# A TRIP TO THE TACONIC PROBLEM AND BACK AND THE NATURE OF THE EASTERN TACONIC CONTACT

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## INTRODUCTION

The purpose of this paper is to provide background information needed for both the full-day trip (Saturday, Sept. 28) and the half-day trip (Sunday, Sept. 29). The full day trip involves data from the entire paper while the half-day trip concentrates on the Taconic Problem primarily. However, to understand either day fully, the entire paper must be read. A separate Road Log for each trip is provided at the end of the paper.

The paper describes geologic features to be examined in area from Saratoga Springs, N.Y. to Manchester, Vt. A discussion and overview of the Taconic region and the "Taconic Problem" will be presented. Consideration will be given to both the sequential and fault hypotheses proposed for the High Taconic region.

The Taconic region is subdivided into the High Taconics and the Low Taconics based on the extreme difference in relief. The High Taconics are the mountains of Vermont, west of the Vermont Valley, with elevations of approximately 3000-4000 ft. The Low Taconics are the hills primarily in New York, west of the High Taconics, with elevations up to approximately 1500 ft. (Hewitt, 1961a). Lithologic and other distinctions will become apparent in the later discussion.

## LOCATION

The trip extends from Saratoga Springs, N.Y. to the area of Schuylerville, N.Y., across the Hudson River to a location south of Cambridge, N.Y. From there the trip continues eastward to the area of West Arlington and Sandgate, Vt., then to Arlington and north to Mt. Equinox and Manchester, Vt. Figure 1 shows the route. Each Stop is located with the approximate mileage between Stops. The basic geology is superimposed on the map.

Topographic maps useful for the area include the Saratoga, N.Y., Schuylerville, N.Y., Cambridge, N.Y.-Vt. and Equinox, Vt. quadrangles. All are 15 minute maps though 7½ minute maps are readily available.

## GEOLOGIC SETTING

### Stratigraphy

The Saratoga Springs area is underlain by early Paleozoic shelf deposits consisting of gray, massive dolostones and associated sandstones and orthoquartzites of Cambrian to early Ordovician age and dark to black

LEGEND

LOW TACONICS

THRUST FAULT

HIGH TACONICS

FIGURE 1

GENERALIZED MAP OF FIELD TRIP AREA

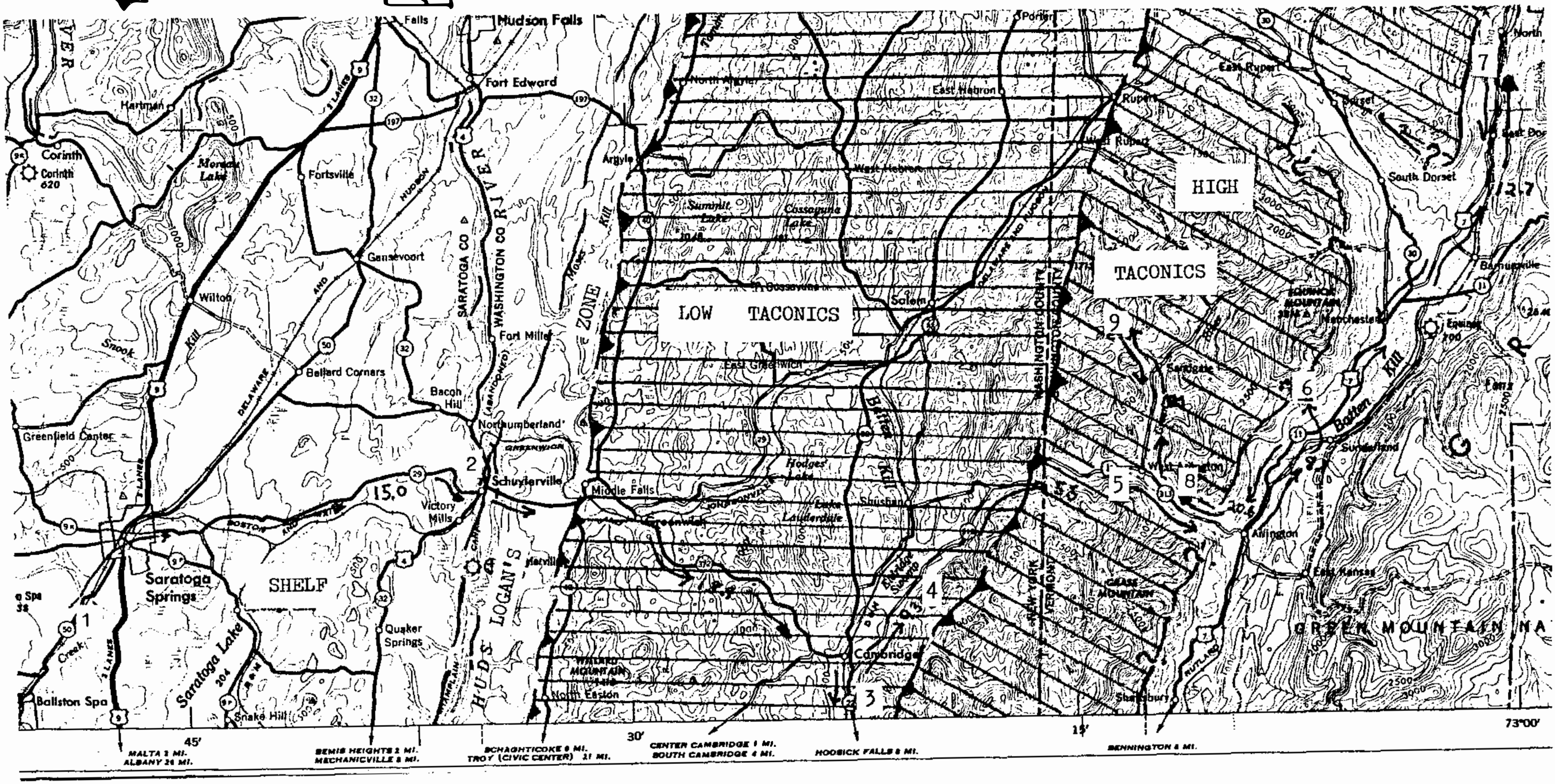
C.I.= 100'

SCALE

1: 250,000

0 5 10





shales of the medial Ordovician age. The Vermont Valley portion of the Equinox Quadrangle is remarkably similar to the lower part of this sequence. The Low Taconics and the lower part of the High Taconics are very similar to the medial Ordovician strata at Saratoga Springs except that they have been metamorphosed. The lower part of the Low Taconic sequence is composed of slates (Mettawee slate, Cushing and Ruedemann, 1914). These and medial Ordovician slates in the Low Taconic sequence are best exposed in the northwest part of the Equinox quadrangle and localities to the north of that area. Some green slaty strata on Route 313 east of Cambridge, N.Y. are generally assigned to the Mettawee and these will be examined at that locality. Additionally, clean calcic marbles of commercial quality and quantity (the Marble Belt) appear in the Ordovician sequence in Vermont.

Finally, the topographically highest unit, the age of which is still uncertain, is the green phyllite variously called the Mt. Anthony formation (MacFadyen, 1956; Hewitt, 1961a) and the Bull formation (Zen, 1959). The age of this unit is considered by some workers (Zen, 1959; Schumaker, 1959) to be Cambrian and to be totally allochthonous, that is, thrust over the known medial Ordovician carbonates. Others (Hewitt, 1951a; MacFadyen, 1956) suggest that these highest green phyllites lie unconformably in some places and gradationally in others upon the middle Ordovician carbonates. In this case, the green phyllites capping the High Taconics would be medial Ordovician or later in age and therefore younger than the carbonates. Table 1 is a list of the relevant formations and the correlations which must be considered in understanding the problem. For a more complete discussion of the stratigraphy see Fisher (1965) and Hewitt (1961a) or the several publications listed in the References.

## Structure

The beds in the Saratoga Springs area are generally quite flat-lying but are disrupted in many localities by numerous normal faults, some of which give rise to the carbonated and mineralized water of the Saratoga Springs. Although these faults will not be examined on this trip, their presence may be inferred at Stop 1 in Saratoga State Park (Hewitt *et al.*, 1965 p. D3-D10).

East of Saratoga Springs and west of the Hudson River in the vicinity of Schuylerville, N.Y. Logan's Line, better described as Logan's Zone is encountered. This is a broad, extensive north-south trending zone of reverse faults along which rocks of the Low Taconic area were thrust over the correlative westerly shelf deposits. More eastwardly are the very highly folded, thrust faulted and metamorphosed Taconic strata. Thrust faults are well known and documented with plentiful evidence available to demonstrate their presence (Hewitt, 1961a; Zen, 1959, etc.) All of the thrust faults, with one exception, display the usual criteria of faulting such as breccia, mylonite, gouge, displacement of key beds and so on. Slickensides cannot be used in this area because all of the beds display this feature as a result of the shearing which accompanied the intense folding.

TABLE 1
List of Formations with Probable Correlations

| | SHELF | TACONICS - Valley Sequence |
|---|---|---|
| Medial Ordovician | Snake Hill shale = Canajoharie (?) | Mt. Anthony Fm. green phyllite<br>(?) Lower Mt. Anthony marble? black phyllite?<br>Wallomsac slate (?) |
| Early Ordovician | Shoreham limestone<br>Larrabee limestone<br>"Amsterdam" limestone<br>Gailor dolostone | Bascom-Beldens dolomitic and calcic marble<br>Shelburne Fm.<br>Columbian marble<br>Intermediate dolostone<br>Sutherland Falls marble |
| Late Cambrian | Little Falls - Hoyt dolostone<br>Mosherville sandstone<br>Potsdam sandstone | Danby-Clarendon Springs dolostone and quartzite |
| Medial Cambrian | | Winooski dolostone |
| Early Cambrian | | Monkton quartzite<br>Dunham dolostone, Cheshire quartzite (Mettawee?)<br>Mendon Formation |
| Precambrian | | Mt. Holly Fm. gneiss |

Uncertain position - may be Cambrian or Ordovician

West Castleton - siltstone w/black shale, etc.

CAMBRIAN BULL FM.:
- Castleton Conglomerate with limestone pebbles
- Mudd Pond - orthoquartzite
- Zion Hill - graywacke to subgraywacke - quartzite graded beds common
- Bomoseen graywacke
- Mettawee Fm. purple and green slates

Biddie Knob Fm. purple and green slates

After Zen (1959)

One proposed fault, and a highly important one that does not display such evidence is the thrust suggested by Zen (1959) and others along the east flank of the High Taconics, the so-called "Taconic Thrust", between the middle Ordovician carbonates and the overlying green phyllites. In this case no breccia, mylonite or gouge is present. The lack of this evidence does not of itself preclude the presence of a fault along the bedding (a bedding plane fault). The green phyllites lie in various localities in sharp contact upon black phyllites, dolomitic marble and other units but in other places there is an apparent gradation between the dolomitic marble (medial Ordovician) and the overlying green phyllites (Hewitt, 1961a; MacFadyen, 1956). Both authors refer to these green phyllites as the Mt. Anthony formation. The nature of the gradation is reserved for later in this paper. Zen (1959) and Shumaker (1959) among other authors propose a fault based on their inference of the equivalence of the green phyllites with other strata of known Cambrian age. If this is true and the green phyllites are of Cambrian age and are on top of the carbonates, then older beds are thrust over younger beds and a fault is present. If on the other hand, there is a gradation anywhere along that contact, an unconformity is more likely. This will be further discussed in a later section.

In addition to faulting very intense folding is evident. The entire Taconic area comprises a large synclinorium. With such complex folding it is often difficult to determine whether beds are right-side-up or not. Folds are often severely overturned to the west, isoclinal or even recumbent. Careful and detailed study is required to delineate the major structures. However, both sedimentologic and stratigraphic evidence are available to suggest a solution in most cases. The section along Route 313 from the N.Y.-Vt. border eastward displays the complexity of the folding. Both bedding plane and axial plane cleavage are well developed. In some localities more than one episode of deformation is apparent as shown by the intersection of axial plane cleavage. Folds may be recumbent or have dips as steep as 45°. Most dips are approximately 20°-30°SE.

## Unconformities

At least one unconformity has been firmly established in the area of concern. MacFadyen (1956) indicated the presence of an unconformity between the lower Ordovician and the overlying Walloomsac slate. Thompson (1959) apparently recognized the same unconformity and indicated that strata as old as Cambrian were truncated by this erosion surface. Other unconformities exist in the Vermont Valley but they do not affect the area of this paper.

The only other unconformity of interest in the area is the one suggested by Hewitt (1961a) between the Mt. Anthony formation (the highest green phyllites) and the underlying Ordovician carbonates. This unconformity lies at the precise horizon at which the "Taconic Thrust" must lie. Therefore, the basic question revolves around the nature of that contact. Therein lies the "Problem".

## THE PROBLEM AND POSSIBLE SOLUTIONS

The discerning reader has already discovered the basis of the present-day Taconic Problem. The original "Problem" was based upon Ebenezer Emmons' use of the term "Taconic System" (1842, 1844). Emmons had failed to recognize that the rocks to which he applied this name were actually a section of Cambrian rocks which were repeated due to faulting. The confusion caused by Emmons was eliminated by Dana (1877, 1887) and Walcott (1888) with their demonstration that the term was invalid.

All of those who have studied the Taconic region agree that the Low Taconics are thrust to the west over the shelf deposits. The evidence along Logan's Zone is very clear. All of the faults from Logan's Zone eastward to the western edge of the High Taconics are well accepted.

Today, the only question to be resolved is the nature of the contact between the carbonates and black phyllites of medial Ordovician age and the green phyllites overlying them on the eastern front of the High Taconics. If the green phyllites, which are the highest units topographically are really Cambrian in age and equivalent to units far lower stratigraphically, then a fault must exist at its contact with the medial Ordovician carbonates and black phyllites but neither higher nor lower than that contact. If the fault were higher than that contact then the green phyllites, at least in part, might be younger than the carbonates and phyllites particularly if a gradation can be demonstrated anywhere along that front. If the fault were lower than that contact, known Ordovocian beds would lie above the fault. Neither situation would satisfy those who would assign a Cambrian age to the green phyllites. No fossils have been found in the green phyllites nor is it likely that any ever will be. The lithology and the metamorphism suggest that no amount of searching will help. Radiometric dating is of no use, for it would provide only the date of metamorphism. If Zen's (1959) Bull formation is of Cambrian age, its equivalence with the Mettawee formation, Zion Hill quartzite and other units which are known to be Cambrian, must be based on lithologic and stratigraphic similarities. According to Zen (1959, 1960) and Schumaker (1959) such equivalence may be inferred if the green phyllite and its included lithologies are up-side-down.

In summary, if the eastern Taconic Thrust exists it lies between green phyllites of supposed Cambrian age which are inverted and above a normal, right-side-up section of sediments that, based on reasonable fossil evidence and tracing extends more or less continuously from early Cambrian through medial Ordovician. This is the only reasonable location for the "Taconic Thrust".

A second hypothesis has been proposed by this author (Hewitt, 1961a, 1961b). In this case, the green phyllites are considered to be younger than the underlying medial Ordovician carbonates and green phyllites. The contact between these units would then be an unconformity and not a fault. In the Equinox quadrangle graded bedding in a lithology similar but not identical to the Zion Hill indicates that the beds are dominantly right-side-up. Structural evidence implies this also since all folding is congruous. Carbonate and black phyllite folding matches the green phyllite folding in axial trends and scale.

More importantly, along the eastern front of the High Taconics no definitive evidence of faulting has been found. It is, however, possible in some localities (Cook Hollow, Skinner Hollow, West Sandgate Rd., for example) to observe a gradational contact between the carbonate-black phyllite surface and the green phyllite. Certainly the beds are interfolded but they also appear to be interbedded. In particular, the highest and last bed of carbonate displays the gradation. The bottom of the bed is totally carbonate and the top is totally phyllite. In other localities the contact between the carbonates (and/or the black phyllites) and the upper green phyllites is quite sharp.

If the above statements are accepted then the sequence of events using this second hypothesis is clear. Following deposition of the carbonates and black phyllites, uplift resulted in the erosion of these middle Ordovician strata. An irregular erosion surface, such as in our present landscape was formed with hills in some places and valleys in others. Erosion cut away at this surface, in part deeply into the carbonate and elsewhere into the black phyllite. As the sea advanced over this surface, erosion continued. Carbonate was worn off of the hills and into the submerged valleys. At the same time the sediment that was to become the green phyllite (after metamorphism) was added. This caused the gradation to occur. Once submergence was complete erosion of the small local hills ceased. Additional deposition buried both the hills and the valleys in the only sediment available., that is, the phyllite material. This would result in sharp contacts over the buried hills and gradational contacts in the buried valleys. Both sharp and gradational contacts were reported by MacFadyen (1956) in the Bennington quadrangle and by Hewitt (1961a) in the Equinox quadrangle.

## CONCLUSION

If there is to be a solution of this problem it is important that sections such as the one at Cook Hollow be studied with care. The traverse westward from Rt. 7 to the top of the landslide scar permits observation of a virtually complete section of rock including the relatively fossiliferous carbonate beds of medial Ordovician age (and other older units) and the green phyllites as well as the contact between them.

This paper will not describe what the author concludes is present at the Cook Hollow exposure. Rather, each individual should be permitted to decide what that observer notes along the traverse without further bias by the writer. However, certain factors should be considered by those who wish to examine the rocks along this traverse. The first factor of concern should be the nature of the carbonate sequence and its fossil content and the relationship of these strata to the green phyllites. Second is the character and lithology of the beds between the known middle Ordovician carbonate and the green phyllite. A third factor would be to consider the structural elements present. Fourth, the precise nature of the contact between the carbonates and overlying green phyllites should also be carefully examined. The precise lithology and sedimentology of the last bed or beds at the contact is a fifth point of importance. Care should be taken to note whether detrital or chemical (or both) carbonates are present. Lastly, one should note the scale of the proposed erosion surface. Other factors as well will undoubtedly occur to any qualified observer at the site.

There is no unanimity of opinion as to which concept is correct or if either is correct. It is possible that some other hypothesis will resolve the issue. What is certain, however, is that any solution must be based upon evidence in the field and not merely on regional considerations. Too often facts are ignored merely to satisfy "the big picture". This is not now nor has it ever been the way of science. It is important that careful research by impartial observers be pursued along the eastern face of the High Taconics.

## ACKNOWLEDGEMENTS

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## ROAD LOG FOR THE TRIP TO THE TACONIC PROBLEM AND BACK

This trip begins at Geyser Spring Parking Lot, Saratoga Springs State Park. To reach the Park from the center of Saratoga Springs, drive south on Routes 9 and 50 to the junction south of town. Bear right (southwest) on Route 50, 2.4 miles to the Park entrance on left (east) side of Route 50. Enter Park and drive 0.7 miles following signs to Geyser Springs Parking Lot. Park opposite the "Island Spouter". Please gather at the Spring. NOTE: NO HAMMERS IN THE PARK PLEASE!

### STOP 1. THE SPRINGS, TUFA TERRACE, AND FLAT-LYING SNAKE HILL SHALE

The Spring along the pathway is typical of the mineralized and carbonated springs in the region. Do taste the water but with caution. Firstly, the water at this Spring passes through the dark shale and therefore, contains iron and sulfur. The amount of sulfur is sufficient to "surprise" the unwary. Secondly, the water contains the radioactive gas radon. Thirdly, the bedrock from which the water rises is a dolostone and in addition to the calcium it contains magnesium. Therefore, this water is an excellent laxative. "A word to the wise is sufficient."

All of the springs are the result of the expansion, along the faults, of carbon dioxide gas released by the weathering of dolomite at depth. Acid water percolates downward to the dolostone, weathers the rock and forms mineralized water plus gas. As the water reaches the faults the carbon dioxide gas expands with the reduction of pressure and the gas carries the water to the surface.

The "Island Spouter" is, of course, not truly a geyser. In this case it is gas within a constricting pipe which allows the water to spurt into the air.

Walk north approximately 500 ft. along the path. Note dark gray to black flat-lying shale. Approximate equivalents to these shales (Snake Hill, Canajoharie?) will be seen later as metamorphic rock. These shales are medial Ordovician in age.

Note the Tufa Terrace. Formed of colloidal and precipitated calcium carbonate from the Spring on the hill above (west) the terrace. Here leaves and insect fossils are formed each year as the organic material is trapped, coated and then permineralized with the calcium carbonate.

| CUMULATIVE MILEAGE | MILES FROM LAST POINT | ROUTE DESCRIPTION |
|---|---|---|
| 0 | 0 | Park entrance. Exit here. Turn right (north) onto Rt. 50. |
| 2.4 | 2.4 | Junction Rts. 9 + 50. North. |
| 2.9 | 0.5 | Turn right (east) onto Rt. 29. |
| 8.5 | 5.6 | Sand dunes. Some totally and partially exhumed. Probably from Lake Albany equivalent. Note long axes to west. Possible 5 minute "extra" stop here if time permits. |
| 8.9 | 0.4 | View of Taconics ahead (east). |
| 13.1 | 4.2 | Saratoga National Monument on right. Battle of Saratoga took place here during Revolutionary War. |
| 13.9 | 0.8 | Junction Rts. 4, 32, 29. Turn left (north) at light. Canal and Hudson River on right (east). |
| 15.0 | 1.1 | Turn left (west) onto Stark's Knob Rd. |

STOP 2. STARK'S KNOB AREA. FOLDED, DISTORTED SHALE

Note badly distorted black shale on right side of road. These are equivalent of those at Stop 1 (Snake Hill). This is part of Logan's Zone and the rocks are faulted, badly fractured and somewhat metamorphosed. Note limestone and dolostone pebbles (gray to blue-gray) in shale and oxidation of parts of shale surfaces. Limestone and dolostones are not indigenous to this locality. They are from the area far to the east. We will see these later in the day <u>in situ</u>. The red oxidized zone probably represents a "baked" zone as the area moved westward during faulting. The "baking" might also have resulted from the emplacement of the basaltic pillow lavas of which Stark's Knob is composed.

Walk uphill and to the right for a quick examination of Stark's Knob. This is a flow of basalt (now pillow basalt) which apparently formed when lava flowed into the sea and across a shaly (or muddy) shoreline with fragments of limestone and dolostone present. The lava and the shale which enclosed it were later thrust westward during the faulting which produced Logan's Zone. We will see basic material similar to this lava but as dikes on Rt. 7 in Vermont. Stark's Knob was formerly used as road metal.

The basalt and the shale are both of medial Ordovician age. Return to cars.

| | | |
|---|---|---|
| 15.0 | 0 | Turn right (south) onto Rts. 4 & 32. Note folded black shales on right side of road along route. |
| 16.1 | 1.1 | Drive past light at intersection with Rt. 29. |
| 16.3 | 0.2 | Turn left (east) onto Rt. 29. Low Taconic area straight ahead (east). |
| 19.0 | 2.7 | Junction Rt. 40. Continue east on Rt. 29. |
| 19.4 | 0.4 | Crossing Batten Kill. |
| 20.8 | 1.4 | Greenwich, N.Y. Straight ahead on Rt. 372, through town and under old Railroad Bridge. |
| 29.5 | 8.7 | Cambridge, N.Y. |
| | 1.0 | Junction Rt. 22. Turn right (south). |
| 32.9 | 3.4 | Slow. Caution. Outcrop on left (east). Turn with great care facing cars to north (the direction from which we came). Park. |

STOP 3. FOLDED WALLOMSAC FORMATION

This outcrop exposes typical black slate and metamorphosed sandstone (now quartzite) of the Walloomsac formation. Strata here are strongly folded and thrust faulted. Cleavage is readily visible. There is some mineralization along the faults. Folds of various magnitudes may be observed here. This outcrop expresses well the folding in the Low Taconics. Virtually every bed is slickensided. Some folds show evidence of refolding.

No fossils have been found to verify the age of this outcrop. However, it maps well into the Walloomsac which is generally considered to be medial Ordovician (Trentonian) in age. It is probably correlative with the Snake Hill. However, lithologically it resembles the Austin Glen member of the Normanskill formation more closely. This unit is believed to be older than the Snake Hill but still medial Ordovician. Return to cars and continue north on Rt. 22.

| | | |
|---|---|---|
| 36.1 | 3.2 | Junction Rt. 313. Turn right (northeast) onto Rt. 313. |
| 37.4 | 1.3 | Black slates and phyllites on both sides of roads. These are visible in many locations along the road. |
| 42.2 | 4.8 | Park cars on right (southeast) side of road. |

STOP 4. GREEN SLATE AND BLACK SLATE OUTCROP

Green slate (or phyllite) is exposed on the left (northwest) side of the road. Black slate (or phyllite) lies across the road on the southeast side. The decision as to whether these are slates or phyllites is rather subjective since they appear to border both lithologies. Beds appear to dip to the southeast which is common in the area. The green slates appear to lie under the black beds. The age of the black phyllites is probably medial Ordovician since they are on strike with the Walloomsac beds. If so, they lie above green beds which, in many ways, resemble those of the beds further east in the High Taconics. The green slates are also on strike with known Cambrian beds of the Mettawee slates (the famous purple and green slates) in the Taconic sequence. Some few purple beds are seen at this locality also but they are better exposed 1.6 miles northeast along Rt. 313. Purple and green Mettawee slates are well known in the northwest part of the Equinox quadrangle. The author considers the green slates to be Cambrian Mettawee formation and the black slates to be Walloomsac. In this case a major unconformity is present. This is probably the unconformity recognized by MacFadyen (1956), Thompson (1959) and others. Return to cars. Continue on Rt. 313 to northeast.

| | | |
|---|---|---|
| 43.1 | 0.9 | Interfolded black and green slates. |
| 43.8 | 0.7 | Purple and green slates. |
| 45.9 | 2.1 | Tight folding, chevron folds in green phyllite (Mt. Anthony fm.) in Vermont. On left (north). These are the same phyllites which lie over the carbonate in the High Taconics. Since crossing the State Line into Vermont, we have been in the High Taconics. |
| 47.7 | 1.8 | Covered Bridge on right (south) and dolomitic marble outcrop on left (north) Pull to right past Covered Bridge and park. |

STOP 5. ORDOVICIAN CARBONATE OUTCROP

This outcrop of medial Ordovician gray to blue-gray dolomitic marble contains many fossil fragments (crinoid, cystoid and related groups) and a few remains of a Trentonian cephalopod (probably Endoceras proteiforme). This establishes these strata as medial Ordovician in age. Although these beds resemble closely the Bascom-Beldens (undifferentiated), the age is too young. The Bascom-Beldens is generally considered to be of early Ordovician age. Therefore, these fossiliferous middle Ordovician rocks were mapped separately and with the associated black phyllite as the lower Mt. Anthony formation (Hewitt, 1961a). If the upper part of the Beldens could be demonstrated to be Trentonian (medial Ordovician) these beds could easily be placed, on purely lithologic grounds in that formation.

The strata at this outcrop directly underlie the green phyllites of the High Taconics assigned to the Mt. Anthony formation (MacFadyen, 1956). It is the nature of the contact between these units that is the crux of the present Taconic problem (see paper preceeding this Road Log for details. Some evidence of that contact will be seen at a later stop and more definitive evidence is presented at Stop 2 of the Road Log for the trip entitled

"The Nature of the eastern Taconic Contact."

Although some observers may conclude that the folding at this locality is not extreme, it should be noted that green phyllite probably lies below the surface as well as above the carbonate. Many of the beds are up-side-down and generally the outcrop is an inverted section at road level. Further up the hill above (north) the road the strata are right-side-up. Some sandy beds show cross-bedding that helps to establish this but the extreme overturning of these folds will be very apparent as the field trip progresses. The nature of the synclinorium actually requires this as our eastward travel will demonstrate. Please return to the cars and drive east, staying on Rt. 313. Note carbonate on drive eastward. We will examine these later.

| | | |
|---|---|---|
| 51.8 | 4.1 | Junction of Rt. 313 and Rt. 7. Turn left (north). Red Mtn. on left. This is the west side of the Vermont Valley. Outcrops within the Valley are Cambro-Ordovician Valley sequence strata. On right (east) are the Green Mtns. of Precambrian to earliest Cambrian age. |
| 52.7 | .9 | View of Mt. Equinox ahead. |
| 54.1 | 1.4 | Delta deposit on left (west) from post-glacial lake (Lake Bennington?). |
| 55.8 | 1.7 | Turn left to entrance to Skyline Drive. <u>Pay toll</u> (approximately $5 per car.) Rest stops here, at first terrace and at top. |

STOP 6. MT. EQUINOX

No mileages will be provided for the drive up Mt. Equinox since easily recognizeable stopping places have been provided. Drive carefully both up and down the mountain! If you do not have faith in your car's brakes and transmission do not attempt the drive. The drive <u>will</u> test your car.

The road up starts gently in the Shelburn formation with a lower member (Sutherland Falls) of creamy to white calcitic marble, a middle (Intermediate dolomite) member and an upper Columbian marble, the commercial marble of the Vermont Marble Belt. None of this formation is exposed until the first bench or terrace is reached. Elsewhere on the mountain, excellent exposures of all three members are easily observed.

Park at the Parking Lot at the first terrace. This is our lunch stop. Rest rooms are opposite the Parking Lot about 300 ft. to the south. Enjoy the view but please keep the area clean.

Before returning to the cars, gather at the picnic tables for a discussion of the geology, history and culture of the mountain. If time permits we will visit a small marble quarry about 900 ft. north of the Parking Lot at an elevation 100 ft. lower than the Parking Lot. You may collect at this quarry. Return to cars and continue drive up the mountain. Do not stop on the road but note when green phyllite first appears. This occurs after first private road on your right (northeast). Continue climb.

Park at Parking Lot on second terrace. This locality is in the green phyllite. It provides excellent samples of the phyllite, pyrite cubes, and pseudomorphs of limonite (goethite) after pyrite, particularly in the northwest part of the exposure. Collect all you want. Return to cars and continue climb.

At first flat area, note Little Equinox Mtn. on right (southeast) and Lake Madelaine on left (west). Note also areas of landslides on right (east) side of sharp turns near top of Mt. Equinox. One of these will be climbed on foot on the trip discussing "The Nature of the eastern Taconic Contact".

At the summit, park but leave car engine running at fast idle for a few minutes before shutting down. This will help cool the engine. Gather in Parking Lot for orientation, geomorphology and overview of Taconic area.

Descend mountain. Keep car in LOW GEAR while descending. Brakes have been known to fade and even burn on descent. Stop at first flat area below summit for view of Lake Madelaine and monastery. Lake Madelaine is totally artificial. That area was formerly Big Spruce Swamp. Continue to base of mountain. Stay in LOW GEAR. Regroup at base of mountain in Parking Lot. Turn left (north) onto Rt. 313.

| | | |
|---|---|---|
| 58.3 | 2.5 | Note Cook Hollow on left (west). White flat outcrop is Table Rock composed of white marble (Columbian?), Landslide Scar visible above Table Rock. This is carbonate-green phyllite eastern Taconic contact. Hewitt (1961a) concludes that this is a gradational contact. |
| 68.5 | 10.2 | Park cars on right (east) side of road. Cross to west side of road. CAUTION: These rocks are loose and dangerous. Do not attempt to move large blocks or undermine surface. CAUTION: WATCH FOR CARS. |

STOP 7. DOLOMITE OUTCROP. BASIC DIKES

This is the Winooski dolostone of medial Cambrian age. Bedding and jointing permit blocks to fall easily so caution is important here. Note basic dikes in wall of exposure near north end. Return to cars. Drive north to next right (east). Then next two lefts and back on to Rt. 7. Turn left (south) onto Rt. 7.

| | | |
|---|---|---|
| 85.2 | 16.7 | Intersection of Rt. 313. Turn left (west) onto Rt. 313. |
| 89.1 | 3.9 | Park on right (north) for examination and photo. |

STOP 8. OVERTURNED FOLD

This structure is a classic fold in the Bascom-Beldens formation. The lithology is dolomitic marble and the folding is typical Taconic folding. BE CAUTIOUS AT THIS OUTCROP. FOLLOW DIRECTIONS OF THOSE DIRECTING TRAFFIC. THEY ARE THERE FOR YOUR PROTECTION. Return to cars and continue on Rt. 313 (west).

| | | |
|---|---|---|
| 91.6 | 2.5 | Corner Sandgate Rd. Turn right (north). |
| 95.1 | 3.5 | Turn left (northwest) over one lane bridge. |
| 99.8 | 4.7 | Corkscrew turn in folded Mt. Anthony formation. Drive through turn and turn at next intersection and reverse direction. Park at end (southeast) of large outcrop. |

STOP 9. CARBONATE-GREEN PHYLLITE CONTACT

The green phyllite (Mt. Anthony formation of MacFadyen (1956)) is well exposed here. Intense folding is obvious. These are small folds on successively larger folds in this area. With care, small folds may be collected here. All of this section appears on first glance to be green phyllite. However, at the southeast corner of the last outcrop on this road the application of cold, dilute hydrochloric acid results in effervescence at the base. It is impossible visually to locate the horizon at which calcium carbonate ends and the phyllite begins. Only an acid reaction or lack of it can determine the difference. Is there a fault here or not? It is up to you to decide. Note the valley to the south. Is this a depression within the phyllite or the result of solution of a carbonate? No outcrops have been located within that depression but plentiful float is found there. Return to cars.

Drive to Rt. 313. Turn right (west). Follow Rt. 313 to Cambridge, N.Y., then take Rt. 372 to Rt. 29 west to Saratoga Springs.

End of trip.

## ROAD LOG FOR THE NATURE OF THE EASTERN TACONIC CONTACT

This trip begins at the Covered Bridge on Rt. 313 in Vermont. From the junction of Rts. 9 and 50 and Rt. 29 in Saratoga Springs, drive east on Rt. 29 to Schuylerville, Middle Falls, and Greenwich, N.Y. From Greenwich take Rt. 372 east to Cambridge, N.Y. Then take Rt. 313 to the Covered Bridge. The total distance is 44.8 miles. The Covered Bridge is 11.6 miles northeast of Cambridge, N.Y.

| CUMULATIVE MILEAGE | MILES FROM LAST POINT | ROUTE DESCRIPTION |
|---|---|---|
| 0 | 0 | Drive east on Rt. 313. |
| 0.4 | 0.4 | Sandgate Rd. Turn left (north). |
| 3.9 | 3.5 | One lane bridge. Turn left (northwest) over bridge. |
| 8.6 | 4.7 | Corkscrew turn in road. Drive through turn. Turn around and reverse direction at next intersection. |
| 8.9 | 0.3 | Park on right at south end of outcrop. |

### STOP 1. CARBONATE-PHYLLITE CONTACT AT SANDGATE

The exposure of green phyllite at this locality lies at the axis of a large anticline that lifts the base of the formation structurally. With favorable topography the lower parts of a formation may be exposed as at this locality. In a synclinorium, it is normal to expect that generally, the higher parts of the formations will lie deeper in the earth. When an anticline fortuitously is cut by erosion to expose lower and lower parts of a formation more data become available. In this case, part of the phyllite section responds to hydrochloric acid in a formation that normally has no calcareous beds.

After a general examination of the exposure a study of the lowest part of the formation visible here should be undertaken. This part is located at the southeast end of the outcrop. Note that the base of the exposure appears to be phyllitic and very much like the rest of the rocks here. If cold, dilute hydrochloric acid is applied, the lowest beds will effervesce. Visually one cannot see a difference between those beds that will react with the acid and those that will not. The question that must be asked is "What does this mean?" No other part of the phyllite reacts with acid. Carbonates are known to lie under the phyllite. Therefore, this is probably the contact of the carbonate and green phyllite. The nature of that contact at this locality is for you to decide.

Note also the depression to the south of this outcrop. Two possibilities exist here. The depression may be a combination of structure and topography.

That is, the depression might lie in a syncline and therefore lower as a result of structure. This does not appear to be the case here because the anticline passes across the depression. It is also possible that the depression is the result of weathering of a carbonate exposed at the base of the phyllite. Return to cars and proceed southward.

| | | |
|---|---|---|
| 13.2 | 4.3 | Junction of Sandgate Rd. and Rt. 313. Turn left (east) onto Rt. 313. Note folding along road. |
| 17.3 | 4.1 | Junction of Rt. 313 and Rt. 7. Turn left (north) onto Rt. 7. |
| 23.8 | 6.5 | Turn left onto McCooey Drive. Continue to end drive up hill. Park at end of the street. |

STOP 2. COOK HOLLOW-EXPOSURE OF CONTACT

It is wise, politic and intelligent to request permission to cross the property here to make the climb. The climb will involve a rise of 1200-1400 ft. in elevation. Caution is important. Parts of the climb are steep. Some parts are slippery. A slow, steady climb with frequent stops is the best way to see the outcrops and arrive at the contact safely.

Each of the formations mentioned are described briefly in Table 1.

The drive from Rt. 7 crossed the upper Cambrian Danby quartzite and Clarendon Springs formation both of which contain quartzite and dolostone. These formations are not exposed along that traverse. After leaving the cars the traverse begins in the Shelburne marble. Exposures of these strata are best in the creek south of the traverse. It is best to begin the traverse by approaching the creek in order to examine the beds during the climb. However, higher parts of the climb may be difficult or nearly impossible in the creek since this is a landslide area. The easiest climb is on the north (right) side of the creek.

The contact of the Shelburne marble with the overlying Bascom-Beldens formation is at Table Rock. White marble, similar to that of the commercial marble in the Shelburne is also found in the Bascom-Beldens. However, most of the Bascom-Beldens formation is dolomitic marble which is blue-gray to black in color. Near the top of the dolomitic sequence, several hundred feet below the contact with the green phyllite are fossiliferous beds in the marble which contain fossils identical to those at the Covered Bridge on Rt. 313. These indicate an age of medial Ordovician (Trentonian). Beds containing fossils continue across the sequence almost to the contact.

Continued climb will reach a zone of carbonate and phyllite interbeds. Above this zone is a flat area or bench with the contact easily visible. Carbonate ends and the green phyllite continues to the top of Mt. Equinox.

No further description will be presented. It is up to the observer to decide what is seen here. Is this a faulted zone? Where is the fault? Between which strata? Is this a gradational contact? Where does one lithology end and the other begin? How would you describe the bed at the end of the carbonates and the beginning of the green phyllite?

It is up to you.

The descent is probably more difficult than the climb but it is much faster. Be careful.

Return to cars.

Field trip ends.