Structure and Rock Fabric Within the Central and Southern Adirondacks

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INTRODUCTION

The area referred to as the southern Adirondacks is shown in Figure 1. Within this region, the Precambrian is bounded approximately by the towns of Lowville and Little Falls on the west and Saratoga Springs and Glens Falls on the east (Fig. 2).

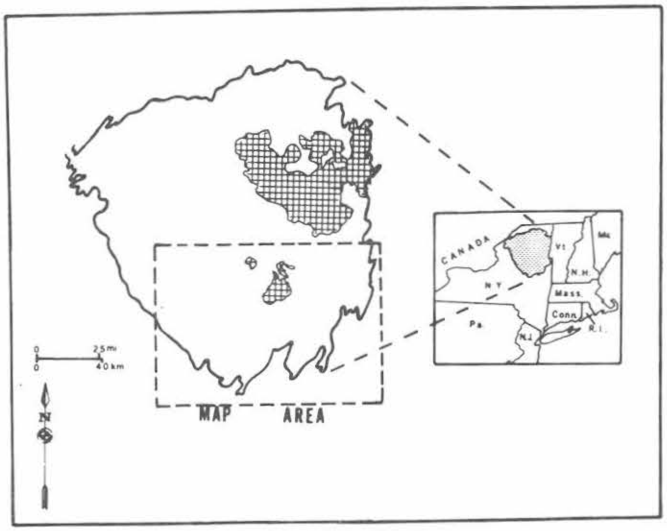

Fig. 1. Location map of the Adirondack Mts. Major anorthosite massifs are represented by the grid pattern. The central and southern Adirondacks lie within the dashed rectangle labeled "Map Area".

Mapping in the southern Adirondacks was done first by Miller (1911, 1916, 1920, 1923), Cushing and Ruedemann (1914), Krieger (1937), and Cannon (1937); more recent investigations were undertaken by Bartholome (1956), Thompson (1959), Nelson (1968), and Lettney (1969). At approximately the same time Walton (1961) began extensive field studies in the eastern portion of the area (Paradox Lake, etc.), de Waard (1962) began his studies in the west (Little Moose Mt. syncline). Subsequently de Waard was joined by Romey (de Waard and Romey, 1969).

Separately and together, Walton and de Waard (1963) demonstrated that the Adirondacks are made up of polydeformational structures, the earliest of which consist of isoclinal, recumbent folds. Their elucidation of Adirondack geology set the tone for future workers in the area. In this regard one of their most important contributions to the regional picture was that the lithologic sequence of the west-central Adirondacks is similar to that of the eastern Adirondacks.

Beginning in 1967 McLelland (1969, 1972) initiated mapping in the southernmost Adirondacks just to the west of Sacandaga Reservoir subsequently this work was extended north and east to connect with that of Walton and de Waard.

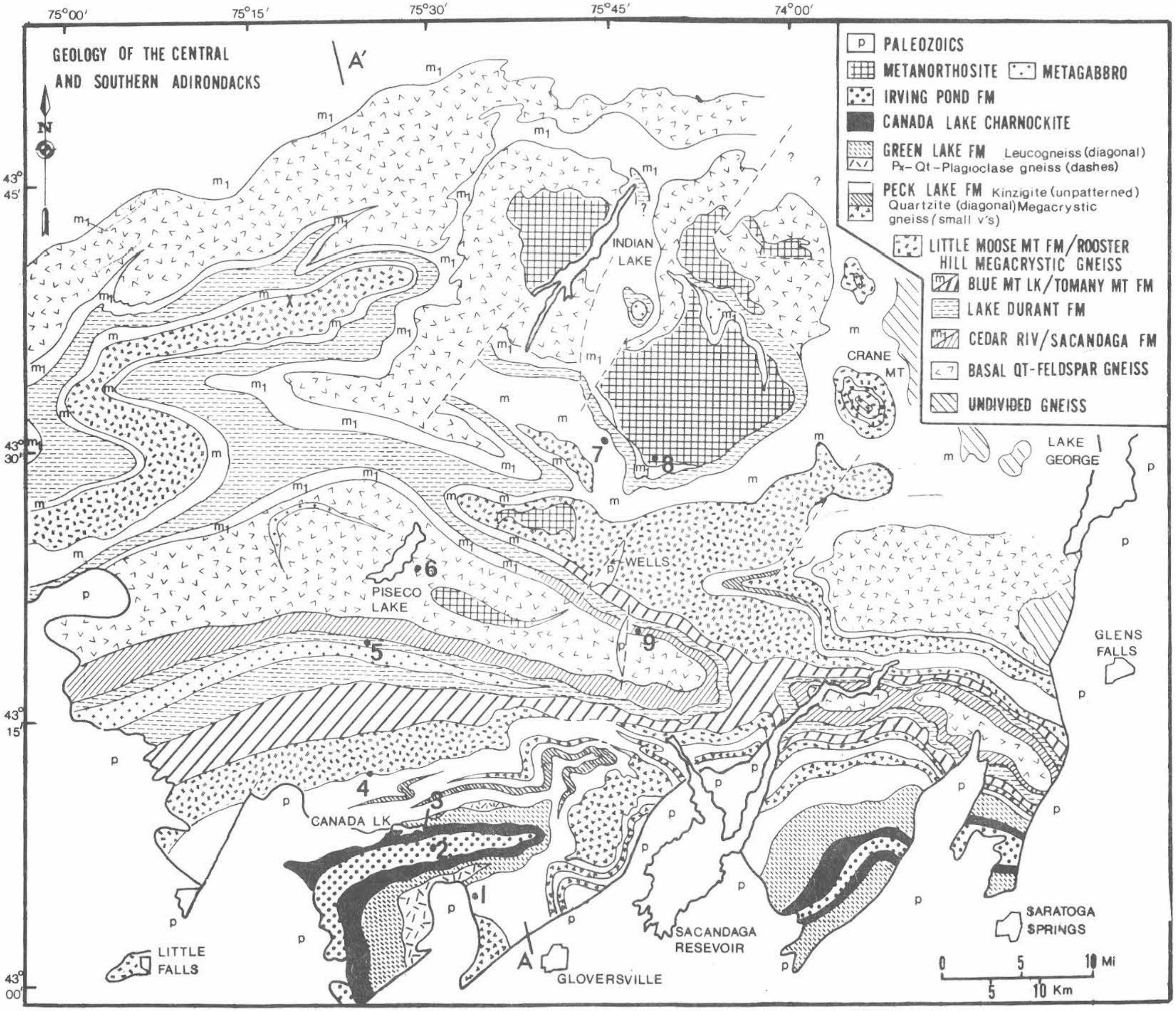

Fig. 2. Formational map and stop localities for the central and southern Adirondacks (from McLelland and Isachsen, 1980)

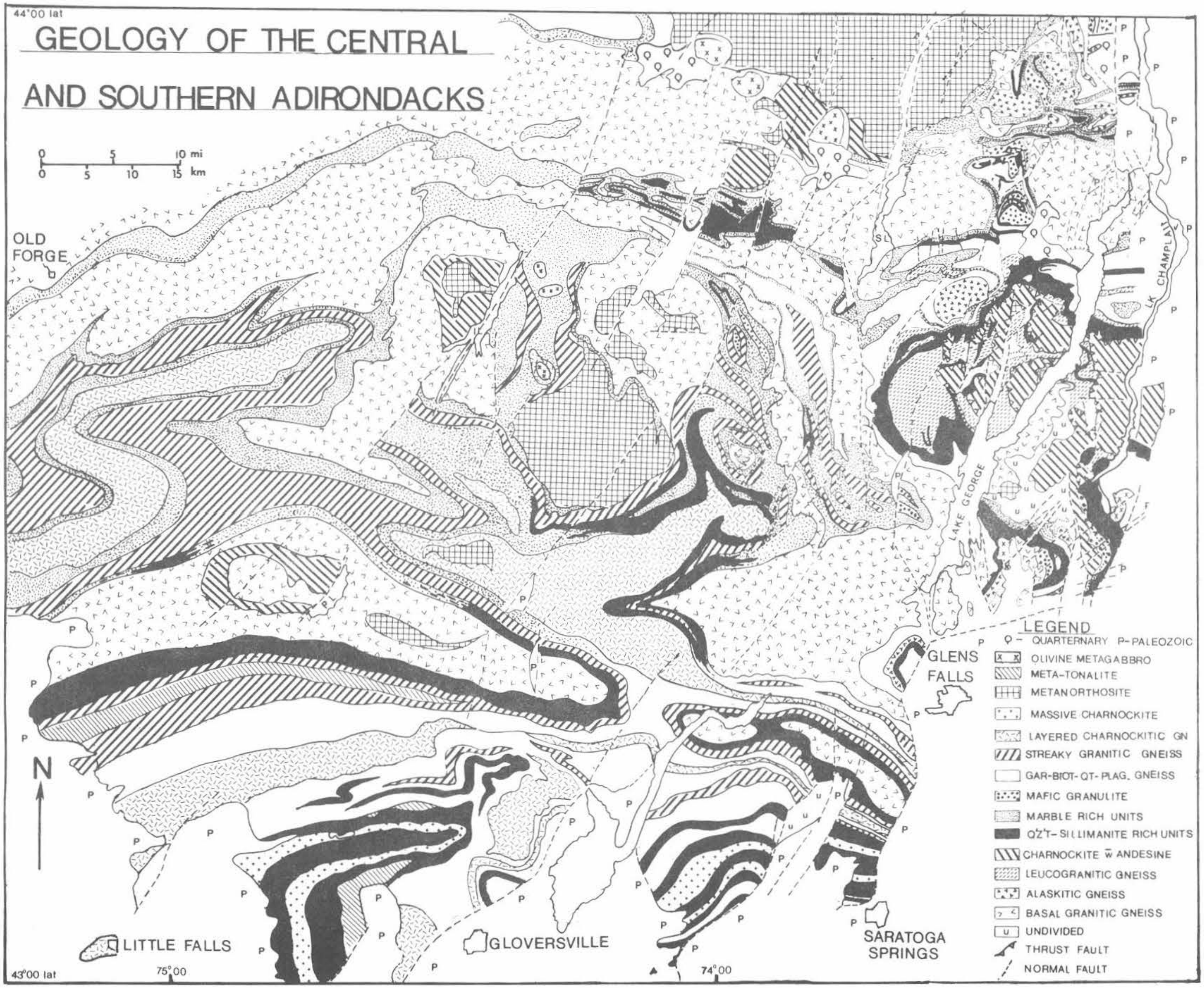

Fig. 3. Lithological map of the central and southern Adirondacks. Note that only a few high angle faults are shown.

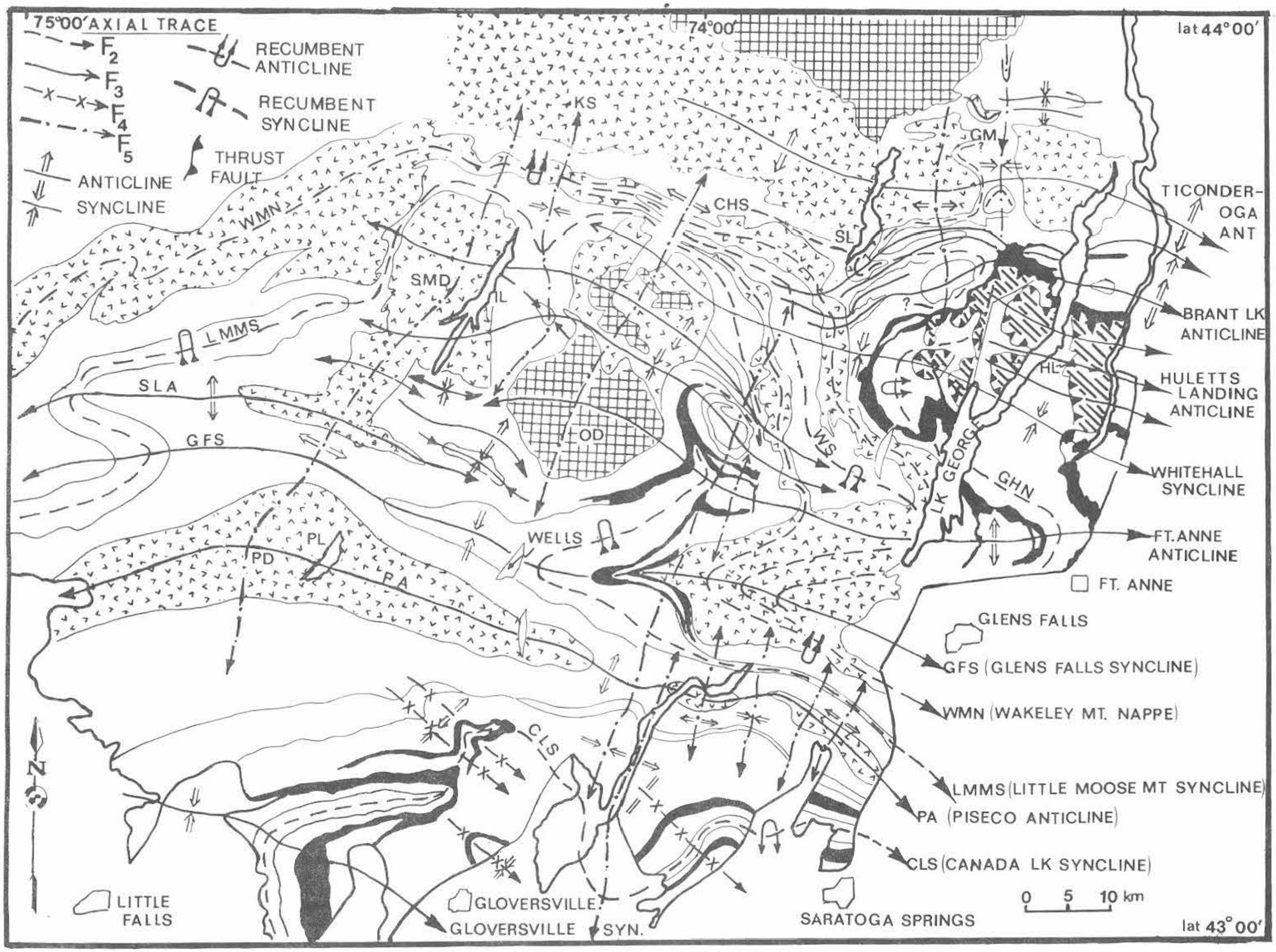

Fig. 4. Axial trace map of the central and southern Adirondacks. For lithological map symbols see Fig. 3. Abbreviations not on map: CHS - Canada Hill syncline; GHN - Green Hill nappe; GM - Glidden Marsh syncline; HL - Hullett's Landing; OD - Oregon Dome; PD - Piseco Dome; PL - Piseco Lake; SL - Schroon Lake; SLA - Spruce Lake anticline; SMD - Snowy Mt. Dome; WS - Warrensburg syncline

Geraghty (1973) and Farrar (1976) undertook detailed mapping in the eastern half of the North Creek 15' quadrangle, and tied into investigations in the Brandt Lake region by Turner (1971). Recently, Geraghty (1978) completed a detailed study of the structure and petrology in the Blue Mt. Lake area. Current investigations by McLelland and by the N.Y. Geological Survey are going forward in the general region surrounding Lake George.

The foregoing investigations have increased our knowledge of the southern Adirondacks, and this fieldtrip is designed to show as many examples of the region's structure, lithology, and petrology as time permits.

STRUCTURAL FRAMEWORK OF THE SOUTHERN ADIRONDACKS

The southern Adirondacks (Figs. 2-5) are underlain by multiply deformed rocks which have been metamorphosed to the granulite facies. The structural framework of the region consists of four unusually large fold sets, F_2 - F_5 together with an early set of isoclines represented solely by intrafolial minor folds with associated axial planar foliation (Figs. 2-4). Relative ages have been assigned to these fold sets, but no information exists concerning actual time intervals involved in any phase of the deformation. It is possible that several, or all of the fold sets, are manifestations of a single deformational continuum.

The earliest and largest of the map-scale folds are recumbent, isoclinal structures (F_2) -- for example the Little Moose Mt. syncline (de Waard, 1962) and Canada Lake nappe (McLelland, 1969) (Figs. 2 and 5). These isoclines have axes that trend approximately E-W and plunge within 20° of the horizontal. As seen in Figures 4 and 5 the axial traces of each of the F_2 folds exceeds 100 km. They are believed to extend across the entire southern Adirondacks. Subsequent useage of the terms "anticline" and "syncline," rather than "antiform" and "synform," is based on correlations with rocks in the Little Moose Mt. syncline where the stratigraphic sequence is thought to be known (de Waard, 1962).

Close examination reveals that the F_2 folds rotate an earlier foliation defined principally by platets of quartz and feldspar and axial planar to minor intrafolial isoclines. Although this foliation is suggestive of pre-F_2 folding, such an event does not seem to be reflected in the regional map patterns (Fig. 3). However, it is possible that major pre-F_1 folds exist but are of dimensions exceeding the area bounded by Figure 3. If this is the situation, their presence may be revealed by continued mapping. The existence of such folds is suggested by the work of Geraghty (1978) in the Blue Mt. area. In the vicinity of Stark Hills charnockites of the Little Moose Mt. Fm. appear to be identical to supposedly older quartzo-feldspathic gneisses (basal) which lie at the base of the lithologic sequence. Given this situation, then the Cedar River and Blue Mt. Lake Fms. are identical, and there emerges a pre-F_2 fold cored by the Lake Durant Formation. However, careful examination of the Lake Durant Formation has failed to reveal the internal symmetry implied by this pre-F_2 fold model. It is possible, of course, that the pre-F_1 foliation may not be related directly to folding (e.g. formed in response to thrusting, gravity sliding, etc.; Mattauer, 1975). Currently the origin of the pre-F_2 foliation remains unresolved. In most outcrops the pre-F_2 foliation cannot be distinguished from that associated with the F_2 folding.

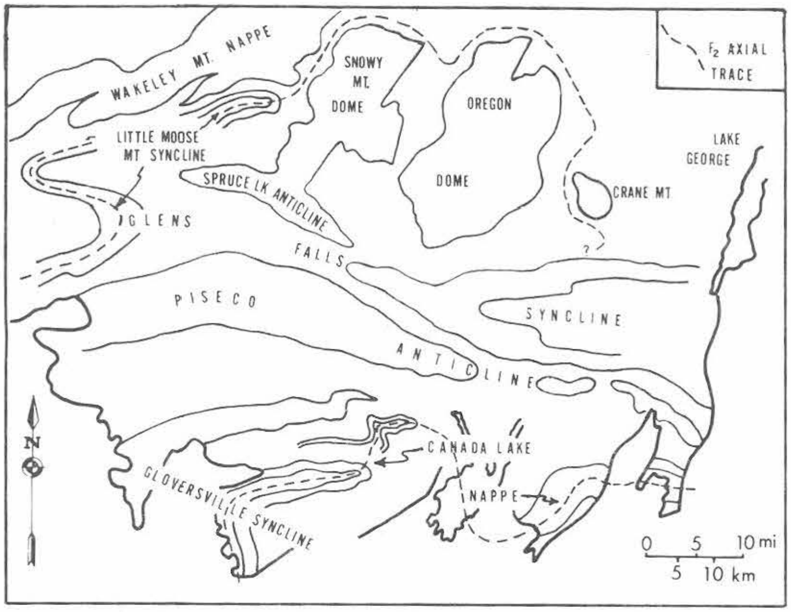

Fig. 5. Blocked out major folds of the central and southern Adirondacks (from McLelland and Isachsen, 1980).

Following the F_2 folding, there developed a relatively open and approximately upright set of F_3 folds (Figs. 2-5). These are coaxial with F_2. In general the F_3 folds are overturned slightly to the north, the exception being the Gloversville syncline with an axial plane that dips 45°N. The F_3 folds have axial traces comparable in length with those of the F_2 set. The Piseco anticline and Glens Falls syncline can be followed along their axial traces for distances exceeding 100 km until they disappear to the east and west beneath Paleozoic cover. The similarity in size and orientation of F_2 and F_3 suggests that both fold sets formed in response to the same force and field.

The fourth fold set (F_4) is open, upright, and trends NW. Within the area these folds are less prevalent than the earlier sets. However, Foose and Carl (1977) have shown that within the NW Adirondacks, northwest-trending folds are widespread and play an important role in the development of basin and dome patterns.

The fourth regional fold set (F_5) consists of large, upright NNE folds having plunges which differ depending upon the orientation of earlier fold surfaces. The F_5 folds are observed to tighten as one proceeds towards the northeast.

The regional outcrop pattern is distinctive because of the interference between members of these four fold sets (Figs. 2-5). For example, the "bent-finger" pattern of the Canada Lake nappe west of Sacandaga Reservoir is due to the superposition of the F_3 Gloversville syncline on the F_2 fold geometry (Fig. 4). East of the reservoir the reemergence of the core rocks of the Canada Lake nappe is due to the superposition on F_2 of a large F_5 anticline whose axis passes along the east arm of the reservoir (Fig. 4). The culmination-depression pattern along the Piseco anticline results from the superposition of F_3 and F_5 folds. The structure of the Piseco dome is due to the intersection of the Piseco anticline (F_3) with the Snowy Mt. anticline (F_5). Farther to the north, Crane Mt. is a classic example of a structural basin formed by the interference of F_3 and F_5 synclines (Figs. 2 and 6).

DISCUSSION AND SYNTHESIS OF STRUCTURAL RELATIONSHIPS

Over a decade ago Walton and de Waard (1963) proposed that rocks of the anorthosite-charnockite suite comprise a pre-Grenvillian basement on which a coherent "supracrustal" sequence was deposited unconformably. Rocks which would be assigned a basement status in this model are designated as basal quartzo-feldspathic gneiss in Figure 3. The basal Cedar River Fm. of the overlying "supracrustal" sequence consists of marbles, quartzites, garnet-sillimanitic gneisses, and various calc-silicates. This lowermost unit is followed upward by various quartzo-feldspathic gneisses, marbles, and other metasedimentary sequences shown in Figure 2. Although our own research agrees with the generalized lithologic sequences of de Waard and Walton, two major provisos are necessary and are given here.

(1) Anorthositic rocks intrude the so-called supracrustal sequence, and therefore the anorthosites post-date these units and cannot be part of an older basement complex (Isachsen, McLelland, and Whitney, 1976; Husch, Kleinspehn, and McLelland, 1976). Isotopic evidence (Valley and O'Neill's (1983); Ashwal and Wooden, 1984) suggests that the anorthosites intruded prior to the 1.1 Ma Grenvillian metamorphism probably during a non-compressional stage (Emslie, 1978, Whitney, 1983). Angular, rotated xenoliths within the anorthosites exhibit pre-intrusion foliation and imply an earlier orogenic event(s).

(2) Within the metastratified units of the region, there exists field evidence for primary facies changes. For example, the well-layered sillimanite-garnet-quartz-feldspar gneisses of the Sacandaga Formation grade laterally into marble-rich units of the Cedar River Fm. exposed north of the Piseco anticline (Figs. 2,3). This transition along strike can be observed just south of the town of Wells, and its recognition is critical to the interpretation of the regional structure. Thus the great thickness of kinzigites (granulite-facies metapelites) south of the Piseco anticline gives way to the north to thinner units marked by marbles, calcsilicates, and quartzites. We interpret this lithologic change as due to a transition from a locally deep basin in which pelitic rocks were accumulating to a shallow-water shelf sequence dominated by carbonates and quartz sands.

Given the foregoing information, it has been possible to map and correlate structures and lithologies on either side of the Piseco anticline. In the northwest the sequence on the northern flank proceeds without structural discontinuity into the core of the Little Moose Mt. syncline. There occurs on the southern flank a mirror image of the northwestern lithologic sequence as units are traced towards the core of the Canada Lake nappe. It follows that the Canada Lake nappe and Little Moose Mt. syncline are parts of the same fold (Fig. 6). The amplitude of this fold exceeds 70 km. and it can be followed for at least 150 km along its axial trace. The major F_2 and F_3 folds of the area are exposed through distances of similar magnitude, but their amplitudes are less than those of the F_1 isoclines. The structural framework that emerges is one dominated by exceptionally large folds.

Accepting that the Little Moose Mt. syncline and Canada Lake nappe are the same fold, and noting that the fold axis is not horizontal, it follows that the axial trace of the fold must close in space. The axial trace of the Canada Lake nappe portion of the structure can be followed from west of Gloversville to Saratoga Springs. Therefore, the axial trace of the Little Moose Mt. syncline also must traverse the Adirondacks to the north. Mapping strongly suggests that the hinge lines of this fold passes through North Creek and south of Crane Mt. (Fig. 6). From here the axial trace swings westward along the north limb of the Glens Falls syncline to a point north of Wells and thence eastward to a point south of Glens Falls. This model is depicted schematically in Figure 6 where the southern Adirondacks are shown as underlain largely by the Canada Lake-Little Moose Mt. syncline. Later folding by F_3 and F_5 events has resulted in regional doming of the F_2 axial surface and erosion has provided a window through the core of this dome. Note the western extension of the Piseco anticline beneath the Paleozoic cover. This extension is consistent with aeromagnetics of the area.

Currently attempts are underway to synthesize the structural framework of the entire Adirondacks by extending the elements of the present model to other areas. A preliminary version is shown in Figure 7 and suggests that most Adirondack structure is explicable in terms of the four regional fold sets described here. Thrust faulting has been recognized in the eastern Adirondacks (Berry, 1961) and high strain zones exist in many other areas of the Adirondacks (McLelland, 1984). Associated with these are distinctive ribbon gneisses (Fig. 8) and sheath folds (Fig. 9). These are further discussed in Stop 6, Road Log.

CONCLUDING SPECULATIONS

The ultimate origin of the structural and petrologic features of the Adirondacks remains obscure. A possible clue to the mechanisms involved is Katz's (1955) determination of 36 km as the present depth to the M-discontinuity beneath the Adirondacks. Because geothermometry-geobarometry place the peak of the Grenville metamorphism at 8-9 kb (24-36 km), a double continental thickness is suggested. Such thicknesses presently exist in two types of sites, both plate-tectonic related. The first is beneath the Andes and seems related to magmatic underplating of the South American plate (James, 1971). The second is beneath the Himalayas and Tibet and is due to thickening in response to collision (Dewey and Burke, 1973) or continental underthrusting (Powell and Conaghan, 1973). The presence of ribbon lineation, sheath folds, and subhorizontal mylonitic foliation within the region strongly suggests regional rotational strain with a dominant component of simple shear (McLelland, 1984). Rotated K-feldspar augen exhibit tails asymmetric to foliation suggesting an east side up and to the west sense of tectonic transport.

Southeastward directed subduction would be consistent with this model. The relevant plate margin presumably lies buried beneath the present day Appalachians.

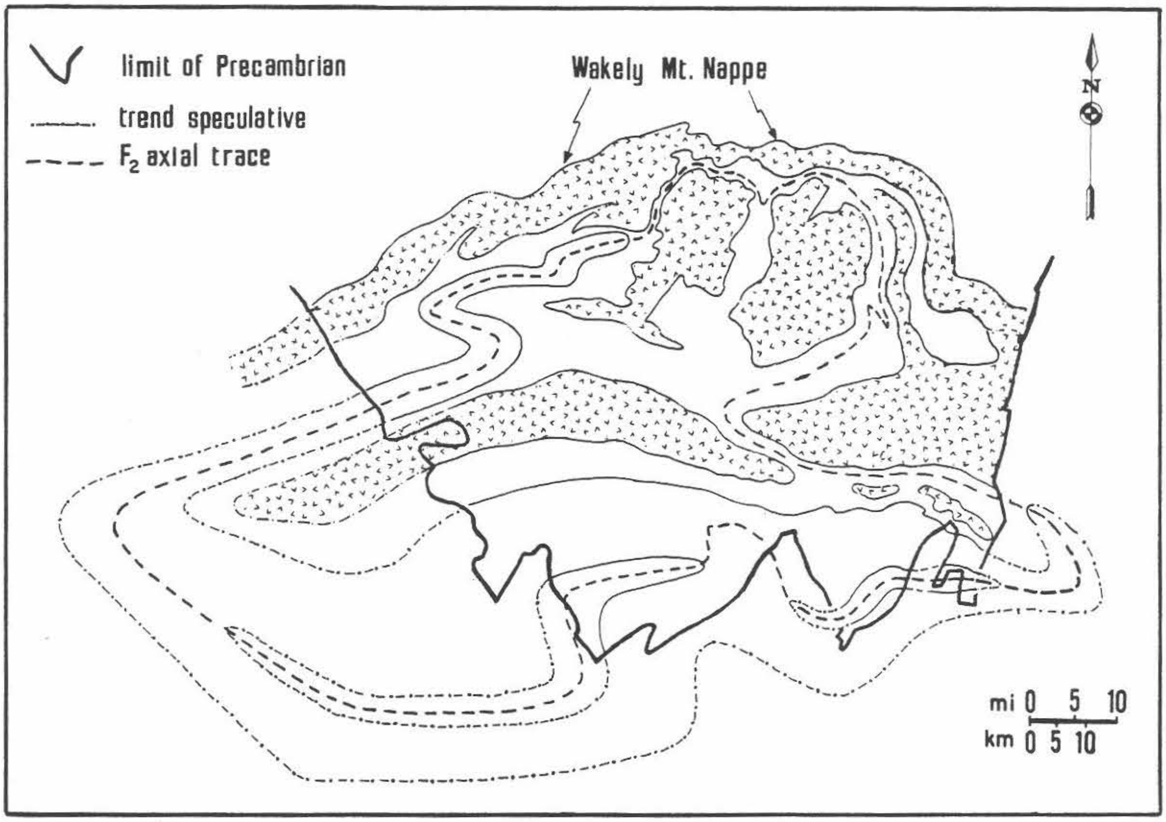

Fig. 6. Geologic sketch map showing the proposed axial trace of the F_2 Little Moose Mt. - Canada Lake syncline. The western extension of the Piseco anticline is inferred from aeromagnetic data (from McLelland Isachsen, 1980).

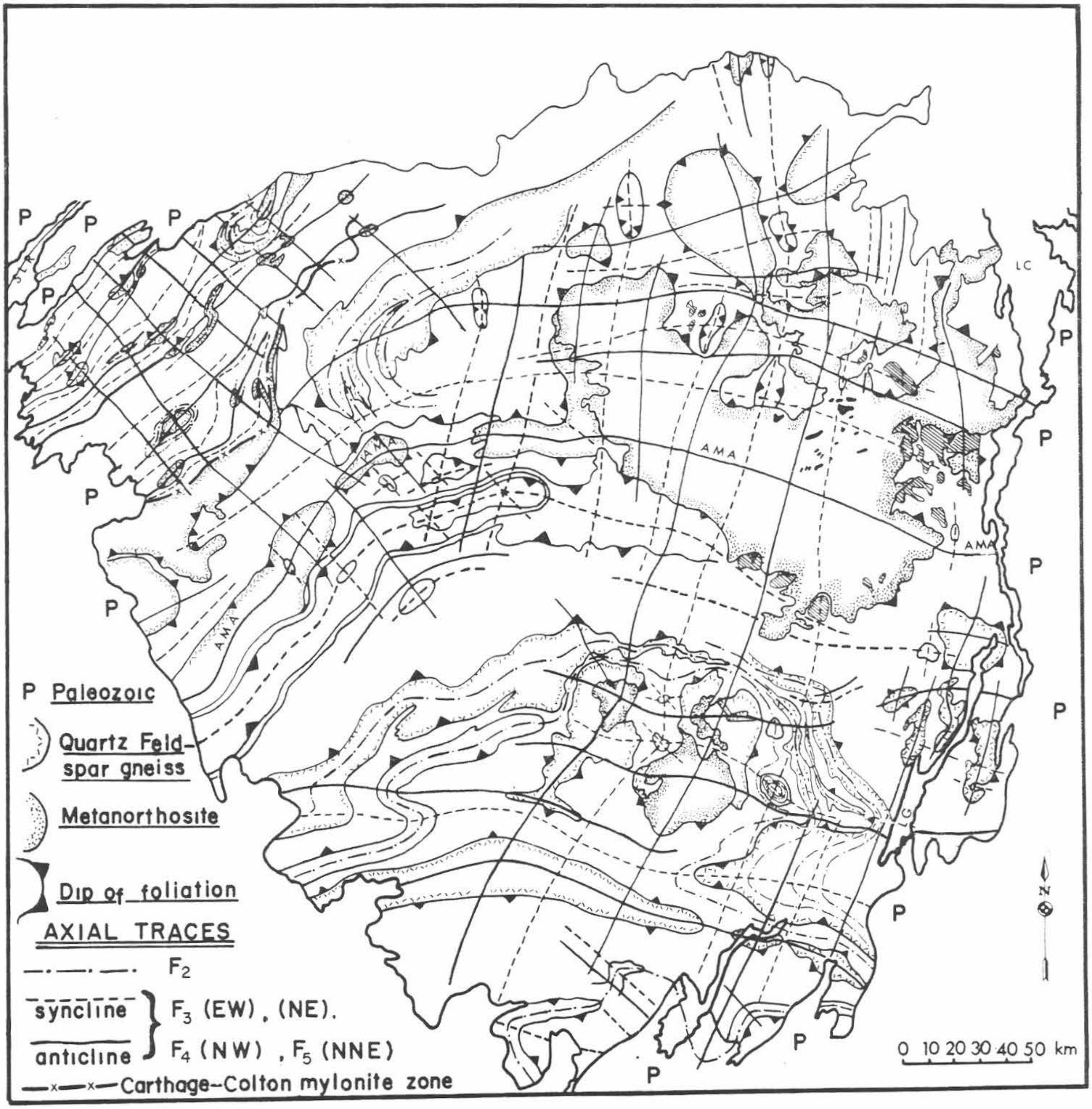

Fig. 7. Axial trace map of the Adirondack Mts. (from McLelland and Isachsen, 1980).

ROAD LOG

Mileage

0 Junction of Willie Road, Peck Hill Road, and NY Rt. 29A

1.3 Mud Lake to northeast of NY Rt. 29A

2.8 Peck Lake to northeast of NY Rt. 29A

3.6 **Stop #1**. Peck Lake Fm.

This exposure along Rt. 29A just north of Peck Lake is the type locality of the sillimanite-garnet-biotite-quartz-feldspar gneisses (kinzigites) of the Peck Lake Fm. In addition, there are exposed excellent minor folds of several generations. Note that the F_2 folds rotate an earlier foliation.

The white quartzo-feldspathic layers in the kinzigites consist of quartz, two feldspars, and garnet and are believed to be anatectic. Note that fish-hook terminations on some of these suggest that they have been transposed. It is also clear that these anatectites have been folded by F_2 indicating a pre-F_2 metamorphic event(s). In a similar fashion some garnets in the rock appear to be flattened while others do not. It is believed that the anatectites formed at the muscovite-quartz reaction and are essentially in situ melts. Further anatexis did not take place due to absence of vapor.

6.1 Junction NY Rt. 29A and NY Rt. 10

8.0 Nick Stoner's Inn on west side of NY Rt. 29A-10

8.6 **Stop #2**. Irving Pond Fm., .5 mile north of Nick Stoner's Inn, Canada Lake.

The outer portion of the Irving Pond Fm. is exposed in low cuts along the east side of Rt. 29A just prior to the crest in the road heading north.

At the southern end of the cut typical, massive quartzites of the Irving Pond are seen. Proceeding north the quartzites become "dirtier" until they are essentially quartzose sillimanite-garnet-biotite-feldspar gneisses (kinzigites).

At the northern end of the cut, and approximately on the Irving Pond/Canada Lake Fm. contact there occurs an excellent set of F_2 minor folds. Polished slabs and thin sections demonstrate that these fold an earlier foliation defined by biotite flakes and flattened quartz grains.

The Irving Pond Fm. is the uppermost unit in the stratigraphy of the southern Adirondacks. Its present thickness is close to 1000 meters, and it is exposed across strike for approximately 4000 meters. Throughout this section massive quartzites dominate.

Recently Eckelmann (pers. comm.) has studied zircon population morphologies in the Rooster Hill and similar lithologies. His results strongly suggest an igneous plutonic origin. This would be consistent with the igneous origin assigned the Hermon granite of the northwest Adirondacks - a rock that is markedly similar to the Rooster Hill.

<u>Mileage</u>

20.0 Low roadcut in kinzigites of Tomany Mt. Fm.

21.4 Avery's Hotel on west side of NY Rt. 10

22.5 Long roadcuts of quartzofeldspathic gneisses and metasediments of Lake Durant Fm. intruded by metagabbro and anorthositic metagabbro.

23.6 Roadcut of anorthositic metagabbro and metanorite.

23.9 Roadcut on west side of highway shows excellent examples of anorthositic gabbros intrusive into layered pink and light green quartzo-feldspathic gneisses. The presence of pegmatites and cross-cutting granitic veins is attributed to anatexis of the quartzo-feldspathic gneisses by the anorthositic rocks.

24.0 **<u>Stop #5</u>**. Lake Durant and Sacandaga Fms. intruded by anorthositic gabbros and gabbroic anorthosites.

These roadcuts are located on Rt. NY 10 just south of Shaker Place.

The northernmost roadcut consists of a variety of metasedimentary rocks. These lie directly above the Piseco anticline and are believed to be stratigraphically equivalent to the Sacandaga Formation. The outcrop displays at least two phases of folding and their related fabric elements. These are believed to be F_2 and F_3. A pre-F_2 foliation is thought to be present. Both axial plane foliations are well developed here. Several examples of folded F_2 closures are present and F_2 foliations (parallel to layering) can be seen being folded about upright F_3 axial planes.

Farther to the south, and overlooking a bend in the west branch of the Sacandaga River, there occurs a long roadcut consisting principally of pink and light green quartz-perthite gneiss belonging to the Lake Durant Fm. About half-way down this roadcut there occurs a large boudin of actinolitic and diopsidic gneiss. To the north of the boudin the quartzo-feldspathic gneisses are intruded pervasively by anorthositic gabbros, gabbroic anorthosites, and various other related igneous varieties. At the north end of the cut and prior to the metastratified sequences these intrusives can be seen folded by upright fold axes. They are crosscut by quartzo-feldspathic material.

Within this general region the Lake Durant Fm. and other quartzo-feldspathic gneisses seem to have undergone substantial anatexis. This is suggested by the "nebular" aspect of the rocks. Good examples of this are seen in the manner in which green and pink portions of the quartzo-feldspathic gneisses mix. Note also the clearly cross-cutting relationships between quartzofeldspathic gneiss and mafic layers at the south end of the roadcut. Here it seems that mobilized Lake Durant is cross-cutting its own internal stratigraphy. Also note that the quantity of pegmatitic material is greater than usual. This increase in anatectic phenomena correlates closely with the appearance of extensive metagabbroic and metanorthositic rocks in this area. It is believed that these provided a substantial portion of the heat that resulted in partial fusion of the quartzo-feldspathic country rock.

Mileage

31.0 Red-stained basal quartzofeldspathic gneisses that have been faulted along NNE fractures.

31.5 Junction NY Rt. 10 and NY Rt. 8. End Rt. 10. Turn east on NY Rt. 8.

33.0 **Stop #6.** Core rocks of the Piseco anticline.

Hinge line of Piseco anticline near domical culmination at Piseco Lake. The rocks here are typical basal quartzo-feldspathic gneisses such as occur in the Piseco anticline and in other large anticlinal structures, for example Snowy Mt. dome, Oregon dome.

The pink "granitic" gneisses of the Piseco anticline do not exhibit marked lithologic variation. Locally grain size is variable and in places megacrysts seem to have been grain size reduced and only a few small remnants of cores are seen. The open folds at this locality are minor folds of the F_3 event. Their axes trend N70W and plunge 10-15° SE parallel to the Piseco anticline. Co-axial F_2 isoclines are also present.

The most striking aspect of the gneisses in the Piseco anticline is their well-developed lineation. This is expressed by rodding and ribbon fabrics. These may consist of alternating ribbons of quartz, quartzo-feldspathic gneiss, and biotite-rich layers. In some instances the rods represent transposed layering on the highly attenuated limbs of early, isoclinal minor folds. Near the northeast end of the roadcut such minor folds are easily seen due to the presence of more massive layers in the rock. Slabbed and polished specimens from this and similar outcrops demonstrates that these early folds are exceedingly abundant in the Piseco anticline. Examination of these folds shows that the dominant foliation in the rock is axial planar to them.

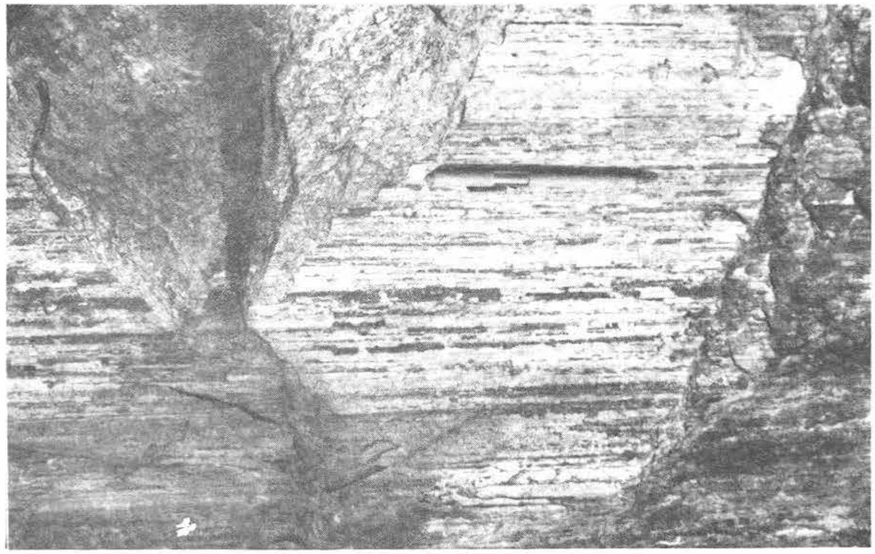

Fig. 8a. Example of ribbon lineation on a foliation surface of quartzofeldspathic gneiss of the Piseco anticline. The dark ribbons are quartz and the light ones K-feldspar.

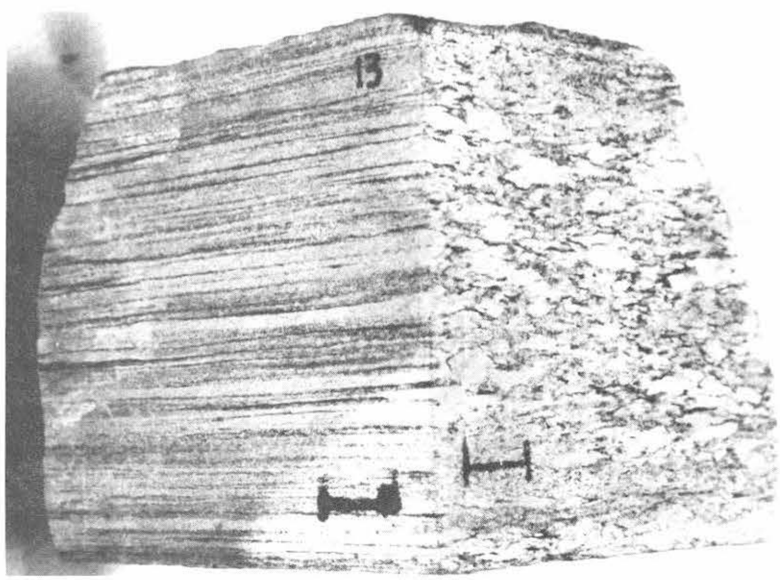

Fig. 8b. Quartzo-feldspathic gneiss of Piseco anticline cut perpendicular to foliation and parallel to lineation (left face) as well as perpendicular to lineation (right face). Note the elongation of the light colored K-feldspar augen in the direction of lineation. Bar markers are 1 cm long.

Fig. 9. The development of tails on K-feldspar augen in a gneiss less deformed than shown in Fig. 8. The face shown is perpendicular to foliation but parallel to lineation. The tails suggest a sinistral shear sense. The bar marker is 1 cm long.

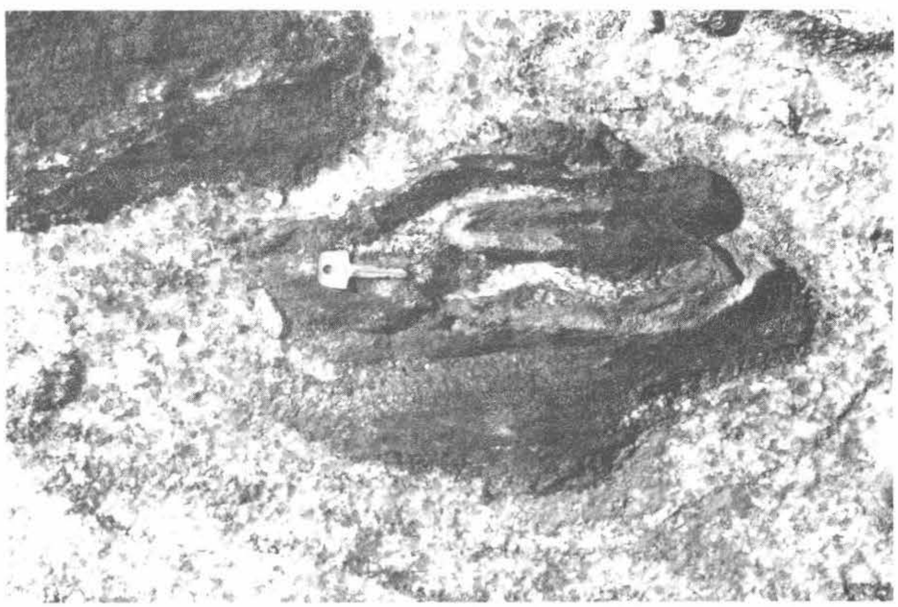

Fig. 10. Sheath fold developed in calcsilicate band in marble. Steep, down dip lineation visible on right hand side. Key is 5 cm long.

The lineation in these outcrops is shown in Fig. 8a while slabbed sections are shown in Figs. 8b,c. Fig. 8b is cut perpendicular to foliation and both parallel to (left face) and perpendicular to (right face) lineation. As can be seen K-feldspar augen have been elongated in the direction of lineation. Together with elongated quartz aggregates, these grain size reduced minerals form the prominent mineral lineation that characterizes foliation surfaces (Fig. 8a). Note that the K-feldspar augen exhibit shapes closer to equant on the right hand face at perpendicular to lineation. This strongly suggests that the rock fabric is the result of rotational strain in the direction parallel to lineation, i.e., the lineation is an elongation, or stretching type. Fig. 9 shows a less deformed sample slabbed perpendicular to foliation and parallel to lineation. The development of tails on K-feldspar augen are clearly visible. These are the result of grain size reduction during ductile rotational strain. A sinistral (east over west) sense of motion is indicated. At more extreme conditions of strain the K-feldspar augen and quartz aggregates are drawn into ribbons as in the present outcrop. Long dimensions of 40-60 cm are common along with thicknesses of a millimeter, or less. Clearly strain has been extreme and elongations of 30-40 times are not unusual.

Ribbon gneiss origin by rotational strain is also suggested by the parallelism between lineation and F_2, F_3 fold axes. It is believed that these fold axes were drawn into parallelism with the lineation by ductile, rotational strain directed from east to west. The most satisfactory mechanism for this configuration is the stacking of thrust sheets and thrust nappes during plate collision. Thrusts have been recognized to the east of Lake George (Fig. 4) and others probably exist although the intense, ductile nature of the deformation has resulted in extremely subtle truncations that are difficult to recognize. Sheath folds (Fig. 10) with tube axes parallel to lineation are consistent with this model. Presumably crustal thickening during the Grenville Orogeny was caused by the stacking of these thrusts.

Mileage

43.5 Junction NY Rt. 8 and NY Rt. 30 in Speculator. Head southeast on NY Rt. 8-30.

47 **Stop #7.** Northern intersection of old Rt. NY 30 and new Rt. NY 30, 3.3 miles east of Speculator, New York.

The Blue Mt. Lake Fm. is exposed in roadcuts on both sides of the highway. These exposures show typical examples of the extreme ductility of the carbonate-rich units. The south wall of the roadcut is particularly striking, for here relatively brittle layers of garnetiferous amphibolite have been intensely boudinaged and broken. The marbles, on the other hand, have yielded plastically and flowed with ease during the deformation. As a result the marble-amphibolite relationships are similar to those that would be expected between magma and country rock. Numerous rotated, angular blocks of amphibolite are scattered throughout the marble in the fashion of xenoliths in igneous intrusions. At the eastern end of the outcrop tight isoclinal folds of amphibolite and metapelitic gneisses have been broken apart and rotated. The isolated fold noses that remain "floating" in the marble have been aptly termed "tectonic fish." The early, isoclinal folds rotate on earlier foliation.

Near the west end of the outcrop a deformed layer of charnockite is well exposed. In other places the charnockite-marble interlayering occurs on the scale of one to two inches.

Exposed at several places in the roadcut are cross-cutting veins of tourmaline and quartz displaying a symplectic type of intergrowth. Other veins include hornblende and sphene bearing pegmatites.

Commonly included in the Blue Mt. Lake Fm., but not exposed here, are quartzites, kinzigites; sillimanite rich, garnetiferous, quartz-microcline gneisses; and fine grained garnetiferous leucogneisses identical to those characterizing the Sacandaga Fm. These lithologies may be seen in roadcuts .5 mile to the south.

Almost certainly these marbles are of inorganic origin. No calcium carbonate secreting organisms appear to have existed during the time in which these carbonates were deposited ($>$ 1 b.y. ago). Presumably the graphite represents remains of stromatolite-like binding algae that operated in shallow water, intertidal zones. If so, the other roadcut lithologies formed in this environment as well. This seems reasonable enough for the clearly metasedimentary units such as the quartzites and kinzigites. The shallow water environment is much more interesting when applied to the charnockitic and amphibolite layers. The fine scale layering, and ubiquitous conformity of these, strongly suggests that they do not have an intrusive origin. Perhaps they represent the metamorphosed products of volcanic material in a shelf like environment. Such intercalation is now occurring in many island arc areas where shallow water sediments cover, and in turn are covered by, ash and lava. Alternatively they may represent metasediments. A large number of minerals are developed within these outcrops. Both calcite and minor dolomite are present in the carbonate horizons. These are accompanied by green diopside and serpentinized forsterite as well as by tourmaline, grpahite, and variosu sulfides. In calcsilicate horizons phlogopite, diopside (white), and tremolite occur. Wollastonite is locally present. The presence of tremolite and wollastonite is believed to be a function of the relative concentration of CO_2 and H_2O in the vapor phase (Valley et al., 1983).

Mileage

47.5 Extensive roadcuts in lower part of Blue Mt. Lake Fm. Quartzites, kinzigites, and leucogneisses dominate. Minor marble and calcsilicate rock is present.

47.9 Large roadcuts in lower Lake Durant Fm. Pink, well-layered quartzo-feldspathic gneisses with subordinate amphibolite and calcsilicate rock.

49.0 **Stop #8.** One half mile south of southern intersection of old Rt. 30 and with new Rt. 30.

On the west side of the road small roadcut exposes an excellent example of Adirondack anorthositic gneiss intermediate in character between the so-called Marcy type (coarse) and the Whiteface type (fine grained). About 50% of the rock consists of fine grained crystals of andesine plagioclase. Some of these crystals appear to have measured from 6-8" prior to grain size reduction. Excellent moonstone sheen can be seen in most crystals. In places ophitic to subophitic texture has been preserved with the mafic phase being represented by orthopyroxene.

In addition to the anorthosite there exists a clearly cross-cutting set of late iron-rich orthopyroxene rich dikes containing xenoliths of coarse grained anorthosite. The latter may represent a late mafic differentiate related to cotetic liquids responsible for the ophitic intracrystalline rest magma. This would be consistent with the iron enrichment trend characteristic of Adirondack igneous differentiation.

Near road level there can be found several inclusions of calcsilicate within the anorthositic rocks. These are believed to have been derived from the Cedar River Fm. and are consistent with a non-basement status for the anorthosite.

The upper, weathered surface of the outcrop affords the best vantage point for studying the textures and mineralogy of the anorthositic rocks. In several places there can be seen excellent examples of garnet coronas of the type that are common throughout Adirondack anorthosites. These coronas are characterized by garnet rims developed around iron-titanium oxides and pyroxenes. Recently McLelland and Whitney (1977) have succeeded in describing the development of these coronas according to the following generalized reaction:

Orthopyroxene + Plagioclase + Fe-bearing oxide + quartz =
garnet + clinopyroxene.

This reaction is similar to one proposed by de Waard (1965) but includes Fe-oxide and quartz as necessary reactant phases. The products are typomorphic of the garnet-clinopyroxene subfacies of the granulite facies (de Waard 1965). The application of various geothermometers to the phases present suggests that the P,T conditions of metamorphism were approximately 8 Kb and 700 ± 50°C respectively.

Mileage

51.0 Cedar River Fm. Minor marble, amphibolite, and calcsilicate rock. Predominantly very light colored sillimanite-garnet-quartz-K-feldspar leucogneisses.

52.0 Junction NY Rt. 8 and NY Rt. 30. Continue south on NY Rt. 30. To the west of the intersection are roadcuts in leucogneisses of the Blue Mt. Lake Fm. A large NNE normal fault passes through here and fault breccias may be found in the roadcut and the woods beyond.

52.5 Entering Little Moose Mt. Fm. on northern limb of the Glens Falls syncline. Note that dips of foliation are to the south.

54.8 Entering town of Wells which is situated on a downdropped block of lower Paleozoic sediments. The minimum displacement along the NNE border faults has been determined to be at least 1000 meters.

58.3 Silver Bells ski area to the east. The slopes of the ski hill are underlain by coarse anorthositic gabbro intrusive into the Blue Mt. Lake Fm.

60.3 Entrance to Sacandaga public campsite. On the north side of NY Rt. 30 are quartzo-feldspathic gneisses and calcsilicate rocks of the Lake Durant Fm. An F_1 recumbent fold trends subparallel to the outcrop and along its hinge line dips become vertical.

60.8 Gabbro and anorthositic gabbro.

62.0 **Stop #9.** Pumpkin Hollow.

Large roadcuts on the east side of Rt. 30 expose excellent examples of the Sacandaga Fm. At the northern end of the outcrop typical two pyroxene-plagioclase granulites can be seen. The central part of the outcrop contains good light colored sillimanite-garnet-microcline-quartz gneisses (leucogneisses). Although the weathered surface of these rocks are often dark due to staining, fresh samples display the typical light color of the Sacandaga Fm. The characteristic excellent layering of the Sacandaga Fm. is clearly developed. Note the strong flattening parallel to layering and the lineation developed on many foliation surfaces. These gneisses are similar to so-called straight gneisses found in proximity to ductile shear zones. The Sacandaga Fm. may represent mylonitic rocks of this type and its layering may, in fact, be tectonic.

Towards the southern end of the outcrop calc-silicates and marbles make their entrance into the section. At one fresh surface a thin layer of diopsidic marble is exposed. NO HAMMERING PLEASE. Many "punky" weathering layers in the outcrop contain calc-silicates and carbonates.

At the far southern end of the roadcut there exists an exposure of the contact between the quartzo-feldspathic gneisses of the Piseco anticline and the overlying Sacandaga Fm. The hills to the south are composed of homogeneous quartzofelds-pathic gneisses coring the Piseco anticline (note how ruggedly this massive unit weathers). The Sacandaga Fm. here has a northerly dip off the northern flank of the Piseco anticline and begins its descent into the southern limb of the Glens Falls syncline.

No angular discordance or other indications of unconformity can be discerned at the base of the Sacandaga Fm. However, this does not preclude the prior existence of an angular discordance which may have been swept into pseudoconformity by tectonism.

Along most of the roadcut there can be found excellent examples of faults and associated pegmatite veins. Note that the drag on several of the faults gives conflicting senses of displacement. The cuase of this is not known to the author. Also note the drag folds which indicate tectonic transport towards the hinge line of the Piseco anticline.

Mileage	
62.5-67.0	All exposures are within the basal quartzo-feldspathic gneisses at the core of the Piseco anticline.
67.0	Re-enter the Sacandaga Fm. Dips are now southerly.
68.0	In long roadcuts of southerly dipping quartzo-feldspathic gneisses of Lake Durant Fm.
70.4	Cross bridge over Sacandaga River.
74.4	Bridge crossing east corner of Sacandaga Reservoir into Northville, New York.

END LOG

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