1-1-1985

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INTRODUCTION

Cameron's Line which extends through the Mt. Prospect region, is the map trace of a thrust fault that forms a major tectonic boundary in western Connecticut (Fig. 1). Rocks east of it are believed to have been deposited on oceanic crust and to have been transported westward onto North American continental crust during the closure of the Iapetus Ocean basin in the Ordovician. The Mt. Prospect Complex is a series of dominantly mafic intrusive igneous rocks east of Cameron's Line and thus intrusive into rocks originally deposited in the Iapetus Ocean. Numerous other mafic intrusives are present east of Cameron's Line (Fig. 1), and the time of emplacement of all these intrusives has been a long standing question in piecing together the geologic history. Recently some (Robinson and Hall, 1980, Hall and Robinson, 1982) have favored early emplacement of the mafic intrusives prior to major motion on the Cameron's Line thrust fault, while others (Merguerian and Ratcliffe, 1977, Merguerian, 1983) have argued that at least one of the mafic intrusives crosscuts Cameron's Line and thus postdates the major thrust movement. Evidence in the Mt. Prospect region indicates that the Mt. Prospect Complex was emplaced prior to major transport along the Cameron's Line thrust fault.

Five phases of deformation have been recognized in the rocks of the Mt. Prospect region. The earliest phase recognized is evident as a foliation in the diorite and as minor folds in the country rocks. Isoclinal folds and associated prominent regional axial plane foliation mark the second phase and third phase isoclinal folds refold the second phase folds. Fourth phase folds produce variations in the trends of all earlier structural elements, and the fifth phase of deformation is marked by northwest trending open folds and a conjugate set of folds that trends east to northeast. Major transport along the Cameron's Line thrust fault and associated thrust faults is considered to have occurred during the second phase of deformation.

STRATIGRAPHY

The rocks of the Mt. Prospect Region have been divided into 21 mappable units ranging in age from Precambrian to Ordovician. There are four stratigraphic-tectonic groups consisting of the Precambrian basement with its autochthonous Paleozoic cover rocks and three thrust sheets, the Waramaug Sheet, Above All Sheet, and Cameron's Line Sheet.

Rocks of the Grenvillian basement are dominantly gray, biotite-quartz plagioclase gneisses.

The autochthonous section consists of Lowerre Quartzite, Inwood Marble, and Manhattan A Schist. Lowerre Quartzite is made up of bedded, white to tan, locally slabby, quartzite, siliceous granulite and microcline-bearing schistose granulite. Inwood Marble is well bedded, white, calcite-tremolite-dolomite marble with thin tremolite-rich beds, and white, calcite-cemented, dolomite marble. Manhattan A is rusty-weathering, sillimanite-garnet-muscovite-plagioclase-biotite-quartz schist with minor, siliceous granulite beds.

The Waramaug Thrust Sheet contains the Shepaug Member, Schistose Granulite Member, an Amphibolite Member, and the Garnetiferous Biotite Schist Member of the Manhattan C. The Shepaug Member is interbedded orthoclase-garnet-plagioclase-biotite-quartz schistose gneiss, rusty-weathering, schistose gneisses and schists with sillimanite rods and subordinate granulite beds with sillimanite nodules similar to those in the Schistose Granulite Member. The Schistose Granulite Member is dominantly a fine-grained, well bedded, garnet-muscovite-biotite-plagioclase-microcline-quartz schistose granulite or granulite with locally large, muscovite-sillimanite-quartz ellipsoids or nodules, and subordinate, rusty-weathering, biotite schist with sillimanite quartz rods. The Amphibolite Member is a fine-grained, dark-green to black, plagioclase-biotite-hornblende gneiss with local thin layers of fine-grained, plagioclase-rich gneiss. The Garnetiferous Biotite Schist Member is largely charcoal-gray, garnetiferous, sillimanite-muscovite-quartz-biotite schist with sillimanite nodules that protrude on the weathered outcrop. These schists are interbedded with minor thin beds of laminated gneisses.

Manhattan C in the Above All Thrust Sheet is divided into an Amphibolite Member and the Warren Member (Dana, 1978). The Amphibolite Member is a lineated to foliated quartz-labradorite-hornblende gneiss. The Warren Member includes mainly interbedded, dark-gray, muscovite-garnet-chlorite-plagioclase-biotite-quartz schist, amphibolite, siliceous granulite, and finely-layered schistose gneiss.

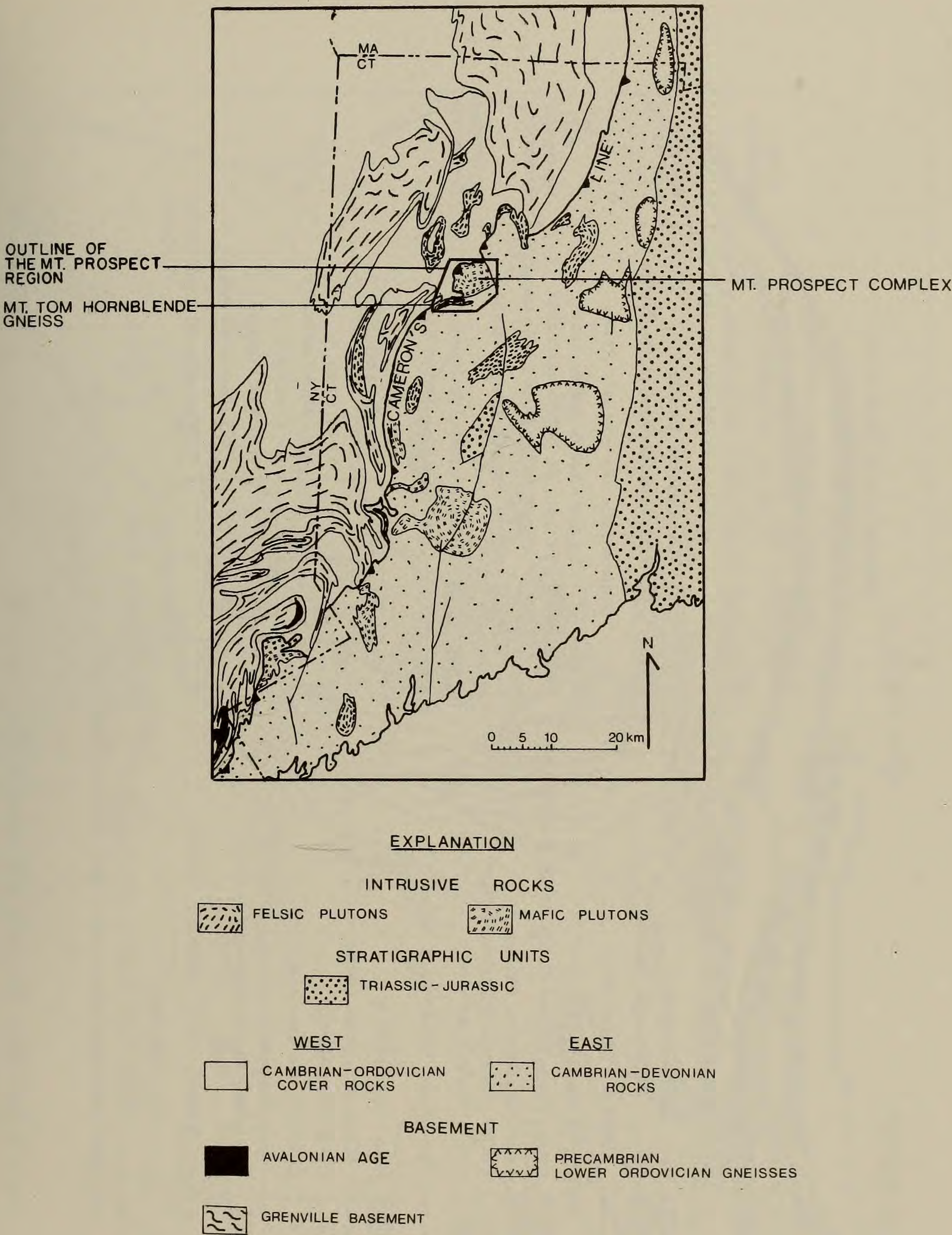


Figure 1: Generalized geologic map of western Connecticut showing the location of the Mt. Prospect area (modified after Hall, 1980).

Explanation:

ROCK UNITS

Above All Thrust Sheet

- €mw - Warren Member
- €mwa - Amphibolite Member

Above All Thrust Fault

Waramaug Thrust Sheet

- €mbs - Garnetiferous Biotite Schist Member
- €ma - Amphibolite Member
- €mgr - Schistose Granulite Member
- €ms - Shepaug Member

Waramaug Thrust Fault

(Above All and Waramaug Thrust Sheets: Manhattan C)

- Oma - Manhattan A

Middle Ordovician Unconformity

- €i - Inwood Marble
- €l - Lowerre Quartzite

Unconformity

- p€g - Precambrian Gneisses

Cameron's Line Thrust Sheet

Mt. Prospect Igneous Complex

Late Intrusives:

- ?Op - Quartz Monzonite Porphyry
- ?Oon - Olivine Norite, Mafic Norite, Peridotite, Pyroxenite
- ?Oqn - Quartz Norite, Norite, Gabbro, Hornblende-Biotite Gneiss

Early Diorites:

- ?Ol - Layered Diorite
- ?Od - Homogeneous Mafic Diorite

Sedimentary and Volcanic Rocks

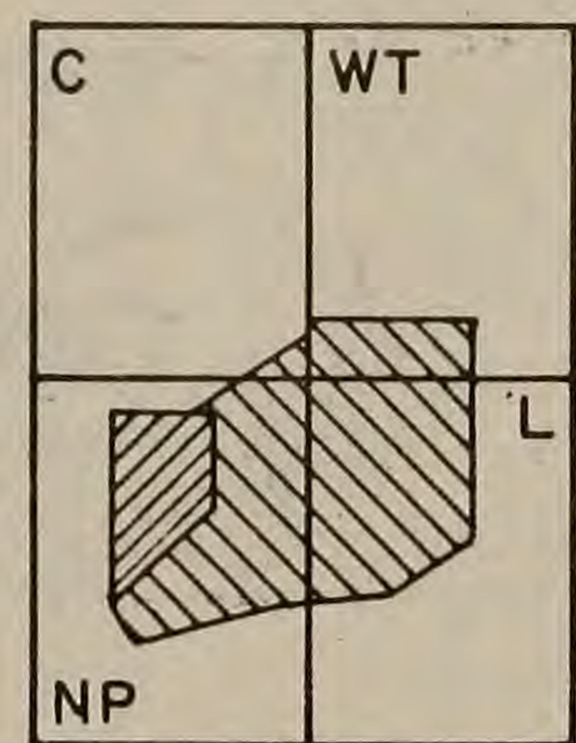
Hartland Formation:

- ?€Ohb - Bee Brook Member
- ?€Omt - Mt. Tom Amphibolite
- ?€Ohm - Muscovite Schist Member
- ?€Ohr - Rusty Schist Member

Mt. Prospect Formation:

- ?€Oa - Amphibolite Member

Cameron's Line Thrust Fault



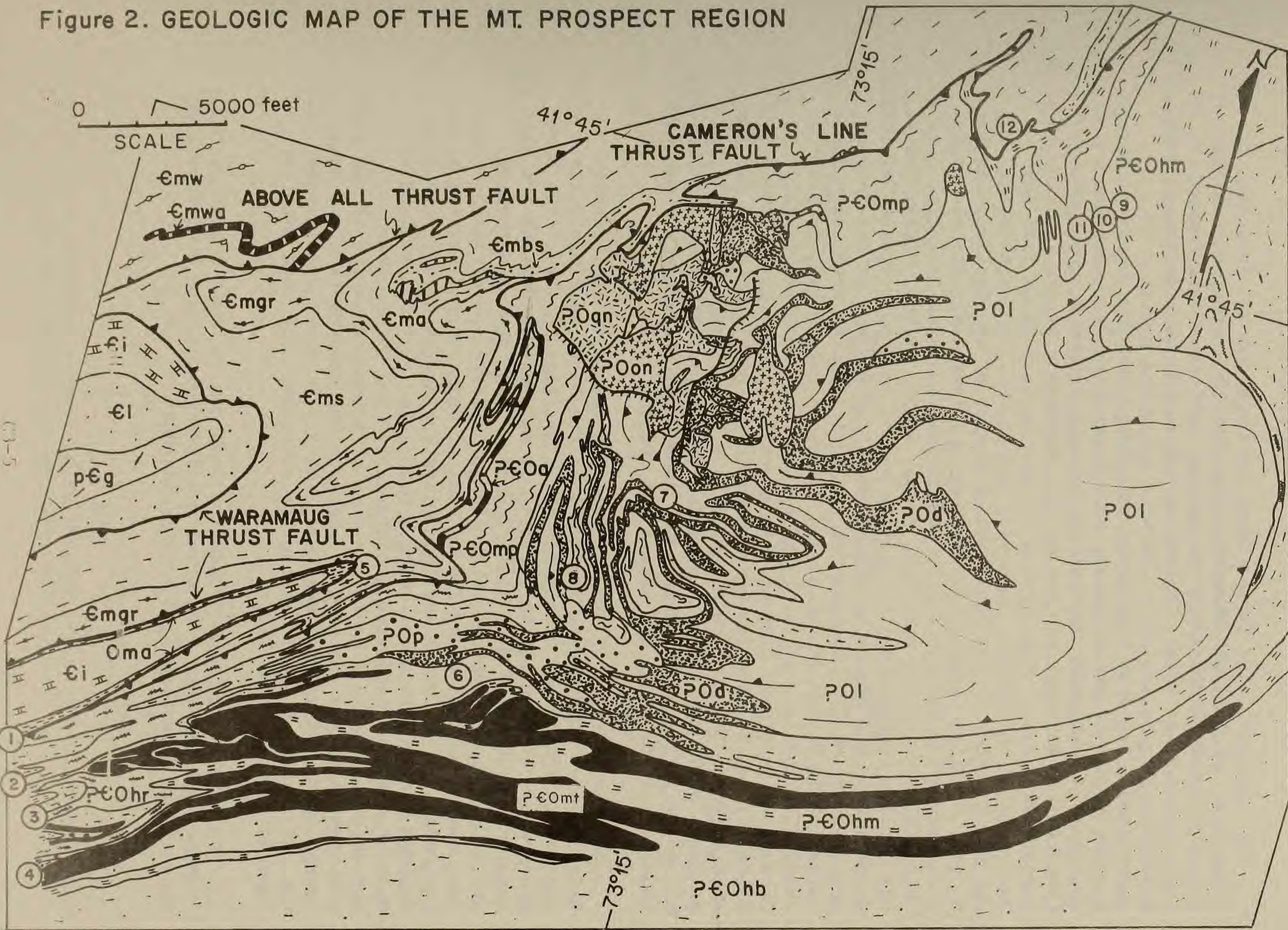
QUADRANGLES

- C - Cornwall
- WT - West Torrington
- L - Litchfield
- NP - New Preston
- *Mapped by Panish*
- *Mapped by Dana (1978)*

SYMBOLS

- ② Field Trip Stop
- Thrust Fault (Teeth in Allochthon)
- Late High Angle Fault (Teeth on Downthrown Side)

Figure 2. GEOLOGIC MAP OF THE MT. PROSPECT REGION



The Cameron's Line Thrust Sheet contains the Mt. Prospect Formation, the Hartland Formation, and the Mt. Prospect Complex. Rocks of the Mt. Prospect Formation are gray to brown, commonly rusty-weathering, thinly layered or laminated, sillimanite-garnet-muscovite-plagioclase-quartz-biotite schistose gneiss with subordinate, commonly laminated, siliceous granulite, gray quartzite, biotite schist, local coticule, and garnet-cordierite-gedrite granulite. A mappable amphibolite horizon in the Mt. Prospect Formation is dark-green, slabby, well foliated, quartz-labradorite-hornblende gneiss. The Hartland Formation is divided into the Rusty-weathering Schist, Muscovite Schist, Mt. Tom Amphibolite, and Bee Brook Members. The Rusty Schist Member of the Hartland consists of gray or silver gray, rusty-weathering, laminated, garnet-plagioclase-muscovite-biotite-quartz schist that contains irregular quartz veins which stain red and thin, sandy, quartz layers, black, rusty-weathering, highly fissile, biotite schist, and subordinate, siliceous granulites. The Muscovite Schist Member is made up of silver-gray, garnet-biotite-oligoclase-quartz -muscovite schist with subordinate layers of biotite-rich schist and laminated quartzites, locally abundant staurolite and/or kyanite, and minor coticule layers. Dark-green to black, fine-to coarse-grained, massive, lineated, or foliated, quartz-andesine-hornblende gneiss constitutes the Mt. Tom Amphibolite. The Bee Brook Member is a thinly bedded unit of fine-grained, gray, massive to laminated, quartz granulites and quartzites, silver gray, muscovite schist, and subordinate, dark-gray, muscovite-biotite schist. Coticule layers are common.

The stratigraphy of the Mt. Prospect region is most easily understood by considering the rocks in the North American plate separately from those of oceanic affinity (Figs. 3, 4a). All known occurrences of Grenvillian basement in western Connecticut are west of Cameron's Line (Fig. 1). These basement rocks are unconformably overlain by an autochthonous section of clastic and carbonate rocks, the Lowerre Quartzite and Inwood Marble, which were deposited along the margin of the North American plate during the Late Precambrian through Early Ordivician. Middle Ordovician sulfidic schists of Manhattan A were deposited unconformably upon these older autochthonous rocks. Manhattan C is a facies equivalent of the basal clastics deposited eastward of the autochthonous section and then tectonically transported westward, locally in two thrust sheets, onto the autochthonous section along thrust faults that root into the Cameron's Line thrust fault.

The clastic and minor volcanic, Cambrian to Lower Ordovician Mt. Prospect and Hartland Formations are inferred to have been deposited east of the Manhattan C on oceanic basement.

The Mt. Prospect Igneous Complex was intruded into the Hartland and Mt. Prospect Formations. The Complex is thus considered to have an oceanic crustal or possibly mantle derivation.

The Mt. Prospect and Hartland Formations, and the Mt. Prospect Igneous Complex were thrust westward as a package along the Cameron's Line thrust fault onto North American basement and its cover rocks, including the allochthonous Manhattan C, during the Taconian Orogeny.

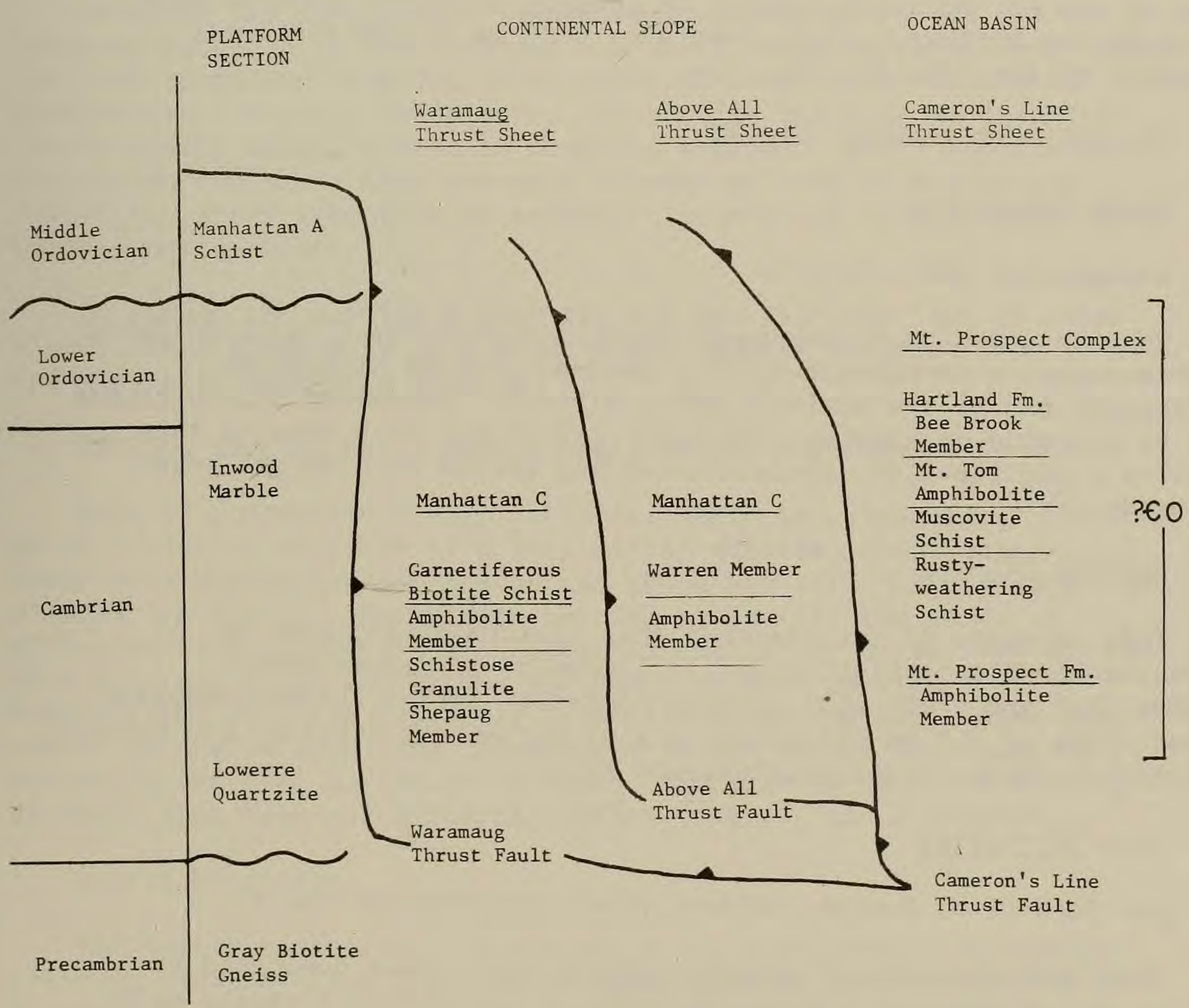


Figure 3. Stratigraphic summary chart showing the tectonic relationships among the rocks of the Mt. Prospect area.

INTRUSIVE IGNEOUS ROCKS

The Mt. Prospect Complex is a highly deformed sheet of related igneous rocks. It was previously mapped by Cameron (1951) whose data were incorporated into quadrangle maps by Gates (1951) and Gates and Bradley (1952). It is a series of intrusive rocks covering a 33 sq. km area. Present mapping indicates that the intrusive rocks were emplaced into the Hartland and Mt. Prospect Formations in the following order: diorites, gabbros and norites, minor peridotites and pyroxenites, and quartz monzonites (Fig. 2). Minor diorite dikes and small hornblendite bodies are the youngest intrusives in the Complex. Cameron's Line trends northeast across the region and the northwest edge of the Mt. Prospect Complex is locally in thrust contact with rocks to the northwest where Cameron's Line is at the northwest boundary of the Complex (Fig. 2).

MT. PROSPECT IGNEOUS COMPLEX:

Early Intrusives

Homogeneous Mafic Diorite

This is a medium-to coarse-grained, indistinctly to well foliated, quartz-andesine-hornblende-biotite gneiss. Either biotite or hornblende may be the dominant mafic mineral. Accessory clinopyroxene may be diopside or augite. One minor additional rock type in this unit is a biotite-rich, scapolite-bearing gneiss with bright green diopside.

Layered Diorite

This consists of interlayered gray, quartz-oligoclase- or andesine-hornblende-biotite gneiss layers of different modal composition and grain size, quartz monzonite layers, layers composed essentially of 2-4 mm oligoclase grains and matrix biotite, and wispy, centimeter thick, biotite-hornblende layers.

Late Intrusives

Quartz Norite, Norite, Gabbro, Hornblende-Biotite Gneiss

This unit consists of several igneous rock types dominated by norite and gabbro, and displaying sharp to indistinct contacts with one another. For simplicity these rock types are shown as one unit on the map (Fig. 2). The oldest rock type, which is also the least abundant, is a hornblende-biotite gneiss that is only present near the summit of Mt. Prospect. It has the distinctive characteristic of being friable and apparently deeply weathered in outcrop even where adjacent igneous rocks are completely fresh. This extensive weathering is probably due to exploitation of alteration products of later igneous rocks by weathering processes.

The norites form several igneous bodies with rock types differing in composition from quartz norite to mafic norite to gabbro. Outcrops may appear massive at first sight, but commonly some sort of foliation is present. This foliation can be an incomplete separation of mafic and felsic minerals into thin layers, preferred orientation of sedimentary rock inclusions, or preferred orientation of elongate feldspar, hornblende, or pyroxene.

Bronzite and plagioclase (andesine to labradorite) are the dominant minerals in the norites, and their relative abundances cause the rock to differ from felsic to mafic although mafic varieties predominate. Augite, hornblende, and biotite can also be important and accessory matrix quartz is commonly present. Where biotite and hornblende are minor they are only present as rims on augite and bronzite. Every gradation in essential mineralogy exists among the norites and gabbros.

In places the norites distinctly cut the diorites, but at other places there appears to be a gradational igneous sequence from norite and gabbro to unlayered diorite.

Olivine Norite, Mafic Norite, Peridotite, and Pyroxenite

This is a compositionally variable, mafic to ultramafic, rock unit which typically consists of a very mafic, massive, plagioclase-hornblende-augite-hypersthene norite which may also contain up to 10% olivine (Fo 65-75). Hornblende-bearing peridotite and hornblende-bearing pyroxenite are local ultramafic varieties that can also form distinct minor intrusives too small to show on Figure 2. Plagioclase, which is typically interstitial to the mafic minerals, ranges in composition from labradorite in the norite to accessory anorthite (An <98) in the peridotites. Hornblende can be a major constituent that rims and replaces olivine, augite, and hypersthene.

Quartz Monzonite

The quartz monzonite is typically a foliated, medium to coarse-grained, biotite-microcline-quartz-oligoclase to andesine gneiss or porphyritic gneiss with various amounts of 2-5 cm long, euhedral, white to pink, microcline megacrysts within a matrix of subhedral feldspar, quartz, and biotite. Locally the megacrysts may reach 15 cm in length. The quartz monzonite forms bodies several centimeters to hundreds of meters thick. The smaller bodies, which can be characterized as dikes, sills, or irregular patches, are particularly abundant in the Layered Diorite. To a much lesser extent the quartz monzonite invades the norites, but it does, and that establishes the intrusive sequence.

Minor Late Intrusives:

There are several late intrusive rock types which form bodies too small to show on the geologic map.

Pyroxenite Dikes

Augite-hypersthene pyroxenite with minor labradorite and various amounts of secondary hornblende forms dikes that cut the quartz norites and olivine norites. These dikes are inferred from their similarity to the hornblendite veins mentioned next to postdate the quartz monzonite.

Late Hornblendite

Black, massive, biotite-augite-hornblendite forms several bodies of uncertain shape and size due to the lack of exposure. On the basis of hornblendite and augite-hornblendite veins that cut the quartz monzonite and that branch off the main hornblendite bodies, the main hornblendite bodies are inferred to postdate the quartz monzonite.

Late Diorite Dikes

There are numerous simple and composite fine-grained diorite dikes that cut all other igneous rock types of the Complex. One diorite dike crosscuts the quartz norite-Mt. Prospect Formation contact at the northwest corner of the Complex.

STRUCTURAL GEOLOGY

Truncation of the Precambrian gneisses at the unconformity beneath the Lowerre Quartzite demonstrates that Precambrian deformation occurred (Dana, 1978), though this is not shown on Figure 2. There is evidence for five phases of Paleozoic deformation, although there are no map scale first phase features recognized (Figs. 2, 4 & 5, Table 1).

The only first phase features recognized are minor isoclinal folds and a foliation. An early foliation, but no recognized early minor folds, occurs in the layered diorite. At Stop 6 a first phase isoclinal fold is refolded by a second phase fold which has an axial planar foliation that is the dominant foliation of the region. Commonly two or more early foliations consisting of oriented minerals such as hornblende, biotite, quartz, and feldspar are present in the

TABLE 1
SUMMARY OF DEFORMATION

PHASE OF DEFORMATION	FIELD TRIP LOCATION	DESCRIPTION
Fifth Phase (Acadian)	Stop 6 Stop 5, Sta. G,H Stop 8	N 10 to 60 W-trending, overturned, open folds developed. Map scale fifth phase folds are responsible for the broad, regional change in foliation strike from NE to E to N to NW across the Mt. Prospect region from the southwest corner to the northeast corner. Smaller fifth phase folds of the Mt. Tom Amphibolite are present at Mt. Tom.
	Stop 6 Stop 8	Open conjugate folds with NE to E trending, fine, axial plane foliation developed during the fifth phase of deformation. No map scale conjugate folds related to the fifth phase are recognized.
Fourth Phase (Acadian)	Stop 8, Sta. G Stop 5, Sta. G,H	Open to tight, NE-trending, fourth phase folds dominate the map pattern. The major change in trend of the axial surfaces of older folds from N-trending in the western part of the Mt. Prospect Complex to E-trending in the southern part of the Complex is due to a fourth phase fold.
Third Phase (Taconian)	Stop 5, Sta. G,H Stop 8	The third phase of deformation is responsible for the refolding of second phase folds in the Mt. Prospect Complex-country rock contacts. The map pattern of the Mt. Prospect Complex is interpreted to be due to the interference of second and third phase isoclinal folds.
Second Phase (Taconian)	Stop 5 Stop 6 Stop 7	The second phase is responsible for the dominant regional foliation, minor folds, and map scale isoclinal folds including folds of the Mt. Prospect Complex-country rock contact. The terminations of the Mt. Tom Amphibolite in the southeastern part of the area are interpreted to be due to a second phase fold hinge line that is repeated by later folding. The Cameron's Line, Waramaug, and Above All thrust faults are considered to be late second phase features.
First Phase (Taconian)	Stop 6 Stop 7	A minor first phase isoclinal fold is isoclinally refolded by a second phase fold at Stop 6. An early foliation that locally occurs in the layered diorite is interpreted to be first phase. No major first phase folds are recognized.

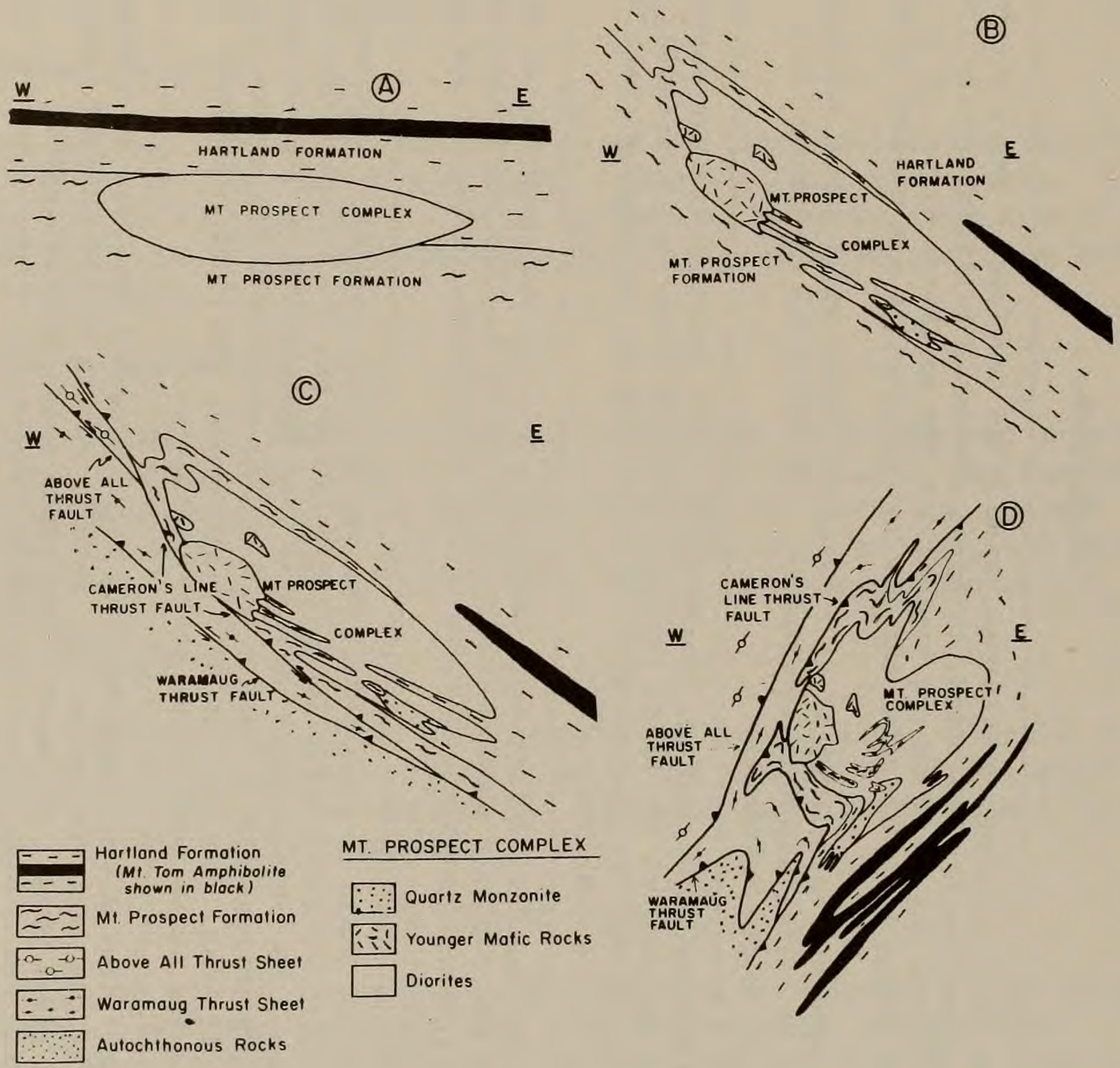


Figure 4: Diagramatic cross sections illustrating the structural development of the Mt. Prospect area.
A. The diorites of the Mt. Prospect Complex intruded along the Hartland/ Mt. Prospect Formation contact.
B. Second phase of deformation: The younger mafic rocks and the quartz monzonite intruded before the second phase of deformation.
C. Second phase of deformation: Major motion on the Cameron's Line and associated thrust faults took place during continued second phase folding.
D. Fourth phase of deformation: Major folds develop in the Mt. Prospect Complex and country rock. The stratigraphic sequence is overturned.

layered diorite (Stop 7). Though it is difficult to determine relative ages with certainty, they are first phase and second phase features.

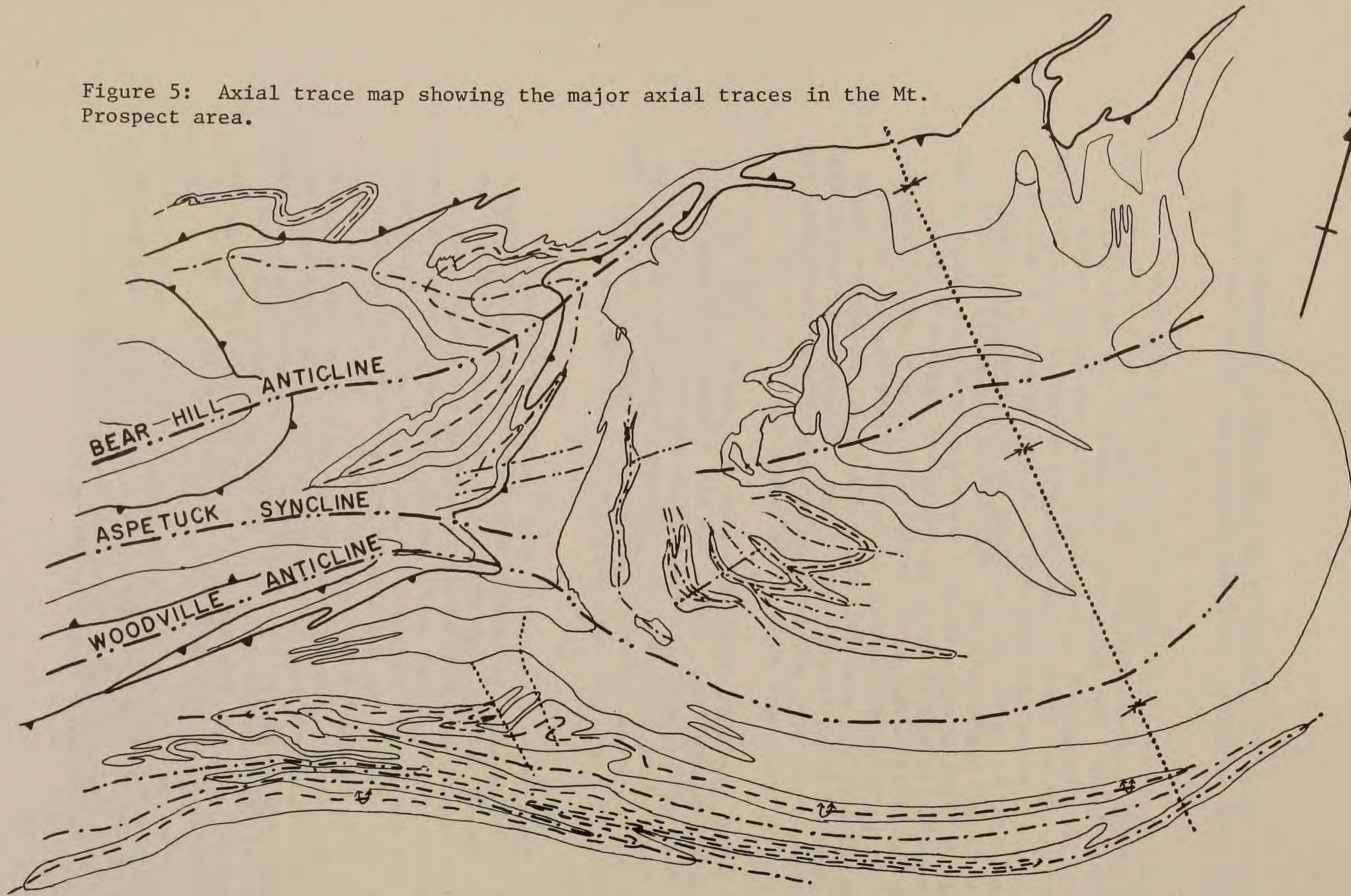
The second phase of deformation is Taconian and includes developmemt of the dominant regional foliation, and both minor and map scale isoclinal folds. The map pattern of the Mt. Tom Amphibolite (Figs. 2 & 5) is interpreted to be a large refolded second phase isoclinal fold. In the western part (largely mapped by Dana, 1978) of the region, second phase isoclinal folds in the Manhattan C section are best explained as being pre-thrusting or syn-thrusting. This includes the second phase isoclinal fold of the Warren Amphibolite which is cut by the Above All Thrust, and the second phase fold in the Garnetiferous Biotite Schist which is cut by the Cameron's Line Thrust. On the other hand, second phase folds deform Cameron's Line (Stop 12). Third phase folds, such as those in the western part of the area and at Stop 12, also fold Cameron's Line. No thrust faults have been observed to cut third phase folds. The major motion on the Cameron's Line, Above All, and Waramaug thrusts is thus considered to have been during the second phase of deformation.

Second phase isoclinal folds have been refolded by tight to isoclinal third phase folds. Within the Mt. Prospect Complex, the interference of second and third phase folds has produced the distorted heart-shaped infolds of Mt. Prospect Formation and zig-zag infolds of the Bee Brook Member of the Hartland (Figs. 2, 4 & 5). The Mt. Tom Amphibolite has also been refolded by east trending third phase folds.

The Mt. Tom Amphibolite-country rock contact is typically concordant being parallel to bedding and the dominant second phase foliation. However the Mt. Tom Amphibolite crosses the Hartland Bee Brook Member-Muscovite Schist Member contact at map scale. Gates (1967) mentions four outcrops where the Mt. Tom Amphibolite apparently crosscuts the bedding and dominant foliation of the Hartland members and argues that the Mt. Tom Amphibolite was intruded during the deformation that caused the dominant foliation. There are two other possibilities. The Mt. Tom Amphibolite may be a lava flow or series of lava flows crossing a time transgressive facies boundary between the Bee Brook and Muscovite Schist Members, or there are early thrust faults cutting the Hartland section. In any of these three interpretations, the Mt. Tom Amphibolite was in place before the end of the second phase of deformation at the very latest.

Critical to all regional tectonic scenarios is the age of intrusion of the Mt. Prospect Igneous Complex. Regional and local evidence imply that all major igneous units of the Complex had intruded the Mt. Prospect Formation and Hartland Formation before

Figure 5: Axial trace map showing the major axial traces in the Mt. Prospect area.



Axial traces:
Second phase - - - - - - Third phase -·-·-· Fourth phase —··—··— Fifth phase ··············

major movement on Cameron's Line. The igneous rocks of the Complex lie completely east of Cameron's Line, do not cut Cameron's Line, and contain inclusions of the Hartland and Mt. Prospect Formations but not Manhattan C. Regionally mafic plutons (Fig. 1) similar to the Mt. Prospect Complex can also be interpreted to lie completely east of Cameron's Line. However Merguerian and Ratcliffe (1977) and Merguerian (1983) interpret one of the mafic plutons, northeast of Mt. Prospect, the Hodges Mafic Complex, as crosscutting Cameron's Line.

The second and third phase folds in the diorite-country rock contact (Stop 8) and the inferred first phase foliation in the diorite (Stop 7) demonstrate that the diorites, which are the oldest major intrusives, intruded before all known deformation. The quartz monzonite, which is the youngest major intrusive is pre-second phase being is folded by major third phase folds (Stop 8) and displaying the dominant second phase foliation as well as minor second phase folds (Stop 5). Its age relation to the first phase of deformation is uncertain.

The generally massive appearance of the norites and related rocks as well as their cross cutting, stock-like, map appearance suggest that they are the youngest intrusives. However in outcrop the quartz monzonite is seen to invade all norite types. These cross-cutting relationships are barely visible on Figure 2. The norites cut the original igneous layering of the diorites, but whether or not they postdate the first phase of deformation is uncertain. A late high angle fault cross-cuts second and third phase folds in the diorite and country rock at the southwest norite contact.

The Acadian fourth phase folds, which dominate the map pattern, are tight to open regional folds with NW-dipping axial surfaces and NE to N20W plunging axes. The major folds have counterclockwise rotation senses with major anticlinal limbs steeply overturned to the southeast. It is important to stress that the regional stratigraphy is consequently overturned (Fig. 4). The fourth phase folds are well defined and the axial surfaces are parallel west of the Mt. Prospect Complex, but they fan out near the Complex. The Bear Hill anticline turns more north and the Woodville Anticline turns to the east along the southern edge of the Complex. The Aspetuck syncline crosses the central part of the Complex and is responsible for the major fold of the Complex. Within the Complex it is difficult to trace a single synclinal axial surface. Instead there seems to be a number of smaller folds.

The dominant N20W to N plunge of the fourth phase folds is the overall plunge of the folded Mt. Prospect Complex sheet. The map pattern is interpreted to be an oblique section through a relatively steep, N-plunging cylinder with a roughly heart-shaped vertical cross section. The E-W vertical cross section in Figure 4 is another oblique section through that cylinder.

A major NW-trending, Acadian (or Alleghanian) fifth phase synform is responsible for the broad, concave northward, warp in the foliation most easily seen along the south and east parts of the map area. Smaller fifth phase folds are seen in the Mt. Tom Amphibolite near Stop 6.

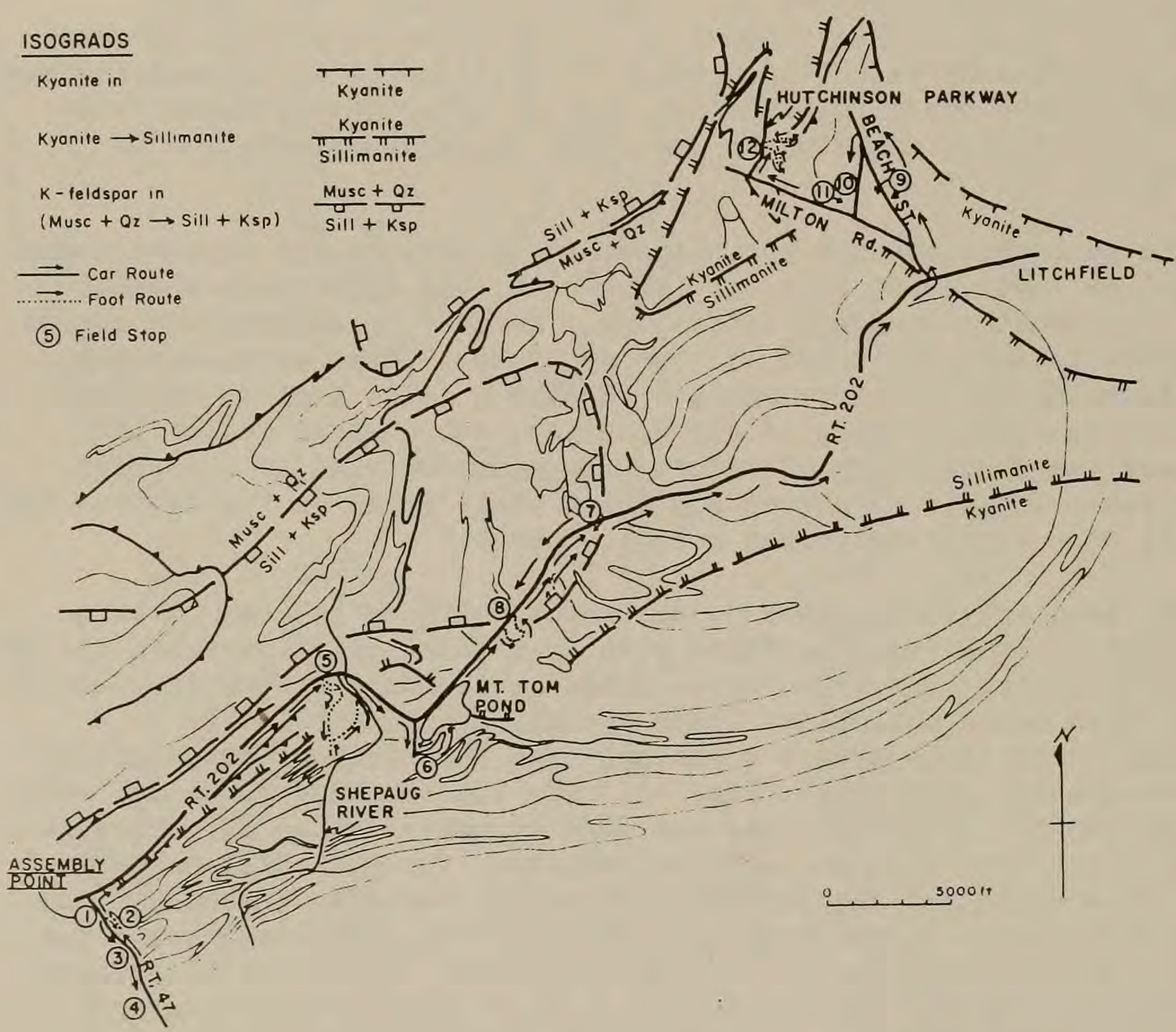


Figure 6: Isograd map of the Mt. Prospect area. Also shown is the field trip route.

METAMORPHISM

The regional metamorphism ranges from staurolite grade in the northeast part of the map area to sillimanite-K-feldspar grade in the west and northwest (Fig. 6). Textural features indicate that the isograds are not the result of a simple prograde or retrograde metamorphic event. Highest grade metamorphism occurred before or during the third phase of deformation. Most biotite and muscovite flakes are oriented in the dominant second phase foliation. Sillimanite and sillimanite-quartz-orthoclase rods tend to be oriented in the dominant foliation and parallel to third or fourth phase fold axes. Kyanite and staurolite, while parallel to the foliation, commomly do not form strong lineations. Kyanite commonly overgrows sillimanite. Garnets commonly have only sillimanite inclusions where the matrix contains sillimanite and kyanite or only kyanite. Kyanite is thus relatively late and could be Acadian. Garnets typically show a prograde chemical zoning (Mg/(Mg+Fe)) increasing toward the rim), but retrograde and complex zoning occur. Large retrograde muscovite plates, commonly containing remnant sillimanite, are oriented at a high angle to the foliation.

Local contact metamorphism is associated with the Mt. Prospect Complex. Garnet-sillimanite-orthoclase-biotite-cordierite and kyanite and/or sillimanite-garnet-biotite-cordierite-gedrite assemblages are typical in these zones. These assemblages pre-date the regional metamorphism and are partly retrograded by it.

Post-diorite norites and hornblendites show metamorphic alterations including fine, metamorphic pigeonite lamellae in augite and compound orthopyroxene-plagioclase-spinel-hornblende rims on olivine.

The maximum temperature and pressure estimates, using various geothermometers and geobarometers, range from 658 C, 6.9 kb in a sillimanite zone sample, to 535 C, 5.2 kb for a staurolite zone sample.

ACKNOWLEDGMENTS

We wish to thank the Connecticut State Geological and Natural History Survey and the Geological Society of America for generous financial support. We also wish to express our appreciation for the permission, cooperation, and often keen interest of the various landowners whose properties we are visiting on this trip. Among them are the E. O. Phelps and Sons Co., Drillers, Fox Chase Farm, Mt. Tom State Park, James Dibble, John and Audrey White, and the Ferrara, McIntosh, and Andrighetti families. Marie Litterer kindly lettered the figures.

ROAD LOG

From the New Haven, Connecticut area follow Route 34 west about 9 miles to Route 8 at Derby. Drive north on Route 8 for about 25 miles to the intersection with Route 109 south of the center of Thomaston. Continue west on Route 109 about 14 miles to the intersection with Route 47. Travel north on Route 47 about 3 miles. The assembly point is along the roadside at Stop 1, 0.1 mile south of the intersection with Rt. 202 (Fig. 7). A small white garage is next to the road. A white farmhouse and a barn with a bright red roof are 150 feet west of the road.

THE FIELD TRIP STARTS AT 9:00 AM.

Stops 1 through 4 are roadcuts and outcrops along Rt. 47 in the Bee Brook valley. The range of rock types in Manhattan A, and in the Rusty-weathering Schist, Muscovite Schist, Mt. Tom Amphibolite and Bee Brook Members of the Hartland Formation are seen at these stops (Fig. 7).

Bedding, and second and third phase planar elements have similar trends in the Bee Brook area (Fig.8). Bedding, the dominant second phase foliation and second phase axial planes average N59E 76NW. The third phase axial planes average N42E 75NW. Second phase lineations consisting of isoclinal fold axes, quartz rods, which are boudinaged quartz layers or detached isoclinal fold noses, and schistosity-bedding intersections, define a great circle with N62E 80NW orientation, essentially parallel to the dominant schistosity, and thus indicating that they all lie in the dominant schistosity. Third phase fold axes have an average plunge of N88W 60.

The two second phase fold axes with clockwise rotation sense are in the Rusty-weathering Schist Member at Stop 2 near the southern contact with the Bee Brook Member. These two axes may be in the southern limb of a second phase map scale fold which crosses the road and closes to the west much like the smaller fold in the Rusty-weathering Schist Member to the north of Stop 2. The two third phase axes are also clockwise and are in the Rusty-weathering Schist near its northwestern contact, southeast of Stop 2. These third phase fold axes are on the southern limb of the third phase fold which refolds the Mt. Tom Amphibolite into a hook pattern about 1000 feet to the northeast.

A very fine, sporadically developed, SW dipping foliation consisting of tiny aligned quartz and biotite grains is fifth phase, but there are no fifth phase folds recognized in the Bee Brook area.

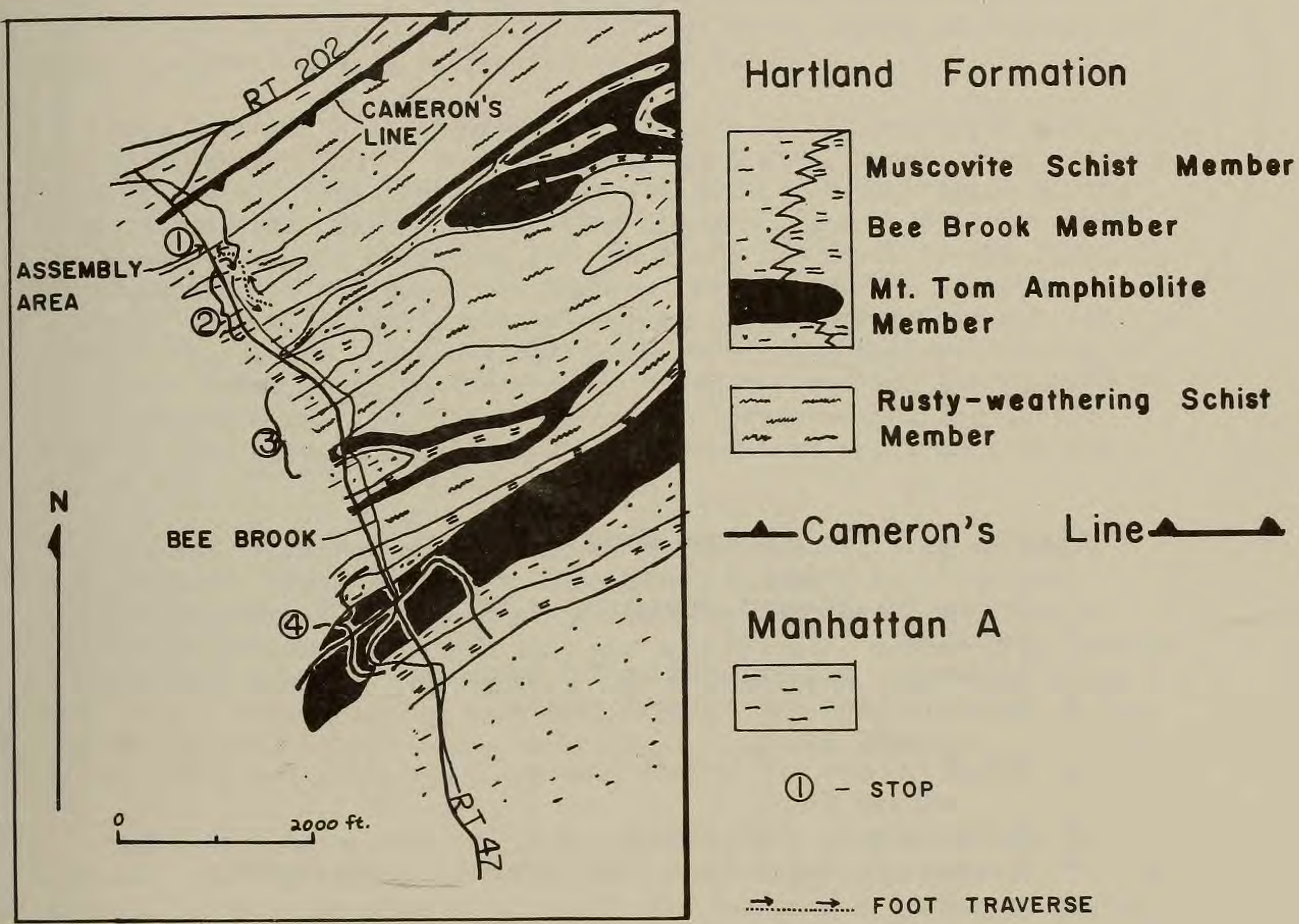


Figure 7: Geologic map of the area around Stops 1-4.

Stop 1: This stop consists of two small roadcuts, one on each side of the road and each about 100 feet north of the small white garage previously mentioned. Thinly-bedded, rusty-to mustard-yellow-weathering, schistose gneisses and schists are present. The dominant rock types include fine-grained, gray-brown staining, well foliated to laminated, slabby, sillimanite-garnet-plagioclase-muscovite-biotite-

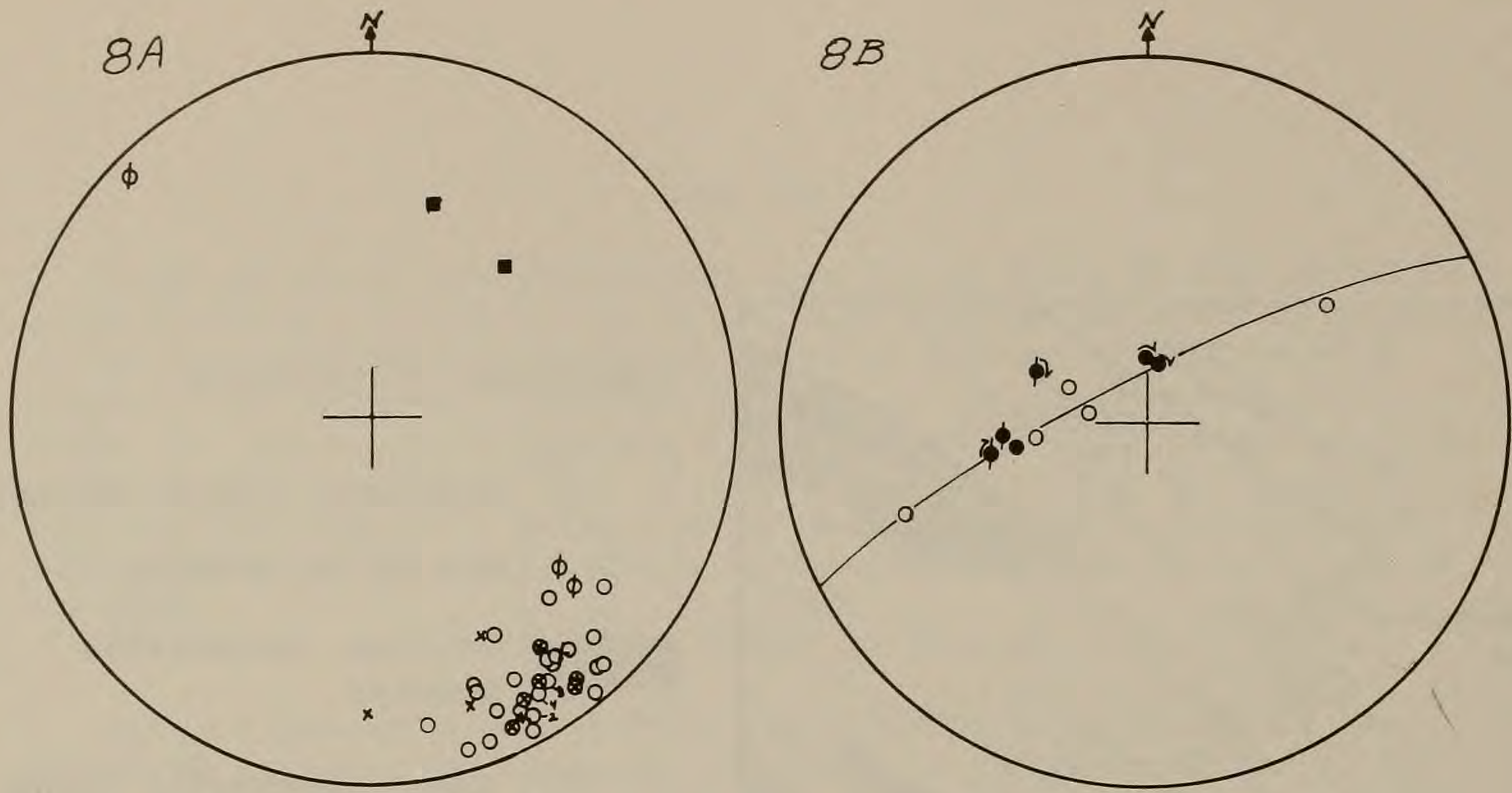


Figure 8A. Foliation data from Stops 1-4.
Poles to planar features = 45
× bedding
○ dominant second phase foliation
⊗ axial plane of second phase minor fold
ϕ axial plane of third phase minor fold
■ fifth phase foliation
number of data that the symbol represents

Figure 8B. Lineation data from Stops 1-4.
Lineations = 11
∘ second phase mineral lineation
second phase fold axis
third phase fold axis

quartz schistose granulite with mustard-yellow-to rusty-weathering foliation surfaces. Fine-to medium-grained staurolite-garnet-plagioclase-muscovite-biotite-quartz-schists and schistose gneisses are also abundant. Subordinately present are siliceous, laminated, garnet-muscovite-biotite-quartz granulites and quartzites; the laminations are most apparent on weathered surfaces. Biotite is commonly more abundant than muscovite, although coarse muscovite may be abundant on foliation surfaces. Medium-grained, granular, millimeter centimeter scale quartz layers and lenses are distributed throughout the rock. A foot thick, dark, very fine-grained, quartz-plagioclase-hornblende-biotite gneiss layer bordered by 1-2 foot thick layers of staurolite-rich, muscovite schist is present in one outcrop.

Stop 2 consists of a number of outcrops of the Bee Brook and Rusty-weathering Schist Members of the Hartland located along a trail east of Rt. 47. The trail joins Rt. 47 about 300 feet south of the Stop 1 outcrops. Walk E to SE along the trail about 300 feet, ford Bee Brook, and walk about 350 feet SE along the trail to the first major outcrop of the Bee Brook Member. After stopping at this outcrop, we will continue east along the trail. Over the next 400 feet of trail, the Bee Brook and Rusty-weathering Members outcrop along the steep slope to the north. along the trail. Two members of the Hartland Formation, the Bee Brook and Rusty-weathering Schist Members, are exposed along a 600 foot stretch of trail east of Bee Brook.

The Bee Brook Member consists of thinly-bedded (1 cm to 2 m), fine-grained, gray, massive to laminated, quartz granulites and quartzites, fine-to medium-grained, silvery-gray, garnet-chlorite-biotite-quartz-muscovite schists, and subordinate, darker gray, muscovite-biotite schists. The granulites are dominant. All rock types have white, millimeter to centimeter thick, coarse-grained, granular, quartz laminae, wispy layers, and lenses. Salmon pink coticule layers and lenses are locally present.

The Rusty-weathering Schist Member consists of fine-to medium-grained, rusty-brown to rusty-yellow-weathering, laminated (on 1-4 mm scale), garnet-muscovite-biotite-plagioclase-quartz schistose gneiss, fine-grained, black, rusty-weathering, biotite schist, and subordinate beds of fine-grained, gray siliceous granulites. Also present are 1-10 cm thick, light-gray, sandy, quartz layers, and coarser-grained, brick red-to orange-staining, massive, irregular, quartz pods and layers.

Mileage Total	Interval	
0.0	-	Return to the vehicles by way of the trail. Leave Stop 2 and proceed south on Rt. 47 to Stop 3.
0.4	0.4	Park along the west side of the road north of the first major roadcut (Stop 3).

Stop 3: Here (Fig. 7) are several roadcuts in Hartland members extending 550 feet along the roadside and displaying abundant minor folds. Starting at the north end and walking south, the following

rock units are encountered:

The Muscovite Schist Member is 10 to 15 feet of fine-to medium-grained, gray to silver gray, garnet-staurolite-chlorite-biotite-quartz-muscovite schist with subordinate, wispy, centimeter scale layers of a darker garnet-chlorite-muscovite-biotite schist. Also present are fine-grained, gray, siliceous granulite layers. Coarse-grained, massive, quartz lenses, pods, and bulbous fold noses <10 cm wide are abundant. Chlorite-biotite-rich schists with local silky, greenish-gray foliation surfaces are also present. The schistosity is commonly crenulated.

The Bee Brook Member which is exposed over an interval of 350 feet consists of thinly-interbedded quartzite, granulite, and schist similar to those at Stop 2. Bedding is from 1 cm to 2 m thick. Gray to slightly greenish-gray, thinly-bedded (3 cm to 1 m), fine-grained, garnet-biotite-chlorite-muscovite quartzites are interbedded with subordinate, gray and greenish-gray, thinly-bedded, fine-to medium-grained, chlorite-biotite-muscovite siliceous schists, and fine-grained, garnet-muscovite-chlorite-biotite-quartz schists. The quartzites are commonly massive, but may be foliated at minor fold hinges or layered on the millimeter to centimeter scale, the layering being due to slight variation in biotite and garnet. The muscovite schist is more abundant over the southern half of the interval. Here the muscovite schist has abundant chlorite patches, fine-grained sandy layers, and wispy biotite layers. Typically white, massive, medium-to coarse-grained quartz layers < 10 cm thick are present. Atypically the quartz layers are pink due to abundant fine-grained garnets. These coarse, white quartz layers may be veins, judging from the local quartz veinlets that interconnect them. Minor folds within these quartz layers demonstrate that the massive fine-grained quartzites are internally folded. Evidence for a progressive increase in intensity of shearing toward the south is present in the form of numerous fine-grained foliated or laminated siliceous layers <30 cm thick.

The Rusty-weathering Schist Member is exposed over the southern 185 feet of roadside. Over the first 25 feet the rock type is mainly a fine-grained, uniform, medium-to dark-gray, chlorite-muscovite-quartz-biotite schist and schistose gneiss with subordinate biotite-quartz granulite with coticule. The rocks are not rusty at this point and are pin-striped with white, fine-grained, quartz layers and granular quartz layers. The coticule forms aphanitic red-brown layers and isolated ellipsoids <5 cm long. The last 160 feet of exposure consists of a very fine-grained, highly fissile, dark-brown-stained, rusty-to yellow-green-weathering, biotite-rich schist with a few rusty-brown <8 cm thick, irregular, quartz layers and pods.

0.4 - Return to the vehicles and continue south on Rt. 47 to Stop 4.

0.9 0.5 Stop 4: Bee Brook Bridge area (Fig. 7). Park along the road north of the intersection of Rt. 47 and Buffum Road. The bridge over Bee Brook is south of the intersection. Walk to the northern contact of the Mt. Tom Amphibolite in the large roadcut north of Buffum Road. We will walk south along Rt. 47 to the southern contact of the Mt. Tom Amphibolite south of Buffum Road.

A 600 foot cross section of the Mt. Tom Amphibolite Member of the Hartland is exposed in two large roadcuts. The local contacts of the amphibolite with the Bee Brook Member are concordant to the compositional layering in the country rock and the dominant foliation.

The Mt. Tom Amphibolite is a dark-green to black, fine-to medium-grained, biotite-andesine-hornblende gneiss with minor quartz, sphene, epidote, and opaques. Thin epidote-rich veins are present. To the north the amphibolite is in contact with about 15 feet of muscovite schist which is interpreted to be a layer within the Bee Brook Member of the Hartland. The amphibolite is in contact with interbedded quartzite and siliceous granulite of the Bee Brook Member to the south. The Mt. Tom Amphibolite ends about 800 feet to the west of these roadcuts in an apparent early fold nose. Lateral facies changes or minor faulting within the Bee Brook Member may account for the lack of exact stratigraphic repetition across the axial surface of the early isoclinal fold. Two, concordant, meter thick, amphibolite layers occur south of the main contact. It is uncertain whether the Mt. Tom Amphibolite is repeated in isoclinal folds, or minor thrusting, or whether these are separate amphibolite layers.

0.9 - Return to your vehicles and head north on Rt. 47 to the intersection with Rt. 202.

1.9 1.0 Turn right (east) at the intersection onto Rt. 202 and continue to Stop 5. The lowland immediately north of Rt. 202 is underlain by the Inwood Marble which lies in the core of the major fourth phase Woodville Anticline. The hills beyond are underlain by the Manhattan A and C. Manhattan A is also present in the southern limb of the Woodville Anticline immediately south of Rt. 202. Manhattan C is truncated by the Cameron's Line thrust fault in the Bee Brook valley, but in the direction of Stop 5 the Manhattan C section appears and thickens between the Manhattan A and Cameron's Line.

4.9 3.0 The large rusty-weathering Manhattan A roadcut on the south side of Rt. 202 is the first station of Stop 5.

Drive east of the roadcut to the intersection of Rt. 202 with Rt. 341 and Romford Road (not named on the New Preston quadrangle map). Park at the corner of Rt. 202 and Romford Road, and walk back to the roadcut.

-PLEASE WATCH OUT FOR TRAFFIC-

Stop 5: This is a traverse that starts at the Manhattan A roadcut located near the nose of the Woodville Anticline and continues southward (Figs. 2, 9). Proceeding southward one crosses the Waramaug Thrust into Manhattan C and then across Cameron's Line into several members of the Hartland Formation as well as quartz monzonite prophyry related to the Mt. Prospect Igneous Complex.

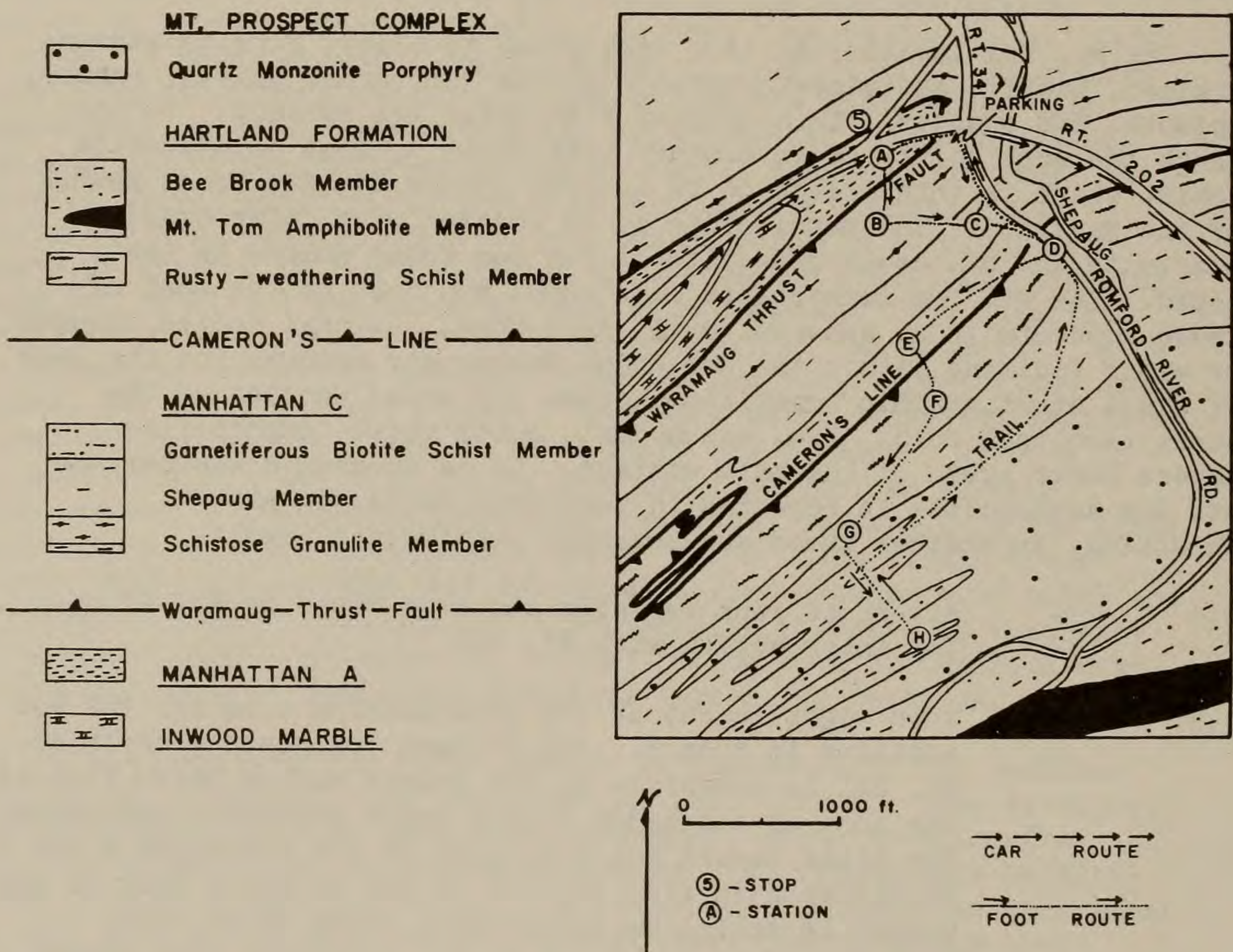


Figure 9: Map of the Stop 5 traverse area located west of the Shepaug River.

The local stratigraphic section is presented in Figure 9. The section, which dips steeply northwest, lies on the overturned, southeast limb of the regional Woodville anticline.

Station A: The Rt. 202 Manhattan A roadcut consists of fine-grained, slabby, rusty-weathering, sulfidic, sillimanite-muscovite-biotite-plagioclase-quartz schistose gneiss and fine-grained, siliceous granulites.

Station B (optional): This is a small outcrop of the Schistose Granulite Member of Manhattan C. It is dominantly a thinly-layered, gritty-surfaced, fine-grained, garnet-muscovite-biotite-plagioclase-siliceous granulite with subordinate schistose gneiss layers. This weathered outcrop has a furrowed, gray-brown surface and a yellow-to burgundy-stained interior. Better exposed outcrops of the Schistose Granulite Member will be seen north of the Mt. Prospect Complex, later in the day.

Station C: Here are pegmatite-rich outcrops of an interbedded, gray, fine-grained, garnet-biotite-plagioclase-quartz schistose granulite and gray, fine-to medium-grained, rough surfaced, garnetiferous, muscovite-biotite-plagioclase-quartz schistose gneiss. White, sillimanite-quartz lenses and <4 mm garnets roughen the surface. Foliation surfaces may be rusty-brown-weathering.

Station D: Proceed southeast along the hillside across Cameron's Line and to two roadside outcrops of the Rusty-weathering Schist Member of the Hartland. Here it consists of thinly-bedded, fine-to medium-grained, yellow brown,to rusty-weathering, garnetiferous, muscovite-garnet-biotite-plagioclase-quartz schist or schistose gneiss. Sillimanite is apparent in coarser varieties.

Station E: Cross Cameron's Line back into the Garnetiferous Biotite Schistose Gneiss Member of the Manhattan C to an exposure of medium-grained, dark-gray, garnetiferous, nubby-surfaced, muscovite-spangled, sillimanite-plagioclase-muscovite-quartz-biotite schistose gneiss. Nubs are sillimanite-quartz pods, lenses, and layers. Garnets may be up to pea size. There are granular, quartz layers <3 cm thick that are boudinaged and lie along the foliation. At most, 5% of the outcrop is poorly foliated, biotite-plagioclase-quartz granulites with patchy mustard-or burgundy-staining, gritty surfaces <25 cm thick.

Station F: Proceed south across Cameron's Line into the Rusty-weathering Schist Member of the Hartland. Here it is a fine-to medium-grained, in places laminated, rusty-brown, sillimanite-staurolite-garnet-muscovite-biotite-quartz-plagioclase schist. Muscovite is concentrated on foliation surfaces. Subordinately present are fine-grained, light-gray, granulites.

Station G: Outcrops of the Bee Brook Member are intruded by sills of quartz monzonite. The dominant country rock types are: thinly-layered, light-gray, fine-grained, siliceous granulite which is massive or laminated with thin white quartz layers, dark-gray, fine-to medium-grained, garnetiferous, sillimanite-garnet-muscovite-feldspar-biotite-quartz schist, and subordinate, fine-grained, white, laminated quartzite. Coarse-grained, massive, quartz layers are also present. A foot thick, concordant, amphibolite layer is present at one place. The main N60E trending Bee Brook Member-Quartz Monzonite contact is approached obliquely as one proceeds 600 feet S45W along the line of outcrops (Fig. 9). The proportion of quartz monzonite increases to the southwest along the exposures. At the northeasternmost of the outcrops, the quartz monzonite is only present as a few <10 cm thick porphyry sills that grade down to thinner medium-grained, wispy, non-porphyritic layers. The southwesternmost outcrop on the traverse, through which the Bee Brook Member-quartz monzonite contact is drawn, is largely quartz monzonite.

Structural Evaluation: The southwesternmost outcrop displays evidence for four phases of deformation in both the country rock and quartz monzonite. The dominant northeast trending foliation, which is the the regional second phase, can be traced from the country rock into the porphyry. In the granulites and schists, the dominant foliation is a muscovite-biotite foliation. The foliation in the quartz monzonite is due to the alignment of biotite and 2-3 mm feldspar grains. Feldspar augen are in the schists adjacent to the igneous contacts. The dominant foliation wraps around the augen. This suggests that the augen and the associated quartz monzonite are older than the formation of the dominant second phase foliation. Since the quartz monzonite is the youngest major intrusive rock of the Mt. Prospect Igneous Complex, then the entire Mt. Prospect Complex was emplaced before or early in the second phase of deformation.

Minor third phase isoclinal folds are present in the country rock. In at least one case a thin non-porphyritic quartz monzonite layer within the schist is folded by third phase folds and a faint foliation is parallel to axial planes of third phase folds.

The ENE-trending regional fourth phase foliation lies at a low angle to the second phase foliation. In the country rock and quartz monzonite this foliation is due to the parallelism of fine-grained quartz and feldspar. Minor fourth phase north plunging "S"-shaped folds are present in the country rock-igneous contacts. The rotation sense of these folds implies a major anticlinal fold to the north, the Woodville anticline.

A vague northwest-trending fifth phase foliation is sporadically present. This foliation is a fracture cleavage with recrystalized minerals along it.

Station H (optional): An outcrop of the Bee Brook Member of the Hartland intruded by quartz monzonite porphyry. The rocks at this outcrop also exhibit structural features that indicate that the quartz monzonite intruded either before or during the development of the dominant foliation. Feldspar porphyroblasts in the schist are probably the product of quartz monzonite contact metasomatism. The dominant foliation wraps around the porphyroblasts and thus probably postdates them. The dominant foliation of the schist continues into the quartz monzonite. The foliation in small Bee Brook Member inclusions in the Quartz Monzonite is continuous with that in the surrounding igneous rock. The inclusions are aligned parallel to this foliation. A wispy non-porphyritic Quartz Monzonite layer in the schist is folded and the dominant second phase foliation is parallel to the axial plane of the fold.

4.9	-	At the end of the traverse walk SE from Station G or NE from Station H until reaching the path north of the power lines. Follow this path northeast until reaching Romford Road. Walk NW on Romford Road to the vehicles. Drive east on Rt. 202. Manhattan C, Cameron's Line, the Mt. Prospect Formation, and members of the Hartland are crossed in this order over the next 0.9 miles.
5.5	0.6	Turn right and follow the signs for Mt. Tom State Park. We cross the folded southwest corner of the Mt. Prospect Complex and enter the Bee Brook Member of the Hartland north of the entrance gate.
5.8	0.3	Pass through the entrance and follow the one-way road around a long loop and to the western parking area.
6.4	0.6	Park in the western parking area.

-LUNCH-

Picnic tables, fresh water, and toilets are available.

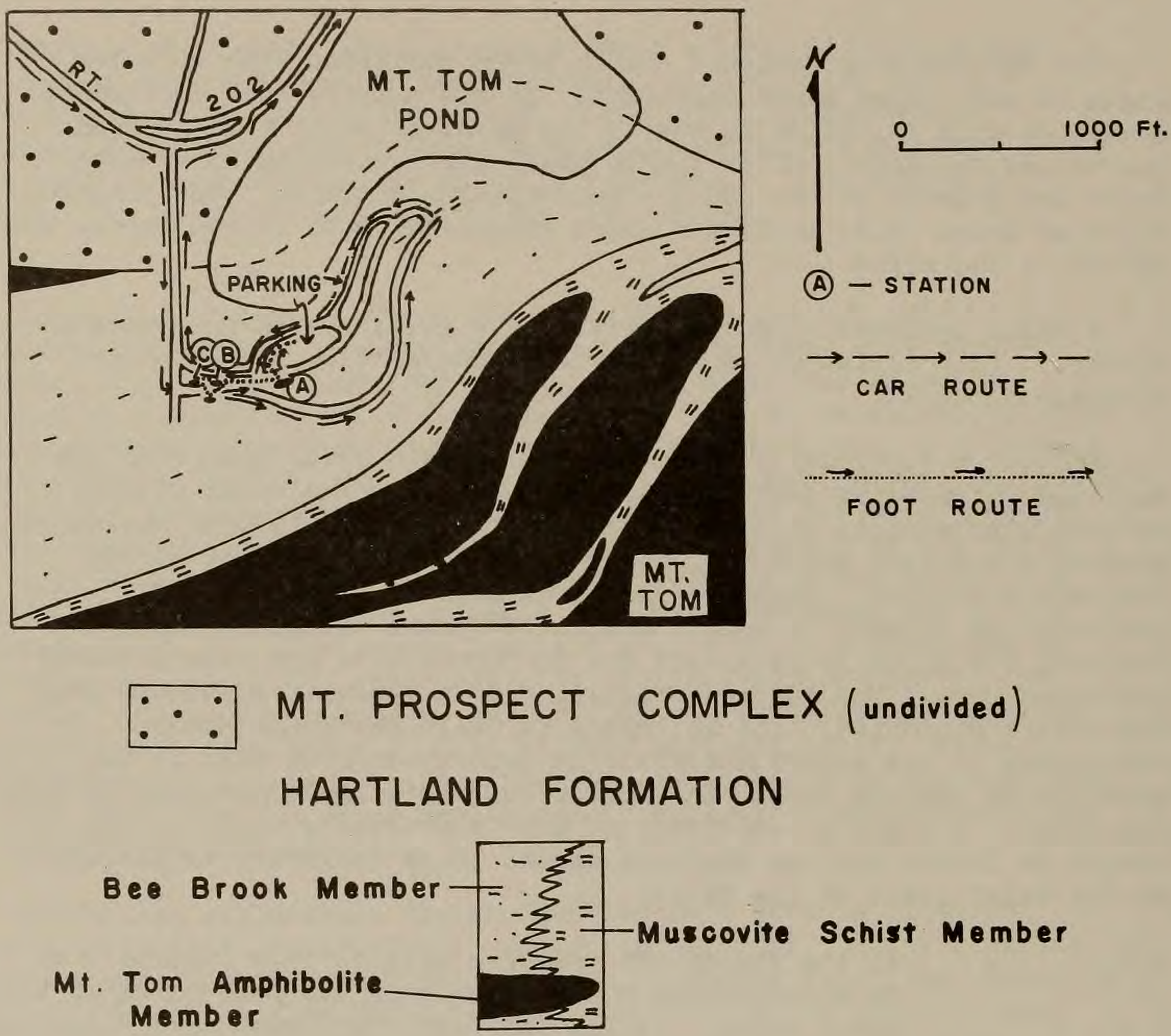


Figure 10: Map of the Stop 6 area located at Mt. Tom State Park.

After lunch walk from the parking lot to the four outcrops of Stop 6.

Stop 6: Several roadside outcrops of the Bee Brook Member that display refolded folds involving the first, second, fourth, and fifth phases of deformation are exposed within the Mt. Tom State Park about 400 ft. south of Mt. Tom Pond (Fig. 10). The rock is composed of thinly-bedded, tan-weathering, fine-grained, silvery-gray, staurolite-biotite-muscovite-quartz schist, slabby, gray, biotite-muscovite, siliceous schistose gneiss, and quartzite. Millimeter scale, fine-grained, white to slightly pink, quartz laminae are present as are coarser-grained, massive, irregular, quartz layers and lenses.

At Station A (Fig. 10) there is evidence in the outcrop for five phases of deformation. A minor first phase isoclinal fold refolded by a second phase fold is exposed on the north facing surface of the outcrop. The dominant schistosity with an average orientation of N 75 E 60 NW (Fig. 11A) is axial planar to the second phase fold. A later foliation has an average orientation of N41E 53SE and consists of fine-grained quartz segregated into paper-thin, millimeter spaced folia. This later foliation cuts across the axial surface of this second phase fold and is axial planar to low amplitude, open folds in the lamination and dominant second phase foliation. This later foliation, which has been observed only south of Rt. 202 (e.g. Stop 8), seems to maintain a SE dip (Figs. 11B, 12, 17), but no known map scale folds are associated with it. This SE dipping foliation is considered to be conjugate to the NW trending fifth phase folds (Fig. 12).

On top of the outcrop fifth phase open folds modify a hook pattern formed by the interference of second and third phase folds.

At Stations B and C, the low angle intersection of very fine compositional layering and the schistosity produces a fine intersection lineation also marked by concentration of biotite and staurolite (Fig. 11A). A closely spaced crinkling of the schistosity seen at B is interpreted to be third phase.

There are two important general features to note among Figures 11, 12, and 13. The poles to bedding and to dominant second phase foliation in the Mt. Tom area including Stop 6 are arrayed in a girdle (Fig. 11C), and the second and third phase lineations have been rotated along great circles to produce a girdle (Fig. 13). These distributions are largely the result of the fourth phase of deformation although the effects of third phase folds, which are interpreted to subparallel the fourth phase folds, are uncertain. A great circle defined by the poles to schistosity around a minor open fourth phase fold at Stop 6 (Fig. 11A) has an orientation similar to the Figure 11C array as demonstrated by the near coincidence of the pole to the schistosity girdle and the axis of the minor fold.

A kink band at B is interpreted to be a fifth phase feature (Fig. 11B). This kink band has a similar orientation to a sporadic, fine-grained NW trending fifth phase foliation seen in the Bee Brook, Muscovite Schist, and Mt. Tom Amphibolite Members of the Hartland Formation (Fig. 12). This foliation is due to thin laminae rich in quartz and feldspar or to the preferred orientation of biotite in the schistose rocks, and to quartz-feldspar laminae or hornblende-quartz-

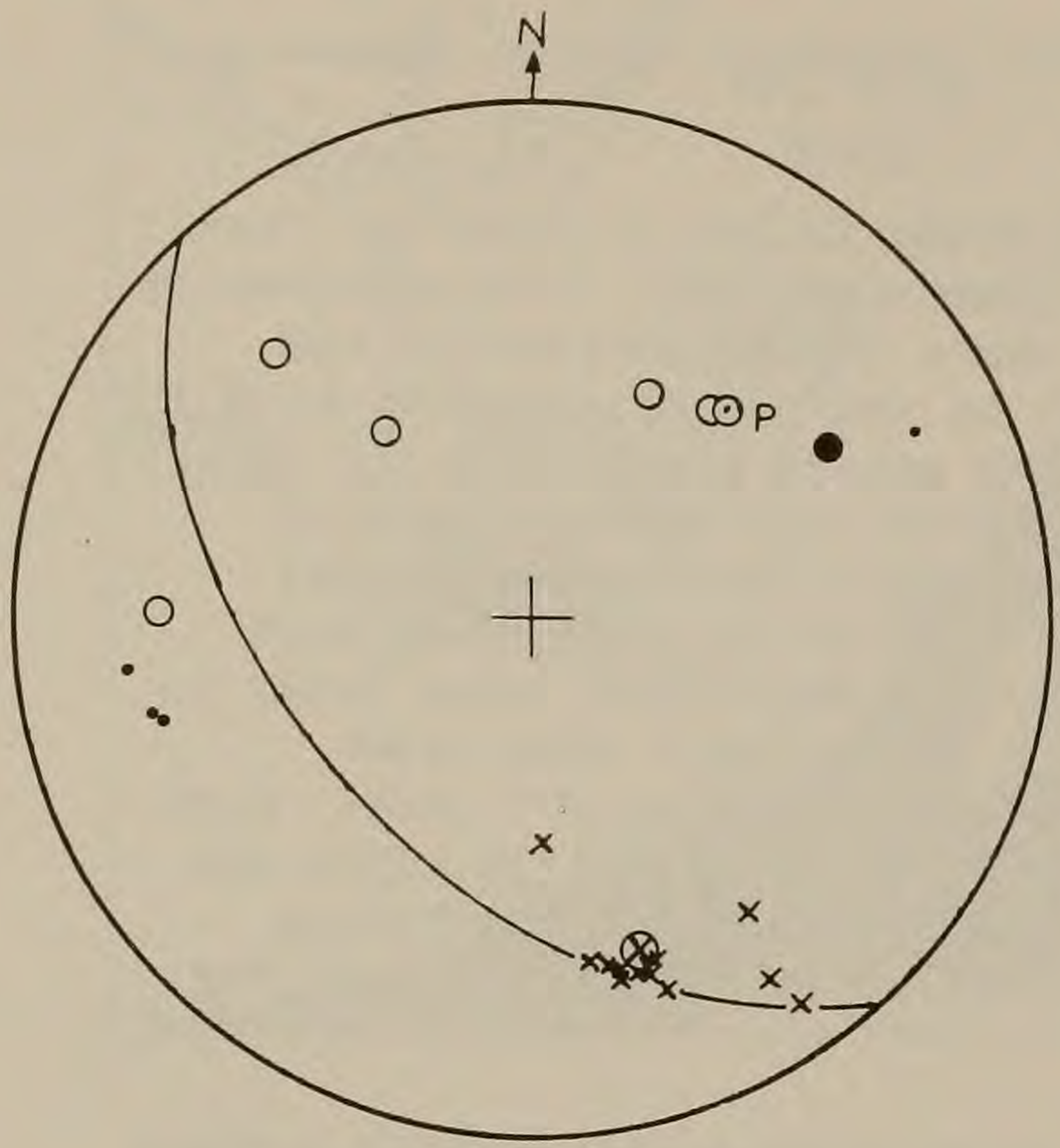


Figure 11A

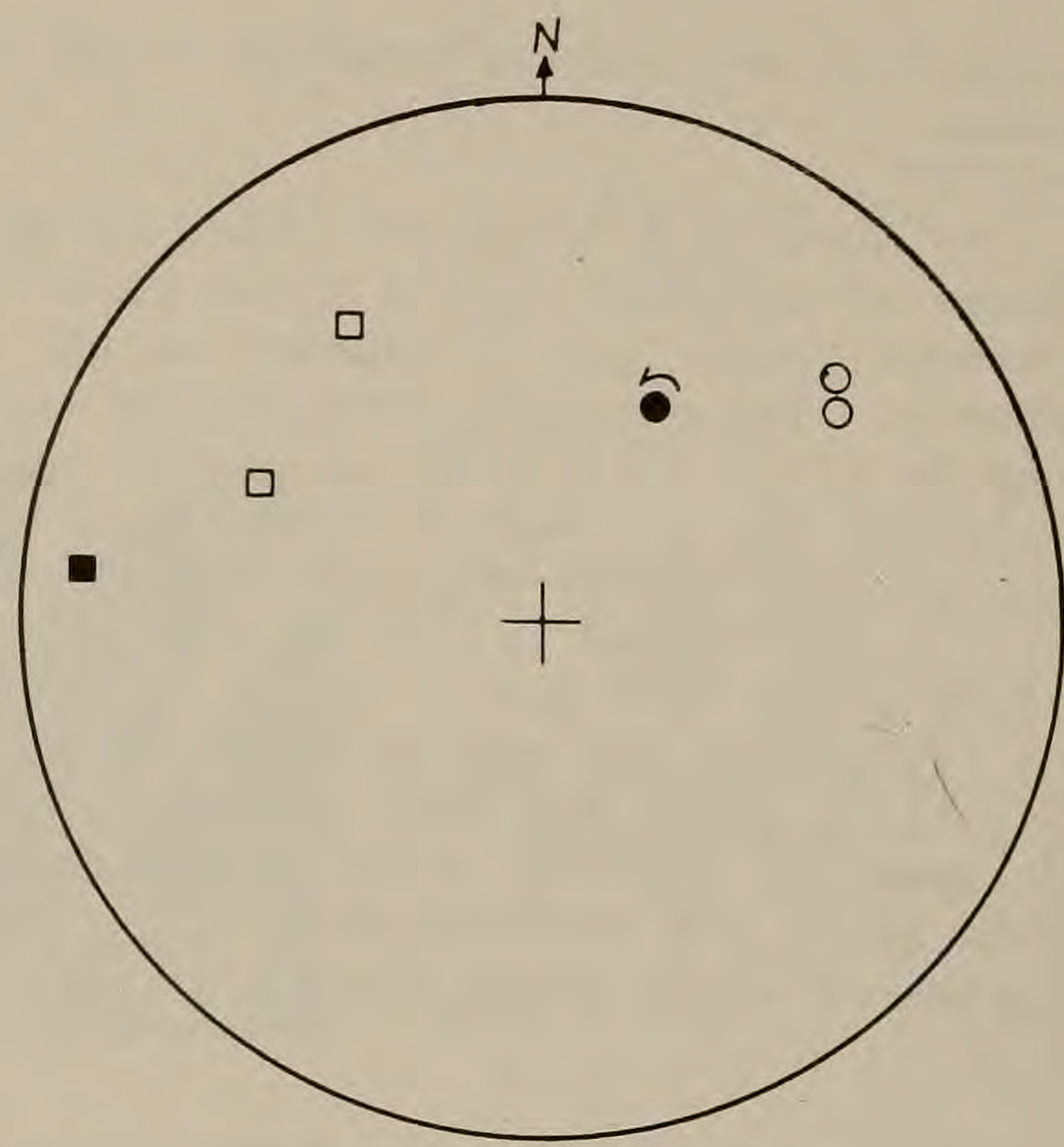


Figure 11B

Figure 11A: Data from Stop 6, Stations A, B, C.
Poles to planar features = 14
× dominant second phase foliation
⊗ second phase axial plane
Lineations = 12
● second phase biotite and staurolite lineation on the dominant foliation
○ minor second phase fold axis
third phase minor fold or crinkle of the dominant schistosity
⊙ axis (N48E 39) to minor fourth phase open fold

P pole to the girdle of Fig. 11C

Figure 11B: Fifth phase data from Stop 6, Stations A, B.
Poles to the planar features = 3
□ fine, fifth phase, quartz-feldspar foliation
■ fifth phase kink band axial plane (N5E 77E)
Lineations = 3
○ intersection of the fifth phase foliation with the second phase schistosity
● fifth phase kink band axis

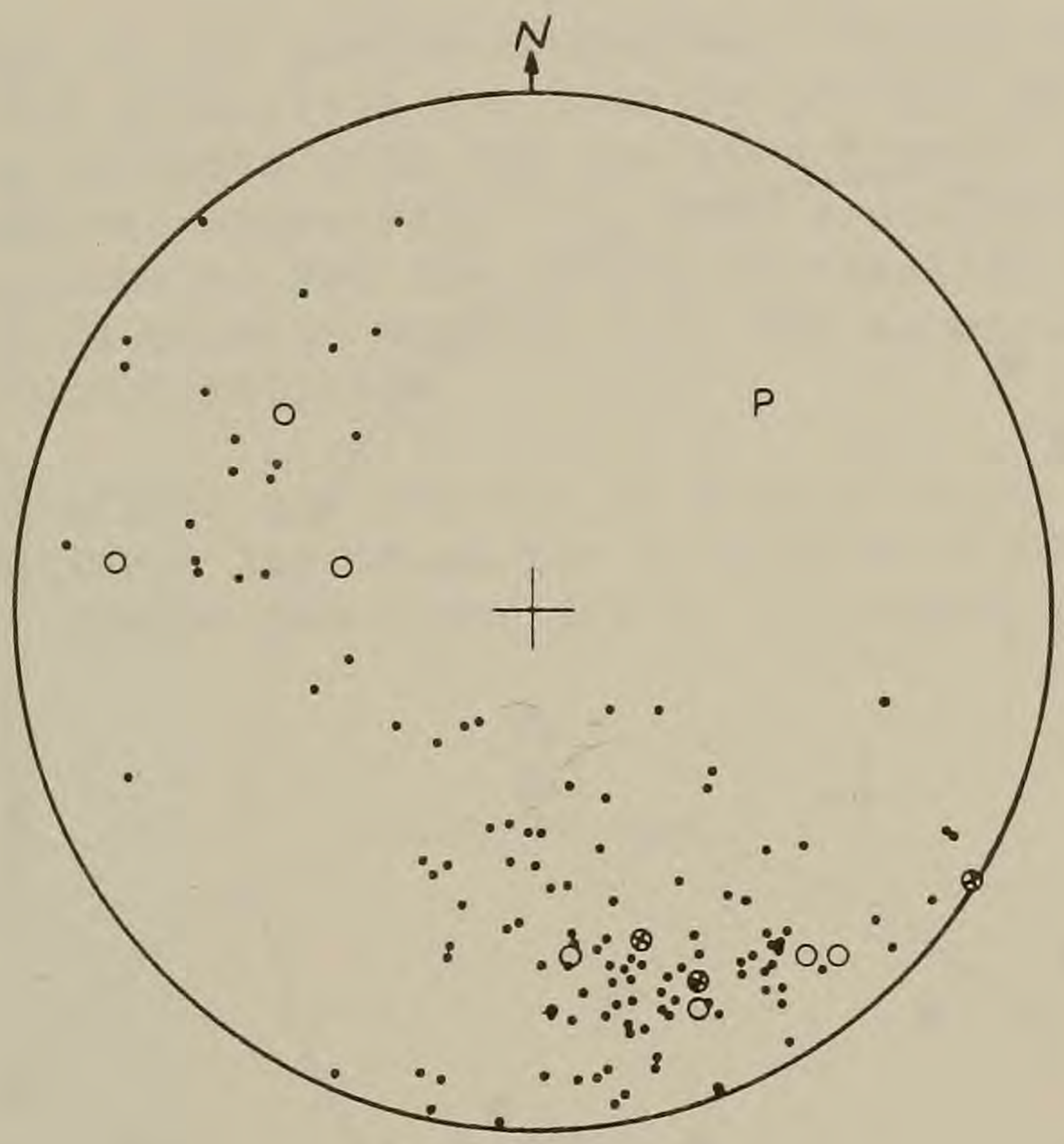


Figure 11C. Foliation data for the Mt. Tom area including Stop 6.
Poles to planar features = 132
o bedding
• dominant second phase foliation
⊗ axial plane of second phase minor fold
Lineations = 1
P pole (N48E 39) to the girdle defined by the poles to bedding and to the second phase planar features

feldspar laminae in the Mt. Tom Amphibolite. The broad, open, NNW map scale folds in the Mt. Tom Amphibolite at Mt. Tom are fifth phase features (Figs. 2, 10).

6.4	-	Return to the vehicles, exit the park to the west, and and head back to Rt. 202.
6.7	0.3	At the "T" intersection before Rt. 202 turn right (east).
6.8	0.1	Turn right (east) onto Rt. 202. The road at first sub-parallels the NE trending Mt. Prospect Complex/country

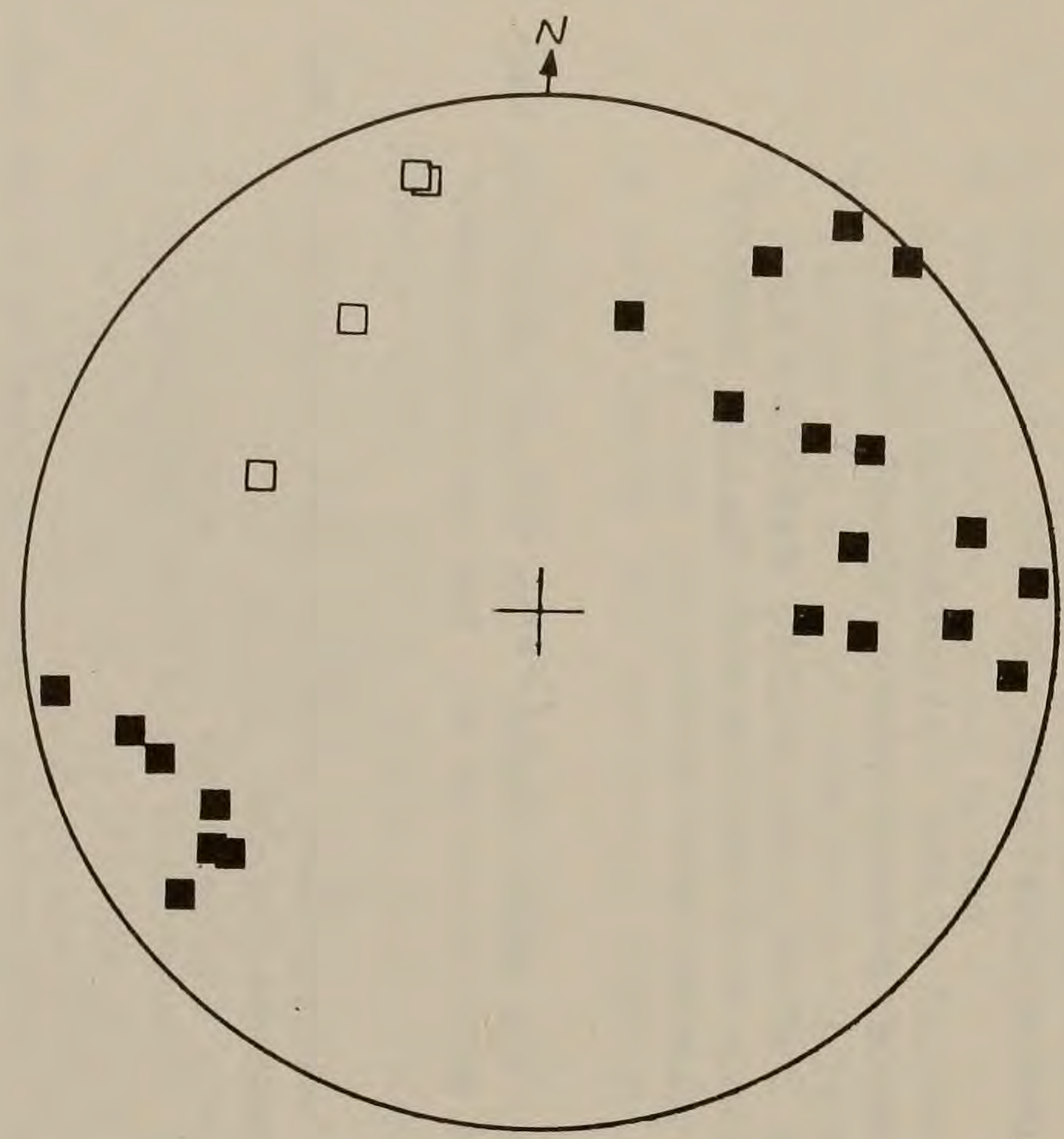


Figure 12 Fifth phase foliation data from the Mt. Tom area
Poles to fifth phase foliation = 25
■ foliation of the set with average NW trending strikes
□ foliation of the conjugate set

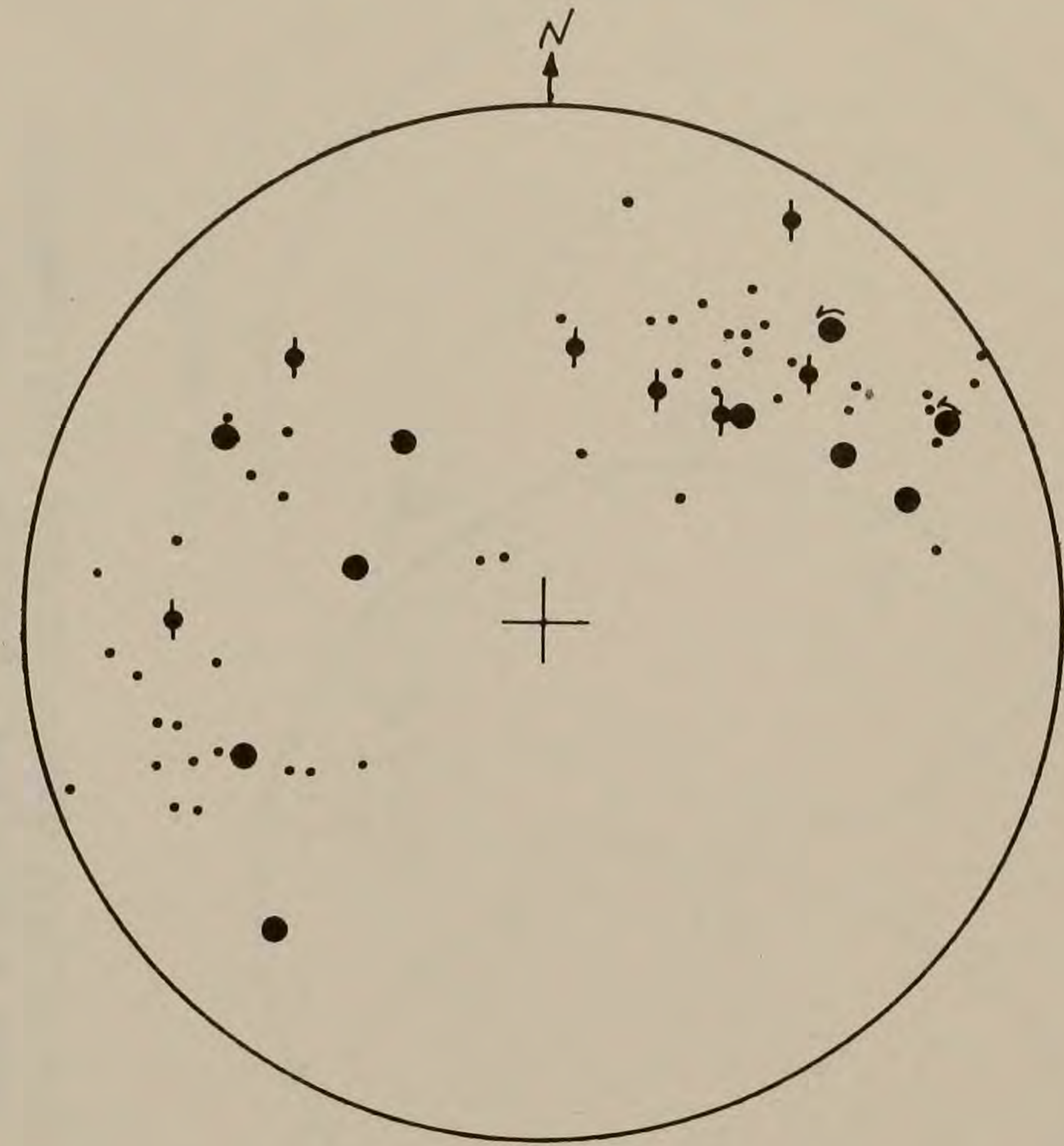


Figure 13 Lineation data from the Mt. Tom area.
Lineations = 35
· second phase mineral lineation or intersection lineation
● second or third phase fold axis
♦ third phase crinkle of the dominant second phase schistosity

xenoliths are common in the quartz monzonite. Though not present at this stop, microcline megacrysts are locally present in the diorite, especially near the contacts with the quartz monzonite porphyry. The localization of euhedral megacrysts only near contacts with the late intruding quartz monzonite, and the random orientation of the megacrysts in foliated diorite suggest that the microcline megacrysts in the diorite are porphyroblasts.

A number of foliations are present in this outcrop (Fig. 14). The foliations most prominent are those due to alignment of 1-3 mm anhedral hornblende grains and those due to alignment of 1-3 mm

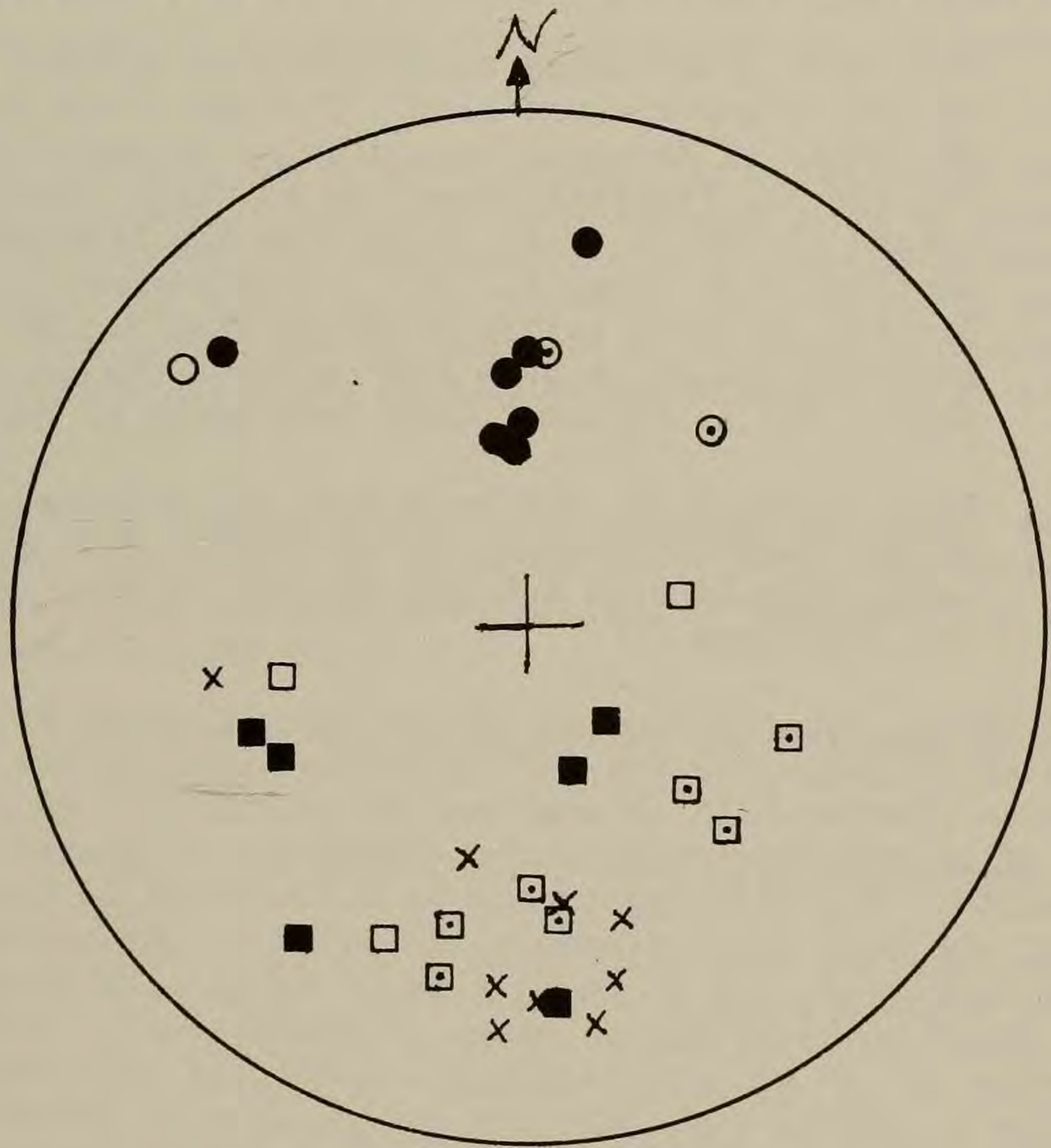


Figure 14: Structural data from Stop 7 and adjacent outcrops.

Poles to planar features=25
igneous layering
hornblende-biotite foliation
feldspar foliation
cleavage

Lineations=10
hornblende lineation
feldspar lineation
intersection of cleavage and igneous layering

rock contact. Primarily diorite and quartz monzonite underlie Mt. Tom Pond to the south, and the Mt. Prospect and Hartland Formations lie to the north. At the NE end of Mt. Tom Pond, the contact trends almost east and crosses the road.

7.5 0.7 Continue along a large road cut which consists of Homogeneous Mafic Diorite in contact with the Bee Brook Member of the Hartland. Layered diorite and quartz monzonite are also present. The road recrosses the Mt. Prospect Complex/country rock contact which locally trends NW due to the Woodville Anticline.

7.8 0.3 Pass Stop 8 and cross the N trending synform cored by the Mt. Prospect Formation. The low hills to the north and south of the road have diorite on their flanks and and the Mt. Prospect Formation at their crests. We will return to Stop 8 after examining the diorite at Stop 7. Continue east along Rt. 202. Pass several diorite outcrops before reaching Stop 7. Mt. Prospect cannot be seen over most of the Rt. 202 route, but it is about 6000 feet north of Stop 7.

8.6 0.8 Park in the E. O. Phelps & Sons Co. driveway. Please do not block the access to the buildings. Stop 7 is the large diorite road cut and natural outcrop adjacent to the buildings.

Stop 7: A large, layered diorite gneiss roadcut along Rt. 202. The layered diorite gneiss is the most extensive unit of the Mt. Prospect Igneous Complex. It is composed of typically 1 cm to 5 m thick layers of quartz-plagioclase-hornblende-biotite gneiss locally with minor augite. The layering is due to differences in the relative proportions of the four major minerals, in color of the rocks from light-gray to dark-gray, and in grain size of rocks with this same mineralogy. Layer contacts may be sharp or gradational. Individual layers may wedge out or show low angle cross-cutting relationships with other layers. Mafic xenoliths are common in more felsic hosts but the reverse relationship is rare. Mafic biotite-hornblende lenses are floating in the diorite or locally concentrated along some felsic veins. The former appear to be partially assimilated xenoliths, while the latter may be cumulate patches.

Layered diorite outcrops contain at least minor amounts of intrusive quartz monzonite in the form of veins, irregular, wispy aggregates, discontinuous layers, sills, and rare dikes. Quartz monzonite layers <2 cm thick are typically not porphyritic, but are rich in 2-4 mm, subhedral to euhedral plagioclase grains. Diorite subhedral to euhedral andesine grains. The hornblende and andesine grains may be randomly distributed in the rock, which is the more general case, or concentrated in wispy lenses. The overall general impression is that these foliations are subparallel to the roughly E-W trending, compositional layers, but in fact low angle intersections among the foliations and compositional layers are common. The layering and foliations together produce the dominant, broadly curved surfaces in the outcrops. Locally the hornblende weathers out to produce either a pitted surface or a crude parting in the rock. Most lineations (Fig. 14) plunge moderately N to NE. This alignment is due to the fourth phase of deformation, and a major fourth phase syncline lies north of Stop 7 (Fig. 2). This lineation orientation roughly parallels the overall plunge of the cylindrical Mt. Prospect Igneous Complex.

There are several, NE-to NW-trending, minor faults in the layered diorite on both sides of the road which locally show an actinolite lineation or slickensides. Displacement is difficult to demonstrate at this outcrop, but these faults postdate the previously mentioned foliations. The faults are in turn cut by randomly oriented, 1 mm wide, felsic veins which may be single and straight or in anastamosing groups.

Foliation that transects the fault consists of small, fine-grained, planar aggregates of feldspar and quartz, and which may be related to the fifth phase of deformation, is sporadically exposed in the large southern outcrop.

8.6	-	Return to the vehicles and proceed west on Rt. 202 to Stop 8.
9.3	0.7	Turn left onto a minor side road which parallels Rt. 202.
9.4	0.1	Park along the side of this road just before the road rejoins Rt. 202. We will cross a private yard to get to the Stop 8 outcrops which lie south of Rt. 202. Beside walking through the woods, we will also be in people's back yards and fields so please respect their property and needs.

Stop 8: The purpose of this traverse is to observe a major third phase fold in the diorite-country rock contact.

The map pattern (Fig. 15) shows a north plunging, steep limbed, third phase, isoclinal syncline that is refolded by minor NE-trending, open, fourth phase folds. Poles to compositional layering and second phase foliation in outcrops around the fold hinge define a girdle with a pole plunging at N 1 E 46 (Fig. 16) which is presumed to define the plunge of the third phase isoclinal syncline. A third phase foliation with an average orientation of N 10 E 82W is axial planar to the major fold. Younger foliations (Fig. 17) have significantly different trends.

Station A: This exposure of the Mt. Prospect Formation consists of interbedded fine-grained, gray, poorly layered, siliceous granulite, gray quartzite and darker-gray, fine-grained, rough-surfaced, garnet-muscovite-plagioclase-biotite-quartz schistose gneiss. Bedding ranges from several centimeters to several meters in thickness. Millimeter scale compositional layering in the schistose gneiss consists of

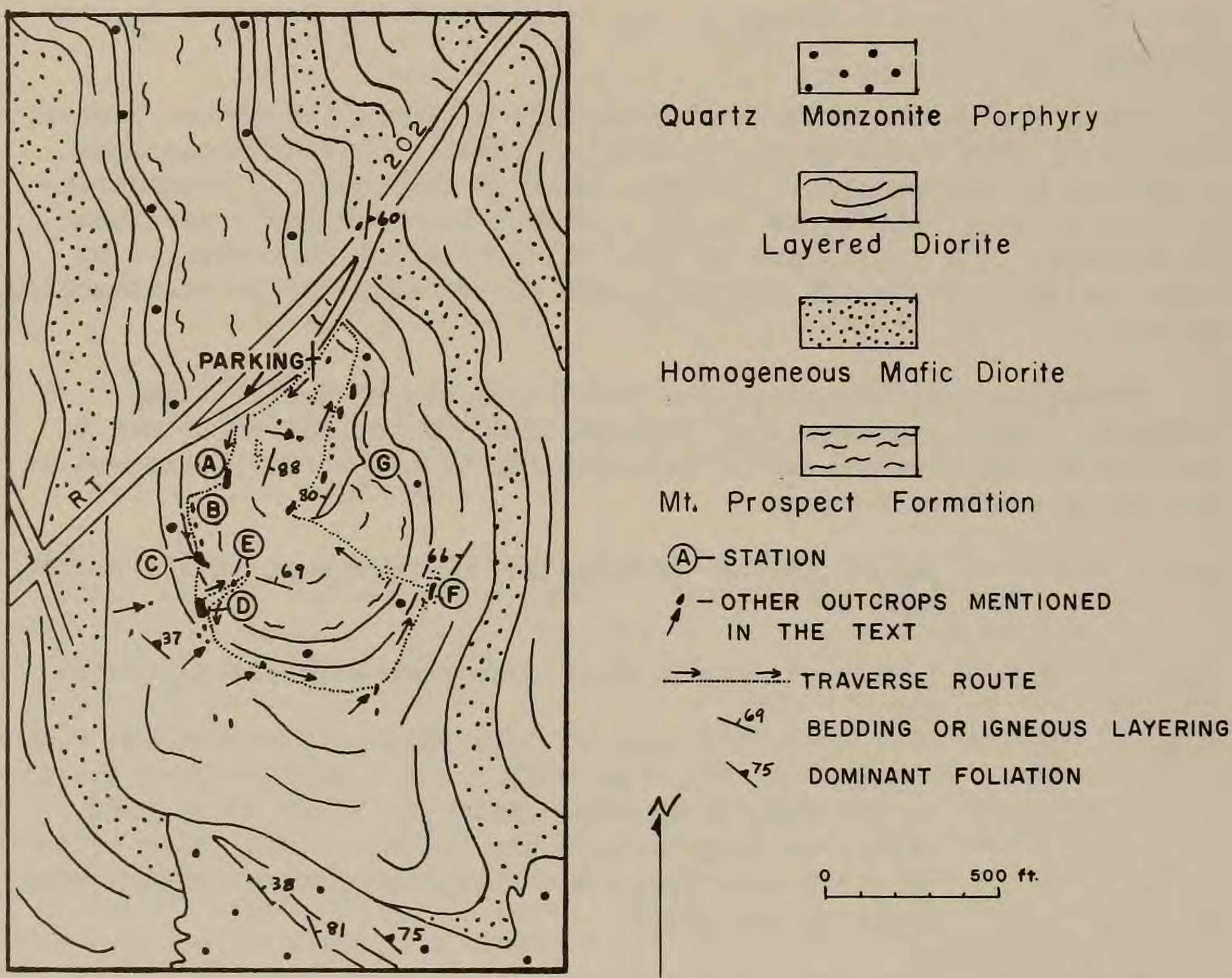


Figure 15: Map of the Stop 8 area showing the third phase fold of the country rock/Mt. Prospect Complex contact.

fine-grained, quartz-rich layers and thinner, biotite-rich layers. The dominant foliation, which is due to the preferred orientation of micas, appears to be parallel to bedding and strikes roughly N-S.

Station B: The Mt. Prospect Formation/diorite contact is exposed here and is subparallel to the NE-trending foliation. The contact and foliation are folded by third phase minor folds.

Station C: This is a fifteen foot high outcrop of fine-grained, well-laminated, gray-white-weathering, plagioclase-garnet-sillimanite-biotite-quartz gneiss. There are two distinct populations of millimeter scale laminations. One consists of smooth, white, fine-grained, quartz layers, and the other is coarser-grained, granular, yellow-staining, irregular, feldspar-quartz layers. The dominant second phase foliation is axial planar to isoclinal folds in the lamination. Also present are 1-10 cm thick, massive, irregular, garnet-quartz layers which may concentrate in 1-2 foot thick zones. The garnet-quartz layers are boudinaged and isoclinally folded and axial plane foliation associated with these folds is due to the preferred orientation of biotite.

Numerous minor third phase isoclinal folds in the layering are obvious and it is possible that several larger isoclinal folds are present in the entire outcrop. Several, late, non-axial planar, faint foliations are sporadically present. One of these, a S-dipping foliation, is probably a fifth phase feature.

Station D: Quartz monzonite porphyry is intrusive into the Mt. Prospect Formation and layered diorite. Foliations are not obvious everywhere in this coarse-grained porphyry but can be identified upon close inspection. The most obvious foliation, due to aligned biotite and small inequant feldspar grains, strikes about N 60 E and dips NW. This is interpreted to be a fourth phase foliation. A weaker, isoclinally folded, second phase foliation is due to aligned biotite. The average N-S trend of this foliation probably represents the trend of the rock units. (Optional): About 250 ft. to the west are small outcrops of layered diorite with NW-trending compositional layering.

Station E: About 100 ft. to the northeast are two small outcrops of the Mt. Prospect Formation with N70W trending laminations. Quartz-feldspar laminae define a fourth phase foliation that trends NE and dips NW. Over the next 1000 ft. of traverse, we will stop at several minor outcrops of diorite in order to demonstrate that the map scale fold closes to the south. We will wind up at Station F.

Station F: Slumped blocks are abundant, but the rock is probably in place in a few places. The diorite layering and a subparallel first phase foliation which is produced by the alignment of feldspar and hornblende trend N30E and both appear to be cut by a later N-trending second phase foliation. Walking northwest we will cross an area of quartz monzonite and sedimentary rock float, and eventually arrive at Station G.

Station G: A series of outcrops of the Mt. Prospect Formation extend northward along a minor ridge to the road. Along the way the dominant foliation strikes due north on average and has a near vertical dip. Minor fourth phase folds with NE-striking axial planes and NNE-plunging hinge lines are common. These folds have a counterclockwise rotation sense which is related to the major third phase fold that causes the sharp curve to E-W trending folds near the southern border of the Mt. Prospect Complex (Fig. 2).

9.4	-	Return to the vehicles and turn right (east) onto Rt. 202. Proceed to Stop 9.
10.2	0.8	Pass Stop 7. Mt. Prospect which is over a mile to the north is largely underlain by olivine norite and quartz norite. Some of the norite bodies are within about 500 feet north of Rt. 202, but none of the late intrusives except for Quartz Monzonite are south of the highway.
11.8	1.6	The long low hill with pastures north of the road is a drumlin. Several drumlins can be seen on both sides of the road over the next two miles. Glacial deposits cover most of the eastern half of the Mt. Prospect Complex. Thus detailed mapping is not possible here.
14.1	2.3	Turn left at the traffic lights onto Milton Road (which is not named of the 7.5 minute Litchfield quadrangle map). We have crossed the Mt. Prospect Complex over the last 0.1 to 0.3 mile and are now crossing into the Muscovite Schist Member of the Hartland Formation.
14.4	0.3	Turn right onto Beach Street.
15.2	0.8	Park the vehicles off the road. This is Stop 9. We will cross the stone fence on the east side of the road and go down the slope where there are abundant outcrops of the Muscovite Schist Member of the Hartland Formation.

Stops 9-12: On these traverses we will examine the Muscovite Schist Member of the Hartland, and the Mt. Prospect and Manhattan C Formations north of the Mt. Prospect Complex (Figs. 18, 19). We will cross Cameron's Line several times and demonstrate that it is folded

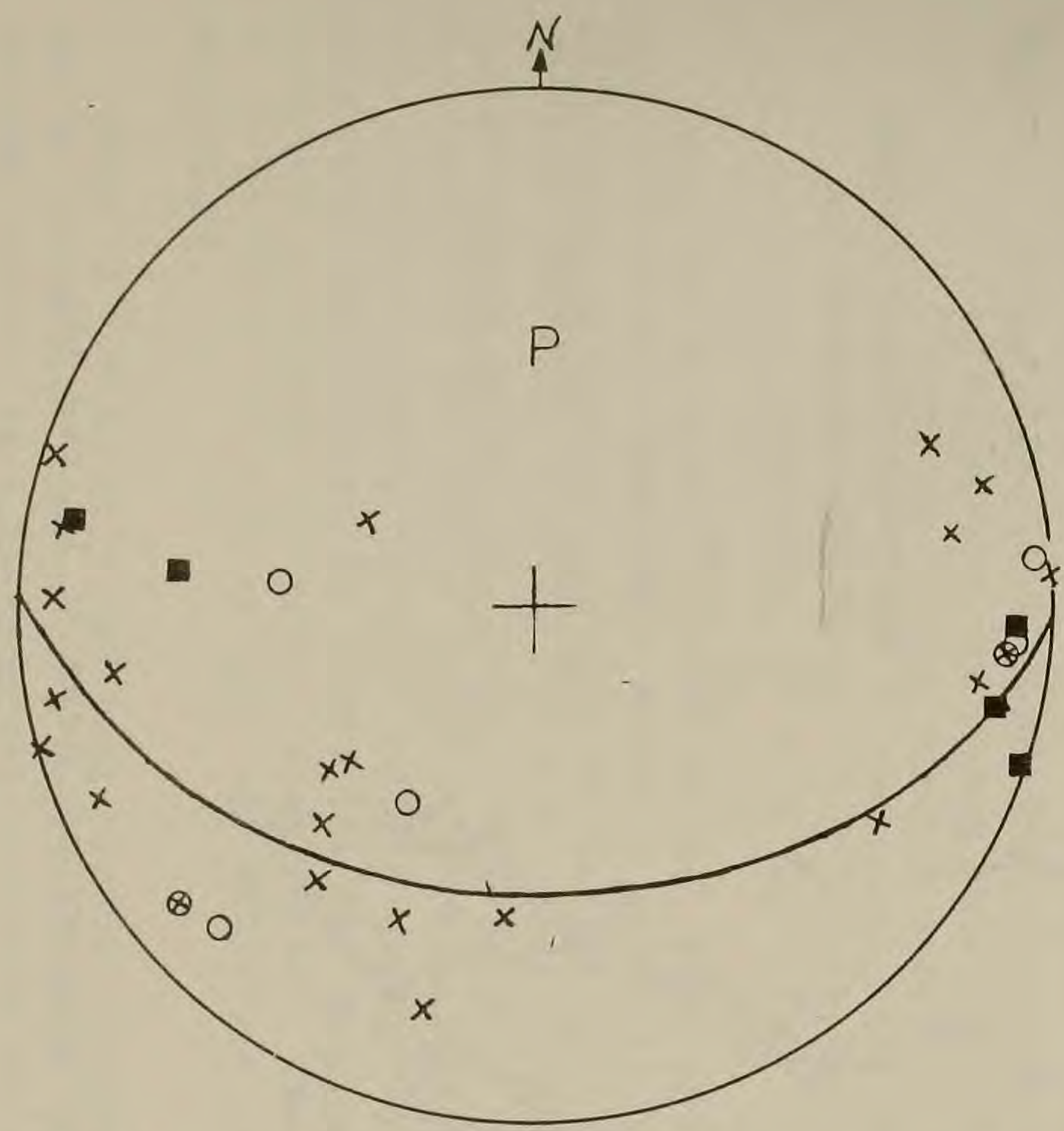


Figure 16. Bedding, second phase, and third phase data from Stop 8 outcrops.

Poles to planar features = 34
- × bedding
- o second phase foliation
- ⊗ axial plane of second phase fold
- ■ third phase foliation

Lineation = 1

P pole (N1E 46) to the plane defined by the poles to bedding and second phase features

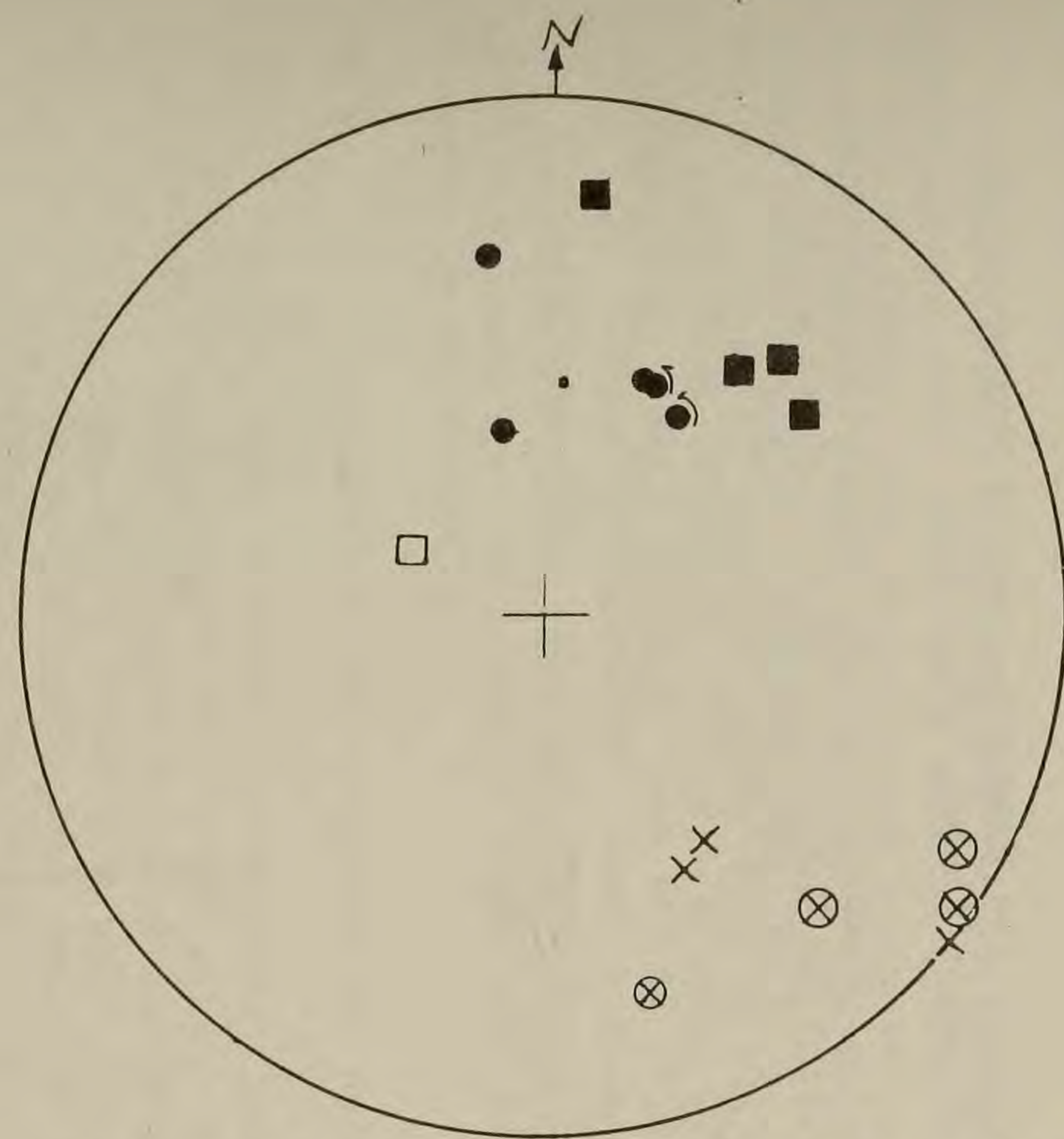


Figure 17. Post-second phase data for Stop 8 outcrops.

Poles to planar features = 12
- × fourth phase foliation
- ⊗ axial plane of fourth phase fold
- ■ foliation of the fifth phase set with average NW trending strikes
- □ conjugate fifth phase foliation

Lineations = 6
- ● fourth phase fold axis
- • intersection of fourth phase foliation and bedding

by second and third phase folds.

Stop 9: Extensive outcrops of the Muscovite Schist Member of the Hartland are on both sides of Beach Street (Fig. 18).

Gray or silver gray, golden-brown-weathering, staurolite-kyanite-plagioclase-chlorite-garnet-biotite-muscovite-quartz schist with millimeter to centimeter scale, fine-grained, sandy, locally laminated, quartz layers, and abundant, coarse, massive, vein-like, quartz layers, lenses, and pods is the most abundant rock. Both types of quartz layers are isoclinally folded. Subordinate, rusty-weathering, dark, biotite-rich schist is present. Rare granitic pegmatites are conformable to the schistosity.

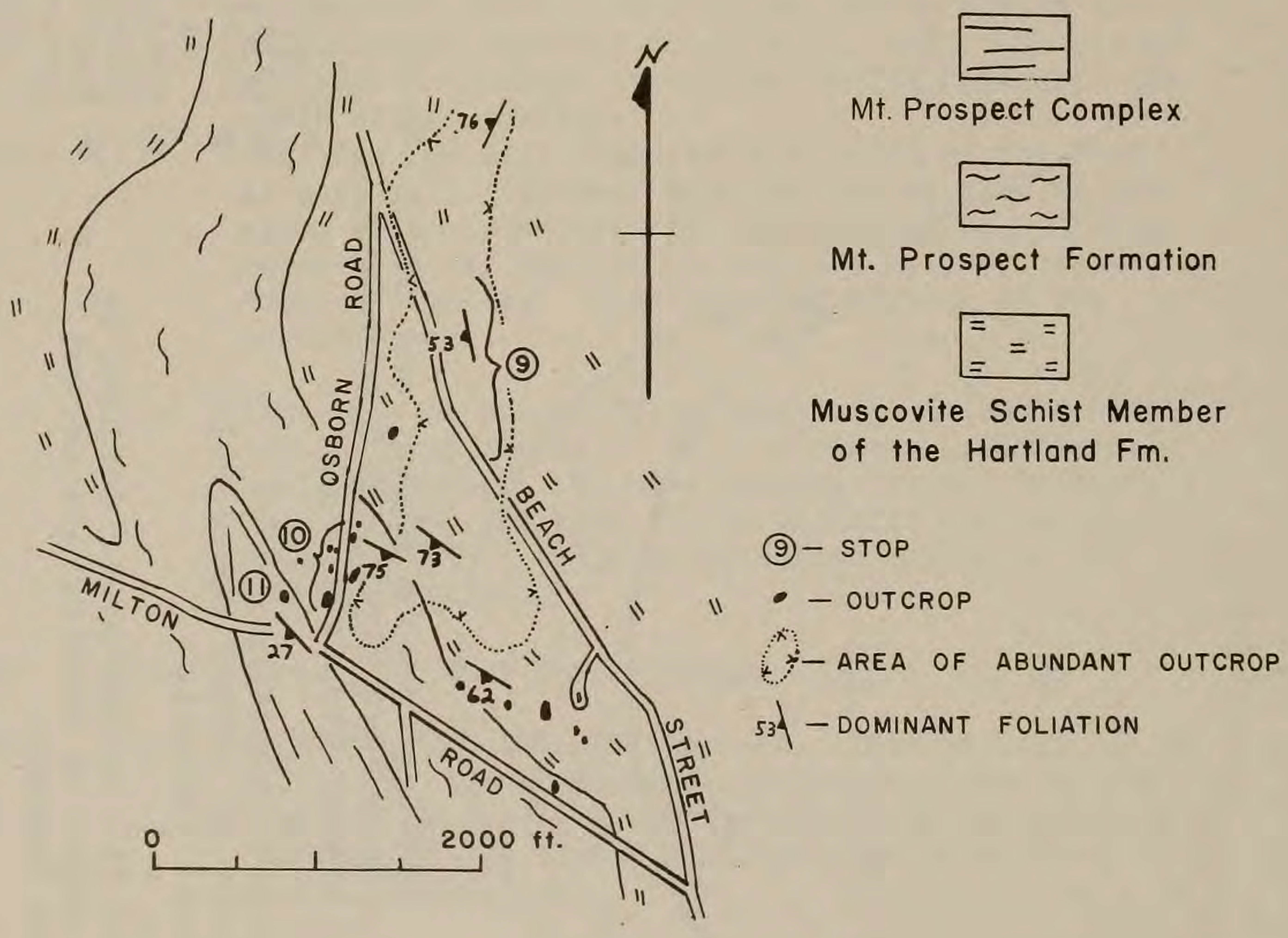


Figure 18: Map of the area around Stops 9, 10, and 11.

A second phase foliation generally trends NW to N. The youngest minor structural features at Stop 9 and 10 are due to the fifth phase of deformation.

Large (<7 cm), biotite-muscovite-garnet-quartz aggregates that are pseudomorphs after staurolite show an imperfect tendency to be aligned in the foliation, and probably are elongate parallel early fold axes. Anhedral, relict staurolite and small euhedral (second generation) staurolites may occur in these pseudomorphs. Quartz rods and fine-grained, elongate, biotite lenses 1-20 cm long are parallel to second phase fold hinge lines and to intersections of compositional layering and second phase schistosity.

One roadside outcrop has abundant muscovite pseudomorphs after andalusite that have rectangular cross sections and are randomly oriented in the foliation.

15.2	-	Return to the vehicles and drive north on Beach Street.
15.4	0.2	Make a sharp (150 degrees) left onto Osborn Road (not named on the 7.5 minute West Torrington quadrangle map and there is no street sign at this intersection) and drive south. We will cross the NW trending Muscovite Schist/Mt. Prospect Formation contact before reaching the Mt. Prospect Formatiom outcrop at Stop 10.
15.9	0.5	Park on either side of the road. The Stop 10 outcrops are along the road over a few hundred feet north of the parking spot. The diorite outcrop of Stop 11 is in the woods about 400 feet west of the parking area. The Muscovite Schist Member is 500 feet east of Stop 10.

Stop 10: At this location the Mt. Prospect Formation consists of medium-grained, dark gray, variably garnetiferous, muscovite-spangled, sillimanite-muscovite-garnet-quartz-biotite schist and various amounts of thin (1-8 cm), light-gray, fine-grained, well laminated, biotite-garnet-quartz granulite layers. The bedding contacts between schist and granulite are nearly parallel to the foliation in the schist, but the granulite layers locally contain wildly contorted laminae. Coarse-grained, granular quartz layers, lenses and pods are isoclinally folded by second phase folds. The quartz layers are down to <1 mm thick to locally give the schistose gneiss a "pin-striped" appearance.

Stop 11 (optional): The most northern known diorite exposure of the Mt. Prospect Complex is a small pavement outcrop (Fig. 18). The outcrop surface is a NW-trending foliation which roughly parallels the foliation in the Mt. Prospect Formation exposed 250 ft. to the east. This diorite body is interpreted to be in conformable, intrusive contact with the Mt. Prospect Formation and the contact outlines a second phase fold involving the diorite.

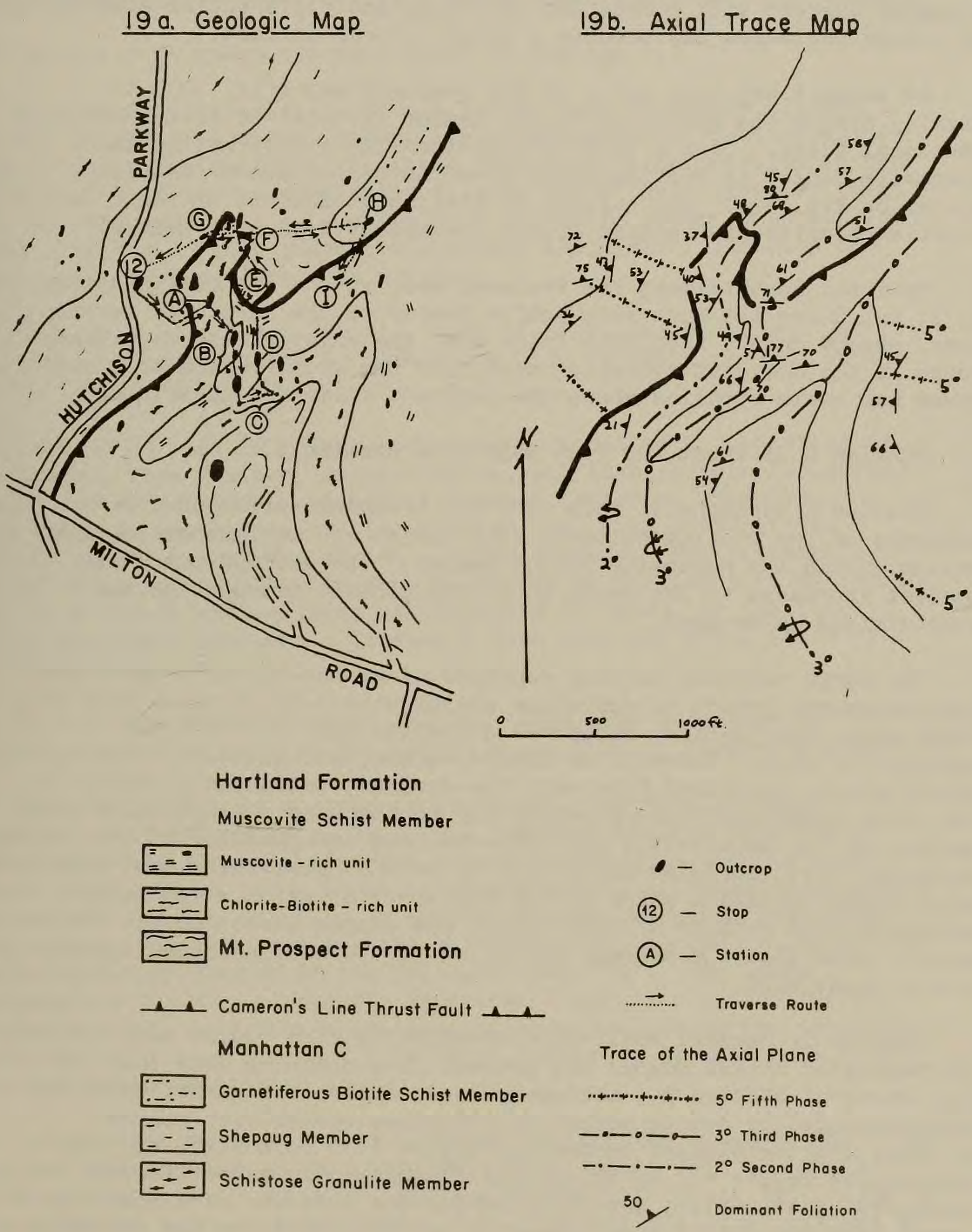
15.9	-	Return to the vehicles and drive south.
16.0	0.1	Turn right (west) at the intersection of Osborn Road and Milton Road and continue NW.
16.8	0.8	Turn right onto Hutchinson Parkway and head north.
17.0	0.2	Park along the road at Stop 12. There are pastures to the west and woods to the east. The first Stop 12 outcrop is a long low outcrop on the east side of the road.

Stop 12: In traveling to Stop 12, we have crossed Cameron's Line. We will now traverse eastward and cross Cameron's Line on foot (Fig. 19). At this locality the map pattern is interpreted to be the result of four phases of deformation. The Cameron's Line thrust juxtaposes truncated Hartland Members against Manhattan C Members. Cameron's Line is subsequently deformed by interfering second, third, and fifth phases of folding. The dominant foliation and associated folds are second phase features. The third phase folds in the foliation also fold Cameron's Line. The open folds are fifth phase features that have an associated SW dipping axial planar crenulation cleavage cleavage.

There is a long, low, roadside outcrop of the Shepaug Member of the Manhattan C at Stop 12. It consists of interbedded, medium-grained, rough-surfaced, garnetiferous, sillimanite-muscovite-garnet-biotite-quartz schistose gneiss, and thinly laminated, fine-to medium-grained, garnet-muscovite-biotite-quartz schistose granulite. The laminae are 1-2 mm siliceous layers and thinner biotite-muscovite-rich layers. Porous clots (<2 cm thick and <15 cm long) in the gneiss are cored by 1 cm diameter garnets or aggregates of small garnets rimmed by sillimanite, quartz, and biotite. The clots are at the noses of minor folds, that together with the SW-dipping crenulation seen here are fifth phase deformational features.

Proceed about 250 ft. S55E along the path to the top of a low hill Station A is about 150 ft. N60E from this point. Cameron's Line, though not exposed, is crossed before reaching Station A.

Station A: An outcrop of the chlorite-biotite-rich schist in the Muscovite Schist Member of the Hartland consists of medium-grained, laminated, garnetiferous, staurolite-garnet-muscovite-biotite-chlorite-quartz schistose gneiss to schist. Aggregates of 1-5 mm



Figures 19A&B: Geologic and structural data maps of the Stop 12 area.

diameter garnets with quartz and chlorite, and differential weathering of folded foliation may produce a rough outcrop surface.

An attempt has been made, on the geologic map (Fig. 19), to locally divide the Muscovite Schist Member in order to better define the local folds. Thus a biotite-chlorite-rich schist within the Muscovite Schist is distinguished from the normal muscovite-rich schist on Fig. 19A. The outcrop at Station A consists of the biotite-chlorite-rich schist within the Muscovite Schist Member.

Optional Route: Among the features seen at the optional Stations B, C, and D are the Muscovite Schist Member of the Hartland, outcrop size, second phase, isoclinal folds with the axial planar foliation, which is the dominant foliation here, and the axial region of a third phase map scale syncline where the dominant foliation is folded.

Station B is about 200 feet S40E from Station A.

Station B (optional): This is a N-S trending series of four outcrops of the biotite-chlorite-rich schist and the muscovite-rich schist within the Muscovite Schist Member. The average muscovite content increases to the south where the contact between the two subdivisions is crossed.

The large northern outcrop consists of garnet-chlorite-muscovite-biotite-quartz schist to schistose gneiss with 1-20 cm thick beds of light-gray, quartz-rich, schistose granulite and 0.3-1 m thick amphibolite beds. There is an outcrop-scale, southwesterly closing, second phase, isoclinal fold with the dominant foliation parallel to its axial plane and dipping moderately to the west. Plagioclase forms laminae in the amphibolite and these laminae are parallel to the layer contacts. Both surfaces are folded by second phase folds that have an axial plane foliation which is the dominant foliation. The normal muscovite-rich schists of this Member are mapped about 100 ft. to the south. Note that the average foliation in the southernmost, outcrop trends about N20E.

Station C: Several small biotite-chlorite-rich schist outcrops in the Muscovite Schist Member are present in a clearing less than 100 feet south of Station B. Medium-grained, staurolite-garnet-chlorite-muscovite-biotite-quartz schist to schistose gneiss with coarse-grained, quartz-feldspar lenses and layers (<10 cm thick), biotite-amphibolite layers (<3 cm thick) and fine-grained, garnetiferous, laminated, quartz-rich, granulite lenses are present. The granulite lenses have apparently been broken up by shearing along the foliation. The foliated biotite-amphibolite layers are at high angles to both the coarse-grained, quartz-feldspar layers and the younger dominant foliation. The change in strike of the dominant second phase foliation indicates that the third phase axial trace has been crossed.

Station D is about 150 feet north of Station C.

Station D (optional): This is a large, low, partially slumped outcrop of medium-grained, staurolite-garnet-chlorite-biotite-muscovite schist. The dominant foliation is varied in orientation in the axial region of the southwesterly closing third phase syncline (Fig. 19b) and this and this outcrop is near the axial trace of this third phase syncline. Fifth phase crenulations and minor folds with SW-dipping axial planes are also present.

Station E lies about 250 ft. east of Station A and about 300 ft. north of optional Station D. Cameron's Line is again crossed on the way to Station E from D.

Station E: This is a large outcrop of Manhattan C consisting of light-gray, fine-grained, garnetiferous, sillimanite-chlorite-muscovite-garnet-plagioclase -biotite siliceous schistose granulite. Resistance to weathering by fine-grained, chlorite-sillimanite-biotite-garnet aggregates yields a nubby surface. The orientation change in dominant foliation from W-dipping at Station A to NW-(north end) or N (south end)-dipping at Station E is caused by the third phase, map-scale syncline. Station E lies near the axial trace of this syncline.

We will now traverse about 250 ft. N30W into a pasture to demonstrate the closure of the second phase fold in Cameron's Line.

Station F: This is a group of three outcrops through which Cameron's Line passes (Fig. 19). The southern outcrop consists of medium-grained, staurolite-garnet-muscovite-chlorite-biotite-quartz schist with a 50 cm thick layer of fine-grained, siliceous granulite. The western outcrop consists of muscovite-biotite-quartz schistose gneiss These two outcrops are the biotite-chlorite-rich schist in the Muscovite Schist Member of the Hartland (Fig. 19). The large northeastern outcrop represents Manhattan C and is a garnetiferous, rough-surfaced, muscovite-biotite-garnet-plagioclase-quartz schistose granulite with subordinate <10 cm thick layers of biotite schist and garnet-hornblende-biotite gneiss.

Cameron's Line trends NW on average through the outcrops while the dominant axial plane second phase foliation trends N30E on average which is parallel to the axial surface of the fold (Fig. 19). Thus this relation between second phase foliation and the axial surface of the fold indicates that this map scale fold is a second phase anticline and that these exposures are in its axial region.

Station G is located about 150 feet N70W from Station F. This outcrop of the Shepaug Member of the Manhattan C consists of light-gray, muscovite-spangled, garnetiferous, chlorite-muscovite-garnet-biotite-quartz schistose gneiss. Individual large garnets or garnet aggregates are surrounded by extensive biotite-chlorite-muscovite-quartz haloes. The dominant foliation dips west. This outcrop further constrains the location of Cameron's Line to the folded shape shown by the second phase fold in Figure 19.

The optional stop in the Garnetiferous Schistose Gneiss Member of Manhattan C at Station H is located about 900 feet east of G. This Member is locally truncated by Cameron's Line.

Station H (optional): The Garnetiferous Schistose Gneiss Member of Manhattan C exposed here is a medium-grained, nubby-surfaced, garnetiferous, sillimanite-muscovite-garnet-biotite-quartz schistose gneiss. "Nubs" are resistant garnets and small sillimanite-quartz lenses. This distinctive, uniform, dark-gray rock, which has relatively few fine-grained granulite layers, is equivalent to that at Stop 5.

Exposures of the Muscovite Schist Member of the Hartland are a few hundred feet south along a minor brook.

Station I (optional): This outcrop consists of coarse-grained, staurolite-garnet-chlorite--biotite-muscovite schist, rusty-weathering schistose gneiss in the stream bed and dark green to black, amphibolite layers. Foliation dips moderately northwest.

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