1-1-1987

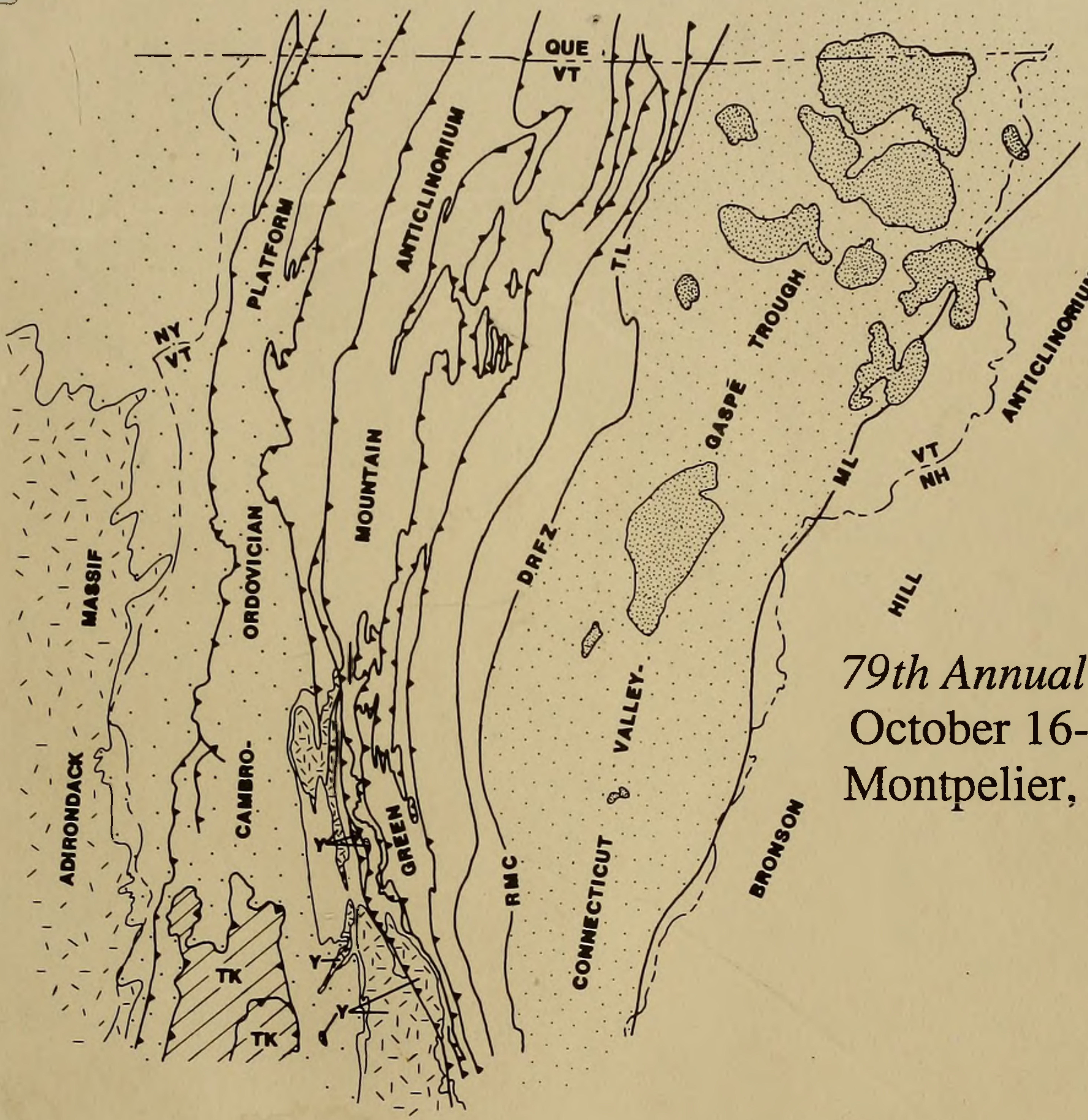
Guidebook for field trips in Vermont: New England Intercollegiate Geological Conference, 79th annual meeting, October 16, 17 and 18, 1987: title pages, table of contents, introduction

New England Intercollegiate Geological Conference (NEIGC)

David S. Westerman

Recommended Citation

New England Intercollegiate Geological Conference (NEIGC) and David S. Westerman, "Guidebook for field trips in Vermont: New England Intercollegiate Geological Conference, 79th annual meeting, October 16, 17 and 18, 1987: title pages, table of contents, introduction" (1987). *NEIGC Trips*. 407.
https://scholars.unh.edu/neigc_trips/407



79th Annual Meeting
October 16-18, 1987
Montpelier, Vermont

New England Intercollegiate Geological Conference

1987

Guidebook for Field Trips in Vermont

Volume 2

New England Intercollegiate Geological Conference
79th Annual Meeting

Guidebook for Field Trips in Vermont

Volume 2

October 16, 17 and 18, 1987
Montpelier, Vermont

Editor
David S. Westerman
Norwich University
Northfield, Vermont

Cover: Western half after Stanley and Ratcliffe (1985); eastern half after Doll and others (1961). For explanation of symbols see p. 110.

Copies of this guidebook are available at the address below as long as supplies last. The cost will be $15.00 (includes postage and handling).

NEIGC 87
Department of Earth Science
Norwich University
Northfield, Vermont 05663

Make checks payable to Norwich University - NEIGC 87

FORWARD: FIFTEEN YEARS OF PROGRESS IN UNDERSTANDING THE GEOLOGY OF VERMONT

Introduction:

Since 1972, when NEIGC was last held in Vermont, advances have occurred in all branches of geology. The most notable local applications of these advances involve applying the model of plate tectonics to Paleozoic and Mesozoic geologic history of the Vermont Appalachians. The products of sedimentation, faulting, folding, metamorphism, and igneous intrusion preserved in the rock record are now understood in relation to the processes of rifting, seafloor spreading, subduction, obduction, transform faulting, and collision of outboard terranes. A new level of clarity in picturing the ancient history has resulted from old fashioned field work mixed with new ideas.

Literature concerning Vermont geology is becoming increasingly abundant. References in this guidebook alone call attention to a large part of the material published during the last 15 years, but numerous works have gone unmentioned. The Vermont State Geologist, Dr. Charles A. Ratte, is making an effort to maintain an up-to-date record of work done in Vermont. He started by publishing Bibliography of Vermont Geology (Ratte and others, 1980) which has been followed by a supplement (Ratte and Vanecek, 1983).

As our understanding of the local geology advances, it is still convenient to talk about geographic regions of the state using familiar terms, but it is important that the names we use are free of false implications. A case in point is the term "Connecticut Valley Synclinorium" which Hatch (Trip B-3) would like to see replaced by "Connecticut Valley Trough". Until it is determined with certainty whether the fine-grained rocks of the Northfield Formation and Meetinghouse Slate (constituting the flanks of that terrain) are the oldest or the youngest rocks of the belt, we won't know if the structure is anticlinorial or synclinorial.

New data and new interpretations of old data are abundant in the articles of this guidebook, and the remainder of this forward will be used to call attention to this information (see Figure 1 for trip locations). A familiarity with the classical ideas regarding Vermont's geologic history is assumed, and frequent reference is made to the locations within the guidebook where fuller coverage can be found.

Grenvillian Basement Massifs:

For the past several years, Karabinos (Trip C-7) has been mapping in the northern part of the Green Mountain massif, a structure cored by the Mount Holly Complex which was first deformed during the Grenville orogeny in Middle Proterozoic time. He has recognized two units in the massif, a tectonically higher unit (northeast) overlain by an eastern cover sequence and a tectonically lower unit (southwest) overlain by a western cover sequence. The fact that the grade of the Proterozoic metamorphism there was higher than the grades of metamorphism during Paleozoic time helps distinguish the basement rocks from those of the cover.

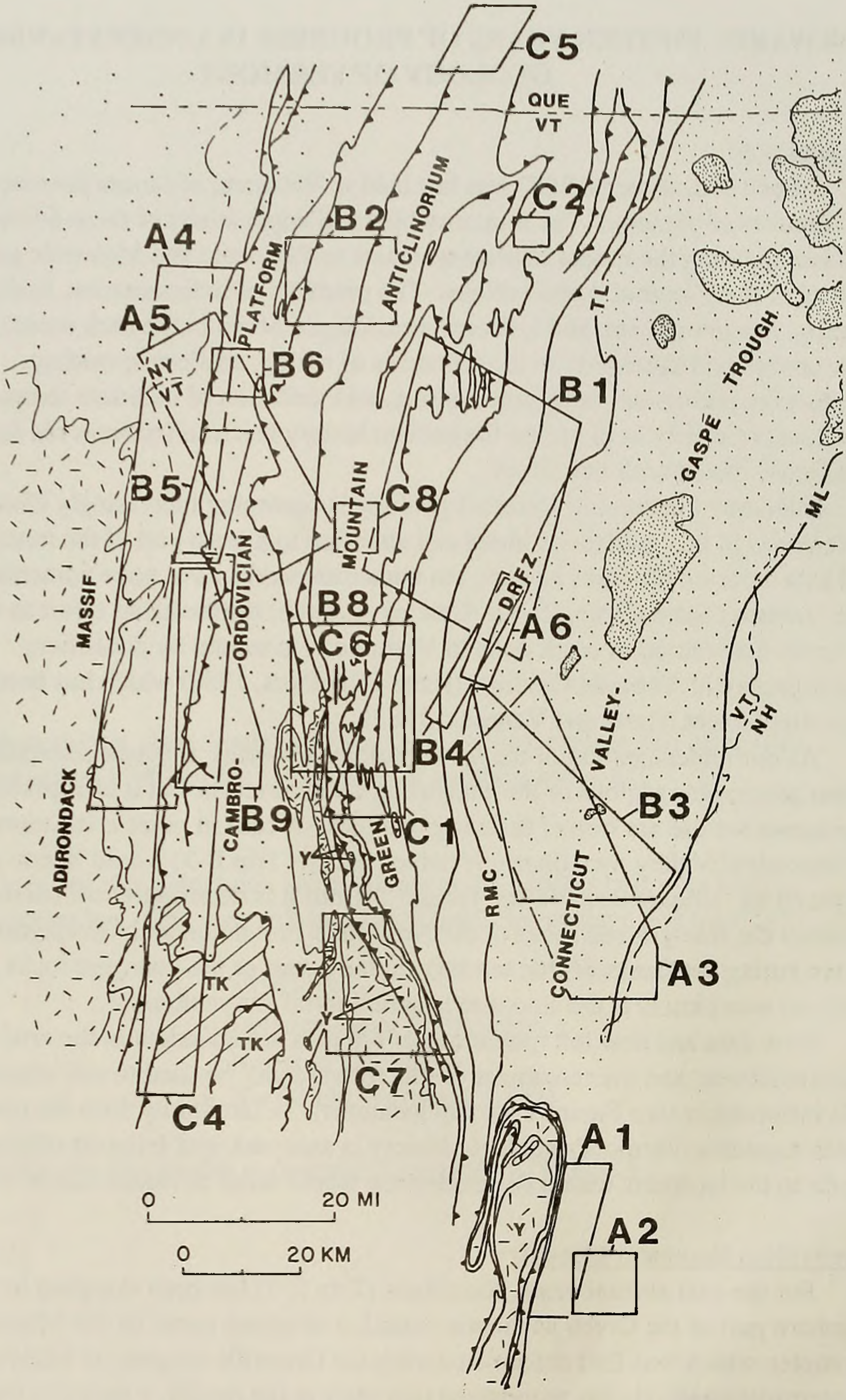


Figure 1. Location map for NEIGC '87 Field Trips. Western half of base after Stanley and Ratcliffe (1985); eastern half after Doll and others (1961).

Stanley and others (Trip B-8) have been studying basement gneisses further to the north and they report Proterozoic mafic dikes which crosscut the Grenvillian foliation along the western margin of the Eastern Lincoln massif. Coish (p. 345 and following) has provided the results and interpretations of his geochemical studies of these rocks which he is able to classify as transitional basalts. These studies support a model in which Late Precambrian rifting initiated the development of an ocean basin (Iapetus Ocean of Rodgers, 1968).

Deposition During Late Precambrian Rifting and Early Paleozoic Time:

Deposition of the earliest sediments on the rifting erosion surface of Middle Proterozoic basement is discussed in several places in the guidebook. Karabinos (Trip C-7) has examined the cover sequences resting unconformably on the Middle Proterozoic Mount Holly complex in the northern part of the Green Mountain massif. After studying the rocks north of the exposed portion of the massif, he finds that a facies change is not observed between the eastern and western cover sequences, but rather they are in fault contact. Stanley and others (Trip B-8) discuss the characteristics of basal conglomerates of the Pinnacle Formation which overlie the gneisses of the Mount Holly complex along the western boundary of the Eastern Lincoln massif.

Late Precambrian/Early Cambrian stratigraphy in southern Quebec has been studied by Colpron and others (Trip C-5) who have been able to determine that subsidence there during the rifting stage remained slow during deposition of the Pinnacle Formation but then accelerated in White Brook time. This contrasts with the more rapid subsidence recorded in Vermont throughout this whole period. Their explanation involves the proximity of the Sutton area to the paleo-position of the triple junction that generated the Quebec reentrant.

Following deposition of the initial rift facies in the newly developing Iapetus Ocean, a stable platform sequence developed during Cambrian and Ordovician time as sedimentation kept pace with the passive subsidence of the shelf (Rodgers, 1968). Mehrtens, Parker and Butler (Trip B-6) describe the facies and evolution of the Cambrian platform sequence in northern Vermont. Study of the three-dimensional spatial distribution of the sequence showed that after the rift clastics were covered by the sands and distal equivalents of the Cheshire Formation, part of the platform collapsed along a listric fault. On the "upthrown" block, the section developed vertically to form the platform sequence. The whole region was experiencing thermal subsidence, but platform sedimentation kept pace with subsidence from Dunham to Danby time. This study provides an excellent example of how the detailed work by geologists trained in one field (here stratigraphy and sedimentation) can be interpreted in the light of other fields (here structure and tectonics) with the results being a more exciting and visable reconstruction of the historical record.

Looking higher in the platform sequence, Chisick, Washington and Friedman (Trip C-4) have been working to establish the stratigraphic and temporal relations of the Middle Beekmantown Group in central and southern Vermont. They review the regional setting in which the shelf sedimentation was occurring during Ordovician time in that area. Their work includes the results of applying an understanding of the regional structural style of thrust faulting to resolve the locally complex arrangement of the stratigraphy.

MacLean (Trip A-4) has studied the Middle Ordovician Glens Falls Limestone, located stratigraphically above the Beekmantown Group discussed above. The alternating limestone and shale beds of this formation record a portion of the depositional history in a rapidly subsiding foreland basin located between a continental massif to the west and an active island arc with impinging thrust nappes coming in from the east. He recognizes that prior conclusions regarding lateral continuity of the section were oversimplified. Pinching of formational thicknesses to the south and facies changes within the Trenton Group to the northeast support tectonic interpretations that such changes may be the result of syndepositionally active block faults. The results of MacLean's work are indicative of how new understanding of tectonic setting provides new perspectives on the history of sedimentation.

Deformation and Metamorphism in the Foreland, Transitional Zone, and Pre-Silurian Hinterland:

Sedimentation in the early Paleozoic Iapetus Ocean continued throughout the spreading and collisional stages until closure of the ocean occurred. Histories of deformation and metamorphism differ along the length of the orogen, and several articles in this guidebook call attention to those differences. Stanley, Leonard and Strehle (Trip A-5) have studied the structural history of the foreland and transitional zone in northwestern Vermont where they recognize north-south trending folds and easterly dipping imbricate thrust faults. They report that along the western margin of the orogen, the Champlain thrust differs in its geometry from the smaller Hinesburg thrust which developed along the overturned limb of a large recumbent fold (Dorsey and others, 1983). They also note that seismic studies have shown that these thrusts extend eastward under the Green Mountains and that the major folds of western Vermont are formed by duplexes and related structures. High-angle Mesozoic faults cut the eastern part of the Platform sequence. Detailed petrographic studies of rocks from the fault zones have increased the confidence in interpretations regarding directions of movement and the conditions within the faults at the time of movement. Regional considerations reviewed in Stanley and Ratcliffe (1985) lead to the conclusion that most of the movement occurred during the Taconic orogeny, but it is important to recognize that available information does not place constraints on the amount of post-Ordovician movement.

Deformation of the foreland has also been studied further to the south in the central Champlain Valley by Washington (Trip B-9) who reports here on the temporal and spatial relations between secondary structures and thrusting. He reviews the various types of thrust systems (duplex and imbricate fan) and the types of folds recognized to be related to these systems (fault-bend folds and related ramp-bend fold trains). Washington has found that the relationship of these folds to the faults that produce them, and the cleavage and joints that form in association with them, can be used to locate thrust faults which are not exposed.

Numerous thrust faults which imbricated the basement and cover rocks of the Green Mountain massif have been recognized by Karabinos (Trip C-7). These westward-directed thrusts have locally transported basement onto the western cover sequence, have separated the massif into two recognizable tectonic units each having its own cover sequence, and have juxtaposed the eastern and western cover sequences north and south of the massif so as to erase the opportunity for determining if the sequences are related by facies changes. He suggests that a large duplex structure involving both western cover and basement may help account for the anticlinorial structure of the massif. The evidence preserved does not allow him to determine if the thrusting occurred during the Taconic orogeny, during the Acadian orogeny, or, as was the case with metamorphism, during both.

Stanley and others (Trips B-8 and C-6) describe a complex history of synmetamorphic thrusting in pre-Silurian rocks located between the platform to the west and the Moretown Formation to the east in central Vermont. They have concluded from their detailed but widespread mapping efforts that the stratigraphy may have been quite simple prior to a complex history of deformation. For example, they propose that the Battell Member of the Underhill Formation, the Granville Formation, and the carbonaceous schists of the Hazens Notch, Pinny Hollow, and Stowe Formations were part of a once-continuous deposit along the eastern edge of North America. They also propose several other correlations between very similar lithologies which have been previously mapped as separate units, suggesting possible physical continuity of these rocks at the time of their deposition.

The deformation of the pre-Silurian rocks is seen by Stanley and his students to be the result of eastward-dipping subduction and the associated westward-directed thrusting. Laird (p. 339 and following) has placed some constraints on the conditions during this synmetamorphic deformation by determining that an earlier medium-high pressure facies metamorphism was followed by a lower greenschist facies metamorphism in mafic schist near a contact between the Pinney Hollow and Ottauquechee Formations. Coish (p. 345 and following) reports on geochemical studies of metamorphosed mafic volcanics in Vermont. Such rocks from the western part of the belt show evidence of having formed within a continental plate, those further to the east have characteristics of having formed near an ocean ridge, and mafic volcanics found in between show charcteristics reflective of both environments. These results support a rifting model with the sequential formation of mafic volcanic units later followed by their accretion during compressional tectonism.

To the north of the area being studied by Stanley and his students, Thompson and Thompson (Trip C-8) have done detailed mapping of structures along the axial trace of the Green Mountain anticlinorium (GMA) north and south of the Winooski River. They recognize two early episodes of folding and interpret them to be of Taconian age, but the third and youngest folding episode is interpreted to have produced the anticlinal structure during the Acadian orogeny. This interpretation conflicts with that of Colpron and others (Trip C-5). Thompson and Thompson have also mapped folded fault surfaces which predate the anticlinal folding, much like those described in rocks to the south by Stanley and others (Trips B-8 and C-6).

Doolan, with Mock and McBean (Trip B-2), provides a complex model of accretion during Ordovician subduction to explain the structures of the Camels Hump Group in northern Vermont. Most of these rocks were deposited as rift-related clastics, laid down prior to the development of a platform sequence. Following the early stages of westward-directed thrusting, some of the supercrustal rocks are proposed to have been backfolded eastward out over the oceanic lithosphere. The model culminates with the deeply deposited Stowe Formation to being thrust westward over the backfolded rocks below. In the process it emerged to provide clasts to the unconformably overlying Umbrella Hill Conglomerate (located at the base of the Moretown Formation). Part of Doolan's model is the separation of the Taconian deformation, which concluded with eastward-directed backfolding, from the collisional stage when island-arc terranes were accreted. Doolan suggests that this final stage was perhaps Acadian and produced the regionally prominent cleavage, the Green Mountain anticlinorium, and the further westward imbrication of the foreland region. Arguments presented below concerning deformation along the western margin of the Connecticut Valley trough support the idea that the regionally prominant cleavage to which he refers is probably Acadian.

Colpron and others (Trip C-5), working to the north in Canada, recognize three phases of deformation in rocks of the Oak Hill Group, all thought to be of Taconic age. They interpret the dominant structural features in that area to have resulted from the second phase, but the third phase was responsible for the formation of the Green-Sutton Mountain anticlinorium.

Working east of the area discussed above, Bothner and Laird (Trip C-2) report that high-pressure facies series metamorphism (Laird and Albee, 1981) is recorded in mafic schists of the Belvidere Mountain Amphibolite member of the Hazens Notch Formation at Tillotson Peak. Their mapping and detailed petrographic analysis of these rocks have led them to postulate that peak metamorphism and earliest folding were subduction related. This was followed by a second metamorphism and deformation before rapid ascent on westward directed thrusts brought the rocks close enough to the surface to cool quickly and preserve the products of the early metamorphism. Also discussed by Bothner and Laird is the complex history of refolding in the area and the preservation of large E-W fold structures, a condition quite rare in Vermont.

Anderson (Trip B-1) recognizes four generations of veins containing primary metamorphic assemblages in rocks of the Green Mountains north of Interstate 89, each having developed as grade was decreasing from peak condition of the event with which it was associated. This contrasts with the timing of host rock mineral growth during the period while conditions were rising toward peak. The relation between these various generations of veins and the multiple metamorphisms reported by Laird (p. 339 and following) remains to be worked out.

Deposition in the Connecticut Valley Trough (CVT):

Questions abound regarding the source, age, and time of deformation of rocks in the Connecticut Valley trough (CVT). The view popularized by Doll and others (1961) of a synclinal basin floored by an erosional unconformity is in revision. Westerman (Trip A-6) reviews the evidence for and implications of the faulted nature of the western boundary of the trough. He concludes that the western margin of the CVT is not an erosional unconformity or a faulted erosional unconformity except very locally where isolated lenses of the Shaw Mountain Formation are present. In most places the fine-grained rocks of the Northfield Formation are the western unit of the CVT and Westerman argues that they were faulted into place rather than having been deposited against the units with which they are now in contact.

A possible revision of the previously published stratigraphy for the units within the belt is proposed by Hatch (Trip B-3). He calls for a reversal of part of the sequence based both on observations of graded beds and on a sedimentary model involving proximal and distal facies of units deposited from an eastern source. He retains the stratigraphic sequence of the Waits River Formation under the Gile Mountain Formation, but he interprets the Northfield Formation as the western, distal facies of the Gile Mountain Formation.

Concerning the age of rocks in the CVT, Westerman (Trip A-6) discusses the reasons for separating the rocks of the Shaw Mountain Formation from the rest in the trough, based on sedimentological arguments. The Shaw Mountain rocks are known to be Silurian or Early Devonian as shown by fossil evidence (Doll, 1984). The time of deposition of the bulk of the rocks of the CVT (exclusive of the isolated lenses of the Shaw Mountain Formation along the western margin) is uncertain, but reports of graptolites from rocks in the trough (Bothner and Berry, 1985; Bothner and Finney, 1986) indicate that at least part of the trough is of Ordovician age. Since some of the graptolites come from the Northfield Formation which Hatch suggests may be the youngest unit in the section, the entire CVT may be pre-Silurian and the Shaw Mountain Formation may represent slivers of near-shore Silurian sediments caught between two accreting Ordovician terranes.

Deformation and Metamorphism in the CVT:

Based on their study of rocks in the CVT in southeast Vermont, Boxwell and Laird (Trip A-1) report evidence for two pulses of prograde metamorphism separated by a deformational event, all followed by retrograde metamorphism which locally reached biotite grade. This occurred in rocks thought to have experienced tectonism only in the Devonian. An important result of their study is the recognition that equilibrium assemblages indicate that conditions during the dominant metamorphism gradually increased from east to west across the study area. This is in contradiction to the pattern of isograds shown on the Centennial Geologic Map of Vermont (Doll and others, 1961).

Anderson's work (Trip B-1) on metamorphic vein development involved rocks from both the GMA and the CVT in north-central Vermont. He reports two prominant generations of metamorphic vein growth in rocks of the CVT with much of the mineral development having occurred as grade was decreasing from the peak conditions of the metamorphic event with which it was associated. His picture of multiple metamorphisms is compatible with earlier work and with the work of Boxwell and Laird discussed above. It is also quite compatible with the multiple episodes of isoclinal folding reported for rocks of the Northfield Formation by Westerman (Trip A-6).

No overall structural model has been proposed to explain the complexity of deformation preserved in the rocks of the CVT. After recognizing the faulted nature of the margins of the basin, and thereby removing the constraint that the marginal rocks need be basal units of a stratigraphic sequence, Hatch (Trip B-3) has developed a structural model of an anticlinal arch that fits his sedimentary model.

Regarding the Question of Taconic vs. Acadian Ages for Structures:

Many geologists have noticed that as they drive eastward across Vermont from Burlington to Montpelier, they cannot with confidence identify the ages of the structures which they observe in the roadcuts. Strongly cleaved rocks occur a few miles east of Burlington, with the cleavage dipping at moderate angles to the east. As one travels eastward, the prominant cleavage steepens, passes through vertical, and in the vicinity of Montpelier it dips steeply to the west. At that location, when passing over a boundary known as the Taconian unconformity of Cady (1960), the Taconian Line of Hatch (1982), and the Richardson Memorial contact (RMC - informal), the transition is made from the Cambrian-Ordovician terranes of the Green Mountains to the rocks of the Connecticut Valley trough. As can be seen at the I-89 outcrop exposing this boundary (Trip A-6, Stop 1), it is a fault zone, and the dominant structures in the rocks on both sides are the same.

Along the length of this fault zone it is common to find exposures of the Shaw Mountain Formation whose Silurian age has been firmly established from fossils (see Westerman, Trip A-6). These Silurian rocks frequently exhibit a well-developed cleavage which is parallel to that on both sides of the RMC, so it seems safe to conclude that the dominant, pervasive cleavage seen in rocks adjacent to the RMC must be Silurian or younger (i.e. Acadian). The outcome of current discussions referred to above regarding the age of rocks within the Connecticut Valley trough does not affect this conclusion.

For the highly deformed and strongly metamorphosed rocks of the Green Mountains, a strong case has been made (Stanley and Ratcliffe, 1985) that westward-directed Taconian thrusts produced the map pattern seen today, and the timing of this major deformation is supported by the work of Sutter and others (1985). Where the cleavage is synmetamorphic and metamorphism occurred during the Ordovician, the cleavage is clearly a Taconic structure.

Assuming from the arguments above that the prominant cleavage seen in rocks on the western flank of the Green Mountains is Ordovician in age and the prominant cleavage seen in the Montpelier area is Devonian in age, and given that it is not readily apparent that these cleavages aren't the same one, then is it reasonable to consider that the development of the prominant cleavage is diachronous and perhaps best described as Tacadian?

Mesozoic Intrusions and Rift Features:

Application of the concepts of plate tectonics is not restricted to the Paleozoic history of Vermont. McHone has been studying Mesozoic dikes and related structures throughout New England, and here (Trip B-5) he discusses his reasons for proposing that the Champlain Valley is a structural basin formed by Cretaceous rifting. This is a model which he sees as inviting comparison to other younger and better-studied rift basins. Radiometric dating of the intrusions shows them to be of undoubted Cretaceous age and their geochemical character supports an intra-plate origin. The high-angle faults of the area also have orientations which match well with such a model, but constraints on the timing of the faults remain limited.

Glacial history:

Studies of past glacial activity in Vermont continue primarily through the efforts of a small group of energetic workers. Three papers in this guidebook, two by Larsen (Trips A-3 and B-4) and one by Ackerly and Larsen (Trip C-1), cover many of the ideas that have come forward in the past 15 years. Although no overwhelming new theory of glaciation has been applied which might be analogous to the application of plate tectonics to ancient mountain building, re-examination of old ideas, applications of ideas from different fields, and a steady search for new information has produced results.

Larsen (Trip A-3) reports on the deglaciation of Vermont and the relative ages of glacial Lake Hitchcock, glacial lake Winooski, and the Champlain Sea. After defining the precise location of the boundaries of Lake Hitchcock, Koteff and Larsen (1985) were able to use elevations of shoreline indicators to calculate the current slope of the ancient lake surface. It is planar and rises 4.74 feet/mile in a direction of N21.5W. The planar character is interpreted to suggest that no rebound had occurred prior to the draining of Lake Hitchcock. Larsen uses evidence of high energy gravel deposits in the valley formerly occupied by Lake Hitchcock to conclude that it drained while Lake Winooski still existed. Since Lake Winooski drained before ice retreated to the St. Lawrence Valley and allowed marine water to flood the Champlain Valley, he further concludes that Lake Hitchcock must have drained long before any marine sediments were deposited in the Champlain Sea about 12,500 BP. Larsen (Trip B-4) uses the glacial and postglacial sediments in the Dog River Valley to test the model of deglaciation described above. Also on this trip he evaluates his conclusions regarding postglacial rebound as determined from the current elevations of features indicative of former lake levels.

Ackerly and Larsen (Trip C-1) report here on evidence indicating glacial ice flow directions in the Green Mountains. Examination of an old set of data indicating southwest-directed ice flow in the area of Middlebury Gap confirms that the data are real and more widespread than previously reported. Alternative explanations include 1) a local ice cap in the Green Mountains with ice flowing southwestward into the Champlain Valley, or 2) reversal of ice flow direction as a result of drawdown of ice thickness in the Champlain Valley. Given an absence of evidence for a local ice cap in the region and anticipation of the ice flow reversal by the theoretical ice surface reconstructions of Hughes and others (1985), Ackerly and Larsen opt for the latter explanation.

Hydrology:

Although there are numerous studies going on in Vermont and other New England states involving efforts to understand hydrologic systems, only one hydrology-related field trip (Caldwell and others; Trip A-2) is available this year (and it's on the "wrong" side of the river). It is unfortunate that the results of most hydrologic studies do not become available for field review by the public since they are conducted for clients in the business sector rather than as pure research.

A catastrophic flood in the Cold River of southwestern New Hampshire produced erosional and depositional features, and had a pronounced effect on the local groundwater system in a small kettle. Recharge far exceeded the total rainfall as a result of runoff into the kettle from the nearby steep hillside. The results of this study indicate that estimates of recharge of an aquifer can be significantly underestimated if secondary recharge is not considered.

BIBLIOGRAPHY

Bothner, W.A. and Berry, W.B.N. (1985), Upper-Ordovician graptolites in the Connecticut Valley-Gaspe synclinorium, southern Quebec: Geol. Assoc. Canada Abstracts w. Programs, V. 10, p. A-6.

Bothner, W.A. and Finney, S.C. (1986), Ordovician graptolites in central Vermont: Richardson revived: Geol. Soc. America Abstracts w. Programs, v. 18, p. 548.Cady, W.M. (1960), Stratigraphic and geotectonic relationships in northern Vermont and southern Quebec: Geol. Soc. America Bull., v. 71, p. 531-576.

Doll, C.G. (1984), Fossils from the metamorphic rocks of the Silurian-Devonian Magog belt in northern Vermont: Vermont Geology, v. 3, 16 p.

Doll, C.G., Cady, W.M., Thompson, J.B., Jr., and Billings, M.P. (1961), Centennial geologic map of Vermont: Montpelier, Vermont Geological Survey, Scale 1:250,000

Dorsey, R.L., Agnew, P.C., Carter, C.M., Rosencrantz, E.J., and Stanley, R.S. (1983), Bedrock geology of the Milton quadrangle, northwestern Vermont: Vermont Geological Survey Special Bulletin No. 3, 14 p.

Hatch, N.L., Jr. (1982), The Taconian Line in western New England and its implications to Paleozoic tectonic history: *in* St. Julien and Beland, J., eds., Major Structural Zones and Faults of the Northern Appalachians: Geol. Assoc. Canada Spec. paper No. 24, p. 67-85.

Hughes, T., Borns, H.W., Jr., Fastook, J.L., Kite, J.S., Hyland, M.R., and Lowell, T.V. (1985), Models of glacial reconstruction and deglaciation applied to maritime Canada and New England: Geol. Soc. America, Spec. Paper 197, p. 139-150.

Koteff, C. and Larsen, F.D. (1985), Postglacial uplift in the Connecticut Valley, western New England: Geol. Soc. Amer., Abstr. w. Programs, v. 17, p. 29.

Laird, Jo and Albee, A.L. (1981), High-pressure metamorphism in mafic schist from Vermont: Am. Jour. Sci., v. 281, p. 97-126.

Ratte, C.A., Vanecek, D.M., and Dunn, A.L., compilers and editors (1980), A Bibliography of Vermont Geology: Vermont Div. Geology and Earth Sci., Montpelier, Vermont, 155 p.

Ratte, C.A. and Vanecek, D.M., compilers and editors (1983), Supplement No. 1 to Bibliography of Vermont Geology: Vermont Div. Geology and Earth Sci., Montpelier, Vermont, 59 p.

Rodgers, J. (1968), The eastern edge of the North American continent during the Cambrian and Early Ordovician, *in*, Zen, E-an, White, W. Hadley, J. and Thompson, eds., Studies in Appalachian Geology, Northern and maritime, Wiley Interscience, New York, p. 141-149.

Stanley, R.S. and Ratcliffe, N.M. (1985), Tectonic synthesis of the Taconic orogeny in western New England: Geological Society of America Bulletin, v. 96, p. 1227-1250.

Sutter, J.F., Ratcliffe, N.M., and Mukasa, S.B. (1985), 40Ar/39Ar and K-Ar data bearing on the metamorphic and tectonic history of western New England: Geol. Soc. America Bull., v. 96, p. 123-136.

David S. Westerman, Editor
September, 1987

CHRONOLOGICAL LISTING OF MEETINGS OF THE NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

Meeting	Year	Location	Organizer
1st	1901	Westfield River Terrace, Mass.	Davis
2nd	1902	Mount Tom, Massachusetts	Emerson
3rd	1903	West Peak, Meriden, Conn.	Rice
4th	1904	Worcester, Massachusetts	Emerson
5th	1905	Boston Harbor and Nantasket	Johnson, Crosby
6th	1906	Meriden to East Berlin, Conn.	Gregory
7th	1907	Providence, Rhode Island	Brown
8th	1908	Long Island, New York	Barrell
9th	1909	North Berkshires, Mass.	Cleland
10th	1910	Hanover, New Hampshire	Goldthwait
11th	1911	Nahant and Medford, Mass.	Lane, Johnson
12th	1912	Higby-Lamentation Blocks	Rice
13th	1915	Waterbury to Winsted, Conn.	Barrell
14th	1916	Blue Hills, Massachusetts	Crosby, Warren
15th	1917	Gay Head and Martha's Vineyard	Woodworth, Wigglesworth
16th	1920	Lamentation and Hanging Hills	Rice, Foye
17th	1921	Attleboro, Massachusetts	Woodworth
18th	1922	Amherst, Massachusetts	Antevs
19th	1923	Beverly, Massachusetts	Lane
20th	1924	Providence, Rhode Island	Brown
21st	1925	Waterville, Maine	Perkins
22nd	1926	New Haven, Connecticut	Longwell
23rd	1927	Worcester, Massachusetts	Perry, Little, Gordon
24th	1928	Cambridge, Massachusetts	Billings, Bryan, Mather
25th	1929	Littleton, New Hampshire	Crosby
26th	1930	Amherst, Massachusetts	Loomis, Gordon
27th	1931	Montreal, Quebec	O'Neill, Graham, Clark, Gill, Osborne, McGerrigle
28th	1932	Providence-Newport, R.I.	Brown
29th	1933	Williamstown, Massachusetts	Cleland, Perry, Knopf
30th	1934	Lewiston, Maine	Fisher, Perkins
31st	1935	Boston, Massachusetts	Morris, Pearsall, Whitehead
32nd	1936	Littleton, New Hampshire	Billings, Hadley, Cleaves, Williams
33rd	1937	New York City & Duchess Co.	O'Connell, Kay, Fluhr, Hubert, Balk
34th	1938	Rutland, Vermont	Bain
35th	1939	Hartford & Conn. Valley	Troxell, Flint, Longwell, Peoples, Wheeler
36th	1940	Hanover, New Hampshire	Goldthwait, Denny, Shaub, Hadley, Bannerman, Stoiber
37th	1941	Northampton, Massachusetts	Balk, Jahns, Lochman Shaub, Willard
38th	1946	Mt. Washington, NH	Billings
39th	1947	Providence, Rhode Island	Quinn
40th	1948	Burlington, Vermont	Doll
41st	1949	Boston, Massachusetts	Nichols, Billings, Schrock, Currier, Stearns
42nd	1950	Bangor, Maine	Trefethen, Raisz
43rd	1951	Worcester, Massachusetts	Lougee, Little
44th	1952	Williamstown, Massachusetts	Perry, Foote, McFadyen, Ramsdell
45th	1953	Hartford, Connecticut	Flint, Gates, Peoples, Cushman, Aitken, Rodgers, Troxell

Meeting	Year	Location	Organizer
46th	1954	Hanover, New Hampshire	Elston, Washburn, Lyons, McKinstry, Stoiber, McNair, Thompson
47th	1955	Tigonderoga, New York	Rodgers, Walton, MacClintock, Bartolome
48th	1956	Portsmouth, New Hampshire	Novotny, Billings, Chapman, Bradley, Freedman, Stewart
49th	1957	Amherst, Massachusetts	Bain, Johannson, Rice, Stobbe, Woodland, Brophy, Kierstead, Webb, Shaub, Nelson
50th	1958	Middleton, Connecticut	Rosenfield, Eaton, Sanders, Porter, Lungren, Rodgers
51st	1959	Rutland, Vermont	Zen, Kay, Welby, Bain, Theokritoff, Osberg, Shumaker, Berry, Thompson
52nd	1960	Rumford, Maine	Griscom, Milton, Wolfe, Caldwell, Peacor
53rd	1961	Montpelier, Vermont	Doll, Cady, White, Chidester, Matthews, Nichols, Baldwin, Stewart, Dennis
54th	1962	Montreal, Quebec	Gill, Clark, Kranck, Stevenson, Stearn, Elson, Eakins, Gold
55th	1963	Providence, Rhode Island	Quinn, Mutch, Schafer, Agron, Chapple, Feininger, Hall
56th	1964	Chestnut Hill, Massachusetts	Skehan
57th	1965	Brunswick, Maine	Hussey
58th	1966	Katahdin, Maine	Caldwell
59th	1967	Amherst, Massachusetts	Robinson, Drake, Foose
60th	1968	New Haven, Connecticut	Orville
61st	1969	Albany, New York	Bird
62nd	1970	Rangeley Lakes, Maine	Boone
63rd	1971	Concord, New Hampshire	Lyons, Stewart
64th	1972	Burlington, Vermont	Doolan, Stanley
65th	1973	Fredericton, New Brunswick	Greiner
66th	1974	Orono, Maine	Osberg
67th	1975	Great Barrington, Mass.	Ratcliffe
68th	1976	Boston, Massachusetts	Cameron
69th	1977	Quebec City, Quebec	Beland, LaSalle
70th	1978	Calais, Maine	Ludman
71st	1979	Troy, New York	Friedman
72nd	1980	Presque Isle, Maine	Roy, Naylor
73rd	1981	Kingston, Rhode Island	Boothroyd, Hermes
74th	1982	Storrs, Connecticut	Joeston, Quarrier
75th	1983	Greenville & Millinocket, Me.	Caldwell, Hanson
76th	1984	Danvers, Massachusetts	Hanson
77th	1985	New Haven, Connecticut	Tracy
78th	1986	Lewiston, Maine	Newberg
79th	1987	Montpelier, Vermont	Westerman

ACKNOWLEDGEMENTS

I am greatly indebted to Frederick D. Larsen for his help in making the publication of this guidebook possible. Without his support and willingness to carry a large part of the load of organizing the conference, it just wouldn't have happened. I also extend my sincere thanks to the administrative and support personnel throughout Norwich University, particularly to Brad Jordan and Kelly Pope, for their assistance in the preparation of this guidebook and the organization of the conference.

TABLE OF CONTENTS