SUMMARY OF THE PRECAMBRIAN GEOLOGY OF THE ADIRONDACK MOUNTAINS

The Adirondack Mountains (Figure C-1) are a southeastern tongue of the Grenville Province of the Canadian Shield and are underlain by a distinctive complex of highly metamorphosed igneous and sedimentary rocks of pre-Cambrian age. Whatever the parent rock, most Adirondack lithologies now have a gneissic structure. The relative age of the major rock units is (oldest at the bottom):

hornblende granite gneiss, biotite granite gneiss
---------major deformation and metamorphism------
pyroxene- quartz syenite gneiss
anorthosite-gabbro
Grenville metasediments including marble, paragneiss,
  quartzite, amphibolite (some may be metagabbro or
  metavolcanic)

The Adirondack Mountain region can be divided into two parts on the basis of lithology and the physiography; the Highlands Core comprising the bulk of the area, and the Grenville Lowlands in the northwest. The Grenville Lowlands area is underlain by Grenville metasedimentary or migmatitic-sedimentary rocks and granite gneisses in about a 3 to 1 ratio (Buddington, 1958). The Highlands Core is dominated by the 1200 square mile body of anorthosite which underlies the high mountain region. In the remainder of this area the younger granite gneisses are most abundant and these are followed in order by rocks of the syenitic complex and Grenville metasediments.

Petrogenesis: A metasedimentary origin for the bulk of the Grenville sequence is probably one of the least debated aspects of Adirondack geology. Layering, coupled with distinctive chemical-mineralogical compositions are the principal criteria. Thus, thick sequences of marble (commonly graphitic and diopsidic) were formed from limestone and dolmitic limestone; quartzite from sandstone; and major amounts of paragneiss including quartz-biotite-feldspar gneiss, garnet-biotite-sillimanite gneiss, pyroxene-hornblende-quartz-feldspar gneiss, amphibolite, etc. were formed from other clastic sedimentary rocks. Recent detailed work by Engel and Engel (1958;1960) suggests that graywacke was the parent sediment for much of the paragenis in the northwest Adirondacks. Some of the amphibolite layers in the Grenville sequence probably are metavolcanics and metagabbro, others are metamorphosed calcareous pelites.

An igneous origin for the great anorthosite pluton and its satelites is accepted by many petrologists. The anorthosite is thought to be younger than the Grenville sequence because "inclusions" of Grenville occur in anorthosite and there has been contact metamorphism of the Grenville near the anorthosite (Buddington, 1941) The presence of "xenocrysts" (Cannon, 1937) of plagioclase and xenoliths of anorthosite in pyroxene-quartz syenite rocks and in hornblende granites suggests that the anorthosite is older than these two. (See Problems) The exact nature of the magma giving rise to the anorthosite and related gabbroic rocks is not clear. Experimental work by Yoder (1955) shows that high water vapor pressure causes a diopside-anorthite melt to yield an end product (eutectic mixture in this case) richer in plagioclase and at a lower temperature than an anhydrous melt. Buddington (1958) proposes a volatile-rich gabbroic anorthosite parent magma as being most consistent with Yoder's experimental work and the following field evidence: the coarse grained nature of the anorthosite, the oxidized character of the iron-titanium oxides, the similarity of composition of the plagioclase in many phases of the anorthosite body, and the development of contact metasomatic wollastonite, hedenbergite, and garnet skarns at Willsboro. On the other hand, block structure and other cataclastic phenonema may indicate that the anorthosite may have been emplaced as a largely crystalline magma rich in plagioclase crystals. (Balk, 1930; Turner and Verhoogen, 1960, p. 326)

The pyroxene-quartz syenite gneiss complex consists of many related rock types that range in composition from pyroxene syenite with less than 1% quartz to hornblende granite with more than 30% quartz. Dikes of the rocks of this complex cut anorthosite and Buddington (1959) believes that the syenitic magmatic activity was distinctly later and genetically unrelated to the anorthosite. On the other hand, Bowen, Balk, and Barth (Turner and Verhoogen, 1960), propose a comagmatic origin for the pyroxene-quartz syenite and anorthosite. Buddington (1948) has further concluded that the long belts of pyroxene-quartz syenite gneiss in the northwest part of the Highlands Core (Figure C - 1) are the outcrops of very thick (up to about 20,000') igneous sheets formed by crystallization and density stratification of a pyroxene-quartz syenite magma. Detailed work by other geologists in the north (Postel, 1956), and south (Cannon, 1937) substantiates the magmatic theory of origin for this complex but these workers have not presented evidence for density stratification sheets.

The youngest major rock type in the Adirondack Mountains is hornblende granite gneiss and biotite granite gneiss. These rocks occur as phacolithic bodies in the northwest. Rare dikes of granite (Postel, 1956) cut the syenite gneiss complex and establish the inferior age of the granitic rocks.

Minor lithologies within the Highlands Core include olivine gabbro, diabase, and granite pegmatite. The bulk of the gabbro is probably older than the pyroxene-quartz syenite complex; diabase dikes were intruded at perhaps five different times during the pre-Cambrian in the Adirondacks; pegmatite dikes are apparently of various ages but many were emplaced late in the last major pre-Cambrian orogeny.

Metamorphism and Structure

All the major lithologies discussed above have been subjected to temperatures up to perhaps 500-800 degrees centigrade and pressures up to perhaps 5000 atmospheres. Metamorphic rocks which develop under these conditions, corresponding to a depth of perhaps 15 kilometers, are referred to the amphibolite and granulites facies. In addition, all the rocks have been subjected to intense shearing stress as shown by cataclastic structures in the anorthosite and pyroxene-quartz syenite gneisses and by marked plastic flowage in other rocks. Walton (1955) has emphasized that under physical conditions noted above marble and granite alike become highly mobile and intrude the less mobile units. Engel and Engel (1953; 1958; 1960) have shown in great detail the structural, mineralogical, and chemical changes in the Grenville paragneiss as it is progressively metamorphosed and granitized near the northwest boundary of the Highlands Core.

Buddington (1958; in Thompson, 1956) suggests that contact metamorphism occurred during each major igneous episode (anorthosite, syenite, granite) but that the major period of deep regional metamorphism and plastic deformation occurred after the emplacement of the pyroxene-quartz syenite complex and during the emplacement of the granites.

In a synthesis of Adirondack structures Buddington (in Thompson, 1956) stresses that the anorthosite and pyroxene-quartz syenite sheets behaved as rigid units and that the more mobile rocks have been isoclinally folded and overturned towards these units. Thus, the isoclinal folds in the Grenville Lowlands dip northwest away from the pyroxene-quartz syenite gneiss sheets; and the Grenville-granite-syenite mixed rocks are isoclinally folded and dip south from the Piseco Dome.

Block faulting in the eastern and southeastern Adirondacks resulted in the downdropping of sedimentary rocks as young as Ordovician into Precambrian terraine. This northeast-tending fault system is reflected in the grain of many lakes and river courses in the area. Most of the faults are of post mid-Ordovician age and many may be reactivated pre-Cambrian faults.

PROBLEMS:

The facts and inferences set down in pragmatic fashion above reflect some general conclusions of some of the geologists who have been studying Adirondack geology during the last 50 years. Yet because of the great structural complexity and the high rank of metamorphism many of the features observed in the field are open to more than one interpretation. Some of the problems facing the Adirondack geologist are:

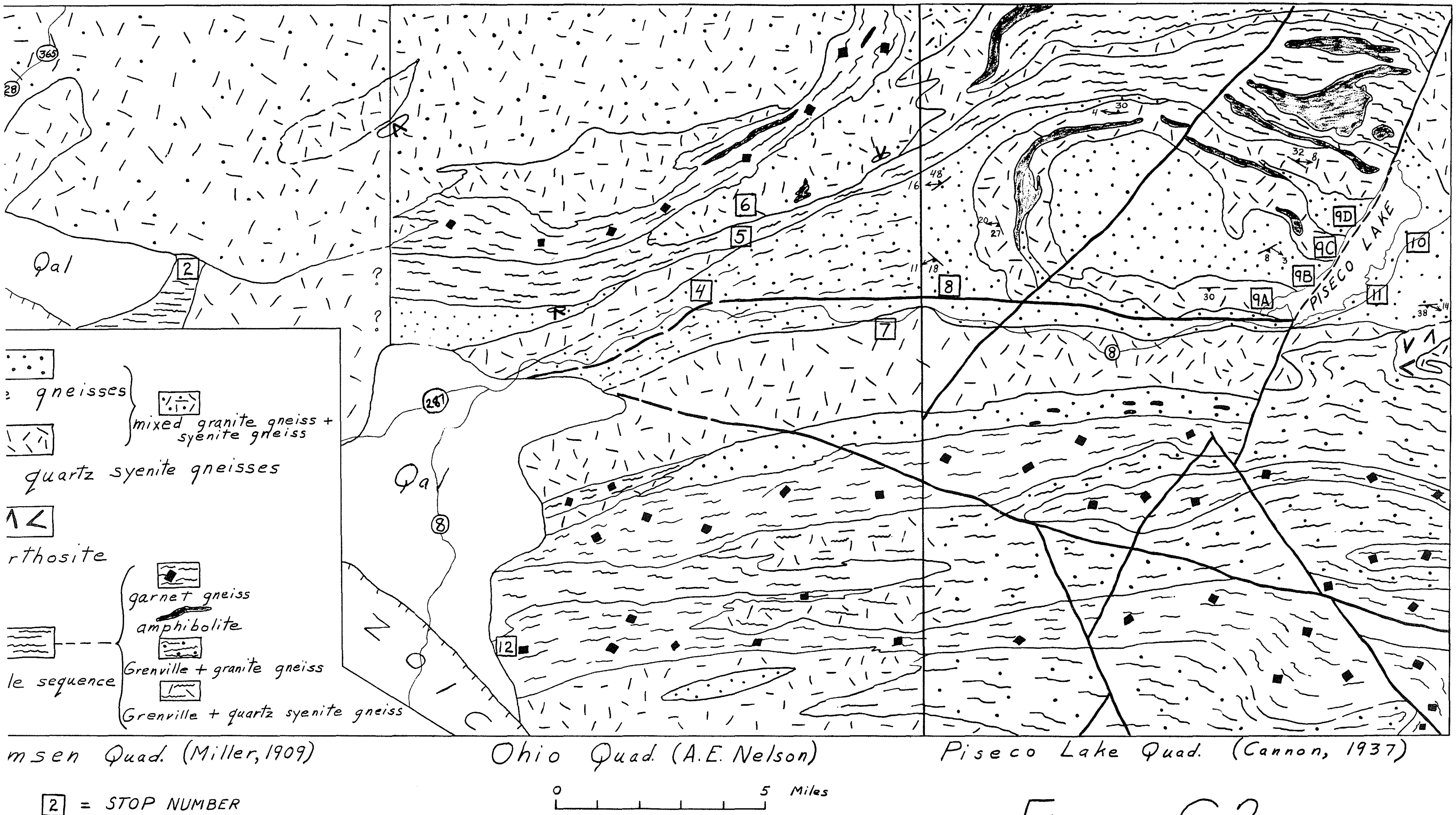
1. Most contacts between different rock types are conformable and there is no information by way of primary sedimentary structures, bedding-cleavage relations, etc. to establish the top side sense of a layer or the relative ages of two layers. Dikes having the compositions of the major igneous rock units are rare, and when they are found they are aften far removed from bodies of the major rock unit so their identity is in doubt.

2. Cross cutting relations (including dikes) actually may not be an indication of the order of crystallization of various igneous types but rather the relative ease and time of mobility of the cross cutting bodies.

3. Is the pyroxene-quartz syenite gneiss really a metaigneous complex, or is it a metasedimentary sequence or is it both? We must remember that the mineralogy of this and other rocks in the highly metamorphosed terraine is that suite of minerals stable during the elevated PT of the last metamorphism and not necessarily the mineralogy of the parent rock.

4. What is the origin of the younger hornblende and biotite granite gneiss? Are these metamorphosed magmatic granites, granites formed by isochemical metamorphism of sediments, granites formed by replacement of solid rock, or granites formed by the moblization of quartz-feldspar components of nearby sediments or igneous rocks?

5. One specific petrologic problem is as follows. The rare large andesine-labradorite crystals in pyroxene-quartz syenite gneiss (Cannon, 1937, p. 26) may represent "xenocrysts" of plagioclase derived from the anorthosite if the composition of these large crystals is different from that of the plagioclase in the matrix of the syenite. However, the presence of labradorite or calcic andesine as a principal phase in any of the Adirondack gneisses does not necessarily establish a genetic or intrusive relation between these gneisses and the anorthosite. Labradorite either as porphyroblasts or as a matrix constituent, can form by high rank isochemical metamorphism of any rock of appropriate (relatively high Ca, low Mg) composition.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mixed granite gneiss + syenite gneiss
quartz syenite gneisses
rthosite
garnet gneiss
amphibolite
Grenville + granite gneiss
le sequence
Grenville + quartz syenite gneiss
msen Quad. (Miller, 1909)
Ohio Quad. (A.E. Nelson)
Piseco Lake Quad. (Cannon, 1937)
2 = STOP NUMBER
0
5 Miles

Figure C-2

TRIP C (PRECAMBRIAN)

Purpose: To visit the Remsen, Ohio and Piseco Lake Quadrangles (Fig. C-2) and see several of the Adirondack Mountain lithologies, the Piseco Dome, and smaller structures.

Acknowledgements: The information presented here is based largely on the work of Miller (1909) in the Remsen Quadrangle, Nelson (recently completed field work) in the Ohio Quadrangle, and Cannon (1937) in the Piseco Lake Quadrangle..

General: The Remsen, Ohio, and Piseco Lake Quadrangles lie in the southern part of the Adirondack Mountain Highlands Core, and in these quadrangles can be found most of the major lithologies of the Core (see Summary). The Table below is based almost entirely on information from the Ohio and Piseco Lake Quadrangles. Miller's (1909) work in the Remsen Quadrangle is of a reconnaissance nature.

Table of pre-Cambrian formations in the Remsen, Ohio, and Piseco Lake Quadrangles.

Granite-granite gneiss:	Fine grained pink, rarely greenish or gray hornblende-biotite granite gneiss, microperthite is dominant feldspar in porphyritic facies, and microcline in equigranular facies in Piseco Lake Quad. Sheetlike inclusions of amphibolite common. Lineation pronounced near Piseco dome.

continued on next page

Pyroxene-quartz syenite gneisses:	Phacoidal* (Ohio) or prophyritic (Piseco Lake) quartz syenite gneiss: mainly green, minor red, phacoidal microperthite-oligoclase-quartz-hornblende-augite-hypersthene gneiss. More homogeneous and massive, fewer inclusions than equigranular facies. Equigranular quartz syenite gneiss: dark green fine grained microperthite-oligoclase-quartz-hornblende-augite-hypersthene gneiss. Shreds and lenses of amphibolite and other Grenville rocks, and seams of pegmatite common.
Anorthosite, hypersthene gabbro, olivine norite	
Grenville sequence (dominantly metasedimentary; commonly intimately mixed with quartz-syenite gneiss or granite gneiss	quartz-feldspar-garnet gneiss quartz-feldspar gneiss amphibolite (metagabbro and metasedimentary) quartzite diopsidic marble

*feldspar crystals or crystal aggregates are lens shaped

The Grenville sequence is dominant in the southern half of the Ohio and Piseco Lake Quads. The rocks here are quartz-feldspar-garnet gneiss, quartz-feldspar-biotite gneiss, and related feldspar-rich metasedimentary gneisses, more or less mixed with granite gneiss and syenite gneiss. Much of this gneiss can thus be called migmatite. Amphibolite, derived perhaps from impure limestone and from gabbro, is the next most abundant type; quartzite and diopsidic quartzites are rare. Marble, so abundant in the northwest and southeast Adirondacks is a minor lithology in the Grenville here.

Anorthosite occurs as three small widely separated lenses in the northern half of the Ohio Quadrangle. These lenses occur in granite gneisses or in areas of mixed granite and syenite gneisses. Anorthosite overlies hypersthere gabbro and olivine norite in a layered sill two miles southeast of Piseco Lake. The anorthosite here is fine grained, consisting dominantly of andesine, An 45, and resembling the Whiteface facies of the main pluton. Xenocrysts (?) of calcic andesine occur in the porphyritic quartz syenite gneiss extending east-west across the middle of the Piseco Lake Quad and suggest to Cannon that anorthosite is older than the quartz syenite. Also, the quartz syenite is believed to intrude the hypersthene gabbro member of the sill mentioned above for (Cannon, p. 35) there has been "contamination of the quartz syenite near the contacts by amphibolitic material torn off from the intruded gabbro".

The equigranular and phacoidal (porphyritic according to Cannon) types of quartz syenite gneiss occur in well defined layers (sills according to Cannon) up to about 2000 feet thick in the northern half of the Piseco Lake and Ohio Quadrangles. In the southern half of these two quadrangles the syenitic rocks are generally intermixed (intrusive into (?)) the Grenville sequence. According to Nelson the phacoidal quartz syenite (best developed in the east-west belt across the middle of the Ohio and Piseco Lake Quadrangles) is similar to the orthogneiss of Buddington's (1948) Diana, Stark, and Loon Lake complexes in the northern and northwestern part of the Highlands Core. An attempt by Cannon to test density stratification of this unit in the Piseco Lake Quadrangle yielded no consistent results presumably because of isoclinal folding of the quartz syenite sheet.

Granite gneiss is the dominant rock type in the area. It is best developed in the northern half of the Piseco Lake and Ohio quadrangles where it occurs in phacolithic bodies along the axis of the Piseco Dome. The strongly lineated granite here is characterized by many sheetlike inclusions of amphibolite (metagabbro according to Cannon) and some appreciably "digested inclusions" of Grenville metasediments. Cannon postulates that rocks of the Grenville sequence were originally the dominant rocks at the site of the Piseco Dome; these were intruded by the equigranular quartz syenite sills; and then, during the major period of deformation, granite was forcefully emplaced and "completely disintegrated" most of the included Grenville xenoliths. The amphibolite streaks and lenses represent xenoliths which escaped complete disintegration.

Structure and metamorphism

An east-west grain of the geologic contacts and the foliation in the gneissic rocks is prevalent throughout the three quadrangles. The Piseco Dome is the dominant large structural element in the Piseco Lake and Ohio Quadrangles.

South and southwest of the dome the quartz syenite gneiss and mixed rocks of the Grenville sequence have been isoclinally folded and the folds overturned to the north. Northwest and northeast of the dome the contacts and foliation dip away from the dome towards the axis of major synclinal structures (Cannon, p. 65).

Cannon emphasizes the phacolithic nature of the granites on this dome (see above). His theory of formation is that the equigranular quartz syenite sills, that outline the dome, were intruded into Grenville rocks prior to folding. Granite magma intruded the dome as it was being formed by compression resulting from opposing forces along a north-south axis. The uplift of the dome was augmented by the force of the magmatic intrusion with the result that the granite is thickest along the axis of the fold. This axial thickening is shown by the great westward-tapering wedge of granite that extends west from the nose of the dome at least a third of the way across the Ohio Quadrangle. Note that this wedge wraps part way around the north end of the dome and pinches out against the supposedly more rigid quartz syenite. The east end of the dome is cut by a high angle fault (east side down) and presumably Ordovician sedimentary rocks are present beneath Piseco Lake. (Cannon, p. 68). The granite gneiss east of Piseco Lake corresponds in stratigraphic position to the granite gneiss overlying the quartz syenite "sill" at the western nose of the dome. The dome is slightly assymmetrical with the north limb dipping steeper than the south limb. Foliation and contacts generally do not dip steeper than about 30 degrees in the vicinity of the dome. Linear structures on the limbs and axis of the dome are essentially parallel to the axis of the dome, both as to strike and plunge.

Cannon distinguishes between primary (magmatic) and secondary (tectonic) structures in the granitic and syenitic rocks. Primary structures include banding produced by magmatic flow or by "reaction with Grenville sediments". Secondary foliation is shown by flattened lenticles of granulated feldspar, by thin sheets of granulated mafic minerals, and by platy elements such as leaves of quartz and flakes of biotite. With but few exceptions the "primary" banding is parallel to the "secondary" foliation.

The evidence for high angle faults includes truncation of quartz syenite "sills" at Piseco Lake, probable inlier of Ordovician rocks under Piseco Lake, breccia zones, linear arrangement of diabase dikes, apparent displacement in the pre-Potsdam peneplain (Cannon believes that the tops of the present hills in the Piseco Lake Quad. are approximately remnants of this old surface), linear topographic troughs.

TRIP C (PRECAMBRIAN)

ROAD LOG AND DESCRIPTION OF STOPS FOR GROUP A

Mileage	Description
000.0	Leave Hamilton College. Proceed east down College Hill Road (Rt. 412) to Clinton.
1.7	Village square, Clinton. Leave town via Utica Street (Rt. 12B) toward northeast.
4.0	Intersection Rt. 12 B and Rt. 5A; bear left on Rt. 5A.
5.4	Intersection of Rt. 5 and Rt. 5A; Jog right and then left across Rt. 5 staying on Rt. 5A.
7.1	New York Mills.
8.6	Yorkville. Rts. 12C and 69 join Rt. 5A. Keep straight ahead on Rt. 5A.
11.2	Turn left (north) at light onto Horatio Arterial. Sign reads "Trenton 13." Pass over New York Central tracks, Mohawk River, Barge Canal, and Thruway.
13.1	Proceed up slope over several terraces (500-780 feet) of glacial Lake Amsterdam.
14.3	Intersection of Arterial with Rt. 12. Continue north on Rt. 12.
15.2	Broad terrace of Lake Amsterdam at foot of Marcy Hill. Bedrock beneath terrace is Utica shale. Marcy Hill, immediately to north, is capped with Frankfort Formation (Ordovician).
17.0	Top of Marcy Hill. Adirondack Mountains visible in the distance on a clear day. As we proceed north from Marcy Hill we are travelling down section in the Ordovician formations: Frankfort Formation at the crest of the hill, Utica shale on the north slope, and Trenton limestone group in the broad valley north of the hill.
23.1	Rt. 28 enters from right (southeast). Keep straight ahead.
23.6	Rt. 12C goes off to left to Barneveld P. O. Keep straight on Rt. 12.

24.7 Route cuts through delta (el. 1000 feet) which is part of a large delta plain built into glacial Lake Herkimer.

27.8 Rt. 28B enters from east. Remsen Diner and Slim's Diner.

30.3 Morainal belt.

30.9 Cross over New York Central tracks.

34.6 Rt. 28 bears right. Bear right on Rt. 28 toward Old Forge.

35.6 Deltaic deposit of Lake Forestport. Elevation 1200 feet.

36.5 Turn left off Rt. 28 on black top road just south of bridge.

36.7 Black River below dam. STOP 1.

STOP 1.

Sillimanite gneiss, mapped by Miller (1909) as "syenite-Grenville complex." The dominant rock here is a medium grained gray sillimanite-biotite-quartz-feldspar gneiss. The foliation planes on weathered surface are accentuated by flattened white matts of fine grained fibrous sillimanite (fibrolite), quartz, feldspar, and magnetite. This rock does not resemble any of the syenite gneisses. It is probably a metasediment of the Grenville sequence.

Does the presence of sillimanite distributed through this gneiss indicate that the parent rock was sedimentary?

Magnetite seems to be more abundant in this rock than in other lithologies of the region. Why is it associated with sillimanite?

The following interesting side trip to Enos must be omitted because of lack of time. At Enos there is exposure of steeply-dipping Grenville metasediments. Proceed from Forestport as follows:

00.0 Proceed north across bridge below dam and enter town of Forestport.. Turn right onto road to Forestport Station.

0.4 Pass under Rt. 28 and continue up north side of Black River.

1.2 Cross Woodhull Creek. Road enters from right, keep straight ahead.

1.6 Forestport Station. Turn right across tracks of N Y C R R on road to Bardwell Mill and Pine Creek Trout Farm.

2.4 Turn left on road to Enos. Cross extensive sand plain, elevation 1200 feet.

6.9 Bridge over Black River at Enos. STOP 2.

STOP 2.

On southeast side of river, downstream from the bridge, the following steeply dipping interlayers of the Grenville sequence can be seen:

medium grained garnetiferous quartzite
medium grained rusty weathering diopside-quartz marble
graphitic calcareous tremolite-diopside quartzite
biotite gneiss
silicified metasediments: well defined nearly vertical bedding preserved in a solid mass of quartz which exhibits nearly horizontal jointing.

About two hundred yards above the bridge on the southeast side of the river is exposed a sillimanite-biotite-quartz feldspar gneiss.

Retrace part of route to south.

36.7 Leave Stop 1 and proceed south on Rt. 28.

38.8 Traffic cloverleaf; follow Rts. 28 and 12 and signs to Utica south.

45.6 Rt. 28B enters from east. Remsen Diner and Slim's Diner.

48.7 Turn right off Rts. 28 and 12 at traffic cloverleaf and proceed east under Rts. 28 and 12 towards Rt. 28B, Prospect, and Speculator.

49.1 Cincinnati Creek. Exposures of Trenton group. Rt. 28B enters from southeast. Keep straight ahead.

49.2 Pass under N Y C R R.

50.8 Prospect. Proceed to 4-way intersection northwest of small village triangle. Cross intersection and follow Rt. 287 and signs to Hinckley. The West Canada Creek makes a sharp bend at Prospect, reflecting a post-glacial diversion. The West Canada Creek rises in the West Canada Lake region of the Adirondacks and flows southwesterly to Prospect; at Prospect the river turns abruptly southeast and flows through the Trenton Gorge and southeast to the Mohawk River. Presumably the pre-glacial West Canada Creek had a continuous southwesterly course from source to the Mohawk River near Rome; an ice or drift dam deflected the West Canada Creek at Prospect in late glacial time and caused the river to flow southeasterly from this point and cut the Trenton Gorge. At Prospect Falls, just east of the village, there are excellent exposures of fossiliferous Coburg Formation (Trenton group).

52.9 Hinckley.

53.3 Dam across West Canada Creek. Hinckley Reservoir (Utica water supply) begins here and extends 5 miles upstream.

57.2 Low hill with outcrops on north side of road. Dirt road from Wheelertown enters main route (287) from north about 100 yards east of outcrop. STOP 3.

STOP 3.

Coarse grained hornblende-quartz-microperthite gneiss; dominantly pink, some greenish. Note contorted and wavy foliation planes. Mapped by Miller (1909) as "syenite." This rock is more massive than the bulk of the granite and syenite gneisses in the region. This lithology is interesting because it points up the problem of rock nomenclature in the Adirondacks. On the basis of mineralogy, is this a syenite gneiss?

57.2 Leave Stop 3 and proceed east on Rt. 287.

60.6 Approximate west boundary of Ohio Quadrangle.

63.3 Intersection of Rt. 8 and Rt. 287 in west central quadrant of the Ohio Quadrangle. Continue east on Rt. 8. GROUP B ENTERS HERE.

66.2 Road 69 from Gray and Norway enters from right at bend.

68.8 Nobleboro. If time and roads permit two stops will be made along the west side of West Canada Creek. Access to these stops is via dirt road leading northeasterly up the west side of West Canada Creek from Nobleboro.

Mileage from Nobleboro along dirt road extending northeast along west bank of West Canada Creek.

00.0 Nobleboro. Turn north off Rt. 8 onto dirt road and cross small bridge.

0.7 Small quarry on shoulder of hill. STOP 4.

STOP 4.

Note that Figure C-2 indicates that this rock is part of the great wedge of granite that tapers westward from the Piseco Dome. Nelson has recently mapped this rock as a mixed Grenville and granite gneiss unit, and notes the migmatitic nature of this exposure. The rock is a medium grained biotite gneiss with augen of pink feldspar and seams of aplitic and pegmatitic material parallel to the foliation. The foliation strikes between north-south and N 60 E, and dips to the west or northwest.

Continue northeastward up dirt road.

2.8 Camp named "Potter's Hideaway." Walk down to west bank of West Canada Creek. STOP 5.

STOP 5.

Nelson maps this as part of Grenville sequence. The rocks here are coarse grained and gneissic. The dominant lithology is a coarse hornblende-garnet-quartz-plagioclase gneiss. Many large gray crystals of labradorite occur in this gneiss. In places these large crystals and smaller plagioclase crystals in the matrix of the rock exhibit a blue play of colors. The composition of one of the larger crystals was determined to be An_{52}, and it was seen under the microscope to be crowded with small inclusions. (See "Problem" 5 under "Summary of Precambrian of the Adirondack Mountains.")

Interlayered with this hornblende-labradorite gneiss are dark bands of amphibolite and thin bands of biotite gneiss.

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Buses must turn around here. As a guide for smaller groups, the following stop (STOP 6) 0.7 miles upstream from Stop 5, and 3.5 miles from Nobleboro, is accessible by rough dirt road.

STOP 6.

Broad outcrops along west side of West Canada Creek. Nelson maps this as equigranular quartz syenite gneiss and notes the presence of streaks of granite and amphibolite. Also present are coarse grained hornblende-feldspar pegmatite bodies. Note sheet structure which dips toward the stream on both banks, thus forming a natural gutter for the stream course. Pot holes on gently sloping rock surface on east bank.

****

Return along dirt road 2.8 miles to Nobleboro.

68.8 Turn east on Rt. 8 at Nobleboro.

68.9 Cross West Canada Creek.

70.3 Herkimer-Hamilton County line.

73.6 General store, Morehouseville.

73.9 Top of hill. STOP 7.

STOP 7.

PLEASE BE CAREFUL NOT TO DAMAGE THE CHRISTMAS TREES. Exposure of dark greenish gray phacoidal quartz syenite gneiss. Texture is best seen on weathered surfaces. Cannon (p. 26) reports calcic andesine "xenocrysts" in syenite at "quarry just east of Morehouseville." This quarry is presumably south of the road. North of the road the gneiss is finer grained, phacoidal texture is not as obvious, and there are a few small pegmatite dikes. Note (Figure C-2) that this stop is about midway on the large east-west trending belt of quartz syenite gneiss that extends across the middle of the Piseco Lake and Ohio Quadrangles. Cannon considers this to be a thick, isoclinally folded porphyritic quartz syenite sill dipping steeply south.

73.9 Leave Stop 7 and proceed east on Rt. 8.

75.0 East edge of Ohio Quadrangle; enter Piseco Lake Quadrangle.

75.2 Turn left (north) off Rt. 8 onto Mountain Home Road.

75.5 Cross South Branch of West Canada Creek.

75.7 First house on left after crossing bridge; Smith's property. Outcrops in field and woods in back of house. STOP 8.

STOP 8.

Strongly lineated granite gneiss with sheets of metagabbro. Note that this stop is in the granite gneiss on the western nose of the Piseco Dome. The gneiss in the vicinity of the dome is strikingly lineated; the development of this lineation bears no obvious spatial relation to the faults. Note the elongated and flattened pencils of quartz and feldspar and the difficulty in identifying the "dark minerals" in this rock.

The metagabbro presents a special problem. Cannon (p. 17) notes that these tabular bodies are generally dark gray and fine grained; principal minerals are labradorite (An_{57}), hypersthene, and augite. He postulates that the gabbro intruded the Grenville sequence, and then the granite intruded both; the granite intrusion completely "disintegrated" the Grenville so that the gabbro sills are the only remnants of the older Grenville-gabbro sequence. Smith (1894), however, interprets the gabbro bodies as sills intrusive into the granite. Note: the general conformity between foliation in the granite gneiss and metagabbro contacts; the conformity as to direction and magnitude of plunge of lineation in the gneiss and in the metagabbro; the apparent chill borders of the metagabbro (Cannon says the crystals in the centers of the metagabbro sheets are not coarser grained than those near the borders; the crystals in the center are merely clumped together giving the appearance of larger grain size); locally metagabbro sheets transect the foliation in the granite gneiss; at a few places thin dikes of granitic material cut the metagabbro. Who is right, Cannon,or Smyth?

75.7 Leave Stop 8 and return to Rt. 8.

76.2 Turn left (east) on Rt. 8. For the next 8 miles Rt. 8 runs along the east-west belt of "porphyritic" quartz syenite gneiss. Prominent row of mountains immediately north and parallel to the road is underlain by equigranular quartz syenite on the south flank of the Piseco Dome.

77.8 Hoffmeister P. O.

79.9 Bear Path Inn.

84.2 Black top road turns off to left (north) to Piseco. Sign reads "Piseco 6." Turn off Rt. 8 onto road to Piseco.

84.5 Cross inlet to Piseco Lake. Irondequoit Bay ahead on right.

85.0 Southeast shoulder of Irondequoit Mountain. Begin STOP 9 which is a series of designated places chosen to exhibit a cross section at right angles to the axis of the Piseco Dome.

STOP 9A.

Dark green hornblendic quartz syenite gneiss. Note gentle south dip of foliation. This is the main equigranular quartz syenite "sill" on the southern limb of the Piseco Dome.

85.4 Point Comfort State Campsite. LUNCH HERE IF A GOOD DAY. Lunch served by Methodist Church, Speculator. Bedrock exposed along west side of road is blocky, jointed greenish quartz syenite gneiss; same sill referred to in STOP 9A.

85.8 Cross contact between quartz syenite gneiss and granite gneiss.

86.3 Outcrop 200 feet west of road. STOP 9B.

STOP 9B.

Low ledges and blocky talus of strongly lineated granite gneiss. The axis of the Piseco Dome is in the vicinity of this stop and mileage note 86.5.

86.5 Strongly lineated granite gneiss plunging gently east-southeast along west side of road; houses close to road on east side.

87.1 Cross contact between granite gneiss and quartz syenite gneiss.

87.3 Entrance to Little Sand Point State Campsite. About 200 feet north of campsite entrance and 200 feet west of the road is STOP 9C.

STOP 9C.

Outcrops of equigranular hornblende-quartz syenite gneiss on the north limb of the Piseco Dome. Note development of hornblende, as contrasted to the mafics in the granite gneiss, and the fact that lineation is not as conspicuous in this gneiss as in the granite. This is the same "sill" as noted at STOP 9A. Note north-dipping foliation.

87.7 Contact between quartz syenite gneiss and granite gneiss along west side of road.

87.8 Note gentle north dip of strongly lineated pink granite gneiss.

88.2 Entrance to Poplar Point State Campsite.

88.5 Outcrops west of road in woods. STOP 9D.

STOP 9D.

Lineated pink biotite granite gneiss. Foliation planes dip gently to north.

88.9 Approximate contact between granite gneiss and quartz syenite gneiss on the north limb of the Piseco Dome.

90.1 Road enters from left; keep straight ahead.

90.3 Piseco P. O.

90.7 Cross Fall Stream.

91.5 Granite gneiss on left.

91.6 LUNCH STOP IF RAINY DAY. Piseco Fish and Game Association, Inc. Lunch served by the Methodist Church, Speculator.

After lunch trip will continue clockwise around Piseco Lake.

91.9 Granite gneiss on left.

92.1 Cross Oxbow Lake outlet.

92.3 Piseco road joins Rts. 8 and 10; turn right on Rts. 8 and 10.

93.3 Road cut and broad flat outcrop. STOP 10.

STOP 10.

Strongly lineated granite gneiss with some dark bands of amphibolite. Note (Figure C-2) that this granite gneiss corresponds in stratigraphic position to the granite gneiss at STOP 8. The equigranular quartz syenite sills which we saw at STOPS 9A and 9C presumably lie beneath the granite at this stop.

Continue southwest from STOP 10; outcrops include quartz syenite gneiss and dark greenish gray biotite granite.

94.0 North entrance to Higgins Bay.

95.3 Route 10 enters from left (south). Turn right 0.1 mile towards Higgins Bay. View from Higgins Bay Road looking west: STOP 11.

STOP 11

Look west across Piseco Lake along axis of Piseco Dome. Note assymmetry of higher mountains which are underlain by equigranular quartz syenite gneiss. Granite gneiss in core of dome is less resistant and forms lower ground. Note (Figure C-2) that Cannon postulates a normal fault (east side down) along the west edge of Piseco Lake.

95.5 Return to main highway and follow Rt. 8 to the southwest. Outcrops of granite gneiss and "porphyritic" quartz syenite gneiss along road between here and next mileage notation.

97.6 Piseco Lake outlet.

97.7 "Porphyritic" quartz syenite gneiss.

98.7 Black top road turns off right (north) to Piseco; continue west on Rt. 8 retracing route to western part of Ohio Quadrangle where Rts. 8 and 287 separate.

118.6 Intersection of Rts. 8 and 287; bear left (south) on Rt. 8. GROUP B LEAVES HERE.

118.9 Cross West Canada Creek.

122.7 Road turns off right (west) to Ohio.

125.1 Intersection of County Road 112 and Rt. 8. Turn left (east) onto Road 112.

127.0 Intersection (road "T") of County Road 112 and County Road 4. Park near intersection and visit outcrops on Black Creek above bridge. STOP 12.

STOP 12.

Outcrops along north side of Black Creek about 200 yards upstream from Road 4 (road from Gray north to Wilmurt Corners). NO SMOKING ON THIS PROPERTY, PLEASE. The principal lithology here is garnet-quartz-feldspar-biotite gneiss. Feldspar-rich layers, garnet-rich, and garnet-poor layers, and thin layers of amphibolite give the gneiss a marked banded appearance. Coarse white feldspar augen are present in many of the bands. The gneissic banding strikes about N60E and dips steeply southeast.

Note (Figure C-2) that this garnet gneiss is one of the principal Grenville litholigies in the southern half of the Ohio and Piseco Lake Quadrangles.

Tight isoclinal folds plunging 20 degrees northeast and involving garnet gneiss and fine grained biotite gneiss are well exposed at one place. At a small peninsula of rock there occurs a coarse augen gneiss containing three or four angular blocks of rusty weathering calcareous amphibolite. Note that the foliation in these amphibolite blocks is discordant to the foliation in the surrounding gneiss; note the angularity of the blocks and the fact that borders of these blocks contain less amphibole than the block as a whole; note tight folding of the gneiss in the vicinity of these blocks. What is the origin of this lithology and structure?

Return westward along county Road 112 to Rt. 8.

128.9 Turn left (south) on Rt. 8.

129.9 Approaching glacial outwash deposit of unknown origin. Its steep, irregular north and east sides rise about 120 feet above the surrounding land to a flat top that has an elevation of 1400 feet. It is perhaps a delta built in contact with wasting ice.

135.8 Village of Cold Brook.

136.7 Poland. Turn right (northwest) on Rt. 28 and 8. Follow signs to Utica.

138.2 Turn left on Rt. 8, leaving Rt. 28. Bedrock throughout most of the route from here south to Utica is the Utica shale; the Frankfort formation caps the hills.

147.6 Start descent of Smith Hill into Mohawk Valley. Several well defined terraces of glacial Lake Amsterdam.

149.3 Intersection of Rts. 8 and 12 in north Utica.

END OF LOG

Proceed via Rts. 5A, 12B, and 412 to Hamilton College.

TRIP C (PRECAMBRIAN)

ROAD LOG AND DESCRIPTION OF STOPS FOR GROUP B

Mileage	Description
0.0	Leave Hamilton College. Proceed east down College Hill Road (Rt. 412) to Clinton.
1.7	Village square, Clinton. Leave town via Utica Street (Rt. 12B) toward the northeast.
4.0	Intersection of Rts. 12B and 5A; bear left on Rt. 5A.
5.4	Intersection of Rt. 5A and 5. Jog right and then left across Rt. 5, staying on Rt. 5A.
7.1	New York Mills.
8.6	Yorkville. Rts. 12C and 69 join Rt. 5A. Keep straight ahead on Rt. 5A.
11.2	Turn left (north) at light onto Horatio Arterial. Sign reads "Trenton 13." Pass over New York Central tracks, Mohawk River, Barge Canal and Thruway.
13.0	Turn right off arterial towards Riverside Drive.
13.2	Turn left on Riverside Drive.
14.2	Turn left at light onto Rt. 8.
14.3	Bear right on Rt. 8; Rt. 12 goes off to left. As we climb to the north we pass over several well defined terraces of glacial Lake Amsterdam which have elevations from about 500 feet to 750 feet.
16.0	Bend in road at top of hill. The bedrock between here and the valley of the West Canada Creek (where Rt. 8 joins Rt. 28) is largely Utica shale; the higher hills are capped with the Frankfort formation. Note exposures of dark clay-rich till.
25.4	Junction of Rt. 8 and Rt. 28. Turn right on 8 and 28 which roughly parallel the southeasterly course of the West Canada Creek.
26.9	Poland. Leave Rt. 28. Turn left on Rt. 8. Sign reads "Speculator 52."

27.8 Village of Cold River. Approaching glacial outwash deposit of unknown origin. Its steep, irregular north and east sides rise about 120 feet above the surrounding land to a flat top that has an elevation of 1400 feet. It is, perhaps, a delta built in contact with wasting ice.

34.7 Intersection of County Road 112 and Rt. 8 just north of Black Creek. Turn right on Road 112.

36.6 Intersection (road "T") of County Roads 112 and 4. Park near intersection and visit outcrops on Black Creek above bridge: STOP 12.

STOP 12.

Outcrops along north side of Black Creek about 200 yards upstream from Road 4 (road from Gray north to Wilmurt Corners). NO SMOKING ON THIS PROPERTY, PLEASE. The principal lithology here is garnet-quartz-feldspar-biotite gneiss. Feldspar-rich layers, garnet-rich, and garnet-poor layers, and thin layers of amphibolite give the gneiss a marked banded appearance. Coarse white feldspar augen are present in many of the bands. The gneissic banding strikes about N60E and dips steeply southeast.

Note (Figure C-2) that this garnet gneiss is one of the principal Grenville litholigies in the southern half of the Ohio and Piseco Lake Quadrangles.

Tight isoclinal folds plunging 20 degrees northeast and involving garnet gneiss and fine grained biotite gneiss are well exposed at one place. At a small peninsula of rock there occurs a coarse augen gneiss containing three or four angular blocks of rusty weathering calcareous amphibolite. Note that the foliation in these amphibolite blocks is discordant to the foliation in the surrounding gneiss; note the angularity of the blocks and the fact that borders of these blocks contain less amphibole than the block as a whole; note tight folding of the gneiss in the vicinity of these blocks. What is the origin of this lithology and structure?

Return westward along Road 112 to Rt. 8.

38.5 Turn right (north) on Rt. 8.

40.9 Road off to left (west) to Ohio. Keep straight ahead.

44.7 Cross West Canada Creek.

45.0 Intersection of Rt. 8 and Rt. 287. Turn to mileage point 63.3 of Group A road log and follow Group A road log for itinerary and description of STOPS 4, 5, 6, 7, 8, 9, 10, and 11. Resume this Group B road log when Group A log reads 118.6 miles.

100.3 Intersection of Rts. 8 and 287 in western quadrant of Ohio Quadrangle. Bear right (west) on route 287.

103.0 Approximate western boundary of Ohio Quadrangle.

106.4 Low hill with outcrops on north side of road 0.3 mile west of arm of reservoir. Dirt road from Wheelertown enters Rt. 287 from north and 100 yards east of outcrop. STOP 3.

STOP 3.

Coarse grained hornblende-quartz-microperthite gneiss; dominantly pink, some greenish. Note contorted and wavy foliation planes. Mapped by Miller (1909) as "syenite." This rock is more massive than the bulk of the granite and syenite gneisses in the region. This lithology is interesting because it points up the problem of rock nomenclature in the Adirondacks. On the basis of mineralogy, is this a syenite gneiss?

Proceed west on Rt. 287 along north side of Hinckley Reservoir (Utica water supply).

110.3 Dam across West Canada Creek creating Hinckley Reservoir.

110.7 Hinckley.

112.8 Prospect. Bear left across main intersection in village and follow Rt. 28B towards Trenton. The West Canada Creek makes a sharp bend at Prospect, reflecting a post-glacial diversion. The West Canada Creek rises in the West Canada Lakes area (north of Piseco) and flows southwesterly to Prospect; at Prospect the river turns abruptly and flows through the Trenton Gorge in a southeasterly direction to the Mohawk River. Presumably, the pre-glacial West Canada Creek had a continuous southwesterly course from source to the Mohawk River near Rome; an ice or drift dam deflected the West Canada Creek at

Prospect in late glacial time and caused the river to flow southeasterly from this point and cut the Trenton Gorge. At Prospect Falls, just east of the village, there are excellent exposures of fossiliferous Coburg Formation (Trenton group).

114.4 Pass under N Y C R R.

114.5 Rt. 28B goes off to left. Keep straight ahead. Cross over Cincinnati Creek which exposes Trenton group.

114.8 Cloverleaf. Go north on Rt. 12 toward Old Forge. The sand and gravel exposed in the vicinity of the cloverleaf are part of a large delta plain (elevation 1000 feet) built into glacial Lake Herkimer.

117.9 Route 28B enters from east. Remsen Diner and Slim's Diner.

120.4 Morainal belt.

121.0 Cross over New York Central tracks.

124.7 Rt. 28 bears right. Stay on Rt. 28 toward Old Forge.

125.7 Deltaic deposit of Lake Forestport. Elevation 1200 feet.

126.6 Turn left off Rt. 28 on black top road just south of bridge.

126.7 Black River below dam. STOP 1.

STOP 1.

Sillimanite gneiss, mapped by Miller (1909) as "syenite-Grenville complex." The dominant rock here is a medium grained gray sillimanite-biotite-quartz-feldspar gneiss. The foliation planes on weathered surface are accentuated by flattened white matts of fine grained fibrous sillimanite (fibrolite), quartz, feldspar, and magnetite. This rock does not resemble any of the syenite gneisses. It is probably a metasediment of the Grenville sequence.

Does the presence of sillimanite distributed through this gneiss indicate that the parent rock was sedimentary?

Magnetite seems to be more abundant in this rock than in other lithologies of the region. Why is it associated with sillimanite?

The following interesting side trip to Enos must be omitted because of lack of time. At Enos there is exposure of steeply-dipping Grenville metasediments. Proceed from Forestport as follows:

00.0 Proceed north across bridge below dam and enter town of Forestport.. Turn right onto road to Forestport Station.

0.4 Pass under Rt. 28 and continue up north side of Black River.

1.2 Cross Woodhull Creek. Road enters from right, keep straight ahead.

1.6 Forestport Station. Turn right across tracks of N Y C R R on road to Bardwell Mill and Pine Creek Trout Farm.

2.4 Turn left on road to Enos. Cross extensive sand plain, elevation 1200 feet.

6.9 Bridge over Black River at Enos. STOP 2.

STOP 2.

On southeast side of river, downstream from the bridge, the following steeply dipping interlayers of the Grenville sequence can be seen:

medium grained garnetiferous quartzite
medium grained rusty weathering diopside-quartz marble
graphitic calcareous tremolite-diopside quartzite
biotite gneiss
silicified metasediments: well defined nearly vertical bedding preserved in a solid mass of quartz which exhibits nearly horizontal jointing.

About two hundred yards above the bridge on the southeast side of the river is exposed a sillimanite-biotite-quartz feldspar gneiss.

Return to Rt. 28 and follow Rt. 28 south to junction with Rt. 12 at Alder Creek. Follow signs to Utica.

128.8	Rt. 28 joins Rt. 12. Go south on 4-lane highway.
136.4	Top of Marcy Hill.
149.1	Rts. 12 and 28 go left; bear right on Horatio Arterial towards Rt. 5A.
152.2	Intersection of Horatio Arterial and Rt. 5A.

END OF ROAD LOG

Return to Hamilton College via Rts. 5A, 12B and 412.

REFERENCES FOR SUMMARY OF ADIRONDACK GEOLOGY AND TRIP C

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Buddington, A. F., 1941, Geology of the Willsboro Quadrangle, New York, N.Y. State Mus. Bull., no. 325

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Smyth, C. H., Jr., 1894, On gabbros in the southwestern Adirondack region, Am. Jour, Sci, 3rd. series, vol. 48, pp. 54-65.

Thompson, J. E. (Editor), 1956, The Grenville Problem, Roy. Soc. Canada Spec. Pub. no. 1. (see especially article by Buddington entitled "Correlation of Rigid units, types of folds, and lineation in a Grenville belt")

Turner, F. J. and Verhoogen, J., 1960, Igneous and Metamorphic Petrology, Sec. Ed., McGraw-Hill.

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SOURCES FOR GEOLOGIC MAP OF THE ADIRONDACK MOUNTAINS

(FIGURE C-1)

The following quadrangles are after Buddington, Geol. Soc. Am. Memoir 28, 1948, Plates 1 and 2: Antwerp, Brier Hill, Canton, Cranberry Lake, Carthage, Gouverneur, Hammond, Lake Bonaparte, Long Lake, Lowville, Nicholville, Ogdensberg, Oswegatchie, Potsdam, Raquette Lake, Russell, St. Regis, Santa Clara, Stark, and Tupper Lake. Buddington's plates are based large on his work. Many of these quadrangles are also published as N.Y. State Museum Bulletins.

Other sources are:

Quadrangle	Author	Source
Alexandria Bay	Cushing	N.Y.S. Mus. Bull 145
Theresa	"	"
Port Leyden	Miller	N.Y.S. Mus. Bull. 135
Number Four	no data	
McKeever	"	
Remsen	Miller	N.Y.S. Museum Bull. 126
Big Moose	Buddington	U.S.G.S. open file; some unpub. recon. by Isachsen, State Geol. Surv.
Old Forge	Isachsen	unpublished recon. map, State Geol. Survey, Albany
Ohio	Nelson	unpublished (U.S.G.S.)
Little Falls	Cushing	N.Y.S. Mus. Bull 77
Childwold	very little data; Mem. 28	after Buddington,
West Canada Lakes	Isachsen	unpublished <u>prelim</u>. recon. map, State Geol. Survey
Piseco Lake	Cannon	N.Y.S. Mus. Bull 312
Lassellsville	no data	
Malone	Postel et al	U.S.G.S. Misc. Geol. Inv. Map I-167
Long Lake	Cushing	N.Y.S. Mus. Bull 115
Blue Mtn.	Miller	N.Y.S. Mus. Bull 192
Indian Lake	Krieger	Open file map, State Geol. Survey, Albany
Lake Pleasant	Miller	N.Y.S. Mus. Bull 182
Gloversville	Miller	open file map, State Geol. Survey, Albany
Chateaugay	Balsley, Postel	U.S.G.S., Geoph. Inv. Map GP-191
Loon Lake	Postel et all	U.S.G.S. Geol. Quad. Map 63
Saranac Lake	Buddington	N.Y.S. Mus. Bull. 346
Santanoin	no data; contacts guessed	
Newcomb	Balk	N.Y.S. Mus. Bull 290
Thirteenth Lake	Krieger	N.Y.S. Mus. Bull 308

Quadrangle	Author	Source
Harrisburg	Thompson	open file map, State Geol. Survey, Albany
Broadalbin	Miller	N.Y.S. Mus. Bull. 153
Churubusco	Postel	U.S.G.S. Prof. Paper 237
Lyon Mountain	Postel	U.S.G.S. Prof. Paper 237
Lake Placid	Miller	N.Y.S. Mus. Bull 211
Mt. Marcy	Kemp	N.Y.S. Mus. Bull 229-230
Schroon Lake	Miller	N.Y.S. Mus. Bull 213-214
North Creek	Miller	N.Y.S. Mus. Bull 170
Luzerne	Miller	N.Y.S. Mus. Bull 245-246
Saratoga	Cushing	N.Y.S. Mus. Bull 169
Moores	Cushing	19th Rept. of the N.Y. State Geologist
Danemora	Postel	U.S.G.S. Prof. Paper 237
Ausable Forks	Kemp and Alling	N.Y.S. Mus. Bull 261
Elizabethtown	Kemp	N.Y.S. Mus. Bull 138
Paradox Lake	Walton	open file map, State Geol. Survey, Albany
Bolton	Newland and Vaughan	N.Y.S. Mus. Handbook 19
Glens Falls	"	N.Y.S. Mus. Handbook 19
Willsboro	Buddington	N.Y.S. Mus. Bull. 325
Port Henry	Kemp	N.Y.S. Mus. Bull 138
Ticonderoga	Walton	open file map, State Geol. Survey, Albany
Whitehall	Newland and Vaughan	N.Y.S. Mus. Handbook 19
Fort Ann	Fisher!	N.Y.S. Mus. Bull 359 (Precambrian contact only)