FIELD TRIP GUIDEBOOK

NEW YORK STATE GEOLOGICAL ASSOCIATION

32nd ANNUAL MEETING

HAMILTON COLLEGE

CLINTON, NEW YORK

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GUIDEBOOK FOR FIELD TRIPS

32nd Annual Meeting of the

NEW YORK STATE GEOLOGICAL ASSOCIATION

prepared by

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CONTENTS

STRATIGRAPHIC COLUMN - UTICA AND LITTLE FALLS QUADRANGLES

SYSTEM SERIES Group FORMATION Member	Character of rocks	Thickness in feet
SILURIAN		
CAYUGAN		
Salina		
CAMILLUS	Mottled reddish and yellowish-green, and drab colored calcareous shale with flaggy dolomite beds.	100-300'
VERNON	Red crumbly shale with green layers and spots, and a green zone at base.	160-340'
disconformity.		
NIAGARAN		
Lockport		
ILION	Gray-black dolomitic shale with interbedded dolomite beds, some of which contain stromatoporoids.	60'
Clinton		
HERKIMER	Interbedded gray sandy dolomite, dolomitic sandstone, and shale, with a 3-foot hematitic, sandy, fossiliferous, dolomitic-calcareous ledge at base.	80'
WILLOWVALE	Green, thin-bedded shale with interbeds of fine-grained calcareous sandstone. At base is a 2½-foot bed of red, oolitic hematite.	32'
SAUQUOIT	Interbedded sandstone and shale with thin conglomerate beds. Cross-bedding is common.	160-200'
ONEIDA	Quartz-pebble conglomerate and sandstone, in massive beds. Four to six inches of conglomerate at base is richly impregnated	25-30'

with pyrite. Top is gradational into overlying Sauquoit.

disconformity. . . . .

ORDOVICIAN

CINCINNATIAN

Eden

FRANKFORT

Moyer	Gray, silty to arenaceous shale, with beds of sandstone.	400'
Hasenclever	Finely cross-laminated, thin-bedded fine sandstone and interbedded greenish shale.	50'
Harter	Greenish-gray laminated shale which grades into black shale of the Utica, below.	100'

CHAMPLAINIAN

Trenton

UTICA	Finely laminated black shale.	400-700'

disconformity. . . . .

COBOURG

Steuben	Thick-bedded, cross-laminated calcarenite.	60'
Rust	Mostly thin limestone beds with intercalated calcareous shale.	115'

DENMARK

Russia	Black, bituminous, impure limestone with irregular shale interbeds. The upper 12' is calcareous mudstone and brown-weathering calcareous argillite.	70'
Poland	Interbedded gray-black limestone and calcareous shale.	60'

SHOREHAM

Rathbun	Interbeds of coquina-calcarenite, calcilutite, and calcareous shale.	9'
lower Shoreham	Thin-bedded limestone interbedded with calcareous shale.	35-45'

KIRKFIELD 4-45'

Thin-bedded limestone interbedded with calcareous shale. Thick calcarenite beds at top.

ROCKLAND 0-13'

Black, dark-weathering, somewhat cherty limestone, with shale partings toward the southeast. Missing near boundary between quadrangles.

disconformity. . . . .

Black River

LOWVILLE 26-40'

Upper part is light-gray weathering, medium gray calcilutite. Lower part is gray-brown, heavy-ledged, sandy and muddy limestone.

disconformity. . . . .

CANADIAN

TRIBES HILL 0-45'

Limestone and dolomite, commonly muddy and sandy.

disconformity. . . . .

CAMBRIAN

CROIXIAN

LITTLE FALLS Up to 450'

Dolomite, sandy dolomite, and dolomitic sandstone. Conglomerate at base.

unconformity. . . . .

PRECAMBRIAN (General sequence for southern Adirondacks)

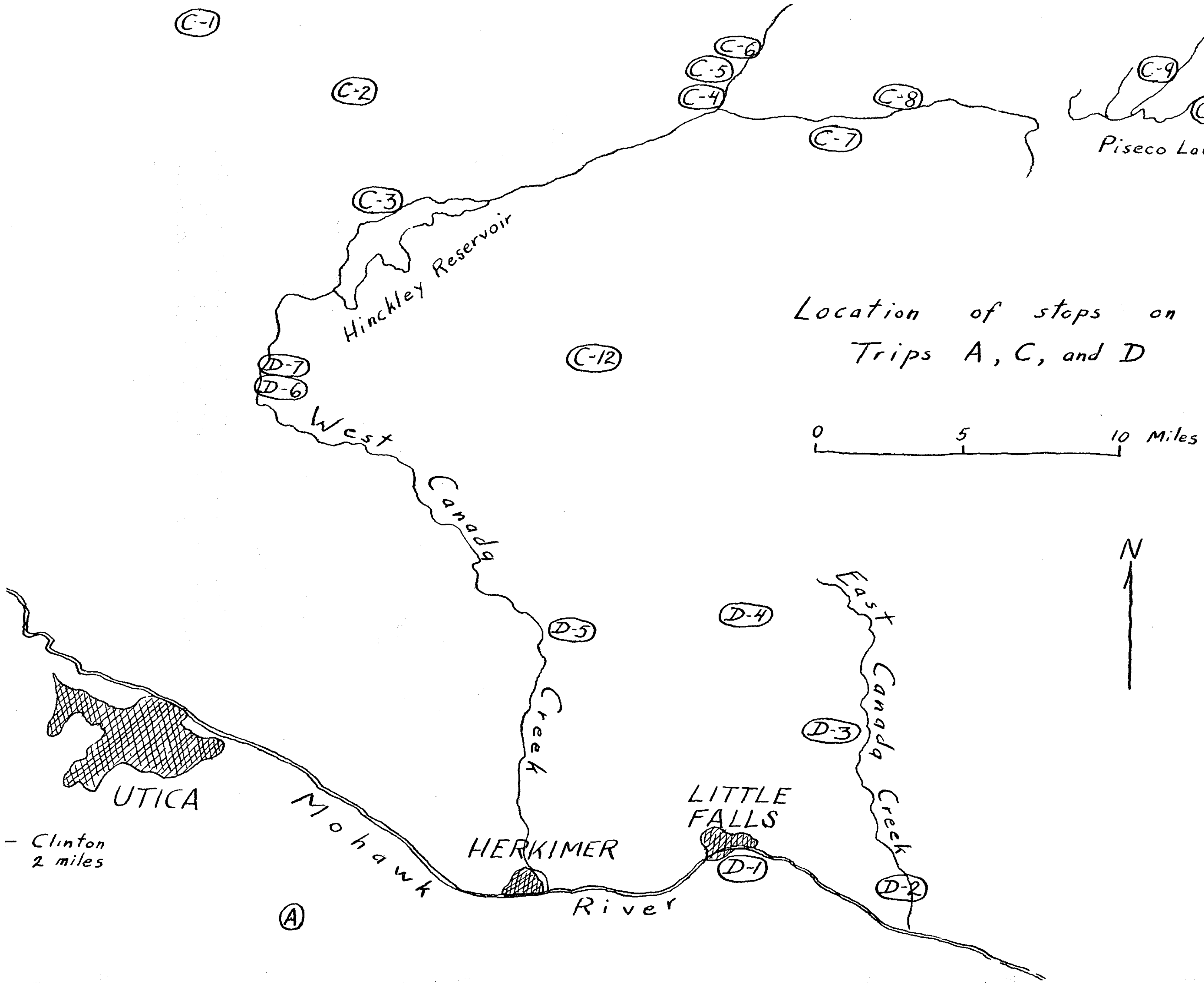
Hornblende-granite gneiss and biotite-granite gneiss

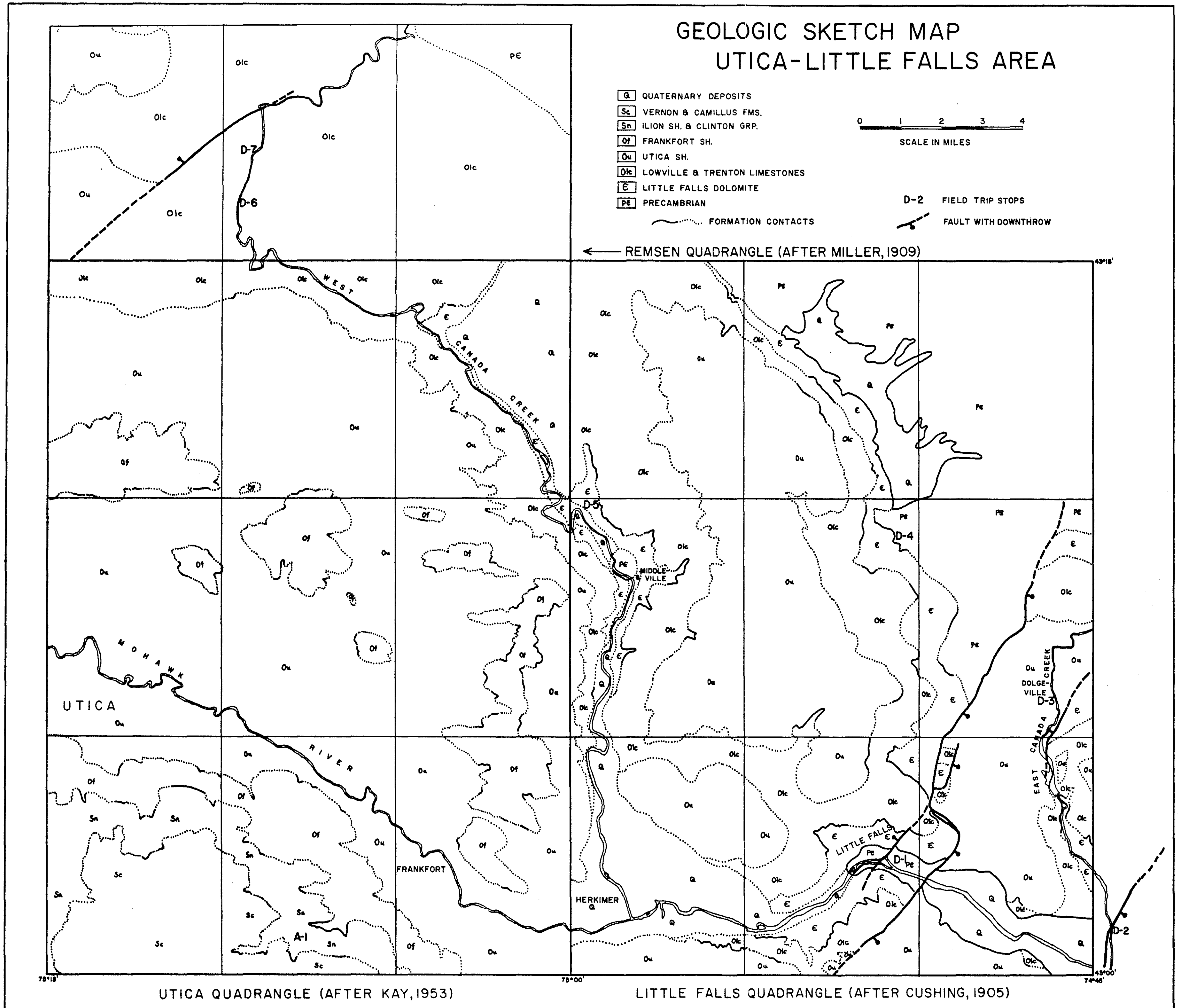
(major deformation and metamorphism)

Pyroxene-quartz-syenite gneiss

Anorthosite-gabbro

Grenville metasediments, including marble, paragneiss, quartzite, and amphibolite (some may be metagabbro or metavolcanic).


Location of stops on Trips A, C, and D
C-1
C-2
C-3
C-4
C-5
C-6
C-7
C-8
C-9
C-10
C-11
C-12
Piseco Lake
Hinckley Reservoir
D-7
D-6
D-5
D-4
D-3
D-2
D-1
West Canada Creek
East Canada Creek
0
5
10 Miles
N
UTICA
Mohawk River
HERKIMER
LITTLE FALLS
- Clinton 2 miles
A


GEOLOGIC SKETCH MAP
UTICA-LITTLE FALLS AREA
Q QUATERNARY DEPOSITS
Sc VERNON & CAMILLUS FMS.
Sn ILION SH. & CLINTON GRP.
Of FRANKFORT SH.
Ou UTICA SH.
Olc LOWVILLE & TRENTON LIMESTONES
Є LITTLE FALLS DOLOMITE
PЄ PRECAMBRIAN
FORMATION CONTACTS
0 1 2 3 4
SCALE IN MILES
D-2 FIELD TRIP STOPS
FAULT WITH DOWNTHROW
REMSEN QUADRANGLE (AFTER MILLER, 1909)
WEST CANADA CREEK
MOHAWK RIVER
UTICA
FRANKFORT
HERKIMER
MIDDLEVILLE
LITTLE FALLS
DOLGEVILLE
EAST CANADA CREEK
D-1
D-2
D-3
D-4
D-5
D-6
D-7
A-1
43°15'
43°00'
75°15'
75°00'
74°45'
UTICA QUADRANGLE (AFTER KAY, 1953)
LITTLE FALLS QUADRANGLE (AFTER CUSHING, 1905)

TRIP A - FRANKFORT GULPH SILURIAN SECTION

Purpose: The trip visits exposures of the Frankfort-Oneida disconformity, the overlying Clinton group, and the Vernon shale. These are the best exposures of the Clinton group in the type area.

Acknowledgments: The itinerary was suggested, and the localities described in Marshall Kay's "Geology of the Utica Quadrangle," 1953, New York State Museum Bulletin #347.

General: The unconformity at the base of the Oneida conglomerate is a reflection of the Taconian orogeny in New England. Most of the upper Ordovician and all of the lower Silurian are missing in this time gap. The overlying formations reflect a shoreline encroaching from west to east across New York State. The peculiar environment of deposition of the Clinton iron ores is discussed in section B of this guidebook. The Vernon shale, lowest member of the Salina group, represents the mud flats of a great delta built out from the east, which was intermittently encroached upon by hyper-saline seas from the west (Fisher, 1957). The extension of seas eastward across the state during Silurian time accompanied the erosional reduction of the Taconian mountains in New England.

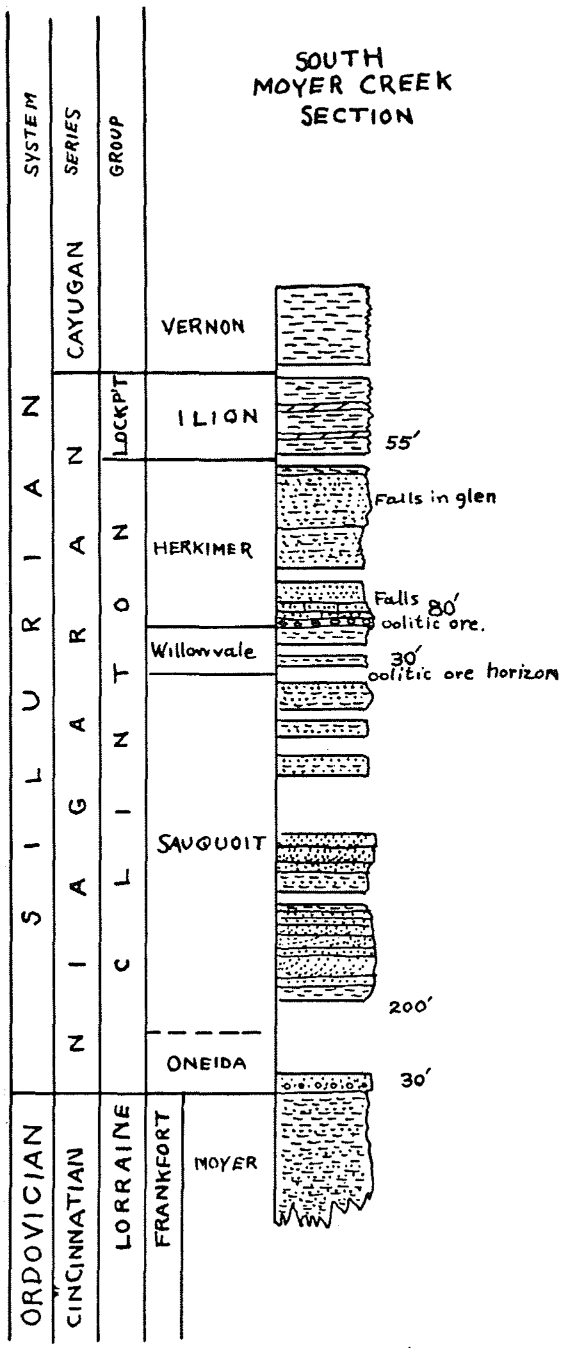
Selected References:

Dale, Nelson C., 1953, Geology and Mineral Resources of the Oriskany Quadrangle (Rome Quadrangle): N. Y. State Mus. Bull. 345.

Fisher, Donald W., 1957, Lithology, Paleoecology, and Paleontology of the Vernon Shale (Late Silurian) in the Type Area: N. Y. State Mus. Bull. 364.

________, 1960, Correlation of the Silurian rocks in New York State: N. Y. State Mus. & Sci. Service, Geol. Sur. Map and Chart Series #1.

Kay, Marshall, 1953, Geology of the Utica Quadrangle, New York: N. Y. State Mus. Bull. 347.



After Kay, 1953, p.31

TRIP A. FRANKFORT GULPH SILURIAN SECTION

Road Log

This trip is being run in two sections. Section 1 will follow the log as shown below, and the walk will be up the valley of South Moyer Creek. Section 2 will drive to the upper end of the valley of South Moyer Creek, and walk down through the section. Buses will wait where their passengers disembarked, and take the other section's passengers back to the campus.

0.0 Leave Hamilton College on College Hill Road going east to Clinton.

1.5 Go straight through Clinton, out Kellogg St. toward the east.

3.1 Y junction. Bear left on Kellogg St., following sign to Chadwicks.

4.7 Cross Rte. 12, continuing east.

5.4 Abandoned quarry to right (S) of road, in Bertie waterlime. This is Crow Hill.

5.9 Snowden Hill Road enters diagonally from right (S).

6.0 Bear left on continuation of Snowden Hill Road.

7.3 Downhill into Sauquoit Valley. Mohawk Valley in distance to left (N).

7.7 Turn right on to Oxford Road.

7.8 Take first right on to Tibbits Road.

8.0 Turn right on Kellogg Road in Washington Mills.

8.1 Cross railroad tracks.

8.4 Cross Oneida Street; traffic light.

9.6 Full stop sign at intersection. Turn right on Higby Road.

10.2 Continue past cemetery on right.

10.6 Continue across Sessions Road.

12.25 Continue across Graffenburg Road. Cemetery on left near corner.

13.4 Turn right on Minden Turnpike, Road 104. This is Stewart Corners.

14.5 Y junction. Bear left on Road 185. Frankfort Hill cemetery in "Y."

15.2 Gravel pit on left (N) has coarse gravel foreset beds. It is a delta that was deposited in Lake Herkimer. Elevation of top is 1280'.

15.7 T junction at hamlet of Gulph. Turn left, down the valley.

17.6 Very sharp curve just beyond bridge over Moyer Creek. Park buses on right beyond curve and disembark. KEEP WELL OVER TO OUTSIDE OF CURVE. EXAMINE THE FRANKFORT-ONEIDA CONTACT, AND MOVE ON SO OTHERS MAY DO SO.

STOP 1. (the only stop on this trip) South Moyer Creek section.

This is one of the representative sections described by Kay (1953) as being the best, almost continuous exposure of the Silurian in the Utica quadrangle, and the following description is partly abstracted from his (p. 28-32).

At the bend of the road at the junction of Moyer and South Moyer Creeks, the road cut exposes the Sauquoit sandstone over the Oneida conglomerate, which in turn lies unconformably on the Frankfort shale (Moyer member). The Oneida is a massive quartz-pebble conglomerate which in the lower part contains many fragments of the underlying Frankfort. The basal 4-6 inches is impregnated with pyrite. The Oneida-Sauquoit contact is not accessible here, and is not sharply defined. It is inferred to be just below the strongly cross-bedded sandstone about 20 feet above the base of the Oneida.

About two hundred feet up the road, descend the bank on a trail, cross Moyer Creek, and proceed up the valley of South Moyer Creek.

Several hundred yards upstream the creek flows in a narrow channel cut in clayey till.

Upstream from the channel-cut till is the first Sauquoit sandstone, pebbly, dark greenish-gray heavy ledges. About fifty yards farther are the ripple-marked, coarsely (3') cross-bedded ledges figured by Kay (1953, p. 34). Worm trails in the sandstone strikingly resemble recent trails on bottom sand, often found here.

Farther upstream, 100' above the Sauquoit base, is a 20-foot zone of hematitic sandstone with red and greenish-gray clay galls and prominent cross-bedding (Grossman, in Kay, 1953, p. 68).

Still in the Sauquoit are beds of green shale inter-bedded with fine-grained sandstone. Interference ripples show well on several beds. These beds are somewhat fossiliferous.

Farther upstream on a 12-18-inch fine conglomerate bed are giant current ripples (WL about 30"), and above that a sandstone bed with prominent smaller current ripples. Current modified interference ripples appear on ledges about fifty yards farther upstream.

In the upper Sauquoit are heavy ledges of hematitic sandstone.

Above this the contact with the overlying Willowvale, and its basal oolitic hematite bed, is covered. The Willowvale is green, thin-bedded shale with some interbeds of fine-grained sandstone and siltstone, 30 feet thick.

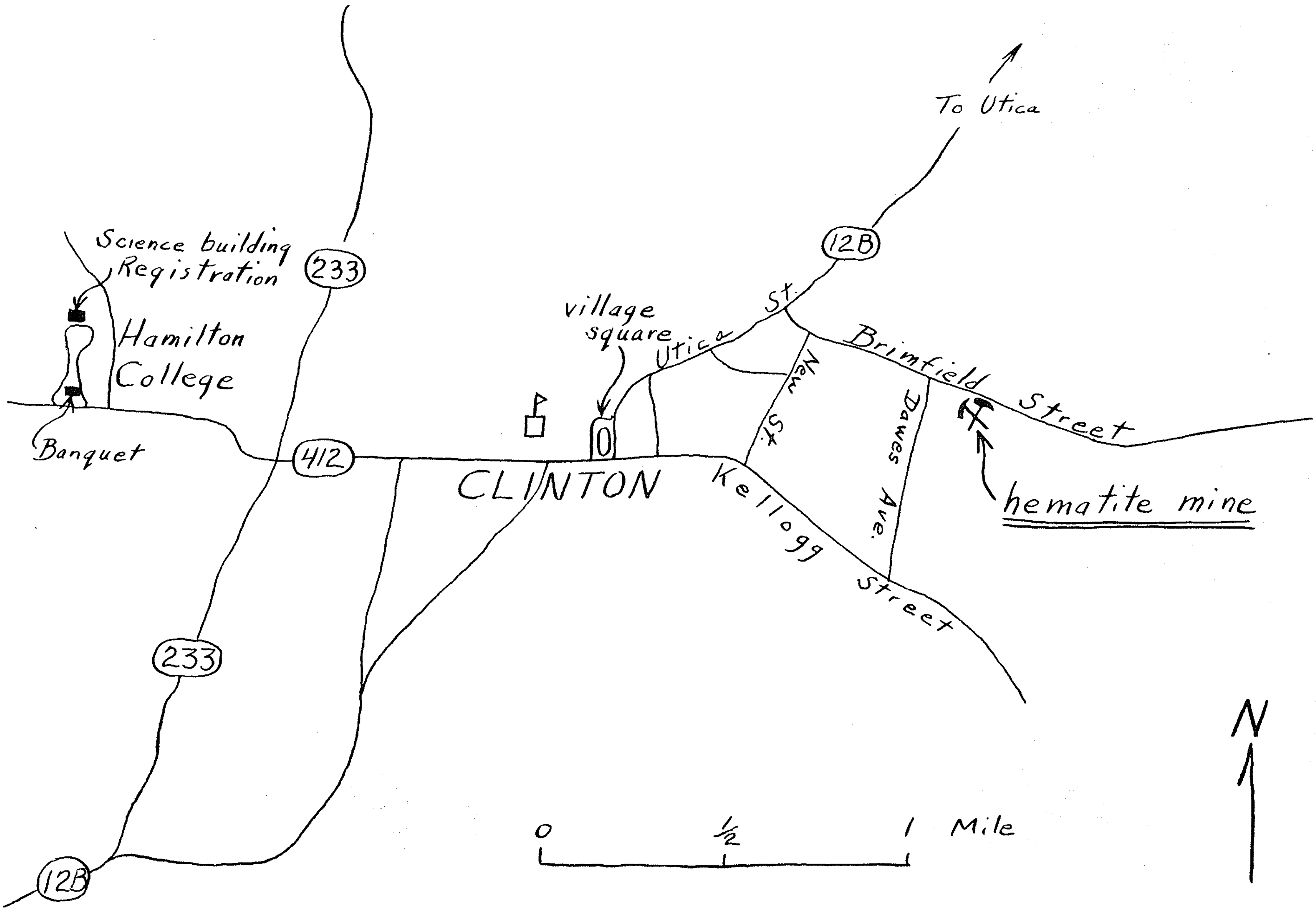
The base of the overlying Herkimer is marked by a prominent 1-2-foot bed of strongly cross-bedded, sandy, oolitic hematite, which in other localities is as much as 3 feet thick (Kay, 1953, p. 35, fig. 25). The Herkimer is 80 feet thick, of interbedded rusty-weathering, pyritiferous, sandy dolomite and dolomitic sandstone, and gray shale. Several cascades are formed by resistant beds in the Herkimer.

The top of the Herkimer is distinct, though the contact with the overlying Ilion shale (Fisher, 1960) is covered. Within a few feet of cover there is a change from the dolomitic sandstone of the Herkimer, below, to dark gray, fissile shale with 2-4-inch dolomite beds. The Ilion (Lockport?) is shown in fig. 24, p. 35 of Kay. It is 55 feet thick here.

The overlying Vernon has at its base 5 feet or more of green shale which is noticeable lowest in the stream channel. Above the basal green shale zone, which contains a few dolomite concretionary beds, is the typical red, crumbly, practically unbedded mudstone. The Vernon continues to the top of the exposed section in South Moyer Creek.

Board the waiting buses and return to the Hamilton Campus.

Location of hematite mine (Trip B)



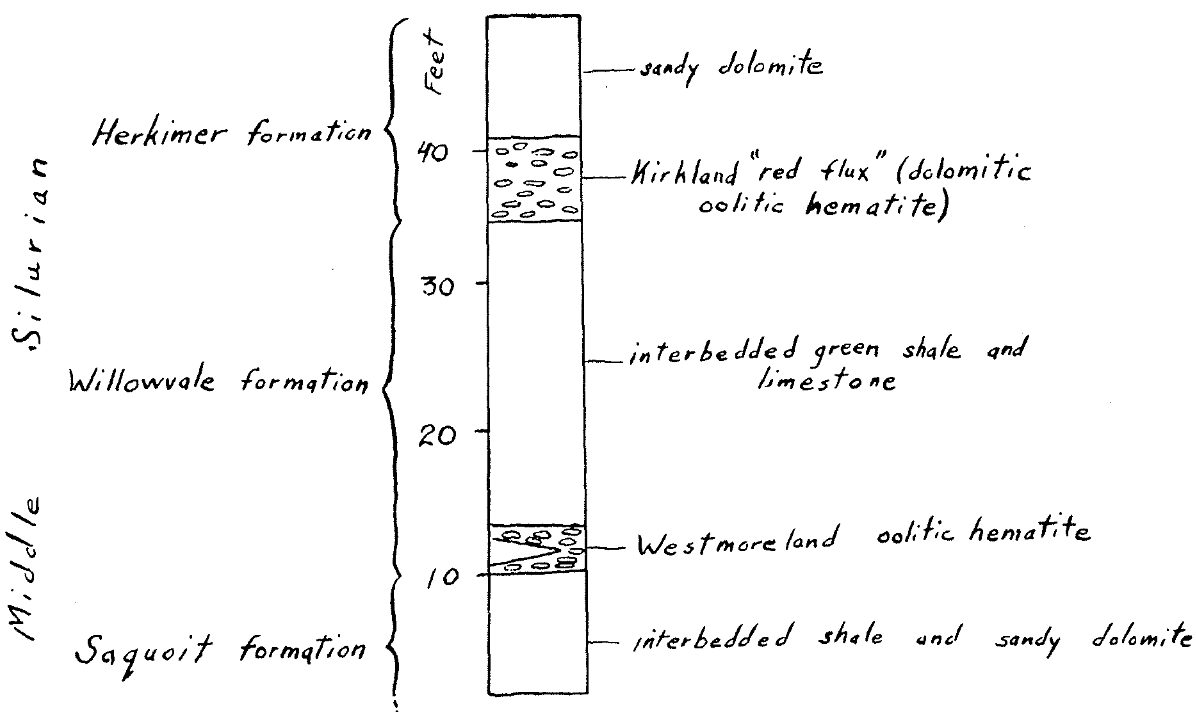
Trip B. Clinton Metallic Paint Company Mine, Brimfield Street, Clinton, N.Y. Proceed to mine by your own transportation. Small groups will be taken underground at regular intervals between 1:30 P.M. and 4:15 P.M.

Owner: Mr. Bruce M. Bare
Mine Foreman: Mr. Robert Barry
In charge of Mine Trip: Mr. Alvin J. Snyder

EVERYONE VISITING THIS MINE MUST SIGN A WAIVER AND GIVE IT TO MR. SNYDER BEFORE GOING UNDERGROUND. PLEASE SHOW DUE RESPECT FOR ALL PROPERTY AT THIS TIME.

The mining of oolitic hematite at Clinton, N.Y. dates back to 1797. Up until the first World War ore was used as a source of iron and the smelting was done locally at Franklin Springs and Kirkland. The Clinton Metallic Paint Company sank its Brimfield Street shaft in 1928. The mining is a modified longwall operation; the ore is hand sorted at the working face and again at the mine head. At the company's plant in Franklin Springs the ore is crushed to pass 325 mesh, bagged, and sold as a paint pigment, coloring agent for cements, and as a casting powder.

There are two principal beds of oolitic hematite in the Clinton Group (see details below and general stratigraphic position in the Table of Silurian Formations, Trip A)



After Alling, 1947, p. 999

The Westmoreland ore is the bed mined at Brimfield Street. Alling (1947) shows that the Westmoreland ore at Clinton, N.Y. consists of a lower one-foot layer of oolitic hematite separated by two feet of "siliceous" rock from an overlying two-foot layer of oolitic hematite. At the Brimfield Street mine this intervening "siliceous rock" or shale parting is generally absent so that the Westmoreland ore bed is about 30 to 36 inches thick and quite homogeneous. The Kirkland "red flux", a low grade dolomitic hematite bed, occurs 18 feet stratigraphically above the Westmoreland ore bed but the former cannot be seen in the encased shaft of the mine.

Sharp upper and lower bedding plane contacts are typical of the Westmoreland ore. Current ripple marks having a wave length of more than one foot are seen along the upper contact of the oolitic hamatite at several places in the mine. Oolitic hematite beds in the south branch of Moyer Creek (See Trip A) exhibit well developed crossbedding. Dale (1953) notes the presence of ripple marks and channel fillings in the overlying fossiliferous Willowvale formation, and both he and Alling conclude that the oolitic hematite beds are integral members of a shallow water marine depositional sequence.

The oolitic hematite consists principally of small ellipsoidal concretions or oolites from one to four millimeters in maximum dimension. Each oolite (Alling, 1947) consists of "onion skin" layers of fine grained hematite and chamosite (iron-rich chlorite) surrounding a nucleus of well-rounded quartz, calcite, or hematite. The oolitic ore is dominantly a dull (Tuscan) red with some irregular thin lenses and seams of bright red microcrystalline earthy hematite. Interstitial to the oolites is silica (largely quartz, minor chert), dolomite, calcite, glauconite, pyrite, and francolite apatite). Newland and Hartnagel (1908, p. 62) give the following average chemical analysis for oolitic hematite from the mines at Clinton, N.Y.

SiO_2	12.63
Al_2O_3	5.45
Fe_2O_3	63.0
MnO	.15
CaO	6.2
MgO	2.77
S	.23
P_2O_5	1.5
CO_2	6.15
H_2O	2.77

Crinoid columnals and tests of brachiopods, cephalopods, bryozoa, and gastropods, all replaced by hematite, are quite common in the ore. Alling (1947) proposes a diagnetic replacement origin for the ore and summarizes the evidence as follows: 1) they (the ores) are of the bedded type in the strictest sense; 2) they are thin, long lenses, which pinch out and come in again; 3) they are very extensive (oolitic hematite beds of this age occur as far west as Wisconsin and as far south as Alabama); 4) they are associated with sediments of shallow-water origin; 5) they are integral members of a stratified series; 6) they are not the result of replacement long after the deposition and lithification of the rocks, otherwise the ores would be "pockety", and the iron would stain the adjacent rocks; 7) many stages of replacement including replacement of fossil fragments by hematite can be seen in thin section; 8) groundwater played no essential part in the formation of the ore. Alling believes that solutions carrying iron, silica, and alumina were introduced into moderately turbulent, yet clear shallow seas and there precipitated by reaction with carbonates, the marine salts, and possibly by bacteria and oxidation. The oolites may represent precipitation of hematite and chamosite (iron-rich chlorite) from a colloidal state during a period of some agitation of the water.

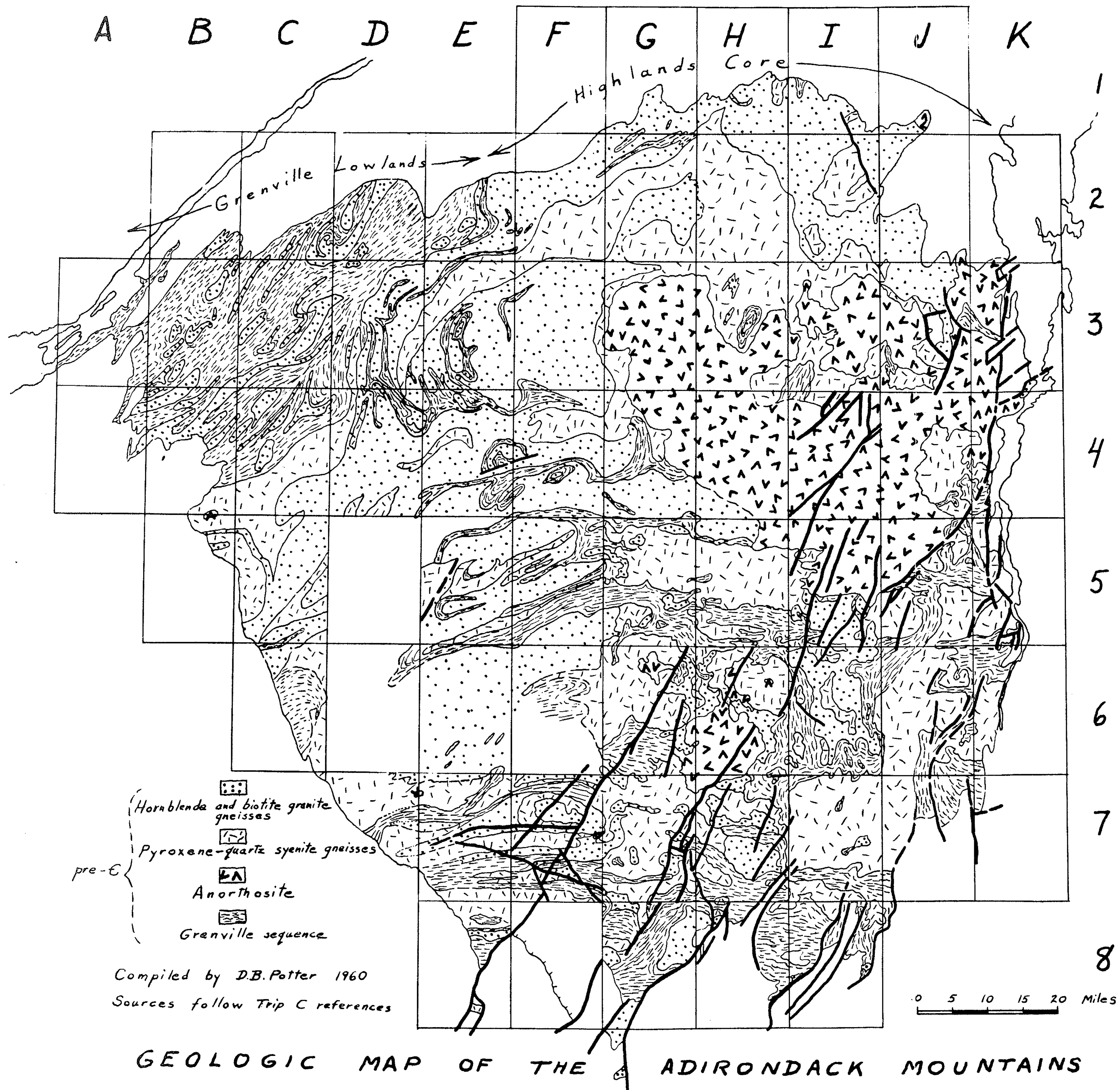
REFERENCES

Alling, Harold L., 1947, Diagenesis of the Clinton Hematite Ores of New York, Geol. Soc. Am. Bull., vol. 58, pp. 991-1018

Dale, Nelson C., 1953, Geology and Mineral Resources of the Oriskany Quadrangle, New York State Museum Bulletin No. 345.

Newland, D. H., and Hartnagel, C. A., 1908, Iron Ores of the Clinton Formation in New York State, New York State Museum Bulletin No. 123.

Figure C-1



GEOLOGIC MAP OF THE ADIRONDACK MOUNTAINS

KEY TO QUADRANGLES

A3	Alexandria Bay
A4	Theresa
B2	Brier Hill
B3	Hammond
B4	Antwerp
B5	Carthage
C2	Ogdensberg
C3	Gouverneur
C4	Lake Bonaparte
C5	Lowville
C6	Port Leyden
D2	Canton
D3	Russell
D4	Oswegatche
D5	Number Four
D6	McKeever
D7	Remsen
E2	Potsdam
E3	Stark
E4	Cranberry Lake
E5	Big Moose
E6	Old Forge
E7	Ohio
E8	Little Falls
F2	Nicholville
F3	Childwold
F4	Tupper Lake
F5	Raquette Lake
F6	West Canada Lakes
F7	Piseco Lake
F8	Lassellsville
G1	Malone
G2	Santa Clara
G3	St. Regis
G4	Long Lake
G5	Blue Mountain
G6	Indian Lake
G7	Lake Pleasant
G8	Gloversville
H1	Chateaugay
H2	Loon Lake
H3	Saranac Lake
H4	Santanoni
H5	Newcomb
H6	Thirteenth Lake
H7	Harrisburg
H8	Broadalbin
I1	Churubusco
I2	Lyon Mountain
I3	Lake Placid
I4	Mt. Marcy
I5	Schroon Lake
I6	North Creek
I7	Luzerne
I8	Saratoga
J1	Moores
J2	Danemora
J3	Ausable Forks
J4	Elizabethtown
J5	Paradox Lake
J6	Bolton
J7	Glens Falls
K3	Willsboro
K4	Port Henry
K5	Ticonderoga
K6	Whitehall
K7	Fort Ann

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 paragenies 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:

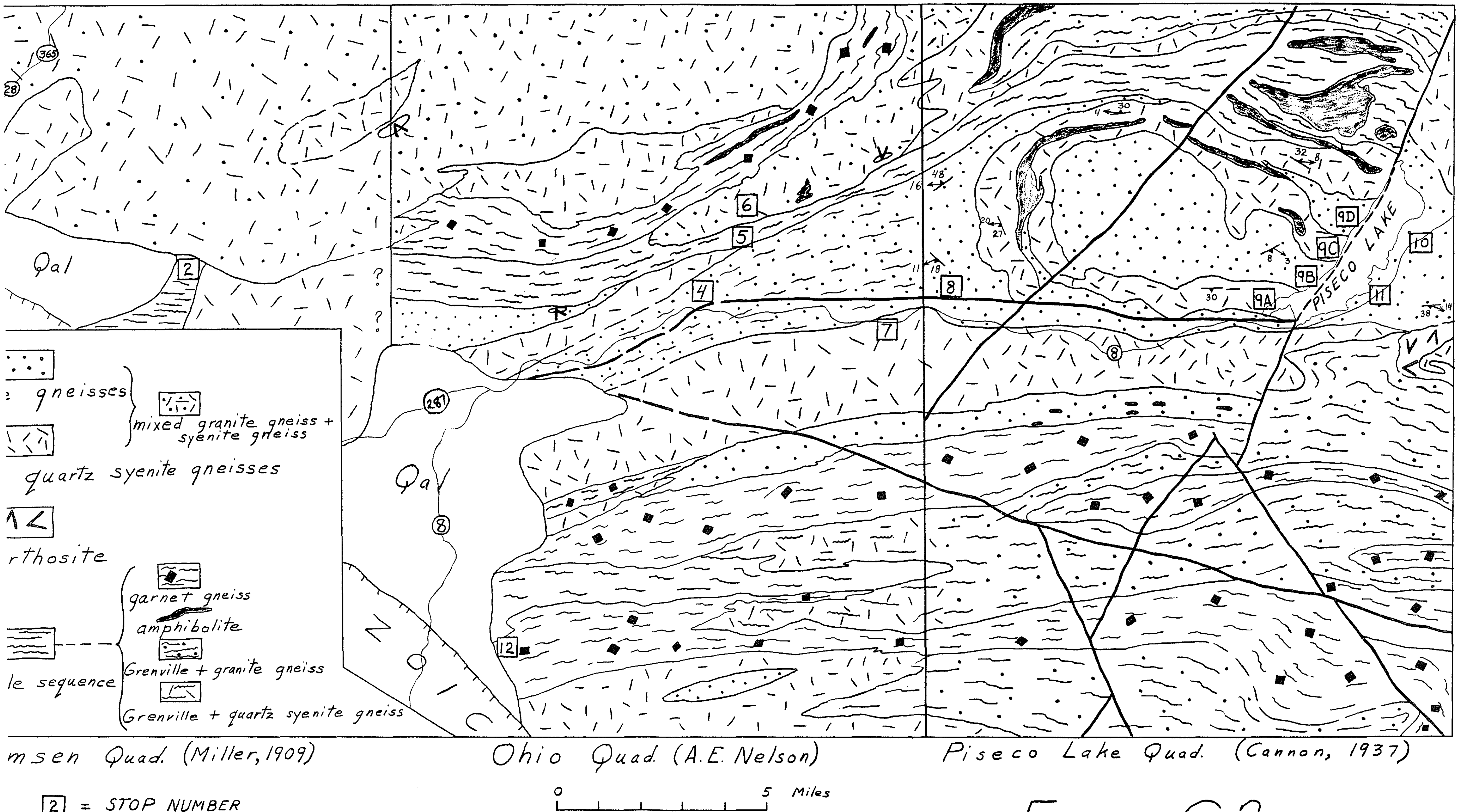
1. Most contacts between different rock types are conformable and there is no information by way of primary sedimentary structures, bedding-cleavage relations, etc. to establish the top side sense of a layer or the relative ages of two layers. Dikes having the compositions of the major igneous rock units 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.



Qal
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365
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8
8
gneisses
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)
0
5 Miles
2 = STOP NUMBER

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

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.

<u>Pyroxene-quartz syenite gneisses</u>:

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.

<u>Anorthosite</u>, <u>hypersthene gabbro</u>, <u>olivine norite</u>

<u>Grenville sequence</u>

(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 hypersthene 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. <u>STOP 2.</u>

<u>STOP 2.</u>

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 south-east 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.

****

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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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)

TRIP D - LITTLE FALLS AREA TO TRENTON GORGE

Purpose: The trip was arranged to permit observation of salient structures and the stratigraphy of formations in this area from the Precambrian through most of the Trenton group. In the sections observed there is evidence for the existence of an Adirondack arch, extending southwest through the Little Falls area.

Acknowledgments: Both the itinerary and the information in the field guide are heavily dependent on the work of Marshall Kay, particularly where the Trenton group is involved. For the Little Falls quadrangle the older work of H. P. Cushing has been used, and James R. Dunn, who has recently remapped the area, helped with the selection and explanation of localities in the field, and provided the summary of its geology for the guidebook. Donald W. Fisher helped with advice in the field, particularly regarding the extent to which Canadian formations are found in this area, and criteria for their identification.

General: The structural behavior of an arch extending southwestward from the south central Adirondacks through the Little Falls - Canajoharie area affected the types of sediment deposited, and whether or not any was deposited (or at least preserved) during the first half of the Ordovician period. Canadian formations, subject to intermittent warping during their deposition in the eastern Mohawk Valley, extend only as far west as Little Falls (Fisher, 1954). Of the Black River group, 230 feet thick in the Black River Valley, only the Lowville limestone reaches this area, and it is absent from Canajoharie eastward to the Amsterdam area (Young, 1943, and Fisher, 1954). Of the Trenton group, the lower formations (Rockland and Kirkfield) thin southeastward toward the arch, and are missing at Canajoharie where the Shoreham rests directly on Canadian strata (Kay, 1953).

The Shoreham is the youngest Ordovician formation to extend as a limestone around the south flank of the Adirondacks. The overlying Denmark, mostly limestone at Trenton Falls, changes eastward through the Dolgeville facies in the Little Falls quadrangle, to the much thicker Canajoharie shale of the eastern Mohawk Valley. The Cobourg similarly undergoes a facies change eastward, thickening and becoming the lower member of the Utica shale, if this may be called Utica (Kay, 1953, p. 46). The influx of argillaceous sediment from the east accumulated in greater thickness east of the arch, suggesting more rapid subsidence there than on the arch and westward from it, and the arch acted as a facies barrier during Denmark time. The muds spread westward across the arch during Cobourg time, though at Trenton limestone is found. Above the Cobourg, the Utica and younger shales indicate that the entire region was depressed and tilted southeastward, the direction in which the shales thicken. Details of this history are discussed in Kay (1953), pp. 74-76).

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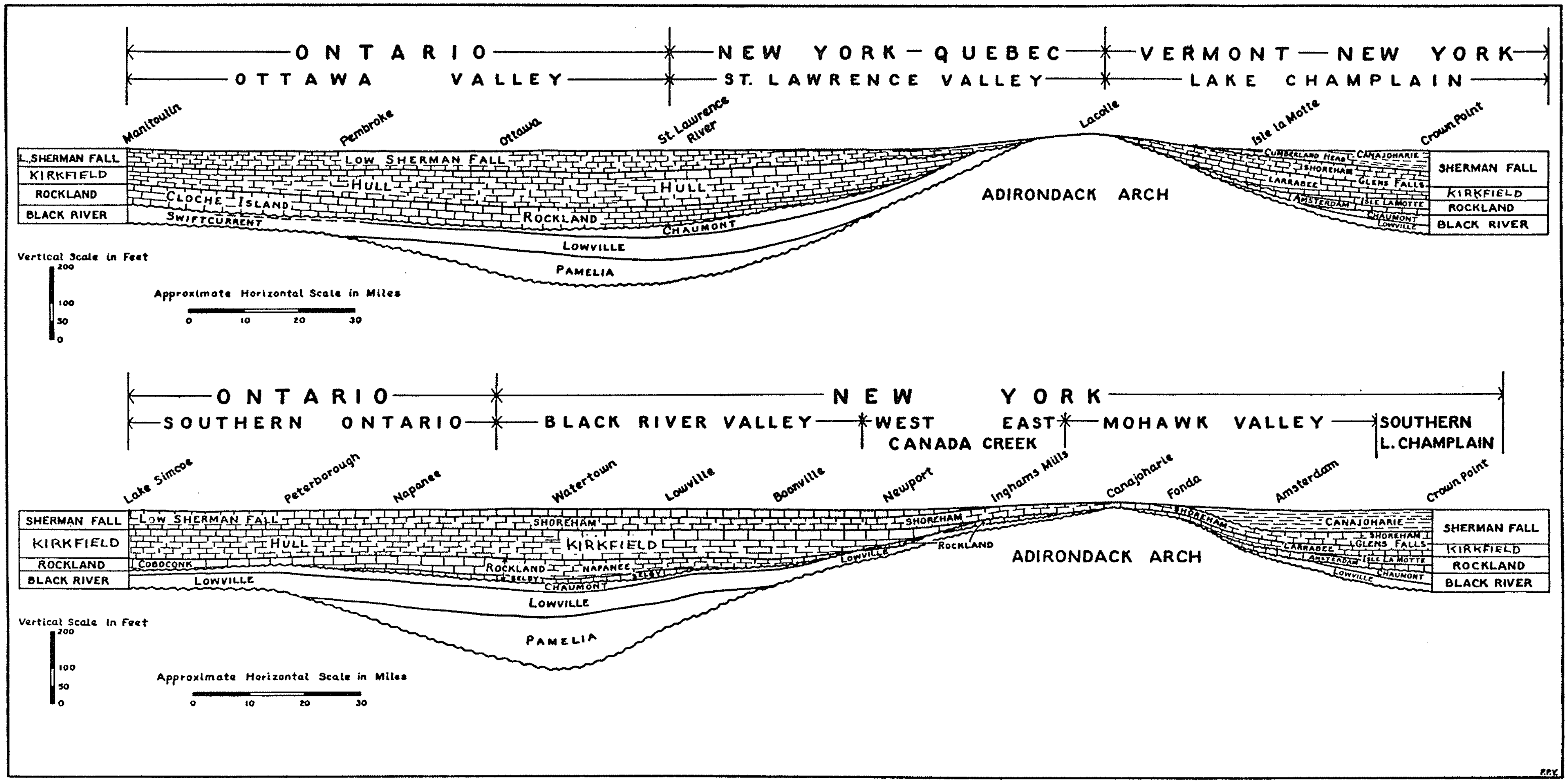
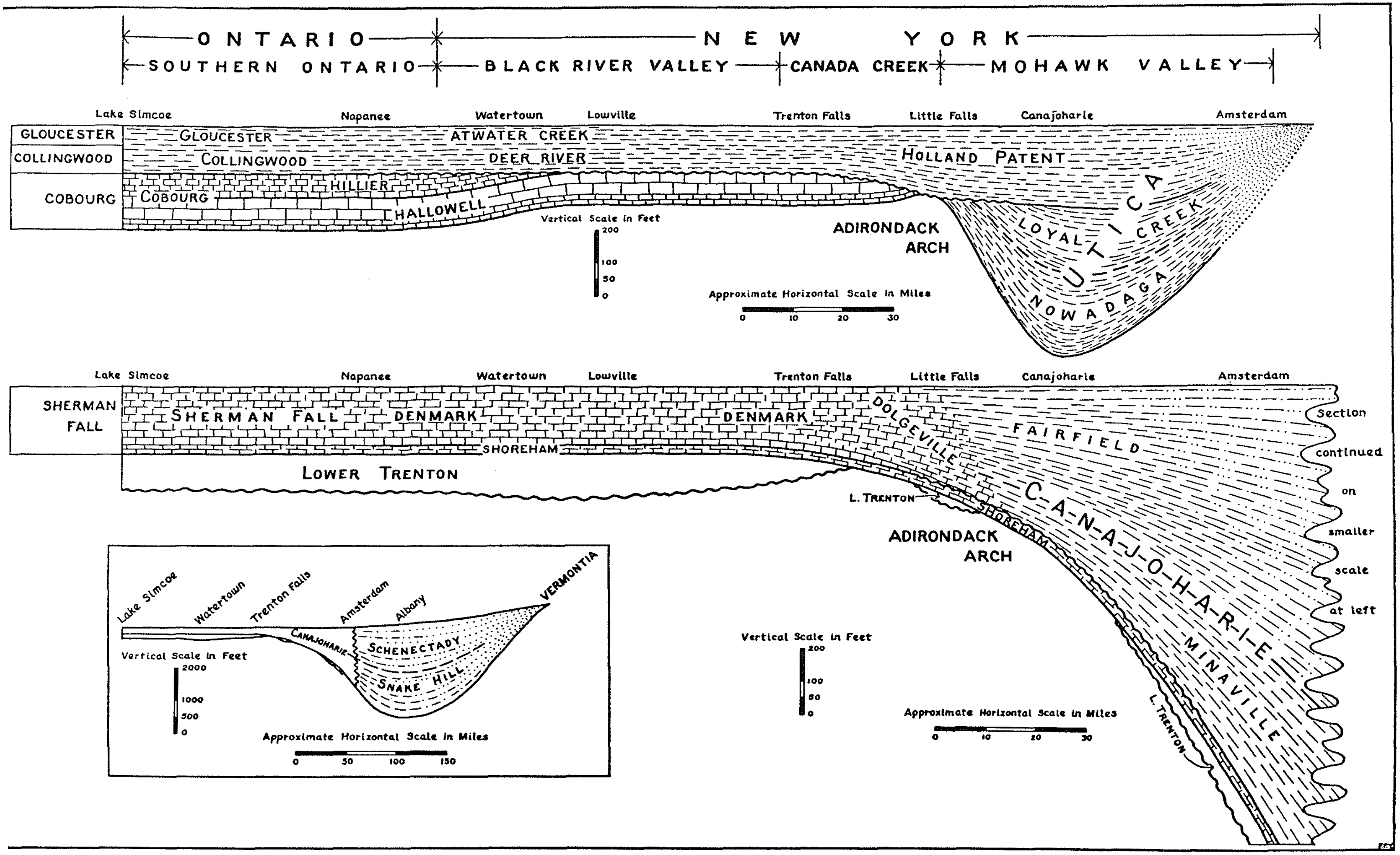


RESTORED SECTIONS OF LOWER TRENTON FORMATIONS ACROSS THE ADIRONDACK ARCH

From Marshall Kay's "Stratigraphy of the Trenton Group"
Geol. Soc. America Bull., v. 48, 1937

Note: As suggested by Kay in later publications, "Kirkfield" has been substituted for "Hull" in the standard columns and in the Black River Valley, on this chart.



RESTORED SECTIONS OF HIGHER TRENTON FORMATIONS FROM CENTRAL ONTARIO TO THE HUDSON VALLEY

From Marshall Kay's "Stratigraphy of the Trenton Group"
Geol. Soc. America Bull., v. 48, 1937

TRENTON LITHOLOGIES

Black River valley	Trenton Falls and Gravesville	Poland	Middleville	East Canada Creek	Canajo-harie	Amsterdam
LOWER COBOURG A/B	Steuben A	? absent ?	part of UTICA E	Part of UTICA E	part of UTICA E	part of UTICA E
	Rust B	B-C ?-D?-				
DENMARK B	Russia CD	Russia CD	E	E	CANAJO-HARIE E	CANAJO-HARIE E
			Dolgev'l D	Dolgeville D		
	Poland C	Poland C	Poland DC			
SHOREHAM B	Rathbun B	Rathbun B	Rathbun B	? absent ?	? absent ?	?
	SHOREHAM B	SHOREHAM B	SHOREHAM B	SHOREHAM AB	SHOREHAM AB	SHOREHAM B

A - coarse-textured calcite sandstone, calcarenite
B - shell limestone (coquina), fossiliferous shale, and calcilutite
C - dark, dense fossiliferous limestone and calcareous shale
D - sparsely fossiliferous argillaceous calcilutite and laminated shale
E - black, finely-laminated, graptolitic shale

From Kay, 1953, p. 48

Table D-1

Summary of the Geology of the Little Falls Quadrangle

by James R. Dunn

Stratigraphy

Precambrian

The oldest rocks exposed in the Little Falls area are the Grenville complex of pre-Cambrian age. With the exception of some diabase, all of the rocks are gneiss. The predominant type is the greenish to bluish gray "quartz syenite" gneiss or "granite" gneiss which is so common in the Grenville province. However, distinctly metasedimentary types are represented 4 miles north-northeast of Little Falls where typical Grenville marbles, garnetiferous gneisses and amphibolites outcrop. A large diabase dike which occurs just east of Little Falls is not metamorphosed and does not cut the overlying Paleozoic rocks.

Little Falls Formation

Lying unconformably on the Grenville throughout the area is the Little Falls formation of Upper Cambrian or Lower Ordovician age. It is largely a tan to buff weathering, sandy, cherty, medium grained dolomite. Sandstones and conglomerates occur at its base where it is in contact with the pre-Cambrian rocks. The thickness of the Little Falls formation is extremely variable in the area because of the rugged nature of the Grenville erosion surface. The Little Falls formation may feather out to nothing against the Adirondack highland to the north and be from 300 to 400 feet thick at Little Falls.

The Little Falls dolomite is particularly interesting because it contains abundant water-clear quartz crystals which are known as Little Falls or Herkimer County "diamonds." Of additional interest is the occurrence of cryptozoon beds (algal reef growths), anthraxolite (a coal-like residue of a former fluid carbohydrate or hydrocarbon), glauconitic zones and local concentrations of galena, pyrite, marcasite and sphalerite (locally white).

Canadian Rocks

Canadian rocks of Lower Ordovician age have limited outcrops at Little Falls and East Canada Creek where they are from 40 to 50 feet thick. They die out at a mile to two miles north of this. They are represented by several formations and are transitional in lithologic type between the dolomites below and the Black River limestones above. They consist of blue gray to tannish gray, sandy, glauconitic, fine to medium grained, limestones, dolomites and intermediate types.

Lowville Formation

The Lowville formation is a white weathering, dove gray on fresh surface, fine grained to cryptocrystalline limestone of Middle Ordovician age (Black River). It averages about 40 feet at the north to about 20 feet to the south and east. It contains abundant Phytopsis (worm borings), straight cephalopods, tribolites and brachiopods.

Trenton Formations

The Trenton formations, with their type locality at Trenton Falls gorge just northwest of the Little Falls quadrangle, are well represented in the area. All of the Trenton units are calcareous and are shades of medium to dark gray. Most are abundantly fossiliferous with brachipods and tribolites most common.

The lowest Trenton units are the Kirkfield and Shoreham formations which are about 60 to 80 feet thick. They consist of medium to coarse grained limestone layers usually 1 to 10 inches thick, separated by thin shaly beds up to 1 inch thick.

The Denmark formation has the Poland member as its lower unit. The Poland member is a fine-grained, dark gray limestone which is about 120 feet thick west of the Little Falls graben and very much thinner to the east. The bedding planes are from 1 to 4 inches thick with thin shale parting between. Fossils, although locally abundant, are generally not as common as in other Trenton rocks.

The Russia member of the Denmark formation occurs in the northwestern part of the Little Falls quadrangle but rapidly changes south and east to the calcareous shales and barren limestones of the Dolgeville Facies. The Russia, like the lower units, consists of limestone layers with shale intercalations. It is coarser than the Poland member, and is more fossiliferous.

Trenton shales are the uppermost Ordovician unit of the area. The Dolgeville facies, the Canajoharie and the Utica formations are all dark gray calcareous shales and are lithologically indistinguishable. Tribolites and graptolites are common.

Late Dike Rocks

Two thin vertical dikes can be seen cutting the Little Falls formation at East Canada Creek near the power station about 1 mile north of Route 5. They are highly altered, but they are believed to be a potash-rich lamprophyric type called alnoite.

Structure

The Grenville rocks are gneissose and are intensely folded. No detail has been obtained, but the metasedimentary strata which are north-northeast of Little Falls trend almost east-west.

The limestones overlying the Grenville dip about 1½ degrees westward at the northwestern part of the Little Falls quadrangle to about 1½ degrees southward at the south part of the quadrangle.

The most striking structural feature in the area is the series of zig-zag vertical faults which break the rocks into a series of horsts and grabens. The fault movements are probably along old pre-Cambrian lines of weakness which broke the overlying strata during a general and irregular uplift of the Adirondacks. The fault blocks moved independently and at different rates causing reversals in the direction of fault drag. The movement may have occurred throughout the Cambrian and Ordovician as suggested by radical horizontal changes in thickness and nature of the various formations in the immediate vicinity of Little Falls. A well, which was completed in March, 1960, on the southern extension of Little Falls-Dolgeville graben, showed an abnormal thickness of Trenton shale suggesting that the graben was active at that time. Interestingly enough, the change from Trenton limestone to Trenton shale is everywhere marked in this area by a zone of contorted bedding and bentonite. The correlation of volcanic activity producing volcanic ash, shaking of the crust (to cause the gravity (?) crumpling of soft beds), the change from limestone to shale and the great thickening of shales in the Little Falls graben is probably more than coincidental.

Economic Geology

The principal economic rock assets in the area are limestone and gravel. Gravel is being quarried at several places along West Canada Creek. Limestone is quarried for crushed stone (Little Falls, Lowville, and Trenton limestones) and for dimension stone and agricultural lime (Lowville formation mainly). In addition, parts of the Trenton could possibly be used in the manufacture of portland cememt.

Iron ore in the form of magnetite was mined 1 mile north-northeast of Salisbury and prospect pits have been cut into galena and sphalerite locally but with no apparent success.

TRIP D. LITTLE FALLS AREA TO TRENTON GORGE

Road Log

Mileages in the following log should be considered approximate. They have been compensated for error in the recording odometer, but the guide-user's odometer is likely to be inaccurate, too.

With a group of this size it is essential that the buses be reloaded promptly at the end of the time allotted to each stop. Three blasts of the bus horn will be the five-minute warning. A single long blast will be the one-minute warning.

0.0 Leave campus driving north on Campus Road.

1.45 Turn right (E) at the T intersection.

2.6 Turn left (N) at bottom of hill, on Rte. 233.

3.0 Kames and/or crevasse fillings form partly wooded small hills on the Oriskany Valley floor to the right.

3.8 Turn right (E) on Rte. 5, in Kirkland hamlet.

6.8 Bear left (NE) on Utica truck Rte. 5A.

9.9 Continue on Rte. 5A through Yorkville.

12.4 Turn left (N) on arterial overpass. Sign: "Trenton 13".

12.9 Cross Mohawk River.

13.5 Cross New York State Barge Canal and turn right (E) to Thruway (sign).

14.8 Enter Thruway Toll gate. Go east, toward Albany.

18.4 Hills across the valley to the right (S) are the escarpment of the Clinton group, and are the northern edge of the Appalachian plateaus. Hills to the left (N) are underlain by Utica shale, and capped by the Frankfort shale.

25.2)
25.8) Large road cuts in black, fissile Utica shale at left.

26.7 Knobby hills across the valley to the right (S) are terminal moraine of the Ontarian lobe, a last-gasp glacial advance in this area. This represents its easternmost extent.

27.1 To the left (N) in a large gravel pit are foreset beds of a gravelly delta. As its top elevation is about 520', it would be assigned to post-glacial Lake Amsterdam of Fairchild.

28.0 Exit Thruway toll gate at Herkimer.

28.1 Turn right (NE) on Rte. 28, toward Herkimer.

28.3 Turn left (N), following Rte. 28 toward Rte. 5.

28.5 Turn right (E), on Rte. 5.

28.9 Cross West Canada Creek, leaving Herkimer, and climb hill to the top of the 520-foot terrace along the north side of the Mohawk Valley.

33.9 To the left are large gravel pits in lenticular coarse gravel and sand beds.

36.1 In Little Falls turn right off Rte. 5 on Fourth Street.

36.2 Take first left, and then right on railroad overpass. Then turn left, following Rte. 167.

36.3 Following Rte. 167 right at station, and turn first left off Rte. 167, on E. Mill St. W. (Note: On the field trip the buses will not follow this turn if permission can be obtained to drive them to Lock 17.)

36.6 Turn right on S. William St. (to Lock 17). Across the bridge, turn left and continue to:

37.2 Parking area at Lock 17, on Moss Island.

<u>STOP 1</u> Moss Island, in Little Falls, N. Y.

The bedrock here is quartzose syenite gneiss of Precambrian age, faulted up on the Little Falls fault block. The same rock forms the cliffs to the south, across the canal. The line of the top of the cliffs is approximately the unconformity on which the Cambrian Little Falls dolomite lies, though the dolomite is not visible from here, in the woods above the cliffs. This raised block of resistant rock formed the pre-glacial divide between the Hudson and St. Lawrence drainage basins. However, following melting back of the continental ice sheet to the extent that the Hudson and Mohawk valleys were open, and the St. Lawrence still dammed, this valley drained ice melt-water from the entire eastern Great Lakes (Lake Iroquois). This discharge, probably at least as large as the present Niagara River, cut down the divide here, resulting in its westward shift to Rome, N. Y.

Walk northward across Moss Island. Along most of the northern margin is a complex of enormous potholes cut when the post-glacial Great Lakes drainage spilled over Moss Island in a thundering cataract.

0.0 Leave Moss Island, and retrace to Rte. 5 via Rte. 167.

1.2 Turn right (E) on Rte. 5, from Rte. 167.

1.4 Road cut in Precambrian greenish-gray, brown-weathering syenite gneiss.

2.9 Downgrade toward the east, Rte. 5 crosses the Little Falls fault-line scarp. On the Little Falls block is Precambrian gneiss. East of the fault is Utica shale covered with glacial and alluvial deposits. Cushing estimates the displacement here at between 750 and 850 feet.

4.0)
4.4) To the left (N) are large gravel pits cut into the
4.6) side of the 460-foot terrace.

7.5 Turn left off Rte. 5 on "old Rte. 5" at the "Manor" sign.

7.8 Turn left off "old Rte. 5" on gravel road parallel to East Canada Creek.

8.0 To the left the bluff is the fault-line scarp of the Manheim fault, which will be seen at close hand at the Beardslee power station.

8.3 Fork in gravel road. Disembark from buses and walk on right (E) fork to power station. Buses will take left fork and continue for one half mile to T road junction where they will wait.

STOP 2 East Canada Creek gorge at Beardslee power station.

FOLLOW LEADERS CLOSELY PAST STATION. DO NOT ENTER STATION OR GO NEAR HIGH TENSION LINES AND TRANSFORMERS.

Water levels permitting, we will go down the steps by the station, cross the creek bed on a concrete wall, and hike for about one half mile up the gorge. Opposite the power station the Manheim fault is well exposed. The displacement is estimated by Fisher (1954, p. 78) to be about 400 feet.

Sulphides in the fault zone once led to an abortive attempt to open a lead mine. The upstream (upthrown) wall is Little Falls dolomite. At the base of the downstream (downthrown) wall are a few beds of the uppermost Shoreham limestone (coarse calcarenite) overlain by about 25 feet of the Dolgeville facies, interbedded barren limestones and dark shales between fossiliferous Trenton limestones and overlying black shale. Overlying the Dolgeville beds is the Canajoharie black calcareous shale, equivalent to the Denmark limestone of lower Trenton Gorge (Stop 6).

About 100 feet upstream from the fault are two thin (6") alnoite dikes bearing biotite phenocrysts. In the same locality the dolomite contains a greenish-gray chert bed about 8 inches thick, and an intraformational breccia bed several feet thick exposed on the wall beside the lower pool.

In the middle area of the gorge, opposite the old mill ruin, there are several large potholes loaded with the tools of their erosion. Just above the area of the potholes is 1 to 2-foot bed of contorted laminated sandy dolomite, with some cabbage-head forms attributed by Dr. Donald Fisher to cryptozoon. In this part of the gorge there are fractures and vugs containing calcite and quartz crystals, and anthraxolite (identified by Dr. James R. Dunn).

Upstream from the broad upper pool the uppermost 10 to 15 feet of the Little Falls formation is the "reddish zone", which contains graded sandstone and intraformational breccia beds. The overlying Lower Ordovician Tribes Hill formation is composed of fossiliferous limestone and dolomite, commonly muddy and sandy, with a "fretwork" weathered surface. One of the least inconspicuous of the fossils is a gastropod, *Ophileta* sp. The Tribes Hill formation, about 45 feet thick here (Fisher, 1954, p. 93), forms the ledges for some distance both down and upstream from the old dam.

Overlying the Tribes Hill with a distinct change in lithic type is Lowville limestone, of Black River age, a gray calcilutite. This appears below the newer dam, with its distinctive worm tube, *Phytopsis*. Here also there are several minor faults, and veins containing pyrite. There are some veins of anthraxolite and quartz crystals, along joint surfaces.

Return to buses by walking south next to the penstock until there is room to pass beneath it.

0.0 Leave upper gravel road junction and proceed west on gravel road.

0.5 Continue straight ahead from gravel to paved road.

2.4 Turn left on Road 42 past church on hill (left).

3.4 Full stop junction. Turn left (W), cross creek and uphill.

3.8 Turn right (N) to join Rte. 167 going to Dolgeville.

5.3 Bluff in the distance to the left (W) is the fault-line scarp of the Little Falls fault. Little Falls dolomite forms the bluff, faulted up against the Utica shale (down on the east).

8.15 In Dolgeville, turn left on Elm Street and park. Disembark for lunch.

STOP 3 Lunch stop. Lunch is being served by the Rebeccas of Dolgeville in their hall to the rear of the brown frame building on the southwest side of the street.

0.0 Proceed ahead (NW) on Elm Street to N. Helmer Avenue, and turn right. Continue on N. Helmer Ave., after 1 block joining Rte. 29 northward out of town toward Salisbury Center.

1.7 Ahead and to the left (W) is the Little Falls fault-line scarp. Precambrian Grenville rock underlies the hills, with down-faulted Trenton limestone and shale opposite on the east.

3.1 Intersection in Salisbury Center. Bear left, following Rte. 29 westward.

5.1 Salisbury. Turn right (NW) on Road 36.

5.4 T junction. Continue straight on Road 36.

7.1 Diamond Hill. Disembark, and walk downstream on the near side of Spruce Creek, to the right of the old bridge.

STOP 4 Basal Cambrian unconformity. Little Falls fm. on Grenville gneiss.

Conglomeratic basal beds of the upper Cambrian Little Falls formation overlap northward a hill of Grenville quartzose gneiss. Upstream the gneiss occupies an elevation 100 feet or more higher than the basal beds of the Little Falls lying on the gneiss at the foot of the cascades. The initial dip of the Little Falls beds is noticeable.

Shoreham limestone crops out only one half mile WNW at an altitude of 1460 feet. Inasmuch as Grenville gneiss crops out on Diamond Hill at least as high as 1360 feet, only about 100 feet are available for all the formations between the Shoreham and Precambrian. The Little Falls alone is 450 feet thick in cliffs south of the Mohawk River at Little Falls.

MR. D. H. BURRELL, THE OWNER OF THIS PROPERTY, HAS GIVEN US PERMISSION TO BE HERE, AND REQUESTED THAT NO ONE EXCAVATE IN SEARCH OF LITTLE FALLS "DIAMONDS". BE ESPECIALLY CAREFUL NOT TO DEFACE THE NATURAL BEAUTY OF HIS PROPERTY.

0.0 Leave Diamond Hill and return to Salisbury.

1.9 Turn right (W) in Salisbury, on Rte. 29. The road west climbs up through the stratigraphic section from Little Falls to Utica shale, and back down again as it descends into West Canada Creek Valley at Middleville.

5.7 View west into West Canada Creek Valley. Harter and Hasenclever Hills, on the opposide side of the valley, are underlain by Utica shale, capped by Frankfort shale. Precambrian gneissoid syenite crops out in the bottom of the valley at Middleville.

8.25 Road cut in Kirkfield and Shoreham limestones.

8.6 Road cut in Little Falls dolomite.

9.5 Middleville traffic light. Turn right (NW) on Rte. 28.

11.3 On the near side of an old house directly across the road from a barn, turn right, but not sharp right, off Rte. 28, and proceed uphill.

11.6 At junction with gravel road, forking downhill to left, stop and disembark, and walk down the gravel road to "City Brook" (Wolf Hollow Brook). This locality is known as Old City.

STOP 5 Stratigraphic section on "City Brook" (Wolf Hollow Creek).

This section, discussed by Kay (1953), includes much of the Little Falls dolomite, and extends upward through the Lowville, Kirkfield, Shoreham and well into the Denmark formation.

The top of the Little Falls formation is the top of the sandy dolomite stratum in the bed of the creek immediately upstream from the bridge at Old City. Crytozoon is abundant in four feet of dolomite about 60 feet below the top of the formation.

The Canadian strata, present at Stop 1 (45 feet of Tribes Hill fm.), are missing between the Little Falls and Lowville on City Brook.

The Lowville formation forms the lower 26 feet of the cascades and is exposed in the small quarry south of the creek. The lower member, seven feet thick here, is tan-weathering, gray-brown, medium textured, heavy-ledged, tough, sandy and muddy limestone. The upper member, here 19 feet thick, is light-gray-weathering, medium gray calcilutite with some shale partings. A 3-inch metabentonite bed can be seen approximately at the base of the upper member, well exposed about 3 feet above the floor of the quarry. The Lowville is the only member of the Black River group present.

The Rockland limestone is not present here, even though it is 13 feet thick above the Lowville at Ingham Mills on East Canada Creek, and 8 feet thick in a quarry one mile northwest of Newport.

The Kirkfield formation, overlying the Lowville here, is interbedded thin-bedded limestone and black calcareous shale, abundantly fossiliferous, about 45 feet thick at City Brook. A metabentonite bed is weathered far back in a recess part way up the falls, about 8 feet above the formation base. The uppermost beds are thick calcarenite strata, some of which have para-ripples.

The Shoreham limestone, overlying the Kirkfield, is 45 feet thick here. The lower part is interbedded thin-bedded shell limestone and calcareous shale, with the trilobite Cryptolithus common a few feet above the base on City Brook. The upper 9 feet, called the Rathbun member by Kay (1953, p. 44), has a basal ledge of calcarenite, above which are interbeds of calcilutite, coquina-calcarenite, and calcareous shale. Below the upper bridge is a zone where the bryozoan

Prasopora is large and common.

The basal Denmark beds, of the Poland member, appear in a ledge to the right of the creek as one proceeds about 100 feet upstream from the upper bridge. They are black, irregular, impure bituminous limestone beds in which the cephalopods *Geisonoceras*, *Endoceras*, and *Trocholites* are abundant. About 3 feet above this *Trocholites* zone is the lowest Poland metabentonite. In its lower 50 feet here the beds are typically Poland in rock type, heavy-ledged, fine-grained, fossiliferous limestone, though there are some relatively barren, knobby-surfaced calcilutite beds. Farther upstream are barren, fine-grained limestone beds intercalated with black calcareous shale, typical of the Dolgeville facies, probably equivalent to the lower Russia member (upper Denmark) at Trenton Falls (Kay, 1953, p. 53).

0.0 Leave upper bridge area of City Brook and return to Rte. 28.

0.5 Turn right (W) on Rte. 28.

2.1 The conspicuous terrace across the valley to the left (SW) is the result of resistant limestone beds at the base of the Poland member of the Denmark limestone (Kay, 1953, p. 105).

4.4 Northwest of Newport, there is a low-level floodplain terrace to the right (NE). Higher knobs northeastward are dissected remnants of once continuous varved clay overlain by sand. The top of the clay is persistent at about 800 feet, and the top of the sand at about 1000 feet (Kay, 1953, p. 97). They are post glacial lacustrine sediments.

5.2 The basal Poland limestone stratum plain terrace continues across the river to the left (SW).

6.9 Continue on Rte. 28 through Poland.

7.2 Knobs to the right (NE) are probably kames. In some cases, at least, they are composed of sand and gravel (Kay, 1953, p. 97).

8.3 Bear right, continuing on Rte. 28 across West Canada Creek.

11.35 Cross West Canada Creek.

13.4 Go straight ahead, leaving Rte. 28 which curves left, then turn sharp right (NE) on road to Trenton Falls.

14.35 Stop at intersection in Trenton Falls hamlet, and disembark. Cross the bridge over West Canada Creek, keeping in narrow file on the upstream side of the bridge. Turn left at east end of bridge, and descend to ledges.

STOP 6 Lower end of Trenton Gorge.

The ledges upstream from the bridge are in the lower part of the Poland member of the Denmark formation, and are only a few feet higher than the lowest beds of the Trenton Falls section which Kay has described (1953, p. 27). Here the Poland member is composed of heavy ledges of black, fine-grained, fossiliferous limestone interbedded with fossiliferous calcareous shale. Upstream one hundred yards or so can be seen the two metabentonite beds, about nine feet apart, weathered back into the wall of the gorge. These are the second and third metabentonites in the Poland. The Poland limestone ledges in the stream channel above the bridge are equivalent to the Canajoharie shale above the thin remnant of the Dolgeville facies downstream from the fault at Beardslee power station (Stop 1).

0.0 Proceed north from Trenton Falls hamlet toward Niagara Mohawk property.

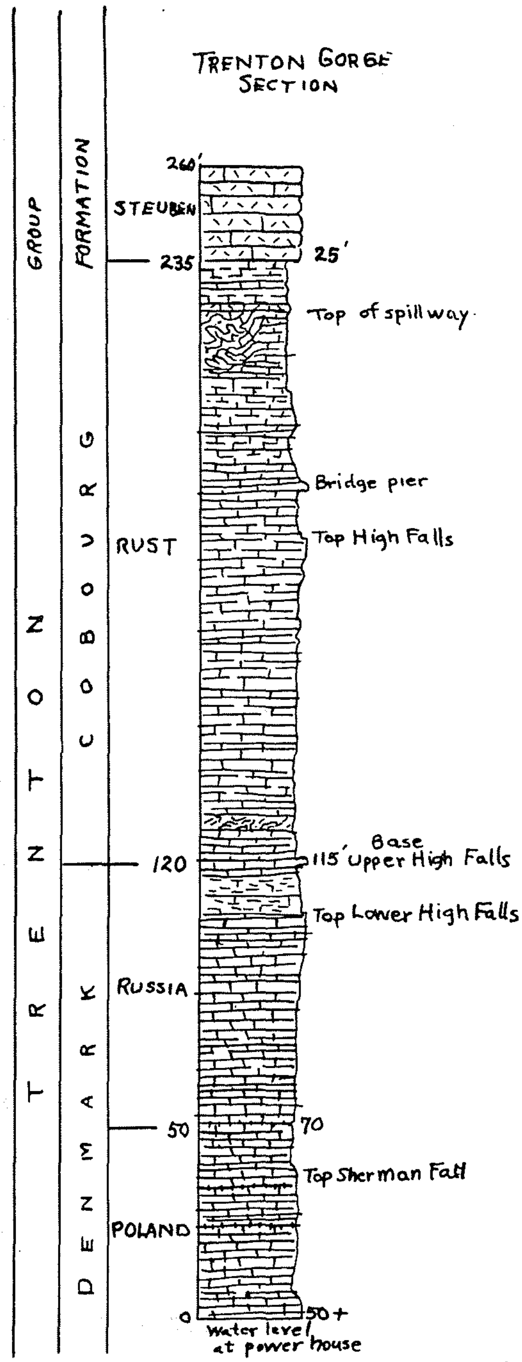
0.35 Turn right, then left around monument at the transformer station.

0.4 Turn left before reaching gate, toward parking area by barn. Disembark, and walk up the road through the gate.

STOP 7 Middle Trenton Gorge.

The ledges exposed in and beside the road are in the upper part of the Rust member of the Cobourg formation. About 300 yards up the road one can look down into the gorge to the right (E) and see the brink of the upper high falls. The base of the Cobourg is at the base of the upper high falls. The Rust member, 115 feet of thin limestone beds intercalated with shale, forms most of the gorge wall here.

Just below the parking area and garage-like building at the dam, an abandoned road leads diagonally down the wall of the gorge toward the base of the dam. The weathered road cut is abundantly fossiliferous. From the bottom of this



From Kay, 1953, p. 26

road, above the penstocks below the dam, one can look across the gorge to see the 15-foot contorted zone just below the lip of the spillway. This zone is discontinuous, but appears in varying thicknesses at this horizon in many places on the gorge wall. It is the result of a submarine slide. This is indicated by the coarse calcarenite bed immediately overlying the contorted zone, which fills in hollows and around fragments at its base, and has a comparatively even upper surface.

At the top of the eastern gorge wall, above the dam, are the thick beds of the Steuben limestone, the upper member of the Cobourg. In the vicinity of East Canada Creek (Stop 1) the entire Cobourg formation and most of the Denmark have changed facies to black calcareous shale in which the contact between the Canajoharie and Utica shales is obscure.

0.0 Retrace through Trenton Falls hamlet to Rte. 28.

1.5 Turn right (W) on Rte. 28.

2.4 Turn left (S) on Rte. 12.

8.4 Crest of Marcy Hill, capped by lower Cincinnatian Frankfort shale. The lower slopes of the hill, both north and south, are underlain by Utica shale. Ahead (S) is the Mohawk Valley.

10.9 Bear right, leaving Rte. 12. Sign points to Rte. 5A.

12.7 Overpass Thruway and barge canal.

13.9 Turn right on Rte. 5A, at south end of arterial highway.

16.4 Continue on Rte. 5A beyond Yorkville, bearing left.

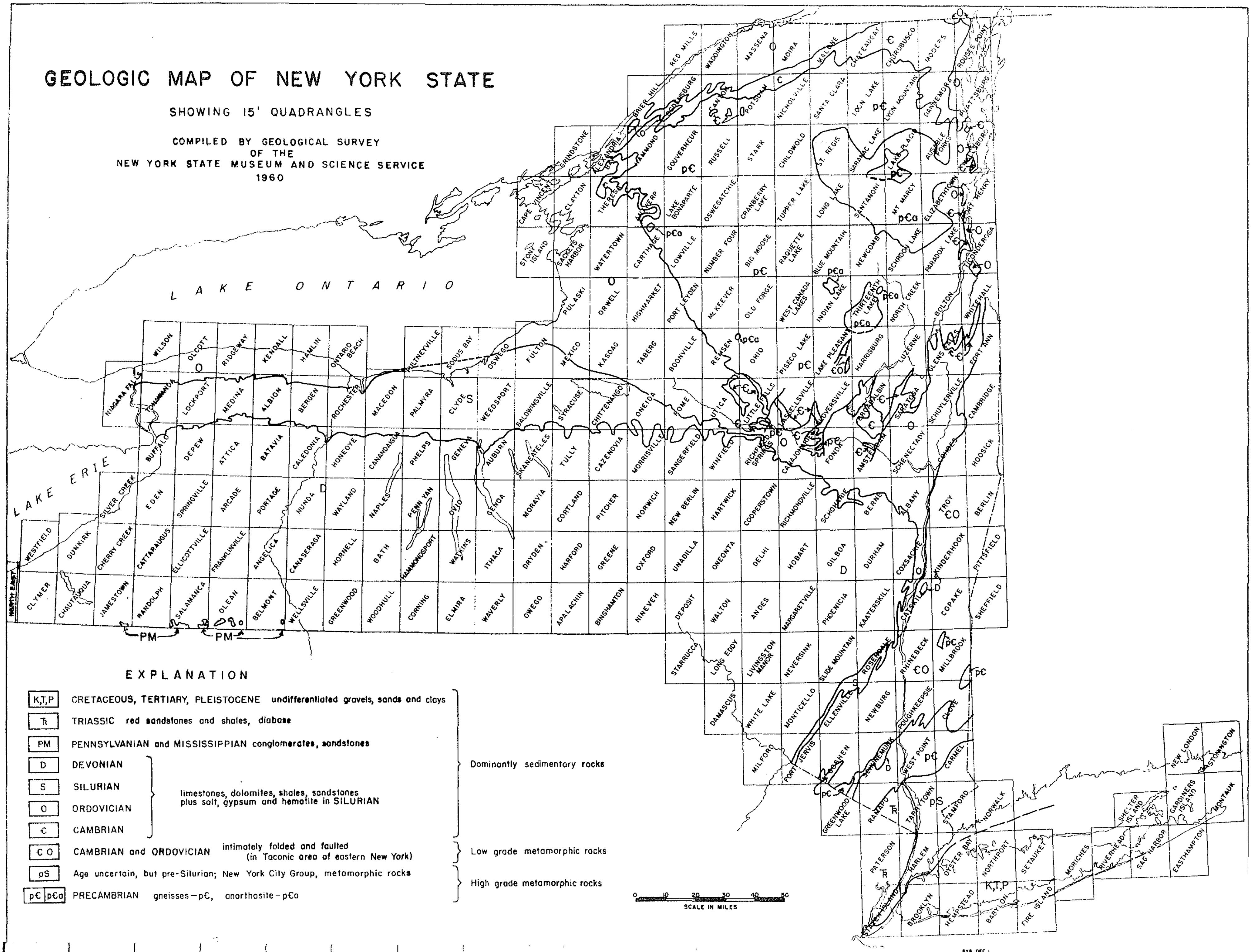
19.5 Turn right (W) at end of Rte. 5A, on to Rte. 5.

22.5 After crossing Oriskany Creek, in Kirkland hamlet, turn left on Rte. 233.

23.7 Turn right off Rte. 233, and proceed up hill.

24.8 Turn left (S). This is the first left after leaving Rte. 233.

26.3 Hamilton College campus.


GEOLOGIC MAP OF NEW YORK STATE
SHOWING 15' QUADRANGLES
COMPILED BY GEOLOGICAL SURVEY OF THE NEW YORK STATE MUSEUM AND SCIENCE SERVICE
1960
LAKE ONTARIO
LAKE ERIE
EXPLANATION
K,T,P CRETACEOUS, TERTIARY, PLEISTOCENE undifferentiated gravels, sands and clays
Tr TRIASSIC red sandstones and shales, diabase
PM PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones
D DEVONIAN
S SILURIAN
O ORDOVICIAN
Є CAMBRIAN
limestones, dolomites, shales, sandstones plus salt, gypsum and hematite in SILURIAN
Dominantly sedimentary rocks
ЄO CAMBRIAN and ORDOVICIAN intimately folded and faulted (in Taconic area of eastern New York)
Low grade metamorphic rocks
pS Age uncertain, but pre-Silurian; New York City Group, metamorphic rocks
pЄ pЄa PRECAMBRIAN gneisses – pЄ, anorthosite – pЄa
High grade metamorphic rocks
0 10 20 30 40 50
SCALE IN MILES