THE STRUCTURE AND STRATIGRAPHY OF

THE PORT JERVIS SOUTH-OTISVILLE QUADRANGLES

co-authors

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TRIP C

INTRODUCTION

The area of this field trip, Port Jervis South-Otisville Quadrangles, (Fig. 1) includes parts of the Folded Appalachian Mountain, Great Valley and the Appalachian Plateau geomorphic provinces. The Paleozoic formations, deposited originally as horizontal sediments in an extensive geosyncline, have in this area an aggregate thickness in excess of 5,000' and consist of the following units, in ascending order: Martinsburg Graywacke Shale and Sandstone (Middle (?) and Upper Ordovician), Shawangunk Conglomerate (Lower to Middle Silurian), High Falls Red Beds (Middle to Upper Silurian), Poxono Island Shale, Bossardville Limestone and Keyser Group (Upper Silurian), Helderberg and Oriskany Groups, Esopus Shale and Ondondaga Limestone (Lower Devonian), and the Hamilton Group (Middle Devonian). Quaternary glacial drift and till occurs throughout the area (Pl. 1).

There is evidence for at least three periods of tectonic activity. The Late Ordovician Taconic Orogeny affected the Martinsburg Shales and Sandstones and older sediments prior to the deposition of the basal Silurian conglomerate. At the close of the Early Devonian Epoch, a second orogenic movement culminated in the Acadian Mountains. The final period of tectonic activity, terminating the Paleozoic Geosyncline formed the Appalachian Mountains during the Permian, with Kittatiny (Shawangunk) Mountain the easternmost ridge of this extensive range. Thrust faults, cross faults and tight folds (gentler towards the northwest) attest to the severity of this last orogenic movement. Folded synclinal structures, thrust towards the northwest, ruptured along cross faults. The oversteepened and overturned western limb of an anticline demonstrates the severity of the dragging along the eastward dipping major thrust fault plane.

The complicated folded and faulted structures found in the Port Jervis Quadrangle die out as they are traced northeast towards Otisville. In this area a monoclinal structure characterizes the northeast continuation of Kittatiny Mountain. The regional strike is N30-35°E with dips of 40°NW decreasing as the beds are traced westward. The western limit of Appalachian folding is marked by a steep east facing escarpment, The Alleghany Front. The Alleghany Front separates the Ridge and Valley province from the Appalachian Plateau province.

Sculpture of the area into its present topography is the result of post-Paleozoic erosion. The area was glaciated during the Pleistocene. The affects of glaciation are seen in the till covered valleys and the disturbed drainage pattern in the area. Glacial movement was toward the west and southwest.

Although the site of several lead-zinc mining ventures in the 1880's and 1890's, present day activity is limited to sand and gravel quarries in the Neversink Valley.

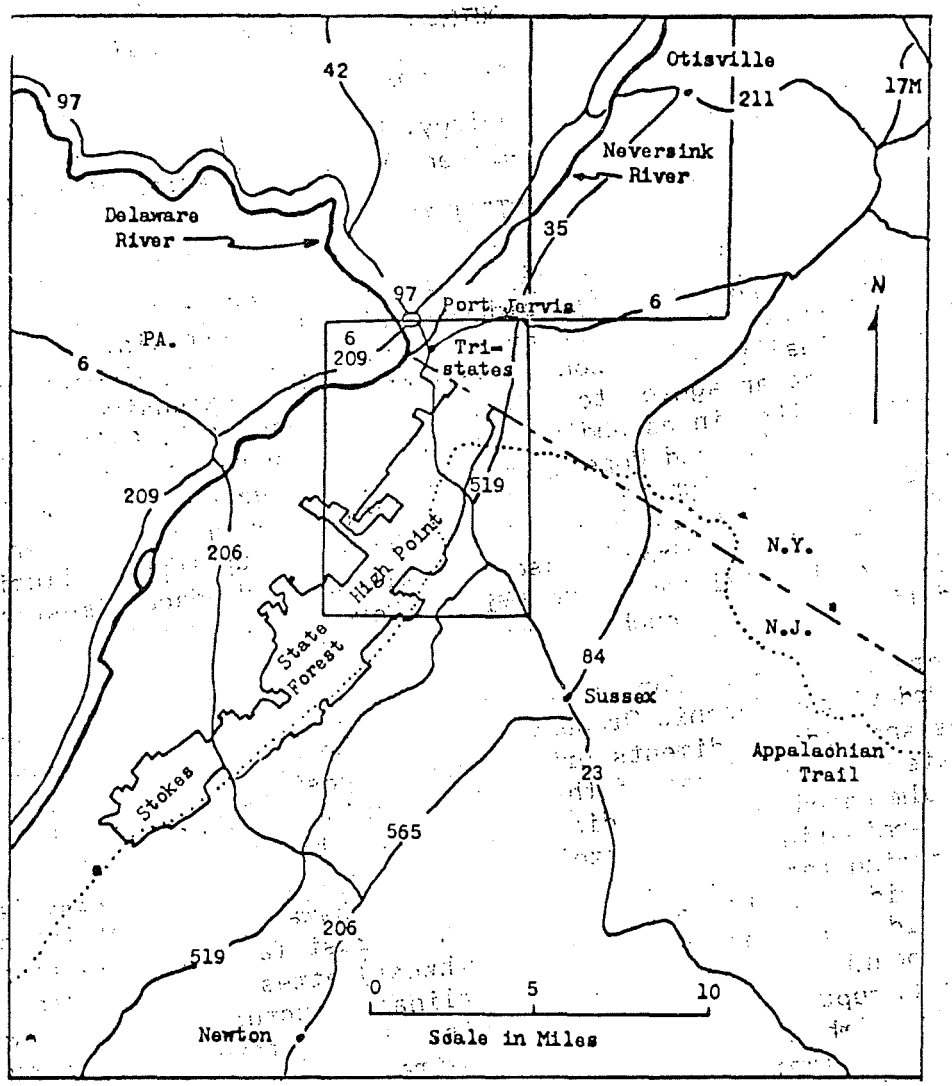

FIG. 1 INDEX MAP SHOWING THE LOCATION OF THE PORT JERVIS SOUTH AND OTISVILLE 7 1/2' QUADRANGLES

Structure of Kittatinny Mountain

Kittatinny (Shawangunk) Mountain, occupying the greatest portion of this area, is one of the major ridges of the Folded Appalachian Mountain chain. This ridge, supported by the extremely resistant basal Silurian conglomerate and quartz sandstone, is frequently illustrated in cross section as a monocline, dipping approximately 30° to the northwest (Fink, 1959, M.S. thesis, New York University, page 27). Younger belts of weaker and more resistant rocks form valleys and topographically lower ridges than Kittatinny Mountain to the northwest. Its monoclinal nature is nicely expressed at the northeastern limit and the southwestern limit of the Port Jervis quadrangle. Between these two limits, the structure of Kittatinny Mountain becomes noticeably complex.

Lake Rutherford lies in a syncline (called the Lake Rutherford syncline for simplicity) formed in the Shawangunk Conglomerate. The western limb of this syncline forms a formidable ridge of considerable topographic height. This ridge may also be considered the eastern limb of the anticline, whose western limb forms a second pronounced ridge slightly to the west (Pl. 2). This western limb of the anticline marks the upper portion of the lithologically fairly uniform Shawangunk Conglomerate. High Falls outcrops are encountered several hundred feet down-dip (west) of this ridge. The anticline is partially breached and extending parallel the length of its valley, is a thrust fault dipping steeply eastward. Surface indications of this major fault are scarce. Aerial photographs do not show conclusively a fault parallel to the axial plane of this partially breach anticline. However, the western limb of the anticline is considerably oversteepened, with dips ranging from vertical to 75° NW to 75° SE (overturned) along the strike. A 500 foot water well drilled by the American Telephone and Telegraph Company about 530' S 20°W of BM 1513 encountered a considerable fault zone within the Martinsburg Shale at a depth of 412 feet. At the same locality, the face of a steep outcrop of the Shawangunk Conglomerate had been extensively slickensided with the western limb having moved down with respect to the eastern limb of this partially breached anticline. A second well drilled to a total depth of 500 feet approximately fifty feet east of the first well location, did not encounter this fault zone. Apparently, the fault plane is steep, having a dip of approximately 80° to the east.

The Lake Rutherford syncline plunges to the southwest, with the nose of the structure about 1 mile north of Lake Rutherford. High Falls Sandstone is nestled in the trough of this structure as far south as the vicinity of the east-west road (southern portion of quadrangle), for only northwesterly dipping outcrops of conglomerate occur south of that area. On this basis, it is assumed that the Lake Rutherford syncline is actually doubly plunging.

Immediately north of the synclinal nose a spur of the Martinsburg Shale extends as an outcrop belt northwestward as far as the oversteepened western limb of the anticline. (This limb continues northeastward where it dips become gentler, averaging 20-30° northwest.) These shales then trend north as far as Lake Marcia and outcrop as a considerably thinner belt. Where meagre outcrops of shale occur in this belt, no bedding planes

are evident; the shales being highly cleaved. The fine, chip-like fragments, a type of mylonite within this zone, indicates that possibly the thrust fault passes through this area. With the thrust fault plane passing near the crest of this anticline and the concentration of tension joints due to the stretching of the conglomerate near the crest of this structure, weathering and erosion succeeded in partially breaching this anticline and exposing the older Martinsburg Shale as this north trending spur (Pl. 3).

A tightly folded, doubly plunging syncline rises as a high ridge east of Lake Marcia. The highest topographic elevations in the State of New Jersey occur along the steeply eastward dipping west limb of this syncline. The southwestern nose extends to the northwest trending belt of Martinsburg Shale, where it terminates with a precipitous drop of 100 feet or more, the base of the cliff supported by Martinsburg Shale.

Both synclinal structures, having an undulatory axis, are thus doubly plunging. The northeastern, tightly folded syncline, must have once been continuous with the Lake Rutherford syncline. Apparently, movement along a cross-fault permitted the northeastern syncline to be thrust as a complete unit (nose and all) farther towards the northwest, with the differential movement resulting in the much tighter folding. Considerable erosion along the cross-fault exposed subsequently the older northwest trending belt of Martinsburg Shale.

The northeastern nose ($\frac{1}{2}$ mile northeast of Cedar Swamp) of this tightly folded structure shows evidence of additional cross-faulting. The deformation was of such a nature that the northwest-southeast strike of the gently southwest dipping beds of the nose butt up directly against the southeast dipping beds of conglomerate from the western limb of the syncline. Apparently, this second cross-fault did not allow the comparatively incompetent conglomerate to adjust completely to the distorting forces, and the nose of this structure ruptured horizontally along this northwest-southeast trending fault. A portion of the nose then was thrust against the eastern limb of the anticline, with the remaining portion apparently faulted out altogether along the major thrust. These cross-faults do not extend any considerable distance to the northwest or southeast. Even though they are comparatively local in extent they contribute materially to the over-all deformation picture of this area. The gap between Trilobite and Wallpack Ridge may be the result of a third cross-fault in this area.

From the Camp Minisink Lakes (immediately northeast of Cedar Swamp) northeastward, the conglomerate dips consistently with angles up to 30° towards the northwest.

The entire down dip slope of Kittatinny Mountain is covered with glacial drift. Outcrops are scarce and consist almost entirely of High Falls. This formation flairs out considerably to the southwest, thinning toward the northeast. The thinner outcrop belt may be the result of steeper dips due to greater compressional forces in the northeast. The wider outcrop belt of High Falls to the southwest might be the result of shallower dips; the compressional forces being of lower magnitude.

Wallpack and Trilobite Ridges

Along the northwestern foothills of Kittatinny Mountain, the writer undertook geologic field work on a reconnaissance basis. Trilobite Mountain (northeast of Tristates) is underlain by the same Lower Devonian formations as is Wallpack Ridge to the southwest. The formations, however, at Trilobite Mountain are thinner in outcrop; the result of steeper dips due to differentially greater compressional forces in this sector of the quadrangle. A thrust fault has faulted out the Lower Devonian limestones to a great extent, leaving the Esopus Shale and some Oriskany Limestones as the only formations at Tristates, New York. The same situation exists at Duttonville, New Jersey, where the northeastern limit of Wallpack Ridge consists of Esopus Shale, the other Lower Devonian formations having been faulted along the thrust fault.

Pocono Plateau

During the brief time spent in this geomorphic province, the writer established gentle westerly dips (10-15°) for the Middle Devonian sandstones and shales. The area is essentially a gently westerly dipping plateau that is in the mature stage in the cycle of erosion.

CONCLUSION

At Port Jervis, New York, the diverse lithologies and structures attent to the pronounced changes the tectonic framework of sedimentation underwent during the Paleozoic Era. The coarser clastics (Shawangunk Conglomerate and Hamilton Group) deposited in the extensive geosyncline, were derived from rapidly rising source areas during the close of the Late Ordovician and Early Devonian Periods. Folded and faulted structures along Kittatinny Mountain are reflections of the Late Paleozoic orogenic movements that elevated the thick accumulation of sedimentary rocks in the geosyncline to form ultimately the Folded Appalachian Mountains.

Doubly plunging anticlinal and synclinal structures of the conglomerate are ruptured along cross-faults and thrust faults. The northern portion of a once continuous syncline was thrust several hundred feet more towards the northwest than its southern counterpart, with dragging along the thrust fault plane resulting in oversteepened dips along the western limb. Today, the highest elevation in New Jersey has been established along this limb. A second thrust fault in the Lower Devonian rocks along the eastern foothills of Wallpack - Trilobite Mountain thrust out several of the limestone formations.

The topographic expressions as seen today are the result of epeirogenic movements since Cretaceous time. Differential erosion along the belts of weaker and stronger rock has developed the present ridge and valley topography while continental glaciation, spreading a veneer of ground morainal deposits over this entire region during Pleistocene time, developed the gently rolling landscape seen in the Great Valley today.

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ROUTE STOPS

Mileage	
0.0	Hotel Minisink in Port Jervis - straight (NE) on Pike St.
0.1	Right (SE) on E. Main St. at traffic light.
0.4	Left (NE) on U.S. 209 at traffic light.
1.1	Roadcut through kame (at sharp turn).
2.0	Outcrop of Esopus Formation (along right side of road); well-developed southeast slaty cleavage.
2.3	Travelling along base of Appalachian Front on left (NW). The lowland is underlain by the Onondaga Limestone, which is hidden by a cover of till.
3.5	Helderberg Ridge (lower Devonian) on right (SE); dip-slope of Kittatinny (Shawangunk) Mountain farther east.
6.0	Marcellus Shale dipping gently NW (into Appalachian Front) at left (NW). Overlying these black fossiliferous shales are the olive-gray graywacke shales and sandstones of the Hamilton group. These represent the sediments derived from source areas to the east at the onset of the Acadian Orogeny.

Mileage

7.6-8.2 Unsorted and unstratified glacial till.

8.5 Cross over Neversink River

9.2 Right (E) on U.S. 211.

9.2-9.7 Crossing (E) Neversink Valley covered with glacial till

9.8 Entering Helderberg Ridge.

10.1-10.3 STOP 1: Esopus Formation.

The rocks exposed along the road are the black shales of the Esopus Formation. This formation is characterized by its well-developed southeast dipping slaty cleavage. The normal northwest dip of these lower Devonian beds is obscured due to the cleavage. The Esopus is the most important formation in the ridge west of Shawangunk Mountain (Pl. 5, Fig. 1). At the crest of this ridge is the Glenerie Cherty Limestone. The Glenerie is a limestone facie of the Oriskany Sandstone. In the valley between this ridge and Shawangunk Mountain to the east is found the limestones of the Helderberg Group (Pl. 5, Fig. 2).

11.4 Cross over Erie Railroad tracks via bridge.

12.2 STOP 2: Unconformable contact between Martinsburg Shale and Shawangunk Conglomerate (walk approx. 300 feet east along railroad tracks).

In this railroad cut is exposed an angular unconformity between the Martinsburg and Shawangunk Formations. The Martinsburg dips 37°NW and the overlying Shawangunk dips 28°NW. The Martinsburg is made of interbedded graywacke shales and sandstones. The Shawangunk is a massive quartz sandstone with a 40-50 foot basal quartz conglomerate. The high percentage of quartz, the well-rounded grains, the high index of sorting, and the great thickness, all characterize a beach deposit developed over a long period of time. In an old quarry above the road, Schuchert (1916) found Eurypterids in the shale beds found within the Shawangunk. In places the Shawangunk is cut by quartz-filled veins that are mineralized with pyrite, chalcopyrite, galena and sphalerite. These veins near Guymard (3.5 miles southwest of this locality) were the site of a small lead-zinc industry approximately 75 years ago.

12.2 Intersection with Orange County road 61.

12.2 Left (NW) on Orange County road 61.

Mileage

13.4 STOP 3: Small quarry in New Scotland Formation.

The beds exposed in this cut are those of the Lower Devonian New Scotland Formation. Most of the formation consists of dark blue-black shaly limestones. Toward the base of the formation abundant chert is found. The chert layers represent the Kalkberg Member of the New Scotland. The non-cherty beds are characterized by the following fauna:

Spirifer maclopleura
Leptaena rhomboidalis

13.4 Return to U.S. 211 via Orange County road 61.

14.6 Left on U.S. 211.

15.8 Right at T-intersection with Sanatorium Ave. (Kelley Hill).

16.2 STOP 4: Recumbent fold in Martinsburg (east side of Erie Railroad tunnel) - walk approx. 500 feet along railroad track.

On the north side of the track, the Martinsburg has been folded into a recumbent fold. In the same locality other signs of deformation are seen, (1) overturned beds, (2) small scale fault east of the recumbent fold. Although folding and faulting are seen in the area, metamorphism of the shales is not evident. It is interesting to note that the Shawangunk-Martinsburg contact is found near the crest of Shawangunk Mountain and not near the base. This is due to the predominance of sandstone beds that are quite massive in the upper part of the Martinsburg. The valley east of Shawangunk Mountain is part of the Great Valley and is underlain in this area by the Martinsburg Formation.

16.2 Return to U.S. 211.

16.6 Left at intersection with U.S. 211.

16.6 Left over bridge.

16.6 Right at end of bridge.

17.1 Fork in road; left (SW) onto Field Road.

18.2 Martinsburg on right (W).

19.0 Exposure of Martinsburg on right (W).

21.1 Intersection with Orange County road 24 and 35; continue southwest on Orange County road 35 (Finchville).

Mileage

26.2 Intersection with U.S. 6; cross-over U.S. 6 and continue southwest on Orange County road 55.

28.5 Intersection with road leading right (NW) to Camp Minisink; continue on Orange County road 55 (southwest).

29.6 New York-New Jersey border; continue southwest on Susse County road 519.

29.9 STOP 5: Martinsburg Formation.

Cyclic repetition of graywacke sandstone (with some layers becoming quite heavily bedded) and black, fissile shale characterizes the lithology of the upper portion of the Martinsburg, the oldest formation in this area (Upper Ordovician). Massive graywacke, several feet in thickness, quite prevalent near the top of the Martinsburg section (striking northeast and dipping on the average of 30 northwest), partially supports Kittatinny Mountain. The contact between this formation and the overlying Shawangunk Conglomerate, nowhere exposed in this area, lies just below the topographic crest of this ridge. Irregularities in sedimentation (seen readily in other exposures along the strike) are represented by irregularly-shaped fragments of shale within the massive graywacke layers. These isolated pieces are lenticular and the subjacent beds show no gaps into which they might fit. Other fragments are concave and sharply angular at their ends and appear torn from their position by slight tectonic movements. Undoubtedly, irregularities in primary sedimentation or slumping or other settling movements, incidental to primary deposition but taking place after sufficient hardening of the deformed layers, permitted them to act as competent units. Van Houten (1954) proposed that Martinsburg mud accumulated slowly in a marine environment. Sand, periodically stirred up in the shallow sea was carried to deeper water environments by spasmodic turbidity currents, and as the velocity decreased, the unsorted sediments settled in graded beds (not a prominent feature in the sandstone because no great range in grain size is involved in vertical sorting). These deposits may represent a "poured in" type of sediment, derived from the rapid erosion of tectonic source areas.

32.5 Intersection U.S. 23; right (W) onto U.S. 23.

33.0 Boundary of High Point State Park.

33.6 Entrance to High Point State Park.

33.7 Boulder of Shawangunk Conglomerate in center of road.

33.8 Right (E) on "Monument via Scenic Drive" road.

Mileage

34.0 STOP 6: Exposure of Shawangunk Conglomerate.

This is near the nose of a doubly plunging syncline of this formation. (See Pl. 6 and accompanying discussion.)

34.5 to 35.0 Lake Marcia on left (W) underlain by strongly sheared Martinsburg Shale. The "scenic drive" parallels the strike of the western limb of the syncline; dips range from 30° to 70° southeast.

35.0 Intersection with Monument Drive; right (NE).

35.4 Base of monument; park buses; walk to monument.

35.4 STOP 7: Highest elevation in New Jersey. 1,803 feet a.s.l.

This is the highest point in New Jersey. We are still on the western limb of the plunging syncline. Note the steep southeast dips (60°SE). Lake Marcia is located in the Martinsburg Shale as a result of breaching of the anticline immediately to the west and erosion along a thrust fault. The anticlinal, unbreached structure continues southwest (southwest of the A. T. & T. tower) until it ultimately dies out (in the southwestern portion of the Port Jervis South Quadrangle). All structures are doubly plunging. Toward the west lies the Pocono Plateau and along the east, the Great Valley underlain by the Martinsburg Formation.

37.2 Intersection with U.S. 23; right (W).

42.1 Intersection with U.S. 6 at traffic light; left into Port Jervis.

43.7 Intersection with U.S. 209 at traffic light; continue to second traffic light.

44.0 Intersection with Pike St.; left at traffic light.

44.1 Hotel Minisink.

GENERALIZED COLUMNAR SECTION
PORT JERVIS, N.Y.- N.J.- PA.

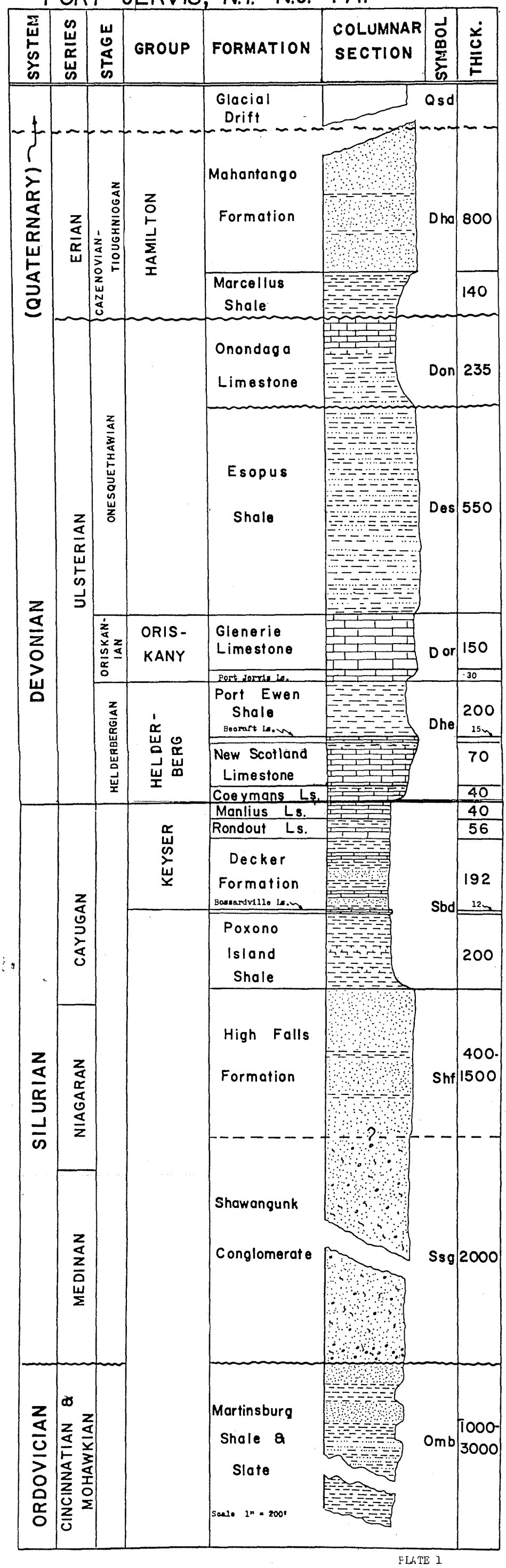
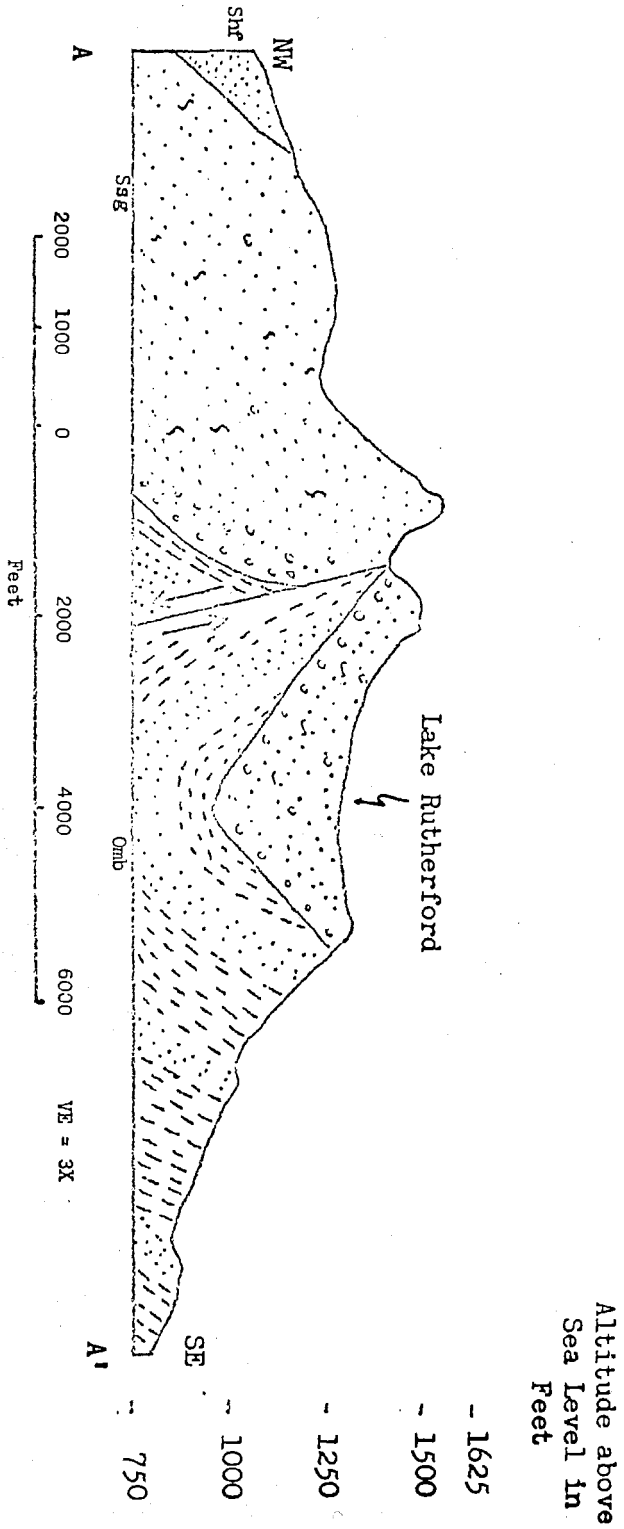
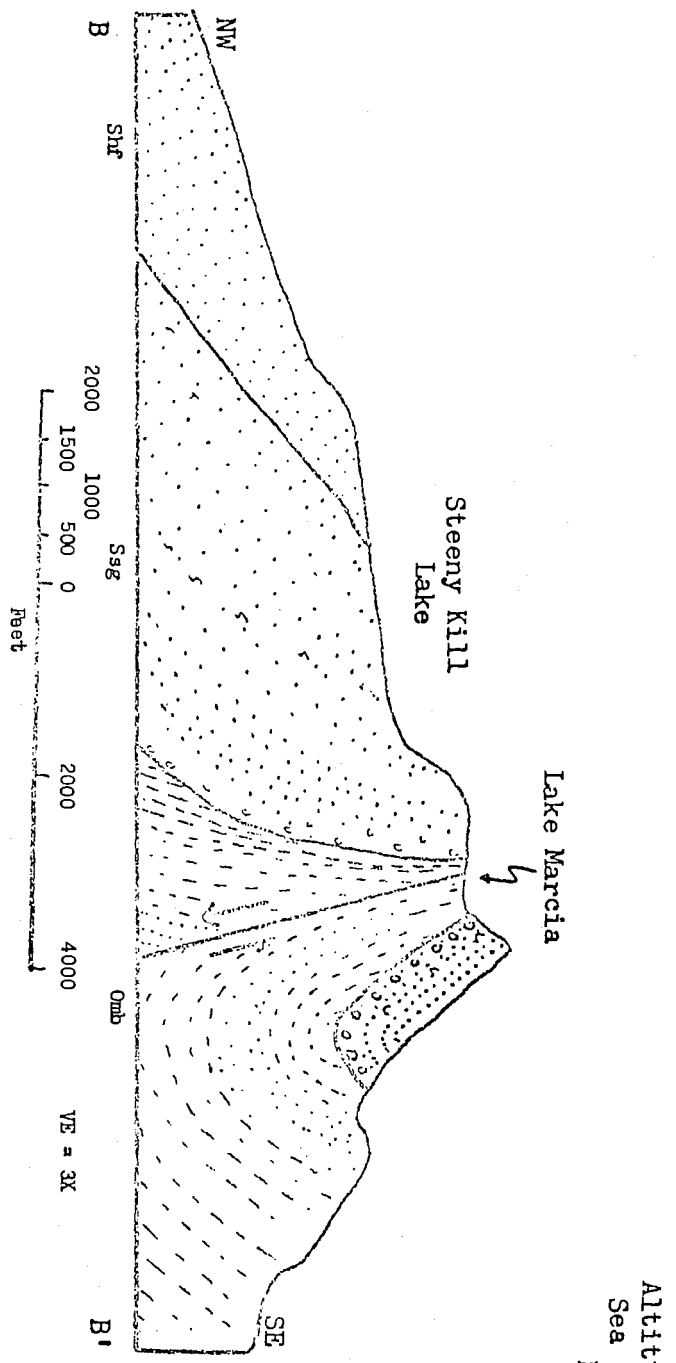


PLATE 1

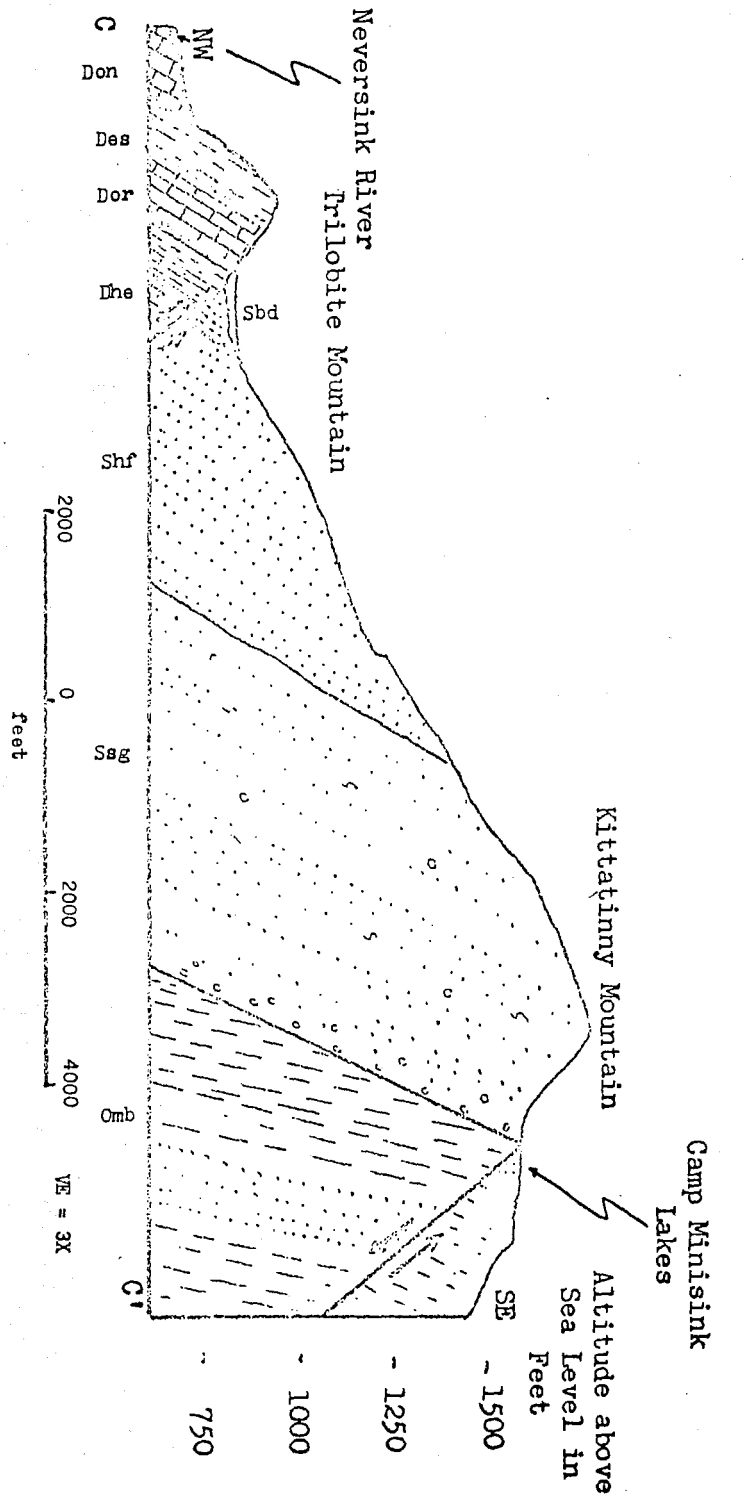
Section Through Lake Rutherford, New Jersey

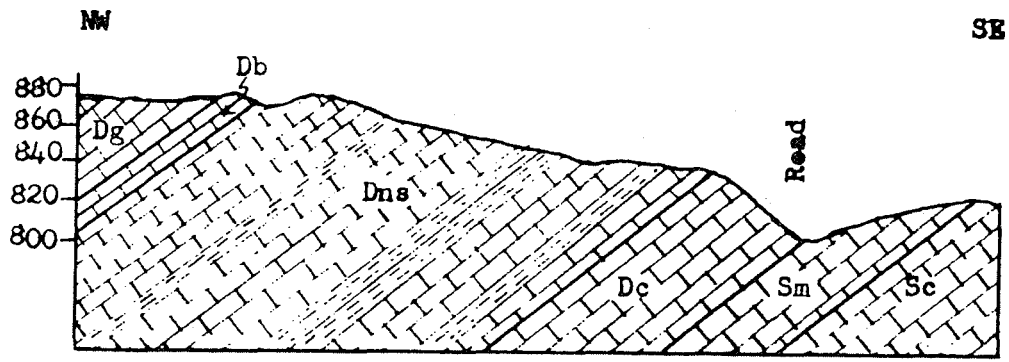


Section Through Lake Marcia, New Jersey



Section Through Kittatinny and Trilobite Mountains
New York





LEGEND

Dg Glenerie ls
Db Becraft ls
Dns New Scotland beds
Dc Ceeymans ls
Sm Manlius ls
Sc Cayugan group

Fig. 1 Cross section of Helderberg Mt. south end of Guymard Lake
Scale 1"=100'

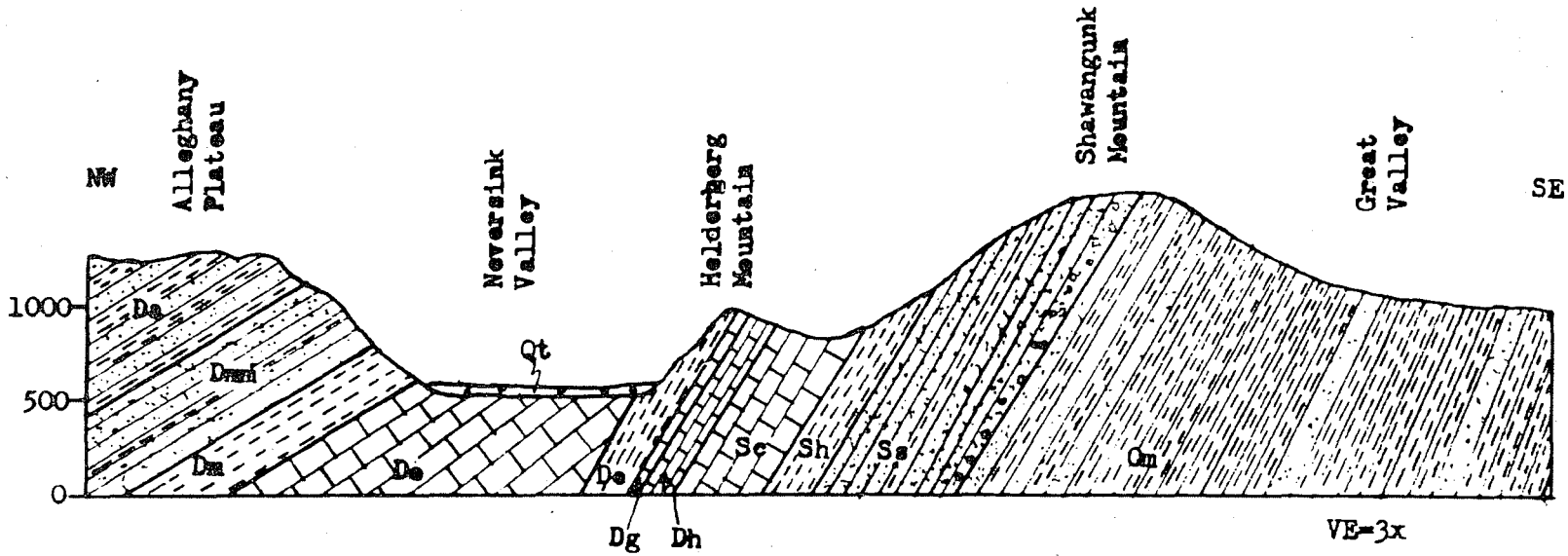
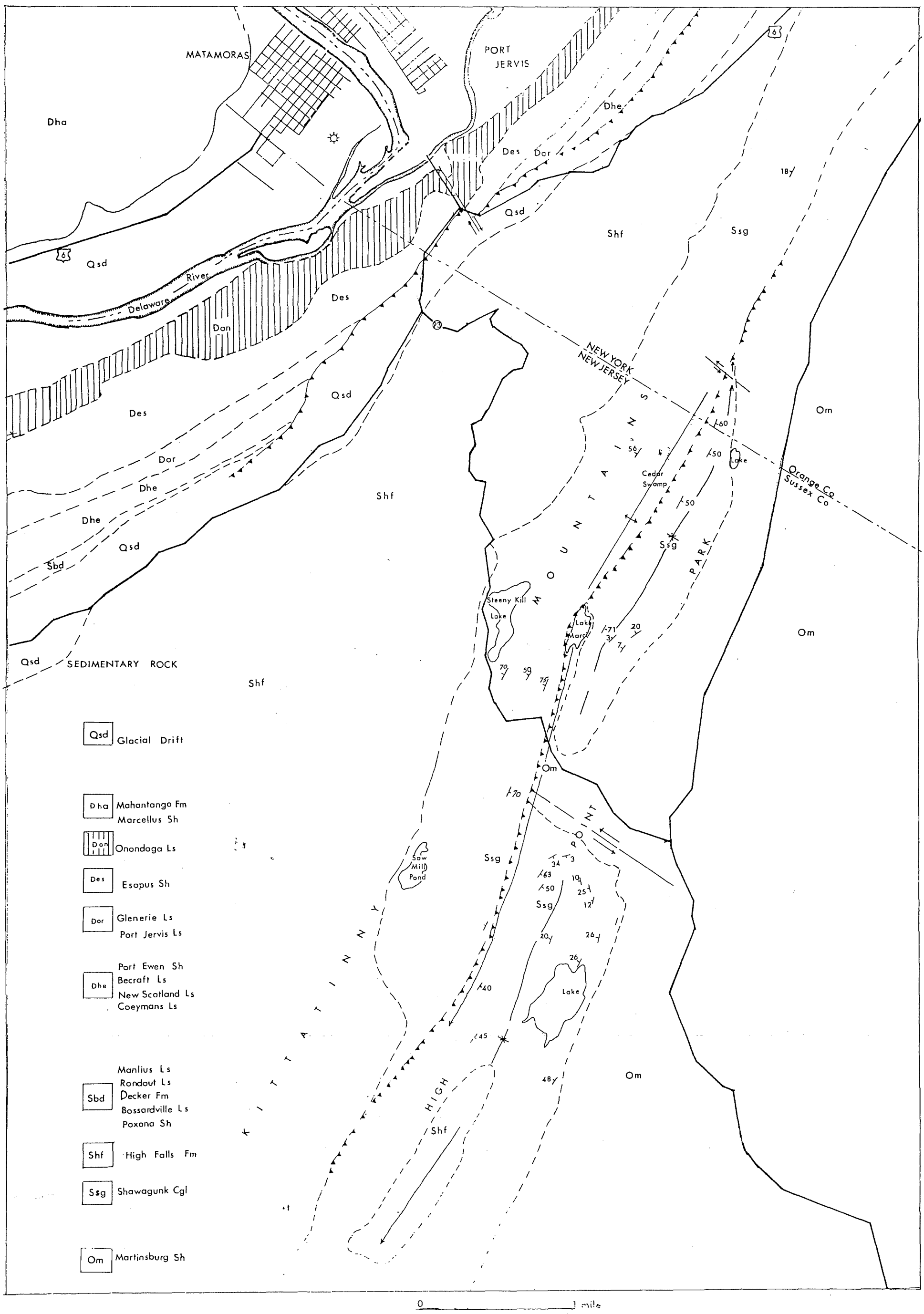


Fig. 2 Generalized cross section of the Otisville quadrangle
Scale 1"=0.5mi.

Port Jervis


MATAMORAS
PORT JERVIS
Dha
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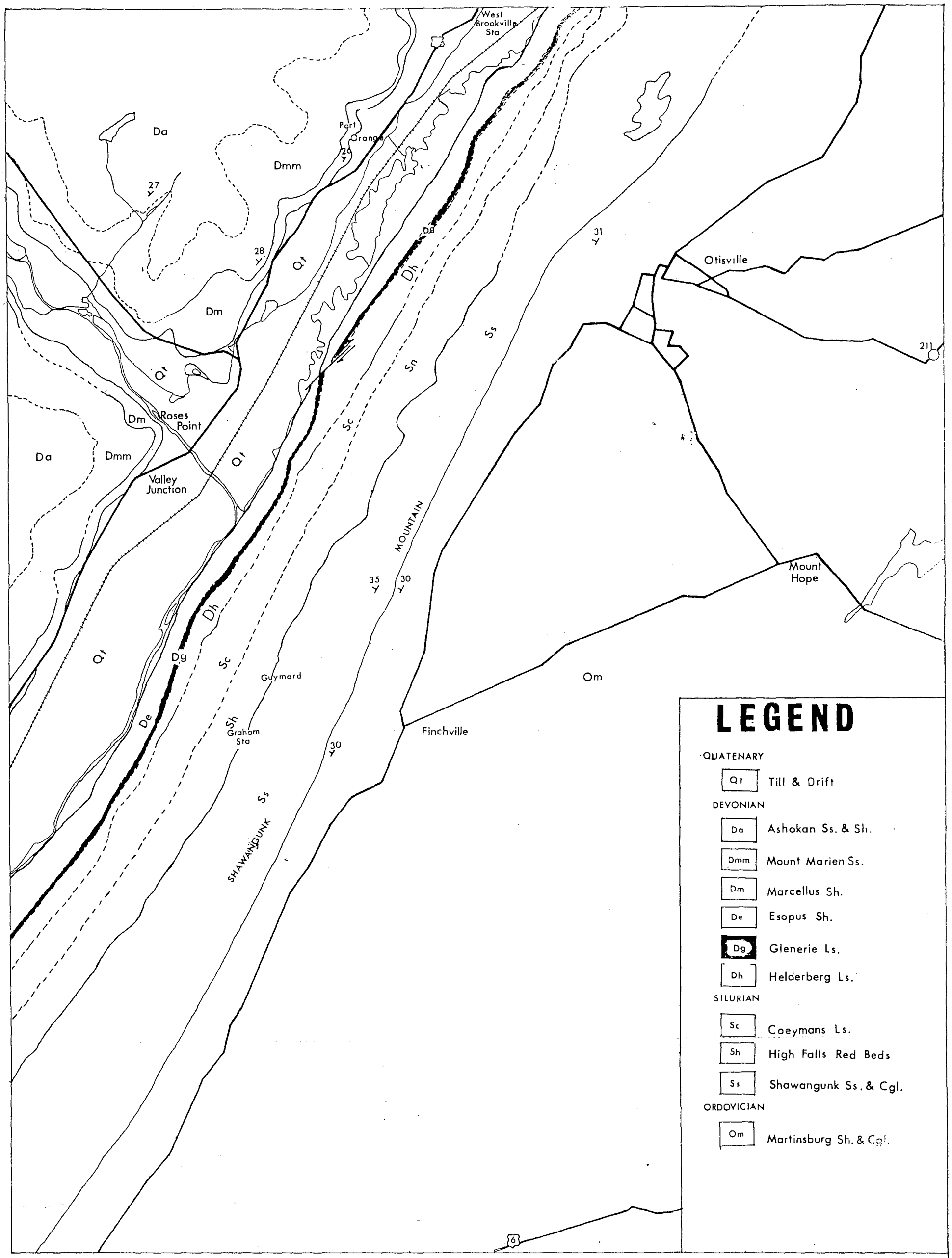
Qsd
Shf
Ssg
18y
Delaware River
Don
NEW YORK
NEW JERSEY
Om
Orange Co
Sussex Co
Cedar Swamp
Lake
MOUNTAIN
PARK
Steeny Kill Lake
Lake Marcy
Saw Mill Pond
POINT
Lake
Sbd
SEDIMENTARY ROCK
KITTATINNY
HIGH
Qsd Glacial Drift
Dha Mahantango Fm
Marcellus Sh
Don Onondoga Ls
Des Esopus Sh
Dor Glenerie Ls
Port Jervis Ls
Dhe Port Ewen Sh
Becraft Ls
New Scotland Ls
Coeymans Ls
Sbd Manlius Ls
Rondout Ls
Decker Fm
Bossardville Ls
Poxona Sh
Shf High Falls Fm
Ssg Shawagunk Cgl
Om Martinsburg Sh
0
1 mile

OTISVILLE



LEGEND

QUATENARY

- Qt — Till & Drift

DEVONIAN

- Da — Ashokan Ss. & Sh.
- Dmm — Mount Marien Ss.
- Dm — Marcellus Sh.
- De — Esopus Sh.
- Dg — Glenerie Ls.
- Dh — Helderberg Ls.

SILURIAN

- Sc — Coeymans Ls.
- Sh — High Falls Red Beds
- Ss — Shawangunk Ss. & Cgl.

ORDOVICIAN

- Om — Martinsburg Sh. & Cgl.