U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Preliminary geologic map of the Arlington quadrangle and Vermont portion of the Shushan quadrangle, Bennington County, Vermont

by

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Open-file Report 94-262

Prepared in cooperation with the State of Vermont, Geological Survey

1994

Introduction

The bedrock geology of the Arlington 7.5-minute quadrangle, Vermont, and the Vermont portion of the Shushan 7.5-minute quadrangle were mapped during the summer of 1993 with the able assistance of W. Lansing Taylor. The map area is divided almost evenly between the rocks of the Dorset Mountain slice of the Taconic allochthon in the west and northwest and the rocks of the Vermont Valley sequence in the southeast. Each of these two areas has its own set of problems making geologic mapping difficult. Most of the rocks of the Taconic allochthon in this area are very fine grained phyllites, slates, and siltstones that rarely show evidence of bedding, thus hindering stratigraphic and structural interpretation. Though the substantial relief of mountains such as Red, Grass, West, and Big Spruce suggests ample outcrop, vast areas on the slopes of these mountains are covered by a thin veneer of colluvium, and outcrops are most common on ridge tops and in streams. Mapping different phyllites commonly depends on distinguishing subtle differences between gray and grayish-green shades of color. Gray phyllites found in stream beds commonly weather grayish-green, compounding the problem. The decision has been made in this preliminary report not to give any formal names to the rocks of the Taconic allochthon until future mapping has been completed in West Rupert and Salem 7.5-minute quadrangles immediately to the north of the map area.

The rocks of the Vermont Valley sequence are poorly exposed over much of the map area due to fairly thick glacial deposits, particularly in the valley between Shaftsbury and Arlington where deltaic sands and gravel may be several hundred feet thick. In the southeast corner of the map in Glastenbury township the gentle west dipping slopes of the Green Mountains are underlain by Cheshire Quartzite which is mostly covered by colluvium. However, there are areas with good outcrop on the low ridges between Warm Brook and Fayville Branch, as well as roadcuts along Vermont Route 313. Two fairly new roadcuts along Route 313 where it connects old Route 7 (now 7A) and new Route 7 just south of East Arlington are noteworthy (neither new Route 7 nor the Route 313 connector road are shown on this topographic base). The eastern roadcut consists of an outcrop of Winooski Dolomite 220 meters long , which exposes a series of thrust faults and tight west-verging folds that are not seen elsewhere in the map area. The cross sections, particularly B-B', are greatly influenced by this outcrop.

Previous Work

Several important studies have been published in this region, including the classic early studies of Dale (1893, 1894, 1904). The work of Cady (1945) in west-central Vermont continues to influence anyone mapping in the Vermont Valley. The Bennington area to the south has been mapped by MacFadyen (1956). The more recent publications of Potter (1963, 1972) in the Hoosick Falls area, just west of Bennington, present convincing evidence that MacFadyen was mistaken in many of his interpretations for the Taconic rocks underlying Mount Anthony and West Mountain. To the north in the Pawlet 15-minute quadrangle Shumaker (1967) and Thompson (1967) present excellent summaries of stratigraphic and structural problems that have direct bearing on the present mapping. Particularly valuable is the analysis by Thompson of how the carbonate stratigraphy of Cady (1945) farther north should and should not be carried into this area.

This map area is part of the Equinox 15-minute quadrangle mapped by Hewitt (1961b). There are several important differences between that earlier work and this report; namely, Hewitt rejected the notion of a far-travelled Taconic allochthon (Hewitt, 1961a, b; Hewitt and Mac Fadyen, 1963); while in this report I embrace the concept of a large allochthon. Eloquent arguments and exhaustive summaries of the Taconic debate have been presented elsewhere and will not be dealt with here (e.g., Zen, 1961, 1964a, 1964b, 1967; Stanley and Ratcliffe, 1985). The breakdown of units within the Taconic rocks in this report differ significantly from Hewitt and I have not been able to detect bedding in many of the phyllites where Hewitt reports such data. Hewitt recognized black, gray and green phyllites as well as limited areas of coarser clastic rocks, such as quartzites and conglomerates in his Mount Anthony Formation. Hewitt separated out a lower part of the Mount Anthony, which correlates very crudely with some areas that I have mapped as both Walloomsac and black phyllite unit of the Dorset Mountain slice. However, I have mapped much larger areas of the rocks that I must assume Hewitt would call lower Mount Anthony. Hewitt showed the Vermont Valley sequence to be a mostly east-dipping, but west-younging sequence. In certain areas, I agree with this interpretation, while in other areas I show several faults which partly duplicate this sequence. While none of these faults require more than 1800 feet offset and thus may not be deemed major, their existence does change the structural interpretation somewhat. It is possible, and indeed likely, that in the subsurface there may be more extensive dislocations In fact, if the new roadcut on Route 313 mentioned above is taken to be a fair representation of the structure underlying the valley, then I expect other unrecognized faults exist. Burton (1993) did not recognize faults in the adjoining Sunderland quadrangle where the exposure is also poor.

Hayes (1978) mapped all of the Shushan 7.5-minute quadrangle as part of a Master's Thesis. He followed the lead of Potter (1972) in some of his correlations and some of his work has direct application to the west part of the map area.

Lithology and Stratigraphy

A note on the gray and green phyllite problem

Perhaps the most significant problem mapping the rocks in the mountains west of the Arlington-Shaftsbury valley is how to distinguish differences among very fine-grained rocks that rarely exhibit bedding or marker beds. All of these rocks appear to have undergone the same structural and metamorphic history, so subtle mineralogical and lithological differences should be critical in mapping. While the rare coarser clastic rocks have helped in unraveling some stratigraphic and structural problems, and while areas dominated by siltstones have been distinquished from areas dominated by phyllite, the main criteria for field mapping in this terrane is color. Put simply, large areas of greenish-gray phyllite and associated greenish-gray siltstone can, and have been, distinquished from large areas of gray and black phyllites. This gray-green problem has been addressed by many workers mapping in the high Taconic slices. The danger of subdividing rocks primarily on color and secondarily on other, seemingly more important, lithologic and stratigraphic criteria is recognized. Compounding the problem is whether there are really two different gray to black phyllite units as shown on this map, or whether they all should be mapped as one. Immediately to the southwest of the map area at the type locality of the Walloomsac Formation, graptolites have been discovered that document a Middle Ordovician age (Potter, 1972). In other areas to the south, conodonts from calcitic marbles of the Walloomsac have confirmed this age. Potter (1972) maps extensive areas of Walloomsac in the adjacent Hoosick Falls 7.5-minute quadrangle, and subdivides this formation into a number of members. MacFadyen (1956) earlier mapped Walloomsac over large areas of the adjacent Bennington 15-minute quadrangle. Both authors accept the notion that the Walloomsac rests unconformably upon a variety of Lower Ordovician and Cambrian carbonates of the Vermont Valley sequence. To the north of the map area in the Pawlet 15-minute quadrangle, Thompson (1967) maps the Ira Formation, a presumed correlative of the Walloomsac, resting unconformably on Lower Ordovician through Middle Proterozoic rocks. Although it is possible that some of the rocks mapped by MacFadyen as Walloomsac may in fact belong in the Taconic allochthon (first suggested by Potter (1972)), there has been no recent mapping in the Bennington 7.5-minute quadrangle to resolve this question adequately. Another possibility is that the Walloomsac is part of a large composite thrust sheet that contains both allochthonous and autochthonous rocks.

Along the entire west side of the carbonate valley in the map area, the calcitic marbles of the Lower Ordovician Bascom Formation are overlain by gray to black, carbonaceous, pyritiferous phyllites which I have called Walloomsac Formation. The contact between these two units can be seen or closely bracketed in several areas on Red Mountain and West Mountain. At all of these localities, the basal Walloomsac phyllites show the effects of intense shearing, post-dating the regional foliation, and movement indicators show east over west movement. Therefore, a thrust fault has been mapped everywhere at this contact. To the west this fault merges with the basal thrust of rocks of the Taconic allochthon (Ꞓg, Ꞓgs, Ꞓb). This is very similar to the Dorset Mountain thrust fault mapped to the north in the Pawlet quadrangle (Thompson, 1967). Although it is permissible that the Walloomsac rests unconformably upon the Bascom, the question is moot in this area because of the faulting at the contact. Almost everywhere the Walloomsac is overlain, presumably structurally, by greenish-gray phyllite and lesser siltstone of the greenish-gray phyllite unit (Ꞓg) of the allochthon. At two localities on the south and east flanks of Red Mountain, dark bluish gray calcitic marble and tan-weathering light gray dolomitic marble are found interlayered with the basal black pyritiferous phyllites of the Walloomsac. At one locality these carbonates clearly appear to be interbedded with the phyllites, while at the other localities an argument can be made that the carbonates are tectonic slivers. Two collections of these carbonates were examined for conodonts or other acid-resistant microfossils by John Repetski of the U. S. Geological Survey (1993, written communication). Both samples were proved barren. Although disappointing, this in itself is interesting, for most Walloomsac carbonate samples previously studied from other locations have abundant microfossils (Anita Harris, U.S. Geological Survey, personal communication).

Considerably west of the Arlington-Shaftsbury valley similar gray to black phyllites (Ꞓb) underlie much of Big Spruce Mountain and the hills both north and south of Black Hole Hollow in the Shushan quadrangle. In addition, the gray and black phyllites can be seen interbedded with the greenish-gray phyllite unit (Ꞓg) and the greenish-gray siltstone unit. Unlike the belt of rocks mapped as Walloomsac Formation to the east, these rocks have rare interbeds of quartzite and conglomerate and an increased percentage of interbedded gray siltstone. Although some of the quartzites are slightly dolomitic, no beds of marble have been found within the black phyllite unit (Ꞓb) of the allochthon.

In the absence of fossils in either the Walloomsac (Ow) and the black phyllite unit (Ꞓb), and their remarkable similarity the question of whether they are the same unit is difficult to determine. It is clear that the greenish-gray rocks of the allochthon become coarser grained going from east to west. The gray to black phyllites do not coarsen westward, however, the rare interbeds of quartzite in this unit do increase in number. Near the south edge of the map in the belt of black phyllites mapped as Walloomsac, there is a small mapped area of greenish-gray phyllite. As shown on cross section B-B' I interpret this to be an infold of the structurally overlying greenish-gray phyllite unit of the allochthon (Ꞓg). An alternative hypothesis is that these greenish-gray phyllites are interbedded with the black phyllite.

Evidence of shearing is more common in the basal Walloomsac than in the rocks near the base of the Taconic allochthon. However, the shearing at the base of the Walloomsac clearly post-dates the regional foliation, which in turn post-dates the emplacement of the allochthon. This is seen in both shear bands which rotate the regional foliation and in slickensides. Because the carbonates mapped within the Walloomsac are barren of fossils, and one area of greenish-gray phyllite might be interbedded with the Walloomsac, the possibility must be admitted that the black to gray phyllites of the Walloomsac have been mismapped and should be part of the Taconic sequence.

Correlation of rocks within the allochthon

In order to characterize the stratigraphy of the rocks of the Dorset Mountain slice of the Taconic allochthon in the Arlington area it is necessary to have a firm understanding of the regional structural of these units. Critical areas to the north and west in the West Rupert 7.5-minute quadrangle must be completed before an answer is found. However, several general statements can be made. It appears that the greenish-gray rocks of the allochthon coarsen from east to west, dominated by phyllites (Ꞓg) in the east and siltstones (Ꞓgs) with rare coarser clastics in the west. Overall, greenish-gray rocks appear to grade upward into gray and black rocks. This transition has been noted by Hayes (1978) in the Shushan quadrangle, I have also documented it in several local areas. The major belt of gray phyllite

(Ꞓb) occurring between the greenish-gray phyllite unit (Ꞓg) on Red and West Mountains and greenish-gray siltstone unit (Ꞓgs) on the hills north and south of Buck Hill appears to overlie both of the greenish-gray units, however, Ꞓb appears to underlie the Ꞓg on the west flank of Grass Mountain. This relation suggests a comparison with the transition from St. Catharine Formation to West Castleton Formation in the Pawlet area (Shumaker, 1967). Potter (1972) and Hayes (1978) both consider the St. Catharine to be equivalent to the Cambrian to Late Proterozoic Nassau Formation.

Structure and Metamorphism

All of the rocks in the map area appear to have undergone a single greenschist facies prograde metamorphic event. Temperatures determined by the Conodont Alteration Index technique from a sample of Bascom Formation collected 1 km north of Dry Brook Hollow on the lower east flank of The Ball (labelled "F" on map) suggest a minimum of 440° C. Biotite is a constituent of many phyllites, though it is not well developed. Based on regional considerations and $^{40}Ar/^{39}Ar$ thermochronology of muscovites reported by Burton (1993) in the neighboring Sunderland quadrangle, the age of this metamorphism and the accompanying penetrative deformations appear to be Taconian. The thrust beneath the Walloomsac which may represent the sole thrust of a composite thrust sheet of allochthonous and autochthonous rocks would post-date this, but could still be Taconian. Going westward from the Arlington quadrangle into the Shushan quadrangle, the metamorphic grade appears to decrease somewhat as phyllites change to slates and shales and biotite disappears.

All of the rocks in the map area have undergone at least two regional structural events. The earlier event (D_1) is characterized by asymmetric, west-verging folds with a penetrative axial plane foliation (S_1) that dips gently to moderately to the southeast. In general, the dip of the S_1 foliation becomes more gently dipping to the west. In the Batten Kill valley and in the allochthon F_1 folds are often recumbent. Excellent examples of these folds can be seen in the roadcuts along Vermont Route 313 in the Bascom Formation west of Arlington. These folds are characterized by very long gently dipping to subhorizontal right-side-up limbs and short steeply dipping overturned limbs. Although measured bedding in the vast majority of locations dips to the east, the overall stratigraphic succession youngs to the west creating a paradox. The cross-sections illustrate this well. The F_1 folds generally plunge gently north-northeast and south-southwest, although in some locations they plunge more easterly down the dip of the foliation. The axial plane foliation (S_1) is penetrative throughout most of the allochthon and well-developed throughout the carbonate section, particularly in heterogeneous units such as the Winooski Dolomite. S_1 is commonly reactiveate along slickensides and transposed in minor shear zones. If the thrust fault underlying the Walloomsac represents a complete decoupling of the Walloomsac and overlying rocks of the Taconic allocthon from the carbonates of the Vermont Valley sequence, then it is possible that this thrust has truncated F_1 folds in the carbonates. It would also suggest that some early folds in the Taconic allochthon might not be found in the underlying carbonate section.

The S_1 foliation is folded by a later upright set of open folds (F_2). This deformation increases markedly in intensity from east to west and is spectacularly developed in the greenish-gray siltstone unit (Єgs) in the west part of the map area. These folds plunge gently to the north or north-northeast (and to a lesser degree to the south and south-southwest). In the west part of the map area, west of West Arlington and Big Spruce Mountain, virtually every outcrop displays beautiful upright conjugate sets of chevron folds that have both steeply west- and east-dipping axial-plane spaced cleavages (S_2). In the east part of the map area, particular on Red and West Mountains it is clear that S_1 has been folded, but the F_2 structures do not appear to have a penetrative cleavage associated with them. Some of these warps may be caused by even later north-northeast-trending open folds, but this is hard to prove.

Late northwest-trending cross folds (F_3) probably explain the domal structure exposing the Shelburne Formation along the Batten Kill 2 km west of Arlington. Burton (1993) shows similar structures in the adjoining Sunderland quadrangle.

Although numerous shear zones with greenschist mineralogy are recognized in outcrop in the allochthon, none can be traced any distance. These shear zones appear to cut S_1 but are in turn folded by F_2. This is also true for the major thrust fault mapped at the base of the Walloomsac Formation. Since the stratigraphic package in the map area is regionally subhorizontal and not very thick, the entire area could well have been deformed by the arrival of this far-travelled thrust sheet. Interestingly, the Bascom Formation in proximity to the basal thrust of the Dorset Mountain slice is not terribly sheared. Most of the deformation was taken up in the overlying phyllites.

The Warm Brook fault and the Fayville Branch fault partially duplicate the carbonate section of the valley. These faults are based on outcrop pattern and have not been seen in the field. Individual outcrops, particularly the large roadcut in the Winooski Dolomite on Vermont Route 313 just south of East Arlington documents that structures such as these exist, but poor outcrop precludes proving it. These faults cut S_1.

In the central part of the Shushan quadrangle in New York State, Hayes (1978) notes a series of through-going, straight faults that dip moderately to the east and appear to post-date both F_1 and F_2 and cut both the Dorset Mountain and Giddings Brook slices. This fault zone may be the same age as the Chatham fault (Ratcliffe and Bahrami, 1976), i.e., Acadian. No structure like this has been seen in the map area thus far.

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Description of Map Units

Ow Walloomsac Formation (Middle Ordovician)--Fine-grained, medium-gray to black, pyritiferous, carbonaceous, rusty phyllite, lesser slate and rare siltstone and argillite. Near the base of the unit on the south slope of Red Mountain, thin-bedded, dark gray, calcitic marble and thin- to medium-bedded, light gray, tan-weathering, dolomitic marble occur interbedded with black phyllite in a zone up 2 m thick. In another locality at the base of the unit on the east slope of Red Mountain, near the north edge of the map, dark bluish gray calcitic marble appears to be tectonically interlayered with the black phyllite. Bedding almost never recognizable, although rarely the siltstones exhibit mm-scale layering, which may represent bedding. Quartz veins and stringers common. Although the rock is invariably fine grained, large pyrites up to 4 cm in diameter are common. Unit present on the east slopes of The Ball, Spruce Peak, and West Mountain, as well as the east and south slopes of Red Mountain, and is easily confused with gray to black phyllites mapped within the Taconic allochthon (Ꞓb); however, the Walloomsac in this map area never contains the quartzites and conglomerates seen in Ꞓb. About 10 km to the south, near the Walloomsac River graptolites have been reported establishing a Middle Ordovician age (Potter, 1972); however, in this area no fossils have been found. The basal contact is exposed in several areas and is always marked by extensive shearing, thus it is interpreted to be a thrust fault. However, to both the north and south of the map area other workers have noted that the Walloomsac rests unconformably upon units ranging from Middle Proterozoic gneiss to Lower Ordovician carbonates. In the map area, this unit is always underlain by the Bascom Formation. The Walloomsac is overlain structurally by both greenish-gray phyllites (Ꞓg) and gray phyllites (Ꞓb) of the Dorset Mountain slice of the Taconic allochthon. This contact is not exposed. The minimum thickness of this unit is about 200 m

Ob Bascom Formation (Lower Ordovician)--Medium-gray to bluish-gray, medium grained, sugary-textured, thin- to medium-bedded, calcitic marble interbedded with lesser, thin- to medium-bedded, light-gray, tan- to yellowish-weathering dolomite. In numerous places the calcitic marble appears to be bioturbated and mottled. Beautifully exposed in almost 2 km of semi-continuous roadcuts along Vermont Route 313 between Arlington and West Arlington, though in the rest of the map area this unit is very poorly exposed. This unit is overlain, presumably unconformably, by the Walloomsac Formation, but the upper contact where exposed in this quadrangle is always marked by extensive shearing. It is possible that some of the dolomites found in the uppermost part of this unit could be equivalent to the Beldens Member of the Chipman Formation (Cady and Zen, 1960), however, from scant conodont data obtained near the top of this unit on the east flank of The Ball, it would appear that the upper part of the unit is probably older than Beldens. Sparse conodont elements (J. E. Repetski, 1993, written communication) appear most likely to be forms found in the middle part of the Ibexian Series of Medial to late Early Ordovician age. The lower contact is closely bracketed in three localities in the map area, but the best exposures are along the Batten Kill on Vermont Route 313. There it is seen in gradational contact over less than 3 m with the underlying white calcitic marble of the Shelburne Formation. On the south slope of Red Mountain the thickness of this unit is at least 265 m.

Osh Shelburne Formation (Lower Ordovician)--White to very light-gray with green and black streaks, fine- to coarse-grained, medium- to thick-bedded, calcitic marble. Except for two small quarries on opposite sides of the Batten Kill about 2 km west of Arlington, and one small outcrop on the east shore of Lake Shaftsbury, this unit crops out very poorly. The upper contact is gradational with the overlying Bascom. The lower contact is never seen in the map area. Although Potter (1972) reports one Cambrian trilobite from rocks that are described as similar to this unit, this correlation is not strong enough to warrant extending the age of the Shelburne into the Cambrian. Based on cross sections, the estimated thickness of this unit is about 180 m

Ꞓcs Clarendon Springs Dolomite (Upper Cambrian)--Light gray to medium gray, yellowish-orange to moderate brown-weathering, fine-grained, medium- to very thick-bedded, generally massive, but in some places faintly laminated, dolomite with occasional stringers or nodules of quartz (presumably originally chert). In places rusty weathering after pyrite. There is only one excellent outcrop of this unit in the entire quadrangle, which is a new roadcut along the Vermont Route 313 connector between Routes 7A and 7. Poor exposure precluded the possibility of mapping the underlying Danby Formation as others have done nearby (see Thompson, 1967). The Danby if present in this area is included in the outcrop belt of the Clarendon Springs Dolomite. The estimated thickness based on cross sections is about 160 m

Ꞓw Winooski Dolomite (Middle and/or Lower Cambrian)--Highly variegated unit consisting of light gray, fine-grained, medium to thick bedded dolomite that weathers orange-red, yellow, buff, or medium gray interbedded with white, fine-grained, thin-bedded dolomitic quartzites (5 to 10 cm thick) , dolomites with thin sandy laminations, and silver to black, lustrous phyllites. Because of the variable rock types and medium-bedded nature of this unit, tight folds (in some places disharmonic) are common. Excellent roadcuts are on the Vermont Route 313 connector between Routes 7A and 7. Although the contact between this unit and the overlying Clarendon Springs is shown in the southeast corner of the map, this is projected from mapping of MacFadyen (1956) to the south and could not be controlled by mapping in this area. The contact with the underying Monkton Quartzite is gradational and placed above the uppermost massive, medium- to thick-bedded, fine- to coarse-grained vitreous quartzite in the Monkton. Otherwise, the rock types in both units show quite a bit of similarity. Estimated thickness of the unit is about 200 m

Ꞓm Monkton Quartzite (Lower Cambrian)--Light-gray to medium-bluish-gray, yellow gray-weathering, fine-grained, very thin- to medium-bedded dolomitic sandstone interbedded with light gray, dusky yellow to dark yellowish orange-weathering, thin- to very thick-bedded dolomite with fine sandy laminations, and very light gray to white to reddish, massive, medium to thick bedded vitreous quartzite. The reddish color of the quartzite is due to disseminated hematite and can weather to a very deep distinctive red. In some places gray to black phyllite is found as chips in the soil, but rarely crop out. Numerous sedimentary structures, such as cross bedding, ripple marks, possible mudcracks, and shallow channels are present. An excellent section is exposed in Roaring Brook under the covered bridge at Chiselville. Numerous outcrops show excellent penetrative cleavage with extensive pressure solution along the cleavage planes. The upper contact is gradational with the overlying Winooski Dolomite and is placed above the uppermost massive, fairly thick bed of quartzite or dolomitic sandstone. The lower contact is gradational over approximately 30 m with the underlying Dunham Dolomite, and is placed below the lowest massive, medium- to thick-bedded quartzite beds, and above where thin- to medium-bedded, light gray, slightly fizzy dolomitic marble begins to dominate the section. The only place this contact has been seen in the map area is on the small hill 1 km ESE of Shaftsbury. The estimated thickness of this unit is 180 m

Ꞓdh Dunham Dolomite (Lower Cambrian)--Light gray to medium gray-weathering, thin- to medium-bedded, fairly fizzy dolomitic marble with thin wispy silty laminae interbedded with more massive, mottled, medium-bedded dolomitic marble. Overlying contact with Monkton Quartzite is gradational. Underlying contact with Cheshire not exposed. Estimated thickness of the extremely poorly exposed unit is 160 m

Ꞓc Cheshire Quartzite (Lower Cambrian)--Massive, white to tan, fine-grained, medium- to thick-bedded quartzite which rarely shows good bedding, but does show excellent cross-bedded laminations where dark heavy minerals are concentrated. The only place the Cheshire crops out is in the southeast corner of the map where it makes a dip slope off the Green Mountains. In places, black phyllite is present along partings in the quartzite and presumably represents bedding. Upper contact is placed near the base of the dip slope, but is not at all well constrained. The lower contact is not present in this map area, but has been mapped by Burton (1993) in the Sunderland 7.5-minute quadrangle to the east, where it overlies the Dalton Formation. Estimated thickness of this unit is about 180 m

ЄZd Dalton Formation (Lower Cambrian and Late Proterozoic)--*Only shown in cross section.* A transitional unit consisting of feldspathic quartzites, black schist, gray laminated quartzite, and pebbly quartzite and conglomerate at the base

Y Undifferentied basement gneisses (Middle Proterozoic)--*Only shown in cross section*

Rocks of the Dorset Mountain slice of the Taconic allochthon

Greenish-gray unit (Cambrian)

Єg Greenish-gray phyllite unit--Fine-grained, greenish-gray to dark

Єgq greenish-gray phyllites interbedded with lesser greenish-gray siltstone, lustrous light to dark green phyllite, and light gray to dark gray phyllite. Also rare thin to medium bedded quartzite with pervasive rusty spots. Veins, stringers, and pods of quartz are common in all rock types. The key minerals in these monotonous rocks are quartz-muscovite-chlorite--biotite-albite-ilmenite. At the highest elevations on Red Mountain the phyllites have a lustrous sheen and in places are darker green, perhaps denoting an increase in the amount of chlorite, the absence of biotite, and the presence of paragonite. Hewitt (1961b) notes chloritoid rosettes at high elevations, presumably on Red Mountain, but the present mapping has not confirmed this. In places, siltstones exhibit very fine mm-scale laminations; while it is possible that this represents bedding, it is just as likely a transposition foliation. Discontinuous lenses of medium- to thick-bedded, fine- to medium-grained, gray to dark green and rarely white, brown-weathering , rusty-spotted quartzite and and rare fine-pebble conglomerate (Єgq) occur as discontinuous lenses within this unit. The greenish-gray matrix of Єgq consists of quartz, chlorite, plagioclase, pyrite and carbonate. The clasts consists most commonly of white to bluish quartz with lesser white-weathering plagioclase, and fragments of argillite. As noted by Potter (1972) the greenish-gray phyllites (Єg) are most likely equivalent to the Nassau Formation (Bird, 1962). These rocks closely resemble the lower part of the

St. Catharine Formation (Thompson, 1967) on Dorset Mountain. There are similarities between some of the quartzites and conglomerates (Ꞓgq) and both the Rensselaer Graywacke Member and the Zion Hill Quartzite Member of the Nassau Formation as described by Potter (1972) to the south near Hoosick Falls, New York. On much of Red Mountain, and particularly in Tidd Hollow, Ꞓg is at higher elevations than the gray to black phyllites (Ꞓb) to the west, and appears to overlie it; however, the absence of reliable bedding indicators makes it uncertain whether the contact is overturned or right-side-up. Much of Ꞓb may in fact overlie Ꞓg (as seen south of Black Hole Hollow in the Shushan quadrangle) and thus the large poorly constrained area of Ꞓb near West Arlington and on Big Spruce Mountain may be an overturned synclinal infold. A reliable estimate of the thickness of Ꞓg is difficult, but is probably greater than 200 m, while the maximum thickness of Ꞓgq is 35 m

Ꞓgs Greenish-gray siltstone unit (Cambrian)--Greenish gray siltstone interbedded
Ꞓgq with minor greenish-gray phyllite and slate, and gray phyllite, as well as quartzite and conglomerate (Ꞓgq described above). Mineralogy of the siltstone is quartz-muscovite-chlorite-albite-opaques. Although bedding is more common in this unit than in the greenish-gray phyllites (Ꞓg), it is still very difficult to recognize in most outcrops. This unit crops out to the west or northwest of the greenish gray phyllite unit (Ꞓg) and appears to be lower in the section (see cross section A-A'), however a poor understanding of the overall structure within the Dorset Mountain slice prevents a definitive answer at this time. At least locally, this unit underlies the black phyllite unit (Ꞓb) cropping out north and south of West Arlington, but it is a good possibility that this large area of Ꞓb is an infold and actually overlies most of the greenish gray rocks (Ꞓg and Ꞓgs). If this were the case, then Ꞓgs would be a lateral western equivalent of Ꞓg. In addition to the rocks being coarser to the west, the amount of interbedded quartzite and conglomerate (Ꞓgq) is also greater. Estimated thickness of Ꞓgs is about 400 m

Ꞓb Black phyllite unit (Cambrian)--Medium gray to black carbonaceous phyllite
Ꞓbq interbedded with lesser medium gray slate and siltstone. Mapped separately from, and occurring as discontinuous lenses within the black phyllite unit, is massive, light gray, medium to thick bedded quartzite, generally quite clean, but in some places slightly dolomitic, as well as lesser amounts of conglomerate (Ꞓbq). The clasts in the conglomerate are commonly quartz and more rarely black shale while the matrix is poorly sorted quartz and fine-grained chlorite and muscovite. Although the black phyllite unit can quite easily be mistaken for the Walloomsac Formation, as presently mapped in this map the Walloomsac contains no quartzite or conglomerate. However, both Ꞓb and Ow are commonly carbonaceous and pyritiferous. Small lenses as much as 100 m thick of Ꞓb are interbedded with both Ꞓg and Ꞓgs. Large

areas of Ꞓb tend to be above Ꞓgs in the western part of the map area. On the west flank of Red Mountain Ꞓb crops out at lower elevations, and thus appears to underlie Ꞓg. Since structural control is lacking in this area, it is possible that Ꞓb overlies Ꞓg in a large overturned synclinal infold that passes through the belt on Grass Mountain. The thickness of this unit is difficult to estimate, but in places it exceeds 200 m. The maximum thickness of Ꞓbq is about 20 m

EXPLANATION OF MAP SYMBOLS

Contact--Solid where accurately located, dashed where approximate

Thrust fault and shear zone--Sawteeth on upper plate; solid where accurately located, dashed where approximate

Thrust fault (pre-metamorphic)--Sawteeth on upper plate; solid where accurately located, dashed where approximate

PLANAR FEATURES

(May be combined with linear features; where two or more planar symbols are combined, their intersection marks the point of observation)

Strike and dip of bedding--Where shown, ball indicates facing direction as determined by sedimentary structures

Horizontal

Inclined

Overturned

Strike and dip of generalized bedding

Inclined

Strike and dip of first generation (F_1) foliation of presumed Taconic age

Inclined

Vertical

Strike and dip of average first generation (F_1) foliation

Inclined

Strike and dip of bedding and parallel first generation foliation

Inclined

Strike and dip of second generation (F_2) foliation or crenulation cleavage of presumed Taconic age

Inclined

Vertical

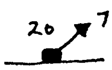
Strike and dip of shear zone which post-dates S_1 but predates S_2

Inclined

Strike and dip of axial surface of first generation (F_1) fold; where shown arrow indicates direction and amount of plunge of fold axis

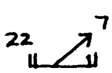
Inclined

Strike and dip of axial surface of second generation (F_2) fold; where shown arrow indicates direction and amount of plunge of fold axis



Inclined

Strike and dip of slickenside; where shown arrow indicates direction and amount of plunge of slickenline



Inclined

Strike and dip of joint

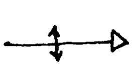
Inclined

Vertical

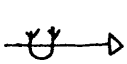
FOLDS

Axial trace of first generation (F_1) fold, arrow shows general direction of plunge

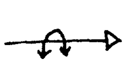
Syncline



Anticline



Overturned syncline



Overturned anticline

Axial trace of second generation (F_2) fold, arrow shows general direction of plunge

Syncline

Anticline

Axial trace of third generation (F_3) fold, arrow shows general direction of plunge

Anticline

LINEAR FEATURES

(May be combined with planar features)

Azimuth and plunge of first generation (F_1) fold axis

Inclined

Horizontal

Azimuth and plunge of second generation (F_2) fold axis

Inclined

Horizontal

Azimuth and plunge of calculated intersection of bedding and first generation foliation

Inclined

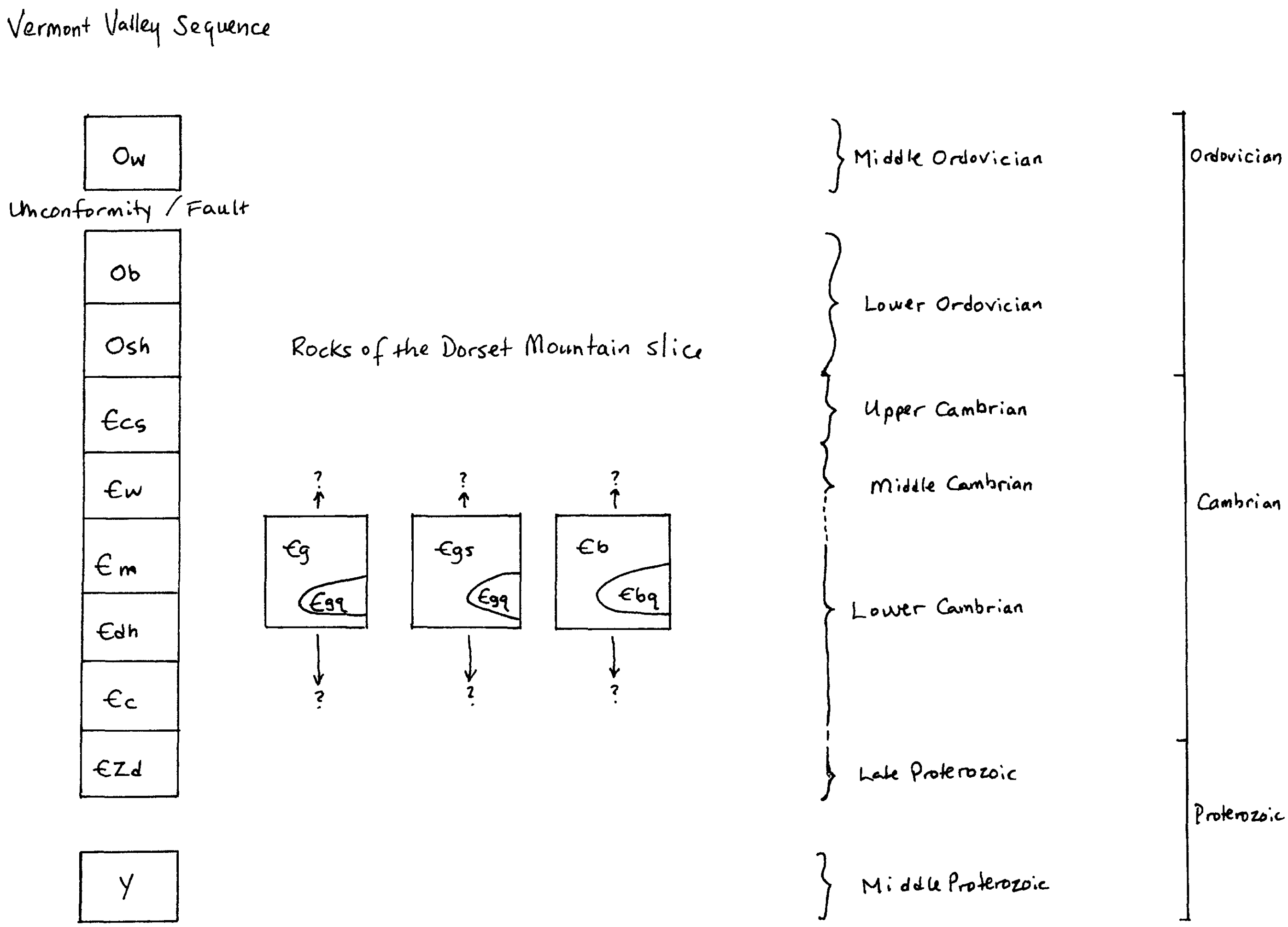
Azimuth and plunge of slickenline or smear lineation

Inclined (used in combination with planar surfaces that have been reactivated)

OTHER SYMBOLS

Location of quarry

Sample location of conodont collection in Bascom Formation


Vermont Valley Sequence
Ow
Unconformity / Fault
Ob
Osh
€cs
€w
€m
€dh
€c
€Zd
Y
Rocks of the Dorset Mountain slice
€g
€gq
€gs
€gq
€b
€bq
Middle Ordovician
Lower Ordovician
Upper Cambrian
Middle Cambrian
Lower Cambrian
Late Proterozoic
Middle Proterozoic
Ordovician
Cambrian
Proterozoic