TRIP AB-2

BEDROCK GEOLOGY OF THE GRAMPUS LAKE AREA, LONG LAKE QUADRANGLE, NEW YORK

Page Fallon
Department of Geology and Geography, University of Massachusetts, Amherst, MA

INTRODUCTION

What follows is a brief description of the geology of the Grampus Lake area. These are the preliminary results of a study conducted under the guidance of Professor Leo M. Hall at the University of Massachusetts. The map area lies in the southwest part of the Long Lake quadrangle and includes a portion of the southeast corner of the Tupper Lake quadrangle (see Figure 1). Previous work in the area was done by Cushing (1907) in the Long Lake quadrangle and Buddington and Leonard (1962) in the Tupper Lake quadrangle.

Stratigraphy

Stratified rocks in the Grampus Lake area include quartz-rich calcareous gneisses, quartzites, and subordinate amounts of pelitic gneisses and marbles, locally interlayered with granitic gneisses. These rocks overlie a basal gneiss, undivided in this study, which includes granitic, charnockitic and syenitic gneisses. Metamorphosed intrusive rocks are abundant in the area (see Figure 2).

Basal gneiss

This unit consists of undivided granitic, charnockitic, and pyroxene syenitic gneisses. The granitic gneiss is a pinkish gray or tan weathering hornblende-biotite-othoclase-microperthite granitic gneiss. It is commonly felsic, with less than four percent dark minerals, and is poorly foliated. The pyroxene microperthite syenitic gneiss is well foliated. It weathers orange, buff, or tan. Aggregates of feldspar and quartz, or microperthite augen lie in the foliation. An orange brown rind or "maple sugar" brown weathering is common. A well foliated charnockitic gneiss is present in the basal gneisses. This is a deeply weathering orange-brown or gray gneiss. Lenses of coarse quartz and feldspar are aligned in the foliation. A biotite-antiperthite gneiss weathers gray, pink, or tan and is poorly foliated. It is commonly equigranular. Locally abundant feldspar augen are present.

Interlayered granitic and quartz granular gneisses

The basal gneisses are overlain by pink weathering, locally garnetiferous granitic gneisses interlayered with subordinate amounts of quartz granulites. The granitic gneisses occur in well-foliated or layered textures and in more massive equigranular textures. Layers of pink and white-weathering feldspar, coarse quartz which forms ribs on the outcrop

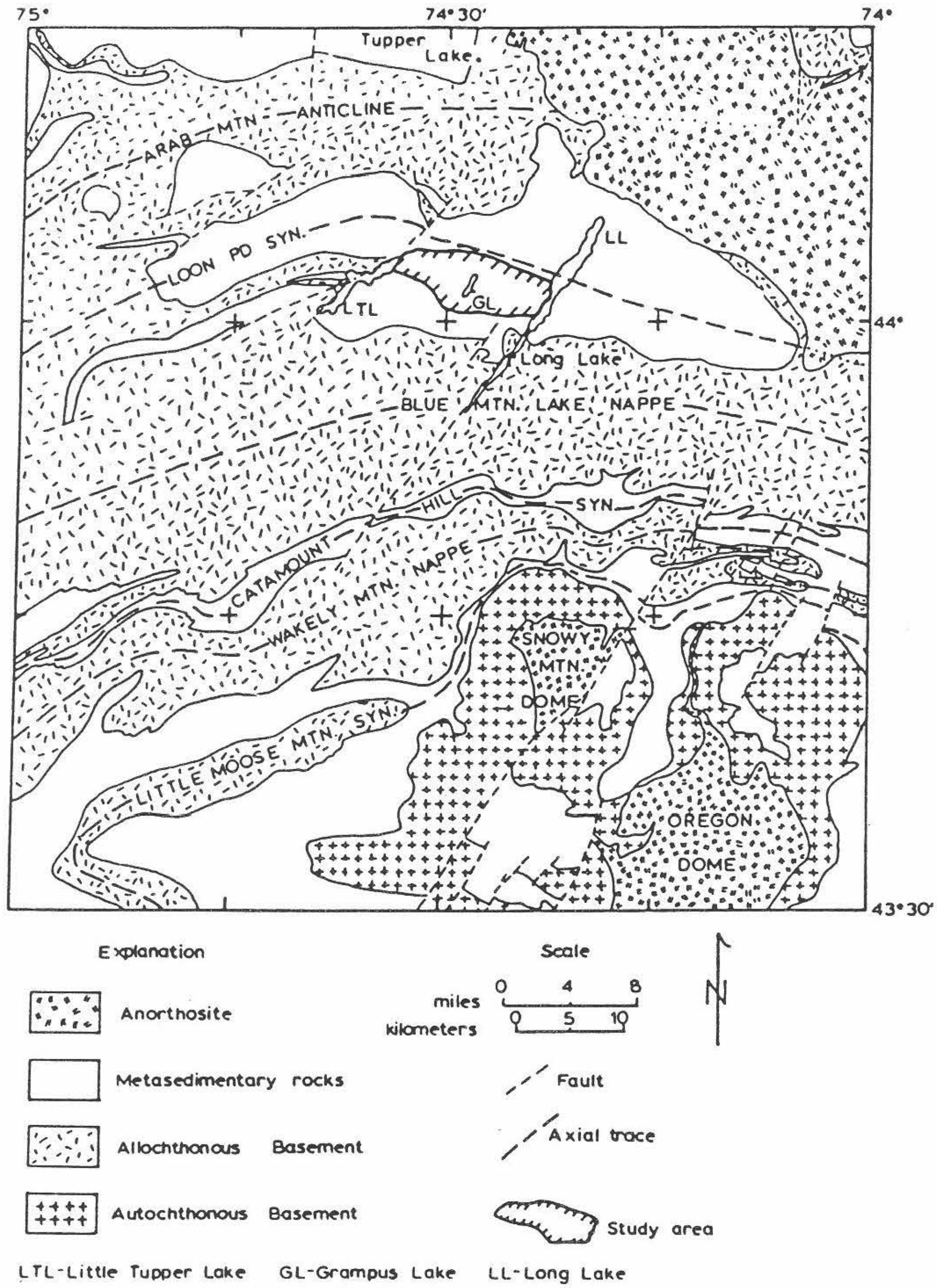

Figure 1. Generalized regional geology of a portion of the central Adirondacks. Compiled from Walton and DeWaard (1963), Fisher et al. (1971), McLelland and Isachsen (1980), Turner (1980), and Ollila (pers. comm., 1981).

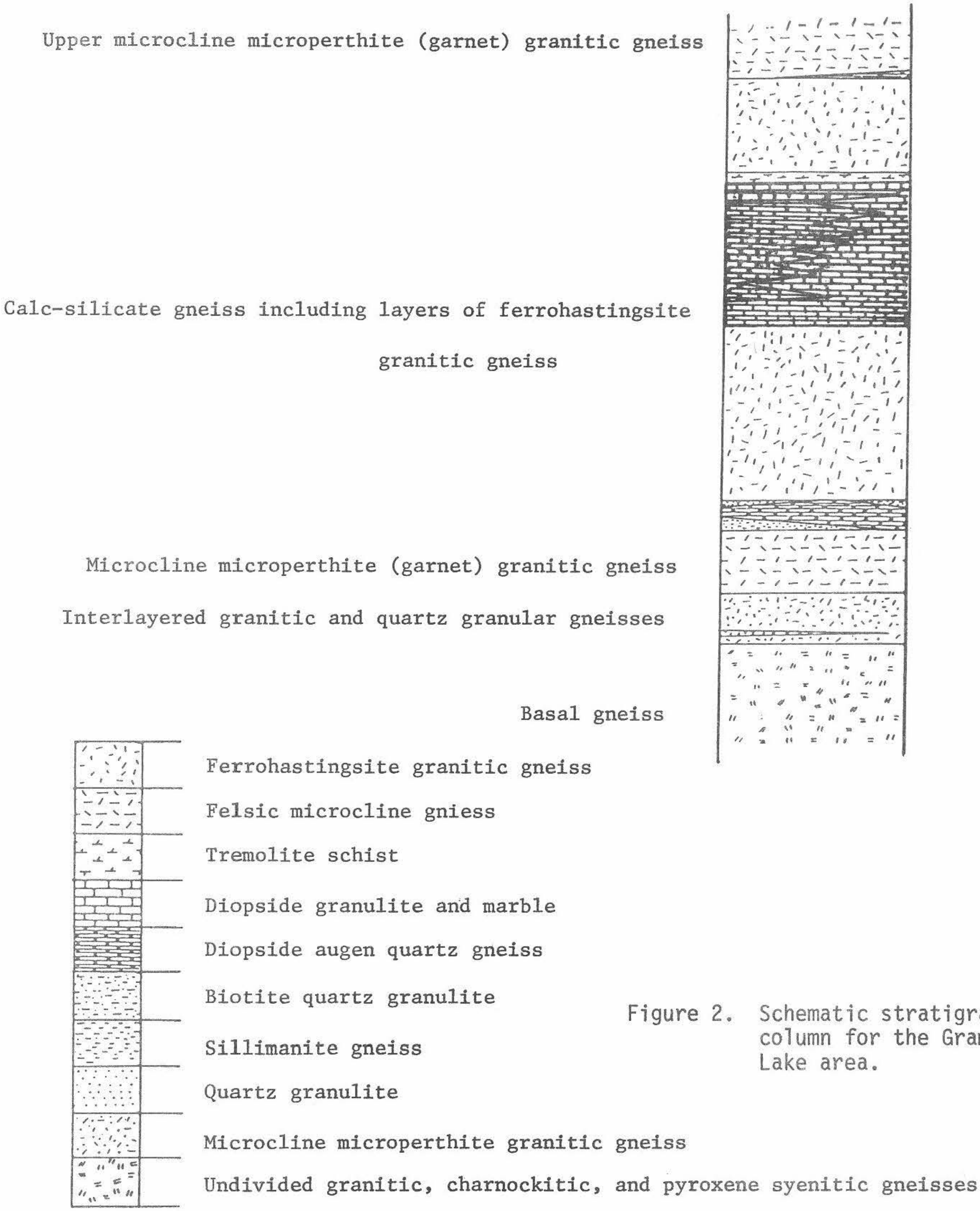

Figure 2. Schematic stratigraphic column for the Grampus Lake area.

surface, and anastomosing layers of hornblende are locally present. Thin amphibolites are locally present, as are leaves of bluish-gray quartz in the felsic gneisses. The massive granitic gneiss is a moderately fine-grained equigranular rock.

Microcline microperthite (garnet) granitic gneiss

This gneiss weathers pink, brown, or gray. A moderately fine-grained equigranular texture is most common. This texture consists of interlocking microcline and quartz grains with tiny disseminated garnet present locally. In places the gneiss assumes a more granitic, even pegmatitic, appearance. Augen of pink microcline and coarse leaves of bluish quartz are locally present.

Calc-silicate gneisses

The most abundant lithic type in the calc-silicate gneisses is diopside augen quartz gneiss. Diopside augen, commonly several centimeters long, weather into the outcrop leaving a characteristic rough network of quartz selvages. Glassy quartzites, of similar mineralogy but lacking diopside augen, are also present. Scapolite is common in this rock. Wollastonite is rare. Diopside granulites are abundant in the upper part of the unit. These are commonly buff or rusty weathering, poorly foliated rocks consisting of diopside and microcline, diopside and quartz, or diopside and calcite. Microcline augen are present locally. Gray weathering gneisses consisting of diopside and phlogopite and others consisting of tremolite, phlogopite, and diopside are found in the upper part of the unit. Rare outcrops of very coarse marbles and of sugary textured, fine-grained marbles are present. Minor biotite-feldspar-quartz granular gneiss is present in the lower part of the unit. This is a fine-grained rock which weathers black and commonly is thinly layered. Sillimanite-rich gneisses are also present in the lower part of the unit.

Upper microcline microperthite (garnet) granitic gneiss

This is a felsic, pink weathering, poorly foliated gneiss. Small amounts of biotite and locally hornblende are present. The gneiss is locally garnetiferous. In places interlayered quartz granulites are present.

Metamorphosed Igneous Rocks

General Statement

Metamorphosed plutonic igneous rocks include ferrohastingsite granitic gneiss, pyroxene quartz syenitic and augite syenitic gneisses, well foliated pyroxene gneiss, pyroxene (garnet) gneiss, gabbroic gneiss, and andesine augen dioritic gneiss. All are moderately to well foliated and commonly appear concordant to bedding and the early foliation in the stratified rocks.

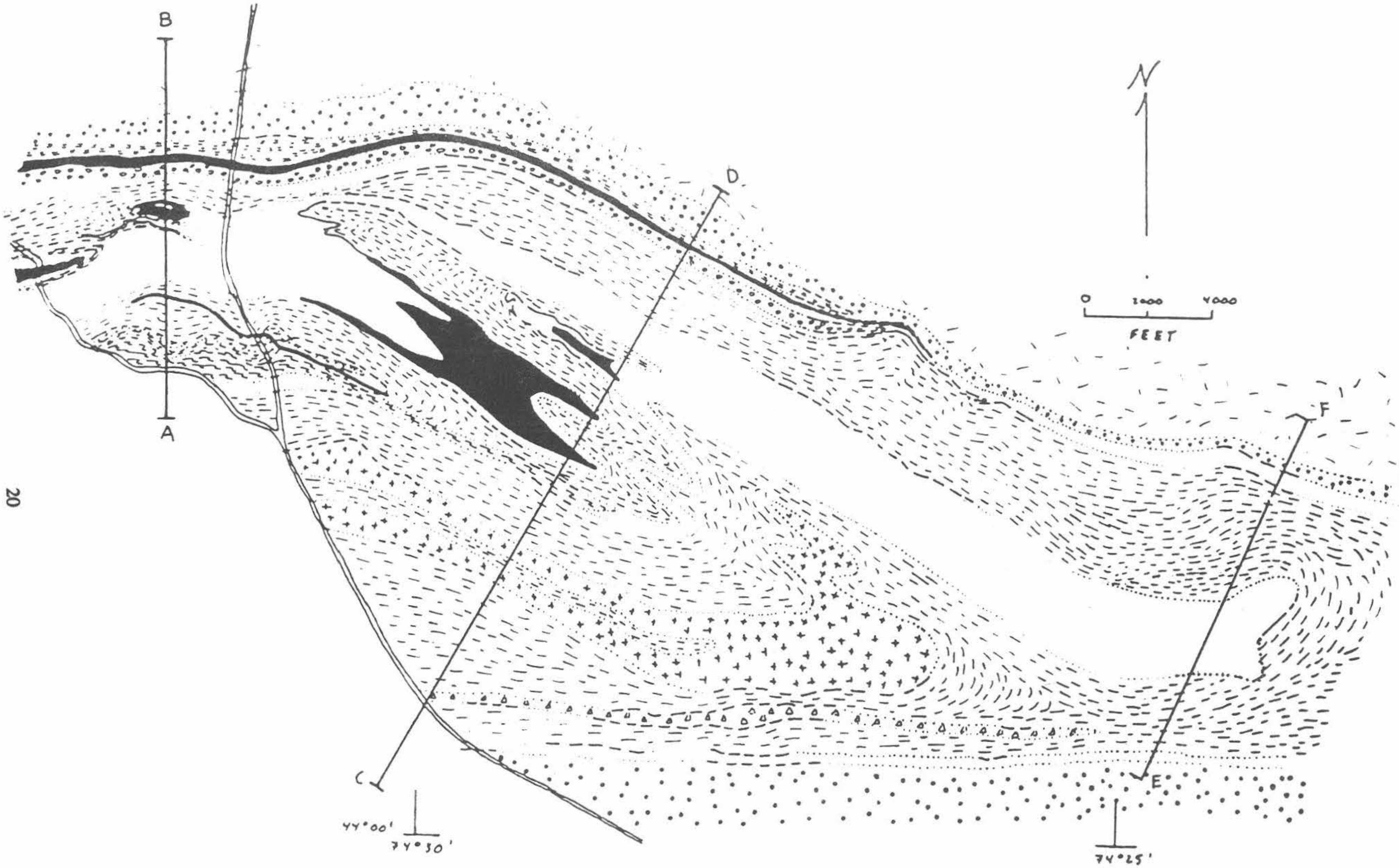

Figure 3. Geologic map of the Grampus Lake area.

Stratified Rocks

- Upper microcline microperthite (garnet) granitic gneiss
- Calc-silicate gneisses
- Lower microcline microperthite (garnet) granitic gneiss
- Interlayered granitic and quartz granular gneisses
- Basal gneisses

Contacts: Known

Approximate

Inferred

Generalized local strike and dip of bedding or regional foliation 60

Intrusive Rocks

- Andesine augen dioritic gneiss
- Well foliated pyroxene gneiss
- Pyroxene (garnet) gneiss
- Augite syenitic gneiss
- Pyroxene quartz syenitic gneiss
- Ferrohastingsite granitic gneiss

Figure 3. (continued) Explanation of geologic map.

Ferrohastingsite granitic gneiss

This is a moderately to poorly foliated pink, tan, or gray weathering gneiss. Sparse biotite is an additional mafic mineral. Augen of microperthite under 1 cm in diameter are common. Where observed, the contacts and foliation in the granitic gneiss are parallel to the compositional layering or foliation in the metamorphosed sedimentary rocks, which is associated with the early deformation.

Pyroxene quartz syenitic gneiss

A hornblende ± augite ± hypersthene syenitic or quartz syenitic gneiss. The rock weathers white or tan and displays the characteristic "maple sugar" brown weathered rind. K-feldspar is orthoclase microperthite or mesoperthite which is olive green on a fresh surface. A strong linear fabric of coarse hornblende is locally present. The foliation in this gneiss is folded by third phase hinges, therefore the intrusion of the syenite must have occurred before or during the second phase of deformation.

Augite syenitic gneiss

The augite syenitic gneiss is a gray weathering moderately well foliated gneiss which commonly contains abundant discontinuous layers of coarse feldspar. A felsic and locally massive granitic gneiss is locally interlayered in the syenitic gneiss. Where both are present, an apparent gradational relationship obscures the distinctions between the two. The augite syenitic gneiss, however, is more strongly foliated, has a higher color index, and commonly shows dark colored feldspar, either dark greenish brown or reddish brown, on a fresh surface. The granitic gneiss is commonly more massive, more felsic, and lighter in color on a fresh surface. The augite syenitic gneiss predates third phase deformation.

Gabbroic gneiss

The gabbroic gneiss is a black weathering rock which contains plagioclase, augite, and hypersthene in a subophitic texture. Hornblende, biotite, and garnet form corona textures. Massive and well foliated varieties are present. Thin sheets of gabbroic gneiss are present in the basal gneiss and are not shown on the geologic map. The contacts of the gabbroic gneiss locally truncate the regional foliation.

Pyroxene (garnet) gneiss

The garnetiferous variety is a white and black weathering moderately well foliated rock. Clots of pinhead garnets 1 cm to 3 cm across are common. Plagioclase and hornblende are commonly equigranular and medium grained. Angular augen of plagioclase are present locally. The variety which lacks garnet contains elongate patches of fine grained black hornblende and augite which weather out in slight relief against the white, equigranular andesine. Centimeter size augen of andesine are present.

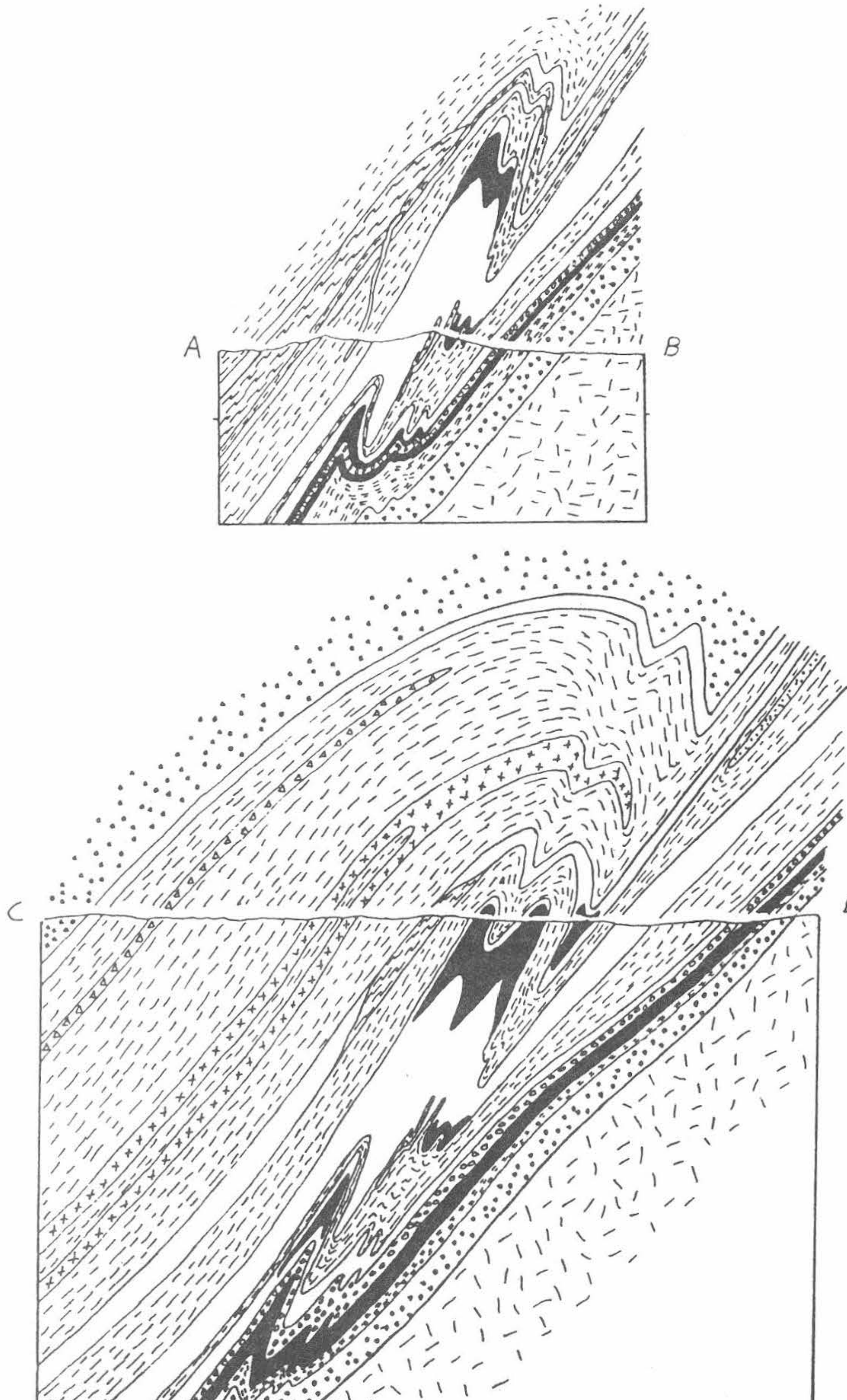

Figure 4. Geologic cross sections.

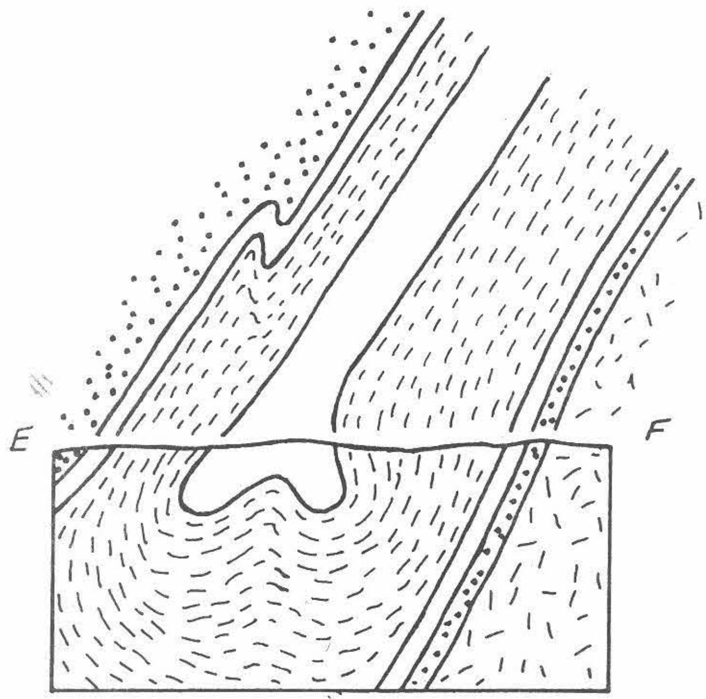

Figure 4. Continued.

Well foliated pyroxene gneiss

The well foliated pyroxene gneiss is black and tan weathering, locally with a pinkish caste. More mafic portions weather black and orange while felsic parts are beige. This unit is characterized by strong foliation and locally abrupt variation in color index. The timing of intrusion of this gneiss is uncertain.

Andesine augen dioritic gneiss

A black and white weathering, well foliated hornblende ± augite andesine dioritic gneiss which commonly intrudes as thin layers and in thicker layers which are shown on the geologic map. White weathering augen of andesine commonly comprise up to thirty percent of the rock. Hornblende is the major dark mineral, clinopyroxene is subordinate, and orthopyroxene is locally present. A thin sheet of this gneiss truncates a second phase fold. The gneiss appears to predate third phase deformation.

Structural Geology

General Statement

The geologic map and structure sections of the Grampus Lake area are dominated by the hook patterns formed by interference of second and third phase folds (see Figures 3 and 4). Gentle folding on northerly trending axial surfaces is late. Evidence of four phases of folding has been observed in the area.

No map scale early fold has been observed in the study area. The prominent regional foliation is axial planar to minor first phase folds. These folds are tight isoclinal folds with narrow, pointed profiles.

Second phase folds are isoclinal folds in the regional foliation which have rounded hinges and lack a prominent axial plane feature. Second phase axes plunge moderately to the south at high angles to the trend of the axial surfaces. The Rock Pond Syncline is a major second phase fold with an axial trace 20 km long within the area (see Figure 5).

Third phase folds have tightly appressed profiles and an intense axial plane foliation developed locally in the hinge area. Axes plunge gently southeast. Axial surfaces trend west or northwest and dip steeply south. The prominent convex up shape of the structure (see Figure 4) and the local trends of contacts and foliations are due to the third phase folds.

Fourth phase folds are locally developed, low amplitude folds with open parallel profiles. Axial surfaces trend northerly and have steep dips. Local changes in plunge are caused by fourth phase folding.

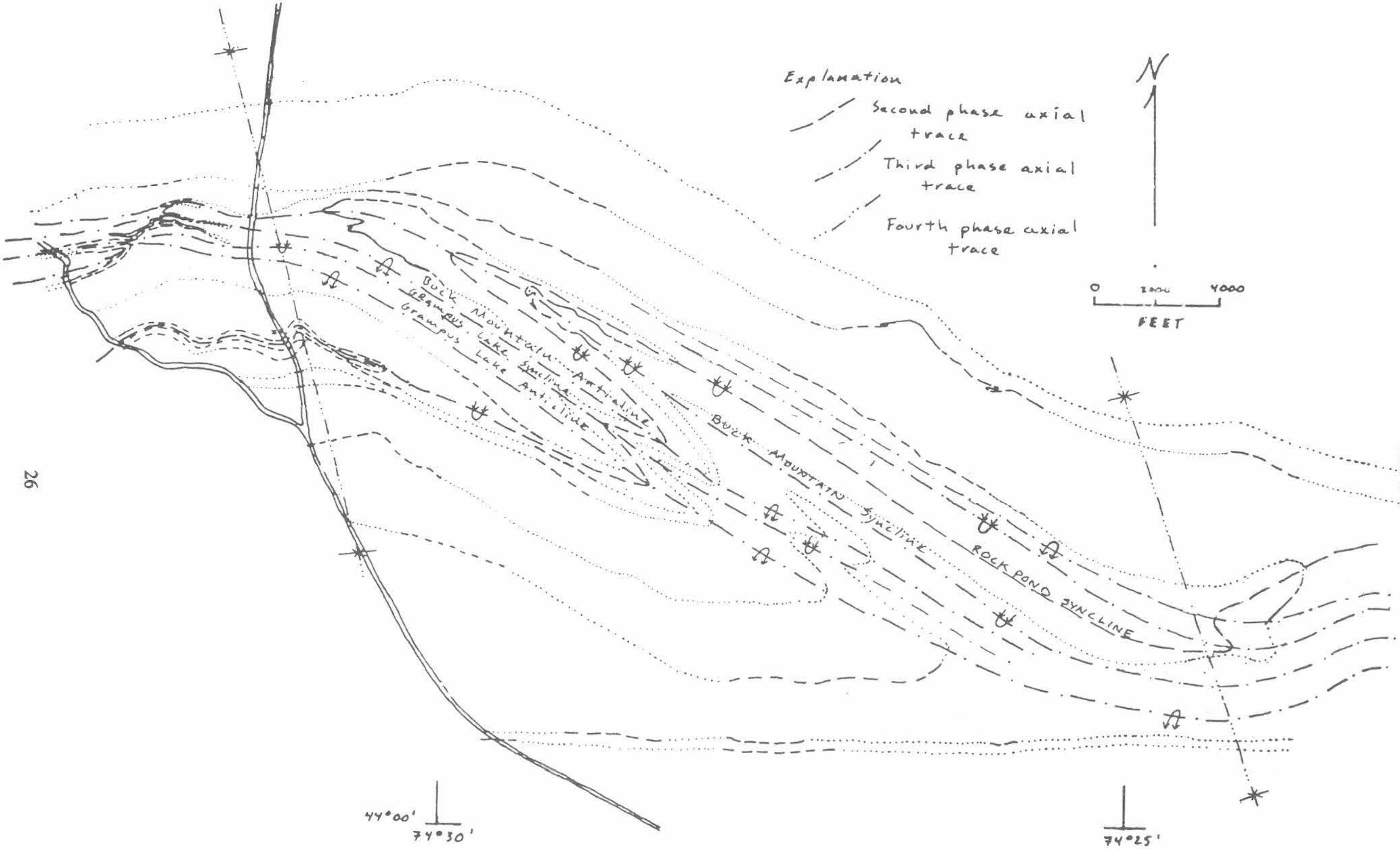

Figure 5. Generalized geologic map showing locations of axial traces of major local folds.

Major Folds

Map-scale folds of the second, third, and fourth phases are present in the area. The Rock Pond Syncline is a large second phase fold. The limbs of this fold dip moderately to steeply south and the axes plunge south or southwest. The fold is approximately reclined over much of the area. The axial trace of this fold is shown on Figure 5. In the east, the core of fold is occupied by diopside granulites. Further west and higher in the section, diopside quartz gneisses become more abundant. The fold is refolded by third phase folds in the central part of the area (Figures 3 and 4). The granitic gneiss which occupies the core of the fold in this region is interpreted as a folded layer, thinner on the southern limb of the fold than on the northern. A thin layer of quartzites and diopside quartz gneisses sporadically occurs between the granitic gneiss and the overlying microcline microperthite (garnet) granitic gneiss which lies in the core of the Rock Pond Syncline in the western part of the area.

Pairs of synclines and anticlines associated with third phase folding have axial traces which cross the area from northwest to southeast (see Figure 5). These folds have axial surfaces which dip steeply south and axes which plunge gently southeast. In the center of the map area a hook pattern results from interference of third phase folds and the Rock Pond Syncline. The convex-up shape of the structure and the orientations of strikes and dips in the area are due to third phase deformation (see Figure 4).

The axial traces of only two fourth phase folds are shown on Figure 5. Other map scale fourth phase folds are known or inferred in places. These folds dip steeply to moderately southwest. Plunges to the south are due to the orientation of the regional foliation. In this interpretation, fourth phase folds are responsible for gradual changes in strike of bedding and foliation shown on the geologic map (Figure 3).

Metamorphism

Mineral assemblages present in the rocks of the Grampus Lake area record metamorphism in the intermediate pressure granulite facies (Green and Ringwood, 1967). Temperature estimates of 730 ± 30°C have recently been made by garnet-clinopyroxene exchange thermometry on a sample from the nearby Newcomb quadrangle (Johnson _et al_. 1983). Pressures of 7.7 ± 1 kb have been estimated from the _equilibrium_ forsterite + anorthite = garnet in the metagabbro from the Newcomb quadrangle (Johnson and Essene, 1982). Mineral assemblages in the study area are consistent with these estimates. Undersaturated rocks contain the assemblage clinopyroxene-almandine, consistent with the clinopyroxene almandine isograds of Buddington (1963) and DeWaard (1968). Sillimanite is the stable aluminosilicate. Kyanite has not been found. The assemblage diopside-calcite-quartz is common in the calc-silicate gneiss. The assemblage wollastonite-calcite-quartz is observed at one locality (Stop 1). Disequilibrium textures present there suggest that wollastonite may have formed at fairly constant, moderate temperatures as fluid composition became progressively more water rich. The same assemblage with the addition of graphite and sulfides is present at another location (Stop 2). The buffering effect graphite exerts on fluid composition suggests a possible lower limit of temperature, given a pressure (Figure 6).

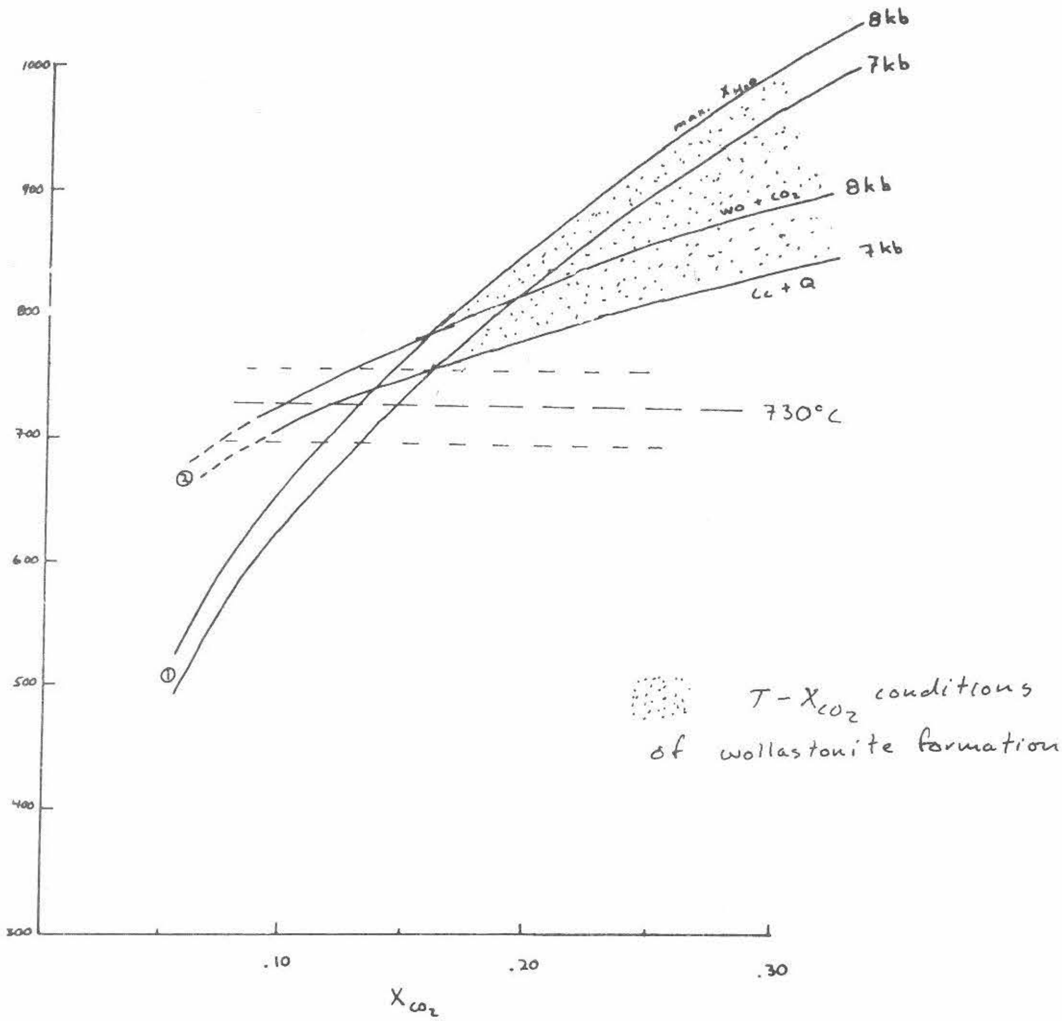

Figure 6

1.) Ohmoto and Kerrick, (1977). 2.) calculated from data of Yu. P. Mel'nik (1972) and G. B. Skippen, (1977). 3.) Johnson et al., (1983).

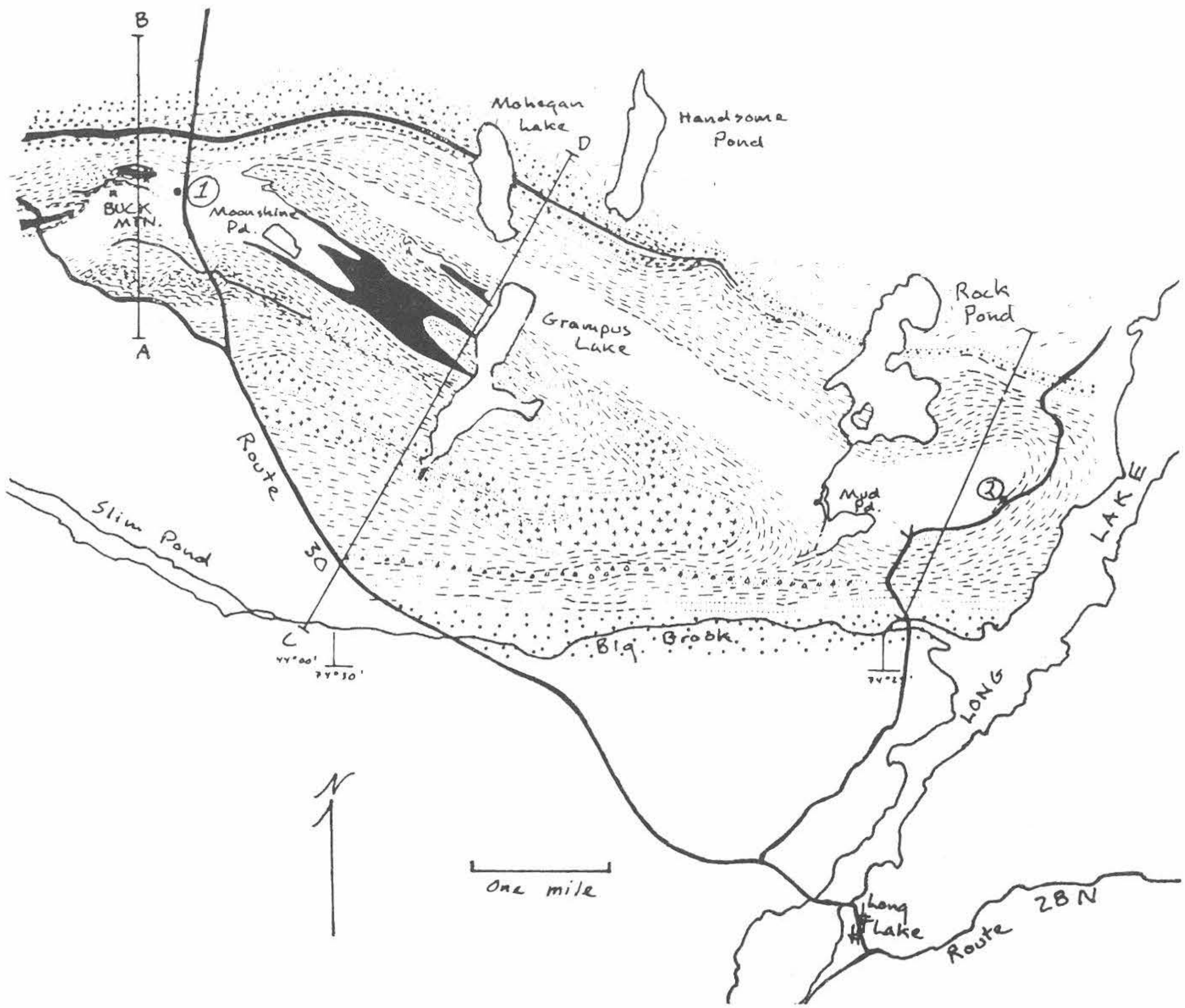

Figure 7. Field trip stops in the Grampus Lake area.

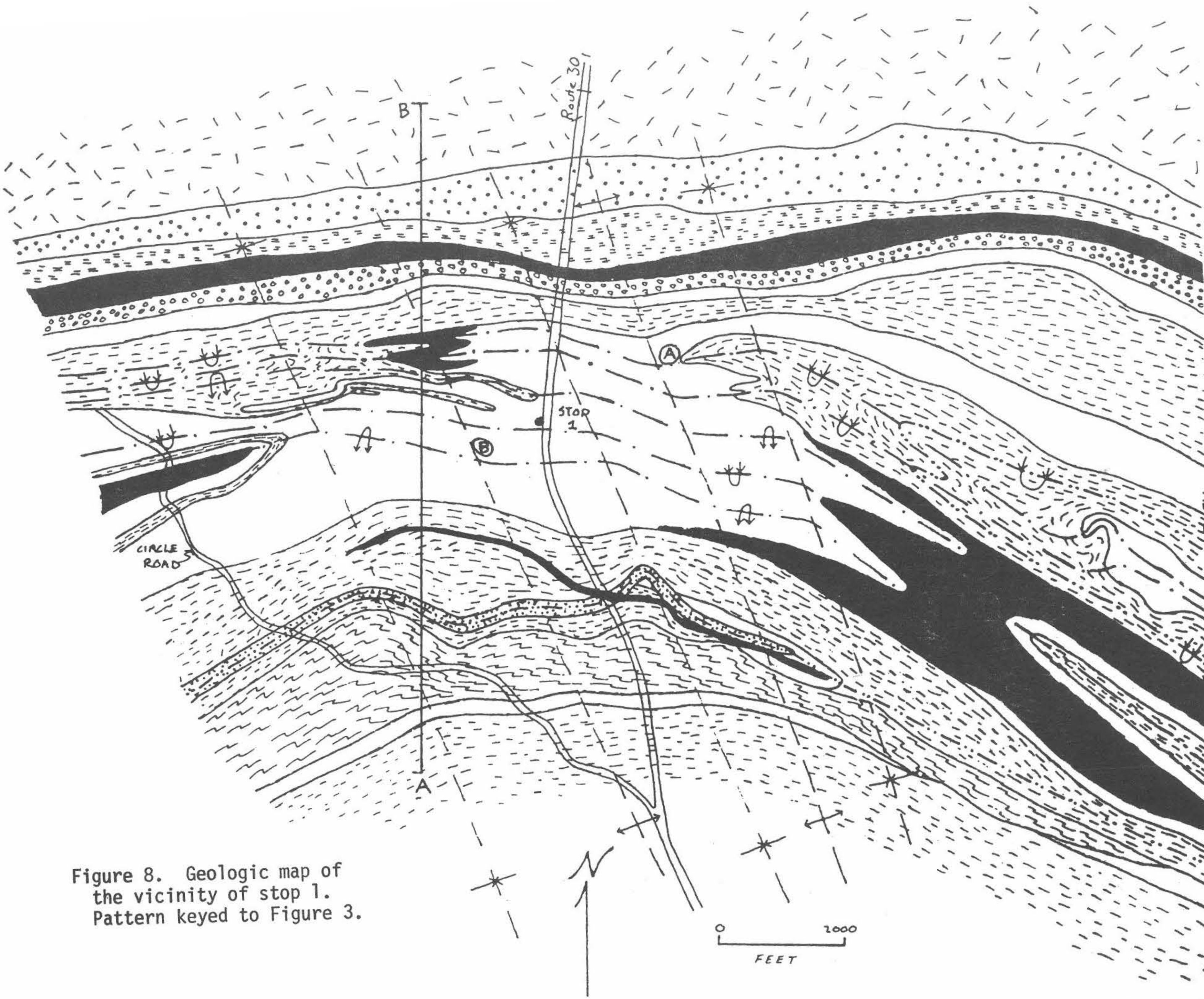

Figure 8. Geologic map of the vicinity of stop 1. Pattern keyed to Figure 3.

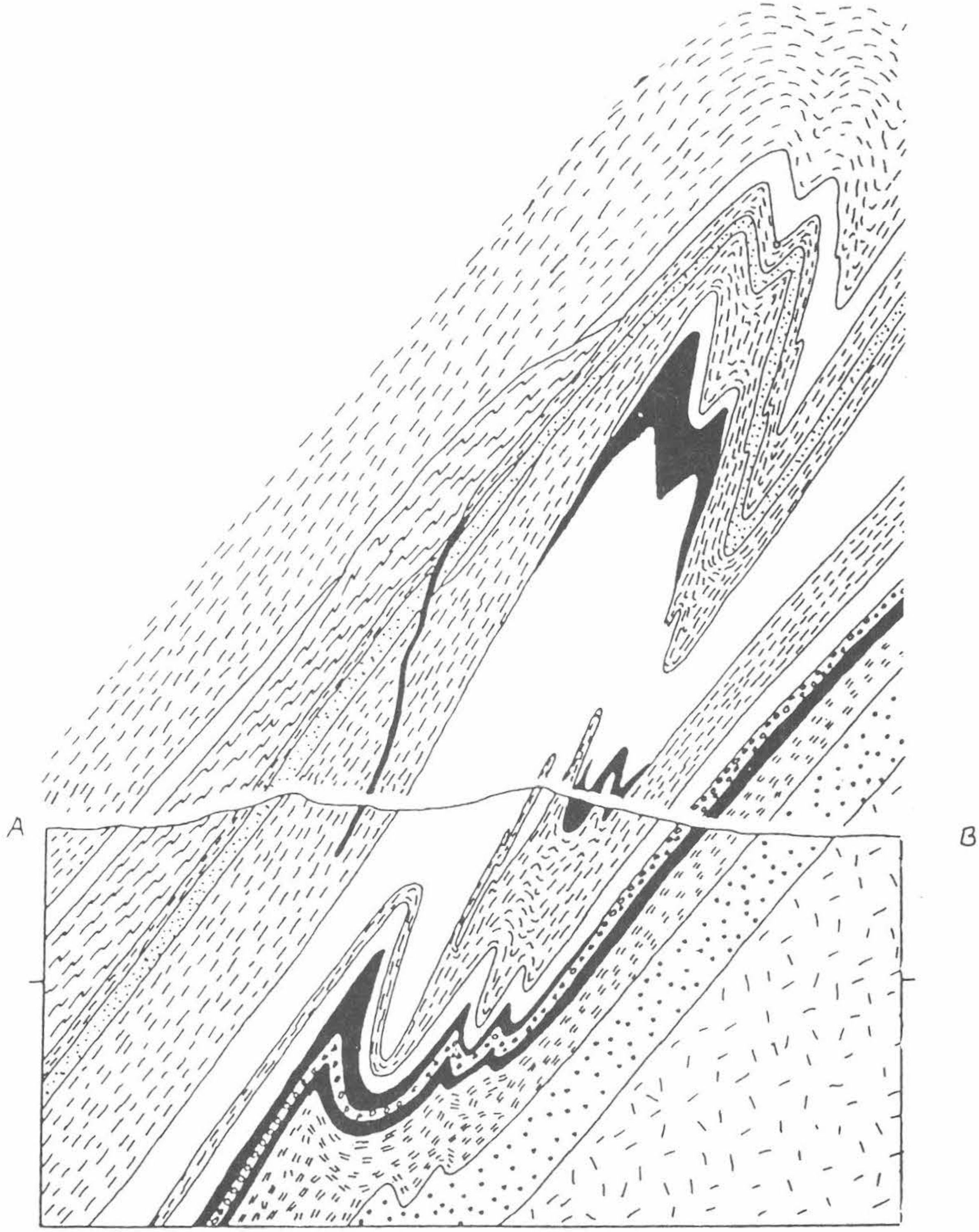

Figure 9. Cross section A-B to accompany Figure 8.

REFERENCES

Buddington, A. F., and Leonard, B. F., 1962, Regional geology of the St. Lawrence County magnetite district, northwest Adirondack, New York: U. S. Geological Survey Professional Paper 376,145 p.

Buddington, A. F., 1963, Isograds and the role of H_2O in metamorphic facies of orthogneisses of the northwest Adirondack area, New York: Geological Society of America Bulletin, v. 74, p.1155-1182

Cushing, H. P., 1907, Geology of the Long Lake quadrangle: New York State Museum Bulletin 115, pp.451-531.

DeWaard, D., 1968, Threefold division of the granulite facies in the Adirondack Mountains: Krystalinikum v. 7, p. 85-93

Fisher, D. W., Isachsen, Y. W., and Rickard, L. V., 1971, Geologic Map of New York: New York State Museum and Science Service Map and Chart Series, no. 15: 1;250,000

Green, D. H., and Ringwood, A. E., 1967, An experiemntal investigation of the gabbro to eclogite transformation and its petrological applications: Geochimica Cosmochimica Acta, v. 31, p. 767-833

Johnson, C. A., and Essene, E. J., 1982, Formation of garnet in olivine-bearing metagabbros from the Adirondacks: Contributions to Mineralogy and Petrology, v. 81, p. 240-251

Johnson, C. A., Bohlen, S. R., and Essene, E. J., 1983, An evaluation of garnet-clinopyroxene geothermometry in granulites: Contributions to Mineralogy and Petrology, v. 84, p. 191-198

McLelland, J., and Isachsen, Y. W., 1980, Structural synthesis of the central and southern Adirondacks: A model for the Adirondacks as a whole and plate tectonic interpretations: Geological Society of America Bulletin, Part II, v. 91, pp. 208-292.

Mel'nik, Yu. P., 1972, Thermodynamic parameters of compressed gases and metamorphic reactions involving water and carbon dioxide: Geochemistry International, v. 9, pp. 419-426.

Ohmoto, H., and Kerrick, D., 1977, Devolatization equilibria in graphitic systems: American Journal of Science, v. 277, pp. 1013-1044.

Skippen, G.B., 1977, Dehydration and decarbonation equilibria in Short Course in Applications of Thermodynamics to Petrology and Ore Deposits, H. J. Greenwood, ed. 1977, Mineralogical Association of Canada Short Course Handbook, v. 2, April, 1977

Turner, B. B., 1980, Polyphase Precambrian deformation and stratigraphic relations, central to southeastern Adirondack Mountains, New York: A reinterpretation: Geological Society of America Bulletin, Part II, v. 91, p. 293-325

Walton, M.S., and De Waard, D., Orogenic evolution of the Precambrian in the Adirondack Highlands, a new synthesis, Koninkl, Nederl, Akademie van Wettenschappen-Amsterdam, Ser. B., v. 66, pp. 98-106

Road Log

Distance given in miles from last stop in Potter's log.

Miles

0.0 Proceed south on Route 30.

2.7 Buck Mountain Fold Complex

This stop offers the opportunity to see the diopside augen quartz gneiss and other quartz rich gneisses and well exposed examples of second and third phase folds.

Road Cuts: Glassy quartzites and diopside augen quartz gneiss with small sparse diopside augen are exposed on the western side of Route 30. The small outcrop on the eastern side of the highway contains a few large dark green diopside porphyroblasts.

1-A.) Buck Mountain Syncline. Walk east from the highway 600 feet down the logging road. Bear left at a small cabin onto an overgrown skidder trail. Walk 1000 feet approximately N45E along a contour. The outcrop on the steep slope to the southeast exposes the hinge of the Buck Mountain Syncline, a large third phase fold (see figs. 8 and 9). This is a tight fold which plunges moderately to the southeast on a northwest trending, steeply south dipping axial surface.

1-B.) Proceed west from the highway on an overgrown trail from the south end of the western road cut for about 1000 feet. Turn north and climb the hill to a large pavement outcrop.

The rock is typical diopside augen quartz gneiss. The augen which have weathered out, giving the rock this distinctive texture, are large single crystals or aggregates of smaller grains of green to white diopside. Scapolite is common. Minor K-feldspar, and traces of calcite, sphene, and zoisite are present.

A second phase isoclinal fold, outlined by a thin amphibolite, is refolded by a tight third phase fold, forming a hook interference pattern. Note the lack of an axial plane foliation in the hinge of the second phase fold. A more prominent axial plane feature is present in the hinges of third phase folds. Other folds, and a nice view to the south, are visible higher on the hill.

Return to highway and proceed south.

7.0 Turn left at Cheerio's Cabins.

10.0 Bear right at the three-way intersection.

10.8 Stop 2. Rock Pond Syncline

The low outcrop to the left is a buff weathering diopside granulite which contains, in addition to diopside, calcite, plagioclase, and minor microperthite and quartz. Sulfides are present and graphite is abundant.

The structure of this area is poorly understood. The Rock Pond Syncline closes around the calcsilicate gneisses just to the northwest. Refolding in the third phase produced north-side up folds (see fig. 4, Section E-F). The inappropriate rotation sense of the third phase fold is attributed to original curvature of the hinge line of the Rock Pond Syncline. Late folding about northwest trending axial surfaces causes local changes in the direction of plunge of the third phase fold.

End of road log.

Thank you for comments and criticisms.