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Geology of the Guilford Dome Area, Southeastern Vermont

Hepburn, J. Christopher

Trip B-11

GEOLOGY OF THE GUILFORD DOME AREA, SOUTHEASTERN VERMONT

by

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Introduction

The Guilford dome lies within the broad outlines of the regional Connecticut Valley-Gaspé synclinorium. This synclinorium, principally underlain by Siluro-Devonian rocks, separates the Oliverian gneiss-cored domes of the Bronson Hill anticlinorium to the east from the Green Mountain anticlinorium to the west. The Guilford dome is part of a belt of domes that extends southward from east-central Vermont to Connecticut, west of the Connecticut River, analogous to but more widely spaced than the domes of the Bronson Hill anticlinorium. Large recumbent folds are found in the strata mantling these domes in eastern Vermont (Doll et al., 1961; Rosenfeld, 1968). The Standing Pond Volcanics is an important marker unit outlining many of these recumbent folds and domes. The axial surfaces of the recumbent folds have been arched by the later doming. The arcuate, closed, double band of the Standing Pond Volcanics around the southern end of the Guilford dome (Fig. 1) outlines such a refolded recumbent fold. One of the main purposes of the field trip is to investigate this fold and the proposed east-facing recumbent anticline above it. Other stops will be made to view the Black Mountain Granite, an important key in determining the time of deformation; the Siluro-Devonian Waits River Formation in the exposed core of the dome; and the Putney Volcanics, which separates the "Vermont" and "New Hampshire" sequences.

Acknowledgements

Geological mapping of the Guilford dome area was part of a Ph.D. thesis at Harvard University under the direction of Professors M. P. Billings and James B. Thompson, Jr., whose help the author would particularly like to acknowledge. I would also like to thank the many persons who assisted during the course of the field work. Financial assistance of the Reginald and Louise Daly Fund, Harvard University, is gratefully acknowledged.

Stratigraphy

Please refer to Skehan and Hepburn (this volume), Stratigraphy of the East Limb of the Green Mountain Anticlinorium, Southern Vermont, for a brief description of most of the stratigraphic units and for a regional correlation chart. The units most pertinent to this trip are summarized below.

Middle Ordovician

BARNARD VOLCANIC MEMBER, MISSISQUOI FORMATION: 4000-8000 feet thick. Massive porphyritic and non-porphyritic amphibolites, feldspar-rich gneisses, and layered gneisses.

Siluro-Devonian

SHAW MOUNTAIN FORMATION: 0-20 feet thick. Quartzite and quartz-pebble conglomerate, hornblende fasciculite schist, amphibolite, and mica schist.

NORTHFIELD FORMATION: 1000-2500 feet thick. Gray mica schist with abundant almandine porphyroblasts, minor impure quartzite and impure punky-brown weathering marble.

WAITS RIVER FORMATION: 3000-7500 feet thick. Mica schist (phyllite at lower metamorphic grades) and calcareous mica schist with abundant interbeds of punky-brown weathering, impure marble; thin interbeds of micaceous quartzite. Quartzitic member: feldspathic and micaceous quartzite interlayered with muscovite schist.

STANDING POND VOLCANICS: 0-500 feet thick. Medium-grained amphibolite and epidote amphibolite; garnet-hornblende fasciculite schist. Eastern band: plagioclase-biotite-hornblende-quartz granulite and gneiss.

GILE MOUNTAIN FORMATION: 2500-5000 feet thick. Light gray to gray, micaceous and feldspathic quartzite and mica schist; gray fine-grained phyllite and slate with interbedded, thin micaceous quartzite; and rare impure marble. Marble member: black phyllite with interbeds of punky-brown weathering, impure marble and micaceous quartzite.

PUTNEY VOLCANICS: 0-400 feet thick. Light, greenish gray phyllite; buff to light brown weathering feldspathic phyllite; thin beds of feldspathic granulite; and minor gray slate. Conglomeratic member: lenses of polymict conglomerate with a gray slate matrix; pebbles abundant to scarce.

LITTLETON FORMATION: 5000-6000 feet thick. Gray slate or phyllite with interbedded quartzite.

Early to Middle Devonian Intrusive Rocks.

BLACK MOUNTAIN GRANITE: Medium-grained two-mica granodiorite, correlated with the New Hampshire Plutonic Series (Billings, 1956).

No new definitive evidence for the facing of the Waits River, Standing Pond, and Gile Mountain Formations has yet been found by the author. However the sequence, oldest to youngest, of Waits River, Standing Pond, and Gile Mountain, as shown on Figure 1 is favored, although a possible inversion of this order cannot be ruled out.

The Putney Volcanics (Stops 1 and 2) consists of a belt of rocks that were formerly included in the Standing Pond Volcanics (Doll *et al.*, 1961; Trask, 1964). Since the proper correlation of these rocks has not yet been established, Hepburn (1972) designated them as a separate formation.

Structural Geology

The major tectonic features in the Guilford dome area formed during the Acadian orogeny, between the end of sedimentation in the Early Devonian and the crystallization of late, unoriented, coarse muscovite crystals in the Black Mountain Granite 377-383 m.y. ago (Naylor, 1971). Late normal faulting and possibly some minor folding occurred during the Triassic. The two major stages of deformation in the area include (1) the development of large recumbent folds, followed by (2) the rise of the Guilford dome.

The doubly-closed loop of the Standing Pond Volcanics around the southern part of the Guilford dome outlines the Prospect Hill recumbent fold, named for exposures at the hinge (Stop 3). The Gile Mountain Formation forms the core of the fold. Originally the Prospect Hill fold had a subhorizontal axial surface and a hinge striking northeast-southwest. The subsequent doming about a roughly N-S axis arched the axial surface of the recumbent fold, so that now the hinge plunges moderately northeast and southwest away from the axial trace of the Guilford dome. An early, tight, now overturned, steeply east-dipping synform must lie between the Standing Pond bands in the doubly-closed loop and a third band lying to the east of the Guilford dome (Fig. 1). The hinge line where the Standing Pond rocks cross the axial surface of this synform is not seen in the Brattleboro area and is presumably buried. This synform, the Northfield Formation around the north end of the Guilford dome, and the Fall Brook anticline which exposes the Barnard Volcanics, are interpreted as the upper (anticlinal) portion of the Prospect Hill fold (Fig. 1, Cross-section A).

It is very likely that the Prospect Hill fold is continuous with the Ascutney sigmoid in the Saxtons River quadrangle to the north (Rosenfeld, 1968; Doll et al., 1961). If this is true, the hinge of the Prospect Hill fold must turn more northerly a short distance north of Stop 3.

The Guilford dome, which occupies much of the central portion of the Brattleboro quadrangle (Fig. 1), is a large, elliptical, doubly-plunging anticline formed during the second major stage of deformation. The Waits River Formation forms the exposed core of the dome. The foliation dips away in all directions from the axial trace, which strikes slightly east of north and plunges moderately to the north and south at the ends of the anticline. The axial surface of the dome dips very steeply to the west. A small depression in the exposed central portion of the dome divides it into a northern and southern lobe. The axial trace of the dome is closer to its eastern side. Here, the foliation has steep dips a short distance east of the axial trace. Dips are more gentle to the west. Bedding with a schistosity parallel to it has been arched by the dome.

It is likely that the two major stages of deformation were not greatly separated in time.

Minor Folds

Minor folds of at least five different stages are present in the Guilford dome area and the Brattleboro syncline to the east of the dome. These stages of minor folding are summarized below:

F1. Small isoclinal folds in layering, with schistosity developed parallel to the axial surfaces (Stop 3).

F2. Tight to isoclinal folds congruous with the large-scale recumbent folding (Prospect Hill fold). These fold the schistosity and the F1 folds. Weak to moderate axial-planar cleavage. Plunge moderately NE. or SW.

F3. Open folds, particularly west and south of the Guilford dome. Excellent slip-cleavage developed parallel to the axial surfaces. The axial surfaces generally strike NE. and dip steeply NW. The hinges plunge moderately NE. Excellent crinkle lineations occur at the intersection of this slip-cleavage and the schistosity surfaces in the pelitic rocks.

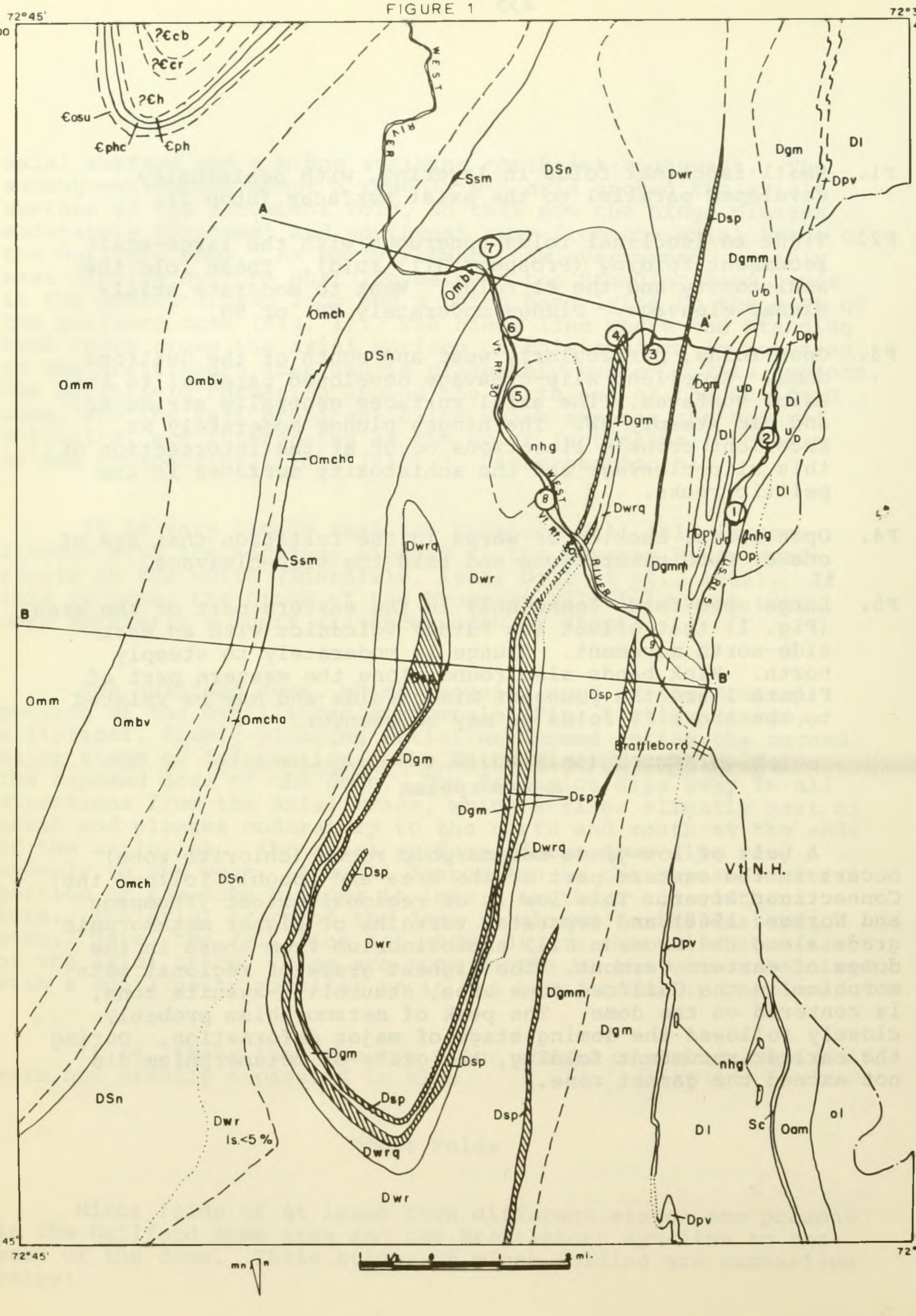
F4. Open folds, buckles or warps in the foliation that are of one or more generations and fold the slip-cleavage.

F5. Large open folds found only in the eastern part of the area (Fig. 1) that offset the Putney Volcanics with an east-side-north movement. Plunge is moderately to steeply north. Kink bands also found along the eastern part of Figure 1 are the youngest minor folds and may be related to the above F5 folds or may be younger.

Metamorphism

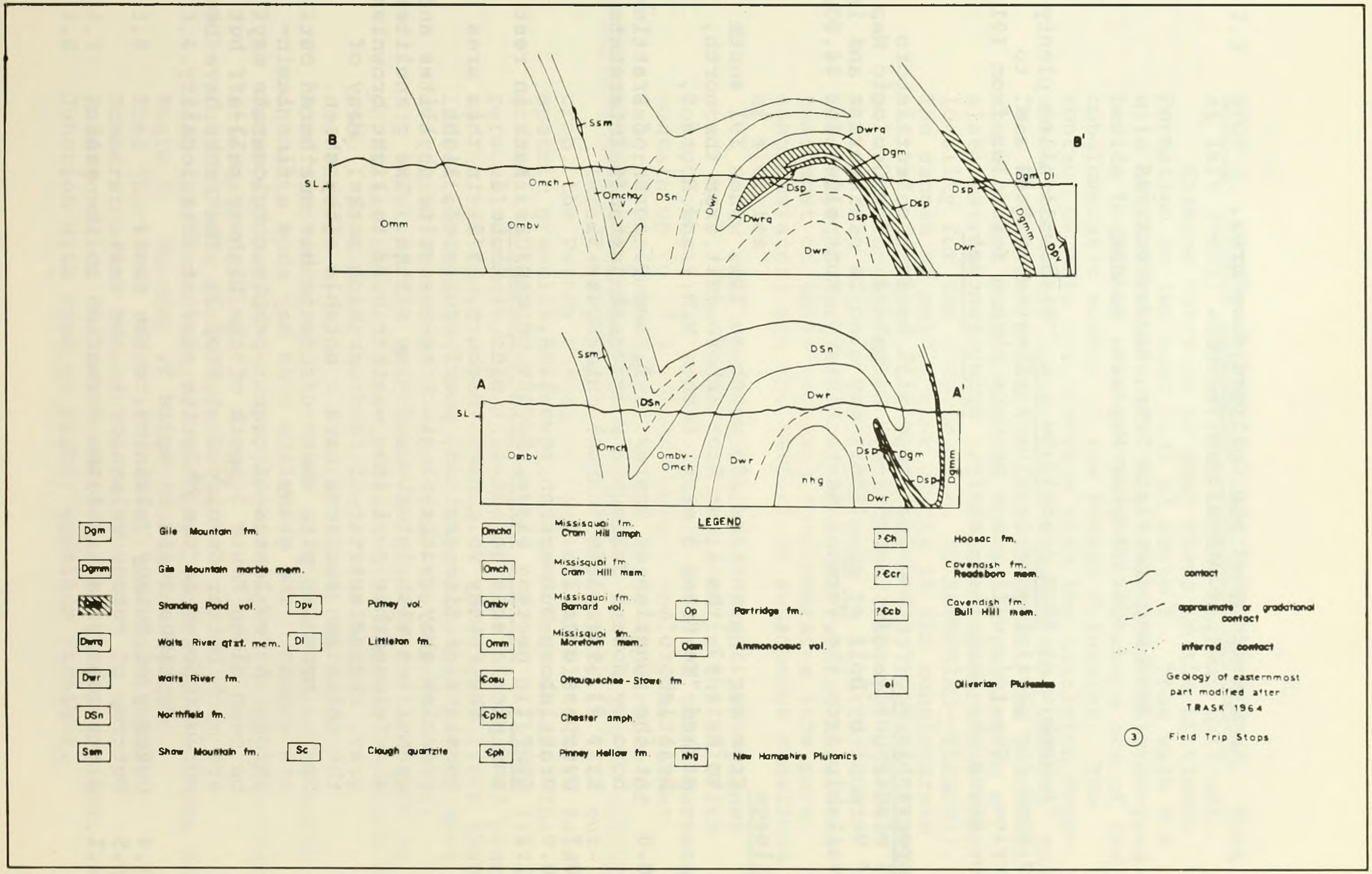
A belt of low-grade metamorphic rocks (chlorite zone) occurs in the eastern part of the area and roughly follows the Connecticut River. This low is of regional extent (Thompson and Norton, 1968) and separates terrains of higher metamorphic grade along the Bronson Hill anticlinorium from those in the domes of eastern Vermont. The highest grade of regional metamorphism in the Guilford dome area, staurolite-kyanite zone, is centered on the dome. The peak of metamorphism probably closely followed the doming stage of major deformation. During the earlier recumbent folding, the grade of metamorphism did not exceed the garnet zone.

FIGURE 1



GEOLOGIC MAP OF THE BRATTLEBORO AREA

FIGURE 1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nhg
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LEGEND
Dgm Gile Mountain fm.
Dgmm Gile Mountain marble mem.
Standing Pond vol.
Dpv Putney vol.
Dwrq Waits River qtzt. mem.
Dl Littleton fm.
Dwr Waits River fm.
DSn Northfield fm.
Ssm Shaw Mountain fm.
Sc Clough quartzite
Omcha Missisquoi fm. Cram Hill amph.
Omch Missisquoi fm. Cram Hill mem.
Ombv Missisquoi fm. Barnard vol.
Omm Missisquoi fm. Moretown mem.
Cosu Ottauquechee - Stowe fm.
Cphc Chester amph.
Cph Pinney Hollow fm.
Op Partridge fm.
Oam Ammonoosuc vol.
nhg New Hampshire Plutonics
?Ch Hoosac fm.
?Ccr Cavendish fm. Readsboro mem.
?Ccb Cavendish fm. Bull Hill mem.
ol Oliverian Plutonics
contact
approximate or gradational contact
inferred contact
Geology of easternmost part modified after TRASK 1964
3 Field Trip Stops

Geology of the Guilford dome area,
southeastern Vermont.

Road Log for Field Trip, Sunday Oct. 15
J. Christopher Hepburn, Leader

Assemble at STOP 1 at 10:30 a.m. This will allow plenty of time for participants leaving Burlington by 8:00 a.m. to arrive. The trip will never be more than a few miles from I91 for those who must leave early. Bring lunches.

Topographic map: Scheduled stops will be in the Brattleboro 15 minute quadrangle, Vermont-New Hampshire. The Geologic Map of Vermont by Doll *et al*. (1961) may also be of interest and is available from the Vermont State Library, Montpelier for $4.00.

Mileage

From Burlington take I89 south to I91. Then I91 south to Exit #3, the first Brattleboro exit from the north, marked "To Route 9 east, Keene, N.H.; and Route 5, Brattleboro".

0.0 At the junction of Routes 5, 9, and 91 north of Brattleboro by Howard Johnson's Restaurant just off Interstate Exit #3, turn left (north) onto Route 5.

0.7 Overpass over I91.

0.9 Brattleboro-Dummerston town line.

1.2 STOP 1. Meeting Place, PUTNEY VOLCANICS. Park in rest and picnic area on the east side of Route 5.

The Putney Volcanics (Hepburn, 1972) in this area consists of fine-grained, poorly foliated, light greenish gray quartz-plagioclase-muscovite phyllites and granulites with interbedded gray slates. The granulites and feldspathic phyllites weather buff to light brownish gray, characteristic of feldspar-rich rocks. Many of the foliation surfaces have a notable silky sheen. Small, brownish pits where carbonate has weathered out are common. The granulite beds may show a fine lamination. A few lenses of quartz-pebble conglomerate may be seen along Route 5 south of the highway pull-off but are much better developed at Stop 2. The rocks have been metamorphosed to the chlorite zone at this locality.

Continue north on Route 5.

1.4 Outcrop of Putney Volcanics to the east.

1.5 Outcrop of Putney Volcanics to the west.

2.1 Slate quarry in Littleton Formation to the east.

2.3 STOP 2. PUTNEY VOLCANICS, CONGLOMERATIC MEMBER. Park at left (west) side of road in the highway pull-off.

Examine outcrops of gray slate in the Littleton Formation on the east side of Route 5. Then walk 0.1 mile north through woods to an abandoned chicken-yard beside houses to west of Route 5. Outcrops are of the conglomeratic member of the Putney Volcanics. The contact of this conglomerate with the Littleton Formation represents the division between the "Vermont" and "New Hampshire" sequences in this area. The conglomerate contains both quartzite and slate pebbles in a slate matrix. (As this is the best exposure and type locality for the conglomerate, NO HAMMERING--PLEASE!). The excess of matrix over clasts in the conglomerate indicates it best fits Pettijohn's (1957) classification as a paraconglomerate. Pettijohn (1957, pp. 265-266) states that "it now seems probable in light of our knowledge of turbidity currents and related mudstones that most of these abnormal conglomerates [the paraconglomerates] are the product of subaqueous mudslides or slurries".

A few small porphyroblasts of light pink garnet occur here. The outcrop is included in the chlorite zone, however, as probe analyses indicate these garnets contain up to 15.9 weight percent MnO. (The garnet isograd has been mapped on the first appearance of almandine in the pelitic rocks.)

Immediately west of the conglomerate in this outcrop, the Putney Volcanics consists of slate with feldspathic granulite interbeds up to 2 feet thick. The granulites have fine laminations. M. P. Billings (1971, personal communication) indicated that a number of years ago he had found cross-bedding in these granulites that indicated tops to the west. This stop has become more overgrown in recent years, since the chickens left.

West of the abandoned chicken-yard a sequence of phyllites and feldspathic granulites similar to those at Stop 1 is exposed on the side of the hill.

Return to cars. Continue north on Route 5.

2.4 Road junction with dirt road on right. Continue north on Route 5.

2.6 Roger's Construction Co. yard on right (east), possible alternate parking for Stop 2.

2.9 Dutton Pines State Forest.

3.4 Road junction with road to East Dummerston; continue on Route 5. Outcrop of Putney Volcanics to west.

3.8 Road junction. Turn left (west) on road to East Dummerston and Dummerston Center.

4.7 Road junction in East Dummerston; continue straight.

4.8 Junction with road on right; continue straight.

4.9 Outcrop of Waits River Formation.
5.9 Dummerston Center. Turn sharp left (south).
6.0 STOP 3. NORTHFIELD FORMATION. Park along side of road. Walk west to outcrops of the Northfield Formation exposed near the hinge area of the recumbent anticline above the Prospect Hill fold (See Fig. 1). The Northfield here is a gray well-foliated mica schist with conspicuous garnet porphyroblasts and fewer porphyroblasts of biotite and staurolite. A few thin interbedded quartzites are also present.

Turn around; return north to Dummerston Center.

6.1 Dummerston Center. Turn left (west) on paved road past the fire station.
6.5 STOP 4. HINGE OF PROSPECT HILL FOLD, WAITS RIVER FORMATION AND STANDING POND VOLCANICS. Park in road pull-off on north side of the road just before the curve.

The Standing Pond Volcanics outline the northeasterly plunging hinge of the Prospect Hill recumbent fold at this locality (Fig. 1). A 1/2 mile traverse will be made around the hinge, following the contact between the amphibolites of the Standing Pond Volcanics and the schists, calcareous schists, and impure marbles of the Waits River Formation. This traverse presents an excellent opportunity to view a well-exposed hinge of a major recumbent fold. The contact is sharp and is easy to follow. The traverse starts just east of the pull-off near a very small creek along the eastern contact of the Standing Pond Volcanics. Follow this contact to the north and around the northeasterly plunging hinge of the recumbent fold, which closes on the lower south-facing slopes of Prospect Hill. Continue along the contact southward (now the western contact of the Standing Pond with the Waits River). The paved road is encountered again 1/4 mile west of the starting point.

If time permits, Prospect Hill will be climbed for the excellent view from the open summit (perhaps lunch). Please be particularly careful on this traverse with litter and the indiscriminate use of hammers. We are able to make this stop only with special permission.

Particular note should be made of the minor folds during the traverse. The most common folds are the F2 generation, those formed congruously with the recumbent folding. These plunge NE. and show a reversal in drag sense around the hinge. A few F1 minor folds that predate the recumbent folding, have the principal schistosity parallel to their axial surfaces, and are refolded by the F2 folds are visible in outcrops near the road.

Return to cars; proceed west on paved road.

6.7 Outcrops of the Standing Pond Volcanics in the hinge of the Prospect Hill recumbent fold.

6.8 Contact of the Standing Pond Volcanics with the Waits River Formation.
6.9 Junction with dirt road to south; continue straight on paved road.
7.4 Outcrop of aplitic dike associated with the Black Mountain Granite.
7.8 Junction with road from right (north); continue straight.
8.5 Road junction; take sharp left onto dirt road.
9.3 STOP 5. BLACK MOUNTAIN GRANITE. Park by abandoned quarry buildings and follow path east to the abandoned Presbury-Leland granite quarry.

The Black Mountain Granite is a late synorogenic to post-orogenic two-mica granodiorite correlated with the New Hampshire Plutonic Series (Billings, 1956). Note the weak foliation produced by the alignment of the fine-grained micas. Coarse, unoriented muscovites that are younger than this foliation have been dated by Naylor (1971) from this locality. He obtained Rb/Sr ages of 377 m.y. and 383 m.y. for these muscovites, which sets a minimum age for the pluton as late Early to early Middle Devonian.

West- to northwest-dipping sheeting is well exposed in the quarry walls. Note particularly the increased thickness of the individual sheets with depth.

STOP 5a.

Walk west from the quarry to the banks of the West River. The contact of the granite body with the surrounding Waits River Formation is well exposed here. Dikes and sills of granite and aplite are numerous within a few hundred feet of the contact and may indicate a stoping mechanism for the emplacement of the granite pluton. The dikes cross-cut bedding and the principal schistosity. Some have a weak foliation roughly parallel to the regional schistosity but clearly post-date the major deformation. The country rocks near the granite have been altered by contact metamorphism, in addition to being regionally metamorphosed to the staurolite-kyanite zone.

Return to cars; turn around and retrace route north to the main road.

10.1 Junction with paved road; continue straight (north).
10.2 STOP 6. WAITS RIVER FORMATION. Park just beyond the entrance to the covered bridge, heading north.

Outcrops typical of the Waits River Formation in the center of the Guilford dome are seen along the east bank of the West River. The rocks are interbedded impure marbles, calcareous mica schists, and mica schists. Most of the minor folds present here are assigned to the F2 stage and developed congruously with the large-scale recumbent folding. They were refolded into their present attitude by the rising of the Guilford dome.

Return to cars; proceed straight (north) on the dirt road along the east side of the West River.

10.7 Junction with road to right; continue straight.

11.2 STOP 7. BARNARD VOLCANICS. Park along the road above the east end of the old West Dummerston Dam. Climb down the steep bank (Use caution.) to the west end of the now abandoned dam.

The Middle Ordovician Barnard Volcanics are exposed here in the center of the Fall Brook anticline, which forms the core of the proposed recumbent anticline above the Prospect Hill recumbent fold (Fig. 1). At this stop the rocks include amphibolites and felsic gneisses. Minor amounts of rusty-weathering schist similar to the Cram Hill are present along with the Barnard in this anticline but have not been designated separately on Figure 1.

Turn around; retrace route south to the covered bridge.

12.2 Covered bridge; turn right; cross the bridge. At the west end, turn left (south) onto Route 30.

12.9 West Dummerston Village. Note Black Mountain and the granite quarry to the east across the West River.

13.3-13.6 Outcrops of the Waits River Formation.

13.8 Iron bridge to left; junction of road to the right. Continue straight on Route 30. Outcrops of granite in the brook to the west.

15.2 STOP 8. WAITS RIVER FORMATION ALTERED BY CONTACT METAMORPHISM. Park at the side of Route 30 by the large road-cut on the right (west).

The Waits River Formation in this outcrop is near the contact of the Black Mountain Granite. Calc-silicates (particularly actinolite and diopside) are well developed in the impure marble beds. Diopside has not been observed in the Waits River Formation of the Guilford dome area outside of the contact aureole of the Black Mountain Granite.

Continue south on Route 30.

16.8 Roadmetal quarry in the Waits River Formation to the west.

17.0 Outcrop of Waits River Formation.

17.7 STOP 9. GILE MOUNTAIN FORMATION, MARBLE MEMBER. Park at left in the pull-off under the I91 overpass.

Outcrops under the overpass are fairly fresh exposures of the marble member of the Gile Mountain Formation, metamorphosed to the biotite zone. The impure marble beds (already starting to obtain the distinctive punky-brown weathering rind) similar to those in the Waits River Formation are interbedded with phyllites. The percentage of micaceous quartzite beds is fairly high here (approximately 15 percent), as is typical of this member.

END OF FIELD TRIP

Continue south 1.5 miles to Brattleboro for junctions with the major highways.

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[illegible] that have been thermally metamorphosed, as is typical of this [illegible].

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[illegible] 1.5 miles [illegible] with the major highways.

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Trip B-12

STRATIGRAPHIC AND STRUCTURAL PROBLEMS OF THE SOUTHERN PART OF THE GREEN MOUNTAIN ANTICLINORIUM, BENNINGTON-WILMINGTON, VERMONT

by

James W. Skehan, S.J.*

INTRODUCTION

This field trip is an introduction to several aspects of problems that have vexed students of the geology of the Green Mountains, the Berkshires and the Taconic Mountains for decades. Hitchcock very early (1861) noted that the rock units flanking the eastern side of the Precambrian core of the Green Mountains were different from those of its western flank (Fig. 1). Prindle and Knopf (1932) explained this and the juxtaposition of the two contrasting sequences by inferring the existence of the Hoosac Thrust which they and MacFadyen (1956) mapped as far north as Heartwellville. They also mapped the "Cambrian outliers" in the dominantly Precambrian terrain of the Green Mountain core (Figs. 1 and 2). Skehan (1961 and this paper) extended the Hoosac fault northeasterly and infers tentatively that it marks the trace of the plane of angular discordance between the Mt. Holly Complex and the Cavendish Formation. Dale (1914-16) was the first to map this same contact of the Green Mountain core, which he referred to the Algonkian, with the younger rocks (Cambrian) to the east in Searsburg (Stops 7 and 8). He regarded this boundary as an angular unconformity. The related problem of recognizing the source area and mechanism of emplacement of the Taconic allochthon has been addressed by many students of Green Mountain and Taconic geology.

Skehan (1953 and 1961) traced rock units mapped by Thompson (1950) and Rosenfeld (1954) in the Ludlow and Saxtons River quadrangles respectively through the Wilmington area to the Massachusetts border. Mapping in adjacent parts of Massachusetts has been carried out by Pumpelly, Wolff and Dale (1894), Osberg (1950), Chidester et al. (1951), Segerstrom (1956), Herz (1958), Hatch (1967) and Hatch, Stanley and Clark (1970) who have traced the units of the Vermont sequence south to Connecticut.

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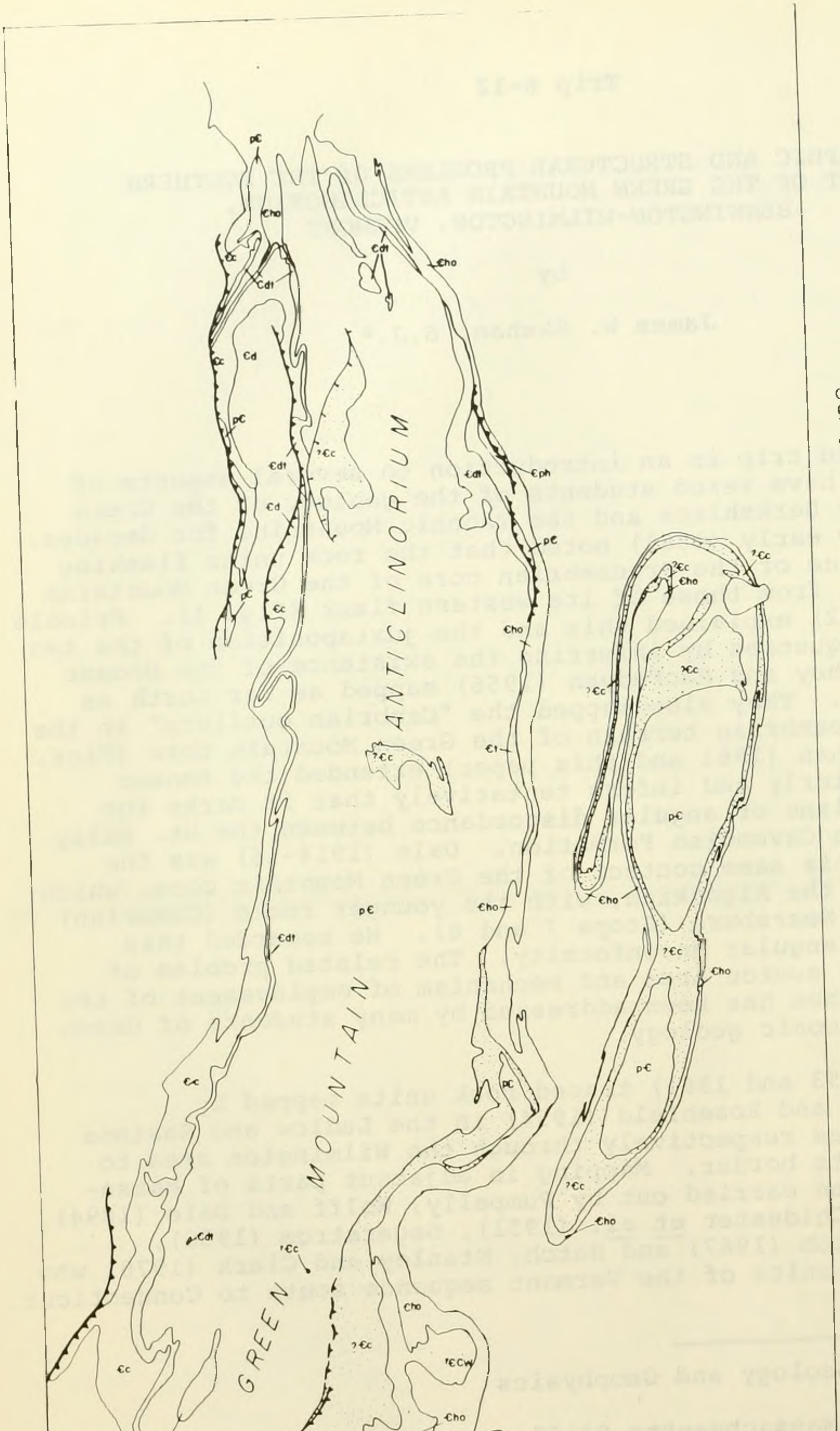

FIGURE 1

GEOLOGIC MAP SHOWING THE CAVENDISH FORMATION RELATIVE TO THE GREEN MOUNTAIN ANTICLINORIUM AND RELATED FORMATIONS

LEGEND

€ph	Pinney Hollow fm
€ho	Hoosac fm.
€t	Tyson fm.
?€cw	Wilmington gneiss
?€c	Cavendish fm.
p€	pre-Cambrian
€d	Dunham dolomite
€c	Cheshire quartzite
€dt	Dalton fm. (Mendon fm.)

fault (thrust)

inferred fault

fault (normal)

5 0 5 miles

N

All of these workers recognized that the rocks of the Taconic Allochthon (Zen, 1967, Bird, 1969) are similar to those of the eugeosynclinal sequence east of the Green Mountains allowing for differences in the grade of metamorphism. Several of these geologists have research projects in progress which bear on a solution to problems of the present field trip.

The present field trip proposes to introduce the participants to representative rock types of the western Cambrian sequence (Stops 1 and 2) and its continuation on the eastern flank (Stop 12) as well as to the Precambrian core rocks of the Green Mountains (Stops 3, 4, 5, and 7). Additionally several of the component stratigraphic units as well as structural relationships of the questionable Cambrian sequence of the Cavendish Formation of Doll *et al*. (1961) (Stops 6, 8, and 11) to other units will be studied.

STRATIGRAPHY

The stratigraphic succession of the area of the field trip (Fig. 2) includes the Mt. Holly Complex of Precambrian age, the Cavendish Formation including the Wilmington Gneiss of questionable Cambrian age and the Dalton and Cheshire Formations of Lower Cambrian age and the Hoosac Formation of Cambrian age.

Mount Holly Complex

The Mt. Holly Complex (Skehan, 1961, pp. 28-45) forming the core of the Green Mountain Anticlinorium consists of several units:

Microcline Gneiss. The largest part of the Green Mountain core in the Wilmington-Woodford area is underlain by coarse-grained banded biotite-epidote-quartz-microcline augen gneiss. Commonly the quartz is blue. This unit is lithologically similar to and in many exposures texturally identical with rocks of the Stamford Granite Gneiss. Except that blue quartz is absent in the Wilmington Gneiss, it is otherwise indistinguishable from the microcline gneiss of the Mt. Holly Complex (Skehan, 1961, pp. 29-31) and the Bull Hill Gneiss of the Cavendish Formation of Doll *et al*. (1961).

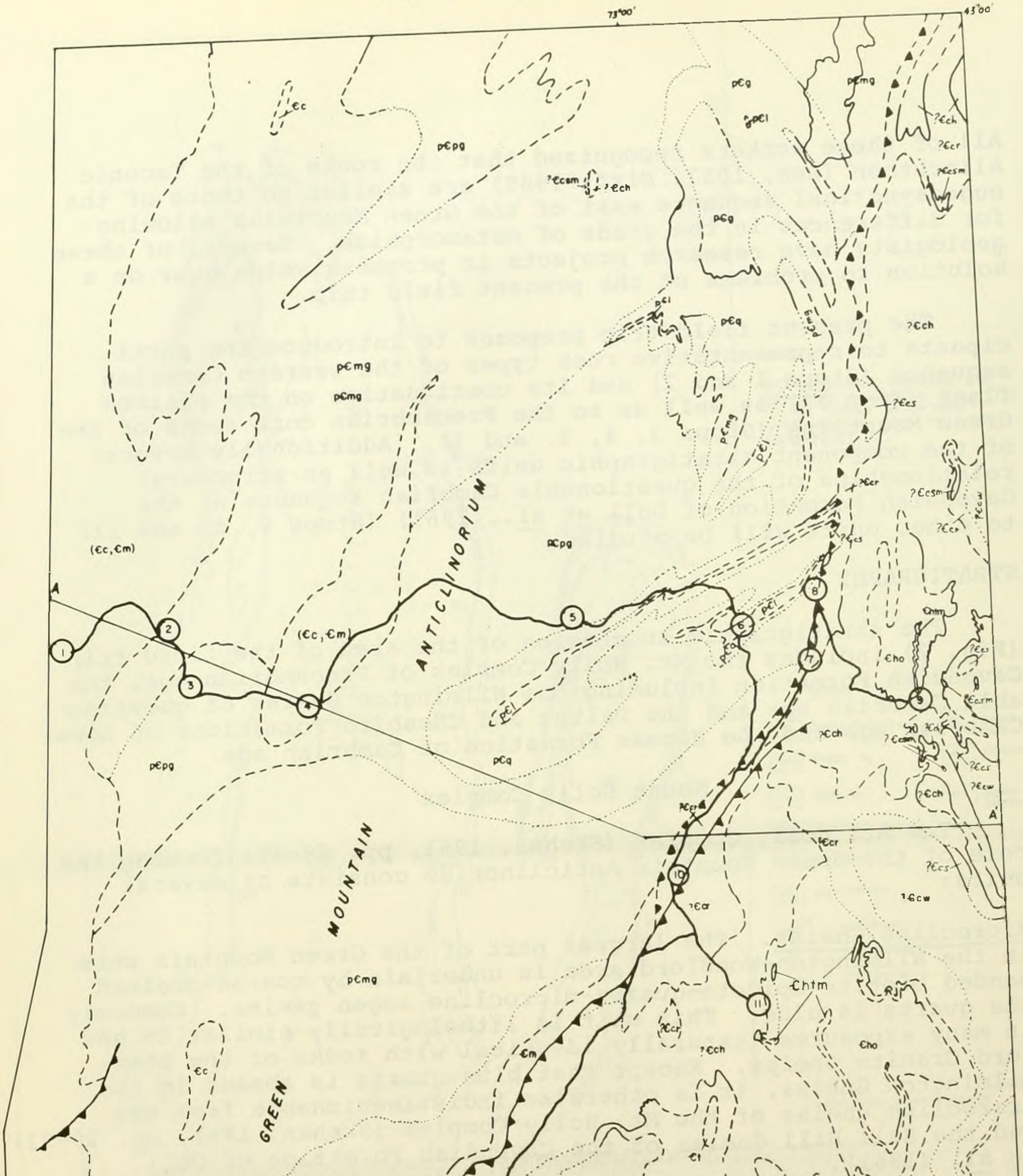

FIGURE 2.

GEOLOGIC MAP OF THE WILMINGTON WOODFORD AREA

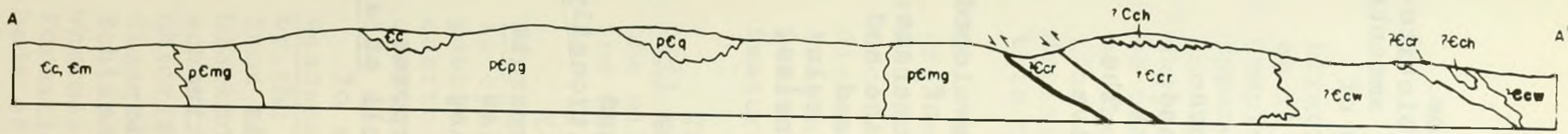

FIGURE 3

LEGEND

Qal	Quaternary alluvium
€ho	Hoosac fm. (green schist = €hg)
€c	Cheshire quartzite
€m	Mendon fm. (Dalton of Doll et al., 1961)
€htm	Turkey Mountain mem.
€t	Tyson fm.
?€ch	Heartwellville schist
?€csm	Sherman marble
?€cr	Readsboro schist
?€cs	Searsburg cong.
?€cw	Wilmington gneiss
p€g	Plagioclase gneiss
p€l	Lime silicates
p€q	Quartzite
p€pg	Plagioclase gneiss
p€mg	Microcline gneiss
p€sg	Stamford granite gneiss

Cavendish Fm. (?€ch, ?€csm, ?€cr, ?€cs, ?€cw)

contact exactly located

contact approximately located

inferred or gradational contact

thrust fault

(7) stop

Plagioclase Gneiss. (Harmon Hill Gneiss). Large areas of the Green Mountain core are underlain by dark, banded muscovite-biotite-epidote-plagioclase-quartz gneiss commonly containing lesser amounts of microcline and quartz in layers and pods, as well as beds of amphibolite (Skehan, 1961, pp. 31-35).

Stamford Granite Gneiss. This distinctive rock is a coarse-grained porphyritic gneiss with very large rectangular to rounded microcline crystals. The finer grained groundmass consists of blue quartz, albite, microcline, biotite, epidote and magnetite. This unit (Doll et al., 1961) is in many respects similar to the Bull Hill Gneiss of the Cavendish Formation. The Stamford Granite Gneiss is considered to be probably intrusive into the Microcline Gneiss unit (p€mg) and related rocks (Pumpelly et al., 1894).

Younger Metasedimentary Rocks. A distinctive sequence is developed in the eastern part of the Green Mountain core and consists of massive, buff to blue vitreous quartzite, blue quartz conglomerate; conglomeratic gneiss composed of angular to rounded microcline and granite gneiss pebbles; crystalline graphite-bearing, blue and white quartz-rich white gneiss; fine to very coarse-grained calc-silicate granulite, and blue and white quartz-plagioclase gneiss.

Cavendish Formation

Skehan (1961, pp. 46-65 and Pl. 1) mapped the following sequence in the area east of the Green Mountain core: the Searsburg Conglomerate Member, the Readsboro Schist unit, and the Sherman Marble Member of the Readsboro Formation. Additionally he mapped the Heartwellville Schist, which is lithologically similar to the Gassetts Schist of the Chester Dome, as a separate and younger unit. Doll et al. (1961) showed this sequence as the Cavendish Formation (Fig. 1) distinguishing the following units: the Sherman Marble, the Bull Hill Gneiss and the Readsboro-Gassetts Schist. In the present paper for the purposes of more general discussions we shall follow the usage of Doll et al. and use the term Cavendish to refer to this entire sequence of Searsburg-Heartwellville Schist.

It is useful, however, for detailed discussions of this particular area to further subdivide the Cavendish Formation of the Wilmington-Woodford area into its generally distinctive lithologies even though their stratigraphic position is not clear in all parts of the area (Fig. 2). In the present discussion the Wilmington Gneiss, lithologically similar to the Bull Hill Gneiss, is considered as closely related to the Cavendish Formation and is tentatively included in that sequence (Figs. 2 and 3).

Wilmington Gneiss

The Wilmington Gneiss named by Skehan (1961) is of uncertain stratigraphic position. It may be Precambrian in age, resembling as it does the microcline gneiss sequence of the Mt. Holly Complex of the Green Mountain core. On the other hand the apparently conformable relationship immediately beneath the Hoosac and Tyson Formations along their eastern contact (Fig. 1) suggests strongly the possibility that the Wilmington Gneiss may be of Cambrian age. The complex and very complicated relationships of the Wilmington Gneiss to the members of the Cavendish Formation of Doll *et al.* (1961) along the western contact makes a decision as to the age of the Wilmington Gneiss impossible at this time.

The Wilmington Gneiss consists of a medium to very coarse-grained, well-banded, somewhat foliated biotite-epidote-quartz-microcline-augen gneiss. The microcline is gray to pink and occurs as lenticular augen and flaser in which the average long diameter is about 7 mm. Locally the augen may reach 8 inches in length and are usually flattened into the plane of the foliation. Quartz rods and linearly aligned streaks of biotite are a common feature of the Wilmington Gneiss.

The Wilmington Gneiss may be the correlative of the Bull Hill Gneiss of Doll *et al.* (1961) an exposure of which is only one mile north of and on line with the northernmost exposure of the Wilmington Gneiss of the Wilmington quadrangle (Skehan, 1961, Pl. I).

Searsburg Conglomerate Member. The Searsburg Conglomerate Member is typically a blue or white quartz, albite and/or microcline-pebble conglomerate in a dark biotite-muscovite-carbonate-albite-quartz schist matrix. Thin bedded vitreous buff, white and gray quartzite in dark mica quartz schist is closely associated with the conglomeratic facies.

Readsboro Schist. The Readsboro Schist as presently understood by the writer is indistinguishable in hand specimen or outcrop from the Hoosac Formation consisting as it does of gray, brown and black, medium to coarse-grained muscovite-biotite-albite-quartz schist locally containing variable amounts of chlorite, muscovite, chloritoid, paragonite and garnet. Albite megacrysts 2-15 mm. in diameter are characteristic of the formation. The Readsboro Schist encloses calcite and dolomite marble of the Sherman Member whereas no marble beds have so far been recognized in the Hoosac Formation. The Hoosac Formation does, however, contain amphibolite beds of volcanic origin. These two formations are thus mapped on the basis of these differences.

Sherman Marble Member. The Sherman Marble is a coarse to very coarse-grained white, mottled green and gray to pink, quartz-calcite marble with coarse crystals of graphite up to 1 cm. in diameter; actinolite or diopside-phlogopite-talc calc-silicate granulite; and fine-grained quartz-dolomite marble. This marble is more commonly enclosed in the albite schist sequence but in the northern part of Mount Snow (Pisgah) it occurs in the Heartwellville beds.

Heartwellville Schist. The Heartwellville Schist is the lithologic and possibly the stratigraphic equivalent of the Gassetts Schist of Doll et al. (1961) of the Cavendish Formation. In the Wilmington-Woodford area the lower part of the Heartwellville Schist consists dominantly of green chlorite-muscovite-(paragonite-chloritoid)-garnet-quartz schist whereas the upper part is dominantly coaly-black, rusty weathering muscovite-chlorite-garnet-quartz schist. In hand specimen or in outcrop these rocks are indistinguishable from their counterparts in the Pinney Hollow and Ottauquechee Formations except that the Heartwellville is characteristically more highly deformed.

Dalton Formation

The Dalton Formation of the Wilmington-Woodford area is separated from the overlying rocks of the Cavendish Formation on the southeastern flank of the Green Mountain Anticlinorium by the Hoosac Thrust and from the Mt. Holly Complex by an angular unconformity. The Dalton consists of thin-bedded schistose muscovite-blue quartz quartzite; biotite-albite-quartz schist; black chloritoid-muscovite-quartz phyllite (Mendon Formation of MacFadyen, 1956 and Skehan, 1961); and microcline-quartz gneiss. The Dalton Formation is of Lower Cambrian age since Walcott (1888) found fragments of Olenellus about 100 feet above the Stamford Gneiss contact near North Adams, Massachusetts in a quartzitic graywacke stratigraphically beneath a band of black phyllite considered to be the equivalent of the Moosalamoo and Mendon Formations.

Cheshire Quartzite

The Cheshire Quartzite is stratigraphically above the Dalton into which it grades. It is a buff, gray to light pink vitreous quartzite consisting of rounded quartz grains commonly showing overgrowths of quartz and cemented together by quartz and/or calcite. In many occurrences, the Cheshire shows primary sedimentary structures and is generally a ridge-former because of its resistance to erosion.

HOOSAC FORMATION

The Hoosac Formation (Hoosac Schist of Pumpelly et al., 1894) consists of gray, brown and black, medium to coarse-grained muscovite-biotite-albite-quartz schists locally containing variable amounts of chlorite, muscovite, paragonite and garnet. Rocks containing appreciable garnet commonly weather to a mottled rusty color. Albite megacrysts 2-15 mm. in diameter are characteristic of the formation, which is distinguished from the overlying Pinney Hollow Formation by the presence of more abundant albite megacrysts, its color, and its generally coarser and more granular texture.

The Turkey Mountain Member of the Hoosac Formation (named by Rosenfeld, 1954) is typically a dense dark green to black amphibolite commonly characterized by rounded to sub-angular white, gray, green or dark brown "amygdules" composed of quartz and albite commonly with included epidote, hornblende and garnet.

STRUCTURAL GEOLOGY

The area of the field trip is the southernmost part of the Green Mountain Anticlinorium which plunges south beneath the Cambro-Ordovician arenaceous and carbonate sequence of the North Adams-Williamstown area. The Cambrian beds of the western flank are overturned and in part faulted along high angle reverse faults (Fig. 2).

The Cambrian rocks of the southeastern flank of the Green Mountains are truncated by the easterly dipping Hoosac Thrust (Fig. 1). Rocks of the Cavendish Formation lie above the Hoosac Thrust and/or the Precambrian-Cambrian unconformity along the eastern Green Mountain front. This boundary between the Cavendish Formation and the Mt. Holly Complex is now considered tentatively by the writer to be a thrust fault since in this region the Precambrian beds show a strong angular relationship to the Cavendish beds (Fig. 2). Elsewhere in the Green Mountains where the Cavendish or the Tyson Formations contact the Precambrian rocks, beds on both sides of the contact have been rotated or smeared out by tectonic forces into apparent conformability adjacent to the boundary. At some distance from the contact, however, the angular difference is observable. The presence of strong angular discordance close to the contact of the Mt. Holly with the Cavendish Formation suggests that the Precambrian units have been truncated by thrusting.

The data presently available allow the following alternative interpretations:

(1) The Cavendish Formation, including the Wilmington Gneiss, is of Precambrian age; (2) the Cavendish including the Wilmington Gneiss is of Cambrian age but older than the Hoosac Formation of known Cambrian age and (3) the Cavendish and the Hoosac Formations are both of Cambrian age and are coeval facies of each other but the Hoosac now bears a thrust or some other complex structural relationship to the Cavendish. Skehan in 1961 offered the first alternative as his preferred interpretation at that time. Recognizing that each of these hypothesis are possible, his present understanding of the problem leads him now to prefer the second or third hypotheses with (3) being favored, although not proven, because it helps to explain more satisfactorily our present understanding of the relationship of the Cavendish to the Dalton Formation of the southeastern margin of the Green Mountain core as well as to the core rocks themselves (Figs. 1 and 2).

The fact that the Hoosac Formation (Fig. 3) overlies the rocks of the Cavendish Formation with an angular discordance led Skehan (1961) to consider these rocks of questionable Precambrian age and Doll et al. (1961) to regard them as of questionable Cambrian age.

TRIP LOG

Bennington may be reached by travelling south from Burlington on Route 7 (the shortest distance) or on I-91 (a faster highway) to Brattleboro and driving about 35 miles west on Route 9.

The primary references for this trip are:

Skehan, J.W., S.J., The Green Mountain Anticlinorium in the Vicinity of Wilmington and Woodford, Vermont: Bull. 17, Vermont Geological Survey, 159 p., 1961 ($3.00).

----, Geologic Map of the Wilmington-Woodford, Vermont Area, from Bull. 17, Vermont Geological Survey, 1961 (25¢).

Doll et al., Centennial Geologic Map of Vermont, October, 1961 ($4.00).

(These three reference materials may be obtained from the State of Vermont, Department of Libraries, Montpelier, Vermont by enclosing remittance with order.)

NOTE: Proceed on your own to Stop 1 after which go to Stop 2, where the group will meet at 10:00 a.m. for a traverse along City Stream.

Mileage

0.00 Woodford-Bennington township line on Route 9 east of Bennington Center about 3.5 miles.

0.20 Stop 1. CHESHIRE QUARTZITE

A few hundred feet east of the township boundary of Bennington and Woodford on Route 9. Park off the highway near Mountain Melody Motel and walk south to the outcrop on the west side of the highway. These beds of Lower Cambrian Cheshire Quartzite consist of vitreous, buff to light pink, cross-bedded quartzite gently folded in an open anticline plunging westerly at approximately 15°. This fold is closely related spatially to but disharmonic as regards the major syncline whose southwesterly plunging axial trace passes near Woodford Hollow.

As indicated by sedimentary cross-bedding, these beds are right side up. Hand specimen and thin section examination of the rock shows rounded grains of detrital quartz. The beds of the eastern limb of this syncline rapidly become more steeply dipping and are even inverted toward the northeast in the direction of the western margin of the Precambrian core of the Green Mountains (Fig. 3), as the Cheshire Quartzite beds to the west give way to the stratigraphically lower beds of the Dalton Formation.

Return to cars and drive east on Route 9.

0.40 Outcrops of Cheshire Quartzite in the brook on the east. Much of the western slope of Harmon Hill to the east is upheld by the resistant beds of the Cheshire and Dalton Formations.

1.30 Junction of the Long Trail and Appalachian Trail with Route 9.

1.70 Junction of Woodford Hollow Road on the north with Route 9.

2.00 Stop 2. DALTON (MENDON) FORMATION AND MT. HOLLY COMPLEX

Park cars off the highway near the place where the high-tension power line crosses Route 9. Make a traverse on foot along City Stream in a westerly direction. This stop is an introduction to the Dalton Formation and to some of the Precambrian rocks and is designed to illustrate the problem of mapping the precise location of the Precambrian-Cambrian contact especially where the rocks on either side have been smeared into apparent conformability. Commonly, however, retrograde metamorphic effects in

Mileage (cont'd)

Precambrian rocks of appropriate composition are recognizable especially in thin sections. Moreover, many of the beds of the Lower Cambrian Dalton Formation, especially those consisting of vitreous quartzite containing rounded blue quartz sand grains and pebbles, are sufficiently distinctive to be recognized. The Dalton Formation additionally contains biotite-albite-quartz schist, and schistose muscovite-chlorite quartzite. In places, however, where biotite-plagioclase gneiss and microcline gneiss of the Dalton Formation overlies rocks of similar composition of the Mt. Holly Complex, from which they were derived by erosion, the precise location of the contact may be difficult to determine.

The Precambrian-Cambrian contact at this locality, about 350 feet west of the high-tension utility line, is placed at the western margin of a pyrite-bearing biotite-microcline gneiss which is closely associated with a chlorite-epidote amphibolite bed. The contact is considered to be folded or faulted since the rocks just mentioned are separated by a band of blue quartz conglomerate of the Dalton Formation from pink microcline gneiss to the east assigned to the Mt. Holly Complex (Skehan, 1961).

Proceed east on Route 9.

2.95 Pull off the highway at the large roadcuts near Dunville Hollow.

Stop 3. MOUNT HOLLY COMPLEX

Large roadcuts on both sides of Route 9 expose tight isoclinally folded bands of the dominantly plagioclase gneiss sequence of the Mt. Holly Complex of Precambrian age (Skehan, 1961, pp. 28-35). A less important component of the sequence here consists of microcline-rich bands and thin meta-amphibolites. The northeasterly trending well-developed folds are characterized by nearly vertical to steep westerly dipping axial planes. Post-metamorphic faults and shears, although variously oriented, are commonly developed essentially parallel to the axial planes of the folds (Skehan, 1961, Fig. 6). The second of two localities in the Wilmington-Woodford area where an unmetamorphosed basalt dike, considered to be of Triassic or Jurassic age, has been recognized is at this series of outcrops.

The rocks of the core of the Green Mountain Anticlinorium have been affected by both Precambrian and Paleozoic

Mileage (cont'd)

regional metamorphism. Broughton et al. (1962) refer the Precambrian metamorphism of the nearby rocks of the eastern Adirondacks to a "hypersthene zone" corresponding in its mineral assemblages to the higher grade part of the sillimanite-K feldspar zone as developed in the Paleozoic rocks of New England (Thompson and Norton, 1968). The rock sequence of the Mt. Holly Complex as mapped in the Wilmington-Woodford area bears a striking resemblance to that of the eastern Adirondacks, due allowance being made for the fact that the rocks of the Green Mountain Massif have been altered by retrograde Paleozoic metamorphism of approximately the biotite and garnet zones.

The dominantly dark biotite-plagioclase gneisses dip steeply to the west. Deformed pink microcline pegmatite layers and light gray feldspathic bands reveal that the sequence has been subjected to considerable deformation by being isoclinally folded. There are many bedding plane faults which are recognized as being essentially axial plane faults since the beds are so tightly folded.

Proceed east on Route 9 up the western flank of the Green Mountain Anticlinorium.

3.50 Large roadcut on the left in dark plagioclase gneiss is crosscut by folded Precambrian pegmatite.

3.85 On the right is a sequence of dark migmatitic gneisses. The migmatite is of microcline granite and pegmatite. Approximate western contact of the Cambrian beds of the Woodford "outlier" with the Mt. Holly Complex. Dark phyllite is well exposed in City Stream on the south side of Route 9 between here and Stop 4.

4.50 Black chloritoid-sericite-quartz phyllite of the Lower Cambrian Mendon Formation (MacFadyen, 1956; Skehan, 1961; and mapped as Dalton Formation by Doll et al., 1961) in City Stream on the south side of Route 9.

4.70 Stop 4. DALTON (MENDON) FORMATION

Park on the north side of the highway. Cross the road and examine the fine-grained chloritoid phyllite in the outcrops on City Stream.

Mileage (cont'd)

There are several localities in the core of the Green Mountain Anticlinorium where isolated outcrops of Lower Cambrian rocks of the Dalton Formation (Doll et al., 1961) are exposed of which the Woodford "outlier" is the largest exposure. It is about 5 miles long and 1 mile wide over much of its length. The northeasterly trending Woodford syncline is comprised of two major rock units: (1) the black carbonaceous biotite-sericite-chloritoid phyllite of the Dalton Formation and (2) the vitreous gray quartzite and schistose quartzite which may represent quartzite beds in the Dalton (Mendon) Formation.

The fact that the sequence of the Woodford syncline is comprised in large part of dark arenaceous phyllite suggests that its environment of deposition was more closely related to that of the Lower Cambrian Moosalamoo Phyllite (Doll et al., 1961) than to that of the dominantly arenaceous rocks which typify the Dalton Formation. Both are considered to be essentially of equivalent age.

These outcrops at Woodford are about 10 miles north of the locality near North Adams, Mass., at which Walcott (1888) found fragments of Olenellus mentioned above.

At this stop note that cleavage to bedding relationships are well developed. Cleavage chiefly dips more steeply than the bedding. Southeasterly dipping beds reveal that the structural analysis,however, fits no simple model of a typical synclinal structure developed by compression. Although various aspects of the Woodford "outlier" have been described by Prindle and Knopf (1932), MacFadyen (1956) and Skehan (1961) it is not definitely known whether these rocks are in normal depositional or in a thrust relationship to the underlying Precambrian Mt. Holly Complex.

Return to cars and proceed northeasterly on Route 9.

5.00 Near the entrance to the Prospect Mountain Ski area on the right, thin bedded, gray northeasterly-dipping sericite quartzite beds were exposed in 1959.

5.35 In Woodford Center near the church on the east side of the road folded, gray to black phyllite is exposed, the beds having the attitude, N. 75°W., 20°NE.

Mileage (cont'd)

5.75 200 feet southwest of the Peter Pan Motel on the left folded, thin-bedded quartzite beds crop out having the attitude, N.85°W., 35°SW. The folds, displaying a left-handed pattern (Skehan, 1961, p. 112sq.) plunge S.35°W. at 30°.

6.20 Big Pond on the left.

7.00 The divide at the crest of the Green Mountains intercepts Route 9 approximately at this location. Proceed downslope to the east. The topographic relief of the crest of the Green Mountains is generally subdued, outcrops are sparse and the swamp and forest cover are heavy. This condition, which is typical of large tracts in the Precambrian core of the Green Mountains, renders geologic mapping sufficiently difficult to impede detailed mapping and consequently a sophisticated understanding of the geology of the core of this massif.

8.25 Ann Marie's Restaurant -- the only all-weather restaurant between Bennington and Wilmington with the possible exception of motel-related dining facilities.

9.25 Stop 5. VIEW AND PICTURE STOP

Park on the north side of the highway at an abandoned gasoline station and cabins. To the north is a panoramic view of the breadth of the Green Mountain Massif with one of its highest peaks, Stratton Mountain in the Londonderry Quadrangle, visible in the distance. The rocks of the Mt. Holly Complex lie to the east of the Dalton Formation and Cheshire Quartzite, the ridge-formers on the near skyline to the northwest. In the far distance to the northwest may be seen Mt. Equinox of the Taconic Allochthon. To the east and northeast is the very prominent Mt. Snow (Pisgah)-Mt. Haystack Ridge comprised of questionable Cambrian metasediments of the Cavendish Formation of Doll et al.(1961).

Return to cars and proceed east on Route 9.

11.40 Junction of Route 9 with Route 8. Proceed south on Route 8.

11.95 Stop 6. VIEW AND PHOTO STOP

Park off the road and out of the line of traffic. Rusty weathering calc-silicate granulites are exposed in small road outcrops. This stop is near the eastern margin of the Precambrian core of the Green Mountains, which is

Mileage (cont'd)

bounded on the east by the easterly dipping Hoosac Thrust. The intensely deformed rocks of the Cavendish Formation rise up in the Haystack Mountain and Mount Snow (Pisgah) ridge. Their higher slopes are typically capped by the resistant dark muscovite-garnet-chlorite-quartz schists (Heartwellville Schist of Skehan (1961) and Gassetts Schists of Doll et al. (1961)). The Harriman Reservoir, filling a former river valley in the Wilmington Gneiss, may be seen to the east-southeast as viewed along the valley occupied by the east branch of the Deerfield River. Hogback Mountain on the distant skyline is held up by the Pinney Hollow garnet-muscovite-quartz schists and the Chester Amphibolite, the Ottauquechee and Stowe Formations, the schistose portions of these units being nearly identical in composition to rocks of the Cavendish Formation.

Proceed south on Route 8.

13.95 Junction of Route 8 with Sleepy Hollow Road. Farrington Cemetery is on the southeast corner of the junction. Turn left on Sleepy Hollow Road, and proceed 2 miles northeasterly to Bond Brook. Park off the road as best you can.

15.95 Stop 7. READSBORO AND HEARTWELLVILLE SCHISTS

Proceed on foot in an easterly direction along the north side of the swampy area. The stratigraphic section in Bond Brook consists of biotite-muscovite-garnet-albite-quartz schists overlain by garnetiferous chlorite-muscovite-quartz schist of the Cavendish Formation, these being identical in lithology with the Hoosac and Pinney Hollow Formations. The main thrust (and/or unconformity) is probably just west of Sleepy Hollow Road at this locality. Return to cars and proceed northerly toward Route 9.

16.35 Bridge over the penstock aqueduct which carries water from Searsburg Dam to Medburyville Power Plant.

16.55 Junction of Sleepy Hollow Road with Route 9. The trace of the boundary between the Mt. Holly Complex and Cavendish units (the Algonkian-Cambrian boundary of Dale, 1914-16) passes beneath this intersection and follows the trend of Route 9 for a few hundred feet.

Mileage (cont'd)

At the junction of Route 9 and Sleepy Hollow Road, turn left (west) on Route 9.

16.75 Turn north on the road to the Searsburg Reservoir and park out of traffic.

Stop 8. PRECAMBRIAN QUARTZITE AND LIME SILICATE GNEISS

On the northwest corner of this intersection is a small outcrop which together with the rock units at Stop 7 exemplifies several features typical of the boundary between the Cavendish Formation and the well-authenticated Precambrian rocks of the Mt. Holly Complex. This outcrop of blue-quartz quartzite of the Mt. Holly Complex has the attitude N.70°E., 90°. The presence of blue quartz is a characteristic feature of a number of the units of the Mt. Holly Complex.

A few hundred feet southwest of this intersection are outcrops of rusty weathering calc-silicate granulite beds. The east-northeasterly strike of these beds contrasts strongly with the attitude of the overlying Cavendish Formation (Readsboro and Heartwellville Schists of Skehan, 1961, pp. 45-63) exposed a few hundred feet to the east, whose attitude is N.15°E, 60°SE, and which were studied at Stop 7.

Two hundred feet downslope to the east of this blue quartzite outcrop may be seen the penstock aqueduct, the foundation of whose pedestals are on a well developed sequence of identical and related kinds of Precambrian rocks. Crawl under the penstock at one of the openings and proceed on foot in a northeasterly direction to the Deerfield River and rock-hop your way to the outcrops of dark biotite-muscovite-quartz schist cropping out on the east side of the river. These rocks grade up into biotite-albite-garnet-quartz schists which in turn pass upward within a short distance (Skehan, 1961, Pl. I) into the green (continuous with the beds of Stop 7) and black quartz-mica schist of the Heartwellville Schist.

The Searsburg Conglomerate is difficult to find at this locality but has been exposed in one outcrop south of Searsburg Reservoir and consists of elongate quartzite pebbles in a calcite-biotite-chlorite-quartz schist matrix.

Return to cars and proceed north to the Searsburg Dam for .7 mile on the unpaved road. Turn around in the field

Mileage (cont'd)

adjacent to the gatehouse at the dam. The Precambrian gneisses and schists exposed in the spillway of the dam are separated by only 300 feet from the Cavendish Schists in the Deerfield River below the spillway. Return to cars and proceed south to Route 9.

17.95 Junction of Route 9 and road to Searsburg Dam. Turn left (east) on Route 9.

18.05 Trace of the Precambrian-Cambrian boundary (noted above at Mile 16.55) is approximately at this location. Continue east on Route 9.

19.05 The high ridges to the north of the river and Route 9 are the green garnet schist of the Heartwellville units.

19.35 Bridge over Bond Brook of Stop 7.

20.25 Large outcrops of black quartz-mica schist of the Heartwellville Schist, on the left. The black and green beds of the Heartwellville Schist also outcrop from mile 20.35 to 20.90.

21.55 On the left may be seen the high cliffs of Stop 9.

21.65 Wilmington-Searsburg Township Line.

21.95 Medburyville Bridge. Make a U-turn and proceed west on Route 9 0.1 mile and bear right on an unpaved road. Proceed 0.35 mile to the old hotel beyond the Wilmington-Searsburg Township line and park off the road.

Stop 9. HOOSAC FORMATION, SEARSBURG CONGLOMERATE, READSBORO SCHIST, SHERMAN MARBLE AND HEARTWELLVILLE SCHIST.

Excellent exposure of cliffs of albite schist of the Hoosac Formation (formerly considered to be Readsboro Schist in Skehan, 1961, Pl. I) in contact with green and black schist unit of the Heartwellville Schist to the east. This albite schist is regarded as Hoosac Schist since it is now known to contain amphibolite similar to the Turkey Mountain Member. Traverse easterly across these beds to the contact with the coarse-grained albite schist of the Readsboro Schist enclosing layers of calcite marble of the Sherman Member. Proceed northeasterly to the outcrops of Searsburg Conglomerate exposed northeast of Medburyville and pictured in Skehan, (1961, Figs. 13 and 14, pp. 46-47 and described on pp. 45-49).

Mileage (cont'd)

Return to Route 9 and go west 4.20 miles to the junction of Sleepy Hollow Road.

26.15 Turn left on Sleepy Hollow Road. Proceed 2.5 miles to the junction of Sleepy Hollow Road with Route 8. Farrington Cemetery, the same as at Mileage 13.95, is on the left.

28.75 Turn left on Route 8 and proceed south 2.1 miles.

30.85 Stop 10. READSBORO SCHIST

Outcrops of dark muscovite-biotite-albite-garnet-quartz schist of the Readsboro Formation (Skehan, 1961, pp. 49-57) are exposed in the north fork of the west branch of the Deerfield River north of Heartwellville. These outcrops are immediately east of the inferred location of the Hoosac Thrust.

Proceed south on Route 8 a distance of 0.55 mile to the junction of Routes 100 and 8. Proceed easterly (left) on Route 100, 1.2 miles. Park off the highway near Lamb Brook 0.1 mile south of Stop 11.

32.60 Stop 11. HEARTWELLVILLE SCHIST

Walk back to the outcrop. Excellent road cuts in the dark schist of the Cavendish Formation (Heartwellville Schist, Skehan, 1961, Fig. 16, p. 60) at the type locality of the Heartwellville.

33.80 Retrace the route 1.2 miles to Routes 8 and 100. Proceed south on Route 8.

34.00 Heartwellville Center.

34.70 To the west of the highway in the grove of trees a quartz breccia is recognized and interpreted as fault breccia related to the Hoosac Thrust.

35.20 Dutch Hill Ski Area.

35.80 Heartwellville Lodge to the right.

36.60 The inferred location of the Hoosac Thrust between Heartwellville and Stop 12 lies west (to the right) of the highway. The ridge to the west is the Green Mountain core whose eastern part is flanked by the Cambrian Dalton

Mileage (cont'd)

Formation consisting of thin vitreous quartzite beds, schistose feldspathic quartzite and biotite-albite schist. The ridges to the east are comprised of the double decker overthrust sheets of the Cavendish units on the lower thrust and the Tyson-Hoosac units on the upper thrust.

39.60 Stop 12. HEARTWELLVILLE SCHIST, DALTON FORMATION AND STAMFORD GRANITE GNEISS.

Turn right (west) from Route 8 and go 0.7 mile to the home of Arthur Lincoln. Park off the road and in his yard and proceed up the hill to the large outcrops of garnet-chlorite-quartz schist of the Heartwellville Formation lithologically identical to the Pinney Hollow Formation (Tables 12 and 13, pp. 61 and 63). Traverse this section up slope, (down stratigraphically) to the contact of the Heartwellville with the Dalton Formation.

The Hoosac Thrust is interpreted as bringing the shale and graywacke facies of the Cavendish units to a position above the autochthonous rocks of the Cambrian beds which are traceable approximately three miles to the south to fossiliferous beds of the Olenellus zone of Clarksburg Mountain in North Adams discussed above. Proceed westerly to the contact of the Dalton beds with the Precambrian Stamford Granite Gneiss. Return to cars and return to Route 8. Turn right and proceed south toward Stamford on Routes 8 and 100.

41.25 Stop 13. VIEW AND PHOTO STOP

A view to the south along the Stamford Valley, underlain by Quaternary Alluvium which in turn may be underlain by Cheshire Quartzite as well as Cambro-Ordovician carbonate beds such as are exposed at Natural Bridge in North Adams. The steep western slope of Hoosac Mountain is developed above the easterly dipping Hoosac Thrust Fault, the trace of which is near the base of the slope. This slope may contain the traces of multiple thrusts which have been mapped by Norton in the Windsor quadrangle (oral communication, 1972).

Mt. Greylock, (el. 3,491 ft., the highest mountain in Massachusetts) comprised of marble interbedded in albite schist and green and dark muscovite-quartz-mica schist, looms up directly to the south. The Cheshire Quartzite and the Dalton Formation of the autochthonous sequence to

Mileage (cont'd)

the west of the viewer may be traced on the skyline in a southwesterly direction as they continue around the southerly plunging end of the Green Mountain Anticlinorium in the vicinity of North Adams and Williamstown. After this view, the field trip participants who are going south and east have several options. The junction of Route 2 and Route 8 is 5.35 miles to the south. The New York Thruway may be reached by following Route 2 west about 50 miles to the vicinity of Albany. The Massachusetts Turnpike may be reached by following Route 2 east to I-91 at Greenfield a distance of about 35 miles (driving time 50 minutes) and going south on I-91 to Springfield. Alternatively Route 2 may be followed west to Route 7 south which in turn meets the Massachusetts Turnpike at Stockbridge, Massachusetts, about 50 miles south of North Adams.

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