fossils of brachiopods and gastropods are in abundance. Worm burrows are evident on the top surface when cleanly exposed. Oriskany Sandstone is readily seen in the many stone fences along the Altamont-Knox Road (Goldring,1933).

Pictured is a roadcut driving up to Countryman Hill showing a 4 foot outcrop of this attractive sandstone filled with quartz sands.

This sandstone is known for its natural gas production. Thicker beds have been tapped for their methane (Isachsen, 1991). In the Town of Berne, many homes experience the problem of natural gas in their water wells, possibly due to tapping the water table of the Oriskany. An explosive situation to say the least.

K: Esopus Shale

As the continent of Avalon approached for the Acadian Orogeny, the Appalachian basin underwent an abrupt deepening (Anderson, 1989). Dark green-gray mudstones and shales resulted. The bottom of the Esopus starts as a flinty sandstone and transitions to a black shale that crumbles easily when handled. The sea bottom of the Esopus was soft and muddy and oxygen poor. This contributed to the lack of fossils in this layer, since few organisms could survive in this environment.

Esopus grit, as it is often called, breaks down to form gentle slopes between the Oriskany Sandstone below and the Onondaga Limestone above. The soils are rocky and poor, only good for grazing (Goldring,1933).

Pictured is a large exposure of the Esopus at the foot of Countryman Hill in the Helderbergs. This cut appears solid and resistant, but crumbles on contact.

Above the Esopus is Schoharie Grit in some places. Most of the Helderbergs offer little Schoharie grit, or it is often indistinguishable from the Esopus. I was unable to locate a good example.

L: Onondaga Limestone

Onondaga Limestone forms the second great cliff of the Helderbergs as seen from the Albany plain. Presence of sands and pebbles consistent with the Oriskany indicate a possible non-depositional period where some higher ground exposed Oriskany Sandstone eroded into the basin where the Onondaga Limestone was collecting (Anderson, 1986). Unconformities to the west add credence to this assertion.

The shales above and below the Onondaga leave it exposed in the higher hills of the Helderbergs so that many of the roads parallel the vertically fractured cliffs. The stone is blue-gray, weathering to brown often showing quantities of chert deposits.

The Onondaga represents another deepening cycle. Deep water limestone deposits have fossils of coral reefs and numerous vertebrates, cephalopods and gastropods. Later beds show evidence of even deeper seas with layers of shale from volcanic ash called the Tioga ash beds

(Isachsen, 1991). This is evidence of volcanic activity as the subduction of the seafloor preceding the Acadian Orogeny took place.

Photo is from the south side of Countryman Hill. Fresh breaks show the blue color of the stone before weathering brown.

M: Marcellus Black Shale

The continent of Avalon collided into Proto North America in the Middle Devonian. This deepened the Appalachian Basin and generated new clastic materials as the land to the east began to rise. The first flux of muds from the Acadian Orogen caused a black shale deposit that was bituminous, pyritiferous and very fissile (Goldring, 1933). These beds are as much as 200 feet thick in the area, but difficult to find since they are rapidly eroded and covered in soil and vegetation.

The Marcellus is the bottom of the Hamilton group. The grassy knoll of Countryman Hill at the top of the Helderbergs (home to a forest of TV transmission towers and microwave relays) is mostly Marcellus and Hamilton shales and sandstones.

This photo comes from near the top of Countryman Hill and Camp Pinnacle.

REFERENCES

Anderson, E.J., Brett, C.E., Fisher, D.w., Goodwin, P.W., Kloc, G.J.,Landing, E., Lindemann, R.H., 1986, Upper Silurian to Middle Devonian Stratigraphy and Depositional Controls, East-Central New York, New York State Education Department, New York State Museum Bulletin No. 462 , p 111-134.

Goldring, Winifred, 1933, Guide to the Geology of John Boyd Thatcher Park (Indian Ladder Region) and Vicinity, New York State Education Department, New York State Museum Handbook No 14, pp 7-103.

Isachsen, Y.W., Landing, E., Lauber, J.M., Richard, L.V. and Rogers, w. B., 1991, Geology of New York, A Simplified Account: New York State Education Department, Education Leaflet No. 28 , pp 53-66, 101-137 , appendix pp 256-258.

Oliver, W.A., and Heckt, W.S., 1994, Well-preserved Favosid Corals in the Oriskany Sandstone of New York, Studies in Stratigraphy and Paleontology in Honor of Donald Fisher, New York State Education Department, New York State Museum Bulletin No. 481 P 265

Rogers, W.B., Isachsen, Y. W., Mock, T. D. and Nyahay, R, E., 1990, New York State Geological Highway Map: New York State Education Department, Education Leaflet No.33.

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