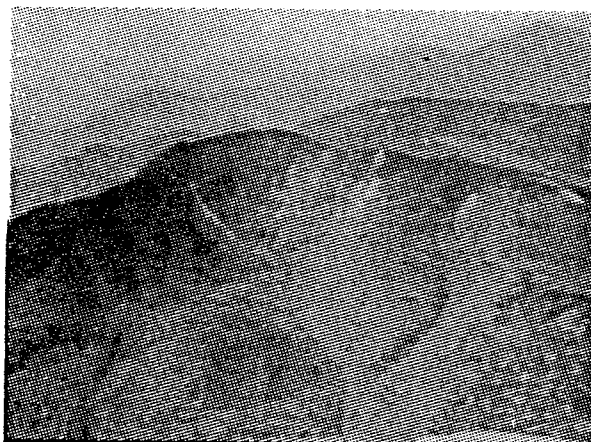


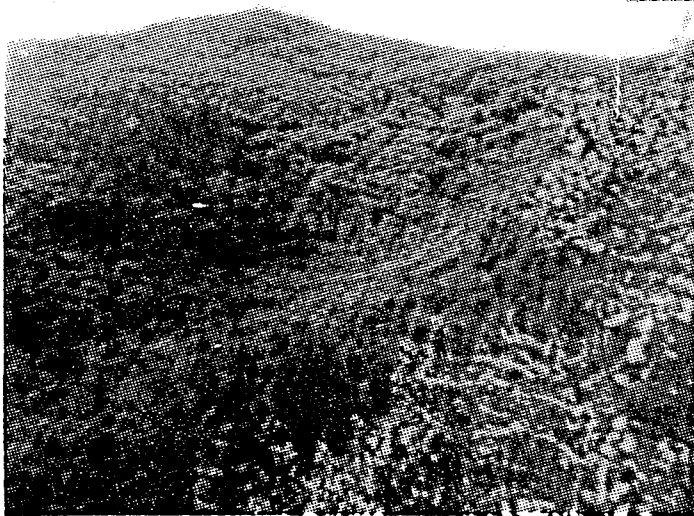
**EVIDENCE  
of  
LOCAL GLACIATION  
ADIRONDACK MTS.  
NEW YORK**

**42<sup>nd</sup> ANNUAL REUNION  
EASTERN FRIENDS  
OF THE  
PLEISTOCENE**



**by**

**JESSE L. CRAFT**



**1979**

EVIDENCE OF LOCAL GLACIATION, ADIRONDACK MOUNTAINS, NEW YORK

by

Jesse L. Craft

42nd Annual Reunion

EASTERN FRIENDS OF THE PLEISTOCENE

1979

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## ABSTRACT

The purpose of the study was to find evidence for or against the hypothesis that local glaciation occurred in the High Peaks area of the Adirondack Mountains, New York, following recession of the Late Wisconsinan Laurentide ice sheet.

Field investigations consisted of: evaluating landforms using air photos, detailed mapping of glacially deposited materials, investigating landforms of possible glacial origin, measuring the orientation of pebbles in deposits of till and collecting till samples for laboratory analysis.

Laboratory methods comprised the identification of light minerals of the 0.044 mm to 0.125 mm sized fraction of all till samples; the identification of pebbles and the grain-size analysis in the sand, silt and clay fractions from selected sites throughout the study area.

The air photo and field studies identified 224 cirques in the High Peaks region. Detailed analysis of these features indicates that bedrock jointing and faulting are the primary controlling factors in the position and aspect of cirque development. Topographic position and elevation influences the degree of development of the glaciated valleys. Schrund elevations, a possible indication of snowlines, were determined for all cirques. The schrund elevation studies indicate two possible snowlines: one at 1700-2700 feet ASL, and another at 2400 to 3400 feet ASL. The lower values of schrund elevation for each possible snowline are associated with cirques which are located on the west, north and east sides of mountain masses and open northward. Cirques located on the south sides of the mountains have higher minimum schrund elevations.

The distribution of erratics from north of the Adirondacks and striae in the main valleys demonstrate that the Laurentide ice sheet overrode the mountains. The most conclusive evidence of the time relationship between local glaciation and continental glaciation was obtained from the studies of the light mineral (quartz, orthoclase and plagioclase) fraction of the tills. Quantitative analysis demonstrates a correlation between sources of glaciation and till composition. Materials deposited from local ice sources within the Anorthosite Massif contain less than 20 percent quartz, less than 35 percent orthoclase and from 50 to 85 percent plagioclase. Continental tills contain less than 55 percent plagioclase with nearly equal amounts of orthoclase and quartz.

Striations on bedrock and elongate pebble orientation studies provide evidence of ice movement at nearly right angles to the Laurentide ice flow direction in Roaring Brook on the west side of Giant Mountain, at the Coon Pit on Whiteface Mountain and at Newcomb. A northward flow of ice is recorded at the McIntyre Development, Tahawus, N. Y. Lithology distributions indicating ice flow in directions other than that expected by the Laurentide ice advance have been found in White Brook Valley.

End moraines formed by local glaciation have been identified at St. Huberts, below Giant Mountain; Cooperkill Pond; Weston Mountain Cirque; Blue Ridge; Boreas Mountain and Redfield Cirque. Lateral moraines were observed in White Brook Valley, Styles Brook, Johns Brook and Boreas Mountain.

The approximate time of the last episode of local glaciation has been established by the existence of an outwash delta into Glacial Lake Warrensburg

at Blue Ridge, N. Y. Glacial Lake Warrensburg is correlated to the Luzerne Readvance of Connally and Sirkin (1971) at 13,200 years BP. The oldest glacial event is established by a date of greater than 55,000 years BP (Muller, 1969) for lacustrine sediments overlying till at Tahawus, N. Y.

A climatic model is proposed to explain the existence of local glacial activity south of the Laurentide ice sheet.

The history of local glaciation in the Adirondack Mountains is believed to comprise the following episodes:

During Early Wisconsinan time, the Adirondack Mountains probably became a local ice center. This early ice melted away and the lake deposits at the McIntyre Development were formed. A major Laurentide ice advance then completely overrode the High Peaks. The Laurentide ice mass melted from the High Peaks region possibly during the Erie Interstade. The local ice probably redeveloped during the Port Bruce Stade and receded to some extent during the Mackinaw Interstade. Deglaciation of local ice to recessional moraine positions is related to the Two Creeks Interstadial. Rapid valley deglaciation occurred with the draining of Lake Iroquois. All glacial ice was probably gone by the time of the completion of the Champlain Sea phase of deglaciation.

#### PURPOSE OF THE INVESTIGATION

The existence of mountain glaciation in the Adirondack Mountains has been accepted in the literature since Taylor published a paper on this subject in 1897. However, the time that mountain glaciation occurred is not known. Goldthwait (1913) and Fairchild (1917) suggested that the valleys were occupied by local ice prior to continental glaciation and not re-occupied by ice following continental deglaciation. Cushing (1899), Ogilvie (1902a), Johnson (1917) and Ailing (1919) believed that local glaciation occurred after continental deglaciation of the Adirondack Mountains.

Using modern understanding of Pleistocene history, field investigations and laboratory methodology, evidence which would establish the glacial history of the Adirondack Mountains was sought. A search was made for indications of both continental and local glaciation and for the sequence of these glacial events. The area was studied with the premise that the landforms and glacial deposits could have been formed either by continental or by local glaciation, or they could have been formed first by one, and then been modified by the other.

#### GEOGRAPHICAL SETTING

The Adirondack Highlands, a nearly circular, domical uplifted area of Precambrian rocks, is a southeasterly extension of the Grenville Province of the Canadian Shield and is connected to the Shield by a narrow arch known as the Frontenac Axis (Broughton et al., 1962). This mountainous area is located in the northeastern part of New York between 43° and 44°45' North latitude and between 73°30' and 75°45' West longitude (figure 2). This region is bounded on the north by the St. Lawrence

# HIGH PEAK REGION

ADIRONDACK MOUNTAINS NEW YORK

COMPILED FROM U.S.G.S TOPOGRAPHIC MAPS

## LEGEND

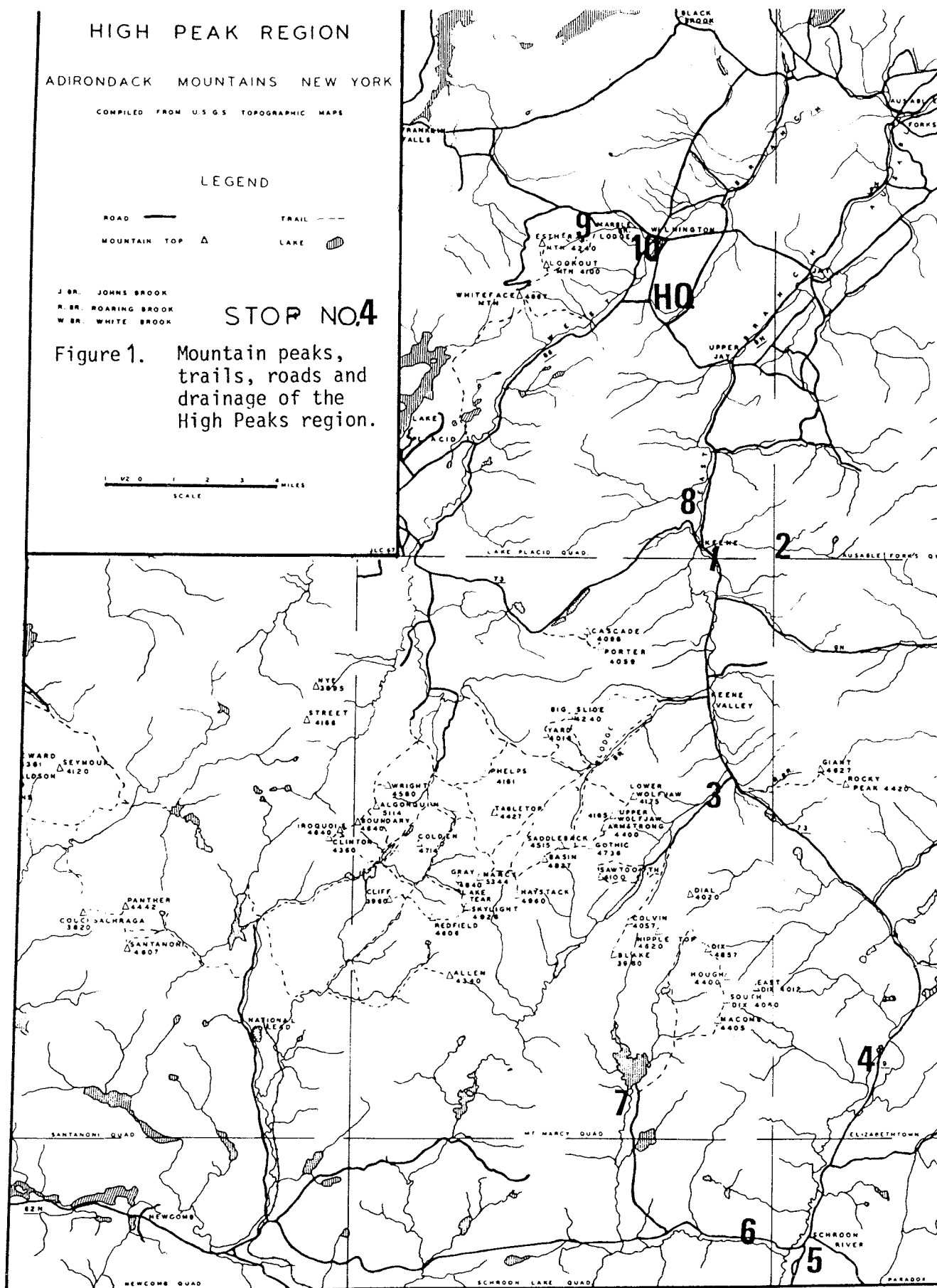
ROAD — TRAIL - - -  
MOUNTAIN TOP Δ LAKE

J.B.R. JOHNS BROOK  
R.B.R. ROARING BROOK  
W.B.R. WHITE BROOK

STOP NO. 4

Figure 1. Mountain peaks, trails, roads and drainage of the High Peaks region.

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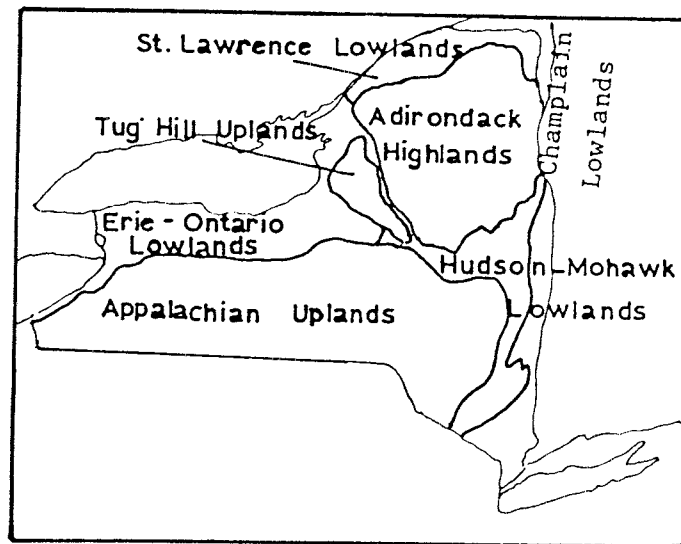


Figure 2. Physiographic subdivisions of New York State. (From New York State Geological Map, 1963.)

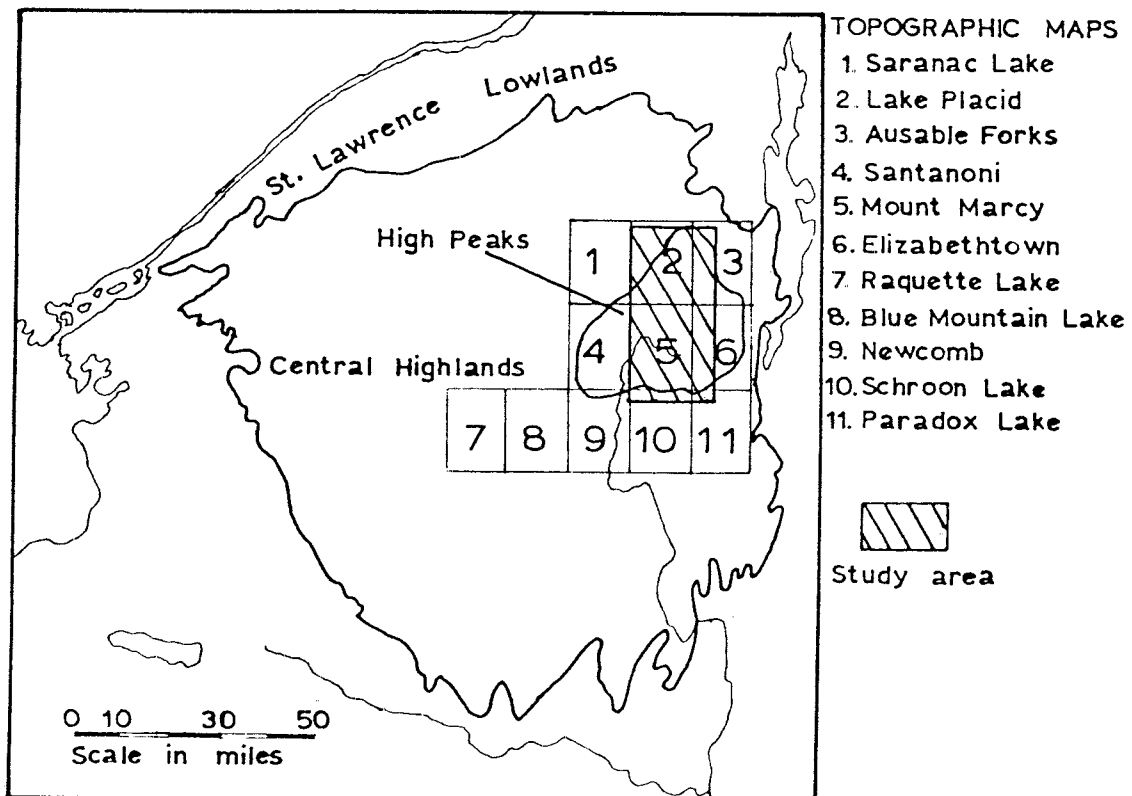


Figure 3. Physiographic divisions within the Adirondack Highlands physiographic province. Cross-lined area is the field region covered in this study.

Lowlands, on the east by the Champlain Lowlands, on the south by the Hudson-Mohawk Lowlands, and on the west by the Tug Hill Uplands (figure 2).

The study area can be divided into two geomorphic districts: the Central Highlands and the High Peaks (figure 3). These landform subdivisions are largely controlled by the bedrock lithology (figure 4).

#### HIGH PEAKS REGION TOPOGRAPHY

This study deals primarily with the High Peaks region. It lies within the boundaries of five fifteen-minute topographic quadrangles: Lake Placid, Santanoni, Mount Marcy, Ausable Forks, and Elizabethtown. The highest elevation in the area is Mount Marcy, (Mount Marcy Quadrangle) at 5344 feet ASL, next highest is Algonquin, 5114 feet ASL. In all there are forty-six prominent peaks in this region that stand above 4000 feet ASL (figure 1). The mountain ridges are arranged in a northeast-southwest line with extremely steep slopes ( $50^{\circ}$  to  $90^{\circ}$ ) along the sides of the ridges. The northeastern and southwestern ends of the mountain ridges are generally more gently sloping ( $30^{\circ}$  to  $50^{\circ}$ ) than the sides of the ridges. There are numerous low cols or passes through these ridges at the heads of tributary valleys, which give the skyline the appearance of an arete. Armchair-shaped theaters, cut into the main ridge lines, constitute the cirque forms that are so common in the High Peaks region. The major features of bedrock relief are the results of interplay of several major factors such as composition, resistance to weathering and erosion, presence of foliation and linear structures of the rocks, and fault lines and major joint systems.

#### GEOLOGIC SETTING

The bedrock geology of the High Peaks region has been reported by Kemp (1898), Miller (1919), and Crosby (1966) for the Lake Placid Quadrangle; Cushing (1899), Kemp (1894), Kemp and Newland (1899), and Van Diver (1968) for the Santanoni Quadrangle; Kemp (1921) and Balk (1931) for the Mount Marcy Quadrangle and Kemp (1910) for the Elizabethtown Quadrangle. Buddington (1953, 1966) studied the bedrock geology in the northern part of the High Peaks region and the rocks of the Central Highlands to the north and east. Isachsen compiled all known information for the Geologic Map of New York State (Broughton et al., 1962).


In general the area is underlain by metamorphic rocks of Precambrian age composed mostly of anorthosite. Bordering the edge of the Anorthosite Massif is a complex sequence of granitic gneisses, syenite gneisses, charnockites and metasedimentary rocks of the amphibolite facies of metamorphism (Broughton et al., 1962). A generalized map compiled from the sources listed above is part of figure 4.

Resting unconformably on the Precambrian bedrock to the north and northeast of the High Peaks region is an extensive sequence of Lower Paleozoic sedimentary rocks. The most significant as a source for glacial deposits is the Upper Cambrian Potsdam sandstone. This easily recognized rock is a common constituent in the continental glacial deposits throughout the region.

The major structural feature of the region is a series of northeast-

# LEGEND


## DETAILED MAP IN FIELD GUIDE Field Trip Stops Labeled

Metasedimentary and Charnockite Rocks 

B Stops 9 and 10

Anorthosite 

C Figure 18

Site Location and Number 

D Stop 8

Highway Number 

E Figure 19

Scale Contour interval 500 feet

H Stop 1

 0 1 2 miles

Base map compiled from U.S.G.S. Topographic Map

I Stop 2

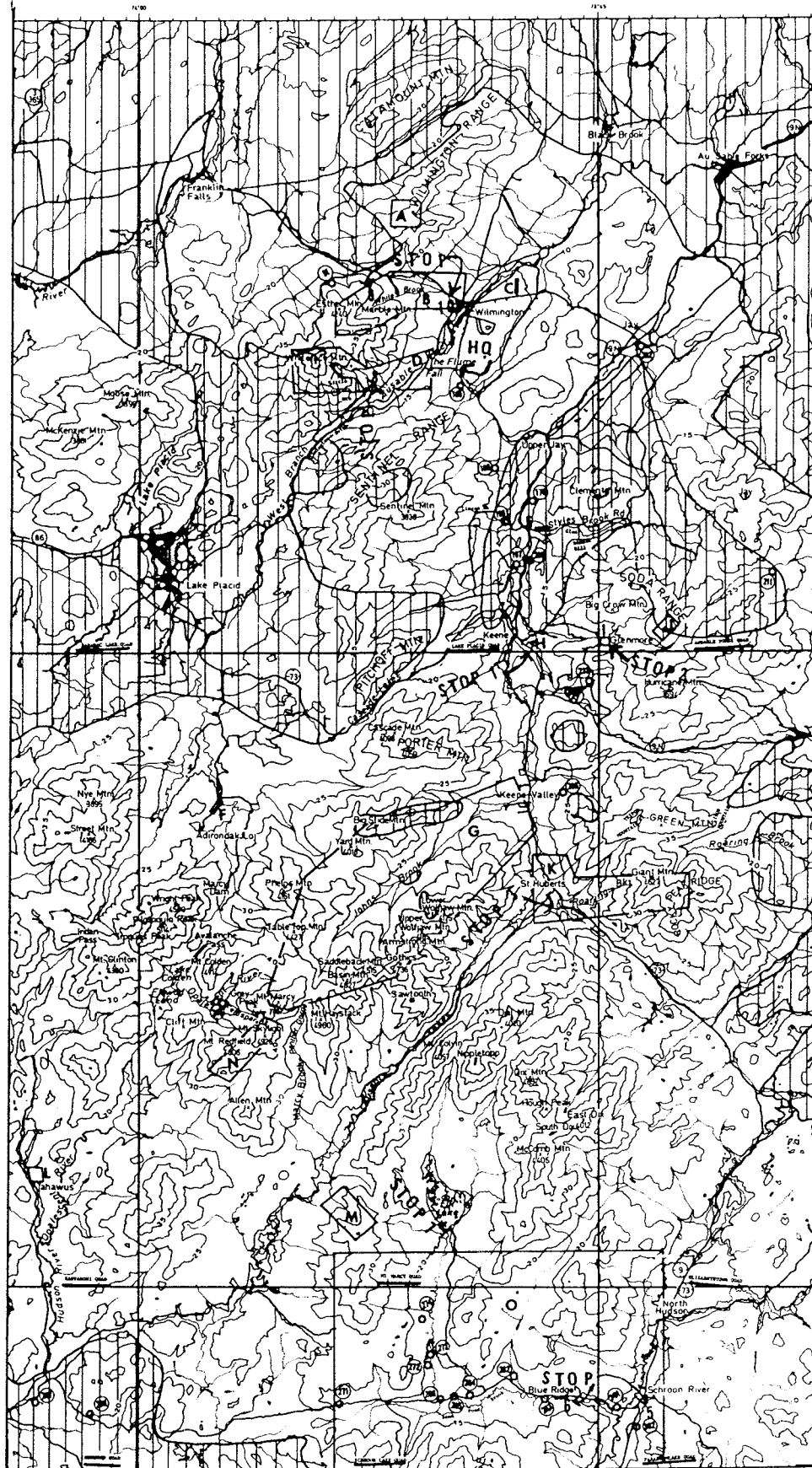
Geology from Balk (1931) and Broughton, et al., 1962

K Stop 3

O Stops 5, 6, and 7

Figure 4. Geologic and Field Location Map, High Peaks Region, Adirondack Mountains, New York





southwest faults. Deep valleys have been eroded along them, and they also determine the location of the main passes through the mountain area. The most important fault passes in the High Peaks are: Wilmington Notch (Lake Placid Quadrangle), Cascade Pass, Avalanche Pass, Ausable Lakes Pass, Chapel Pond Pass (Mount Marcy Quadrangle) and Indian Falls Pass (Santanoni Quadrangle). Lake Placid is a large fault zones, blocked off at the south end by a massive moraine (Alling, 1919).

Buddington (1953) reported two major joint directions which are prevalent throughout the Northern Adirondacks; N 70° E and N 80° W. The northeast joint system is commonly slickensided and is related to the major faulting in the area. A third direction, between N 45° and 70° W is present in many places and has local structural significance. All of the joint systems have a steep dip.

The surficial geology of the region is dominated by Pleistocene glacial erosional landforms and deposits. Bedrock exposures in the valleys are scarce because of the drift blanket. It is only on the higher elevations in areas of very steep slope that bedrock is well exposed.

#### DRAINAGE

The individual streams exhibit rectangular drainage patterns, however, the regional drainage is radial (figure 1). Water flows into both the Hudson River system to the south and the St. Lawrence system to the north. In the south and southwest, the rivers flow directly to the Hudson River or into the Mohawk River which then joins the Hudson River at Albany. In the north and east, the waters reach the St. Lawrence River via Lake George and Lake Champlain. In the northwest, the water flows either into Lake Ontario or directly to the St. Lawrence River.

The major rivers of the area are the Hudson and its tributaries flowing south; the Black River flowing directly into Lake Ontario to the north; the Oswegatchie, Grass, Raquette and Salmon Rivers which flow north to the St. Lawrence River; and the Saranac and Ausable Rivers which flow into Lake Champlain. The rivers follow pre-glacial valleys throughout much of their course but are locally diverted from these valleys by glacial drift. In many cases, this diversion of the stream from one valley to another is through very deep bedrock gorges.

The stream channels reflect the control of underlying bedrock structure related to the regional jointing of N 75° E to N 80° W and the major north-east to north trending faults. Wherever valleys have been filled by drift, streams tend to meander through swampy ground and the pattern becomes dendritic.

#### PREVIOUS WORK

A summary of previous investigators who have worked in the vicinity of the study area and the pertinence of their contributions to the present study is shown in Table 1.

Table 1. Summary of Previous Workers, Their Contributions and Pertinence to the Present Study

Author	Contribution	Pertinence to Present Study
Taylor (1897)	Suggested possible local valley glaciation in the Adirondacks, recognized beach terraces, ice dammed lakes, importance of Potsdam sandstone erratics.	Recognition of local valley glaciers.
Hitchcock (1898)	Noted distribution of erratic materials high up on the slope of Whiteface and other high peaks.	Use of erratics from outside the Adirondack Massif as indicator of continental glaciation.
Kemp (1898)	Described moraine at Lake Placid Village, observed large glacial erratics, recognized lake-bottom sediments, deltaic outwash and other related deposits. Recognized cirques on slopes of Whiteface, and Sentinel Range, Giant and Gothics.	Recognition of cirque-cutting as significant in the glacial history of the region.
Cushing (1899)	Mapped a morainic area on the north flanks of the Adirondacks that contained erratics deposited by a "northward flow of ice from an Adirondack Center".	Recognition of local glaciation.
Ogilvie (1902a)	Placed glacial events of the Adirondacks in chronological sequence, recognized ice-dammed lakes, beach deposits, local glaciers, moraines.	Recognition of a local glaciation following the melting away of the continental ice mass from the High Peaks.
Cushing (1905)	Suggested the mass of the Adirondack Highlands blocked off the southward flow of the continental ice mass, forming two great ice streams. Also recognized the importance of local glacial erosion in making minor modifications of the landscape.	The role of local glacial erosion in minor landscape modification.
Kemp (1906)	Described cirques on flanks of mountain ridges; mentioned possibility of local glaciation.	Identification of cirques.

Author	Contribution	Pertinence to Present Study
Cushing (1907)	Described cirques on flanks of mountain ridges; mentioned possibility of local glaciation.	Identification of cirques.
Miller (1910)	Described cirques on flanks of mountain ridges; mentioned possibility of local glaciation.	Identification of cirques.
Fairchild (1913)	Argued against the idea of local glaciation in the Adirondacks; envisioned the High Peaks as a bare rock area surrounded by the continental ice mass.	Established the controversy as to whether local glaciation played a role in the glacial history of the Adirondacks.
Goldthwait (1913)	Worked in the Presidential Range of New Hampshire; came to the conclusion that cirques were developed before continental glaciation and that cirque valleys were not reoccupied after the continental ice mass melted away. Same conclusions as Fairchild for the Adirondacks.	Helped establish the controversy by inference that if local glaciers could not exist in the Presidential Range, they could not exist in the Adirondacks.
Johnson (1917, 1933)	Recognized lateral moraines in the Adirondacks as deposits from local glaciers; disagreed with Fairchild and Goldthwait on the interpretation of field evidence for local glaciation.	First to establish real field evidence of local glaciation.
Kemp (1921)	Wrote a generalized report on the Adirondacks; followed Goldthwait's idea of pre-continental local glaciation and used Fairchild's 1913 maps to illustrate the deglaciation of the Adirondacks.	Carried on the controversy.
Atling (1919, 1921)	Described in more detail the lateral moraine recognized by Johnson; described in detail a lake sequence in the Lake Placid region; recognized the late glacial origin of cirque glaciers.	Established more evidence of local glaciation after the melting away of the continental ice mass.
Miller (1925)	Described Glacial Lake Warrensburg extending from Luzerne, N. Y. to North Hudson.	Local glacial moraine at Blue Ridge, N. Y. has a delta built into this lake.

Author	Contribution	Pertinence to Present Study
Balk (1932)	Recorded observation of glacial erratics; noted that highest peaks were free of erratics.	Substantiated by this author's observations on the lack of erratics on peaks higher than 4200 feet ASL.
Buddington (1937, 1953)	Briefly discussed the glacial history of the area and described specific valleys as being formed by local glaciation.	Identification of additional valleys of local glacial origin.
Muller (1965a, 1965b)	Described a multiple till section at Tahawus, N. Y. with C14 date of greater than 55,000 B.P.	Demonstrates earlier period of glaciation.
Connally and Sirkin (1969)	Obtained C14 date from material in front of Luzerne Moraine that dates Glacial Lake Warrensburg at 12,400 B.P.	Established the time frame of reference for local glaciation in the High Peaks region.
Connally and Sirkin (1970b, and 1973)	Re-evaluated date of Luzerne Readvance to 13,200 B.P.	Established the time frame of reference for local glaciation in the High Peaks region.
Coates and Kirkland (1974)	Applied a theoretically derived ice model to the advance and retreat of the Laurentide ice sheet.	Suggested that ice surrounded the Adirondacks, overrode and melted leaving the High Peaks region ice free while surrounded by lobes of Laurentide ice.

## GLACIAL MOVEMENT

Evidence of direction of glacial movement in the Adirondack Mountains consists of striae and grooves in bedrock, the orientation of elongate pebbles in till deposits, and the lithologic composition of till.

The flow direction indicators mentioned above are the result of glacial erosion and transport or deposition of glacial debris at the base of the moving ice mass. These indicators of local glacial movement were strongly controlled by the existing bedrock topography. It is, therefore, no great surprise that, throughout the Adirondacks, indicators of glacial flow tend to follow the orientation of valleys.

All of the ice flow direction indicators reported in the literature (Buddington, 1953) are located in the main valleys and suggest a general flow of ice through the mountains from northeast to southwest with local variation determined by the controlling topography (figure 5) as it confined the ice within the valleys.

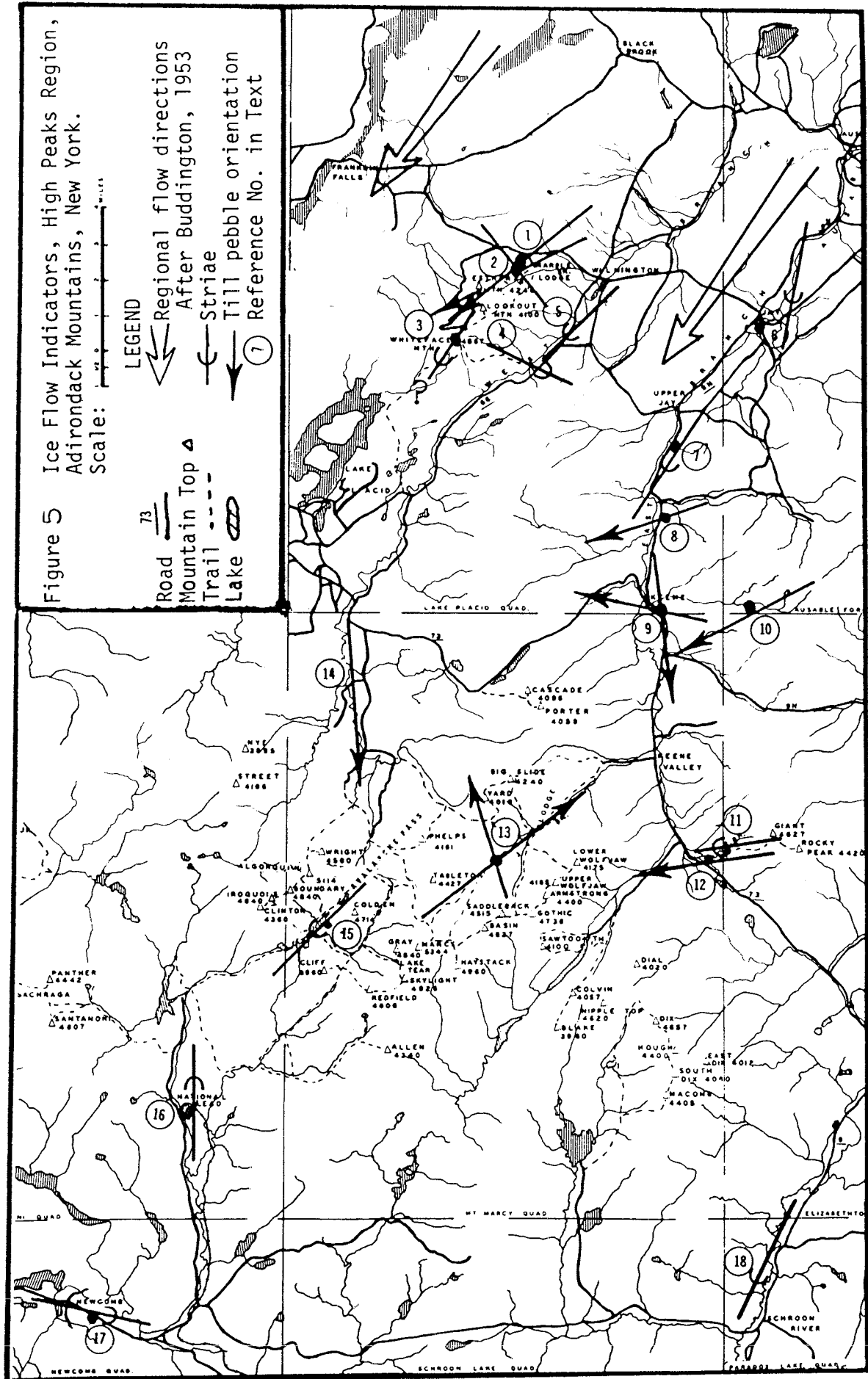
## GLACIAL STRIAE AND GROOVES

Throughout the High Peaks region striae are scarce. Unreported striae were observed at nine locations. Of these, six coincide with the regional ice flow direction, and four indicate glacial movement in directions other than that of regional flow.

A survey of literature shows that many more striae have been measured throughout the Adirondack Mountains (Ogilvie, 1902a, 1902b; Alling, 1916, 1919, 1921; Miller, 1910, 1916, 1917, 1919, 1921, 1926; and Buddington, 1953). Buddington (1953) compiled all of the information published on striae and plotted a regional flow map for the Adirondacks (figure 5). Buddington (1953) does not show any variation of flow direction through the High Peaks region. His arrows indicate the ice flowing towards and around the mountain mass, not through it. Striae have, however, been observed in the main valleys of the High Peaks and record the flow of the continental ice mass through the mountains. These striae have been recorded (figure 5) at Avalanche Pass (site 13), the Flume (site 5), Jay, N. Y. (site 6), between Upper Jay and Keene (site 7) and along Interstate 87 between the Route 73 junction and the North Hudson exit (site 18). Striae in directions other than that of continental flow have been recorded on Giant Mountain (site 12), Whiteface Mountain (site 4), in the Newcomb Blue Ridge Valley (site 17) and at the National Lead Co. McIntyre Development at Tahawus, N. Y. (site 16).

## ALIGNMENT OF ELONGATE PEBBLES

Measurements of alignment of elongate pebbles were made throughout the High Peaks region in valleys tributary to the main north-south drainage valleys. Measurements were made wherever an exposure of till could be cleared below the winter freeze line. Eleven sets of measurements were made at eight localities (figure 5). The results of these measurements are shown in figure 6.



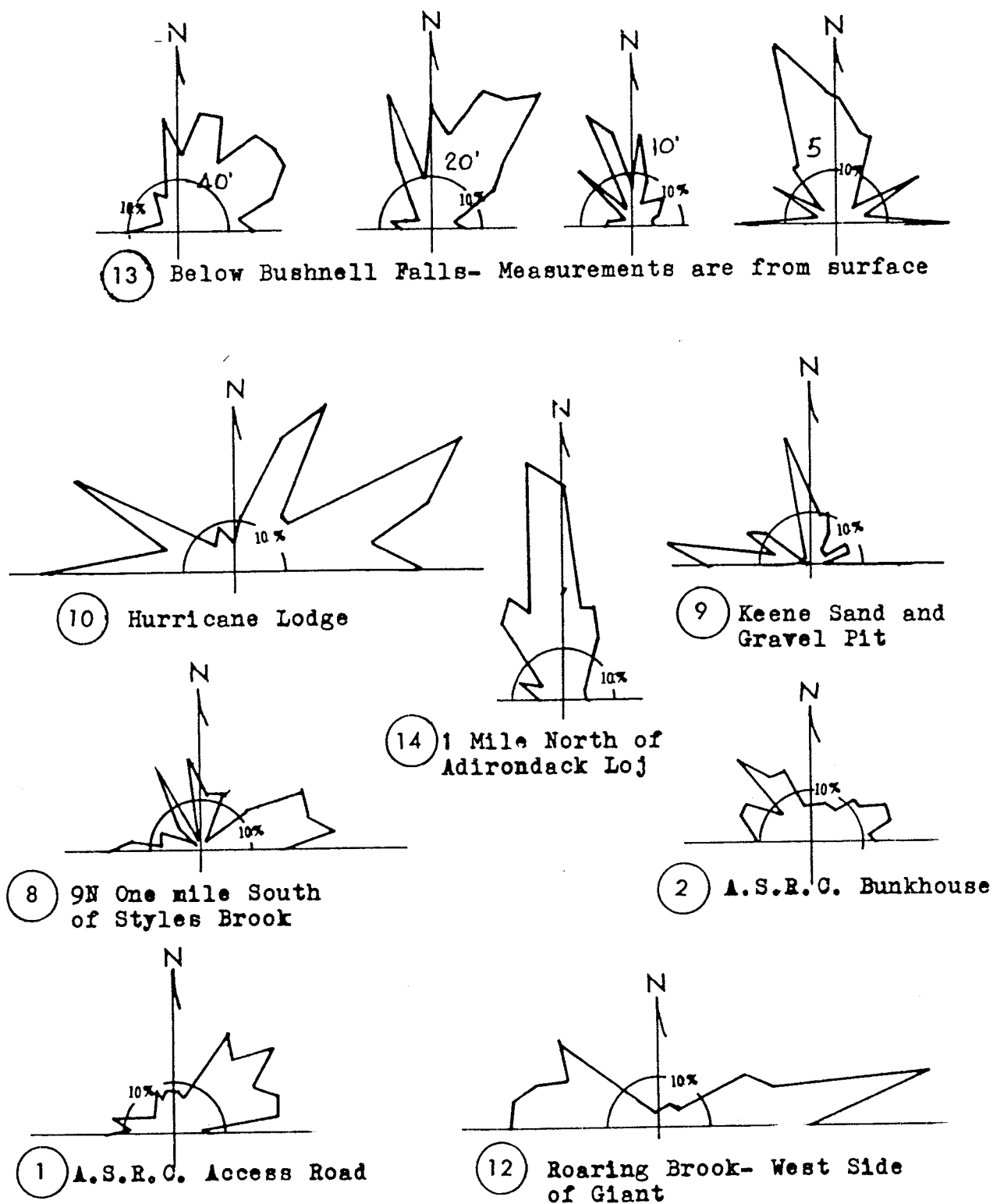


Figure 6. Pebble orientations rose diagrams. All plots are to true north. Numbers refer to locations on Figure 5.



All of the pebble orientations bear a strong relationship to the orientation of the valleys, with pebbles oriented in the long valley direction. Site 14, one mile north of Adirondack Loj, is the exception to this. This site is located in the center of a broad, flat valley and there would be little if any topographic control of ice flow in the immediate vicinity.

Sites 1, 2, 9, and 14 have elongate pebble orientations near to that of regional ice flow direction (figure 5) and nearly parallel to the main valley orientation. Sites 8 and 12 are located along the edges of main valleys at the mouths of tributary valleys. They show a strong correlation to the orientation of the tributary valley. Sites 2 and 9 show two peak orientations possibly indicating a reorientation of an earlier direction of ice flow. Site 13 includes a series of measurements at different depths which show a change in ice flow direction from top to bottom.

#### RECOGNITION OF GLACIAL TILL IN THE HIGH PEAKS REGION

The early workers (Ogilvie, 1902a; Taylor, 1897; Kemp, 1898; Alling, 1916, 1919, 1921) in reporting their observations of glacial deposits in the High Peaks region describe poorly sorted and well stratified glacio-fluvial deposits, ice contact stratified drift, and outwash sand and gravels. Nowhere do they describe or identify till as a typical ice deposited material. This non-recognition of glacial till is understandable as most work on glacial deposits at that time in New York had been done in glacial deposits associated with fine grained sedimentary rock and the tills were quite silty in composition. The role of bedrock in till texture and composition had not at this time been recognized. Adirondack tills are quite sandy (figure 7) due to the character of bedrock from which they were derived. These tills do not resemble the classical silty tills of central New York with which the early field researchers were familiar.

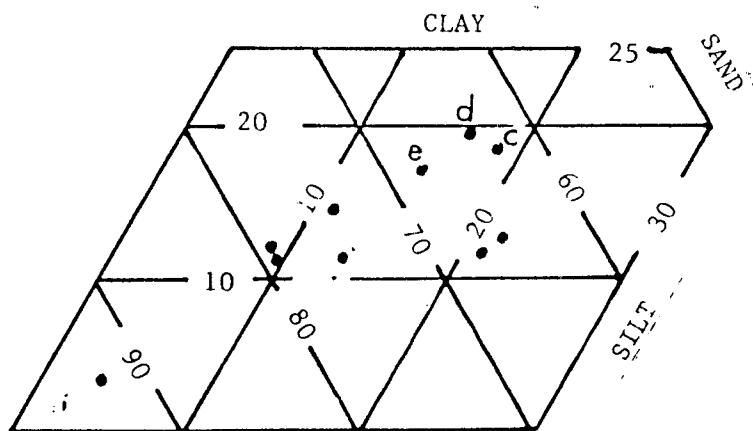


Figure 7. Ternary diagram plot of sand, silt and clay of ten Adirondack till samples.

When the author first started field work in the Adirondacks, many of the deposits described in the literature were visited. In most cases, the reported poorly sorted sands and gravels were found to be sandy and silty tills. This recognition of till within the High Peaks region, combined with

the detailed studies of the light mineral composition of these tills, has played a significant role in establishing the glacial sequence within the High Peaks region.

### CHARACTERISTICS OF HIGH PEAKS TILLS

Undisturbed Adirondack till deposits have the appearance of poorly sorted sand and gravel. In some deposits where large boulders are not present and the surface has been weathered, it is almost impossible to identify the origin of the deposit. However, excavation into the deposit beyond the freeze-thaw zone will reveal evidence of their origin. The following are criteria used for recognition of tills in the High Peaks region:

- (1) Apparent lack of sorting and stratification of the deposit, and the presence of considerably more silt-clay sized particles than in glacio-fluvial sands and gravels.
- (2) Compacted nature of the deposit. In active gravel pits, the till will hold a vertical face. When the till is excavated, it comes out in chunks. However, these chunks break apart easily in the hand. It is difficult to collect a block of till and keep it intact.
- (3) Occurrences of striated and faceted pebbles combined with
- (4) Silt coating on pebbles and boulders.

Two deposits of silt-clay rich till were located; one of the Styles Brook Road and one just east of Wilmington. In each case, ice moved across lacustrine deposits prior to the deposition of till.

### LITHOLOGIC COMPOSITION OF ADIRONDACK TILLS

A survey of the geologic literature on the Adirondacks and the area to the north and northeast of the Adirondacks shows three distinctive rock assemblages and associated mineral compositions: Precambrian anorthosite, Precambrian metasedimentary rocks, and Paleozoic sedimentary rocks (figure 4). These distinctive assemblages are extremely useful in determining whether a deposit was formed by local or by continental glacial action.

### PRECAMBRIAN ANORTHOSITE

The central core of the High Peaks region is composed almost exclusively of anorthosite. According to Buddington (1966), the anorthosite series have an average mineral composition ranging from 62% to 94% plagioclase, 0% to 2% orthoclase, and 0% to 3% quartz, with small percentages of other minerals particularly hornblende, biotite, garnet and augite. Buddington (1966) gives data on mineral compositions of gabbroic differentiates, pegmatites and satellitic intrusives of the anorthosite series. In these rocks, plagioclase ranges from 39% to 55%, orthoclase from 2% to 6%, and quartz from 0% to 2%. There is a marked increase in amounts of ferro-magnesian minerals

in these rocks.

Anorthosites are easily identified in the pebble size fractions and larger, and it is possible to separate the anorthosite into three distinctive types - the Marcy facies, the Whiteface facies, and the pink plagioclase facies.

#### Marcy facies

The Marcy facies is characterized by being light blue-green to white with a fine matrix of plagioclase feldspar containing phenocrysts of labradorite feldspar. The matrix is commonly so fine that individual crystals cannot be seen without magnification. Some mafic minerals are present, especially in the higher elevations of the mountain and in areas close to exposures of the Whiteface facies type of anorthosite. A complete range of the changes in the Marcy anorthosite can be seen on a traverse from the lower end of Johns Brook to the top of Mount Marcy.

#### Whiteface Facies

This facies is named after exposures on Whiteface Mountain. This rock is characterized by a crystalline equigranular texture composed mostly of white plagioclase feldspar crystals with more than 25% mafic minerals present. Numerous large inclusions of charnockite have been observed in Whiteface anorthosite.

#### Pink Plagioclase Facies

The pink plagioclase facies has been observed only along the ridges of White Brook Valley (Lake Placid Quadrangle) below Esther Mountain, where it makes up most of the ridges on both sides of the valley. The rock is not exposed in the bottom of the valley where it is believed to be buried under a blanket of glacial drift. This rock is very similar in appearance to the Marcy anorthosite, i.e. fine grained matrix with phenocrysts, but the matrix is pale pink. The phenocrysts resemble salmon microcline in color but exhibit well developed albite twinning. The importance of this rock in understanding the glacial history was discussed in the section on the deposits of White Brook Valley. Bed rock exposures of the Wilmington Range, north of White Brook, were investigated for pink anorthosite but none were observed.

### PRECAMBRIAN METASEDIMENTARY ROCK

The anorthosite core of the Adirondacks is completely surrounded by a complex sequence of metasedimentary rocks. Rock types are charnockites, amphibolites, granitic gneisses, marble, and quartzite of varying mineral compositions and appearances.

The metasedimentary rocks are so variable locally that there are no significant rock or mineral variations within the metasedimentary sequence to permit identification of directions of ice movements. However, these rocks are significantly different from the anorthosite both in appearance and in mineralogy.

The quartz, K-feldspar, and plagioclase compositions of these rocks are distinctly different from those occurring in anorthosite. In metasedimentary rocks, the quartz content ranges from 16 to 60 percent; K-feldspar content varies from less than 5 percent in amphibolites to 40 percent in granitic gneisses; and plagioclase content ranges from 16 to 50 percent. Presence of a considerable amount of perthite made separation of plagioclase and K-feldspar difficult in the mineral counts. For the purposes of this study, if the perthite was stained as K-feldspar even though albite twinning was present, it was counted as K-feldspar. This is justified because perthite is associated only with the metasedimentary sequence and the purpose of the light mineral counts was to determine whether the till originated from anorthosite or metasedimentary terrains.

Pebbles and boulders from the metasedimentary rocks are easily identified as to their source. The only confusion in identification is in distinguishing the Whiteface anorthosite from amphibolite and weathered charnockite.

Charnockites weather to a brown sugar color and close investigation with a hand lens will usually allow identification of some quartz. Amphibolites are rich in mafic minerals with white plagioclase feldspar. The plagioclase forms bands separated by mafic minerals in the amphibolites whereas it is dispersed as individual grains in the Whiteface anorthosite. If the rock fragment is very large, it will usually show mineral banding in the amphibolites and a salt and pepper appearance in the anorthosite.

#### PALEOZOIC SEDIMENTARY ROCKS

Surrounding the metasedimentary rocks on the outer edge of the Adirondack Mountain area is a sequence of Paleozoic sedimentary rocks. In this study, the author is interested in those sedimentary rocks that have been transported by glaciers and that are found in tills. This is primarily the Cambrian Potsdam sandstone. A few pebbles of completely weathered Ordovician Chazy limestone were observed in the till at the north end of Wilmington Valley.

The Potsdam sandstone outcrops all around the north and northeast edge of the Adirondacks and any continental glacier moving out of the St. Lawrence Valley into the mountains had to override these rocks. Since the Potsdam is a very pure quartz sandstone bound together by quartz cement, it weathers very slowly. The combination of stability and sedimentary characteristics of the Potsdam sandstone makes it easily recognized as rock fragments in the till. It was first thought that the presence of Potsdam sandstone erratics was positive evidence of continental glaciation and unrelated to local glaciation; however, in some cases, local ice movement has reworked previous continental deposits containing Potsdam sandstone erratics (see discussion of deposits on White Brook Valley).

#### LIGHT MINERAL COMPOSITION OF ADIRONDACK TILLS

Due to the distinctive mineralogical character of the rocks of the High Peaks region, light mineral determinations were made of all till

samples collected during the field work.

Light mineral studies were conducted on 13 till samples from the Raquette Lake area (figure 3). These results are shown in figures 8 and 9. The Raquette Lake samples contain nearly equal percentages of quartz, K-feldspar and plagioclase feldspar. The mean values and the standard deviations of quartz, K-feldspar and plagioclase are respectively:  $39.9\% \pm 6.65$ ,  $39.2\% \pm 13.33$ , and  $29.9\% \pm 5.48$ . Figure 9 shows the frequency distributions of these light mineral fractions as histograms with crossline patterns.

In metasedimentary rocks the light mineral composition ranges are: quartz, 16 to 60%; K-feldspar, 5 to 40%; and plagioclase feldspar, 16 to 50% (Buddington, 1966). The light mineral contents of the Raquette Lake tills fall within these ranges. Since the nearest exposure of anorthosite is 25 miles to the north, there would be little anorthosite effect on the Raquette Lake tills. Therefore, the Raquette Lake till samples are believed to be representative of the mineralogic composition in tills derived mainly from metasedimentary rocks.

The light mineral compositions of 59 till samples from the High Peaks area were determined and are shown on figures 8 and 9. The mean values and standard deviations for quartz, K-feldspar, and plagioclase are respectively:  $18.1\% \pm 12.33$ ,  $24.6\% \pm 8.05$ , and  $57.4\% \pm 15.32$ .

Comparison of the light mineral frequency distributions of the High Peaks area tills and the Raquette Lake tills (figures 8 and 9) shows that these are different though overlapping distributions. The frequency distribution of quartz in the High Peaks area tills is bimodal indicating two populations with the second mode falling within the range of the Raquette Lake till quartz values. K-feldspar values for the High Peaks area tills are lower than the K-feldspar values for the Raquette Lake area tills and again a suggestion of a second mode in the High Peaks region falls under the mode of the Raquette Lake samples. Plagioclase frequency distributions of tills from the two areas are definitely different, with the values for the Raquette Lake tills being much lower showing only a small overlap of the distributions in the tills from the two regions.

The light mineral composition of a till is indicative of the rocks overridden and eroded by the ice which deposited the till. Anorthosite is a readily identifiable rock because of its high plagioclase, low quartz and low K-feldspar composition. If ice originated on an anorthosite terrain and stopped on the anorthosite terrain, the light mineral composition of the deposited till would be high in plagioclase and low in K-feldspar and quartz. If, however, the ice traversed a metasedimentary terrain and overrode an anorthosite terrain, the plagioclase content of the deposited material would increase as a direct function of the erodability of the anorthosite and the distance over the anorthosite that the original metasedimentary material had been transported. As the plagioclase content increased, the quartz and K-feldspar fractions would be correspondingly reduced.

This relationship is clearly shown on the ternary diagram of the light mineral composition (figure 8). There are three distinctive groupings of values: the Raquette Lake samples, high in quartz and K-feldspar; a middle group, higher in plagioclase and lower in quartz and K-feldspar; and a third group, very high in plagioclase. The middle group is believed to represent a dilution effect in composition which occurs as the ice moves from a

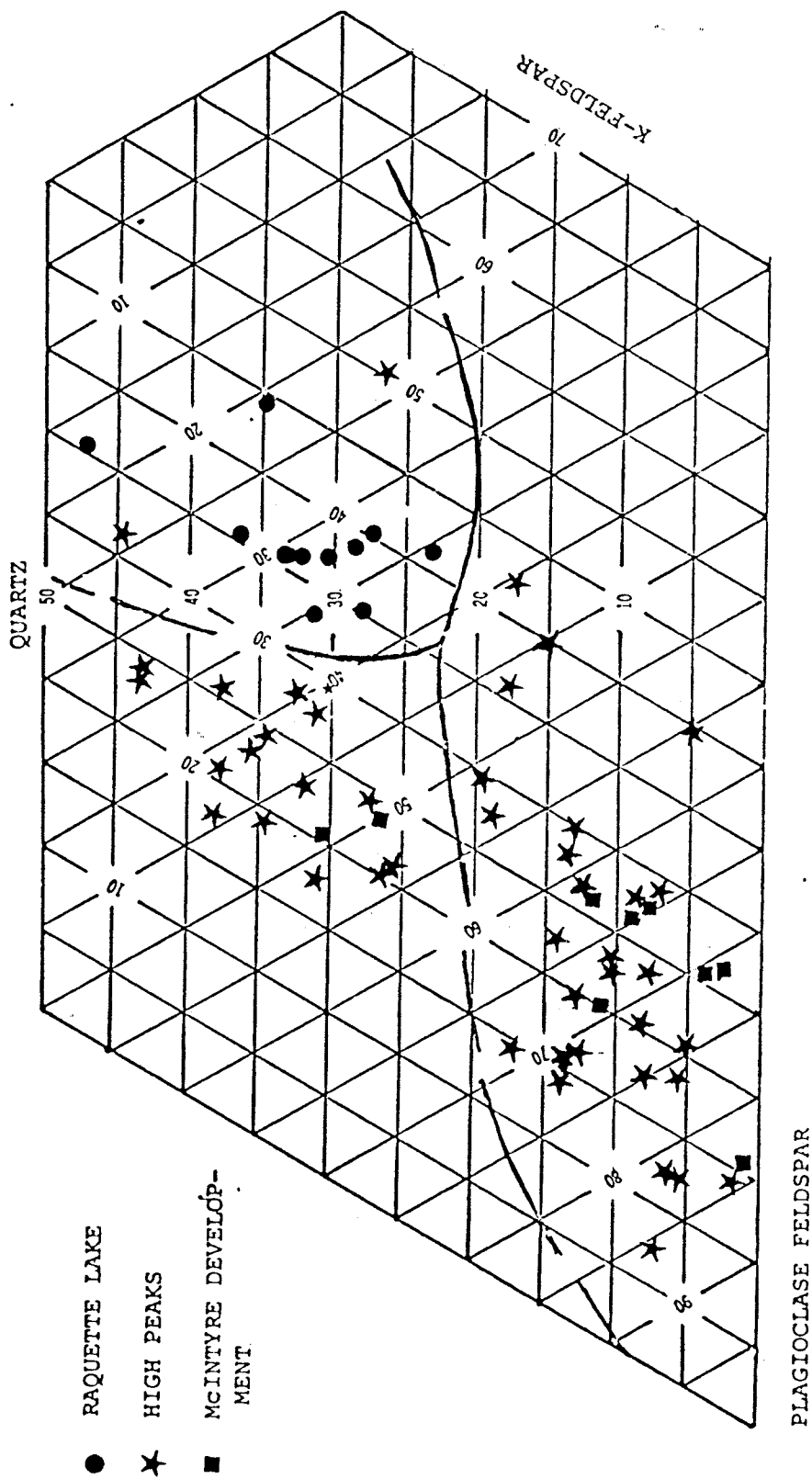


Figure 8. Triangle diagram of the light mineral fraction of Adirondack Tills.

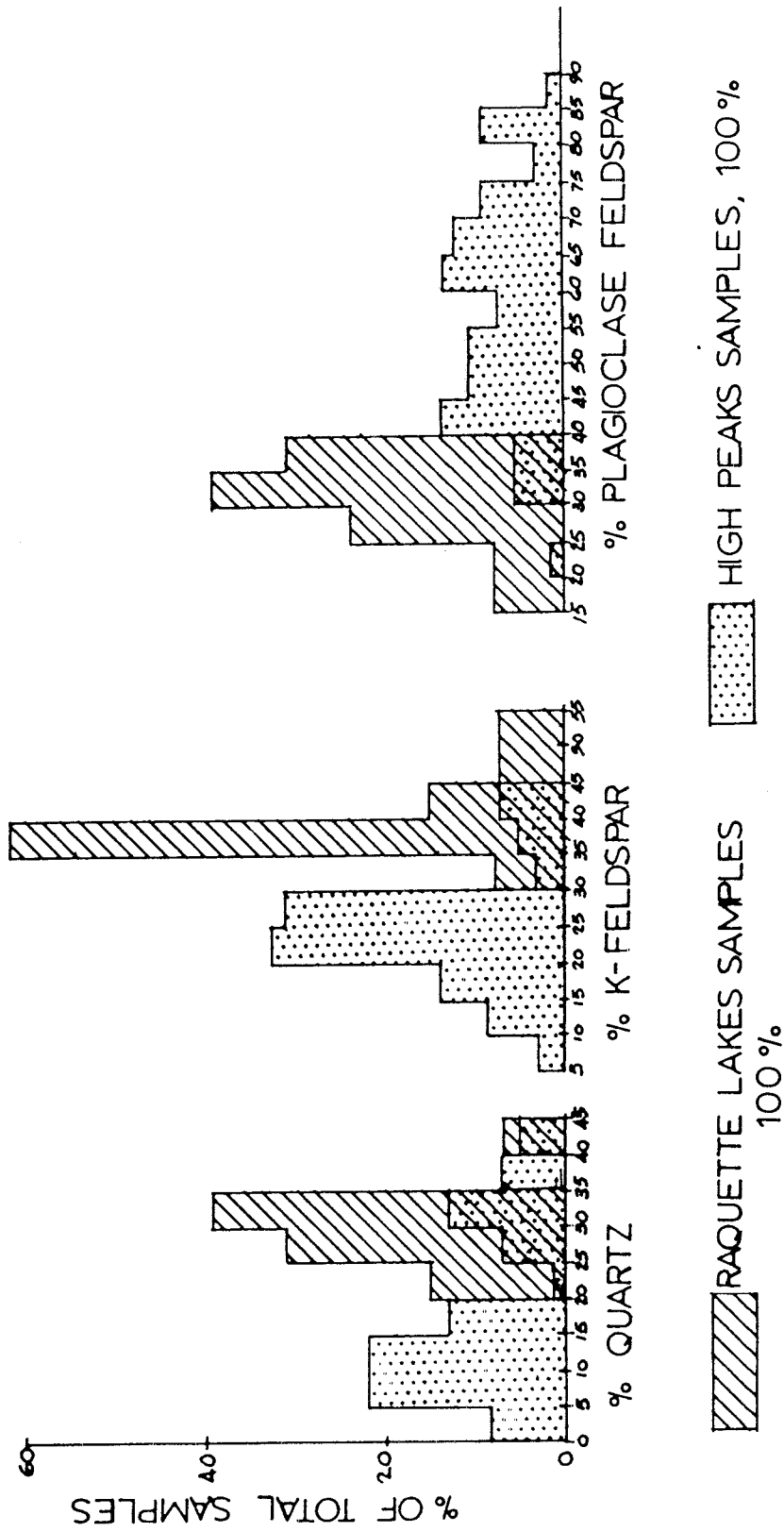


Figure 9. Histogram of quartz, K-feldspar, plagioclase feldspar in matrix of Adirondack Tills.





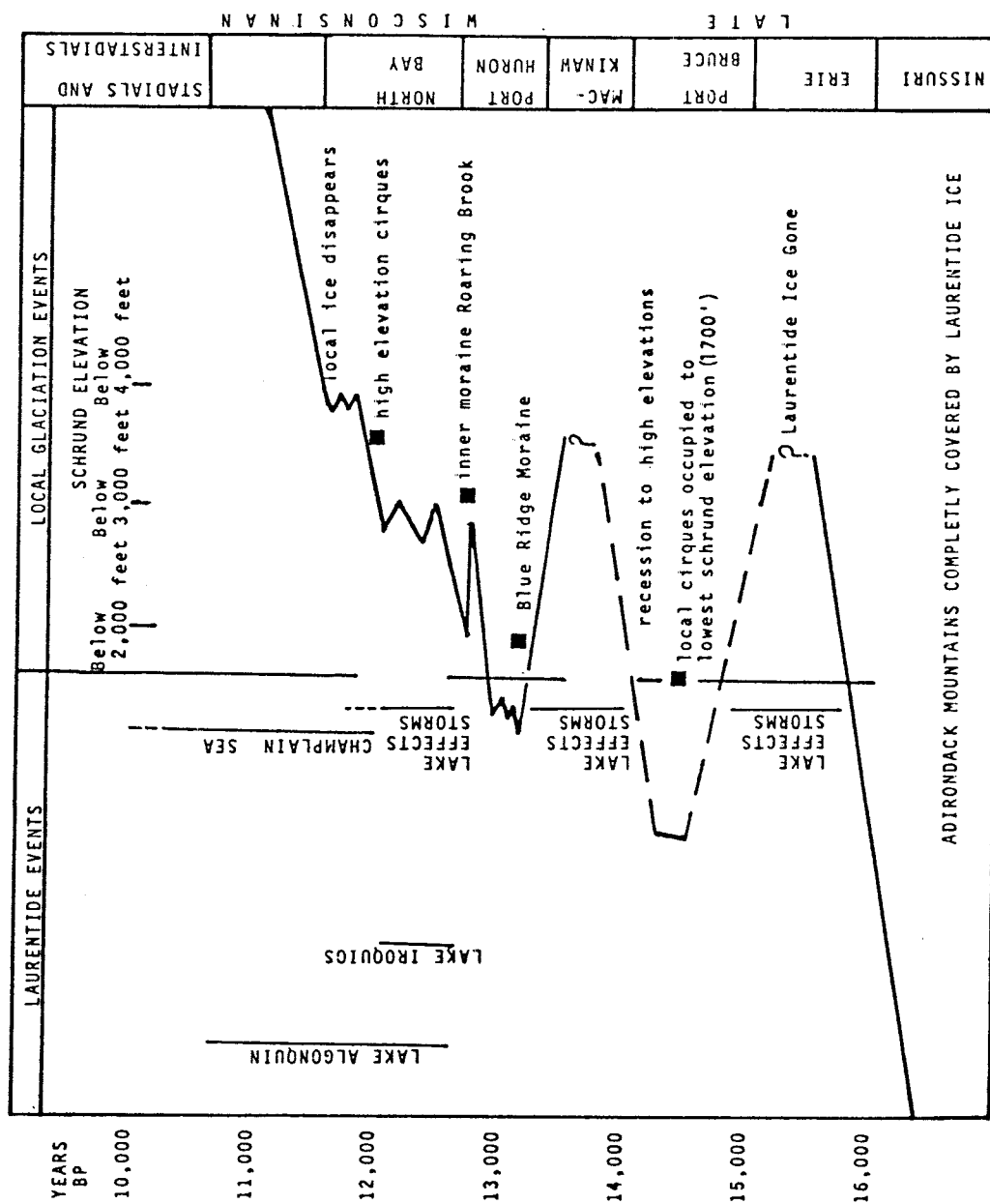


Figure 10. Diagrammatic stratigraphy of the Wisconsin deposits, Adirondack Mountains, St. Lawrence Lowlands to Ohio.

metasedimentary terrain onto an anorthosite terrain.

In some cases, it can be shown that local xenoliths of quartz and K-feldspar-rich bedrock cause an increase in these minerals in the till samples. In other cases, local ice originating in the contact area of metasedimentary rock with anorthosite gives high quartz and K-feldspar values in their deposited tills (see Whiteface Mountain Ski Center, stop 8; and the Blue Ridge area, stops 5, 6 and 7).

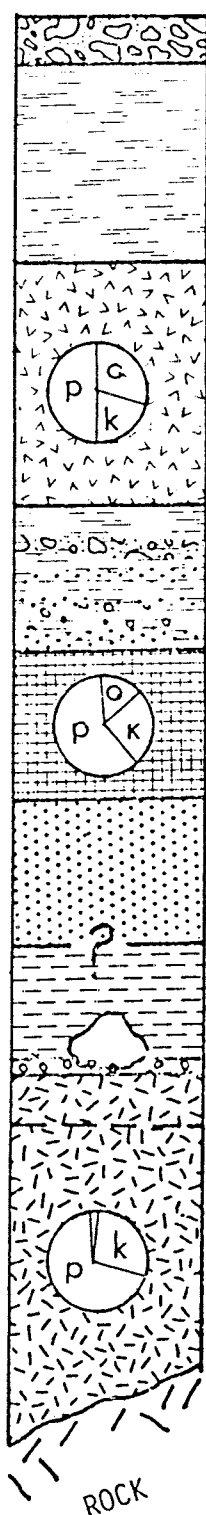
The McIntyre mine tills at Tahawus are very significant (figure 8). Two samples fall in the middle group indicating that the ice has over-ridden a metasedimentary terrain prior to deposition of the till. In this case, the metasedimentary terrain is south of the deposit, indicating a northward flow of ice to deposit the till.

There is a marked variation in the plagioclase content of the High Peaks tills. Although light mineral content of the tills can be used as an indication of the history of the deposits, the plagioclase content alone does not define the history of the till. Other evidence in the individual deposits such as till fabrics, pebble lithology, striations and sediment deformation must be considered before the total relationship of the deposit to the glacial history can be established.

#### GLACIAL HISTORY AND CLIMATIC MODEL OF LOCAL GLACIATION

Cirque development in the Adirondacks must have started very early in Pleistocene time. The oldest till at the McIntyre Development, Tahawus, N. Y., (figure 11, till A) clearly demonstrates a glaciation prior to 55,000 years BP, the age of the overlying lake sediments. These sediments could represent either an Early Port Talbot Interstade or the St. Pierre Interstade. The presence of continuous deposition of the Gentilly Till (Gadd, et al., 1972) in the St. Lawrence Valley from Late St. Pierre Interstade to Early Erie Interstade (figure 10) indicates that the lacustrine sediments were deposited during the St. Pierre Interstade. Till "A" represents the first glacial advance of the Wisconsin Stage. Evidence indicates that the source of the ice that deposited this lower till was from the north. Two other areas of old weathered till were observed in the field study; one in Johns Brook Valley at the base of the Bushnell Falls exposure, the other in the bank of West Branch Ausable River where the Adirondack Loj Road crosses the river. There is no way of establishing an age for these tills except that they are more intensely weathered than the overlying tills. The Johns Brook Valley till, however, does show that the valley bottom existed in this present configuration sometime prior to the glaciation that deposited the older till. Goldthwait (1970) cited evidence of local glaciation and cirque-cutting at this time in the White Mountains. Cushing (1899) described a moraine on the north side of the Adirondacks near Malone, N. Y., composed entirely of Adirondack rocks. Cushing (1899, p. 8) interpreted this moraine as evidence of a late glacial flow of ice northwest from the Adirondacks. Field work in the High Peaks region, however, clearly indicates that the late glacial activity extended ice tongues only to the lower elevations of the main valleys.

Using this sketchy evidence, the following working hypothesis for the time of initial local glaciation and cirque-cutting is proposed (figure 10).



Coarse sand and gravel, oxidized in zones - upper part mixed with excavation fill from Tahawus Village. 2'-5'

Laminated sand, silt, clay, some gravel lenses, upper parts oxidized, well developed ripple marks cut and fill structures throughout, bedding dips 8° N. 1'-20'

Till, yellow brown oxidized moderately stoney, non-calcareous very few ore pebbles. 1'-25'

#### Till "C"

Sandy gravel, laminated sand and silt. Numerous small folds overturned to the north. In some places this layer has been so disturbed it becomes till-like in texture. 4'

Till, gray, moderately stoney, non-calcareous few Potsdam pebbles observed, no ore pebbles. Contact with overlying sediments marked by thin silt bands. 8'-15'

#### Till "B"

Sand, yellow brown oxidized medium to coarse changes to sandy gravel a short distance to the west. Contact with underlying laminated clay not observed. 5'-15'

Clay, brown with few pebbles and disseminated wood fragments including material identified as Pinus strobus (David Bierhorst, Dept. of Botany, Cornell Univ.) Age greater than 40,000 yrs. (W-1520) 3'-12'

Gravel stratified. 1'-2'

Till yellow gray moderately stoney, noncalcareous, oxidized. 5'

Till, stoney, numerous ore pebbles folded silt, sand inclusion, shear planes dipping south. 1'-30'

#### Till "A"

Light Mineral Composition  
of Till Matrix

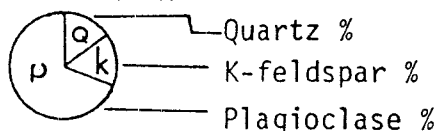


Figure 11. Generalized stratigraphic section of Tahawus, McIntyre development drift deposits. Scale: 1" = 20'

The first glacial advance of the Laurentide ice sheet during Wisconsin time in the St. Lawrence Valley has been reported by Gadd, McDonald and Shilts (1972). This advance blocked the outlet of the Ontario Basin, causing a rise in lake level to form Lake Scarborough (Dreimanis and Goldthwait, 1973). Goldthwait (1970) cited evidence of local glaciation and cirque-cutting in the White Mountains at this time. The existence of Lake Scarborough in the Ontario Basin establishes the criteria for "Lake Effect Storms". The presence of the Laurentide ice front would have created a glacial climate over the High Peaks region. Terasmae (1960) concluded from palynologic studies of the Scarborough Formation that the mean annual temperature at Toronto was 6° C. cooler at that time than at the present time. Goldthwait (1970) suggests that the average summer temperature in the White Mountains of New Hampshire was 9.3° C. cooler than at present. The present mean annual temperature of the Adirondacks at Lake Placid is 3.3° C.; at Burlington, Vermont, 4.4° C.; and at Albany, N. Y., 7° C. (Falconer, R., personal communication, 1969). Mean July temperature at Lake Placid is 18.9° C.; at Albany, N. Y., 22.8° C.; and at Toronto, 23.3° C.

Mordoff (1925) showed the mean annual growing temperature, April to September (interpreted as average summer temperature), to be 13.3° C. for the Adirondacks at the present time. Since snowline occurs where the average summer temperature is at 0° C. or slightly above, it is possible to predict snowline elevations for different annual mean summer temperatures (table 2).

Table 2. Mean Summer Temperature Variation with Elevation.

Mean Temperature Decrease from Present	6° C. <sup>1</sup>	10° C. <sup>2</sup>	11° C. <sup>3</sup>	0° C. <sup>4</sup>
Elevation	Mean Summer Temperature			
2000' ASL	7° C.	4° C.	2° C.	13° C.
3000' ASL	5° C.	2° C.	0° C.	11° C.
4000' ASL	3° C.	0° C.	-2° C.	9° C.
5000' ASL	1° C.	-2° C.	-4° C.	8° C.
6000' ASL	0° C.	-	-	-
9000' ASL	-	-	-	0° C.
Toronto	11° C.	7° C.	6° C.	17° C.

1. Annual mean temperature decrease for Lake Scarborough (Terasmae, 1970).
2. Mean summer temperature decrease for White Mountains (Goldthwait, 1970).
3. Suggested mean summer temperature decrease for Adirondacks by author.
4. Present mean summer temperature at Wilmington, New York.

Snowline in the Adirondack Mountains during the existence of Lake

- 4 -

Scarborough would occur slightly below 6000 feet ASL. This was determined by decreasing the mean annual growing time temperature of 13.3° C. at 2000 feet ASL by 6° C. as suggested by Terasmae (1960) and applying the normal lapse rate of 1.94° C. per 1000 feet elevation.

The influence of the proximity of the Laurentide ice sheet has not been considered in this calculation. Using the temperature decrease of 9.3° C. suggested by Goldthwait for the White Mountains, the snowline would be at 4000 feet ASL. A mean annual summer temperature decrease of 20° F. (11.1° C.) would place the snowline at 3000 feet ASL. Average schrund elevation in the High Peaks is 3036 feet ASL with a range from 1700 feet to 4300 feet ASL. These values suggest local glacial development was possible. It is conceivable that, given time for ice accumulation and the additional cooling effect of the nearby Laurentide ice sheet, an ice cap glacier could have developed over the Adirondack Mountains and flowed northward to deposit the moraine described by Cushing (1899), south over the McIntyre Development to deposit till "A" and out of Johns Brook Valley.

This could have been the stage of glaciation when the low elevation cirques were occupied. When the early Laurentide ice melted from the St. Lawrence Valley, this local ice cap disappeared and the lacustrine sediments overlying the oldest till (figure 11, till "A") were deposited. These sediments are older than 55,000 years BP (Muller, 1969) and may record the St. Pierre Interstadial in the Adirondacks. This interstade was followed by the main Wisconsinan Advance, the Guildwood Stage of Dreimanis and Karrow (1972), which eventually extended south to Long Island and to Olean, New York. Coates and Kirkland (1974) suggest that this main Wisconsinan ice advance first flowed around the Adirondacks and that the Adirondacks eventually became an outflow center influencing the directions of flow of the Laurentide ice sheet. Field evidence in the High Peaks area indicates that the main Laurentide ice advance moved through the main valleys and continued southward. This is indicated by the presence of Potsdam sandstone erratics in the main valleys of the Adirondack Mountains and in the distribution of metasedimentary rocks in the tills deposited on the Anorthosite terrain of the High Peaks. This main Laurentide Advance is also recorded in the Tahawus section (figure 11) by the deposition of till "B". The Adirondacks remained buried beneath this ice mass until Late Wisconsinan time. Deglaciation from the glacial maximum position began about 17,000 years BP (Connally and Sirkin, 1973). Deglaciation of the region appears almost continuous with some readvance of the continental ice mass reported by Connally and Sirkin (1973), the Walkill Readvance, until 13,200 years BP, the date of the Luzerne Readvance (Connally and Sirkin, 1973).

The exact time of Laurentide deglaciation from the High Peaks area is not known. However, a reasonable time frame can be established in relationship to the deglaciation history of the Late Wisconsinan ice mass.

Dreimanis and Goldthwait (1973) describe two Late Wisconsinan interstades, the Erie and the Mackinaw, that relate to the Adirondacks.

The Erie Interstade, approximately 15,500 years BP (Dreimanis and Goldthwait, 1973), is probably the earliest that the Laurentide ice would have melted from the High Peaks region (figure 10). At this time, the area would be surrounded by the Laurentide ice mass with the High Peaks standing as a bed rock island through the ice mass (Fairchild, 1913; and Coates and Kirkland,

1974). Dreimanis (1969) and Dreimanis and Goldthwait (1973) indicate an eastward flow of water from the Erie Basin to the Hudson River Valley during the Erie Interstadial. This implies that the continental ice margin had to be north of the Onondaga Escarpment for the water to reach the Hudson River system. If this were true, then the High Peaks area could have been free of direct influence of the continental ice flow and the Hudson Valley would have been ice-free south of Albany, N. Y.

The Erie Interstade closed with ice advancing to the Lake Escarpment Moraine (Calkin, 1970; White, 1960), to the Valley Heads Moraine (Calkin, 1970; Muller, 1965b; MacClintock and Apfel, 1944) and to the Walkill Valley Moraine (Connally and Sirkin, 1970 a & b and 1973). This ice readvance has been dated by Calkin (1970) at  $14,900 \pm 450$  years BP (I-4216) for the Lake Escarpment Moraine and by Connally and Sirkin (1973) at 15,000 years BP. This readvance is the Port Bruce Stade of Dreimanis and Karrow (1972) and probably represents Phase E suggested by Coates and Kirkland (1974).

The Port Bruce Stade was followed by stagnation and melting back of the ice front during the Mackinaw Interstade (Dreimanis and Goldthwait, 1973) to a line 50 to 150 km. north of the Port Huron Moraine complex in the Erie Basin (Karrow, 1969; Dreimanis, 1967; Dreimanis and Goldthwait, 1973) and receded to a line somewhere north of the south shore of Lake Ontario (Karrow, 1969; Calkin, 1970) and north of Luzerne, New York, in the Hudson-Champlain Valley. During this interstade, the High Peaks area would have open drainage into the Hudson system southward. It is not known if there was a period of open drainage northward into the St. Lawrence Lowlands. MacClintock and Stewart (1965) reported lacustrine sediments between the Malone Till and the Fort Covington Till in the St. Lawrence Valley, and correlated the Fort Covington Advance with the Port Huron. If this correlation is correct, then a partially open drainage to the north was possible during the Mackinaw Interstadial.

The Mackinaw Interstade was followed by the Port Huron Readvance (Dreimanis and Karrow, 1972) in the Erie Basin and the Bridgeport Readvance (Connally and Sirkin, 1970a, 1970b, 1973) in the Hudson-Champlain Valley. Calkin (1970) believes the morainal complex between Lake Ontario and the Onondaga Escarpment is probably related to the Port Huron Readvance. Dreimanis and Evenson (1976) suggest that the Bridgeport and Luzerne Readvances both belong to the Port Huron Stade.

The Luzerne Readvance (Early Port Huron Stade) caused ice to move down the Hudson-Champlain Valley to south of Glen Falls, New York (Connally and Sirkin, 1971, 1973). This advance blocked the Hudson River drainage from the Adirondacks and created Glacial Lake Warrensburg (Miller, 1925; Craft, 1970). Drainage northward was also blocked by ice, creating Glacial Lake Wilmington in the Ausable drainage system and Glacial Lake Saranac in the Saranac system.

The Port Huron Stade was followed by ice retreat and the development of a complex series of proglacial lakes. This lake series has been reported in detail by Hough (1958, 1963); Lewis (1969); Balkin (1970); Karrow et al. (1961, 1975); Dreimanis and Goldthwait (1973); and Prest (1970). The development of the proglacial lakes played an important role in local glacial activity in the High Peaks region.

The return of the Laurentide ice mass to the border of the High Peaks region during the Port Huron Stade brought a return of glacial climatic conditions to the higher elevations of the mountains. Pre-existing depressions were filled with snow, which became thick enough to form ice and, finally, started flowing from the higher elevations as local glaciers. A permanent Arctic high pressure system would develop over the continental ice sheet.

Climatic conditions to the south and southwest were much warmer than to the north. Storm systems probably moved across the area from west to east, just as they do today (Manley, 1955; Wright, 1961; Fairbridge, 1970, 1972) but storm tracks would be pushed farther south. Air masses from the south and west would be relatively warm and moist, similar to those of today. When these warm air masses encountered the cold air from the ice mass, precipitation would occur. This precipitation would be rain in the south at lower elevations, and snow in the north at higher elevations. The rise in surface elevation from south and west to the High Peaks region to the northeast would create an orographic effect on the moving air masses, intensifying precipitation. In the early phase of this sequence, most of the accumulation would be from regional storms moving from the southwest and west towards the east.

With this in mind, let us consider a special type of storm development that may have played a very important role in events in the Adirondack Mountains following the Port Huron Stade of the Laurentide ice sheet, especially during late Port Huron and early North Bay time. This special storm situation is known as the "Great Lakes Snow Storms" or "Lake Effect Storms" (Jiusto et al., 1970; Lansing, 1965; Peace and Sykes, 1966; Falconer, Lansing and Sykes, 1964).

Basically "Lake Effect Storms" are presently generated over the open water surface of the Great Lakes during the winter months, when the air mass over the lakes is colder than the water. The difference in temperature between the air and water causes an unstable air mass condition to develop. Warm moist air rises into the cold air above to generate meso-scale storms with dimensions of about 2 to 20 miles in width and 50 to 100 miles in length (Lansing, 1965). These storms originate over the open water of the lake and then drift over the land, causing precipitation of either rain or snow depending on the air temperature over the land. The land surface rises east of Lake Ontario, causing an orographic lifting of the meso-scale storm and intensifying precipitation. These storms often reach the High Peaks region and because it is colder in this mountain area, precipitation is in the form of snow. For example, in November 1969 a meso-scale storm developed over Lake Ontario and extended eastward. Temperature at Oswego, N. Y., on the lake shore, was 40° F. and precipitation was in the form of rain and sleet. The temperature at Whiteface Mountain, approximately 120 miles east, was 8° F. and precipitation was in the form of snow (Falconer, R., personal communication). Figure 12 is a map showing mean seasonal snowfall in northern New York State. The impact of these "Lake Effect Storms" is readily shown by the amount of snowfall recorded at the east end of Lake Ontario. The greatest mean seasonal snowfall occurs at the highest point on the Tug Hill Plateau with over 220 inches recorded. This is due to a combination of meso-scale storms and orographic lifting of the air masses. The next greatest snowfall area is the High Peaks region of the Adirondack Mountains, with over 190 inches annually. Precipitation from this type of

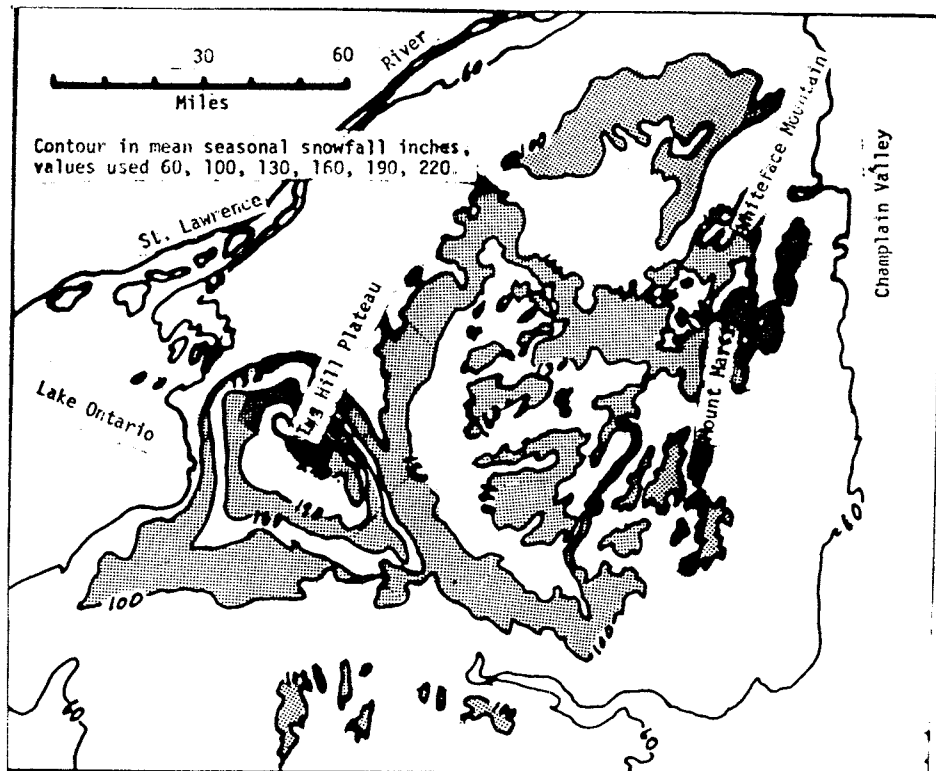


Figure 12. Mean seasonal snowfall map Tug Hill Plateau and Adirondack Mountains (after Muller, 1960). Pattern shading used to delineate area of snow accumulation 100, 130 and 160, 190 for ease of reading.



storm is intense. One single snow squall in 1964 dropped 48 inches of snow on Boonville, N. Y., in 24 hours (Lansing, 1965).

The storms begin to develop in the fall as soon as surface air temperature is lower than surface water temperature, and continue until the lake freezes over or until spring, when the surface air temperature becomes higher than water temperature (Falconer et al., 1964). These storms generate large amount of snowfall. They are caused by a specific combination of conditions, i.e. warm water bodies overlain by cold air masses. These are the conditions that would have existed over the surface of proglacial lakes due to the nearby Laurentide ice field. Conditions would be most favorable for "Lake Effect Storms" following spring break-up of the frozen lakes and in the fall prior to the lakes freezing over. This would shorten the period of summer ablation and provide a source of large amounts of snow.

The conditions for "Lake Effect Storms" existed from the time of deglaciation of the Adirondack Mountains, possibly as early as the Erie Interstade (approximately 15,500 years BP) and lasted with lengthy interruptions and varying degrees of intensity until the retreat of the Laurentide ice north of the St. Lawrence Valley. Between the Erie Interstade and the opening of the Champlain Sea, large bodies of water of varying sizes and geographic positions existed at the edge of the Laurentide ice sheet. Cold polar air existed over the ice mass with warmer air to the south. The proglacial lakes were partially ice free at least during the warmer period of the year. The normal wind circulation was probably from west to east.

Figure 13 is a map showing the maximum possible ice recession position during the Mackinaw Interstade prior to the beginning of the Port Huron Stade. The High Peaks cirques were fully occupied by glaciers at this time. Figure 14 shows the approximate ice position reached by the Port Huron-Luzerne Readvance (Early Port Huron Stade). A very large body of water existed in the Erie Basin i.e. Glacial Lake Whittlesey. Small lakes existed in New York in the Finger Lakes region. The Adirondacks were surrounded on three sides by the continental ice sheet, establishing a cold glacial climate in this highland region. During this time, a delta from the Blue Ridge Moraine was deposited into Glacial Lake Warrensburg. This appears to be the time of local glacial maximum as indicated by the Blue Ridge Moraine and associated deposits. The outer Roaring Brook Moraine, the youngest till (till "C") at the McIntyre Development and Boreas Mountain Moraine were probably deposited at this time. At this period, it is doubtful that any "Lake Effect Storms" generated over Glacial Lake Whittlesey would have reached the Adirondack Highlands. However, regional cyclones from the west and southwest would have reached the mountains, and continued snow accumulation would have taken place.

As the continental ice melted back from this maximum position, the lake system expanded eastward (figure 15) forming Glacial Lake Warren.

The Laurentide ice receded and readvanced to the Bridgeport position of Connally and Sirkin at about 12,900 BP (1973) and Lake Warrensburg drained. Within the Adirondacks, the valley glaciers receded from their maximum positions. The inner moraine of Roaring Brook was formed. The glaciers flowing into Lake Wilmington and Keene were calving off into the lakes.

The connection of Lake Warren between the Ontario and Erie Basins was short lived. Once the Utica outlet was opened by the retreat of the ice

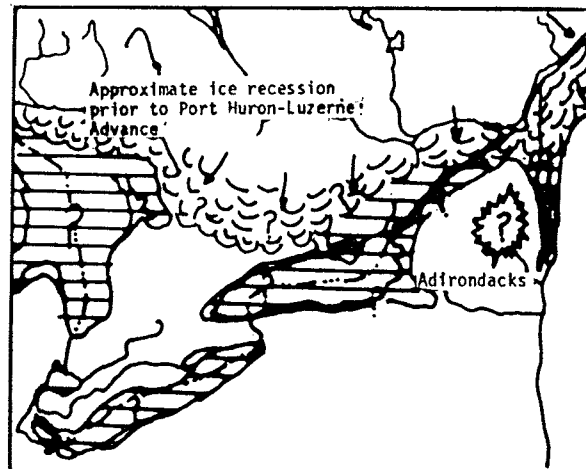


Figure 13. Approximate ice recession during Mackinaw Interstade. Early "Lake Effect Storms" caused snow accumulation in the Adirondacks building local ice masses.

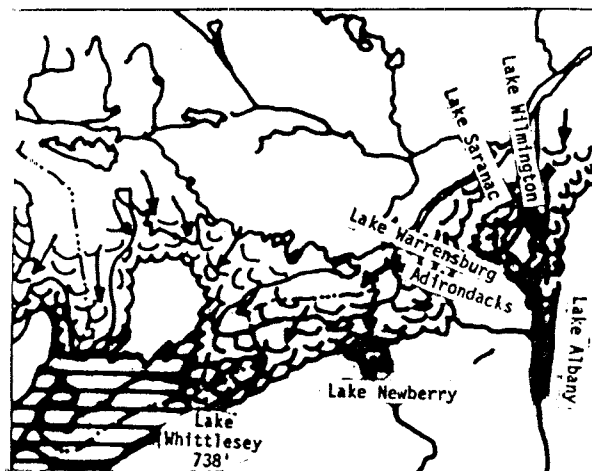


Figure 14. Approximate ice margin during Port Huron Stade. Note Adirondack High Peaks glaciation and presence of Glacial Lakes Warrensburg, Wilmington and Saranac. Local glacial maximum to Blue Ridge and outer Giant Moraines.

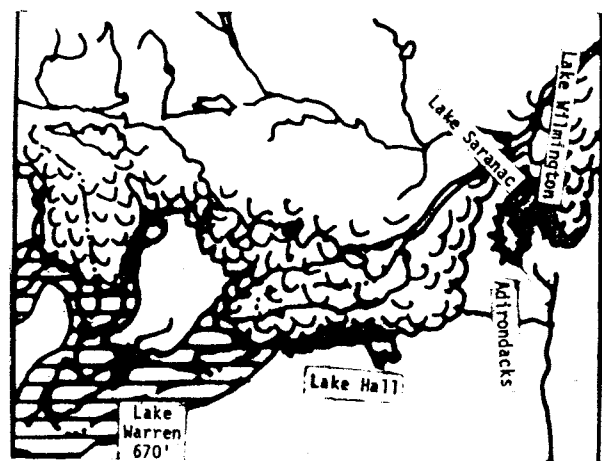


Figure 15. Approximate ice margin Late Port Huron Stade. Glacial Lakes Warren and Hall and the Adirondack lakes at approximately 12,900 BP. Local ice has receded to inner moraine at Giant Mountain.

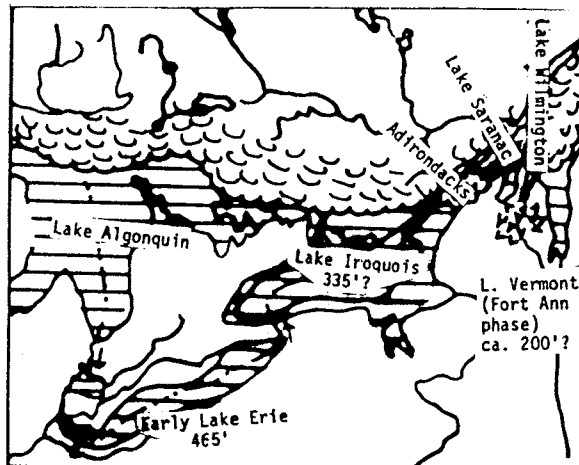


Figure 16. Glacial Lakes Algonquin, Iroquois and Vermont<sup>1</sup>. Note Lake Warrensburg has drained and presence of Lakes Saranac and Wilmington. Time of "Lake Effect Storms". Local recessional lateral moraines developed in Johns Brook and White Brook (approximately 12,000 to 12,600 BP).

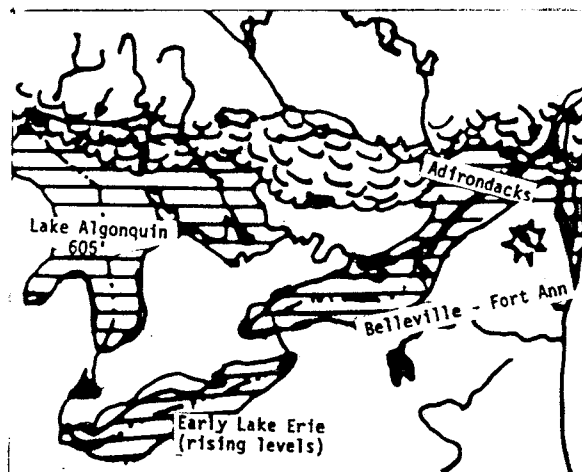


Figure 17. Glacial Lake Algonquin, Belleville-Fort Ann Stage<sup>1</sup> approximately 11,800 to 12,000 BP. Adirondack Lakes have now drained, mountain glacial activity waning. Rapid melting to higher elevations. Ice dammed lakes rapidly drained.

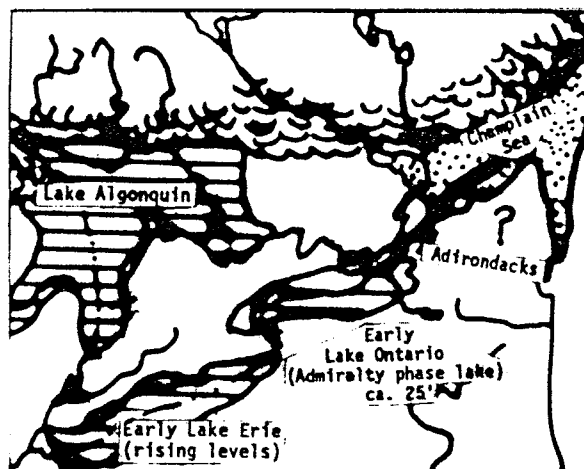


Figure 18. Glacial Lake Algonquin, Champlain Sea<sup>1</sup> approximately 10,200 to 11,800 BP. Early Lake Champlain, high elevation valley glaciers and isolated cirque glaciers e.g. Moss Pond. Probably all Adirondack ice had disappeared by 11,000 BP. Maps modified from Prest (1970).

from the south side of the Tug Hill Plateau, the two basins separated and Glacial Lake Iroquois was formed. Karrow et al. (1975) placed this event at about 12,600 years BP. The creation of this large body of water in New York would have caused the return of the "Lake Effect Storms" affecting the Adirondack Mountains. There would have been a warming trend in the Highland area as the Lake Champlain Basin was freed of ice except at the northern end. Temperature in the mountain area, however, would still have been cold enough to maintain a positive balance of snow accumulation at higher elevations, primarily because of the high snowfall and elevations of the mountains. In the Adirondacks there appears to have been a delicate balance between accumulation in the higher elevations and ablation in the lower elevations. Major valleys were occupied by deep lakes. Local ice tongues advanced into these interior lakes and ice calving occurred.

Snowfall and accumulation rates at higher elevations would have been very high, ablation in the lower elevations would also have been high, as shown by the recession of the continental ice mass around the west and east sides of the mountain area and the rapid expansion of Glacial Lake Iroquois. The "Lake Effect Storm System" would have had its greatest effect when Glacial Lake Iroquois reached its maximum extent (figure 16), and the Laurentide ice mass was still resting against the north edge of the mountains. It was probably during this period that the ice was most active. Accumulation rates would have been high, but ablation rates at lower elevations would also have been high. Therefore, recession probably occurred. It was during this time interval that the recessional moraines of Johns Brook and White Brook were formed.

When the ice retreated to the north side of the St. Lawrence River (figure 17), the Adirondack proglacial lakes drained. The tongues of local valley ice rapidly melted back to higher elevations, leaving only small higher elevation valley glaciers and isolated cirque glaciers. This was probably the time of formation of the moraine in Moss Pond and Redfield Cirques and the upper moraine of White Brook Valley. Lake Belleville would still act as a source for generating "Lake Effect Storms" but ablation would be greater than accumulation. The interior Adirondack lakes would be rapidly draining and the Adirondack region would be warming.

With the beginning of the Champlain Sea at approximately 11,800 years BP (Karrow et al., 1975), the High Peaks climate would be much warmer. The most protected high elevation areas could still contain glaciers; however, they were probably stagnant melting ice masses. It is not possible to determine exactly when the last glacial ice disappeared from the Adirondacks, but all ice was probably gone by 11,000 years BP.

#### STRATIGRAPHIC SECTIONS OF SPECIAL INTEREST NOT VISITED ON FIELD TRIP WILMINGTON WATER PIPE DITCH

A series of measured sections were made in a ditch excavation one mile east of Wilmington, N. Y., on the north side of Route 86, (figure 4, region C). The ditch runs north from the road for approximately 600 feet. Figure 19 is a compilation of the individual measured sections.

This ditch is located almost at the middle of the broad open Wilmington

- 35 -

Valley. Bedrock outcrops in the vicinity of the ditch are Whiteface anorthosite. The nearest metasedimentary rock outcrops are located approximately five miles north near Black Brook (figure 4).

Excavation of the ditch exposed till at the south end and from station 3 (figure 19) to the north end of the ditch. Figure 19 shows the stratigraphic relationship of these two tills to the stratified drift exposed in the ditch.

The till exposed at the south end of the ditch is a deep reddish-brown, silty-clay till with yellow-brown sand inclusions. This is one of two silty-clay tills found in the field study. Very few pebbles were observed in this till. Laboratory analysis of the sand fraction shows a composition of 45% quartz, 31% K-feldspar, and 24% plagioclase feldspar. This is a fairly typical representation of light mineral composition found in till formed by ice overriding the metasedimentary bedrock and then depositing on an anorthosite terrain. A sand sample collected from the layer directly on top of this till was found to have a composition of 30% quartz, 30% K-feldspar, and 40% plagioclase feldspar. Overlying this sand is a deformed clay sequence (figure 19) capped by a sandy-silt till. This till increases in clay content at the south end of the exposure where it incorporates a portion of the deformed clay forming a silty-clay till.

Laboratory analysis of this till (sample 64) shows 7% quartz, 8% K-feldspar, and 85% plagioclase feldspar, a composition indicating an anorthosite source area. Sample 65 collected from the sand overlying this till shows 14% quartz, 28% K-feldspar and 59% plagioclase feldspar.

#### INTERPRETATION OF SECTION

A glacier moving across the metasedimentary rock advanced into a lake bed incorporating clay into its base leaving behind a silty-clay till rich in metasedimentary minerals. The nearest source of metasedimentary rock is 5 miles north of the deposit. As this glacier melted away, sand with a mineral composition similar to the till was deposited on top of the till. This sand deposition was followed by deposition of lake clays. Rootlet channels were observed in these clays, which could indicate plant growth before the next glacial event, or could be due to modern root penetration. A second ice advance occurred and the upper till layer was deposited. This till has an anorthositic composition. Bedrock of the valley floor and the ridges on each side of the valley is anorthosite. The Wilmington Range on the west side of the valley has four cirques cut into its east face and White Brook Valley (figure 4, region B) also opens toward this deposit. Ice originating from any of these cirques would form a till with a matrix composition similar to the mineralogy of the anorthosites, that is, high in plagioclase content and low in K-feldspar and quartz contents. This is the composition of the upper till found in the ditch. Deposition of the upper till was followed by formation of a lake and deposition of its associated sedimentary materials. The sands deposited in this lake sequence are high in plagioclase and low in quartz and K-feldspar, indicating a source from glacial deposits originating from an anorthosite terrain. Some ice rafting occurred during this lake phase, as large boulders were found in the lake sediments. Deformation structures under the boulders indicate that they were emplaced vertically.

# LEGEND



Soil zone  
sand with gravel lenses



Gravel



Coarse sand with  
clay balls



Medium to fine sand with  
clay laminae



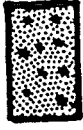
Sandy till



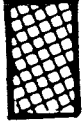
Clay - deformed



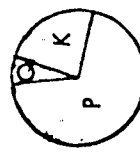
Rootlets



Coarse sand



Silty-clay till



% Quartz

% K-feldspar

% Plagioclase



Base of soil zone



Boulder

64

Sample Number

36 18 0 36 feet

Horizontal

0 1 foot

Vertical

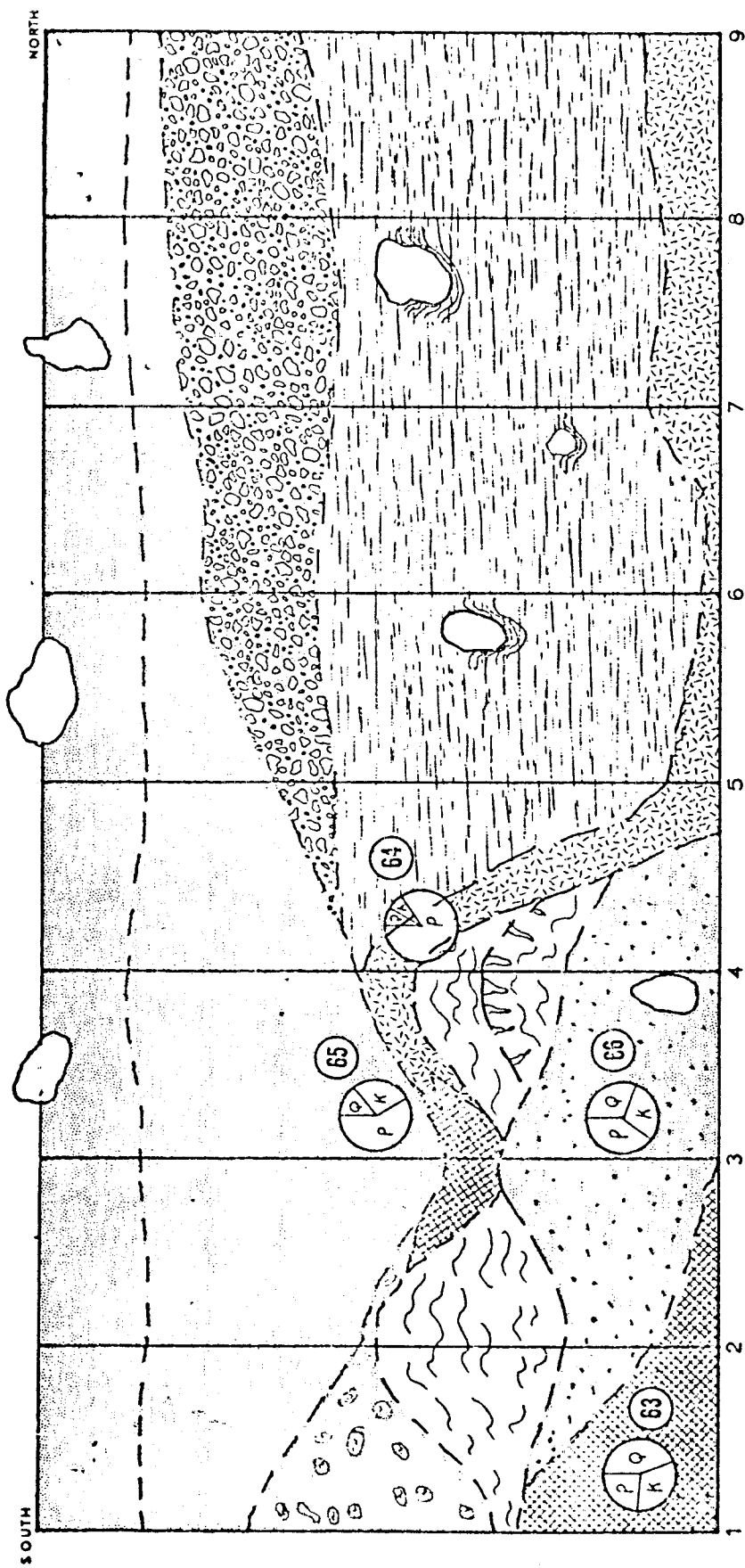


Figure 19. Stratigraphic section, water ditch, one mile east of Wilmington.

## STYLES BROOK ROAD

Styles Brook Road is located 2.75 miles south of Upper Jay (figure 4, region L). Highway repairs in 1966 exposed a stratigraphic section at the west end of the road (figure 20). The section starts at an elevation of 870 feet ASL and continues upward along the road to an elevation of 980 feet ASL.

The section consists of laminated and deformed silt and clay overlain by a thin layer of silty-clay till which, in turn, is overlain by sand and gravel. The total exposure is blanketed by a fine sand layer. The top surface of the deposit forms a well defined terrace at an elevation of 980 feet ASL. This terrace is traceable as a distinct geomorphic feature along both sides of the East Branch Ausable River from Keene, 3 miles south, to Upper Jay, 2.75 miles north. This is the terrace identified by Alling (1916) as "Lower Lake".

Two till samples were collected for light mineral analysis, one at station 8, the second at station 11. Light mineral analyses are shown in table 3.

Table 3. Light mineral analysis of Styles Brook Road till.

	<u>Quartz</u>	<u>K-feldspar</u>	<u>Plagioclase feldspar</u>
Station 8	43%	24%	33%
Station 10	38%	18%	44%

## DISCUSSION OF SECTION

Reference to the geologic map (figure 4) shows that any glacier moving into Styles Brook Valley, regardless of direction, would have overridden an extensive area of metasedimentary rock. This would have resulted in the approximate light mineral composition found in this till. Therefore, it is not possible to determine the direction of ice movement from the till composition in this case.

Information from other parts of the Ausable Valley indicates that the glacier moved into Styles Brook from the east. Exposures in the "Lower Lake" terrace on Lacy Road (figure 4, site 197) and in Liscomb Brook (figure 4, site 196), both located on the west side of Ausable Valley, show 30 feet of laminated silt and clay capped by coarse sand and gravel. No evidence of deformation of clay or presence of till was observed in either cut. The measured sections are shown in figure 21. A third exposure (figure 4, site 290) was located approximately one mile south of the intersection of Styles Brook Road with Route 9 N. This section is located on the east side of the Ausable River Valley at the south edge of Styles Brook Valley. The exposed stratigraphic section (figure 21) consists of compacted sand with thin beds of laminated silt and clay overlain by till. Elongate pebble orientations measured five feet above the base of this till show a strong ENE-WSW preferred orientation indicating flow from the upper part of Styles Brook Valley.



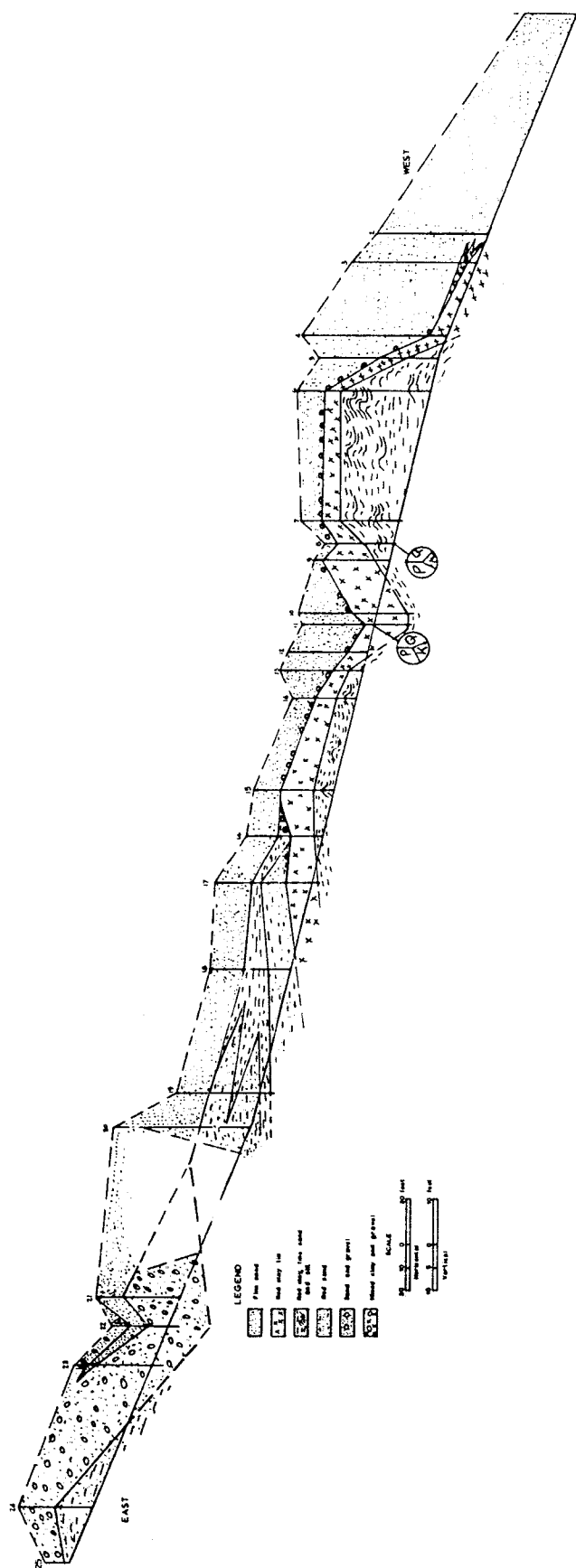


Figure 20. Stratigraphic section Styles Brook Road, for location see figure 4, region E.

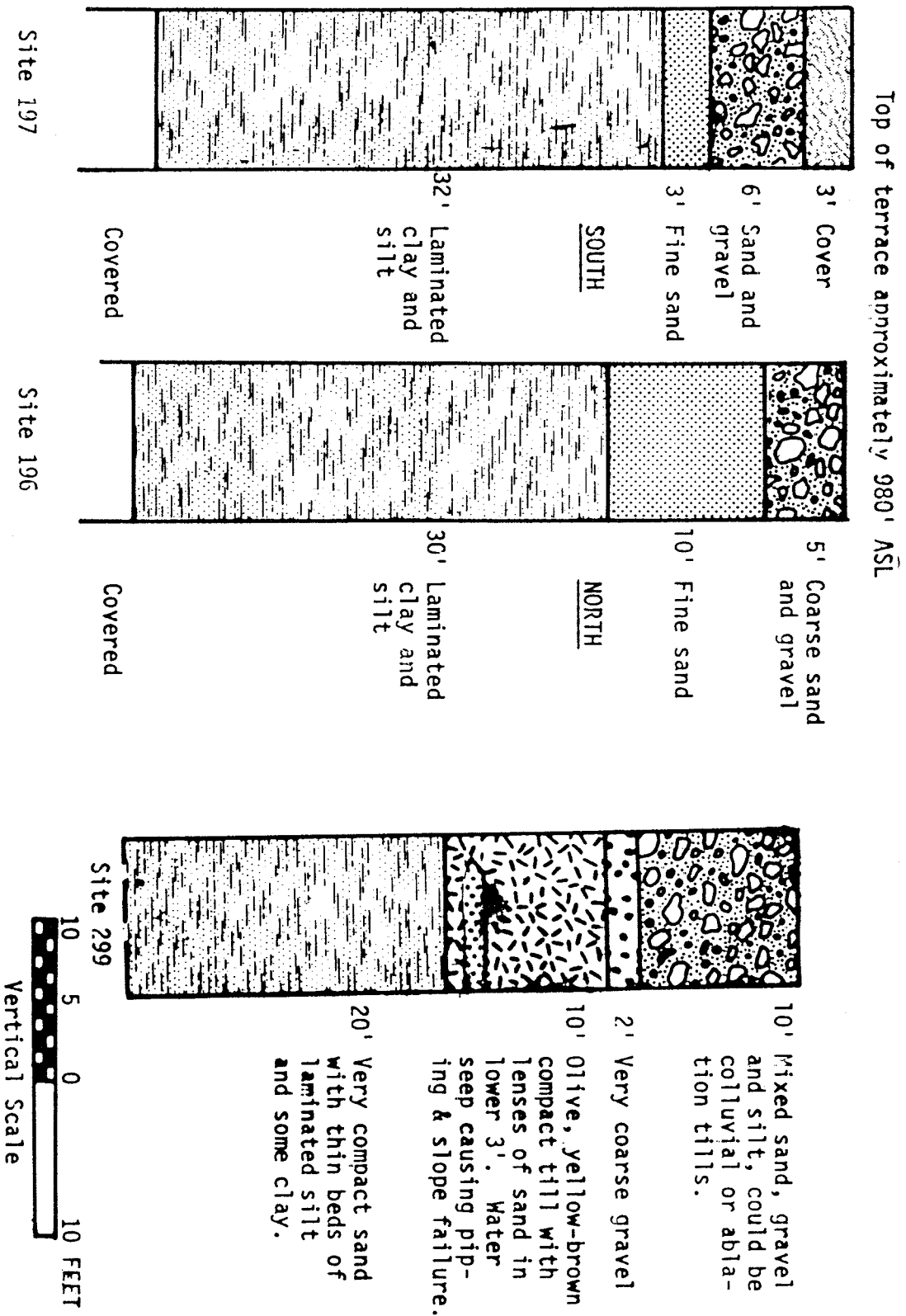


Figure 21. Stratigraphic sections associated with Styles Brook.

Site 196 is directly west of the mouth of Styles Brook and site 197 is one mile south. Therefore, any ice moving into this area from the north, causing the till deposition and clay deformation observed along Styles Brook Road, would have overridden site 196 even though the ice might have stopped before reaching site 197. Therefore, the till in the Styles Brook exposures must have been deposited by a lobe of ice moving westward from the upper reaches of Styles Brook Valley and terminating on the eastern side of the Ausable River Valley.

Five cirque forms were identified in the air photo studies, (one on Jay Mountain, one on Spruce Hill and three on the Soda Range) that could have been feeder sources for a localized tongue of ice flowing out of the Glen and down Styles Brook Valley. Field work identified the existence of a well developed outwash alluvial fan at the top of Styles Brook Road. Alluvial remnants of a lateral moraine were observed at an elevation of 1800 feet ASL on the north side of Bissle Hill. The surface of this moraine slopes to the west into Styles Brook Valley, losing its ridge form at an elevation of approximately 1580 feet ASL. The surface of this ridge is gravel. The internal composition of the ridge is unknown because it is not exposed.

Although conclusive evidence was not found that the ice which moved down Styles Brook Valley was local in origin, there is definite evidence that the valley was occupied by an ice mass moving east to west and that it stopped on the east edge of the Ausable River. There are well developed cirque forms that could have fed a local ice mass in the upper part of Styles Brook Valley.

### CONCLUSIONS

The purpose of the study was to find evidence for or against the hypothesis that local glaciation occurred in the High Peaks area of the Adirondacks after the recession of the Late Wisconsinan Laurentide ice sheet from the mountain mass.

Analysis of cirque schrund elevations in relationship to the positions and aspects of the cirques indicates a possible snowline at 1700 to 2700 feet ASL and a second possible snowline at 2400 feet to 3400 feet ASL. The lowest schrund elevations may relate to the development of an Early Wisconsinan ice cap and to the deposition of Till "A" at Tahawus, N. Y. The higher snowline may be related to the Late Wisconsinan events.

The most conclusive evidence of the time relationship between mountain glaciation and continental glaciation is derived from light mineral studies of the matrix of Adirondack tills. The best example of the stratigraphic relationships between tills deposited by the continental ice advance and local ice activity as defined by light mineral composition of the till matrix is in the Wilmington Ditch section (figure 19). In this exposure, a till with a matrix composed of 85% plagioclase feldspar stratigraphically overlies a till composed of 40% plagioclase feldspar indicating a local ice advance from the anorthosite bedrock mountains on the west side of Wilmington Valley following the recession of the continental ice. The light mineral composition of the High Peaks tills provides evidence of local ice activity; however, light mineral composition by itself cannot be considered conclusive proof of local glaciation. Other factors such as striations, elongate

pebble orientations, pebble lithology distributions, and sediment deformations must be considered and evaluated in relationship to the evidence of light mineral composition of the tills. For example, Laurentide ice flow indicators have been identified in all of the main northeast-southwest trending valleys; however, striations and elongate pebble orientation studies show ice movement at nearly right angles to this continental flow in Roaring Brook Cirque, on the west side of Giant Mountain; at the Coon Pit Cirque on Whiteface Mountain; and at Newcomb. A northward flow of ice is indicated at the McIntyre Development. Lithology distributions indicating flow in directions other than that expected by Laurentide ice advance have been found in White Brook Valley.

Deformation of unconsolidated lacustrine deposits by overriding glacial ice also indicates ice movement after Laurentide deglaciation. This was found at the Whiteface Mountain Ski Center and at Styles Brook Road.

Goldthwait (1913, 1916a, 1916b) and Fairchild (1913) argue that the lack of end moraines at the lower elevations of the mountain valleys is evidence that local glacial activity did not follow Laurentide glaciation in the Adirondacks. Johnson (1917, 1933) observed that many modern glaciers are not developing end moraines; he concluded that the absence of end moraines does not negate the hypothesis of local glaciation. Another possible explanation for the scarcity of end moraines in the Adirondacks is that ice tongues advanced into deep lakes. The ice "calved-off" and floated away, consequently no end moraines could develop. Tills resting on lacustrine sediments and large isolated boulders resting in fine-grained lacustrine sediments have been observed throughout the main valleys and support this explanation for the absence of end moraines. These are described at Whiteface Ski Center, the Wilmington Ditch, and Styles Brook Road.

Three end moraines exist within the interior of the High Peaks region. These are located at St. Huberts, below Giant Mountain; Cooperkill Pond Cirque and Weston Mountain Cirque. Other end moraines were observed south of the High Peaks region at Blue Ridge, Boreas Mountain and Redfield Cirque. Lateral moraines were observed in White Brook Valley, Johns Brook Valley and Styles Brook Valley. The existence of these morainal deposits in the High Peaks area is another indication that local glaciation occurred after Laurentide glaciation.

In summary, the history of local glaciation in the Adirondack Mountains is believed to comprise the following episodes:

1. The first Laurentide glaciation occurred during Early Wisconsinan time and the Adirondack Mountains probably became a local ice center (Till "A", McIntyre Development, Cushing's (1899) moraine and other older till deposits).
2. This early ice melted away and the lake deposits at the McIntyre Development were formed (dated material in silt and clay over Till "A", McIntyre Development).
3. A major Laurentide ice advance from the north moved over the High Peaks area, depositing Till "B" at the McIntyre Development. The mountains were completely overridden by this Late Wisconsinan advance.

4. The Laurentide ice mass melted from the High Peaks region possibly during the Erie Interstade (15,500 years BP).
5. The local ice probably redeveloped during the Port Bruce Stade and receded to some extent during the Mackinaw Interstade. However, sufficient ice accumulated in Late Mackinaw time for ice to advance to the lowest preserved moraine position at Blue Ridge at approximately the same time as the early ice advance of the Port Huron Stade. The Adirondack High Peaks local glaciation is identified in a time relationship to the Luzerne Readvance by the Blue Ridge Moraine and the associated deposits into Glacial Lake Warrensburg, about 13,200 years BP.
6. Deglaciation of local ice to recessional moraine positions can be related to the Two Creeks Interstadial.
7. Rapid valley deglaciation occurred with the draining of Lake Iroquois with only remnants of cirque glaciers left during the Belleville-Fort Ann lake stages (approximately 11,900 years BP).
8. All glacial ice was probably gone by the time of the completion of the Champlain Sea phase of deglaciation, shortly after 12,000 years BP.

FIELD TRIP ROAD LOG

- 0.0 Depart parking area Whiteface Chalet and turn left towards Upper Jay and Keene, NY.
- 1.1 Road junction on left, proceed straight ahead.
- 1.6 Burrow pit in sand delta crossbeds dipping into Wilmington Valley.
- 2.1 Note heavy concentration of round boulder on slopes and irregular topography. This area has appearance of moraine - source unknown.
- 2.9 Road junction to right - proceed straight ahead. Valley floor here is formed on till.
- 3.8 Stop sign - proceed straight ahead, cross East Branch towards Keene on 9N.
- 5.5 Striated bedrock on left, high degree of polish striae bearing N-S.
- 6.1 Pine plantation on left is Keene Campground.
- 6.7 Junction on left, Glen Road (Styles Brook). Anyone with time on Sunday might like to drive up to the open area at the head of this road. It has a beautiful view. See page 38 for discussion of deposits in this area.
- 7.6 Barn on house on right - landslide on left exposed till over stratified drift (site 299, page 40).
- 8.1 Bridge across East Branch. Burrow pit across river is in stratified drift. Higher up slope and along road to right is undisturbed laminated clay, mentioned on page 38.
- 9.7 Junction 86-73 Keene, NY. Continue toward Keene Valley, Skyline Outfitter on left excellent rock climbing supplies available here.

STOP 1

- 10.3 Keene, NY, Sand and Gravel Pit (1 hour).

The Keene Sand and Gravel Pit is located south of Keene on Route 9N past the firehouse. The pit has been extensively worked. The deposit is mostly sand and gravel. Till caps the deposit on the north and south sides and is absent in the middle (figure 22). Elongate pebble orientations were measured on the vertical face of the north till exposure and are shown in figure 6, site 14. The deposit is located in the main valley oriented north-south and is at the mouth of a tributary valley oriented 090°.

- 10.3 Return to highway and turn right.
- 10.7 Turn right on East Hill Road.
- 13.0 The Mountain House - stay on blacktop.

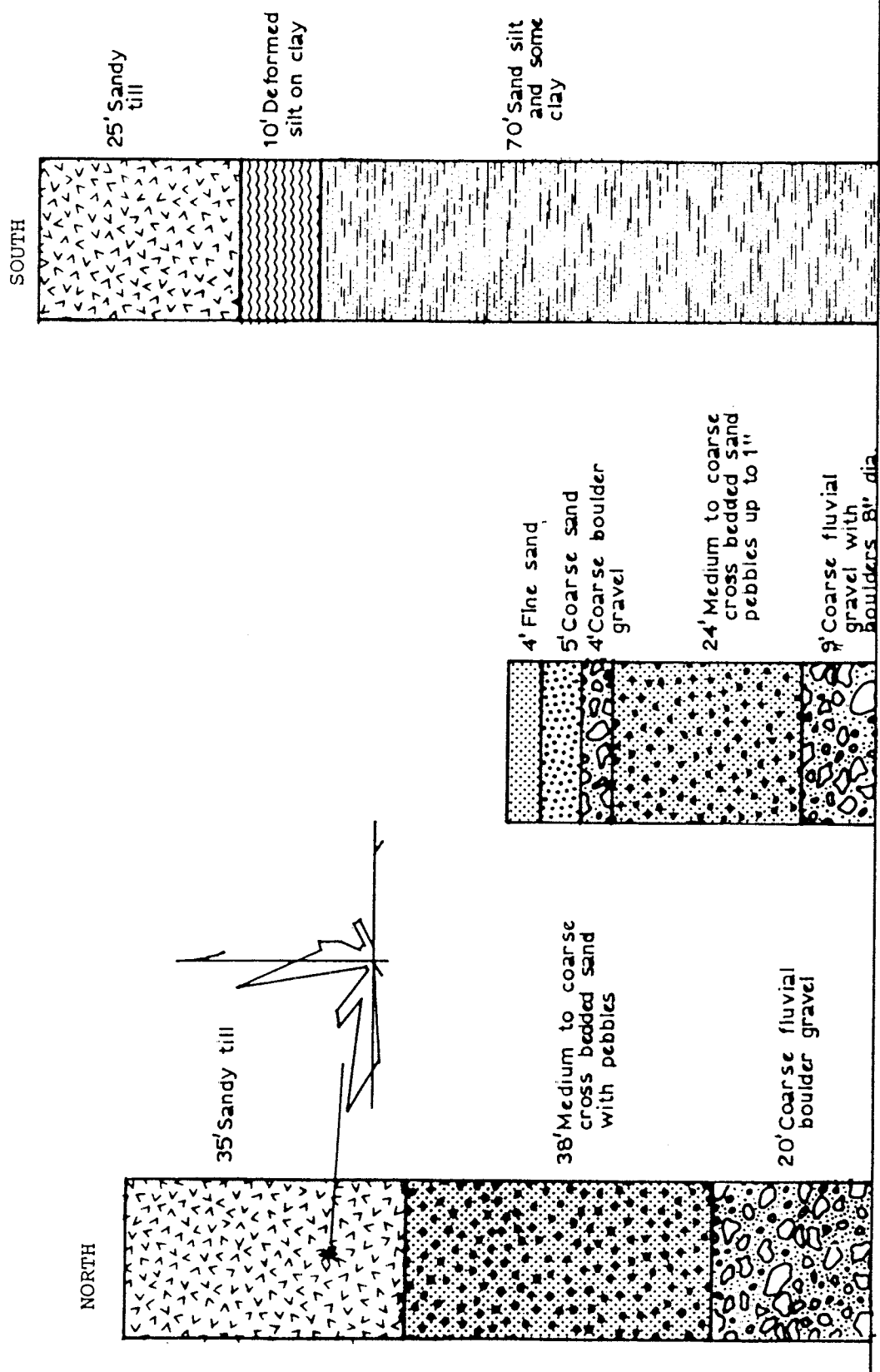


Figure 22. Stratigraphic sections Keene Sand and Gravel Co.

STOP 2 Till over gravel (30 minutes).  
13.2

HURRICANE LODGE SECTION - The Hurricane Lodge exposure is located 2.7 miles east of Keene, NY, on the Hurricane Mountain Road where the road cuts across the head of the valley towards the Elizabethtown Highway. The exposure is the result of road construction. The cut at this point is 55 feet high at the south end and extends in the north-south direction for over 400 feet. The exposure is interrupted near the center by a small stream cutting through the section. The alignments of elongate pebbles were measured at ten feet above the contact of the till (figure 23) with the underlying sand and gravel in the southern portion of the exposure. The till in this exposure forms a vertical face making it impossible to do measurements higher up in the section.

Valley orientation is east-west ( $090^{\circ}$ ). Bedrock in the upper part of this valley is metasedimentary (figure 4, site I). Lower part is Marcy Anorthosite. The light mineral composition clearly shows the metasedimentary effects.

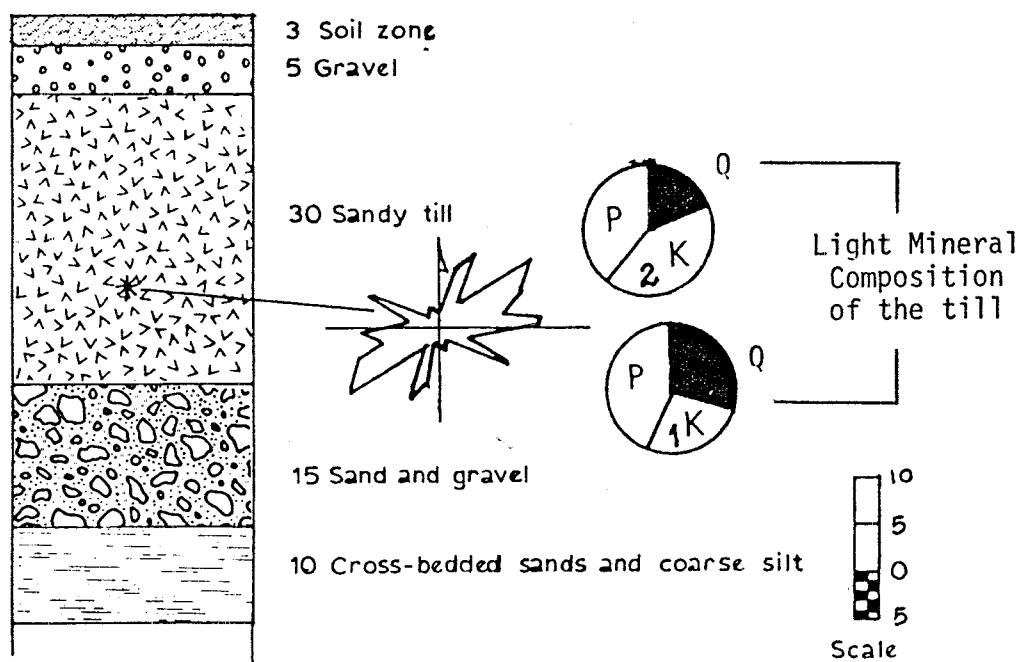


Figure 23. Stratigraphic section, Hurricane Mountain Road, site 244.

- 13.2 Proceed straight ahead.
- 15.4 Road junction to right - proceed straight ahead. Road cuts through till at the point.
- 16.7 Burro pits for sand and gravel, source unknown. Valley here is filled with gravel.



- 17.0 Major highway, YIELD, turn right; as we descend to Ausable River Valley, note thickness of stratified deposits filling this major cross valley.
- 17.3 Excellent view of High Peaks.
- 18.8 Keene Valley Cemetery on low hill to right. Access road closed by landslide. Slide is in laminated clays capped by sand and gravel.
- 18.9 Turn right towards Kenne Valley.
- 19.5 Bridge across East Branch. River makes abrupt change here from the east side of the valley to west side and has cut a bedrock gorge to Keene Level. This change is caused by drift plugging valley.
- 19.6 Keene Valley Airport on right.
- 21.2 Entering Keene Valley New York - Gateway to backpacking trails into the High Peaks.
- 21.7 Crossing Johns Brook.
- 21.9 Spread Eagle Inn - junction to right leads up to the parking lot for trail to Marcy.
- 23.8 Passing through Saint Huberts moraine.
- 24.5 Turn right into Saint Huberts.
- STOP 3
- 25.0 Picture view of Giant Mountain

GIANT MOUNTAIN-ROARING BROOK CIRQUE - Roaring Brook Valley is located on the west side of Giant Mountain (4627 feet ASL) in the Elizabethtown-Mount Marcy Quadrangles (figures 24 and 4, region K). The valley is oriented  $250^{\circ}$  with the opening to the west and is approximately 2500 feet wide and 9000 feet long (figure 24). Schrund elevation is 2980 feet ASL (figure 25) with a slope gradient above schrund elevation of 3540 feet per mile and the gradient below schrund elevation of 460 feet per mile. Landslide debris fills the valley bottom at an elevation of 2700 feet ASL and the stream has eroded through this mass to bedrock. The stream plunges over a nearly vertical 200-foot waterfall at 1500 feet ASL.

Glacial drift fills the sides of the valley below schrund elevation. Striations oriented  $289^{\circ}$  were observed at an elevation of 2200 feet ASL (figure 24). Till pebble orientation at an elevation of 1940 feet ASL shows an orientation maximum at  $288^{\circ}$  (figure 6, no. 12, and figure 24, site 171).

A well developed lateral moraine is visible along the north side of Roaring Brook Valley starting at an elevation of 2500 feet ASL + 40 feet and extending as an almost continuous ridge approximately 1.5 miles north of the junction of Roaring Brook with the Ausable River. There is a less well developed moraine on the west side of the Ausable River Valley. This moraine extends along the

side of the valley from about 1800 feet ASL to the valley floor. A delta with a surface elevation of 1100 feet ASL has been mapped within the boundaries of these moraines. This inner moraine starts at approximately 1540 feet ASL on the south side of Putnam Brook and extends north to the junction of Roaring Brook with the Ausable River. This moraine complex is a kame moraine that has been dissected to bedrock by the Ausable River and Roaring Brook.

Light mineral studies of two till samples from Roaring Brook show low percentages of quartz, slightly higher percentages of K-feldspar and high percentages of plagioclase (table 4).

Table 4. Light Mineral Composition of Roaring Brook Till Samples.

<u>Elevation</u>	<u>Quartz</u>	<u>K-feldspar</u>	<u>Plagioclase Feldspar</u>
1940 feet ASL	12.1%	26.7%	61.2%
2900 feet ASL	15.3%	39.8%	44.9%

Striae were observed on the north side of the valley floor of Roaring Brook at 2200 feet ASL (figure 24, site 179). The striations have been carved into a large xenolith of fine grained mafic-rich anorthosite enclosed in Marcy anorthosite. The striated surface was exposed by the 1963 landslide. Fresh scars from the landslide were observed, superimposed upon the glacially striated surface. The glacial striae are closely spaced parallel grooves on the bedrock oriented N 85° W. The bedrock surface is inclined down the valley at approximately 20°. Joints oriented N 15° W cut across the surface. Plucking on the west (downstream edges) of the joints indicates a westward flow of ice at this point. The striation and the configuration of the grooves indicate active abrasion by ice flowing off the mountain in an east to west direction toward the main north-south valley below.

A till fabric measurement (figure 24, site 171) taken on the south side of the valley at 1940 feet ASL shows an east-west orientation of pebbles which agrees with the striation direction. Fifteen feet of till is exposed in this section. The base of the exposure is covered with colluvium, but the till appears to be resting on bedrock. The orientation measurements were taken at approximately nine feet above the bedrock surface in a freshly exposed face of the till. Valley orientation at this point is N 60° E.

The striations, pebble orientations, light mineral compositions, and distribution of moraines indicate a flow of local ice westward from Giant Mountain. This flow swung northward in the main valley system. The maximum advance stopped 1.5 miles north of the junction of Roaring Brook and Ausable River. A delta developed on the north side of the outer moraine indicates a lake occupied the Ausable River Valley north of this moraine. The inner kame moraine complex indicates a recession of the ice prior to

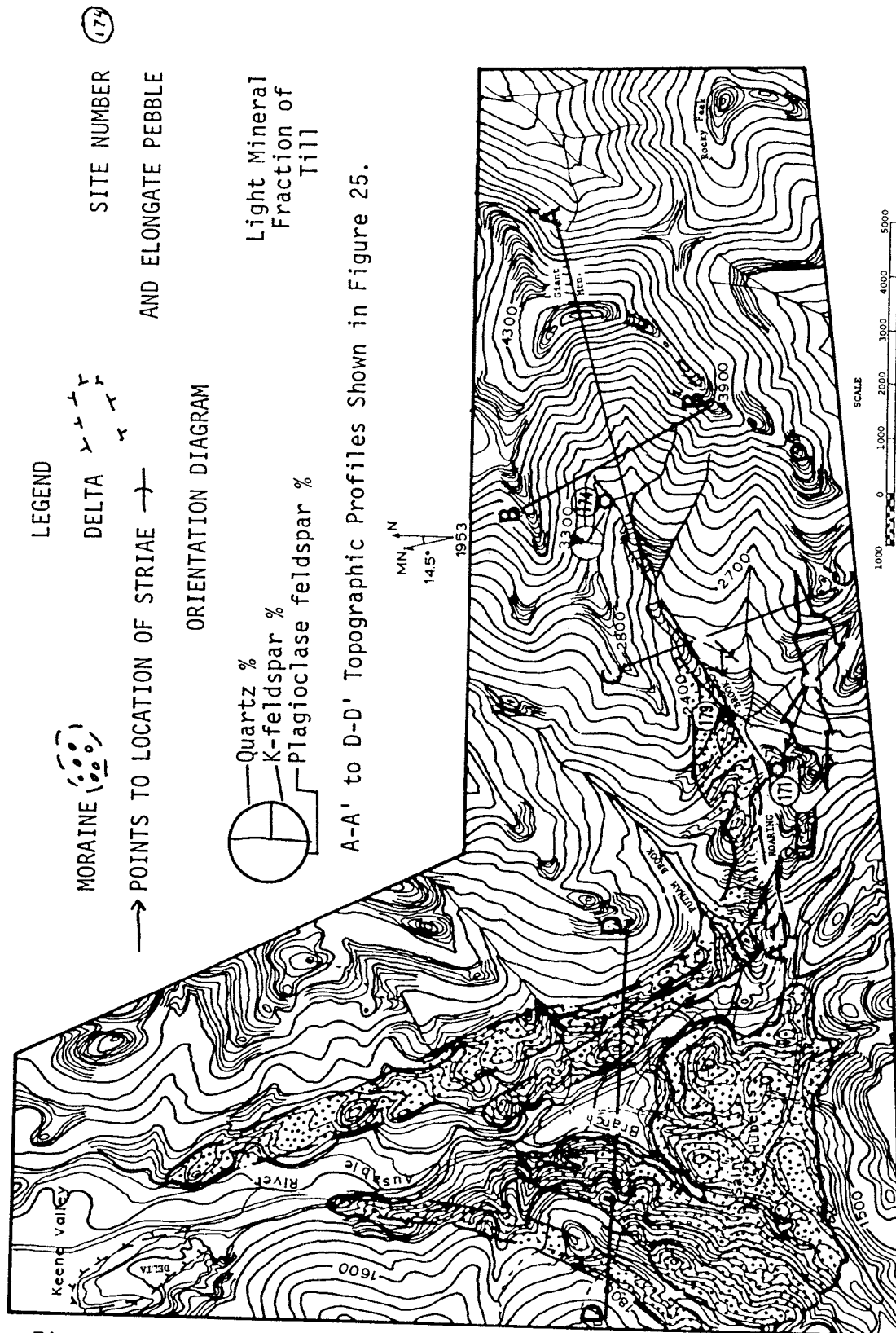


Figure 24. Topographic map Giant Mountain-Roaring Brook Cirque.

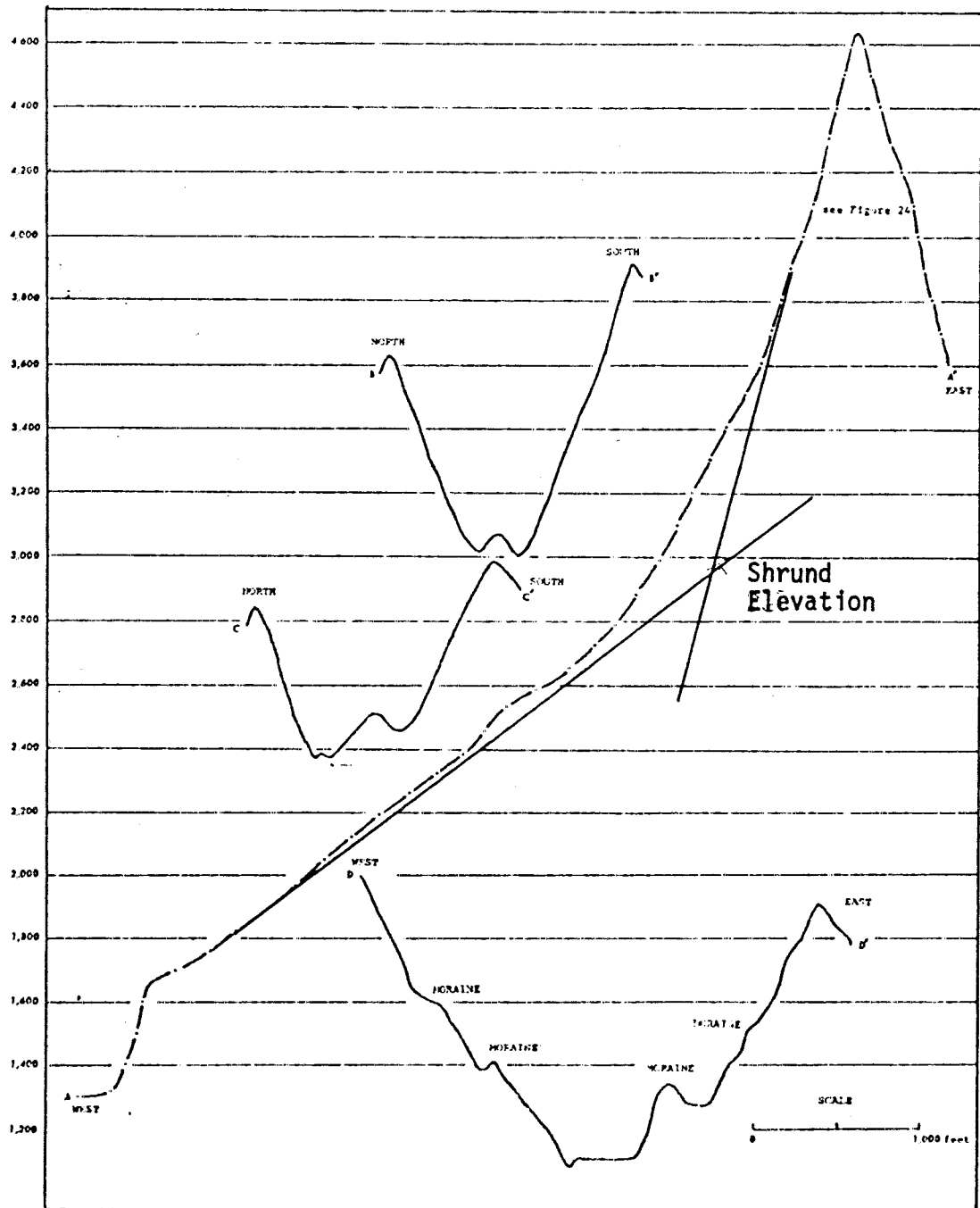


Figure 25. Longitudinal and cross valley topographic profiles of Giant Mountain and Roaring Brook.

final melting.

- 25.0 Proceed straight ahead back to highway.
- 25.7 Stop sign, turn right. High waterfall at left after turn. Rockslide in 1963 created the clear area along the sides of the stream. The slide buried the highway under about 10 feet of rock and trees.
- 27.0 Chapel Pond. Pond appears to be held in place by moraine under road and to the left. This valley is one of the major NE-SW fault passes in the High Peaks.
- 29.3 Pine plantation on right with exposure of gravel at end. Outwash gravel from Dix cirques.
- 30.0 Exposure of striated Marcy anorthosite on right.
- 31.0 Junction Route 9 - proceed straight ahead to Interstate 87.
- 33.1 Junction I-89, proceed southbound, note smoothed bedrock surface along route of interstate.
- 36.3 Mineralized zone of anorthosite.
- STOP 4
- 37.8 Rest Stop - LUNCH (1 hour)
- 43.1 Exit 29, leave interstate, turn right, terrace on left is lake. Warrensburg delta developed into Schroon Valley from the west.
- 43.5 Cross Schroon River.
- 43.6 Stop sign, turn right. Bedrock straight ahead is striated with striae oriented N-S.
- 44.4 Frontier Town Mobil Station, pull into clear area and stop.
- STOP 5
- Glacial Lake Warrensburg deposit.

BLUE RIDGE MORaine AND GLACIAL LAKE WARRENSBURG DELTA - The Blue Ridge Moraine is located at Blue Ridge, N. Y., 2.5 miles west of Schroon River, N. Y., on the Newcomb-Blue Ridge Road. The features discussed are in the Schroon Lake and Paradox Lake Quadrangles (figure 4, region 0).

The Blue Ridge Moraine is one of the few valley-blocking moraines identified in the field area. It is especially significant because of the association of this moraine and its valley train deposits with a delta constructed into Glacial Lake Warrensburg (Miller, 1925).

Miller (1925) traced the shoreline of Glacial Lake Warrensburg from Corinth, N. Y., near Luzerne, N. Y., northward up the Schroon River Valley to Deadwater Pond, 8.5 miles north of Schroon River, N. Y., in the Elizabethtown Quadrangle, a total north to south

distance of seventy miles. Miller (*ibid.*, page 516) identified a sand plain at Schroon Lake Village (900 + feet ASL) and at North Hudson (960 feet ASL). The terrace development along the sides of the Schroon River Valley is nearly continuous between these two points. The elevation of the terrace at Schroon River is approximately 940 feet ASL. A burrow pit located one half mile south of the junction of the Newcomb-Blue Ridge Road and Route 9 exposed deltaic foreset beds dipping eastward towards the east valley wall of the Schroon River (figure 26, site 302). This terrace is also exposed on the west side of the valley (figure 26, site 301) in a cut made during the construction of Interstate Highway 87, Schroon River-North Hudson Interchange. Deltaic foreset beds at this site also dip eastward. The 940 foot terrace surface has been traced westward for about one half mile up Sand Pond Brook where it merges with an outwash valley train deposit. This deposit rises from the 940 feet ASL elevation of Glacial Lake Warrensburg to approximately 1100 feet ASL, where the valley train disappears into a valley-blocking end moraine. A meltwater erosional channel is located along the north side of the moraine. This channel has been traced northward up Niagara Brook. The Blue Ridge Moraine completely blocks the valley. The west side of the moraine has very steep slopes, ending abruptly in a swampy plain. The moraine is composed mostly of till with a variable thickness of sand and gravel covering the surface. The surface expression of the moraine is extremely irregular with a well developed knob and kettle appearance. The highest elevation is on the west side of the moraine. The eastward extension of the morainal topography merges with the valley train deposit.

Figure 27 shows the stratigraphic sections of eleven sites measured at Sand Pond Brook and The Branch.

Light mineral analyses were done on samples of till from sites 263, 271, and 274 (figure 26). The results of these analyses are shown in table 5.

**INTERPRETATION OF BLUE RIDGE MORaine** - The most significant aspect of these deposits is the relationship of the Blue Ridge Moraine and the associated outwash valley train to Glacial Lake Warrensburg. The distribution of glacial fluvial sediments from the Blue Ridge Moraine to the Glacial Lake Warrensburg delta at the mouth of Sand Pond Brook indicates ice occupancy of the moraine during the time of Glacial Lake Warrensburg. The eastward dipping foreset beds of the delta on the east side of the Schroon River are believed to indicate a complete filling of the valley by this delta. The middle portion of the delta was later removed during the formation of the Schroon River Valley. Since this delta was constructed into Glacial Lake Warrensburg, the age of Glacial Lake Warrensburg defines the time of ice occupation of the Blue Ridge Moraine.

Miller (1925) described the ice dam that formed Glacial Lake Warrensburg as located at Corinth, N. Y. Connally and Sirkin (1971) identified this ice dam as the Luzerne readvance and provided the only absolute date for glacial events in the interior of the Adirondack Mountains. A  $C^{14}$  date obtained from the base of a bog

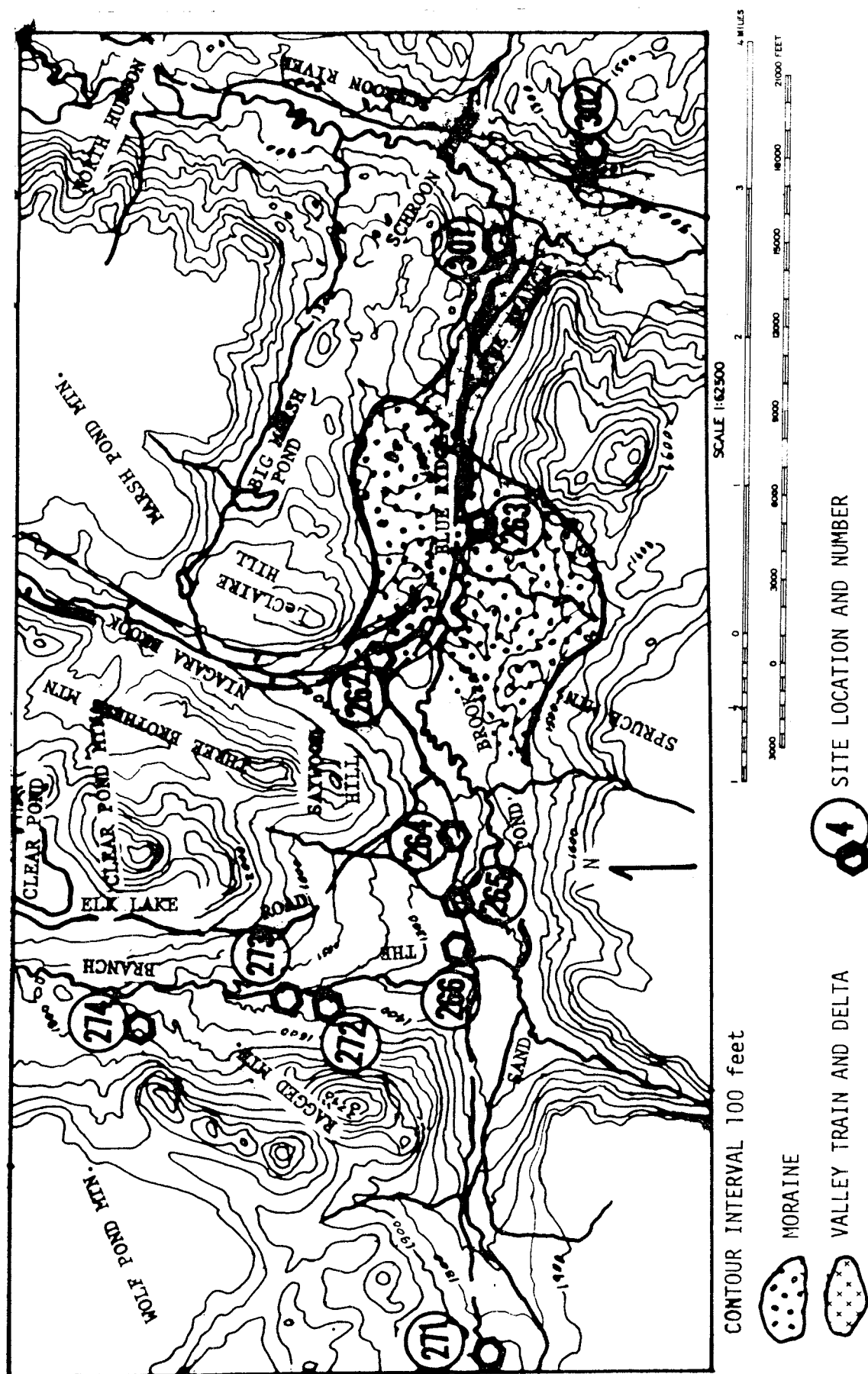


Figure 26. Topographic map of the Blue Ridge area.

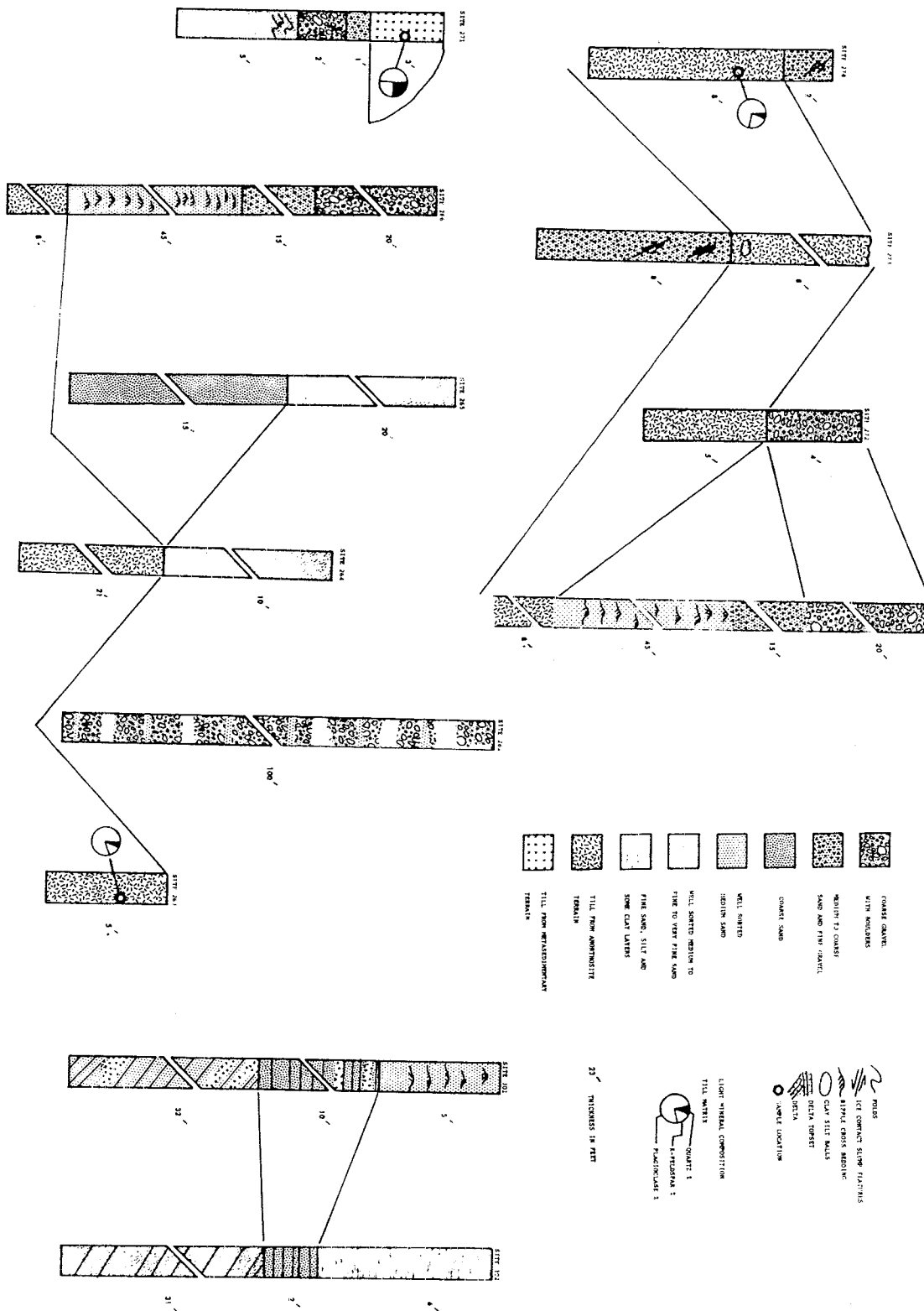


Figure 27. Stratigraphic section, Blue Ridge area.



in the outwash plain of this readvance was  $13,150 \pm 200$  BP. This, therefore, gives the minimum date for the tongue of ice at Blue Ridge as  $13,150 \pm 200$  BP.

Table 5. Light Mineral Composition of Tillis Associated with the Blue Ridge Moraine.

<u>Site Number</u>	<u>Quartz</u>	<u>K-feldspar</u>	<u>Plagioclase feldspar</u>
263	5.5%	12.5%	82.0%
271	26.1%	20.5%	53.4%
274	8.0%	22.0%	70.0%

Light mineral composition of the till in Blue Ridge Moraine, site 263, indicates an anorthosite terrain origin. The light mineral composition of the till at site 274 also indicates an anorthosite origin of the till. However, the light mineral composition at site 271 indicates some addition of metasedimentary rocks. Bedrock west of site 271 is a combination of metasedimentary and anorthosite rocks (figure 4). The bedrock north of Sand Pond Brook is anorthosite. The composition of the till in the Blue Ridge Moraine indicates either that this west to east flow of ice stopped in the vicinity of site 271 or the transported material is buried under the till analysed from the Blue Ridge Moraine, site 263, or is mixed in the moraine in areas not exposed for analysis. The light mineral composition of the till at sites 263 and 274 indicates that the glacial tongue which deposited the Blue Ridge Moraine advanced southward from the Dix Mountain complex to the north of Clear Pond.

A summary of events related to the Blue Ridge Moraine is:

1. A local tongue of ice moved south from the Dix-Mount Colvin Cirque complex into the Newcomb-Blue Ridge Valley and swung eastward stopping  $13,000 \pm$  years ago at the present site of the village of Blue Ridge.
2. A second tongue of ice moving east in the Newcomb-Blue Ridge Valley encountered this tongue of ice and probably merged with it.
3. The valley train developed from the Blue Ridge Moraine built a delta into Glacial Lake Warrensburg. This delta completely filled the Schroon River Valley.
4. The dam at Luzerne opened, draining Glacial Lake Warrensburg and the deposits associated with the Blue Ridge Moraine were dissected by erosion.
5. The ice retreated northward leaving a blanket of outwash gravel filling the center portion of The Branch.

6. A large block of ice was probably buried in the valley behind the Blue Ridge Moraine and the meltwater-transported material was carried across the buried ice block eastward into the Schroon River system.

Return to highway, make right turn onto main road.

- 45.0 Left at junction to I-87, proceed straight ahead toward Blue Ridge and Newcomb.
- 47.8 Entrance to campground at right. Enter, go to top and stop.
- STOP 6 BLUE RIDGE MORaine - refer to discussion for Stop 5.  
Return to main road and turn right.
- 48.4 Village of Blue Ridge.
- 49.6 Moraine behind, dry kettle bottom to left.
- 50.0 Turn right to Elk Lake. This access road is mainly constructed on till, valley to the left is filled with outwash gravel. Chapel Pond is probably a kettle lake.
- 51.0 Burrow pit obtaining gravel from till.
- STOP 7 ELK LAKE MORaine  
53.2  
Return to main road.
- 56.3 Main road turn left to I-87, then north to Wilmington.

#### END OF FIRST DAY

- .0 Whiteface Chalet. Leave parking lot, turn left to T intersection.
- .1 Turn right towards Whiteface Mountain, Whiteface Ski center straight ahead.
- .3 Sag in topo is drainage outlet into Allings Lake Haselton (935 feet). There are a series of deltas and channels here indicating flow from Placid into Wilmington.
- .7 Rising on delta surface-crossbeds indicate flow from Wilmington Notch.
- 1.0 Junction Route 86, turn left. Note pines to front right. They are growing on large sand delta built into Glacial Lake Wilmington.
- STOP 8 Whiteface Mountain Ski Center, turn right go to parking lot. Dis-  
2.0 embark for Ski lift. (2 hours)

WHITEFACE MOUNTAIN - Whiteface Mountain (elevation 4867 feet ASL) is located in the center portion of the Lake Placid 15' Quadrangle (figure 4, region D). Access to the summit is provided by the Whiteface Memorial Highway. The Whiteface Mountain Ski Center operates a chairlift during the summer which gives access to the east slopes of the mountain. There is also a Conservation Department foot trail from Lake Placid over the summit and on to Wilmington. Figure 28 is a detailed topographic map of the Whiteface Mountain and the Ski Center area.

The only evidence of continental glacial erosion on top of any of the mountains was observed on the summit of Whiteface Mountain. The summit of Whiteface Mountain is relatively flat. On the south side of the summit area, the surface rises slightly and has a streamlined appearance. This apparently streamlined area has been smoothed and rounded to the point that it resembles the whale back glacial erosion commonly developed on a bedrock surface. The alignment of the whale back feature is N 35° E which is the approximate regional ice flow direction of the continental ice mass.

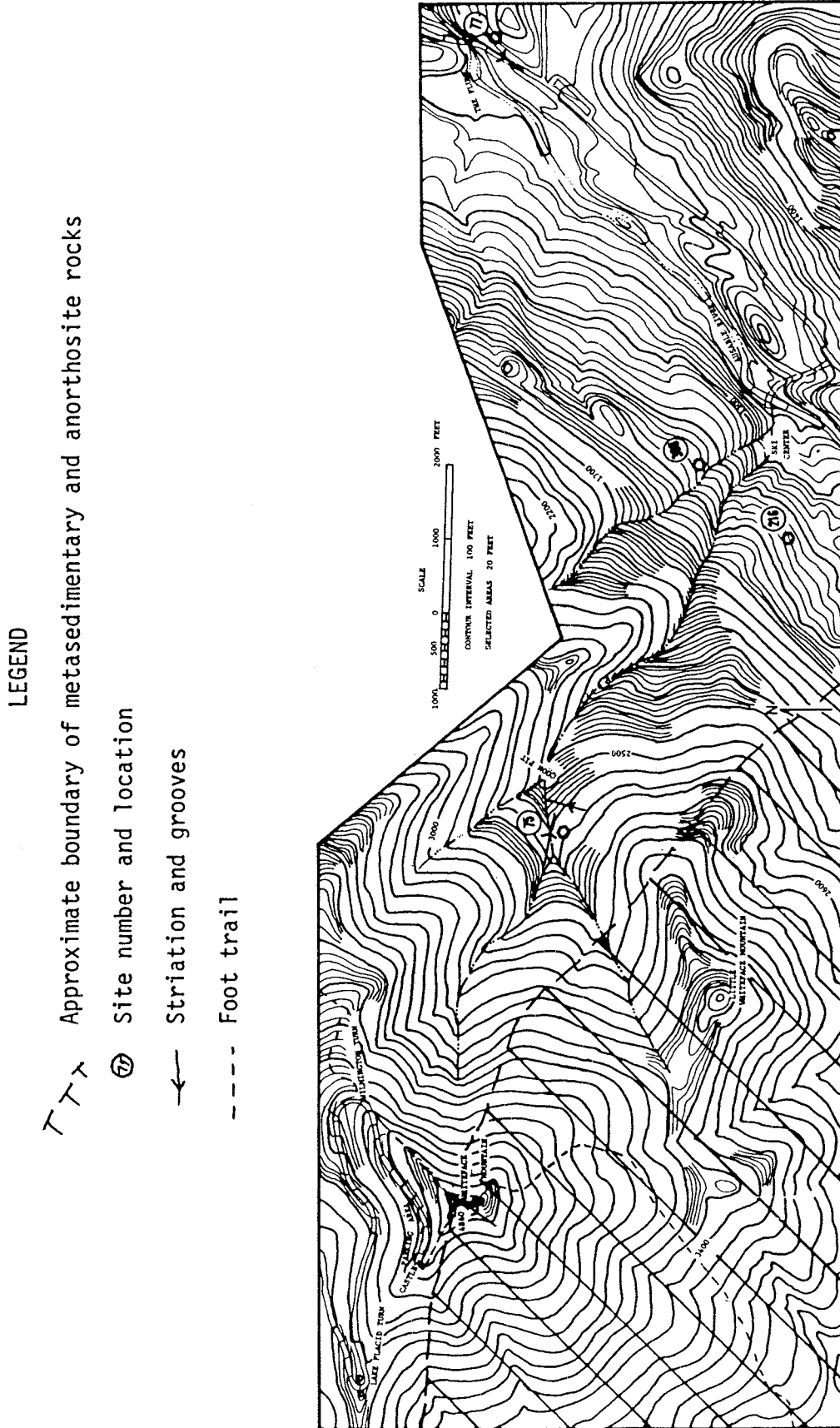
The shape and smoothness could, however, be related to lineation of mineral bands in the Whiteface anorthosite combined with removal of joint blocks by mass wasting on the summit. This surface is walked over by thousands of tourists each year, which would smooth and polish the rock surface giving an appearance of glacial polish. The evidence is really insufficient to determine the true origin of the feature.

The ridges leading up the summit from the Wilmington Turn on the Whiteface Memorial Highway and from the parking lot just below the summit (figure 28) exhibit erosional characteristics that are indicative of glacial activity in the amphitheater depression below. The ridge trending west from the summit towards the parking lot stands 200 feet high. The south side is nearly vertical and the north side slopes from 65° to 80°, approximately parallel to a surface of sheet jointing. This sloping surface has been excavated to a vertical face to build a parking lot.

The south face of this ridge is a vertical cliff for approximately 100 feet then slopes 70° to 80° to the elevation of 3500 feet ASL. The ridge developed by the intersection of the two slopes is about 10 feet wide at its narrowest point and 50 feet wide close to the summit. The ridge runs 305° northwest to the Lake Placid turn where it swings around to the west then to the southwest. The north slope is slightly steeper than the sheet jointing and the present slope stability is controlled by this sheet jointing. The south-facing cliff owes its stability to the nearly vertical jointing in the rock. The joints run 352° to 043°. Joint spacing across the crest forms blocks from 2 to 5 feet across. This cliff is fairly stable with only a few blocks falling off in the spring.

The east-facing cliff along the Wilmington Turn summit trail is similar to the one just described. It also is the head of a cirque depression. The slope of the top of the ridge is controlled by sheet jointing which dips towards the west at 10° along the

Figure 28. Topographic Map of Whiteface Mountain and Ski Center.



crest increasing to 40° below the crest to the west. The headwall face of the mountain slopes between 65° and 80° from the crest to an elevation of approximately 3700 feet ASL at the top of talus and drift accumulation. The Coon Pit Ski Lift is located in the bowl of this cirque.

WHITEFACE MOUNTAIN SKI CENTER - The Whiteface Mountain Ski Center is located off Highway 86, between the Flume and the Wilmington Notch (figure 28) on the west side of the Ausable River at the base of Whiteface Mountain. The ski lodge is built at the edge of the river floodplain and into a stratified sand and gravel terrace. This terrace forms the level ground at the base of the ski slopes. Exposure of the terrace material was observed where roads had been constructed up the slope. Two of these exposures are of special interest; the first, 0.1 miles south of the ski center (figure 28, site 216); the second, 0.2 miles north (figure 28, site 300). The stratigraphic sections are shown in figure 29.

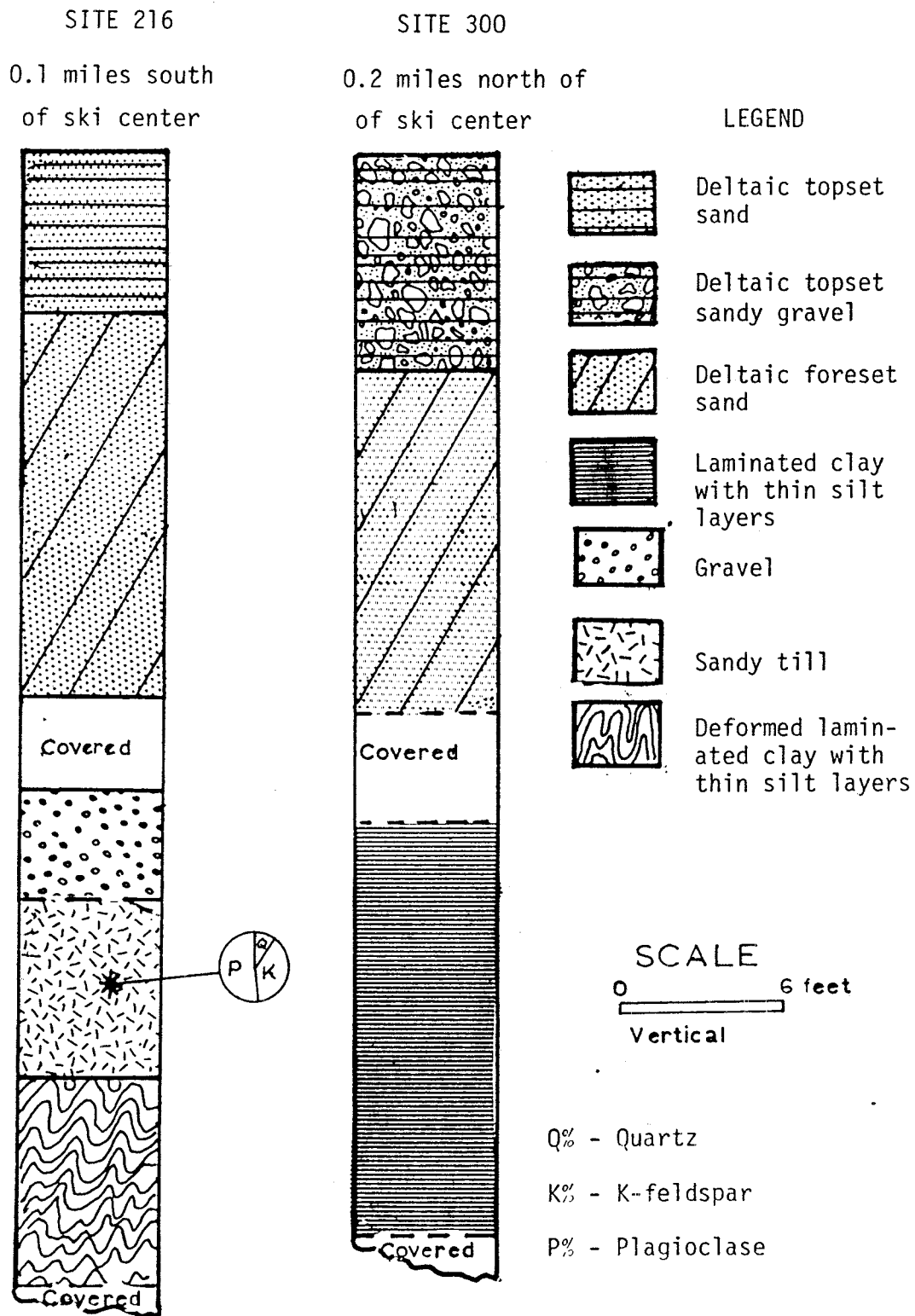
A bedrock ridge breaks the continuity of the terrace behind the maintenance building on the north side of the ski center building complex. This ridge extends up the slope to an approximate elevation of 2240 feet ASL.

The top surface of the two sections is at an elevation of 1440 feet ASL. The stratigraphic sections of the upper parts of both exposures are basically the same, consisting of deltaic sands and gravels. The northern exposure contains no till and shows no deformation. The southern exposure, however, contains a 4-foot thick layer of till lying on top of strongly deformed laminated clays in the lower part of the section. Light mineral analysis of this till shows a mineral composition of 18 percent quartz, 36 percent K-feldspar, and 47 percent plagioclase. A very small amount of perthite was observed in the light mineral counts. Potsdam sandstone pebbles were observed in both the till and the overlying gravels.

Bedrock of the mountain above the deposits is Whiteface and Marcy anorthosites with some metasedimentary rock exposed on the ridge around Little Whiteface Mountain (figure 28). Little Whiteface Mountain is located on the south side of the cirque valley that would feed ice to these deposits.

Tills formed by the erosion of the metasedimentary and anorthosite rocks of the mountains would contain perthite and a higher percentage of quartz and K-feldspar than would be found in till from erosion of only anorthosite rocks.

COON PIT, WHITEFACE MOUNTAIN - The Coon Pit (figure 28, site 75) is the local name for the buildings at the upper end of the first ski lift at Whiteface Mountain Ski Center. Glacial striae and a large glacial cut groove are located in the stream bed above the buildings at an elevation of 2520 feet ASL. Striae are oriented N 80° W and are best seen on a wet surface in reflected light looking towards the sun. The bedrock surface at this point is



Elevation - 1440 feet ASL

Figure 29. Stratigraphic sections of the 1440 foot terrace, Whiteface Mountain Ski Center.

gently inclined down slope. Approximately 15 feet downstream from the striated surface, the stream bed increases its slope to about 70° and continues at this angle to an elevation of 2340 feet ASL.

At an elevation of approximately 2435 feet ASL a joint in the bedrock striking N 15° E has been enlarged by glacial abrasion to form a large groove. The groove is narrower and more sharply defined at the south end, widens to the north and ends abruptly at the base of a 100-foot cliff.

The abrupt termination at this groove at the base of the cliff, in combination with the striae mentioned above, indicate that the ice was moving downslope within the confines of the valley, therefore indicating a west to east flow from Whiteface Mountain.

INTERPRETATION OF THE WHITEFACE MOUNTAIN SITES - Striations and a glacial groove above the Coon Pit on the valley floor at an elevation of 2520 feet ASL indicate an eastward ice movement downslope toward the ski center. Till overlies deformed laminated clays and indicates that ice overrode the valley bottom sediments. The northern exposure of these thinly laminated clays are undisturbed and lack a till cover. The mineral composition of the till, quartz 18%, K-feldspar 26%, and plagioclase 47%, resembles the rocks of the east side of Whiteface Mountain.

This evidence of glaciation is undeniable. Is this local ice from the west or is this continental glaciation from the north? The path of least resistance to continental ice advance would be southward in the Wilmington Valley. The glacial groove and striations indicate an eastward flow of ice. If the glaciation was continental, the northern exposure of laminated clay probably would not escape deformation of clay and deposition of till.

The glacial groove and striations indicate an ice movement from the Coon Pit Cirque towards the ski center. The light mineral composition of the till can be explained by composition of the bedrock over which the ice would flow from the Coon Pit Cirque. The fact that the clay in the northern exposure shows no signs of overriding by ice supports the interpretation that the ski center till was deposited by local ice from Whiteface Mountain. The bedrock ridge behind the ski center maintenance building is believed to have acted as a "cleaver" directing the local ice tongue southward overriding the southern deposit and leaving the northern deposit undisturbed.

- 2.0 Turn left onto I-86 towards Wilmington.
- 3.0 Kelley's Motel on left outcrop of Marcy anorthosite on right cut by basalt dikes. There is a dike with striation on vertical face behind the elders at north end of this exposure. The West Branch of the Ausable River cuts through bedrock here in the largest of these basalt dikes, rises to left on the sand delta of Glacial Lake Wilmington of Alling.
- 5.1 Turn left on 434 toward Whiteface Mountain.

- 5.3 Hill Top Grocery on left is sitting on beach terrace.
- 6.4 House on left - excellent view of White Brook Valley Cirque. Esther Mountain, high peak on right side of White Brook Valley, is the only mountain in Adirondacks named for a woman.

NORTH POLE, NY

- 6.7 SUNY Albany ASRC Whiteface Mountain Research Station. Turn left, proceed to parking area.
  - 8.0 Marble Lodge old Ski Center.
- STOP 9 Till exposure behind bunkhouse. Walk up road to trail to the moraine described by Alling in 1916. This is a 20 minute walk uphill. Anyone not wanting to go up may go into Research Center and look at displays and instrumentation, complete weather station and seismograph. Rest rooms in bunkhouse. (2 hours maximum)

WHITE BROOK VALLEY CIRQUE - White Brook Valley is located in the Lake Placid Quadrangle (figure 4, region B) on the northeast side of Whiteface Mountain between Esther Mountain (4240 feet ASL) and Lookout Mountain (4100 feet ASL). The valley is oriented  $055^{\circ}$  (figure 30). It is approximately 3000 feet wide and 9000 feet long. The northwest and south sides and the backwall are nearly vertical. The head of the valley forms a pass or col through the mountain mass at an elevation of 3860 feet ASL. White Brook flows on the bedrock surface from an elevation of 2900 feet ASL to 1820 feet ASL where it encounters the thick drift cover of the main valley. The stream has cut a deep V-shaped valley along the axis of the U-shaped drift-filled trough.

The bedrock of this part of the mountain consists of various types of anorthosite. The upper elevations show extensive exposures of Whiteface anorthosite. The middle portion of the valley is composed of a light green to pink anorthosite with one-quarter-to two-inch phenocrysts of pink plagioclase. The lower part of the valley floor and Marble Mountain are composed of Marcy anorthosite with one-to five-inch phenocrysts of labradorite.






The vertical distance from the back rim of the cirque amphitheater to the change of slope of the valley floor (schrund elevation) is 1240 feet. The horizontal distance from the top of Mount Esther to the schrund elevation is 0.55 miles which results in a gradient of 2254 feet per mile. The gradient of the valley below the schrund line is 614 feet per mile. Longitudinal and transverse profiles are shown in figure 31.

Esther Mountain can be classified as a horn in the youthful stage of erosional development. Cirque erosion has isolated the mountain peak from the rest of the mountain mass (figure 30). The three ridges radiating out from the peak are very narrow (thirty feet at one point on the northeast ridge) with nearly vertical sides. These ridges change to broad gently sloping bedrock surfaces at an elevation of between 3600 to 3700 feet ASL. This broad flattened surface is covered with numerous Potsdam sandstone erratics lying on the surface and caught in the open






LEGEND


ROCK TYPE:


-  Whiteface Anorthosite
-  Pink Anorthosite
-  Marcy Anorthosite
-  Potsdam Sandstone Erratics
-  Site & Sample Number

GLACIAL DEPOSITS:

-  Till
-  Lacustrine Sand, Silt, Clay
-  Alluvial Fan deposits, Sand and Gravel

 Moraine

 Delta

 Beach

Approx. drift bedrock contact:  
— . . . — . . . — . . . — . . .

Approx. contact between two rock types:  
— . . . — . . . — . . . — . . .

A-A' topographic profile line  
(see figure 31)

Topographic data from  
USGS manuscript map.

LIGHT MINERAL FRACTION

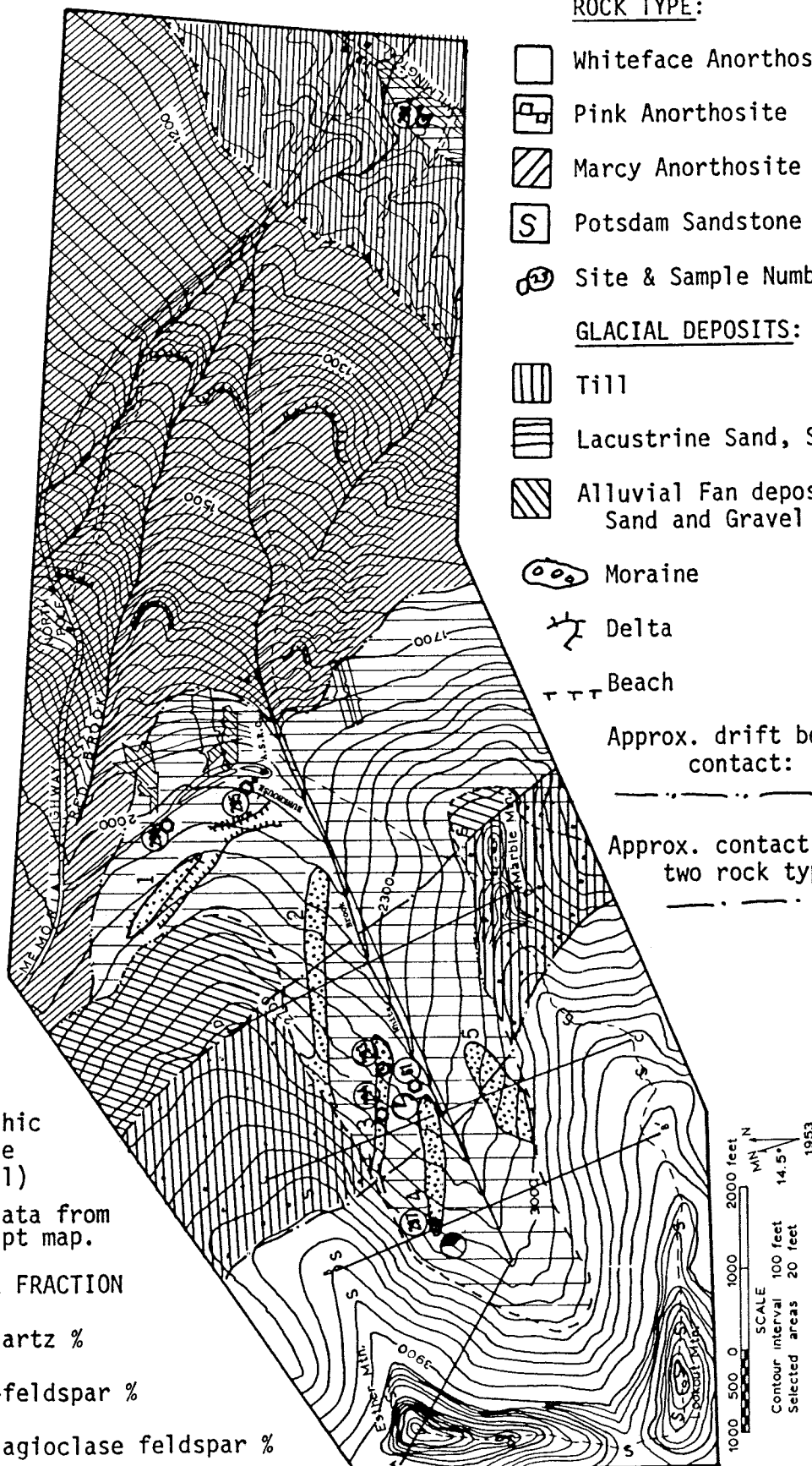
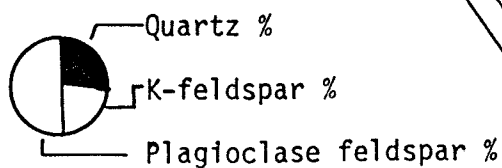


Figure 30. Topographic Map with Bedrock and Glacial Deposits, White Brook Valley.

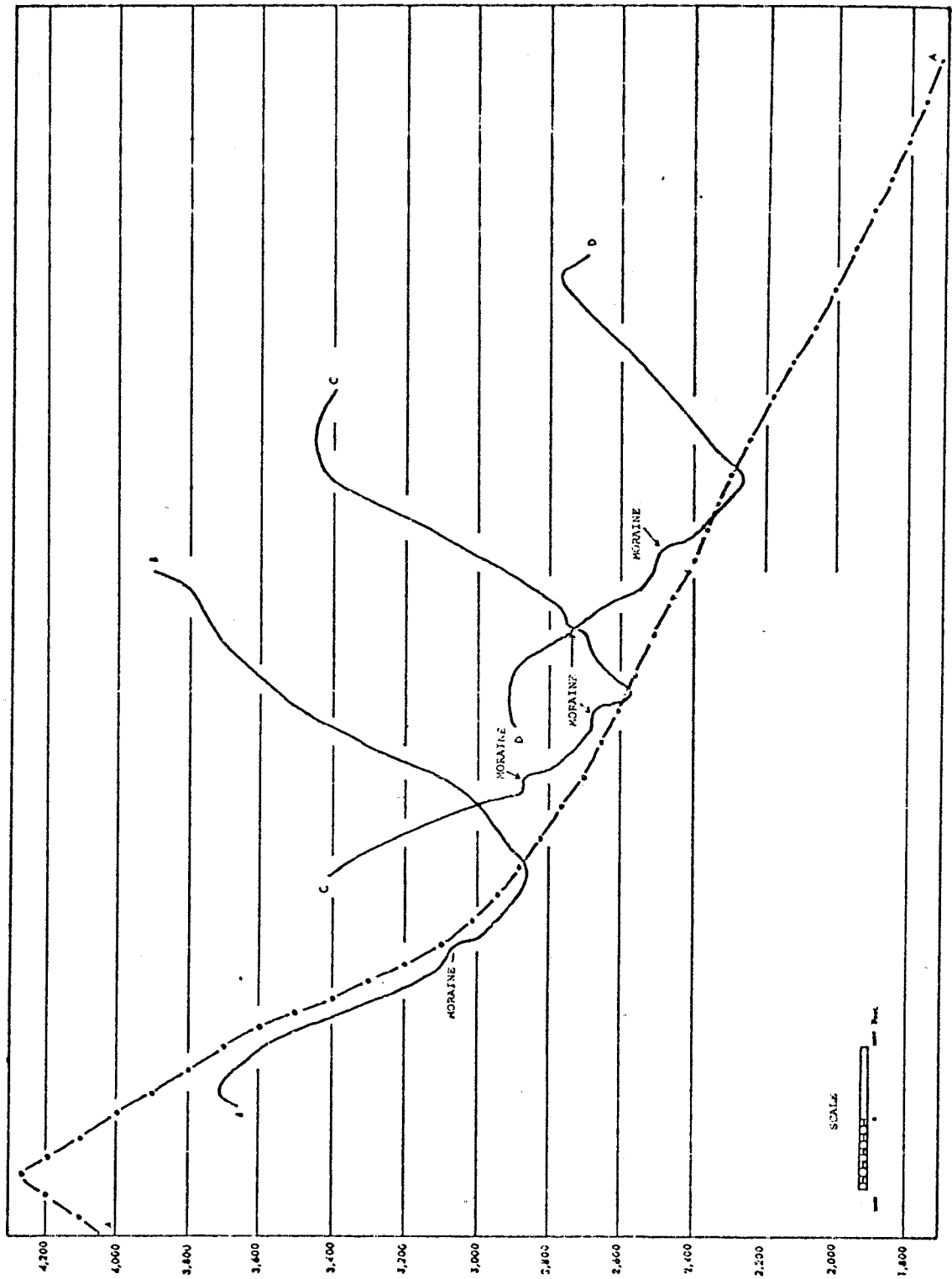


Figure 31. Longitudinal and cross valley topographic profiles of White Brook Valley.

joints.

The occurrence of Potsdam sandstone pebbles lying on the surface is indicated by the letter "S" in figure 30. No Potsdam sandstone pebbles were observed on the top of Esther Mountain. The ridge below the peak of Esther Mountain, however, contained numerous Potsdam pebbles scattered over the bedrock surface and in the joint cracks.

Till-pebble orientations were measured at sites 295 and 296, and their rose diagrams are plotted on figure 30; the results of light mineral studies of two till samples are included in figure 30 adjacent to the sample locations. Nine pebble counts were made. The results are shown in table 6.

Five moraines have been identified in White Brook Valley: three on the northwest side of the valley, one on the southeast side and one above the A.S.R.C. access road: the moraines have been numbered 1-5 on figure 30.

Moraine number five is composed of boulders one to five feet in diameter which form a pronounced boulder terrace with the steepest side parallel to White Brook. The boulders become smaller up the slope and end abruptly at the base of a very steep slope.

Moraines two and three are very similar. These two ridges are composed of till with boulders lying on the surface. Most of the boulders are found on the crests of the ridges and on the north or open valley side of the ridges.

Moraines one and four are composed predominantly of sand and gravel, with boulders lying on their crests. Figure 32 is a measured section of moraine four. This is the only moraine where it was possible to study the internal composition of the deposit.

Moraine number one is somewhat different in that the ridge runs nearly parallel to the valley side. The morainal ridge stands from ten to thirty-five feet above the small valley formed between the moraine and the main valley side. The crest of the ridge is narrow. There are boulders lying on the crest and southwest slope of the moraine but the ridge appears to consist mainly of coarse sand and gravel. The northwestern end of the moraine starts at a bedrock cliff and continues to the southeast (figure 30). The ridge decreases in height but continues at approximately the same elevation until it disappears into a kame terrace just northwest of the first ski slope clearing north of the A.S.R.C. Headquarters. A meltwater channel starts on the south side of the kame terrace and continues to the north edge of White Brook Valley where it disappears into another kame terrace.

Seven till exposures were studied. The locations of these exposures are shown in figure 30. Potsdam erratics were identified in all of the pebble studies (table 6) except for the count made on moraine three, site 294. The highest percentage of Potsdam erratics was found in the upper part of moraine four, site 297. The next

Table 6. Pebble Composition in White Brook Valley Drift

ROCK TYPE	SITE NUMBERS AND ELEVATIONS						
	61 2540' ASL	294 2780' ASL	295 2000' ASL	296 2060' ASL	297 3000' ASL	293 2520' ASL	298 1130' ASL
Pink Anorthosite %	-	10.4	38.5	30.5	2.0	22.2	23.3
Whiteface Anorthosite %	40.0	77.5	25.5	43.2	64.0	50.1	20.3
Marcy Anorthosite %	17.0	0.8	12.4	7.8	-	8.4	13.1
Potsdam Sandstone %	31.0	-	10.5	4.9	25.0	5.5	16.8
Charnockite %	7.0	9.6	3.7	9.8	5.0	10.2	14.0
Amphibolite %	5.0	1.7	4.7	1.9	0.9	12.5	1.9

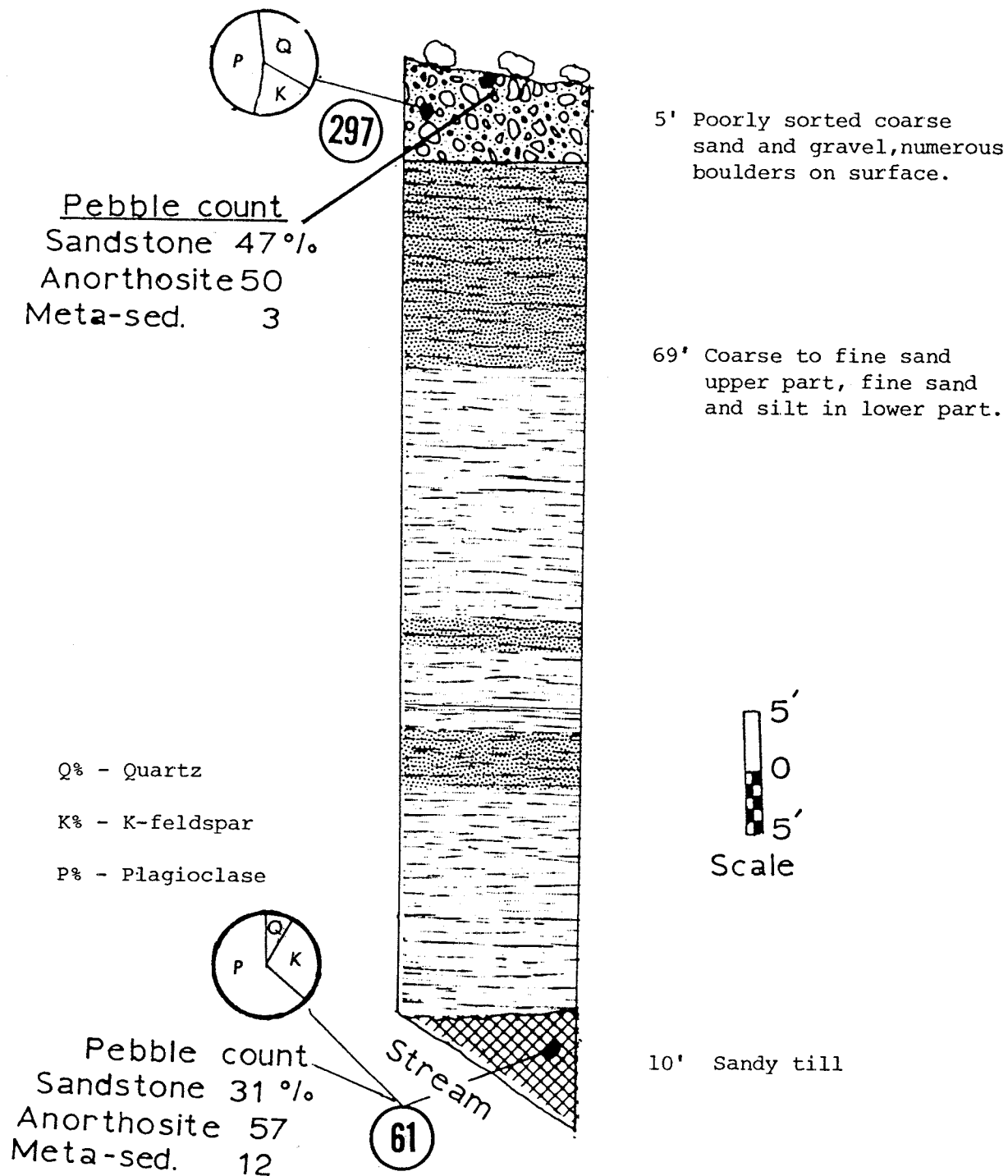


Figure 32. Measured section Moraine 4, White Brook Valley.

highest percentage occurred in the till exposed behind the A & W Root Beer stand (site 298) at the bottom of Wilmington Valley. The presence of Potsdam sandstone in the valley and along the ridges on each side of the valley indicates transportation and deposition by the continental ice sheet.

However, the composition of the light mineral fraction of the till (sample 61) and the distribution of locally derived rock fragments in the valley relative to the positions of the different types of bedrock exposed in the valley presents a different picture. Sample 61 was collected from an exposure of lodgement till in the lower part of moraine four (site 61). It contained 9% quartz, 28% K-feldspar, and 64% plagioclase feldspar. This composition indicates that ice overrode anorthosite bedrock. The anorthosite bedrock outcrops throughout the Wilmington Valley from White Brook Valley northward approximately ten miles to Black Brook. Therefore, this till could have been deposited by local ice moving northeast from White Brook Valley or by continental ice moving southwest into White Brook Valley. Sample 62 collected from ablation drift in the upper part of moraine four (site 297) contained 39% quartz, 19% K-feldspar and 46% plagioclase feldspar indicating a metasedimentary rock origin of the deposit, the nearest source of which is north of Black Brook.

Pebble lithologies of the White Brook Valley drift are particularly informative. Field work in the High Peaks area established that pink plagioclase anorthosite occurs only in White Brook Valley and on the ridges on either side of the valley. The northernmost exposure of pink plagioclase anorthosite was observed on the south side of the Lake Stevens Pass which separates Esther Mountain from the Wilmington Range. The southernmost exposure was observed on the south side of Marble Mountain, the south ridge of White Brook Valley. These findings were confirmed by Crosby in 1966 (personal communication).

The pink anorthosite was found only in samples collected in White Brook Valley and at a single site on the Wilmington-Franklin Falls Road, west of Lake Stevens Pass (site 55). This road goes through the pass between Esther Mountain and the Wilmington Range.

The highest percentage (39%) of pink anorthosite pebbles occurred at site 295 (figure 30) and the next highest (31%) in the exposure north of the bunkhouse along the access road (site 296). The third highest percentage (23%) was at site 298 at the bottom of the valley. Table 6 is arranged to show the distribution of the pink plagioclase from the upper moraine (column one) to the lowest part of the valley (column 6) in descending order of elevation and valley position. These data show an increase in pink anorthosite composition across the outcrop belt in the down valley direction to a maximum at site 295, then a decrease at the bottom of the valley (site 298). Look at pink anorthosite boulders excavated from the till at site 298. All of these boulders except the sixth from the left (Whiteface anorthosite) are pink anorthosite. Note the well developed flat surfaces cut on boulders. These flat faces are glacially ground facets with numerous striae clearly demonstrating glacial transport.

The abundance of Potsdam sandstone and metasedimentary fragments (table 6) suggests a continental glacial origin of the drift. If the deposits were formed by the southwest moving continental glacier only, the lowest elevation in White Brook Valley that the ice would encounter a pink anorthosite outcrop would be 2300 feet ASL. Since the continental glacier would be moving up the valley, no pink anorthosite fragments should be found below 2300 feet ASL. The pink anorthosite fragments occur in deposits below the outcrop with a decreasing concentration as the distance downslope from the outcrop increases. This distribution clearly indicates a northeast flow of ice at least as far as site 298. Ice flowing in this direction must have been of local origin. The Potsdam sandstone and metasedimentary rock fragments associated with the pink anorthosite fragments indicate a reworking of previously deposited continental drift.

The moraines in the upper part of the valley between site 298 and moraine four are recessional moraines. Moraine four (site 298) is an ice stagnation ablation moraine. The high concentration of Potsdam sandstone and metasedimentary rocks (table 6) which occurs on the surface of this moraine is believed to be due to surface sliding of debris from the ridge above the moraine. This ridge, composed of Whiteface and pink anorthosite, is covered with a thin veneer of Potsdam sandstone and metasedimentary erratics.

It could be argued that the distribution of pink anorthosite is not due to a local ice mass but has resulted from a massive landslide following deglaciation of the continental ice mass. However, sites 295, 296, and 298 have the appearance of lodgement tills, and the matrix is compressed tightly around larger fragments. The faceted surfaces on the boulders before excavation at site 298 were observed to be nearly parallel to the ground surface in the outcrop. Such uniformity of position could occur only by ice transport, not by landslide.

Summarizing all the evidence discussed, a conclusion is drawn from the White Brook Valley glacial deposits that they were deposited by local glacial ice moving northeast, out of the cirque at the foot of Esther and Lookout Mountains.

Return to bus

- 8.0 Return to highway
- 8.5 Turn right
- 9.8 Stop sign, turn right on Route 86.
- STOP 10 A & W Root Beer stand. Boulders removed from till during construction of parking area.
- 10.1
- 10.1 Turn right onto Route 86.
- 12.0 Turn left at junction towards Whiteface Chalet.
- 12.9 Stop sign, left into Chalet Parking lot.

## SUGGESTIONS FOR FURTHER STUDIES

A framework of Adirondack glacial history for the Wisconsin Glaciation has been proposed. Additional field work needs to be done to establish more detailed information concerning the relationship of the High Peaks deposits to the deposits outside of the High Peaks area. The following are some suggestions for further investigation:

1. Paleontological and sedimentological studies of the old lake deposits at the McIntyre Development. Additional paleontological studies should also be done on the Adirondack lakes at different elevations and geographic locations.
2. Proglacial lake shorelines, lake outlet channels and drainage history should be established in detail for the interior valleys. These could then be related to events outside the High Peaks.
3. The area described by Cushing (1899) should be located and the sources of the rocks in the moraine should be identified.
4. Field work in the Raquette Lake area has indicated a complex but decipherable history of glacial activity. This area needs to be mapped in detail and its history related to the surrounding regions.

There are abundant opportunities for further studies in the Adirondacks. It is the area of New York of which we know the least about the glacial history. It is a difficult area in which to work, but at the same time, all new information from the area will make a definite contribution to the understanding of the glacial history of the Late Wisconsin Stage.

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