Trip AB-2

CROSS SECTION OF THE LOON POND SYNCLINE, TUPPER LAKE QUADRANGLE, NEW YORK

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INTRODUCTION

This field trip crosses the Loon Pond Syncline, an area mapped during the summers of 1978, 1979, and 1980 under the direction of Leo Hall at the University of Massachusetts. The syncline, a northeast-trending elongate basin, was named and first mapped by Buddington and Leonard (1962) as the northeast part of the Bog River Synclinorium (Figure 1). The syncline occupies most of the southern half of the fifteen minute Tupper Lake Quadrangle, which lies in the central Adirondacks within the Adirondack Highlands region. The Arab Mt. Anticline, composed of charnockitic gneisses, lies to the north, and the Salmon Lake Anticline lies to the south (Figure 1).

The stratigraphy of the syncline is distinctive. In contrast to most of the Adirondack Highland rocks which are chiefly orthogneisses and anorthosite, a great deal of quartzite, marble, and calc-silicate rock as well as quartzofeldspathic gneisses constitute the rocks here. In this respect the rocks of the Loon Pond area are similar to those of the Northwest Lowlands (Figure 1). Erosion of the multiply deformed rocks has exposed a structural basin which shows some similarity to the Darning Needle Syncline in the Cranberry Lake Quadrangle (Leavell, 1977).

Access: Route 10, linked to Route 30 by Route 10A, extends west across the field area to the old Sabattis Railroad station and provides the primary access to the sparsely populated region (Figure 2). With the exception of a clear area south of Sabattis that burned in 1903, the region is heavily wooded. Topographic relief is about 800 feet.

STRATIGRAPHY

General Statement. The Precambrian rocks of the Loon Pond Syncline have been divided into basement, cover, and intrusive rocks. The basement is formed by the East Charley Pond Gneiss, a hornblende-quartz-perthite rock (Figure 3). The overlying cover rocks are inferred to be of sedimentary and volcanic origin, and their interpreted relative ages, from oldest to youngest, are the Little Charley Pond Formation, the Bear Pond Gneiss, and the Lost Pond Marble.

There are two igneous plutons in the field area: the East Charley Pond Gneiss composes one and the Otter Pond Dioritic Gneiss the other. Their stratiform and generally conformable geometry helps to define the overall structure of the area. Some of the isolated bodies of the Otter Pond Dioritic Gneiss are due to erosion of the multiply deformed rocks. It can be shown at outcrop and map scale that all of the older rocks were intruded by the Otter Pond Diorite prior to the first phase of deformation. Intrusion persisted beyond F, and ceased prior

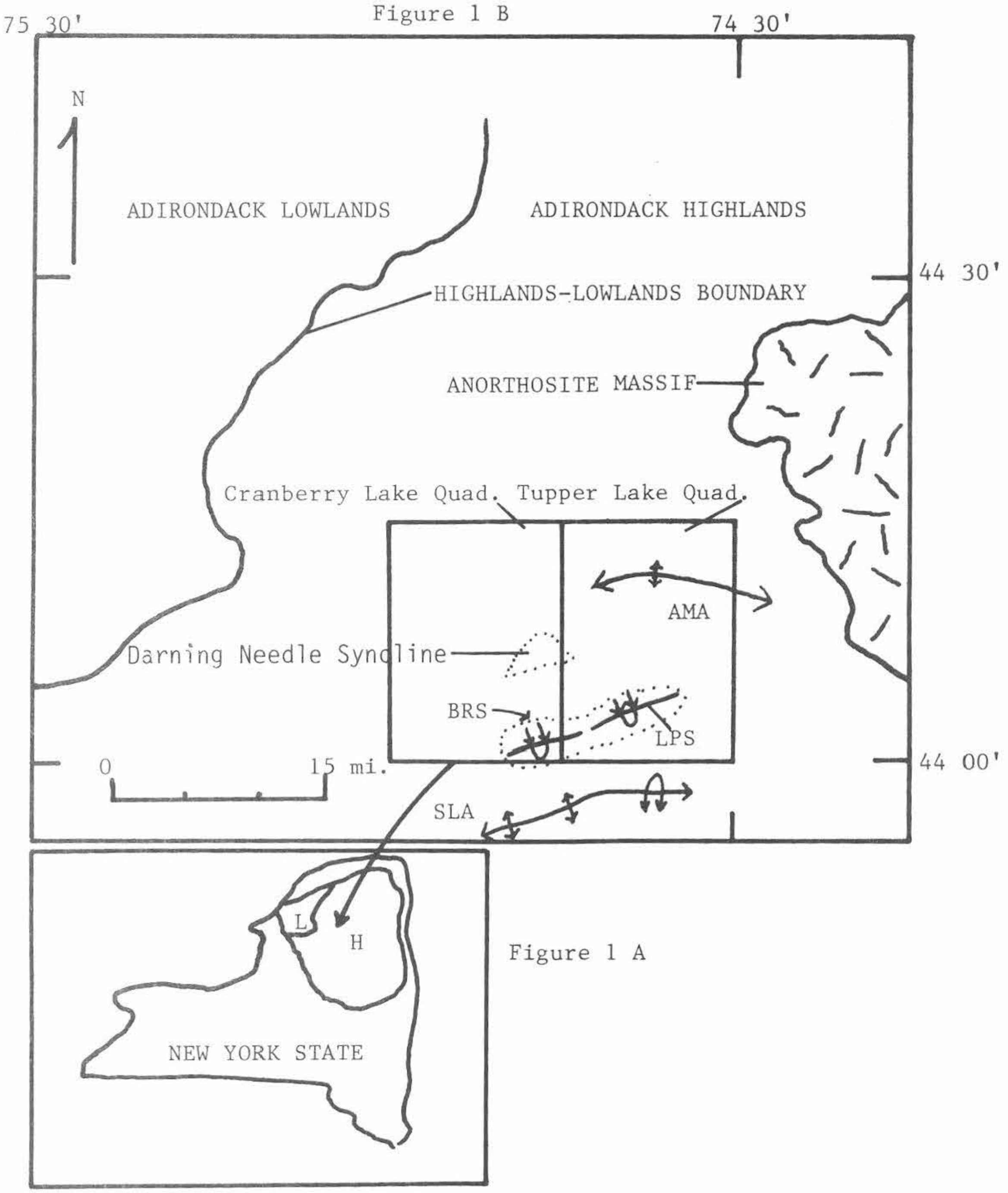


Figure 1 A. Index map of New York State and the Adirondacks. Highland and Lowland divisions of the Adirondacks are noted.

Figure 1 B. The Arab Mountain Anticline lies in the northern half of the Tupper Lake Quadrangle. The Bog River Synclinorium is enclosed by a dotted line (BRS), and the northeastern half of the BRS is the Loon Pond Syncline (LPS). The Salmon Lake Anticline (SLA) lies south of the Tupper Lake Quadrangle.

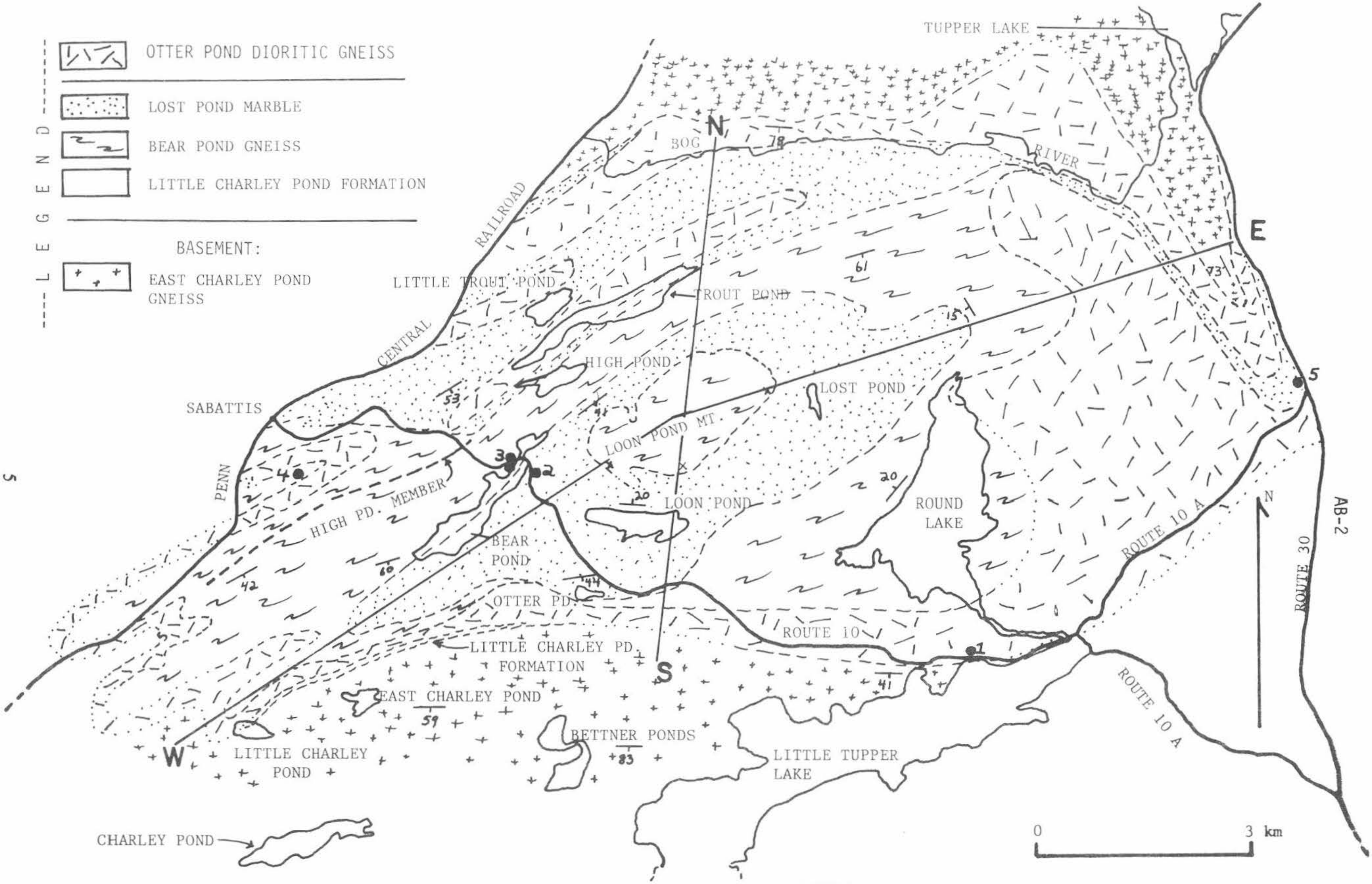
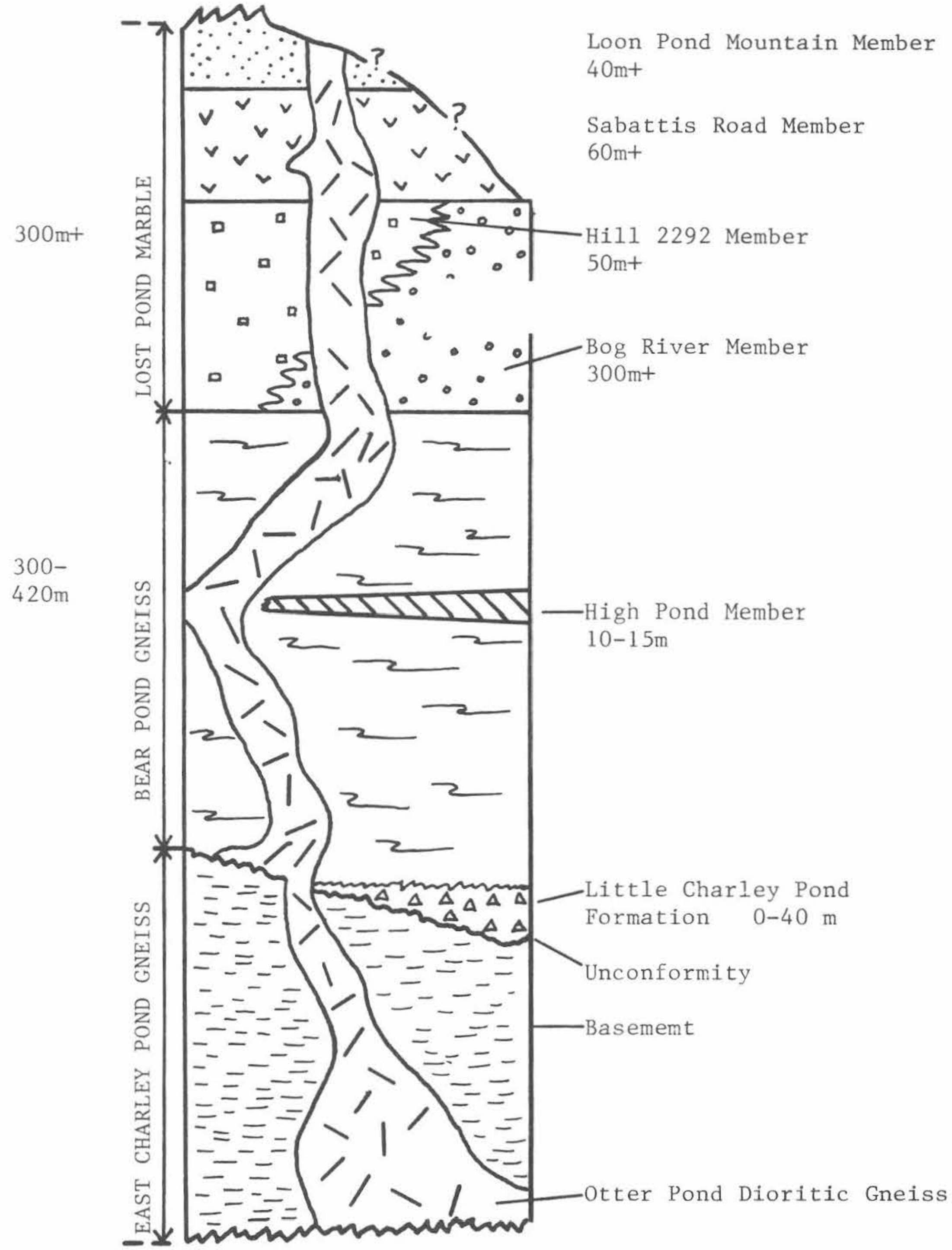


FIGURE 2

Figure 2. Generalized geologic map of the Loon Pond Syncline. Field trip stops along Routes 10 and 10 A are numbered.

Figure 3. Columnar section of rocks in the Loon Pond Syncline area. Relative ages are interpreted on the basis of structural position



to F_2. There is less compelling evidence for the igneous nature of the East Charley Pond Gneiss because crosscutting relationships are absent. The best evidence for an igneous origin are the homogeneous nature of the rock, the rather uniform rock texture and some partially assimilated quartz-rich sedimentary layers.

Several generations or a continuous sequence of granitic pegmatites are present throughout the area. The rocks are common in outcrop but not volumetrically significant. Most are a few cm thick and only a few are thicker than 10 m. They crosscut some second phase folds and are deformed by second phase folds in other places.

The structural interpretation of large-scale early folds in this area is based upon the repetition of the formations and intrusive rocks, and thus the accurate identification and local correlation of units is of greatest importance.

Basement: East Charley Pond Gneiss. This granitic igneous rock is a biotite-magnetite-plagioclase-hornblende-quartz-perthite gneiss with minor garnet in places. It is a ridge former and is exposed on some of the highest hills near East Charley Pond. The rock is considered to be basement, and no thickness has been determined. Outcrops are massive, poorly jointed, and have a homogeneous mineralogy. Coarse pink perthite commonly forms more than half of the rock, and where this occurs outcrops weather dull white or pink. Where hornblende content is more than a few percent the rock may weather brown.

A few thin veins and lenses of pegmatite with compositions similar to the rest of the pluton were noted. The thin pegmatite bodies are almost invariably parallel to foliation.

In many localities foliation is poorly developed or absent. In these places the rock has a coarse homogeneous porphyritic texture with large megacrysts of perthite. Foliation within the gneiss, well developed at some locations, was produced during the first phase of deformation.

Cover Rocks: Little Charley Pond Formation. This interlayered quartzite and diopsidic marble is exposed only in the southern portion of the field area in the vicinity of Little Charley Pond. The formation is up to 40 m thick and thins to zero both east and west along strike. The lower half of the formation consists of 12-18 cm-thick quartzites interbedded with 2-5 cm-thick beds of calcite-diopside-quartz granulite. A distinct foliation is formed by curved wisps of calcite strung out within the quartz matrix.

The upper part of the formation, more deeply pitted by weathering, is a diopsidic marble with scattered .5 m-thick beds of quartzite. This upper portion of the formation is relatively difficult to trace along strike.

Bear Pond Gneiss. The Bear Pond Gneiss, up to 420 m thick, overlies the Little Charley Pond Formation. It is extensively exposed and contains the High Pond Member. The gneiss is named for its excellent exposures at the type locality on the northwest shore of Bear Pond and along Route 10 to the west over a distance of .4 km. By correlation it is inferred to underlie the central and eastern summits of Loon Pond Mountain, and it also occurs as a layer of varied thickness that rings the central portion of the syncline. The rock is absent south of Loon Pond because of the intrusion of the Otter Pond Dioritic Gneiss.

The formation is composed of several different quartz-microcline gneisses with magnetite. Plagioclase, biotite, garnet and sillimanite are commonly present but do not occur in all of the rocks. Muscovite and chlorite are common secondary minerals.

Due to the resistance of various rock types to weathering, the Bear Pond Gneiss produces a variety of topographic features including high ridges, lakes, ponds, and swamps.

The High Pond Member, 10-15 m thick, is predominantly a quartz-rich granulite with a sugary texture. The rock contains magnetite, pyrite, garnet, biotite, sillimanite, quartz, and microcline. Where the pyrite content is high, the rock weathers a rich brown. These granulite beds of the High Pond Member closely resemble the Hill 2292 member of the Lost Pond Marble.

A garnet-quartz-augite-microcline gneiss, less commonly found in this member, is present in small dark-colored boudins. In several locations the contact between the High Pond Member and the Bear Pond Gneiss is transitional, with thin layers of augitic gneiss present in the Bear Pond Gneiss a few meters from the High Pond Member.

Lost Pond Marble. This formation, youngest of the cover rocks, overlies the Bear Pond Gneiss and is named for exposures near Lost Pond. It is divided into four members which from the base upward are: 1) the Bog River Member, a calcite-quartz-clinopyroxene marble with the type locality along the Bog River, 2) the Hill 2292 Member, a sillimanite-microcline-quartz granulite with the type locality along the steep southern slopes of Loon Pond Mountain, 3) the Sabattis Road Member, interbedded coarse graphitic marble, diopside-calcite granulite, and thin-bedded quartzites with the type locality .5 km east of Bear Pond along Route 10 (Stop 2), and 4) the Loon Pond Mountain Member consisting of massive pyritic quartzites. Not all of the members are laterally continuous (Figure 3).

The Lost Pond Marble forms two broad areas of outcrop, one surrounding Loon Pond Mountain and the other in a broad arc that includes Little Trout Pond (Figure 2). With the exception of the massive quartzite unit the formation is characterized by low topographic relief, and many of the swamps in the area are underlain by this marble-rich formation.

Intrusive Rocks: Otter Pond Dioritic Gneiss. This intrusive unit, named for its exposures along the high ridge west of Otter Pond, is extensively distributed throughout the field area. The diorite is exposed in map-scale folds in the southwestern part of the area and has a large areal exposure east of Round Lake. In addition, there are small bodies of dioritic gneiss scattered throughout the area whose discontinuous nature and spatial distribution suggest an igneous origin. The gneiss is a ridge former; outcrops are large and the rock is commonly massive. First described by Buddington and Leonard (1962), the unit has a much greater exposure than that shown on their map.

All of the rocks contain plagioclase, hornblende, and magnetite. Quartz is present in almost all of the thin sections, and biotite is also common. Other minerals not always present include augite, hypersthene, cummingtonite, and garnet. Modes for samples collected near Stop 1 appear in the Road Log.

Fresh samples are dark green, and the rock weathers to a black and white, salt and pepper texture where hornblende and pyroxene compose only a few modal percent. As mafic content increases, weathered surfaces are dark-brown and black. Foliation is well developed to absent. In most outcrops a fair to good foliation is defined by alternate layers of mafic and felsic minerals, and in some outcrops the foliation gives way to a strong lineation. In several locations foliation is absent, and rocks have a granitic texture.

Although the Otter Pond Diorite is concordant with surrounding units in most areas, crosscutting relationships can be demonstrated both at outcrop and map scales. On the ridge west of Otter Pond the hornblende gneiss cuts across the Bear Pond Gneiss at a low angle to layering. At Stop 1 along Route 10, a dike of hornblende diorite cuts the older, foliated dioritic gneiss.

METAMORPHISM

Regional metamorphism in the Loon Pond Syncline area is of the hornblende-granulite facies. Silver (1968) demonstrates that rocks now exposed in the Highlands underwent granulite-facies metamorphism between 1100 and 1020 million years ago. McLelland and Isachsen (1980) suggest that the metamorphism was caused by a doubling of crustal thickness that accompanied the Grenville Orogeny.

Timing of Metamorphism With Respect to Deformation. The dominant foliation, present nearly everywhere except near F_2 axial surfaces, is the product of the F_1 deformation. Extensive recrystallization of the rocks associated with F_1 formed texturally and mineralogically distinct layering on a 1 cm to 1 m scale, especially in the Bear Pond Gneiss. These layers are folded by subsequent deformations.

The second phase of deformation formed a pervasive mineral lineation in the form of sillimanite and streaks of biotite and garnet. The formation of at least some of the garnet lasted longer than that of the sillimanite, and garnet can be seen completely enveloping sillimanite grains in thin section. The recrystallization of magnetite and pyrite also postdates the growth of sillimanite. Both opaque minerals are seen in the field as coatings on large sillimanite needles.

The F_3 phase is associated with a weakly developed mineral lineation, and the F_4 deformation did not involve any observable recrystallization.

STRUCTURAL GEOLOGY

The concentric outcrop pattern (Figure 2) gives the initial impression that the basin is structurally simple, but stratigraphic correlation and field relationships indicate that the rocks have undergone a period of isoclinal folding that was associated with the development of minor structures and large nappes. Subsequent lesser deformations have produced the basin and many of the minor structural features. Deformation of the rocks in the Loon Pond Syncline has produced a pervasive northeast-southwest structural grain which is in contrast to the east-west strike and southerly dip of the rocks surrounding the structure.

Minor Structural Features: Bedding and Foliation. In the Bear Pond Gneiss, textural and mineralogical variations appear to represent relict bedding. In the Lost Pond Marble, interbedded diopside-calcite granulites and quartzites may represent original siliceous dolomite and sandstone beds. No primary sedimentary structures other than bedding are evident, and thus there is no sedimentary evidence for the direction of primary tops.

Foliation is expressed by: 1) individual biotite flakes, 2) sheets and lenses of quartz and sillimanite, 3) thin quartz discs in marble and 4) flattened and elongated granular aggregates of biotite, garnet, and quartz. Foliation and relict bedding are parallel except in hinge areas of early folds, and thus the major foliation is related to the first phase of deformation. A more subtle foliation is present in the axial regions of some second phase folds.

Early Folds. A few early isoclinal folds were found. Relict bedding defines folding, and axial planar foliation is defined by biotite grains. The folds are only a few cm across and in a few localities are refolded. Fold axes may be parallel to those of the second phase.

Second Phase Folds. These open to tight minor folds are related to the southwest-plunging map-scale folds. They fold the dominant foliation and in some cases display an axial planar foliation. Axial surfaces dip southeast and the folds plunge southwest except where modified by subsequent deformation. The consistent southwest plunge is accompanied by a strong parallel mineral lineation.

Third Phase Folds. These open to tight folds are well developed on Loon Pond Mountain and on the shores of Loon Pond. Here axial surfaces dip northwest and plunges range from northwest to southwest.

Fourth Phase Folds. These broad, gentle folds trend north-south and have vertical axial surfaces. They have wavelengths of up to 2 m in outcrop.

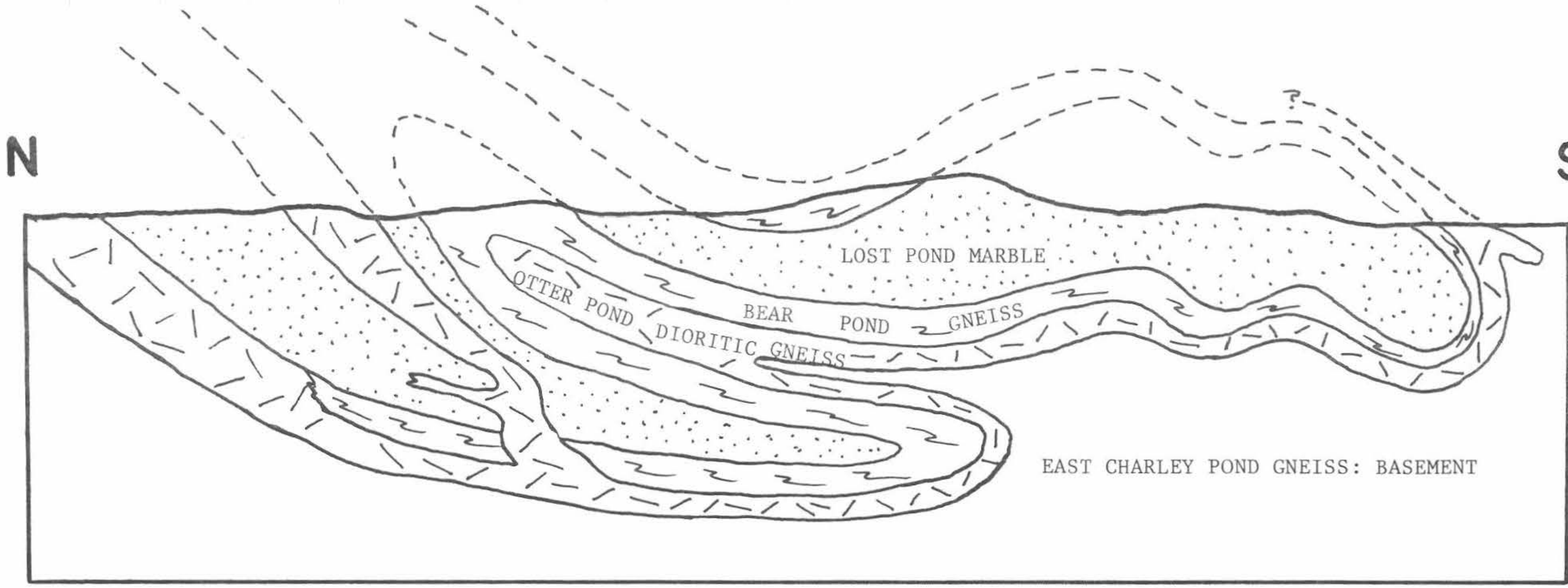


FIGURE 4

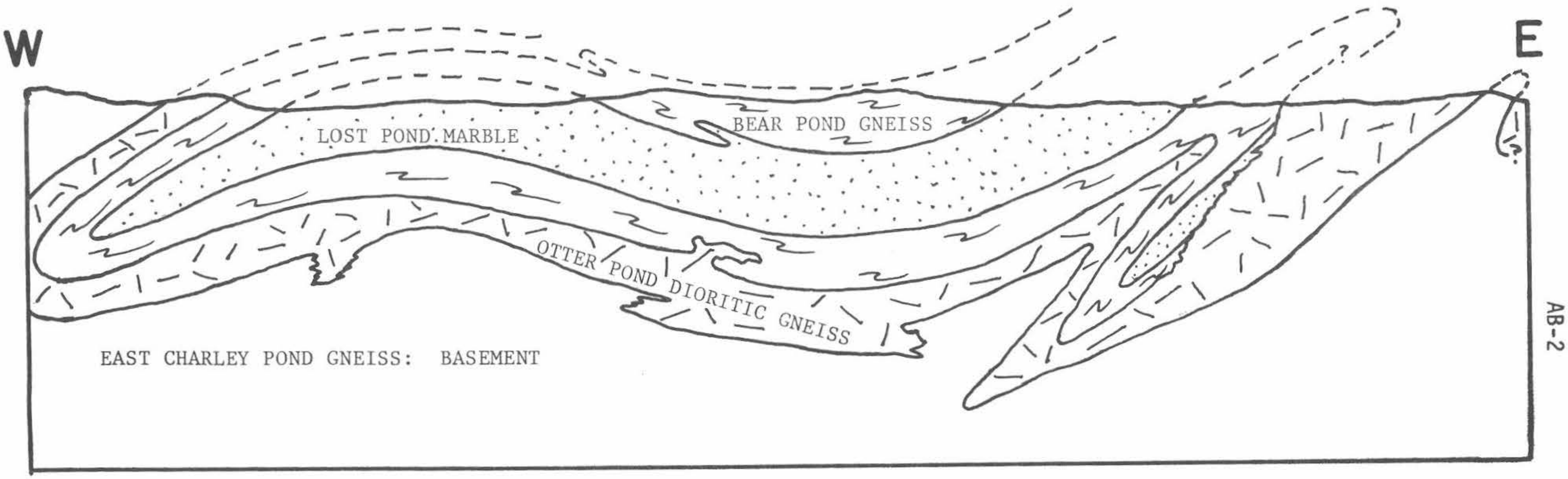


Figure 4. Generalized cross sections, east-west and north-south, across the Loon Pond Syncline. Not to scale.

Mineral Lineations. Most of the mineral lineations measured are sillimanite. Sillimanite needles and quartz form sheets up to 1 cm thick that define both foliation and lineation in the Bear Pond Gneiss. Magnetite, biotite, and hornblende also form clear lineations, as do streaks of garnet and quartz. The mineral lineations show a strong southwest-plunging concentration.

Additional linear features include quartz rods, feldspar rods, and boudin axes. The rods, a few mm to 2 cm wide and up to 1 m long may represent fold hinges separated from limbs by shearing. When rods occur with a mineral lineation in outcrop, the two are parallel.

Major Folds. Several major fold systems (structures of the same generation) and a fold complex (a map scale interference pattern of more than one generation of folds) are present.

The Sabattis Fold System consists of map scale and minor folds of the F_2 phase. Four overturned anticlines and corresponding synclines deform the Bear Pond Gneiss and the Otter Pond Dioritic Gneiss. The first syncline south of Sabattis is best exposed, with excellent outcrop control in the hinge area. Minor structural features, including folded quartz veins, feldspar rods, sillimanite and magnetite needles all closely mimic the planar and linear elements of the major folds.

The Trout Pond Fold System is also a product of the F_2 deformation. The system is a 3.5 km-long series of folds within one of the Otter Pond Diorite bodies. The folds, located southwest of Trout Pond, differ from the Sabattis Fold System in that most of them do not have overturned limbs. The southwest-plunging mineral lineation is present, however.

The Loon Pond Mountain Fold Complex is centered on the three peaks of Loon Pond Mountain. The complex has been affected by all four deformations.

F_1: The repetition of the Bear Pond Gneiss near the center of the structure is caused by the erosion of a large-scale fold of nappe proportions (Figure 4). Other evidence for the F_1 phase includes the digitations of the Bear Pond Gneiss - Lost Pond Marble contact at the center of the structure.

The second phase is responsible for the northeast trend of the complex. The major F_2 fold here is not overturned, although many minor structures of this generation have limbs overturned to the northwest. Minor structures of the F_2 phase plunge southwest except where modified by the F_4 phase.

Excellent examples of the third phase folds are found on the south-facing slopes of Loon Pond Mountain. Axial surfaces dip northwest. Fourth-phase folds are best expressed by the gentle warping in section E-W, Figure 4.

The Loon Pond Mountain Syncline is a basin formed by the interference of second, third(?), and fourth-phase synclines. Although many of the minor second and third phase folds have overturned limbs, the map-scale folds of these two phases at the present level of erosion are not characterized by overturned limbs near the center of the basin.

ROAD LOG

Miles

0.0 Depart Long Lake public beach and proceed north on Route 30.

4.4 Gatehouse for Whitney Park on left.

6.6 Turn left towards Sabattis on Route 10A.

8.9 View of Loon Pond Mountain to the northwest.

9.3 Small outcrops of East Charley Pond Gneiss on both sides the road.

9.5 Cross bridge at the head of Little Tupper Lake.

9.6 Turn left towards Sabattis on Route 10.

10.6 Stop 1. Otter Pond Dioritic Gneiss is exposed along the north side of the road. Near the east end of the outcrop, a late 1 meter-thick vertical dike cuts the foliated gneiss. Discontinuous quartz veins help define the edges of the north-trending dioritic dike.

Estimated modes from thin sections of the foliated gneiss at this outcrop (646) and one .3 miles east (647) follow:

	646	647
Quartz	1	12
Plagioclase	71	43
An percent	(42)	(38)
Biotite	-	1
Augite	13	-
Hornblende	10	36
Apatite	tr.	tr.
Zircon	1	tr.
Magnetite and Ilmenite	4	8

Foliation is N84W,24SW and parallels foliation in basement rocks to the south. The outcrop was mapped by Buddington and Leonard (1962) as a diorite gneiss, but they did not consider the unit to be as widespread as is shown in Figure 2.

10.9 Whitney Headquarters sign.

ROAD LOG

Miles

14.9 Watchung Boy Scout Camp sign.

15.1 Stop 2. The Sabattis Road Member of the Lost Pond Marble is exposed on the north side of the road. Most of the outcrop consists of brown-to gray-weathering marble beds up to 2 m thick. A few layers of quartzite, .5 m thick, are also present. The graphitic marble includes quartz, microcline, pale green diopside, phlogopite, calcite, sphene, and scapolite. The quartz and diopside stand out as small knobs and clusters on the weathered surface.

F_2 fold axes plunge S45W at about 10 degrees, and minor undulations in bedding define a pronounced lineation in places.

15.4 Step 3. The Bear Pond Gneiss is exposed along the northwest shore of Bear Pond. Layering and foliation strike northeast, parallel to the trend of the pond, and dip southeast beneath the Lost Pond Marble of Stop 2. Grain size in the magnetite-biotite-quartz-microcline gneiss varies from fine to pegmatitic.

A biotite-rich unit of the Bear Pond Gneiss lies on the north side of the road .1 mile west of Bear Pond. The gneiss is cut by a coarse microcline pegmatite body that is roughly concordant to foliation.

Near the crest of the hill .2 miles west of Bear Pond a third example of the Bear Pond Gneiss is exposed. The rock is a magnetite-biotite-zircon-garnet-sillimanite-microcline-plagioclase-quartz gneiss. Locally, both sillimanite and coarse garnet constitute more than 10% of the rock. A strong F_2 sillimanite lineation plunges S46W at 4 degrees. Garnet distribution in this "chicken pox" rock is locally random, but in some places the garnet is concentrated in layers parallel to foliation.

16.3 Swamp to north is underlain by Lost Pond Marble.

16.4 Bear Pond Gneiss exposed on left side of road.

17.6 Turn left on dirt road to Charlie Pond Club land. Proceed 100 yards to gate. This area is not generally accessible to the public. Proceed .1 mile to a log landing on the west side of the road. Stop 4. Beginning at the southwest corner of the log landing, walk 400 yards at S40W across uneven terrain to the outlet of a small pond. Here the Bear Pond Gneiss is exposed in the axial region of a map-scale F_2 syncline. Both limbs strike NE and dip SE. Many minor structures exposed along the outlet illustrate the second phase of deformation. Fold axes and mineral lineations form a tight southwest-plunging concentration on an equal area net. If water levels permit, a faint F_3 magnetite lineation will be seen.

The Loon Pond Dioritic Gneiss is exposed on the other side of the outlet .1 mile southwest along the edge of the pond.

17.8 Return to Route 10. Turn left.

18.0 Bear Pond Gneiss on south side of road.

18.2 Abandoned Sabattis Railroad Station. Turn around and return to Little Tupper Lake.

19.8 Trout Pond trailhead on north side of road.

26.4 Turn left at fork and proceed northeast along Route 10A to Route 30.

29.5 Intersection with Route 30. Turn left.

29.6 Stop 5. Overgrown quarry on west side of road. The old quarry is in the Bog River Member of the Lost Pond Marble and contains graphite, calcite, sphere, phlogopite, quartz, calcite, and diopside. Diopside varies in color from pale to dark green and locally forms more than 50% of the rock. The rock is moderately well to poorly foliated, and grain size varies from medium to coarse. There is great variation in the relative proportions of calcite and quartz in the rock.

Rocks at this location bear a strong resemblance to the diopsidic marbles of the Sabattis Road Member of the Lost Pond Marble (Stop 2).

End of this portion of the trip. Turn around and proceed south to Long Lake public beach (mile 40.1) or proceed to next leg of field trip.

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