Thrust Sheets of the Central Taconic Region

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INTRODUCTION

This field trip is based on mapping in the Berlin, Hancock, and Williamstown Quadrangles during the summers of 1976, 77, and 78. This work was done for the U. S. G. S. and in conjunction with Nicholas M. Ratcliffe in preparation for the new geologic map of Massachusetts. The field trip concentrates on key exposures in the valleys of the Hoosic and Little Hoosic Rivers. In addition to the recent field mapping, the author has made some important reinterpretations of faults mapped earlier (Potter, 1972) in the Hoosick Falls area.

Three major thrust sheets and a group of minor thrust slices are recognized in the central Taconic region. Their relative age of emplacement (oldest at bottom), correlation with previously named thrust sheets, and probable times of deformation are as follows:

Former designations (Potter, 1972)	Present designation	Stages of deformation
Not recognized as separate sheet	IV. Berlin Mountain thrust sheet	F_3
Rensselaer Plateau thrust sheet	III. Rensselaer Plateau thrust sheet	F_2
Not named	II. Butternut Hill thrust slices	
North Petersburg thrust sheet	I. Giddings Brook thrust sheet	F_1

Figure 1 shows the field trip route and the thrust slices of the Taconic allochthon. Alas, Zen's (1967) interpretation bears close resemblance to the author's present interpretation in the central Taconic region (Figures 1. and 2.).

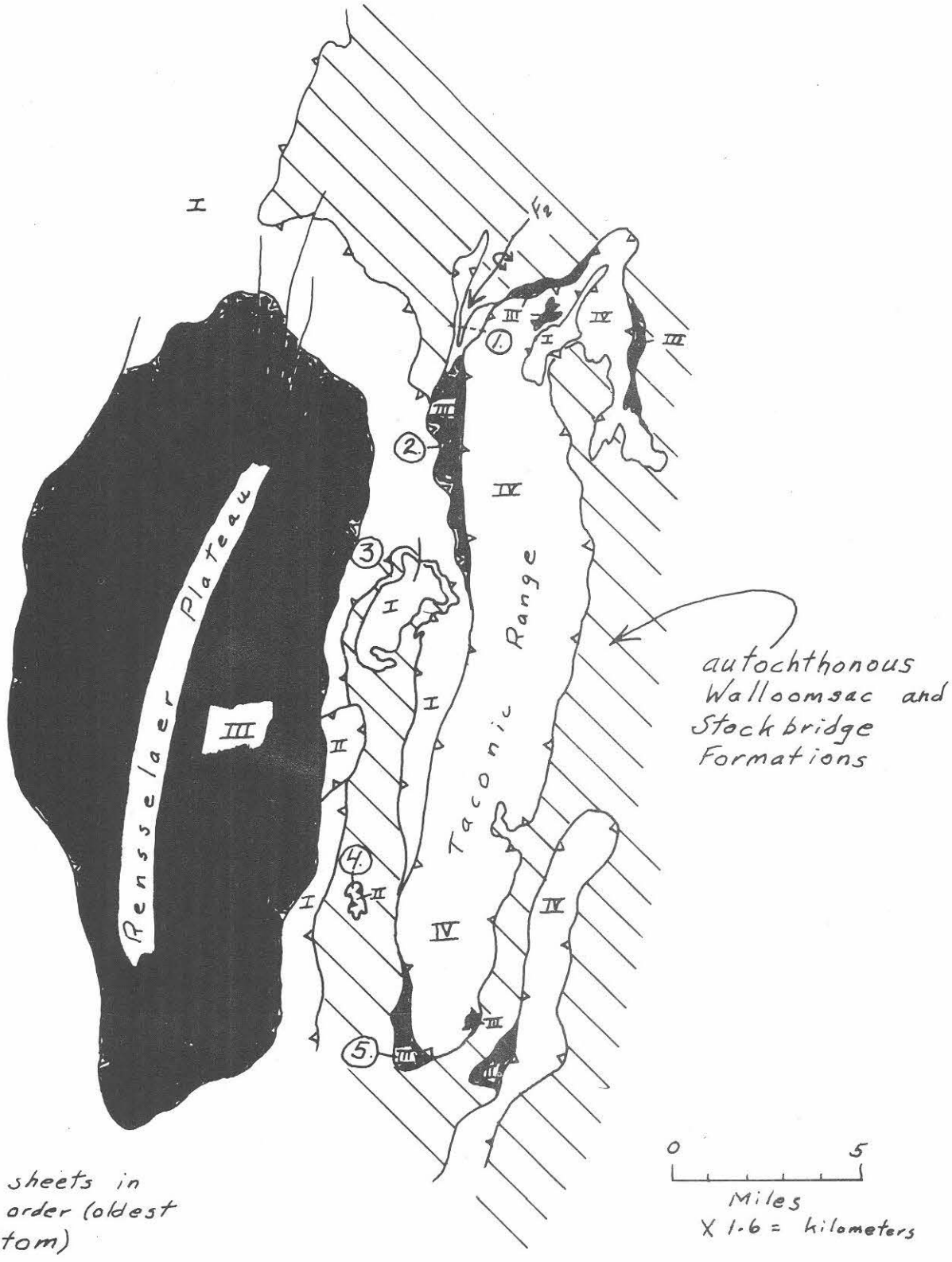


Figure 2. Tectonic sketch map, central Taconic region

I. The Giddings Brook thrust sheet, a name from the northern Taconics and worthy of perpetuating in the central Taconic region, consists of very distinctive stratigraphic units (Figure 3.) several of which are fossiliferous. The dominant thrust sheet in the Taconic allochthon, it was emplaced in Mid-Ordovician time as a gravity slide. Beneath it in the central Taconic region is Mid-Ordovician Walloomsac slate with its Whipstock Breccia member, a wildflysch type of block and shale unit. The Giddings Brook thrust fault is recumbently folded, and the internal structure of the sheet itself is commonly that of a major recumbent anticline opening east with youngest formations at the base of the sheet.

II. The Butternut Hill thrust slices are small lenticular masses consisting of limestones and dolostones of the Stockbridge Formation with infaulted lenses of Rennselaer Graywacke. Near Berlin Village one of these slices truncates the trace of the Giddings Brook thrust fault and is, itself, truncated by the trace of the Rensselaer Plateau thrust fault. The Butternut Hill slices are envisioned as hard dry slices of rock dragged along the base of the advancing Rensselaer Plateau thrust sheet.

III. The Rensselaer Plateau thrust sheet consists dominantly of Rensselaer Graywacke with interbeds of maroon and green-gray slate. Near its base the Rensselaer sheet contains metavolcanic rocks. The position of the Rensselaer Plateau sheet structurally above the Giddings Brook is clearly indicated by numerous excellent exposures many of which have limestone or dolostone slices (Stockbridge Formation) at the thrust contact. This relationship is seen at Stop 2.

IV. Berlin Mountain thrust sheet. This name is given for the greenish and purple chloritoid-bearing slates and phyllites with few distinctive marker beds that make up the bulk of the Taconic Range. Berlin Mountain is a major crest in this range. That this is a separate thrust sheet is suggested by the following evidence: north of the Hoosic River (Stop 1) the chloritoid phyllites in question are separated from distinctive formations of the Giddings Brook thrust sheet by slices and slivers of Stockbridge carbonate rocks. The Giddings Brook sheet is isoclinally folded (F_2) with the Rensselaer Plateau sheet and both lie beneath the Berlin Mountain thrust fault. Also, the position of the Rensselaer Graywacke in the Taconic Range (Figure 2.) casts doubt on an earlier working hypothesis in this region which states that the

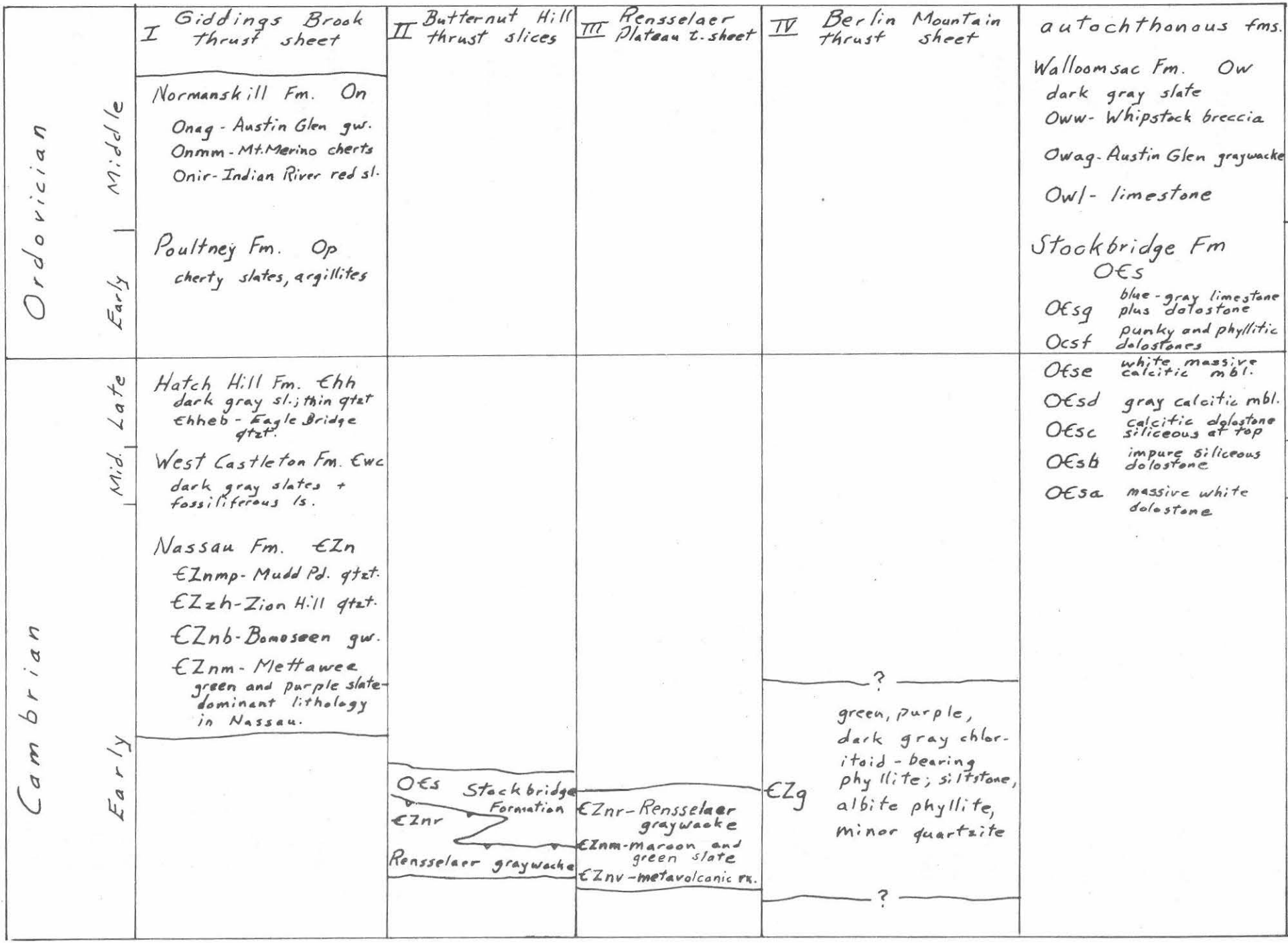


Figure 3. Stratigraphy of thrust sheets and autochthonous formations

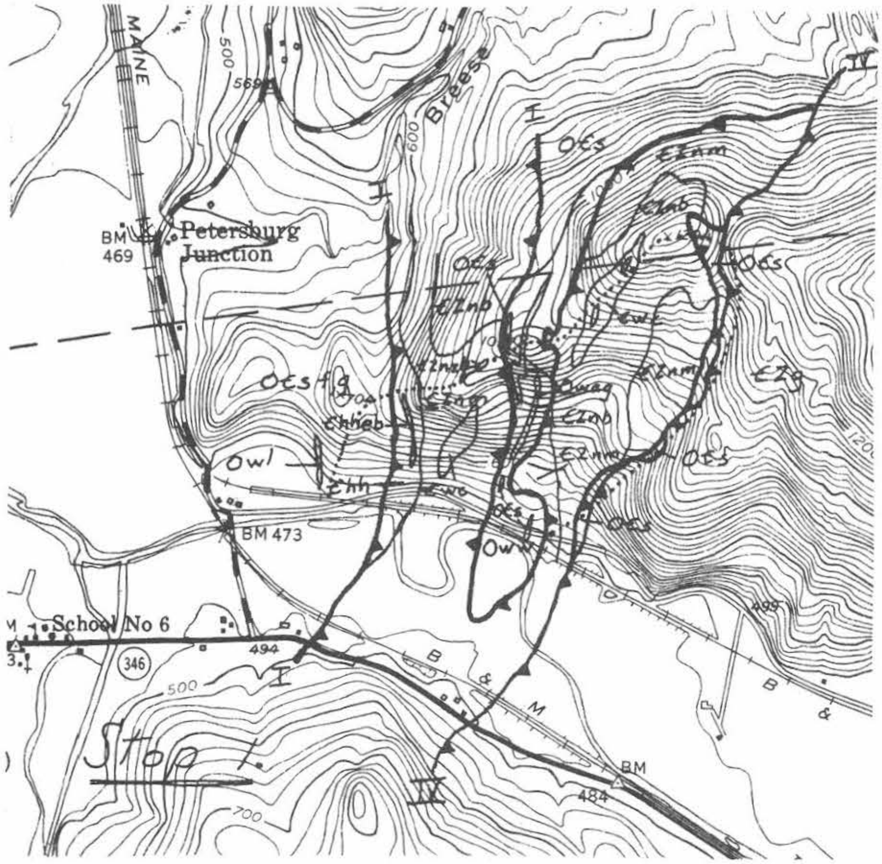
Rensselaer Graywacke was a basal stratigraphic unit in the thrust sheet that formed the range. The graywacke is seen to be limited to the north and south ends of the range and does not occur along the east or west edges nor in the center. Had that Rensselaer Graywacke been present as a stratigraphic unit at the base of the chloritoid phyllites it seems highly likely that it would now be found infolded with them. An alternate hypothesis is proposed: the Rensselaer Graywacke in the Taconic Range belongs to the Rensselaer Plateau thrust sheet; over the top of this was emplaced sheet IV, Berlin Mountain thrust sheet. Both sheets were subsequently cupped into a broad F_3 synform whose axis trends northwest - southeast. Subsequent erosion has exposed the older, Rensselaer Plateau thrust sheet, albeit patchily, at the north and south noses of the synform. Elsewhere the Rensselaer sheet is covered by the Berlin Mountain (IV) thrust sheet.

At least three stages of deformation are recorded. Initial large and small scale recumbent folding (F_1) occurred during the emplacement of the Giddings Brook sheet; the axial plane cleavage (S_1) that formed at this time has been subsequently rotated to a moderately steep southeast dip and has generally been overwhelmed by the development of a pronounced slip cleavage (S_2). This slip cleavage is co-planar with the axial planes of F_2 folds, isoclinal to asymmetrical with axial planes dipping east or southeast. F_2 folds are seen in the outcrop pattern at Stop 3; and a large south-plunging isoclinal anticline involving the Giddings Brook and Rensselaer Plateau thrust sheets is interpreted to be an F_2 fold at Stop 1. F_3 folds have northwest-trending axes. At Stop 3 they bring to the present surface the south-plunging Giddings Brook thrust fault and account for the northwest-southeast outcrop pattern superposed on a large F_1 recumbent fold there; also, F_3 folding accounts for a major fishook pattern on the east side of the Taconic Range. The doubly plunging synform of the Berlin Mountain and Rensselaer Plateau thrust sheets in the Taconic Range probably is an F_3 fold, and the Hoosick Falls embayment (west of Bennington, Figure 1.) is probably produced by erosion of an F_3 anticlinal warp.

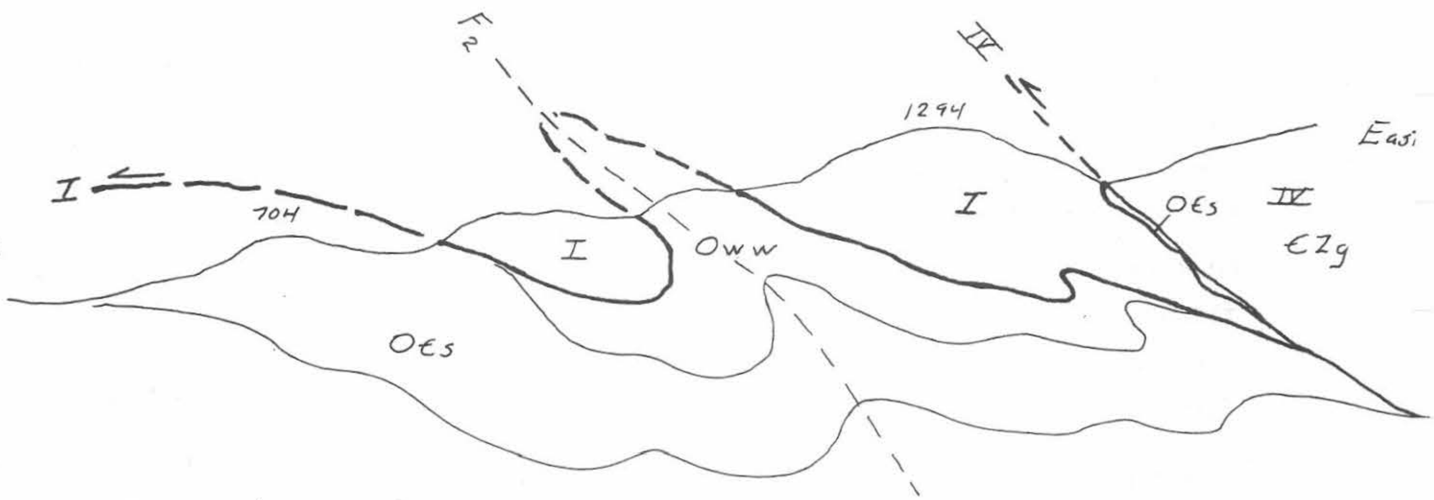
ROAD INFORMATION (Troy to North Petersburg Rts. 7 and 22)

From the RPI campus we will take Route 7 northeast across the Giddings Brook thrust sheet and gain some appreciation of the glacial drift in this

Stop 1.



North Pownal 7½' Quad.



Schematic structure section along ridge crest (route of Stop 1 traverse) from elevation point 704 to 1294. See Figure 3 for stratigraphy. Thrust faults and thrust sheets numbered according to Figure 2.

I - Giddings Brook thrust sheet
IV - Berlin Mountain thrust sheet
.... traverse route

part of the Taconics. About 8 1/2 miles out we see the bold escarpment of the Rensselaer Plateau to the east. The base of this escarpment marks the trace of the Rensselaer Plateau thrust fault and the rocks of the plateau comprise the thrust sheet of that name. Our route continues on the Giddings Brook thrust sheet and skirts around the north end of the Rensselaer Plateau. After passing over Potter Hill and signs that direct one south to Babcock Lake, we start to descend into Shingle Hollow. We are now traversing across younger formations on the inverted limb of the recumbent nappe that makes up the Giddings Brook thrust sheet. The major formation in the hollow is the Bomoseen Graywacke. We cross the Giddings Brook thrust fault at a bend in the road where there is a picnic area, so that when we reach the intersection of Route 22 we are about 0.4 mile into the autochthonous formations. We turn right (south) on Route 22 and traverse across Walloomsac and Stockbridge Formations to North Petersburg, with the trace of the Giddings Brook thrust at the base of the steep hills on our right. The Giddings Brook thrust sheet on the steep slopes displays spectacular large recumbent folds, first recognized by Prindle and Knopf (1932).

ROAD LOG

00.0 North Petersburg, intersection of Routes 22 and 346; go east on 346;
00.5 turn left (north) on Green Road, cross B&M railway and Hoosic River;
00.8 turn sharp right 200 feet north of river and follow river road east for 0.3 mile; cross rail spur and PARK HERE to start a round trip traverse two miles in length with a climb of 800 feet.

STOP-1. The aim of this traverse is to demonstrate the anticlinally folded Giddings Brook (I) thrust sheet with Stockbridge Formation beneath the thrust fault to the west, and chloritoid schists of the Berlin Mountain (IV) thrust sheet above the Giddings Brook to the east. The latter contact is marked by long slivers of limestones and dolostones (Stockbridge Formation). A large F_2 anticline is indicated by the exposure, half-way through this traverse, of autochthonous formations - Whipstock Breccia and Austin Glen Graywacke members of the Walloomsac - beneath the folded Giddings Brook thrust fault.

In the fields above the parking location are limestones and dolostones of

the Stockbridge Formation (probably units F and G). One layer in this sequence yields early Ordovician brachiopods. Other layers in these fields carry Post-Canadian brachiopods, ostracods, trilobites, bryozoa and are mapped as Walloomsac limestone (Owl).

Crossing the Giddings Brook Thrust Fault at the saddle, we encounter various formations of the G. B. thrust sheet: medium-light gray, some dolomitic slates (Poultney); dark gray and black slates (Hatch Hill) enclosing the Eagle Bridge Quartzite; green-gray slate (Mettawee) and Zion Hill Quartzite. At the 1027 crest we cross the Giddings Brook thrust and see autochthonous rocks of the Walloomsac Formation. The dominant lithology here is the Whipstock Breccia, a dark gray slaty rock crowded with rusty and white-weathering chips of siltstone and sandstone. The Whipstock encloses lenses of sheared limestone and dolostone (Stockbridge Fm.) and lenses and beds of Austin Glen Graywacke. The Whipstock is interpreted to be a submarine slide breccia facies of the Walloomsac, deposited in front of the advancing Giddings Brook thrust sheet and containing blocks and lenses of the Taconic Sequence as well as of the Stockbridge Formation and the co-deposited Austin Glen Graywacke.

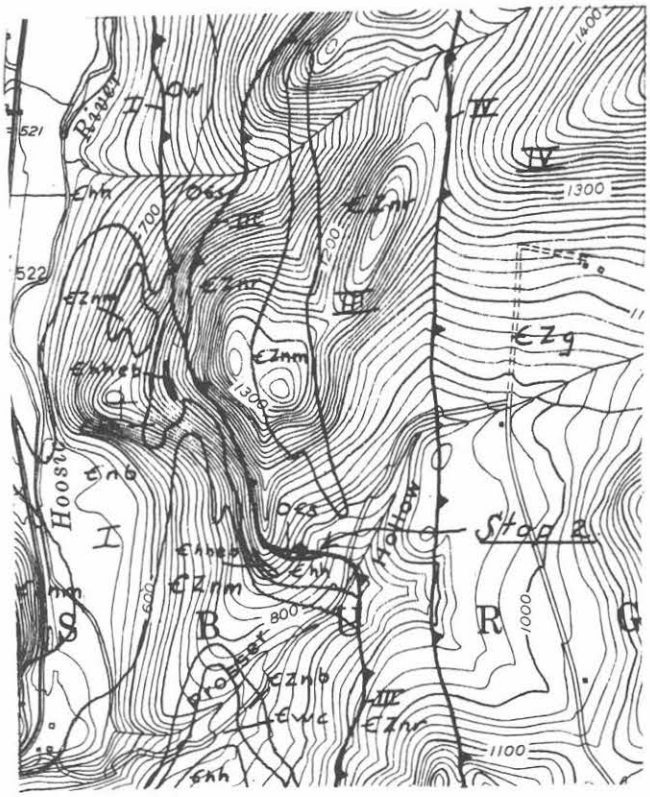
From crest 1027 to crest 1294 we cross the Giddings Brook thrust again and then traverse across variably foliated olive-weathering siltstone (Bomoseen), and dark gray slates containing limestone lenses (West Castleton); east of crest 1294 we encounter a large sliver (2000 feet long and up to 200 hundred feet wide) of sheared limestones and dolostones (Stockbridge Formation) which marks the sole of the highest thrust sheet (Berlin Mountain (IV) Thrust Sheet). The dominant lithology of the Berlin Mountain sheet is green and purple chloritoid schist, with coarsest chloritoid commonly near the thrust fault.

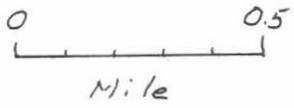
Return to parking area by traversing along the trace of the Berlin Mountain thrust sheet marked by slivers of carbonate rocks. Retrace route to North Petersburg.

00.0 Intersection of Routes 346 and 22 at North Petersburg. Turn left (south) on Route 22.

00.6 - 00.8 Large exposures of recumbently folded Stockbridge (unit G) and Walloomsac limestone on right (west) side of highway.

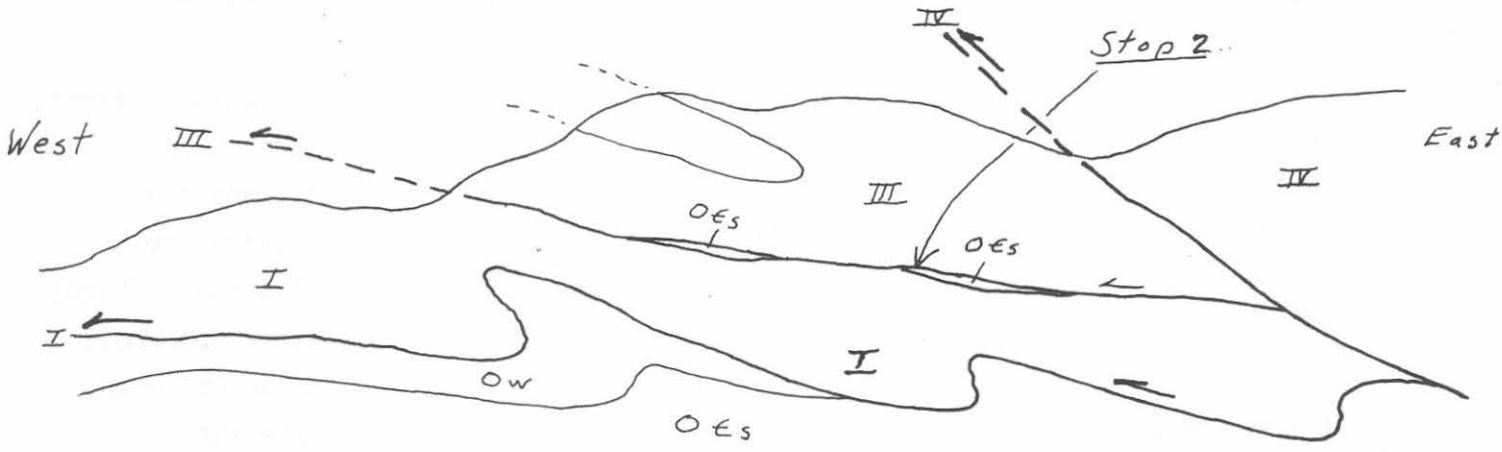
Stop 2.





North Pownal 7½' Quadrangle

See Figure 3 for stratigraphy. Thrust faults and thrust sheets as in Figure 2. I - Giddings Brook, III - Rensselaer Plateau, IV - Berlin Mountain.



Schematic structure section at Stop 2.

01.5 Cross trace of (Giddings Brook) thrust fault, and proceed south on Taconic Sequence formations near base of G. B. thrust sheet.

01.6 Barn on east side highway, house on west. Bold cliffs on Taconic Mountains to east are Rensselaer Graywacke near base of Rensselaer Plateau thrust sheet.

02.3 Bomoseen Graywacke on right side of highway.

02.4 - 02.9 Massive exposures of Mettawee slate on west side of highway. These slates are at the core of the Giddings Brook nappe.

02.9 Junction of Prosser Hollow Road and Route 22; turn left (east) on Prosser Hollow Road.

03.1 Cross Little Hoosic River.

03.8 Woods Road to left. Unload for STOP-2. Walk up to spur for exposure of Rensselaer Plateau thrust fault.

STOP-2. Exposure of the Rensselaer Plateau thrust fault north of Prosser Hollow. Below the thrust fault is an apparently normal sequence of Bomoseen, Mettawee, and Hatch Hill (with Eagle Bridge Quartzite) - all part of the Giddings Brook thrust sheet. The Rensselaer Plateau (III) thrust fault is marked by slivers of limestone and dolostone (Stockbridge Formation) that have been tectonically dragged to their present positions. Immediately above the Rensselaer Plateau thrust is the Rensselaer Graywacke, perhaps several hundreds of feet thick and intensely sheared. The Graywacke is faulted against chloritoid schist 0.3 miles east of this stop, at the trace of the Berlin Mountain thrust fault.

The following details of the Rensselaer Plateau fault zone are noted. First, the Rensselaer Graywacke above the thrust is mylonitic through a zone approximately 150 feet thick (measured perpendicular to foliation), and the mylonitic foliation is concordant with normal foliation above and below the thrust zone. Second, the thrust plane truncates the mylonitic foliation. Third, a well-developed foliation parallel to the thrust plane occurs in the uppermost 2-3 feet of the limestone. Numerous other structural features may be observed. Widely spaced fractures, parallel to the thrust plane, also truncate the foliation and show a similar sense of movement to that on the thrust. Several warps in the thrust plane apparently represent areas where (later) movement on the thrust has locally followed the foliation instead of cutting across it.

Near the upper (western) end of the outcrop, a sliver of mylonitic graywacke about 5' x 5' is completely enclosed within the limestone. West of this, the thrust plane steepens and follows the trend of the foliation in the graywacke for an indefinite distance.

The earliest structural event well-represented at this stop is the formation of the pervasive axial plane foliation, S_2, and the accompanying regional metamorphism. Emplacement of the graywacke along the Rensselaer Plateau Thrust may have occurred prior to the formation of S_2. Evidence for this is the occurrence in several places along the thrust of tectonic slivers of autochthonous carbonates around which S_2 has been refracted.

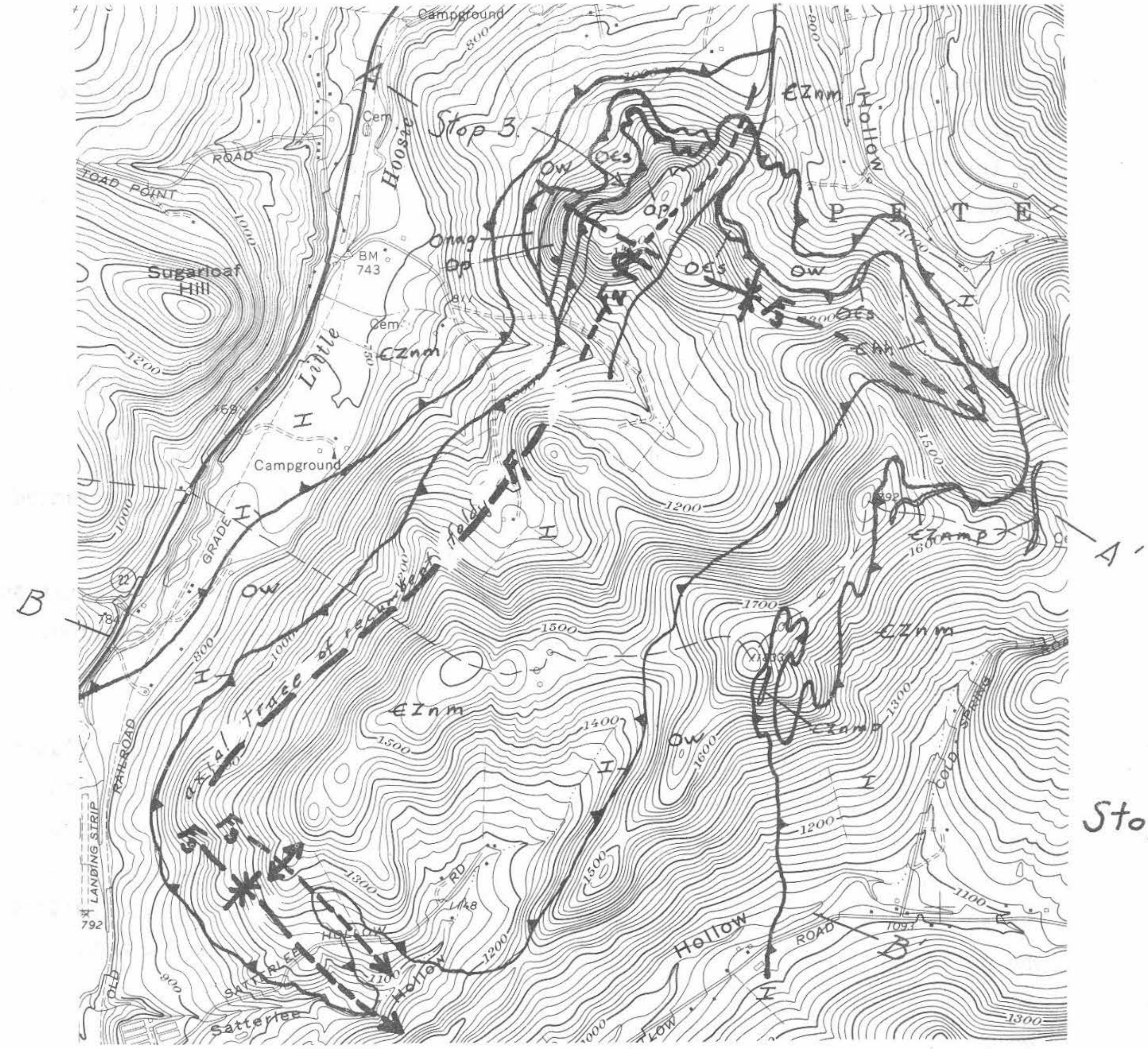
The mylonites either were pre S_2 and rotated into their present orientation during the formation of S_2, or else formed at the same time as the foliation. The latter explanation is preferred.

Following S_2, minor movement occurred between the Graywacke and the slates beneath. This movement caused the presently observed thrust plane, the thin zone of well-developed foliation in the upper few feet of the limestone, and the low angle fractures in the rocks immediately above and below the thrust. Perhaps we are seeing the results of a stick/slide phenomena of thrust faulting and not desrete periods of foliation formation followed by minor movement.

Return via Prosser Hollow Road to Route 22.

04.7 Intersection of Prosser Hollow Road and Route 22. Bomoseen and Mattawee members on west side of Route 22. Turn left (south) on 22.

From here to Petersburg we are in the lower part of the Giddings Brook thrust sheet which has a recumbent anticline structure. Formations exposed in the channel of the Little Hoosic, or near road level, are typically younger formations of the Taconic Sequence on the inverted limb of the recumbent anticline; higher on the east and west slopes of the Little Hoosick Valley are older formations of the nappe, and above these is the Rensselaer Plateau thrust sheet.

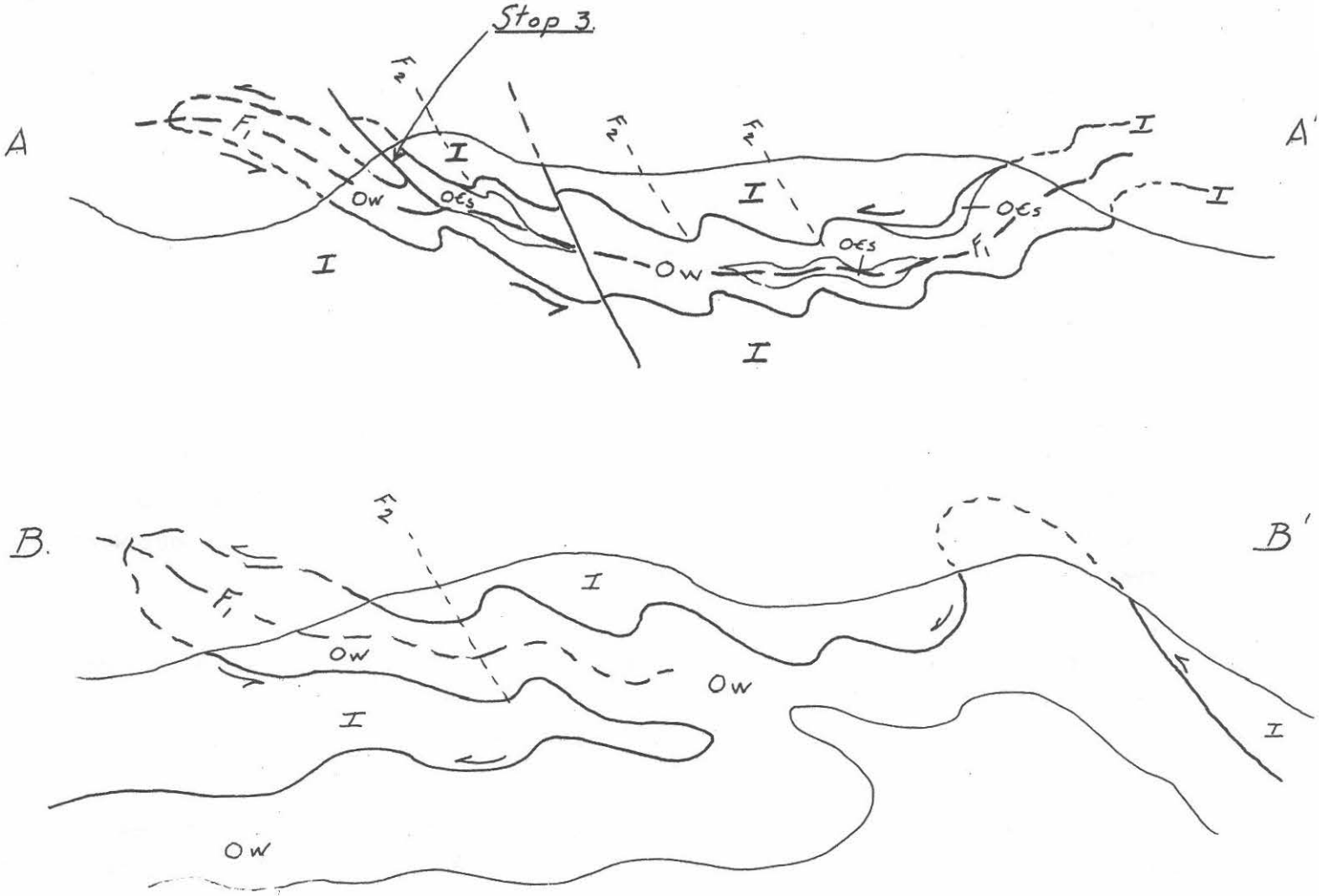


Stop 3.

Berlin 7½' Quadrangle

0 — 0.5
Mile

Stop 3. See Figure 3 for stratigraphy.
I - Giddings Brook thrust fault and thrust sheet.



Schematic structure sections across Jones Hollow - Satterlee Hollow refolded recumbent (Stop 3)

06.3 - 06.5 Mettawee on right.

06.6 - 06.8 Mettawee on right.

07.1 Intersection of Routes 2 and 22; turn left (east) just before overpass and proceed through downtown Petersburg.

07.5 After crossing bridge over Little Hoosic River, turn right on Town Road leading to Jones Hollow.

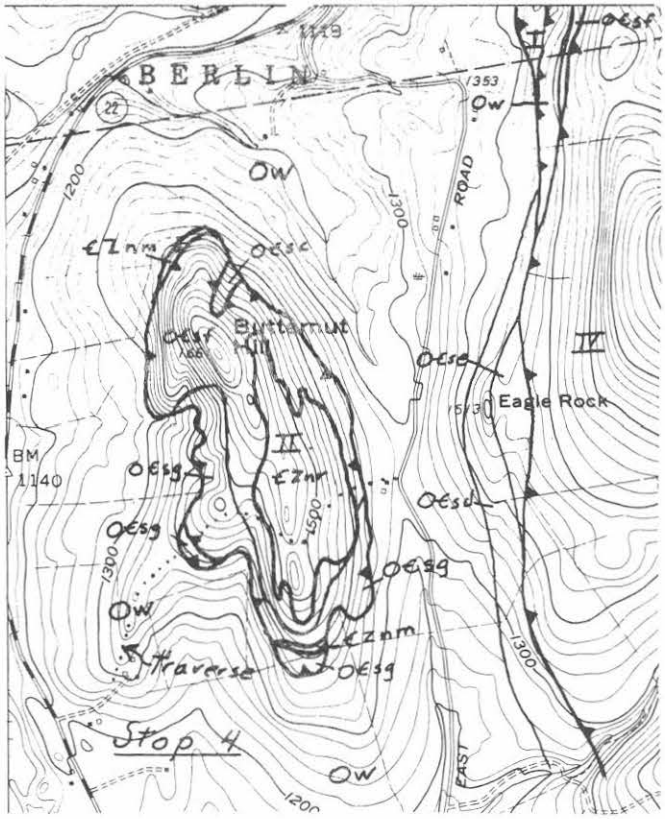
07.7 Jones Hollow Road goes left; keep straight.

08.0 Bear left at intersection and proceed uphill on residential dirt road 0.7 miles park near log house.

STOP-3. Jones Hollow-Satterlee Hollow refolded recumbent. The southward plunge of the Giddings Brook thrust is interupted here by F_3 cross-folds bringing the sole of the Giddings Brook thrust and underlying Walloomsac to the surface. Walloomsac floors the valley of the Little Hoosic River southward from this point.

The JH-SH recumbent covers an area about two miles long and one mile wide. Its outcrop pattern and small scale structures indicate three stages of deformation. The core of the large recumbent fold is marked by Walloomsac slate, and by Stockbridge units F and G.; its upper limb consists of slates of the Mettawee and Poultney formations; its lower limb consists of Mettawee slates, Mudd Pond Quartzite, Hatch Hill Formation. The stages of deformation can best be understood by referring to the map pattern and section. On the map the upper limb has the pattern of a 2 mile-long ram charging northeast. The ram's back gives the northeast trace of the axis of the recumbent fold (F_1); the axial plane cleavage (S_1) associated with this recumbent fold has been rotated from its presumed low angle of dip and it is not as easily seen as is S_2. The second stage of deformation resulted in a northeast - striking slip cleavage (S_2) which dips 35-50 degrees southeast and is co-planar with axial planes of F_2 folds. The ram's head and chest are produced by F_2 folds and the northeast - trending fault that truncates the ram's nose is parallel to S_2. Northwest - trending F_3 folds form the pointed foreleg and the ram's tail.

Stop 4.



0 0.5
Mile

Hancock 7½' Quadrangle

Stop 4. Buttermut Hill thrust slice. See Figure 3 for stratigraphy. See Figure 2 for thrust slices.
I - Giddings Brock, II,- Butternut Hill, IV - Berlin Mountain

We will visit outcrops of Walloomsac and Stockbridge units F and G in the core of the recumbent fold, and the Poultney and Mettawee formations on the upper limb. Of particular interest are the long splinters of Poultney slate formed by S_1-S_2 intersection.

Return to Route 22 via Petersburg

09.6	Overpass of Route 2 over Route 22. Turn left (south). Jones Hollow-Satterlee Hollow recumbent forms prominent hills at 10-11:00 o'clock.
10.0 - 10.4	Outcrops on both sides of road of green Mettawee slate
11.5	Mettawee slate on right in woods. Outcrops above this on east slope on Sugarloaf Hill show pronounced development of S_1 and S_2 cleavages.
12.0 - 12.1	Mettawee slate on right.
12.3	Mettawee slate on right.
14.3	Berlin - Taconic Valley Bank on left, sign to sheriff's office on right.
15.2 - 15.5	On the right (west) side of road, large outcrops of Stockbridge limestones and dolostones (units D and E) which are part of the Butternut Hill thrust slice.
16.7	Little Hoosic River at center Berlin.
17.5	Berlin Lumber Co., Inc.
18.6	Cherry Plain Rd. on left.
19.1	Derby Lane on left.
19.4	Walloomsac slate on right.
19.8 20.1	Walloomsac slate on left.
21.1	Walloomsac slate on both sides of road; turn left (east) off Route 22 on residential Road.

STOP-4. Butternut Hill. We will traverse 3/4 mile east over the top of Butternut Hill to East Road where we will be picked up by busses.

The purpose of this stop is to see one of the smaller thrust slices in this part of the Taconic allochthon: the Butternut Hill (II) thrust slice. The age of its emplacement relative to other thrust sheets cannot be

demonstrated here for it is simply floating in Walloomsac. However, one-half mile south of the village of Berlin, an identical thrust slice cuts the trace of the Giddings Brook thrust fault and is, itself, truncated by the Rensselaer thrust fault, thus establishing the Butternut Hill slice as number II in a series of IV sheets or slices.

The Butternut Hill slices (they are not connected) consist of various members of the Stockbridge Formation with in-faulted Rensselaer Graywacke. This distinctive combination of autochthonous carbonate formations and massive allochthonous turbidite can be found as scores of slices ranging from 2 miles^2 in area (Berlin Village locality) down to slices a few a few feet in length. The slices are generally tucked up under the Rensselaer Plateau thrust fault and may simply represent slabs of Stockbridge carbonate formations into which the Rensselaer Graywacke was neaded as the Rensselaer thrust sheet advanced. Some features of the Butternut Hill slices still remain a puzzle: Why wasn't Walloomsac drawn up with the Stockbridge in these slices? Why do we see only one lithology of the Taconic Sequence (Rensselaer Graywacke) in these slices?

Our traverse will take us across Walloomsac which displays S_1 and S_2 cleavages; a thin mylonite zone; units G and F of the Stockbridge; Rensselaer Graywacke and associated green phyllite.

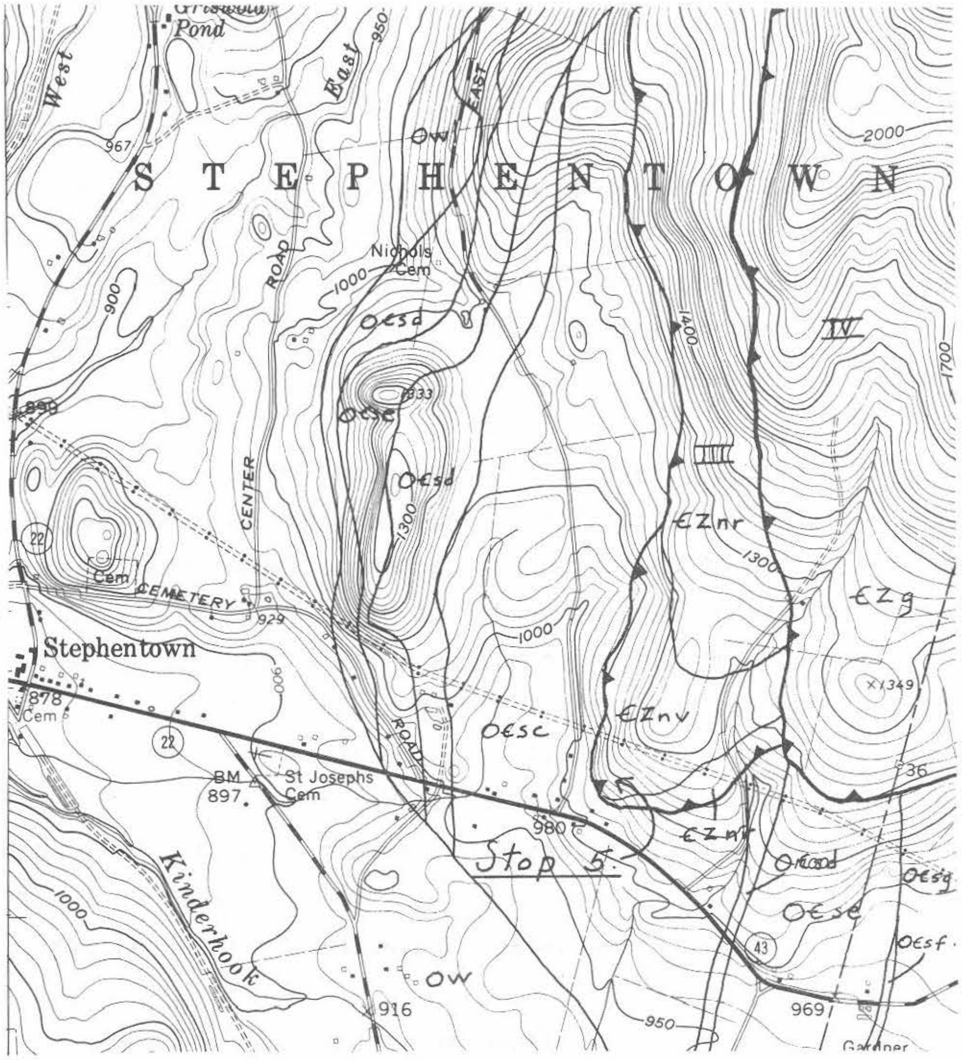
23.5 East Road, 0.2 mile southwest of Eagle Rock. Drive south on East Road to intersection with Giles Road.

24.4 Intersection of Giles Road and East Road. Drive south on East Road. Gentle slopes on your left (east) underlain by Walloomsac and Stockbridge formations; above these on the steep slopes is a thin wedge of the Rensselaer Plateau (III) thrust sheet and above that the Berlin Mountain (IV) thrust sheet.

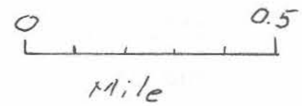
26.2 Intersection with Jones Road, keep straight.

26.9 Stockbridge (unit D) thin platy gray limestone on left.

28.2 Turn left (east) about four hundred feet north of the intersection with Route 43.



Stop 5.



Hancock 7½' Quadrangle

Stop 5. Metavolcanic rock and Rensselaer graywacke in Rensselaer Plateau thrust sheet (III). See Figure 3 for Stratigraphy. Figure 2 gives thrust sheets. IV is Berlin Mountain thrust sheet.

Schematic structure section of major structures at Stop 5.

STOP-5. Volcanic rocks and Rensselaer Graywacke at the base of the Rensselaer Plateau Thrust sheet.

Here, as at many localities along the east edge of the Rensselaer Plateau and to the southeast, the base of the Rensselaer Plateau thrust sheet is marked by a dark green hard metavolcanic unit rich in epidote and chlorite. At one locality within the graywacke terrain on the plateau a similar volcanic unit displays pillow structure. Elsewhere, as at the present locality, the metavolcanic rock appears banded to massive and is characteristically highly deformed. The parent rock was probably a mafic tuff or flow.

We will examine the outcrops of deformed metavolcanic rock and then traverse about 1/4 mile north to see the overlying Rensselaer Graywacke.

END OF TRIP

Return to Troy by going west on Route 43 to Route 66, then northwest on Route 66 to Troy.

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