New York State Museum Bulletin

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No. 193 ALBANY, N. Y. JANUARY 1, 1917

The University of the State of New York

New York State Museum

JOHN M. CLARKE, DIRECTOR

THE ADIRONDACK MOUNTAINS

BY WILLIAM J. MILLER

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ALBANY

THE UNIVERSITY OF THE STATE OF NEW YORK

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The University of the State of New York
Department of Science, January 23, 1917

Dr John H. Finley
President of the University

SIR:

I beg to communicate herewith, and to recommend for publication as a bulletin of the State Museum, the accompanying manuscript entitled "The Adirondack Mountains." This has been prepared as a somewhat untechnical guide to the geology and physiographic history of the Adirondack mountain region.

Very respectfully
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 25th day of January 1917

John H. Finley

President of the University

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JOHN M. CLARKE, *Director*

THE ADIRONDACK MOUNTAINS

BY WILLIAM J. MILLER

Professor of Geology in Smith College
Member of the Staff of the New York State Museum

PREFACE

Among the thousands of people who visit the Adirondack mountains each summer, many are real lovers of nature and would welcome a brief scientific treatment of geographic and geologic features of the region. Most Adirondack visitors, however, have little conception of the origin and history of the mountains, though they are often good observers who find numerous interesting but frequently very puzzling things among the relief features and the rocks of the region. During the last ten summers, while engaged in the state geologic surveys of various portions of the Adirondacks, hundreds of people have asked the writer if there were not some popular scientific account of the natural features of the region. This brief volume has been prepared as an answer to these inquiries. To those who have found the charm of the Adirondacks it is my earnest wish that this book may, in simple language, explain how the more obvious and accessible physical features of the mountains came to be as we see them today after profound revolutionary changes through tens of millions of years of history. If a fuller knowledge is desired of a portion or all of the Adirondacks, the principal publications thereon will be found listed in the appendix.

Whoever writes upon the geology of this region is under abundant obligation to his coworkers in the same field. The foundation of our knowledge of this ancient region was laid by Dr Ebenezer Emmons in 1836–42, when State Geologist in charge of the second geological district. For fifty years after his day no systematic effort was made to elucidate the intricate geological problems of the region, but in 1891 a closer study was organized by the State Geologist and the field was entered by Prof. James F. Kemp, Prof. Charles H. Smyth, and Prof. Henry P. Cushing, with their associates. All these geologists have maintained to the present time their active interest in the mountain region, and to them, their associates and successors we owe our present understanding of Adirondack geology. The writer has been for ten years a worker in this field under the auspices of the State Geological Survey.

INTRODUCTION

Some General Principles of Earth History

The observer who looks out over the Adirondack region sees a great variety of physical features and, unless he has given some study to the subject, is very likely to regard these as practically unchangeable, and to think that they are now essentially as they were in the beginning of the earth's history. But the physical features of the Adirondacks, as we behold them today, represent merely a single phase of a very long continued history. As a result of the work of many able students of earth science during the past hundred years, it is now well established that our planet has a clearly recorded history of many millions of years, and that, during the lapse of those eons, revolutionary changes in geography have occurred, and also that there has been a vast succession of living beings which, from very early times, have gradually passed from simple into more and more complex forms. The geographic changes and the organisms of the past ages have left abundant evidence of their character, and the study of the rock formations has shown that within them we have a fairly complete record of the earth's history. While it is true that very much yet remains to be learned about this old earth, it is a real source of wonderment that man, through the exercise of his highest faculty, has come to know so much concerning it.

Geology, meaning literally " earth science," deals with the history of the earth and its inhabitants as revealed in the rocks. This science is very broad in its scope and treats of the processes by which the earth has been, and is now being, changed; the structure of the earth; the stages through which it has passed; and the evolution of the organisms which have lived upon it.

Geography deals with the distribution of the earth's physical features, in their relation to one another, to the life of sea and land and human life and culture. It is the present and outward expression of geological effects. The terms geography and geology are thus here used in the sense that the latter includes the former, as the cause includes the effect.

"The great lesson taught by the study of the outer crust is that the earth-mother, like her children, has attained her present form through ceaseless change, which marks the pulse of life and which shall cease only when her internal forces slumber and the cloudy air and surf-bound ocean no more are moving garments. The flowing landscapes of geologic time may be likened to a kinetoscopic panorama. The scenes transform from age to age, as from act to act; seas and plains and mountains of different types follow and replace each other through time, as the traveler sees them succeed each other in space. At times the drama hastens and unusual rapidity of geologic action has in fact marked those epochs since man has been a spectator upon the earth. Science demonstrates that mountains are transitory forms, but the eye of man through all his lifetime sees no change, and his reason is appalled at the conception of a duration so vast that the milleniums of written history have not accomplished the shifting of even one of the fleeting views which blend into the moving picture."[1]

All the rocks of the earth's crust may be divided into three great classes: *igneous, sedimentary* and *metamorphic.*

Igneous rocks comprise all those which have ever been in a molten condition, and of these we have the *volcanic* rocks (for example, lavas), which have cooled at or near the surface; *plutonic* rocks (for example, granites), which have cooled in great masses at considerable depths below the surface; and the *dike* rocks which, when molten, have been forced into fissures in the earth's crust and there cooled.

Sedimentary rocks comprise all those which have been deposited under water, except some wind-blown deposits, and they are nearly always arranged in layers (stratified). Such rocks are called strata. They may be of mechanical origin such as clay or mud which hardens to *shale;* sand, which consolidates into *sandstone;* and gravel, which when cemented becomes *conglomerate.* They may be of organic origin such as *limestone,* most of which is formed by the accumulation of calcareous shells; *flint* and *chert,* which

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[1] Joseph Barrell. Central Connecticut in the Geologic Past, p. 1–2.

are accumulations of siliceous shells; or *coal,* which is formed by the accumulation of partly decayed organic matter. Or, finally, they may be formed by chemical precipitation, as beds of *salt, gypsum, bog iron ore,* etc.

Metamorphic rocks include both sedimentary and igneous rocks which have been notably changed from their original condition. Thus, under conditions of moisture, heat and great pressure, sedimentary rocks may become crystalline, as when shale is changed to *schist,* sandstone to *quartzite,* or limestone to *marble;* or an igneous rock may take on a streaked or crudely banded structure due to more or less flattening and rearrangement of its component minerals, and thus become a *gneiss.*

To the modern student of earth science the old notion of "terra firma" is outworn. That idea of a solid, immovable earth could never have emanated from the inhabitants of an earthquake country. Earthquakes are caused by sudden movements in the crust of the earth, most commonly resulting from slipping of one part past another along a fracture. Such fractures, known as "faults," are very common in the southeastern half of the Adirondacks. In the San Francisco earthquake of 1906, along a fracture line of several hundred miles, one portion of the Coast Range mountains suddenly slipped from two to twenty feet past the other. In Alaska in 1899, a portion of the coast was bodily elevated forty-seven feet. In Japan in 1891, for a distance of forty miles along a rift in the earth's crust, there was a sudden movement of from ten to forty feet. These are merely striking instances of many of the sudden earth movements of recent years. It is probably true that the earth is shaking some place all the time.

Still other movements take place more slowly and quietly, but they are very significant for our interpretation of the profound geographic changes which have occurred during the millions of years of earth history. Such movements are now known to be taking place. Thus the northern portion of Sweden is rising several feet a century, while the southern portion is sinking. A fine illustration of notable sinking of the land is proved by the drowned character of the lower Hudson valley, and by the fact that the old Hudson channel has been definitely traced as a distinct trench in the ocean bottom for one hundred miles eastward from Sandy Hook. That this same region has been more recently partially reelevated is indicated by the presence of very young stratified clay beds and sands which are now raised from zero near New York

City to five or six hundred feet at the northern end of Lake Champlain, the elevation gradually increasing northward. Actual surveys show that, in the Great Lakes region, a differential movement of the land is now in progress, the elevation being greater toward the north. Recent changes of level in the Adirondack district will be described toward the close of the next chapter.

Among other important processes which have long been active in modifying the earth are those of *weathering* and *erosion*. Weathering is brought about by the various atmospheric agencies such as moisture, oxygen, carbonic acid gas, etc., together with changes of temperature. The result is to cause all rock masses to disintegrate or decay in the course of time. In this way most soils are produced. In northern New York the original soils of this sort have been very largely reworked and redeposited by the ice or by streams of water in connection with the ice during the great Ice Age. Were it not for the process of erosion, which includes both the breaking up and removal of rock material, soils would be much more widespread than they now are. Weathering prepares the material which is carried away by the streams, and this material is mostly deposited either along the flood-plains of the lower stream courses, or on the bottoms of lakes or oceans into which the streams flow. Every stream, at time of flood, is heavily charged with mud or even coarser sediment which has been derived from the wear of the land of its drainage basin. The very presence of the sediment in the streams proves that the land is being lowered, and although, on first thought, it may be supposed that no really great change could be accomplished by this means, nevertheless we must remember that nature has practically infinite time at her disposal so that slowly but surely vast physical changes are wrought and, perchance, a tremendous canyon like that of the Colorado river in Arizona may be carved out by erosion. The general tendency is for all land masses to wear down to or near sea level and, were it not for renewed earth movements, all lands, even including the mountains, would be thus worn down to what is known as a *peneplain* condition. Northern New York was worn down to the condition of a more or less well-developed peneplain at least twice during its long history. Accordingly, that familiar expression "the everlasting hills" is decidedly incorrect.

Another important process is *vulcanism,* that is to say, igneous activity in general. By this means materials are brought up from within the earth to or near its surface. Thus an active volcano ejects rock fragments, dust etc., or more quietly pours out molten rock, while in many cases great masses of molten rock have been forced upward into the earth's crust without reaching the surface and hence have cooled at greater or lesser depths below the surface. Such deep-seated (plutonic) igneous rocks have become exposed to view only by subsequent profound erosion of the region.

Still another process which has been very influential in the production of certain important physical features of the Adirondacks is *glaciation.* During the great Ice Age, comparatively recently, a vast sheet of ice slowly moved across the whole region and then gradually melted away. Its principal work was erosion and deposition of rock materials, the latter having taken place chiefly during the ice retreat. Most of the soil and rotten rock and some fresh rock were scraped off by the mighty ice plow, and the irregular deposition of the glacial débris brought into existence many minor topographic features. The Adirondack lakes are practically all due to the glaciation.

Geologic time scale

LENGTH IN YEARS	ERA	PERIOD	DOMINANT LIFE
3 to 5 million..	Cenozoic.....	Quaternary......	Age of man
		Tertiary.........	Age of mammals
		Cretaceous......	Age of reptiles; first birds in the Jurassic; first modern plants in Cretaceous
5 to 10 million..	Mesozoic.....	Jurassic.........	
		Triassic.........	Age of amphibians and cycad plants
		Permian.........	Great coal age, with large, simple non-flowering pl nts
		Pennsylvanian...	
		Mississippian....	
15 to 25 million.	Paleozoic.....	Devonian........	Age of fishes
		Silurian.........	Age of invertebrate animals
		Ordovician......	
		Cambrian.......	
		Keweenawan.....	Simple forms of life; records imperfect
		Animikean.......	
....	Proterozoic...	Huronian........	
		Algoman........	
		Sudburian.......	
....	Archeozoic....	Laurentian......	Beginnings of life
		Grenville........	

In order to understand the physical history of the Adirondacks, it is necessary to know that the history of the earth has been divided into great eras and lesser periods and epochs, and that these constitute what is called the geologic time scale. The epoch names for eastern North America are omitted from the above table. So far as they are recorded, the principal events in the history of the Adirondacks will be taken up in the regular order of geologic time in the following pages.

Sources of Information

The purpose of this book is not to give detailed discussions of particular portions of the Adirondack mountains, but rather to present, in simple, nontechnical language, a general outline of the geography, rock formations, physical history, and human history of the region. In fact much of the area has not yet been geologically mapped or studied in detail. Most of the important and striking physical features of the Adirondacks, however, are explained, and many local details will find ready explanation by the application of the principles set forth.

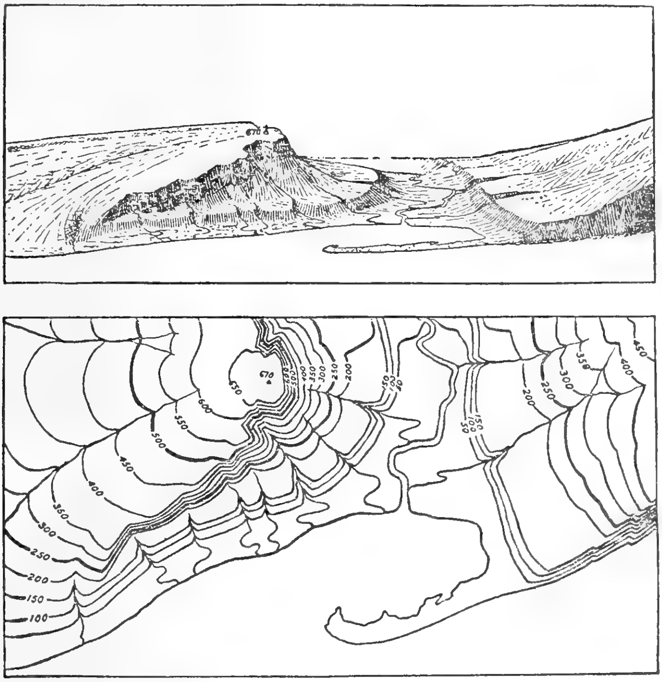

FIG. 1 A landscape and corresponding contour map. (After United States Geological Survey).

The attention of those who may be sufficiently interested is called to the various publications pertaining to Adirondack geography, geology and human history. Most of the more important of these are listed in the appendix. The New York State Museum Bulletins, which contain topographic and geologic maps and explanatory texts regarding certain specified areas, are of special importance. These may be obtained at small cost on application to the Director of the State Museum at Albany. The areas thus mapped in detail to date are indicated on map figure 2.

There are excellent maps showing the topography (surface configuration) of most of the Adirondack mountain district. These topographic (or contour) maps, which are called sheets or quadrangles, are rectangular in shape and bounded by latitude and longitude lines. Each map is about 17½ inches high by 12 to 13 inches wide, the latter varying with the latitude. The scale is 1 to 62,500 or nearly one mile to one inch, that is, a mile on the ground is

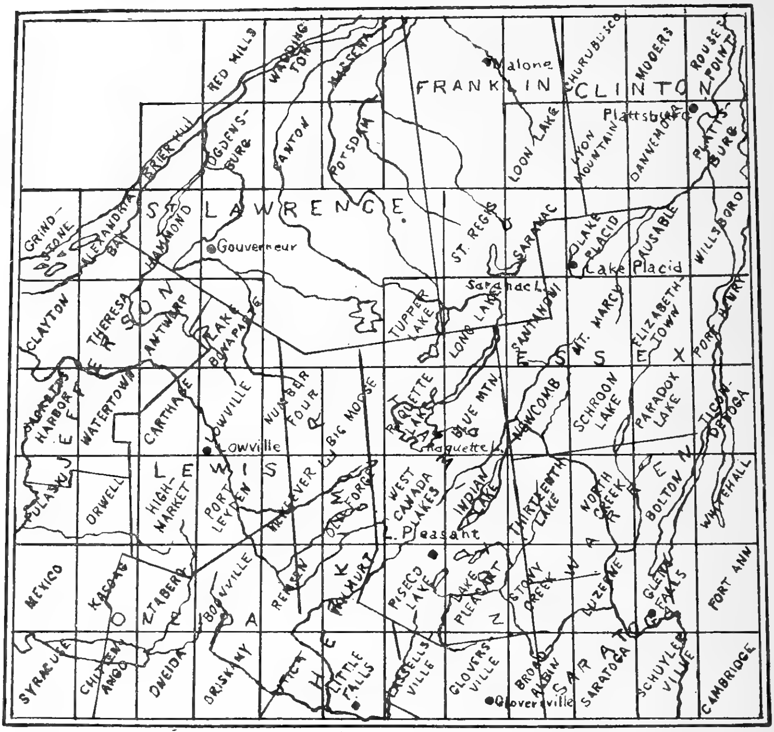

FIG. 2 Sketch map of northern New York showing the names and locations of the various topographic maps (quadrangles) published by the United States Geological Survey in cooperation with New York State to January 1916. Geological maps of the following quadrangles have been published by the New York State Museum: Little Falls, Broadalbin, Saratoga, Schuylerville, Lake Pleasant, Remsen, Port Leyden, North Creek, Paradox Lake, Port Henry, Elizabethtown, Long Lake, Blue Mountain, Alexandria Bay, Grindstone, Clayton, and Theresa. Geologic maps soon to be published are: Schroon Lake, Lake Placid and Mount Marcy.

represented by an inch on the map. The most valuable feature of these maps is the fact that the relief (topography) of the country is so accurately represented, this feature being explained by the accompanying figure and the description generally printed on the back of each map. The relief is shown by contour lines in brown, every point on a given contour being at the same altitude above sea level. On the Adirondack maps the contour interval, that is, vertical distance represented between any two contour lines, is 20 feet. Water features are shown in blue. Artificial features, such as roads, trails, railroads, boundary lines, houses, villages etc., are shown in black. Each quadrangle map is designated by the name of some geographic feature. The maps are published by the United States Geological Survey, and orders for them should be sent to the director of that bureau at Washington, D. C. They are sold at ten cents each when fewer than fifty are purchased, but in lots of fifty or more of the same or different maps, the price is six cents each. Orders should be accompanied by cash or a post office money order. All except the northwestern border of the Adirondack region has been covered by these topographic maps. Figure 2 is an index to both the topographic and geologic maps thus far published.

Any person interested in the geographic setting of any portion of the Adirondacks should procure the proper topographic sheets of that region and thus be provided with the best map of the sort in existence. It would be difficult to overestimate the value of these maps to teachers and pupils of geography, and every school should be provided with a supply of them.

GEOGRAPHY OF THE ADIRONDACKS

General Features

The Adirondack mountain region of northern New York is a very distinct topographic province comprising nearly one-fourth of the area of the State, or about 11,000 square miles. It is an irregular, broad, oval-shaped region with longest axis running 120 miles north-northeast by south-southwest, and short axis 100 miles east and west. The name "Adirondack," meaning "Tree-eater," was a term of contempt applied by the Indians of the south (Iroquois) to the Indians who lived on the northern slope of the mountain region and in the St Lawrence valley. Professor Emmons, in his geological survey of northern New York about 1840, is said to have first applied the name "Adirondack" to a northeast-southwest mountain belt including the highest peaks of the present Adirondack area. Later the term came to be applied to the whole of the mountain region sometimes called the "Great North Woods" or the "Great Wilderness of Northern New York."

The Adirondacks consist almost wholly of a mass of igneous and metamorphosed sedimentary rocks of very great age, that is, pre-Paleozoic. This very ancient rock mass is surrounded by practically unaltered strata of early Paleozoic age.

The whole region is typically mountainous and rugged, with altitudes ranging from 1000 to over 5000 feet, except around the borders. Most of the Adirondacks are heavily wooded, often being truly wilderness in character with very few roads, trails or settlements except scattering camps or summer resorts. In southern Hamilton county, for example, there is an area of 125 square miles without a traveled road or permanent settlement, and with very few trails. Again, most of the Santanoni quadrangle (over 200 square miles) of the east-central Adirondacks has only a few miles of traveled road and very few trails. The writer has had much experience in both the Sierra Nevada mountains of California and in the Adirondacks, and he can testify to the fact that it is decidedly easier to keep one's bearings in the higher, grander mountains of the West. Reasons for this are that in the Adirondacks few mountain peaks rise notably and characteristically above the general mountain summits; the country is so densely and monotonously wooded, usually with thick underbrush, that one might travel for miles without finding a good outlook point; and most of the stream courses are exceedingly irregular and difficult to follow

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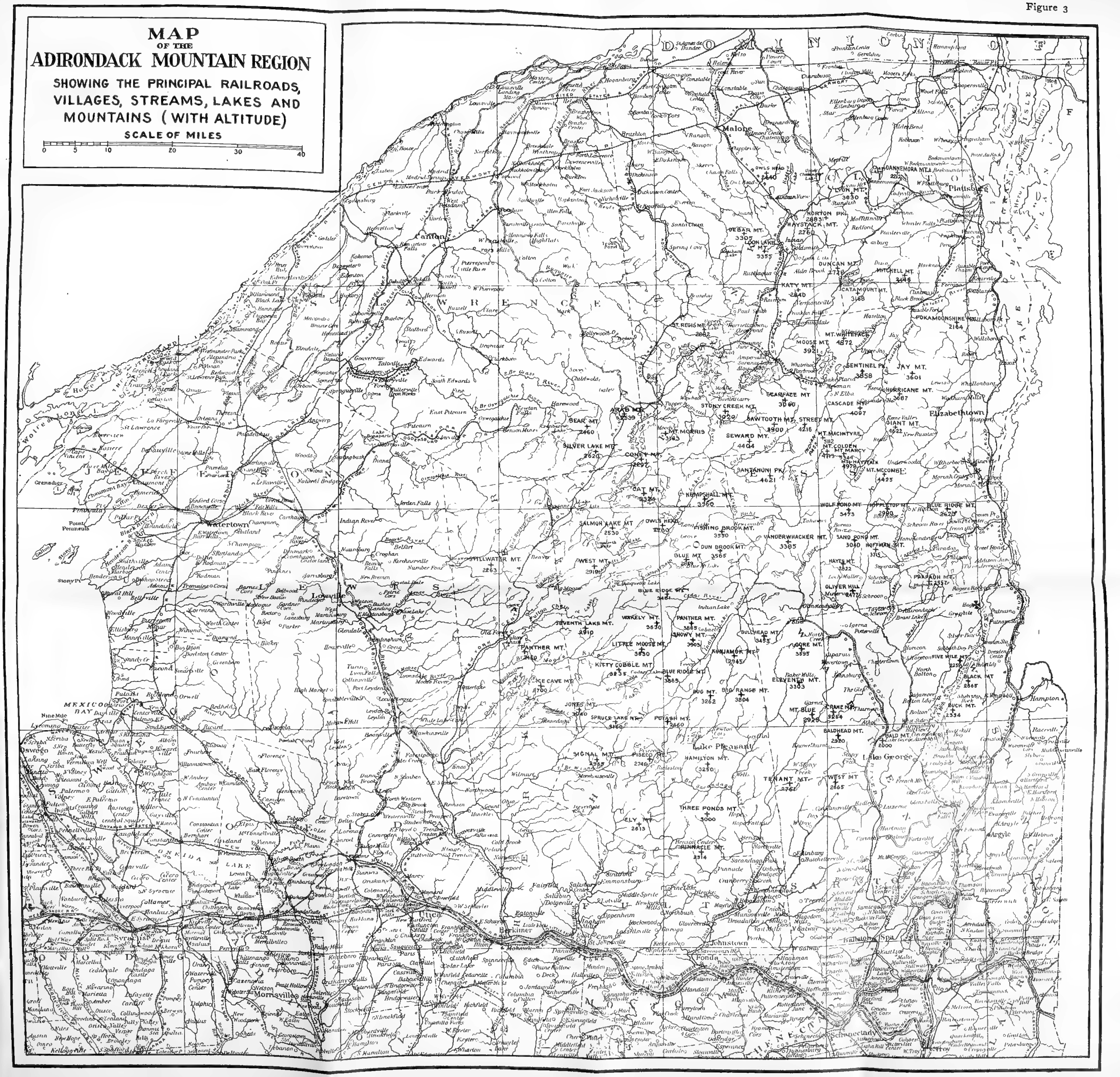
Figure 3


MAP
OF THE
ADIRONDACK MOUNTAIN REGION
SHOWING THE PRINCIPAL RAILROADS, VILLAGES, STREAMS, LAKES AND MOUNTAINS (WITH ALTITUDE)
SCALE OF MILES
0 5 10 20 30 40

because of dense growth of brush or swamps. Most of the Adirondack region is, in the real sense of the term, a well-watered, densely wooded, wilderness. There are, however, hundreds of places throughout the mountains where large tracts are clad with forests relatively free from underbrush, where the lover of the deep, shadowy woods may roam to his heart's content with comparative ease, and many mountain summits from which magnificent panoramic views may be enjoyed.

There are many large areas which have been ravaged by forest fires. A few years after such a fire a dense thicket of raspberry and blackberry briars, popple, and other brush grows over the fallen, charred tree trunks and loose rocks, rendering such an area exceedingly difficult to traverse. There are also many portions of the Adirondacks where lumbering operations have recently been carried on. Such districts, with treetops and other lumberman's refuse piled pell-mell, are also difficult to cross. Mountain ridge summits from 3000 to 4000 feet above sea level often have thickets of scrub evergreen trees so densely intergrown that it is the hardest kind of work to make progress through them at the rate of one-half to one mile an hour. It is therefore not at all surprising that people are frequently lost in the woods. Persons not well acquainted with the Adirondack type of country should be careful not to wander away from well-defined trails or roads unless accompanied by a competent guide or some other person who really understands the region.

The excellent water of the Adirondacks deserves mention. Nearly all the streams which come down the mountain sides are clear, cold, pure and remarkably soft water. Springs and streams of such water are abundant throughout the summer season. Practically the only hard water issues as springs out of the limestone which underlies certain of the valleys.

Except for an occasional rattlesnake at the very southeastern border of the Adirondacks, poisonous reptiles are unknown. Hence one may follow the trails, travel through the woods, or climb the mountains without the slightest dread of encountering a rattlesnake, copperhead, or any other dangerous reptile. In fact it may be affirmed that no Adirondack wild animal is really dangerous, which is a matter of great importance when considering the Adirondacks as a playground for the people. Bears are occasionally seen and sometimes killed but, in common with that of many persons, the writer's experience is that the Adirondack black bear loses little time in getting out of sight of a human being. Of course a mother bear with cubs is likely to put up a fight if really molested or cornered. Thousands of deer roam the " Great North Woods " and they are very frequently seen. During the open season in the fall hundreds of hunters go to the woods and many deer are killed. Red foxes are fairly common, while a silver fox is rarely seen. Squirrels, rabbits and porcupines (hedgehogs) are common. Partridges are very abundant in nearly all parts of the Adirondacks. Hawks are common and American bald eagles rare. Many of the lakes and streams afford good trout and bass fishing, especially early in the season.

Much of the Adirondack area is now owned by the State of New York, and gradually more of the land is being acquired. Camping privileges are free to all on state land. All but the borders of the " Great North Woods " lies within the boundaries of the so-called " Adirondack Park," it being the purpose of the State to gain possession of more and more of the land within the confines of the park. Too much can not be said in favor of this project to control the great, wild, mountainous region as a recreation park and watershed for the benefit of the people.

Surrounding Valleys

With a single slight exception on the southwestern border, the Adirondacks are completely surrounded by prominent valleys whose bottoms are nowhere more than a few hundred feet above sea level. These are the St Lawrence, Champlain, Mohawk and Black River valleys.

The St Lawrence valley, bounding the Adirondacks on the north, is a great open depression of comparatively simple structure and near sea level. Where the river leaves Lake Ontario the altitude is only 247 feet, while points more than a few hundred feet above the sea are comparatively rare. The Thousand Islands form a remarkable feature of the valley where the wide, clear, slow-moving St Lawrence river does not occupy any very distinct channel, but rather flows across a broad, low, hilly region of very moderate relief, thus allowing many of the rocky hills to stand out as islands. The rocks of the valley are chiefly sandstones and limestones of early Paleozoic age, though in the vicinity of the Thousand Islands numerous patches of older (underlying) and much harder pre-Paleozoic rocks are exposed as on many of the islands themselves. The Paleozoic strata form a comparatively thin mantle of nearly horizontal layers over the pre-Paleozoic rocks.

The Champlain valley bounds the Adirondacks on the east, being a great depression which separates the Green mountains on the east from the Adirondacks on the west. Much of the valley bottom is filled by the waters of Lake Champlain, whose altitude is 101 feet. Along the western shores of the lake the topography is characteristically hilly, though seldom above 500 feet in elevation. The transition to the higher and rugged Adirondacks is generally rapid.

Bounding the region on the south, the Mohawk valley clearly separates the Adirondacks from the highlands of the Catskills and the great southwestern plateau of New York. The comparatively narrow inner valley through which the river flows is often erroneously called the Mohawk valley, but in reality the whole depression, from 10 to 30 miles wide and fully 1000 feet deep, between the northern and southern highlands of the State should be called the Mohawk valley. The bottom of the valley is only 300 to 400 feet above sea level. At Little Falls the inner valley narrows to a gorge several hundred feet deep where the river has cut its way through an old divide. The principal rocks of the valley are shales, sandstones and limestones of Cambrian and Ordovician ages, with Ordovician shales predominating. The great depression owes its existence largely to the presence of this belt of soft shales lying between the hard ancient rocks of the Adirondacks on the north and the relatively hard limestones immediately south of the valley. The work of erosion has made rapid progress in this belt of weak rocks, and at two places, Little Falls and Yosts ("The Noses"), the river has cut through to the underlying pre-Paleozoic (Adirondack) rock. In general, the strata of the valley tilt only slightly southward and show little signs of folding (fig. 7), though from Little Falls eastward there are various faults (fractures) in the strata.

On the west, the Adirondack highland is bounded by the Black River valley, which is about 60 miles long and has a maximum depth of nearly 1500 feet. Immediately west of the valley the Tug Hill plateau stands out as a distinct, isolated geographic province. The top of the plateau, covering many square miles, is remarkably flat, swampy and densely wooded with altitudes ranging from 1800 to 2100 feet. This Tug Hill plateau is merely an erosion remnant of a great upraised plain which formerly covered the area of New York State (see page 50). Near Boonville, at an altitude of about 1100 feet, occurs the division of drainage between the Black and Mohawk rivers, this divide not only forming the highest connection between the Tug Hill plateau and the Adirondacks, but also being the highest valley bottom immediately surrounding the Adirondacks. Disregarding the loose, comparatively recent glacial deposits, the eastern half of the Black River valley shows the very ancient Adirondack (pre-Paleozoic) rocks only, while on the western side there are early Paleozoic strata only piled up to a thickness of 1500 feet with slight westward tilt (see figure 12). These strata are limestones, shales and sandstones.

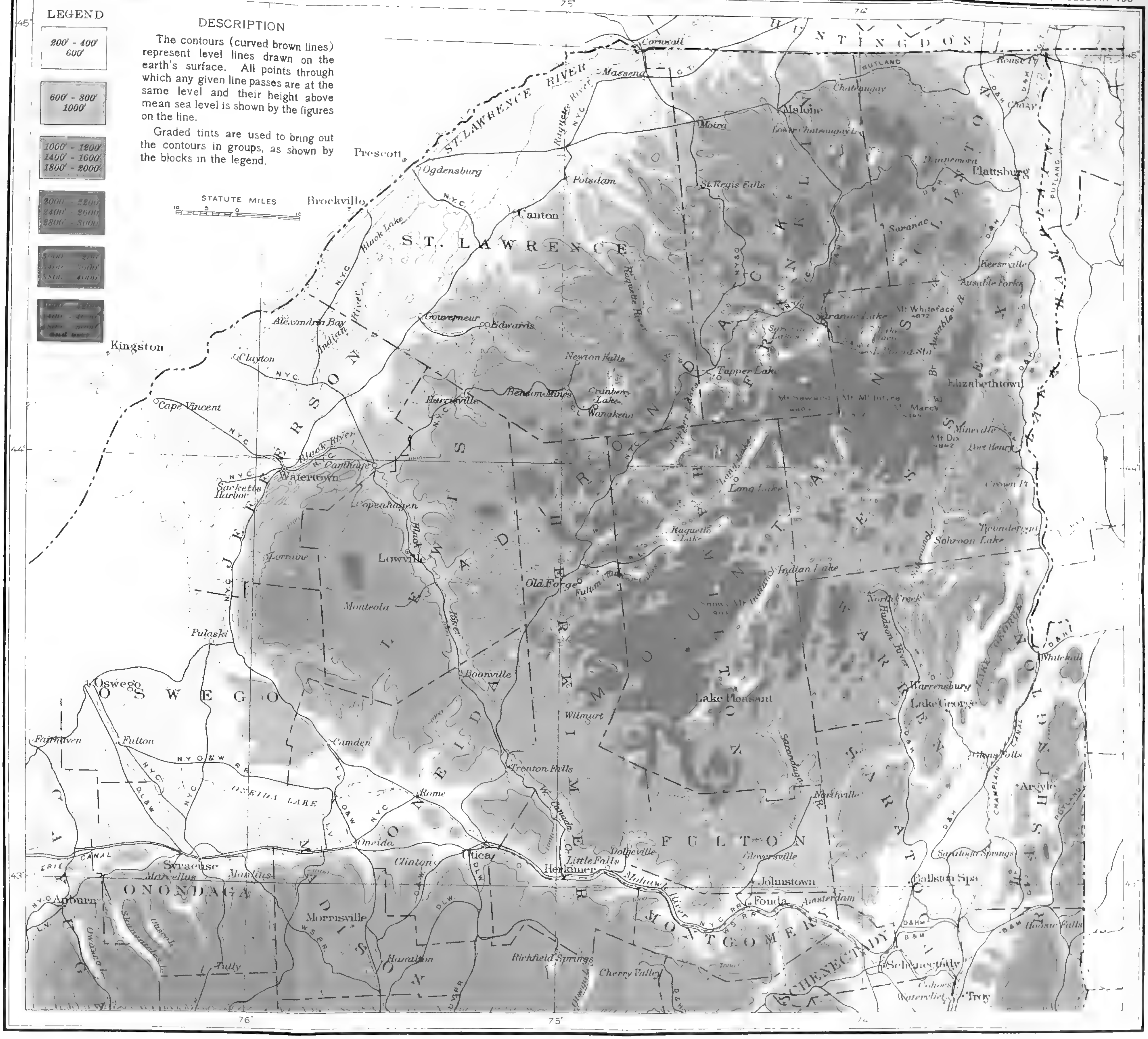
Mountains

The mountains and valleys of the Adirondack region are the present outward expression of an exceedingly long history. An outline of this history will be presented in the next chapter, the purpose now being to describe the principal topographic (relief) features without much explanation of their origin.

Viewed in a broad way, the Adirondack mountains and valleys are very irregularly arranged, this being due largely to the exceedingly patchy distribution of the relatively harder and softer rocks, as explained below, the harder rock masses having stood out most against weathering and erosion to form the mountains. There are no long, distinct, approximately parallel ridges (so-called " ranges ") such as characterize the Appalachians. In the southeastern half of the Adirondacks there is a considerable tendency for many of the mountain masses to be arranged as roughly parallel short ridges with north-northeast by south-southwest trend. This structural feature is due to the fact, as will be explained in the next chapter, that this portion of the region has been highly fractured (faulted), the principal fractures trending parallel to the north-northeast by south-southwest ridges. There are, however, many exceptions to this parallelism of mountain masses, while very few of the ridges are as much as 10 miles long and many of them are not very sharply defined as ridges because of notable variations in width and altitude in individual cases. In spite of this moderate tendency toward parallelism, the Adirondacks are, as the map (figure 4) suggests, a jumbled mass of very irregularly shaped, relatively low mountains.

By far the greatest number of mountains rise from 1000 to 3000 feet above sea level; a considerable number reach altitudes of 3000 to 4000 feet; while very few are over 4000 feet, the highest of all being Mt Marcy in the east-central portion (Essex county). This east-central portion contains the group of loftiest mountains in the Adirondacks, most of the highest ones showing altitudes in feet

FIGURE 4, BULLETIN 193



GENERALIZED TOPOGRAPHIC MAP OF NORTHERN NEW YORK

as follows: Mt Marcy, 5344; Mt McIntyre, 5112; Mt Skylight, 4920; Mt Haystack, 4918; Mt Whiteface, 4872; Dix mountain, 4842; The Gothics, 4738; Mt Colden, 4713; Giant mountain, 4622; Santanoni mountain, 4621; Nipple top, 4620; Mt Redfield, 4606; Saddleback mountain, 4530; Armstrong mountain, 4455; Panther peak, 4443; Table Top mountain, 4440; McComb mountain, 4425; and Seward mountain, 4440. All these high peaks, except Seward mountain, are in the northwestern half of Essex county and confined to an area of five or six hundred square miles. These are the loftiest mountains in eastern North America except the Blue ridge of North Carolina and the White mountains of New Hampshire. "The individual mountains are diversified in shape. Mt Marcy is a very low cone, and the last stages of its ascent are very much like climbing a dome. Mt McIntyre has a gradual slope from the northwest, but a precipitous escarpment on the southeast. The Gothics are like a steep wedge standing on its base, and tapering from all four sides of the base to the ridge. Whiteface is a long sharp ridge, steep if not actually precipitous on each side, and leading up to a peak at the southwestern end. Some buttresses run out from the ridge and make beautiful cirques on its flanks. Hurricane, when viewed from the east, resembles a sharp volcanic cone; from the west it is flat. There are several, of which Dix is the highest example, which, like Vesuvius, have a small conical summit set upon a large mountainous base. Nipple top is a rather favorite name in the local nomenclature of the inhabitants. There are several smaller mountains which have the outlines of a steep haystack when viewed from certain directions, and their precipitous sides and doming tops fix the eye at once. Yet they may each be a ridge when seen from the opposite."[1]

Next to the highest mountain district is the northern half of Hamilton county where many points reach altitudes above 3500 feet, though none quite reach 4000 feet. Some of the highest of these from north to south are: Fishing Brook mountain, 3550; Dun Brook mountain, 3565; Blue mountain, 3759; Wakeley mountain, 3617; Panther mountain, 3865; Snowy mountain, 3903; Little Moose mountain, 3630; Lewey mountain, 3740; and Blue Ridge mountain, 3865.

What has been termed the main axis of elevation, including the highest points, through the Adirondacks runs south along the Franklin-Clinton county boundary and to the vicinity of Mt Marcy;

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[1] J. F. Kemp. Popular Science Monthly, March 1906, p. 197–99.

thence it swings abruptly westward into southern Franklin and northwestern Hamilton counties ; and thence southward clear through Hamilton county. Toward the north two deep, narrow valleys have been cut across the main axis by the two chief branches of the Saranac river. From there southward the two lowest passes across the main axis of elevation are long relatively broad valleys with maximum altitudes of about 1800 feet, one extending east-west across the northern part of the Blue Mountain quadrangle, and the other east-west through Raquette and Blue Mountain lakes.

Valleys

It is almost impossible to think of the mountains apart from the valleys. Like the mountains, the Adirondack valleys are also exceedingly variable in size, shape and distribution. In general there are three types of valleys, one of which is broad, open and usually of irregular shape; the second type is moderately wide, relatively long and more regular in shape; while the third type is deep, narrow and often comparatively straight for some miles. Large scale examples of the first type are the valleys: south to southeast of Lake Placid; around Saranac lake; in the vicinity of Newcomb; from Blue Mountain lake eastward to Rock lake; the region around Indian Lake village; and in the vicinity of Lake Pleasant. These are all some miles across. Large valleys of this sort owe their origin almost entirely to the removal of irregular masses of relatively weak rock by weathering and erosion. Many smaller open valleys of irregular shape have also been produced in this manner. The open, more regular valleys belonging to the second type are confined chiefly to the southeastern half of the Adirondacks, most of them having resulted from the settling of earth-blocks along or between lines of fracture (faults). Excellent examples are the valleys in part occupied by Piseco, Indian and Schroon lakes, and also the remarkable valley at Wells (Hamilton county) which is a wedge-shaped block of earth, several miles long, dropped at least 2000 feet between two earth fractures (see figure 9 and explanation on a succeeding page). There are, to be sure, occasional valleys of this second type which have been produced by ordinary erosion instead of by faulting. The deep, narrow, relatively straight valleys of the third type have resulted for most part in either of two ways, namely, by ordinary erosion where certain streams have been favorably situated as regards volume and velocity of water, or by stream erosion along zones of hard or soft rocks which have

Plate 1

Courtesy of Melvil Dewey of the Lake Placid Club

General view of the highest mountain group in the Adirondacks as seen from the Lake Placid Club grounds near Lake Placid village. Mt Marcy toward the left and Mt McIntyre at the right.

Plate 2

Courtesy of the New York Central Lines

Mt Whiteface as seen from Lake Placid. Sunrise mountain on the right.

Plate 3

H. P. Cushing, photo

The Mt Seward range as seen from Long lake

Plate 4

Photo by E. E. Kellogg, Blue Mountain Lake, N. Y.

Blue mountain (altitude 3759 feet) as seen from the southwest across the southeastern arm of Blue Mountain lake

Plate 5

Photo by I. L. Stedman, Lake Placid, N. Y.

General view of Lake Placid, looking southward from the summit of Eagle Eyrie

Plate 6

Courtesy of the New York Central Lines

A view across Lower Saranac lake in the northern Adirondacks

been notably weakened by having been badly broken or crushed due to earth movements along fractures (faults). These fault-zone, stream-cut valleys are of course wholly confined to the south-eastern half of the Adirondacks, and they have been produced by both small and large streams. A few examples are: the Wilmington notch of the Lake Placid quadrangle; Cascade lakes, Ausable lakes and Avalanche Lake valleys of the Mount Marcy quadrangle, Indian pass of the Santanoni quadrangle; two valleys between mountains in the northern half of the Schroon Lake quadrangle; Squaw Brook valley of the Indian Lake quadrangle; and the valley of the Sacandaga river just south of Wells in the Lake Pleasant quadrangle. These fault-zone valleys are usually very narrow with high, nearly precipitous, rock walls on either side. They mostly trend north-northeast by south-southwest in harmony with the faults. Deep, narrow valleys produced by stream erosion without faulting are very common in the Adirondacks. In some cases such valleys are locally gorgelike, due to the fact that the stream courses have been changed since the great Ice Age and the channels have been cut down so rapidly that widening at the top due to weathering has not yet been very effective. Among many such recently formed gorges are the Ausable chasm of Clinton county cut in sandstone; the gorge of the Hudson river cut in hard rock near Stony Creek station in Warren county; and the gorge of the West branch of the Sacandaga river in the western part of the Lake Pleasant quadrangle. These gorges are seldom as straight as the deep, narrow channels cut out along fault zones.

Streams

Viewed broadly, the Adirondack drainage passes outward in all directions from the central portion of the region. The waters from fully two-thirds of the whole mountain area ultimately reach the St Lawrence valley, while the waters from the remaining one-third of the region passes into the Hudson valley (see map figure 4). Inspection of the drainage map shows that a prominent division of drainage (watershed) crosses the Adirondack district irregularly in a north-northeast by south-southwest direction, dividing the region into two roughly equal parts. On one side nearly all the streams flow northwestward to westward from this great divide, while on the other side they flow eastward to southeastward from it. The north, south and southwest-flowing streams out of the Adirondacks are relatively of minor importance. In part this drainage divide nearly coincides with the main axis of elevation already described, though at two places it lies notably farther to the west.

Fully one-third of the Adirondack area, comprising all the south-eastern portion except that around Lake George, passes either directly into the Hudson river or indirectly by the way of the Mohawk river. The Hudson river, with its two large tributaries, the Schroon and the Sacandaga, catches by far most of this water, while East and West Canada creeks, tributaries of the Mohawk, catch most of the remainder. The Hudson proper follows a remarkable course. With sources on the southwestern slope of Mount Marcy, the river, after flowing south for about 15 miles, turns abruptly westward for several miles where it takes the drainage from the chain of lakes in the vicinity of Newcomb. Thence the river turns sharply to the south-southwest for 10 miles along a remarkably straight channel whose position has been determined by a prominent zone of fracture in the earth. Then, after the junction with Indian river, there is a very sharp swing to the east for 8 miles; thence south for 4 miles; and thence in a general south-eastward direction for 25 miles to near Warrensburg. From the mouth of Indian river to near Warrensburg, the course is largely determined by belts of weak rock (limestone) and earth fractures. Instead of passing southeast into the Lake George depression through one of the two low valleys near Warrensburg, both the Hudson and Schroon rivers keep to the west and, after their junction, flow south to Corinth (Saratoga county) on the way passing through a gorge a thousand feet deep, cut in hard rock near Stony Creek station. From Corinth, instead of flowing south through a broad, low valley, the Hudson turns abruptly through a deep gorge in hard rock across a mountain ridge finally to emerge upon the sandy plain near Glens Falls.

Though shorter, the course of the Sacandaga river is no less remarkable. Beginning at the source of the West branch in the southern part of the Lake Pleasant quadrangle, the water flows southwest, west, north, northeast and east where, after making an almost complete circuit of 28 miles, the river is less than 4 miles from its starting point (see map figure 3). This peculiar course is largely due to the arrangement of fracture zones of weakness in the rocks. A few miles more to the east, the East and West branches are confluent. Thence for 18 miles southeast to Northampton in the Broadalbin quadrangle, the direction of the main river is quite normal for this part of the Adirondacks. At Northampton the river shows a remarkable tendency to double back on its course, changing abruptly from a southeast to a northeast course. Instead of following the broad, low valley southward from Northampton, this northeast course of the river takes it across a ridge of hard rock at Conklingville and into the Hudson at Luzerne. The comparatively straight course of the East Branch Sacandaga has, for at least 12 or 15 miles, been determined along a fracture zone of weakness. The peculiar courses of both the Hudson and Sacandaga near the border of the Adirondacks will be explained in the succeeding chapter.

West Canada creek formerly continued its southwest course into the Mohawk valley, but was forced to turn sharply to the southeast from Trenton Falls because of a blockade of glacial débris accumulated there during the Ice Age.

About one-fourth of the Adirondacks, comprising the northeastern portion together with the vicinity of Lake George, drains into Lake Champlain. Before the great Ice Age, Lake George did not exist but there was a division of drainage between the Hudson and Champlain valleys where the "Narrows" are now located. Most of the streams entering Lake Champlain are east-flowing and relatively short and swift. Two notable exceptions are the Saranac and Ausable rivers.

The main branch of the Saranac begins in the large chain of Saranac lakes and pursues a northeast course straight across the main axis of elevation of this part of the Adirondacks. The north branch of the Saranac also cuts across the main axis of elevation. Prominent earth fractures have probably been influential in determining these courses, though the region has not yet been carefully studied.

Both the East and West branches of the Ausable river have courses largely determined along fault or fracture zones of weakness, the deep gorge of the West branch, known as the Wilmington notch, being a notable example of such influence. The main river flows through the famous Ausable chasm near its mouth, this feature being explained toward the end of the next chapter.

About one-third of the Adirondacks drains directly into the St Lawrence river by many large streams which pursue normal northwesterly courses from the prominent division of drainage across the region. Among the more important streams are the Chateaugay, Salmon, St Regis, Raquette, Grasse, Oswegatchie and Indian rivers. After emerging upon the lowlands of the St Lawrence valley, most of these rivers exhibit a remarkable tendency to swing northeastward and flow nearly parallel to the great river for some miles before entering it. These abnormal courses are doubtless due to either ice erosion or accumulation of glacial débris during the Ice Age.

Greatest of all the northwestward-flowing streams is the Raquette river. After a devious course of over 100 miles, including passage through several large lakes, the river enters the St Lawrence at the international boundary. The principal source of the Raquette river is Blue Mountain lake in the heart of the Adirondacks. This water flows westward about 8 miles by way of Eagle and Utowana lakes and Marion river into the large irregular Raquette lake. Thence the course changes abruptly northeastward through Forked lake and over cascades into Long lake. After flowing nearly 14 miles through this long, narrow body of water, which is only a comparatively recent enlargement of the stream, Raquette river flows sluggishly northward for 5 miles through a wide swampy valley to Raquette falls where the water descends 75 feet in a gorge three-fourths of a mile long. From Raquette falls the general course of the river is north and west, with sluggish current and many loops (oxbows), through a wide, swampy valley into Big Tupper lake. From Tupper lake the river pursues a quite normal course with considerable velocity into the St Lawrence valley. The history of the upper Raquette river drainage basin is discussed in the next chapter.

Oswegatchie river has its sources in and around Cranberry lake, one of the largest bodies of water in the Adirondacks. The river doubles back on its course in a most remarkable manner a few miles west of Gouverneur.

Approximately one-sixth of the Adirondack drainage passes westward into Black river and thence into Lake Ontario. This drainage is, in most respects, quite normal. The largest stream is Moose river with its several branches, the main or South branch rising in the southern Adirondacks, the Middle branch draining the Fulton chain of lakes, and the North branch draining Big Moose lake. Next most important is Beaver river, which has its sources in and around the Red Horse chain of lakes.

Lakes

Including all, from the smallest to the largest, there are probably no less than 2000 lakes and ponds in the Adirondack region. A few only of the more prominent ones are shown on map figure 3. Considering the beautiful setting of the lakes among the wild, densely forested mountains, this is perhaps the most picturesque lake region of eastern North America. Along the shores of all the larger lakes there are many summer homes and hotels ranging from very moderate cottages and boarding houses to magnificent homes and hotels. Most famous of all are Lake George and Lake Placid. Practically none of the lakes were in existence before the Ice Age.

As regards shape, there are several distinct types of Adirondack lakes. One type, which may be called linear, is long, narrow and straight. Such lakes occupy what were stream channels before the Ice Age. Examples are Lake George, Schroon lake, Indian lake and Long lake. Another type has an exceedingly irregular shore line. Lakes of this sort occupy what were, before the Ice Age, broad, relatively flat valleys or, more exactly, two or more adjacent valleys separated by only low divides, the waters backing up into the side valleys and leaving rock islands and peninsulas. Good examples of this tpye are Lower Saranac lake, Cranberry lake and Raquette lake. A third type is comparatively round, many of the ponds and smaller lakes especially belonging to this category. The origin of the various types of lakes will be discussed toward the close of the next chapter.

Though the numerous lakes are scattered throughout the Adirondacks, there are, nevertheless, certain more or less well-defined lake belts or groups. Most conspicuous of all is the great lake belt or district some 60 miles long and 10 to 20 miles wide extending northeast by southwest from Lake Placid and the St Regis Lakes on the north to the Fulton chain of lakes on the south. This lake belt lies almost wholly west of the main axis of elevation through the Adirondacks. Not only are lakes and ponds notably more abundant in this district than elsewhere, but also here are to be found many of the larger and better known lakes as, for example, Lake Placid, the St Regis lakes, the Saranac lakes, Big and Little Tupper lakes, Long lake, Blue Mountain lake, Raquette lake, and the Fulton chain of lakes. Most numerous of all are the lakes and ponds in the Saranac-St Regis Lakes district, there being something like 150 within the 214 square miles of the St Regis quadrangle alone. By far most of the lakes of the great belt lie between 1500 and 2000 feet above sea level. Only a few of the most prominent ones will be briefly described here, the problem of the origin and destruction of the lakes being mainly reserved for discussion in the next chapter.

Lake Placid is by many regarded as the most beautiful sheet of water in the Adirondacks. It is 4 miles long, 1 to 1½ miles wide and at an altitude of 1859 feet. Mountains from 1000 to 3000 feet high rise from its shores on all sides except the south. Mt Whiteface stands out majestically more than 3000 feet above the waters of Lake Placid on its northeastern side. There are three rock islands, two of them large and densely wooded, rising several hundred feet out of the lake.

Upper and Lower Saranac lakes are 7½ and 5 miles long, and 1571 and 1534 feet above sea level, respectively. They lie in a much larger and more open valley than Lake Placid with surrounding mountains not nearly so high, the highest being from 1500 to 2000 feet above the lakes on the east and southeast. Lower Saranac lake is full of rock islands.

Big Tupper lake, 7 miles long and about 1 mile wide, lies in a narrow valley with hills only a few hundred feet high immediately surrounding it. Its surface is 1542 feet above the sea. There is a string of rock islands through the middle of the lake.

Long lake, in the very heart of the Adirondacks, is the most remarkable linear type of lake in the whole region. With a length of 13½ miles, it is almost perfectly straight and never more than 1 mile wide. Its altitude is 1630 feet and lies in a narrow valley of moderate depth, a few mountains only reaching heights of 1000 to 1700 feet immediately around the lake. It contains a number of islands.

Blue Mountain lake is only 2½ miles long by 1¼ miles wide but has a beautiful setting among the mountains near the center of the Great North Woods. It lies 1789 feet above sea level with Blue mountain towering 2000 feet above its waters on the eastern side. The picturesqueness of this lake is greatly enhanced by the scattering, wooded, rock islands. Immediately on the north and south the mountains are only of moderate height.

Raquette lake has one of the most irregular shore lines of any in the Adirondacks. It is 8 miles long and fully 1 mile wide at several places. Its altitude is 1762 feet. This beautiful sheet of water occupies portions of several old, low valleys. Only two points reach heights of 500 to 700 feet around the sides of the lake, but the picturesque islands and numerous bays and peninsulas add much to the beauty of this large body of water.

The Fulton chain of lakes, eight in all, lie in a moderately deep narrow valley on the southwestern slope of the Adirondacks.

Plate 7

W. J. Miller, photo

View looking west across Blue Mountain lake. Eagle and Utowana lakes partially visible in the distance.

Plate 8

Courtesy of the New York Cent .l Lines

A view across Raquette lake

Plate 9

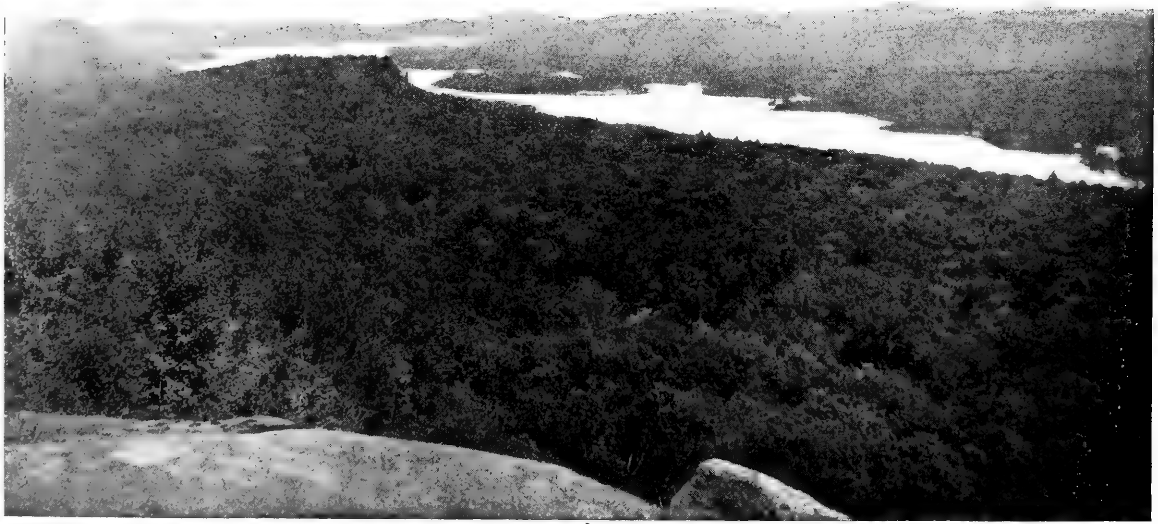


Photo by F. N. Kneeland, Northampton, Mass.

Part of the Fulton Chain of Lakes, viewed from the top of Bald mountain

Plate 10

Courtesy of the Delaware & Hudson Company, and permission of the Detroit Publishing Company

Lower Cascade lake, on the road between Lake Placid and Keene Center, Essex county. Altitude of lake, 2032 feet. A mountain rises steeply 1500 feet on the north side and 2000 feet on the south side.

Plate 11

Courtesy of the Delaware & Hudson Company

Lower Ausable lake, a few miles east of Mt Marcy, Essex county. Mountains rise very steeply 2000 feet above the lake from the very water's edge. Altitude of lake, 1961 feet. Mt Colvin, altitude 4074 feet, plainly seen.

Plate 12

Photo loaned by John A. Cole

View across Sacandaga lake in Hamilton county, looking north from the top of Lookout mountain

Plate 13

Courtesy of the Delaware & Hudson Company

General view of Lake George, looking northward from Shelving Rock. Tongue mountain in the center; the main part of the lake in the foreground and on the right; and Northwest bay on the left.

Plate 14

View looking southward through the narrows of Schroon lake

Fourth lake is the largest, being 5½ miles long, ½ to 1 mile wide and 1707 feet above the sea.

Cranberry lake lies in the northwestern Adirondacks and to the west of the great lake belt just described. This is one of the very largest bodies of water in the whole mountain region, having a length of 9 miles, greatest width of 3 miles and an exceedingly irregular shore line. Like Raquette lake, this sheet of water appears to occupy portions of several old valleys. The surface of the lake is 1540 feet above the sea, and hills rise 500 to 1000 feet around it.

On the northeastern border of the Adirondacks, but in a sense forming a northward continuation of the great lake belt, is a group of three considerable lakes, namely, Lower and Upper Chateaugay lakes and Chazy lake at altitudes of from 1300 to 1500 feet. The immediately surrounding country is fairly rugged and mountainous.

Avalanche lake, though small and outside the great lake belt, deserves special mention. It is really only a large pond, nearly one-half of a mile long and very narrow, lying in one of the deepest and perhaps most romantic notches in the whole Adirondack region. It is situated 2863 feet above sea level at the western base of Mt Colden (Essex county). Great rock walls rise from the water's edge on either side, almost perpendicularly to a height of 1000 feet on the west and on the east very steeply to a height of nearly 2000 feet or to the summit of Mt Colden. At one place there is not even room for a mountain trail along the lake.

A minor lake belt lies immediately east of the main axis of elevation in the south-central Adirondacks, the principal lakes being Indian, Pleasant, Sacandaga and Piseco. Indian lake is very distinctly of the linear type, though forked toward the south. It has a length of 13 miles, greatest width of 1 mile and an altitude of 1650 feet. It occupies a deep narrow valley with mountains on the west side rising from 1000 to 2000 feet above its waters, and on the east side from 500 to 1000 feet. It should be stated that the present size of Indian lake is much greater than the natural lake which formerly occupied this basin because of the state dam at the north end.

Sacandaga lake and Lake Pleasant are close together at the same altitude (1724 feet) and joined by a narrow channel three-fourths of a mile long. They occupy portions of a broad, irregular valley with mountains on all sides rising from a few hundred to a thousand feet or more. Sacandaga lake is of irregular shape about

2 miles across. Lake Pleasant is over 3 miles long and from one-half to 1 mile wide.

Piseco lake is of the linear type with a length of 5 miles and an average width of 1 mile. It lies 1661 feet above sea level. On its eastern side there are low hills only, but a long mountain mass rises abruptly from 600 to 1100 feet above its western shore.

Another group of lakes occupies the southeastern border of the Adirondacks, the principal bodies of water being Lake George, Schroon lake and Brant lake. These are all notably nearer sea level than the usual Adirondack lakes.

Lake George is the most remarkable body of water in the entire Adirondack region. It has a length of 32 miles and a width of from 1 to 2½ miles, so it is easily the largest of all the northern New York lakes. The surface of the lake is only 323 feet above the level of the sea, thus making it one of the very lowest bodies of water in the whole Adirondack region. The valley, or rather combination of two valleys (see page 64), occupied by Lake George is remarkably straight, deep and narrow. For most part mountains rise abruptly from a few hundred to over 2000 feet above the shores of the lake throughout its length. Where the lake is narrowest, for 6 or 8 miles of its middle portion, the scenery is grandest. On the eastern side the Black-Erebus mountain mass rises very steeply 2000 feet or more from the very shore of the lake, while on the western side the Tongue-Fivemile mountain mass rises very abruptly 800 to 1600 feet. There are many islands, especially in the narrow portion, thus greatly enhancing the scenic effect.

Schroon lake is the second largest in the southeastern Adirondacks. It also is of the linear type, being 9 miles long and from one-half to 1½ miles wide. It lies only 807 feet above sea level. There are no high mountains immediately around the lake, the highest hills being on the eastern side where they rise only 400 to 600 feet.

Brant lake is a beautiful sheet of water nearly 5 miles long, one-half to three-quarters of a mile wide and 801 feet above sea level. It is almost completely surrounded by hills from 200 to 800 feet high.

PHYSICAL HISTORY OF THE ADIRONDACKS

Prepaleozoic History

The most ancient (Grenville) rocks and history. The Adirondack mountains are made up almost entirely of exceedingly old rocks. Of these the most ancient known are called the *Grenville* series, so named from a Canadian town in the St Lawrence valley. Not only are the very earliest known records of the history of northern New York written in these Grenville rocks, but also they are to be classed with the very oldest recognized rock formations of the earth. Only during the past 25 years has the real significance of the Grenville and closely associated rocks in the Adirondacks been discovered.

The Grenville consists of a great series of sediments — original muds, sands and limes — which were deposited layer upon layer under water. The widespread extent of the series, far beyond the limits of the Adirondacks, and their great thickness make it certain that the Grenville sediments were accumulated on the bottom of a relatively shallow ocean very much as sediments are now piling up on the marginal sea bottom. Thus, the most ancient known geographic condition of the Adirondack district was an expanse of sea water covering the whole area.

It may occur to the reader to ask: How long ago did the Grenville ocean exist? There are grave difficulties in the way of answering this question in terms of years since we have nothing like an exact standard for such a measurement or comparison. Although we must concede that not even approximate figures can be given, nevertheless it can be demonstrated by several independent lines of reasoning that the time must be measured by at least some tens of millions of years, very conservative estimates ranging from 25 to 50 million years. In any case, the time is utterly inconceivable to us, the important thing to bear in mind being that the great well-known events of earth history which have transpired since the existence of the Grenville ocean require a lapse of many millions of years as shown by the enormous accumulations of sediment in many parts of the earth and the repeated revolutionary changes in geographic and geologic conditions. The ideas here expressed will be much better appreciated by the reader after following through the story of the Adirondacks as set forth in the succeeding pages. By so doing, it is hoped that the reader will not only learn the main events in the history of the Adirondacks, but also gain an understanding of some of the fundamental methods and principles of earth science (geology).

The exact placing of the very ancient Adirondack rocks in the geologic time-table (see page 12) is a difficult matter, through the Grenville series is, in the light of the strongest evidence, to be classed with the Archeozoic or oldest known rock group. For the younger Adirondack rocks (below discussed) which are so closely

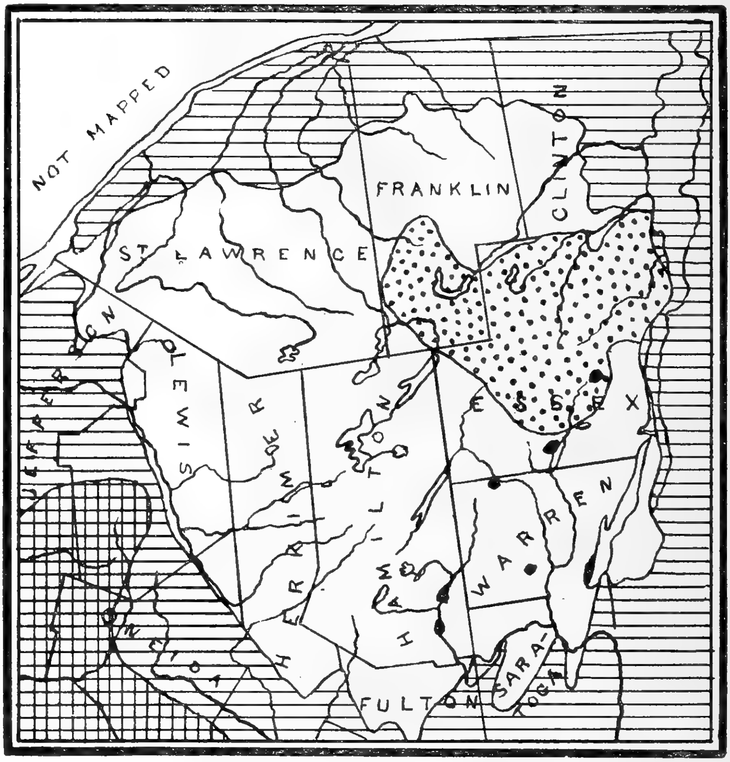
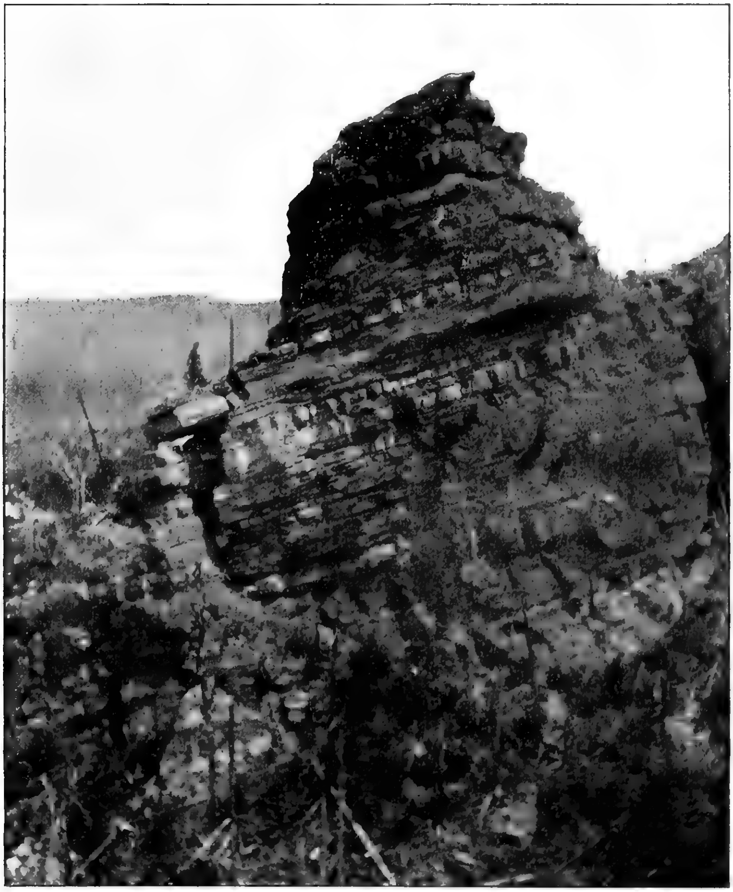


FIG. 5 Generalized geologic map of northern New York showing the distribution of the principal rock systems. Unshaded portion; Prepaleozoic rocks, chiefly Grenville strata, syenite, and granite; dotted portion: Prepaleozoic rock, chiefly anorthosite; horizontal-lined areas: Cambrian and Ordovician strata; cross-lined area: Silurian strata; small black patches: isolated areas of Paleozoic strata.

associated with the Grenville, the evidence is not so clear. They may be partly Archeozoic and partly Proterozoic or they may be wholly Proterozoic. In any case we are certain that they are all earlier than the Paleozoic because very early Paleozoic strata rest upon them around most of the borders of the Adirondacks.

Plate 15



W. J. Miller, photo

Tilted and clearly stratified Grenville rock (various gneisses) on Chimney mountain, Hamilton county

The Grenville strata, as we see them today, do not look like ordinary sediments such as shales, sandstones and limestones. They have been profoundly changed from their original condition; that is to say, they have undergone *metamorphism*. The Grenville rocks now exposed to view were formerly buried at least some miles below the earth's surface, the overlying rocks having been removed by erosion through millions of years of time. Far below the earth's surface, under conditions of relatively high temperature, pressure and moisture, the materials of the Grenville strata completely crystallized into various minerals. Rounded, water-worn grains of the original sediments no longer exist, but instead angular grains (crystals) make up the rocks. The original stratification surfaces (that is, surfaces of separation of the layers of sediment) are almost always still present. Many times this stratification is very clearly evident where lighter and darker colored layers from a fraction of an inch to several inches or feet wide sharply alternate. This well-defined banded structure is one of the most useful criteria for the recognition of the stratified character of the Grenville rocks. The other Adirondack rocks are all igneous in origin; that is, they were once molten, and are much more homogeneous throughout large masses, or if they show variation they are never in sharply defined layers.

Careful examination of Grenville specimens frequently shows that the mineral grains are more or less flattened out parallel to the stratification surfaces. Because of the parallelism of flattened minerals and stratification, and because the Grenville series has never been subjected to severe mountain-making pressure (see below), we are forced to conclude that the mineral flattening took place during the crystallization of the sediments far below the earth's surface under great weight of overlying material and when the strata were still in practically horizontal position. Such mineral flattening would of course have taken place at right angles to the direction of pressure.

Having established the sedimentary origin of the Grenville series, we are led to the interesting and important conclusion that these oldest known rocks are not the most ancient which ever existed in the Adirondack region. The Grenville sediments must have been deposited, layer upon layer, upon a surface of still older rocks. A knowledge of the character and composition of such pre-Grenville rocks would be of very great interest, but thus far we have no positive evidence that such rocks are visible in the Adirondacks, although certain masses still of somewhat doubtful age and origin may belong to that very ancient rock floor. Again, the fact that Grenville sediments were being deposited under water carries with it the corollary that there must have been land somewhere at no great distance from the area of deposition because, then as now, such sediments as muds and sands could have been derived only from the erosion or wear of land and have been deposited in layers under water adjacent to the land mass. Here too we are as yet utterly in the dark regarding any knowledge of the location or character of that very ancient land.

Perhaps the most interesting and characteristic of the Grenville rocks is the *crystalline limestone* or *marble*. It is widely scattered in small to large areas throughout the Adirondacks. Typically it is a white, coarse-grained, granular rock made up almost entirely of crystals of calcite.[1] When exposed to the weather it often crumbles to a gravelly looking mass. Layers of dark or greenish rocks often occur within the limestone, these representing what were originally layers of sea mud interstratified with the lime. Black, shiny flakes of graphite (so-called " black lead ") may nearly always be found in the limestone, while quartz grains several millimeters across are often abundant in certain portions of the limestone formation. This limestone could not possibly have been of other than sedimentary origin.

In numerous places, and sometimes in sharp contact with the limestone, are beds of almost pure quartz rock or so-called *quartzite*. Such rock is a crystallized, metamorphosed sandstone and could not possibly have been of igneous origin. This quartzite is generally in thin layers of clear flintlike or glassy appearance and with perfect stratification. Sometimes other minerals, especially white mica (muscovite), are mixed with the quartz.

Most abundant of all the Grenville rocks, however, are very extensive, thick deposits of usually dark to light gray rocks rich in such minerals as quartz, feldspar, garnet, mica, pyroxene and amphibole. Because of their distinct banded (stratified) structure and close association (often interbanded) with the limestone and quartzite, they are also certainly ancient sediments, in this case original sea muds or less admixed with sand and lime. As a result of heat, pressure and moisture, these sea muds have been crystallized into what are now called *schists* or *gneisses* (see page 10). Certain of the quartzites, schists and gneisses also at times contain scattering flakes of graphite (" black lead "), in some cases

[1] See appendix for descriptions of common Adirondack minerals.

there being a sufficient content of this mineral to warrant its mining, as in Warren and Saratoga counties.

As will be explained shortly, the Grenville strata are associated with younger rocks of pre-Paleozoic age, these later rocks all being of igneous origin and having cut through the Grenville in hundreds of places and in a most irregular manner, so that the ancient strata are not now present as a single continuous mass of rock occupying the whole Adirondack region. A detailed map of the whole mountain area showing the distribution of the Grenville and later rocks would present a decided "patchwork" effect. Portions only of the region have been thus mapped in detail; the writer's geologic maps of the North Creek, Lake Pleasant and Blue Mountain quadrangles recently published by the New York State Museum afford excellent illustrations of the "patchy" distribution of the Grenville strata. Figure 9 of this volume also suggests the same thing.

Since the strata of the Adirondacks are usually badly disturbed, tilted and more or less bent or folded, and since neither top nor bottom of the formation has ever been recognized as such, it is impossible to give anything like an exact figure for the thickness of the Grenville rocks. Continuous successions of strata have been observed in enough places, however, to make it certain that the strata were piled, one layer upon another, to a thickness of many thousands of feet. Across a certain valley in Warren county the writer has seen fully 20,000 feet of Grenville strata piled up and only moderately tilted. This clearly implies that the Grenville ocean existed for a vast length of time which must be measured by no less than a few million years, because, in the light of all our knowledge regarding the rate of deposition of sediments, such a very long time was necessary for the accumulation of so thick a mass of sedimentary rocks. It does not necessarily follow that the Grenville ocean was thousands of feet deep when the deposition began. In fact, the very character of the sediments clearly indicates that the Grenville ocean was, for most part at least, of shallow water, for such sediments as sands and muds have rarely if ever been carried far out into an ocean of deep water. The great ocean abysses of today are not receiving any appreciable amount of land-derived sediments. Hence it is practically certain that the very ancient Grenville sea bottom gradually sank as the sediments accumulated. Similar phenomena are definitely known to have occurred in many later basins of deposition.

There is no evidence whatever for the existence of land life of any kind during this very early era of earth history. Regarding life in the Grenville ocean, however, we are certain that organisms of some kind must have existed as proved by the scattering flakes of graphite through many of the strata, especially the limestone. All that is now left of the organisms is the carbon, and this has been crystallized into graphite so that no original structures whatever are retained. Even though we do not know whether these organisms were plant or animal, the fact that life existed on our planet so many millions of years ago is a fact of very great importance. When we look at the shiny black scales of graphite in a piece of Grenville rock, we can truthfully say that we are gazing upon vestiges of the earliest known organisms which ever lived upon the earth. Graphite thus disseminated through stratified rocks must have been of organic origin. Anthracite coal, which is chemically very similar to graphite, occurs in the late Paleozoic strata of Pennsylvania and is there definitely known to have been derived from plants through the process of carbonization. Graphitic anthracite of like origin occurs in Rhode Island. The earth's first organisms must have been plants, because animals ultimately depend upon plants for their existence. The oldest known clearly preserved fossils are Algae or sea weeds from the Proterozoic. Hence it seems likely that the graphite of the Grenville strata represents the remains of plants, probably of the simple sea-weed type. This by no means proves the absence of animals from the Grenville ocean, because animals with soft parts only would have left no record, while shells would have been destroyed by solution and crystallization under the conditions to which the strata were subjected.

Earliest igneous rocks and their history. After the accumulation of the Grenville sediments, igneous activity took place on grand scales, when great masses of molten rock were forced (intruded) into the sediments from below. At least two distinct times of very early, large scale igneous activity have been discovered. The general effect was to break the Grenville up into patches. The present distribution and mode of occurrence of these igneous rocks show that the molten masses broke into the Grenville strata in a very irregular manner. In most cases the Grenville rocks were pushed aside by, or tilted or domed over, the upwelling molten floods; in many cases the molten materials under great pressure were intimately shot through the Grenville strata; often large or small masses of strata were caught up or enveloped (as inclusions) in the molten floods; in some cases there appears to have been actual local melting or assimilation of Grenville rocks by the molten instrusions; while in still other places large Grenville bodies have apparently been left intact and undisturbed. These igneous rocks are all of the plutonic type; that is, they were never forced up to the earth's surface but solidified at considerable depths below the surface. We see them exposed today only because a tremendous amount of overlying material has been removed by erosion. These igneous rocks are generally easily distinguished from the old sediments of Grenville age because of their more general homogeneity in large masses and their lack of sharply defined bands of varying composition. The fact that the minerals have always crystallized to form medium to coarse grained rocks shows that the rocks solidified under deep-seated conditions, since it is well known that surface flows (lavas) are much finer grained and often with more or less of the rock not crystallized at all. Slow cooling under great pressure favors more complete crystallization and the growth of larger crystals.

The first of the two well-known great intrusions of molten rock in the Adirondacks is represented by the present large area (1200 square miles) of so-called *anorthosite,* mostly in Essex and Franklin counties. The typical rock is very coarse grained, of bluish gray color and consists principally of a feldspar (labradorite). This feldspar is in crystals commonly from one-half of an inch to nearly 2 inches long with shiny cleavage faces when freshly broken, and they often exhibit a pretty play of colors. Fine parallel lines, as though ruled on with a delicate instrument, also very commonly show on the cleavage faces. The typical anorthosite is usually quite homogeneous in large bodies as, for instance, in the Sentinel range a few miles east of Lake Placid, and in the mountains just west of the same lake. An interesting and important variation of the typical rock is known as the Whiteface type of anorthosite, so named from Mt Whiteface, the summit of which is made up of this rock. This is usually white or nearly so, the feldspar crystals having been much broken (granulated) under pressure. Another variation is a darker rock due to a considerable percentage of black minerals, especially pyroxene, amphibole and iron ore. This darker rock is often rather streaked in appearance, the minerals having been drawn out into crude parallelism due, no doubt, to movements or currents in the molten masses just before they congealed. This variety of anorthosite is only locally developed, especially around the borders of large bodies of the typical anorthosite. Many of the highest mountains of the east-central Adirondacks, such as Marcy, McIntyre and Whiteface, consist wholly or largely of anorthosite. The anorthosite intrusion differed from the later intrusions (below described) in two important respects, namely, that it was practically confined to a single great area of 1200 square miles, and that it broke through the Grenville only, no other country rock having been present at the time of the intrusion. A few small masses of anorthosite are known to occur outside of the great area as, for example, in the central part of the Long Lake quadrangle; northern part of the Blue Mountain quadrangle; northeastern part of the Lake Pleasant quadrangle; and near Rand Hill in Clinton county. For most part the molten anorthosite appears to have pushed aside or displaced the Grenville, though in many cases small areas and fragments are seen enveloped by the intrusive, while in a few cases there appears to have been injection or possibly assimilation of the Grenville. That this anorthosite is younger than the Grenville is demonstrated by the facts that tongues of the rock have been observed cutting through the Grenville (see figure 6), and also that fragments of the old strata are frequently seen to have been torn off and completely enveloped in the molten anorthosite.

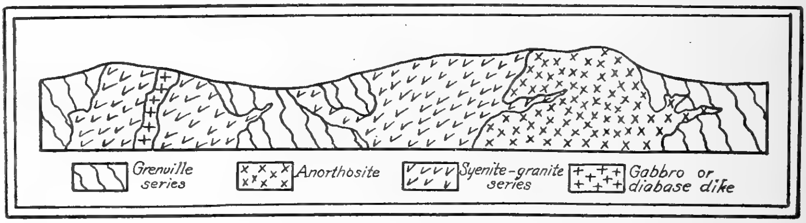


FIG. 6 Generalized section showing how the relative ages of the most common Adirondack rocks are determined. Where one rock mass cuts through the other, the former is the younger. (By W. J. M.)

The next clearly recorded event after the intrusion of the anorthosite was very widespread igneous activity when the rock known as the *syenite-granite* series, so common in the Adirondacks, was forced upward in a molten condition into both the Grenville and the anorthosite. There may have been more than one time of intrusion, as argued by certain workers for the St Lawrence valley, but, for our purpose, it will suffice to regard all the syenite-granite rocks to have been intruded at practically the same time, since the sum total of effects is much the same as though there had been only a single period of igneous activity. All portions of the Adirondacks felt the force of the intrusion of these molten masses which are now represented by numerous large and small areas very irregularly scattered throughout the region. Almost all the higher mountains outside of the anorthosite area consist of syenite or granite, because these rocks have been much more resistant to weathering and erosion than the ordinary Grenville strata which latter, therefore, generally occupy the valleys.

The *granite* is a plutonic igneous rock which consists essentially of quartz and feldspar (orthoclase), but which usually also contains more or less black mica (biotite), amphibole, pyroxene and magnetite. The *syenite* is similar, except that quartz is either absent or much less prominent. Mostly, if not always, these two rocks are merely variations of the great molten masses formed during the cooling and crystallization of the rock. Accordingly it is a very common thing to observe granite and syenite grading back and forth into each other often within short distances, instead of one cutting through the other as would be the case if one were younger than the other. The typical syenite and granite are medium grained, that is, they are made up of mineral crystals a few millimeters across. Locally the rock may be much coarser grained with feldspar and quartz crystals up to an inch or more long. At times some of the feldspar crystals are decidedly larger than the rest of the minerals, giving rise to rock types known as granite or syenite *porphyry*. Syenite is nearly always richer in dark minerals — black mica, amphibole, pyroxene and magnetite — than the granite. Sometimes these dark minerals make up as much as half of the rock. When freshly broken the typical syenite has a greenish gray color, while the weathered surfaces are light to dark brown due to the fact that the iron of the dark minerals has oxidized (weathered out) to produce the brown stain of iron rust. This weathered portion is seldom more than a few inches thick. Sometimes in the woods on mountain sides, the immediate surface of the syenite is nearly white with a brown layer just below the surface. The explanation is that water charged with decomposing organic matter has dissolved off the iron rust. The freshly broken granite varies from greenish gray to light gray to pinkish or even reddish, the color depending largely upon the color of the feldspar. Dark colors are rare in the granite because of the relative scarcity of dark minerals in the rock.

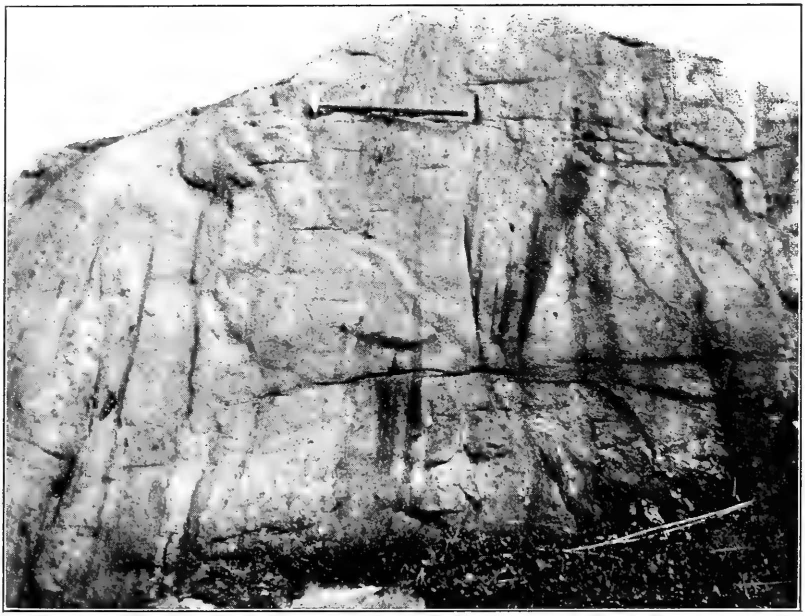
Except for the gradations above referred to, the syenite and granite are fairly homogeneous in large bodies, there being no sharply defined layers as in the Grenville strata. One feature is, however, important to consider, namely, the wavy or streaked appearance presented by so many of the rock ledges of syenite and granite. A close inspection reveals the fact that most of the minerals have been flattened or drawn out into a sort of crude parallelism. This structure is accentuated by the dark-colored minerals. A rock with such a structure is said to be a gneiss (pronounced "nice"). Many ledges of Adirondack syenite or granite exhibit this structure perfectly, but in other cases it is very faint or absent. This phenomenon has generally been ascribed to the flattening and flowage of the minerals under great pressure in the earth's crust after the cooling of the rocks. But very recently the writer has presented much evidence in support of the view that the phenomenon really represents a sort of "flow-structure" produced by currents under moderate pressure during the crystallization and when the rocks were at least partially molten. The rapid changes in direction and the sweeping curves exhibited by the gneissic structure strongly support the "flow-structure" idea.

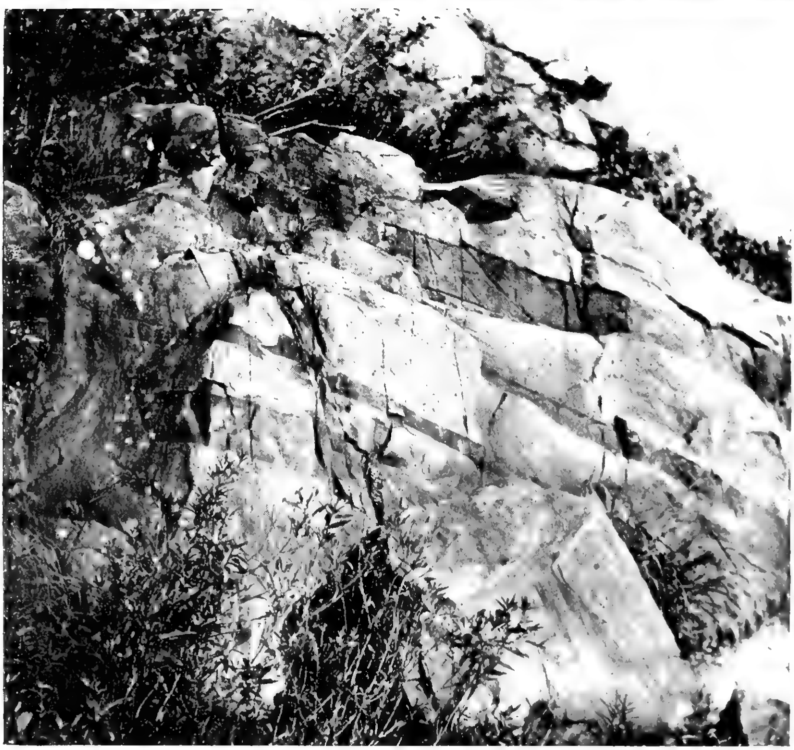
Rocks presenting the characteristics of the syenite and granite are typical plutonic, igneous masses which certainly never reached the surface by intrusion. They were very slowly intruded and slowly cooled under great pressure thousands of feet below the earth's surface. It should be reiterated that rocks of this sort now appear at the surface simply because of vast removal by erosion of the overlying materials.

That these syenite-granite rocks are younger than the anorthosite has been demonstrated by finding tongues of the former cutting or breaking through the latter (see figure 6) as well shown, for example, a few miles east of Tupper Lake village, and on the eastern face of Whiteface mountain.

First known uplift of the Adirondacks. We are now ready to discuss the earliest known uplift of the whole Adirondack region above sea level, or, in other words, the birth of the first known Adirondack mountains. As we have learned, the very character and structure of the rocks now exposed to view in the region show conclusively that they were at one time deeply buried, the inference being perfectly plain that those materials have been removed by erosion. Profound erosion of any land mass means that the land must have been well above sea level, and thus we come to the important conclusion that the great mass of rocks, including Grenville strata, anorthosite and the syenite-granite series, were upraised well above sea level. Just when the uplift occurred can not be positively stated, but there is much evidence favoring the idea that it was concomitant with the great igneous intrusions, especially of the syenite-granite. It is reasonable to believe that the same great force which caused the welling up of so much liquid rock might easily have caused a decided uplift of the whole region. The

Plate 16





H. P. Cushing, photo

Upper view: a typical outcrop of Adirondack syenite in Lewis county

W. J. Miller, photo

Lower view: dikes of diabase (dark rock) in syenite near Northville, Fulton county

Grenville strata are now very frequently not in horizontal position as when they were deposited under the sea. On the other hand, there is no known evidence that the Adirondack Grenville strata were ever severely folded or compressed as has been the case in many mountain ranges, as the Appalachians, for example. Many broad belts of Grenville are known to be only very moderately folded to almost horizontal; numerous masses, large and small, are merely tilted or domed; while very locally the strata sometimes are contorted or sharply folded. The structural relations are, therefore, best explained as having been the result of slow, irregular, upwelling of the more or less plastic molten masses, probably under a moderate compressive force or lateral thrust in the crust of the earth, whereby the strata, previously disturbed little or none at all, were simply broken up or tilted or domed. In many places the evidence is perfectly clear that the tilting of the Grenville strata was directly due to the up-push of the intrusive rocks. Locally, where masses of Grenville were caught between two bodies of upwelling molten rock, the strata were sometimes twisted or sharply folded, this having been especially true of the relatively very plastic limestones. It appears to have been literally true that the Grenville strata were irregularly floated on a vast body of molten rock, the latter in many places either having arched up or broken through the strata. In other words, the Grenville strata, as well as the great intrusives, were not subjected to real mountain-making pressure in the crust of the earth whereby the rocks were thrown into a series of great folds, as has happened in many mountain regions of the world.

We can not even state the approximate height of those very ancient Adirondacks. Also we are utterly in the dark as to the character of the topography and the direction of the drainage lines. The fact that thousands of feet of material have been removed by erosion, thus exposing the present rocks to view, does not necessarily imply that the mountains at any time had a very great height because it is possible that, while elevation slowly progressed, material was steadily removed by erosion. All our knowledge of later and better known mountains, however, leaves little doubt but that those ancient Adirondacks were notably higher than those of today.

Later Prepaleozoic history. The profound erosion of the very ancient Adirondacks extended through some millions of years of the later Prepaleozoic and even into very early Paleozoic time, but the whole problem of this erosion and its significance is discussed a few pages beyond.

At some time after the vast bodies of syenite-granite were thoroughly consolidated, but certainly before the Paleozoic era, there were several relatively minor intrusions of molten rock. These times of intrusion are very distinctly separable and the rocks are of quite different appearance. First of these was the so-called *gabbro.* This rock varies considerably though it is always dark gray to black and usually medium to coarse grained; that is, the mineral constituents range from one or two millimeters to fully an inch in length. Typically the rock contains feldspar (plagioclase), pyroxene, hornblende, black mica (biotite) and magnetite with various other minerals in small amounts. Sometimes the gabbro is difficult to distinguish from certain of the dark border phases of the anorthosite already described, though usually the long, lath-shaped feldspar crystals irregularly inclosing the pyroxene or hornblende characterize the gabbro. Also the mode of occurrence of the gabbro is different from that of the older intrusives. Instead of breaking up, raising up or tilting the country rock, the molten gabbro appears to have penetrated the earth's crust through practically vertical, cylindrical or pipelike openings seldom more than one or two miles in diameter. As seen in the field, the gabbro is a typical plutonic rock with sharp, practically vertical contacts against the older (country) rocks. Sometimes the gabbro exhibits a streaked appearance (gneissoid structure) due to a crudely parallel arrangement of minerals resulting from movements or currents in the still partially molten masses under pressure. These bodies of gabbro are scattered throughout the Adirondack mountains and are well exhibited on most of the published geologic maps (see appendix), fully sixty occurring within the North Creek quadrangle alone.

Another interesting igneous rock, and still later than the gabbro, is the so-called *pegmatite* which is really a sort of very coarse-grained whitish granite. It consists almost wholly of quartz and feldspar in crystals from one-half to several inches across. Usually it contains more or less white mica (muscovite). This rock occurs in the form of dikes, that is, it fills fissures from an inch or two wide and a few yards or rods long to 50 or 75 feet wide and many rods long. Such pegmatite dikes may be seen cutting through all the previously described rocks with very sharp contacts, and hence they are clearly younger. Pegmatite dikes are very common throughout the Adirondacks and they are easily recognized.

The very latest Prepaleozoic rock in the whole Adirondack region is another sort of dike rock known as *diabase*. It is really almost the same as basaltic lava, being fine grained, bluish black where freshly broken and containing chiefly plagioclase feldspar, pyroxene and iron ore (magnetite). It differs from the gabbro in being finer grained and always occurring in sharply defined, narrow, dike or fissure form. These dikes commonly vary from a few inches or feet wide and a few rods long to many feet wide and several miles long. Such dikes are of rather common occurrence throughout the Adirondacks and are very easily recognizable by their black, sharply defined outlines. The fact that they are so fine grained, often even glassy at the borders, shows that they cooled much more quickly and nearer the surface of the earth than any of the other igneous rocks. It seems quite clear, therefore, that the diabase now at the surface was forced into fissures after most of the Prepaleozoic erosion of the region had been accomplished. On the other hand, the intrusions must have taken place before the oldest Paleozoic strata around the Adirondacks were formed because such strata have been observed to rest upon the diabase. In the light of these facts it is safe to say that these latest dike rocks are millions of years younger than the oldest igneous rocks of the Adirondacks.

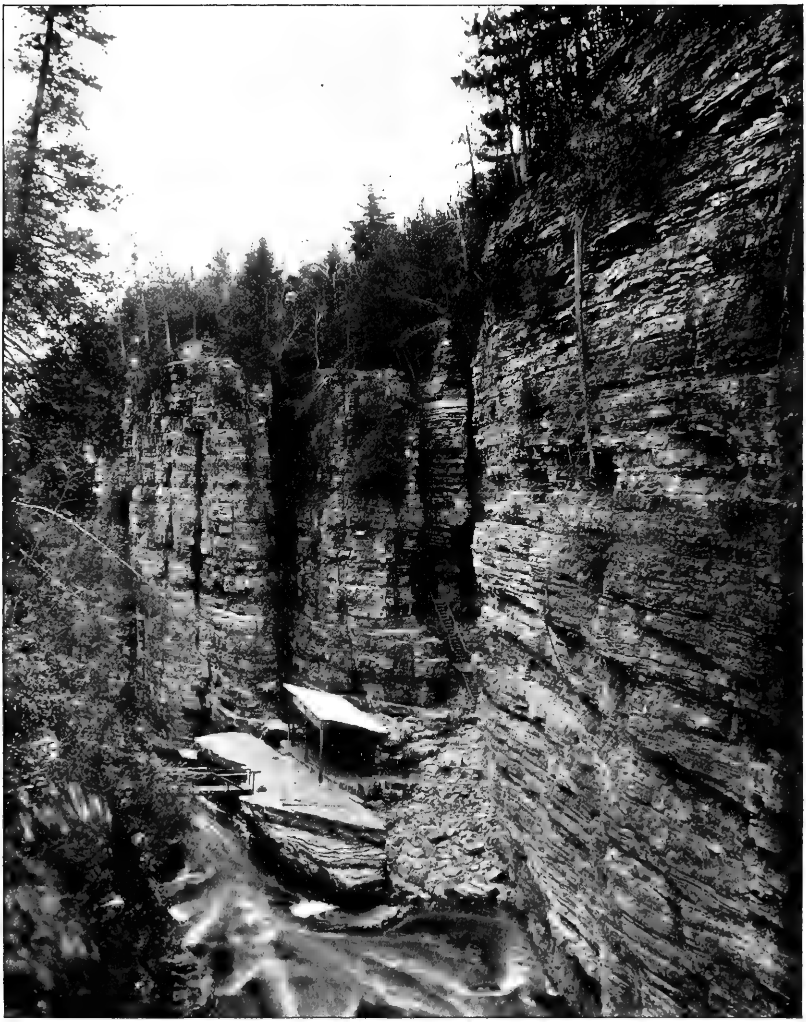
Paleozoic History

Cambrian period. After the first known Adirondack uplift, the whole region was subjected to profound erosion which began long before the opening of the Paleozoic era. The first period of the Paleozoic era is known as the Cambrian. Since later Cambrian strata rest upon the Prepaleozoic rocks around most of the borders of the Adirondacks, and the earlier Cambrian strata are absent, with no reason to think that they ever were deposited there, we conclude that the time of profound erosion extended into the early Paleozoic or, more strictly, into the later Cambrian. The reader may inquire, Where are the sediments which were derived from the wearing down of the ancient Adirondacks during this vast length of time? Regarding the deposition of the Prepaleozoic sediments we have no certain knowledge. They may have washed westward or southwestward into waters which may possibly have existed there; they may have been carried northward or northwestward into Canada to build up later Prepaleozoic strata there; or they may have been transported eastward toward or into the Atlantic basin. Regarding the disposal of the early Paleozoic sediments, however, our knowledge is much more certain. Both early and late Cambrian strata are abundantly represented in western New England and to some extent along the central-eastern border of New York, while only late Cambrian strata rest upon the pre-Paleozoic rocks around the borders of the Adirondacks. Also, the late Cambrian strata of northern New York are nearly a thousand feet thick on the northeastern side of the Adirondacks (in Clinton county) and they become thinner southward and westward through the Champlain, Mohawk and St Lawrence valleys, being entirely absent from the southwestern border of the Adirondacks (in the Black River valley). These facts show that the earlier Cambrian sea did not reach into northern New York, but that the later Cambrian sea did extend most, or all, of the way around the Adirondack region, the encroaching waters having come from the northeast as proved by the older and much thicker Cambrian deposits there.

The first deposit to form in this late Cambrian sea is known as the *Potsdam* sandstone which is well represented in the St Lawrence, Champlain and lower Mohawk valleys. These regions were submerged under the Potsdam sea. Not only is the Potsdam sandstone absent from the southwestern border of the Adirondacks, but there is no evidence that it ever was deposited there, hence it appears that that region was dry land during the Potsdam time. In the southeastern Adirondacks the Potsdam sea certainly extended in as far as Wells (in southern Hamilton county) and North River (northwestern Warren county) because small outlying masses of typical Potsdam sandstone occur at those places. These outlying masses were formerly connected with the larger areas but they have become completely isolated by extensive erosion since they were deposited. There is no evidence whatever that the Potsdam sea covered the interior of the Adirondack region. In short, we may say that the ocean of Potsdam time covered all the borders of the Adirondack area except on the southwest and extended well over the southeastern portion.

What do we know about the character of the topography of the land over which that ancient Potsdam sea spread? As a result of the profound erosion, thousands of feet in thickness of material were removed and the whole region must have been well worn down. Was the region worn down to the condition of a peneplain, that is to say, to an area of very low relief near sea level? Recent detailed studies on all sides of the Adirondacks furnish a very satisfactory

Plate 17



Gilbert Van Ingen, photo

A view in the Ausable chasm of Clinton county showing distinctly stratified Potsdam (upper Cambrian) sandstone

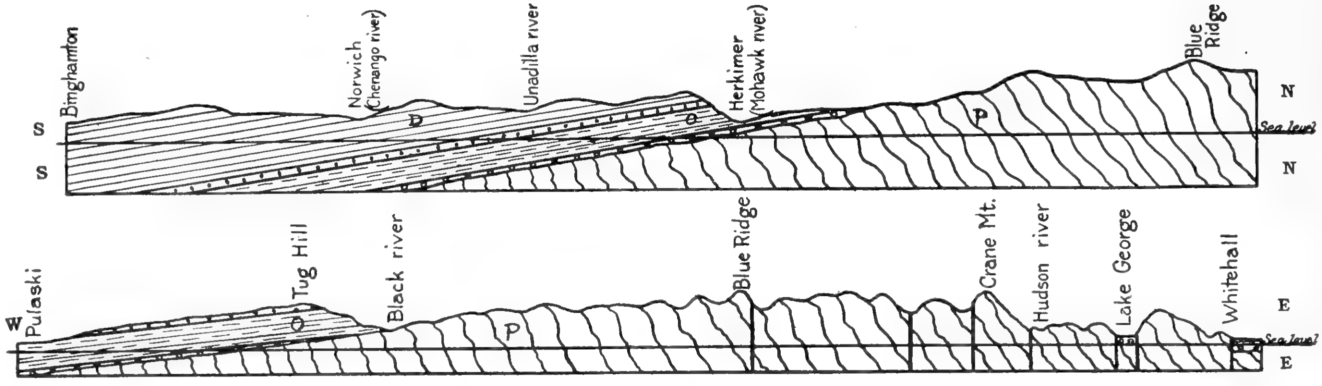


FIG. 7 Diagrammatic sections to illustrate the general relief and relations of the more important rock formations in northern New York. P=Prepaleozoic rock; thin layer next above Cambrian strata; O=Ordovician strata; thin layer next above Ordovician Silurian strata; D=Devonian strata (By W. J. M.)

answer to this question. In many places the Potsdam has been seen in contact with the underlying Prepaleozic rock whose surface clearly proves that the whole region had reached a peneplain condition. Along the northeastern side of the Adirondacks this peneplain was considerably rougher than along the northwestern, southwestern and southern portions. This is explained by the fact that the northeastern area became submerged first and consequently was not subjected to wear so long as the latter named areas. In the southern Adirondack area occasional low knobs of more resistant rock protruded above the otherwise featureless plain.

The Potsdam sandstone formation is very easily recognizable. It is almost wholly made up of clearly visible, rounded grains of quartz and always well stratified or separated into relatively thin layers. Ripple marks everywhere abound in the sandstone, thus indicating the shallow-water (or near-shore) origin of the deposit. Most of the rock is light gray to cream colored, though in some places pinkish to reddish layers are common. The strata are almost invariably in nearly horizontal position because they have not been notably disturbed since their accumulation in the sea. All the rock in the walls of the famous Ausable chasm (Clinton county) is typical Potsdam sandstone.

Marine conditions continued with the deposition of alternating layers of sandstone and limestone 50 to 200 feet thick upon the Potsdam sandstone. This is called the *Theresa* formation. After still greater subsidence, an important formation known as the *Little Falls* limestone (or dolomitic limestone was deposited layer upon layer in the comparatively clear waters of this, the latest Cambrian sea. This formation, which is fine grained, dense, light gray in color and well stratified in fairly thick beds, shows its greatest thickness of 500 feet in the gorge at Little Falls in the Mohawk valley. The Little Falls sea swept all around the Adirondacks except what is now the southwestern border from Oneida county to near the Thousand Islands. Occurrence of the formation in the outlying masses at Wells (Hamilton county) and Schroon Lake (Essex county) proves that the Little Falls sea extended well over the eastern and southeastern Adirondack region. The Adirondack island in this latest Cambrian sea was doubtless somewhat smaller than during Potsdam time, though it was still large. Map figure 8 graphically illustrates the approximate relations of land and water during Little Falls time.

Ordovician period. The Cambrian period closed with the emergence of all northern New York above sea level, but very early in the Ordovician period a submergence of the same region set in, reaching a maximum in the middle of the period. Such emergence and submergence are proved by the fact that the early Ordovician strata rest upon a distinctly eroded surface of the Little Falls (Cambrian) limestone. The duration of the emergence, geologically speaking, was not very long. Even at the time of maxi-

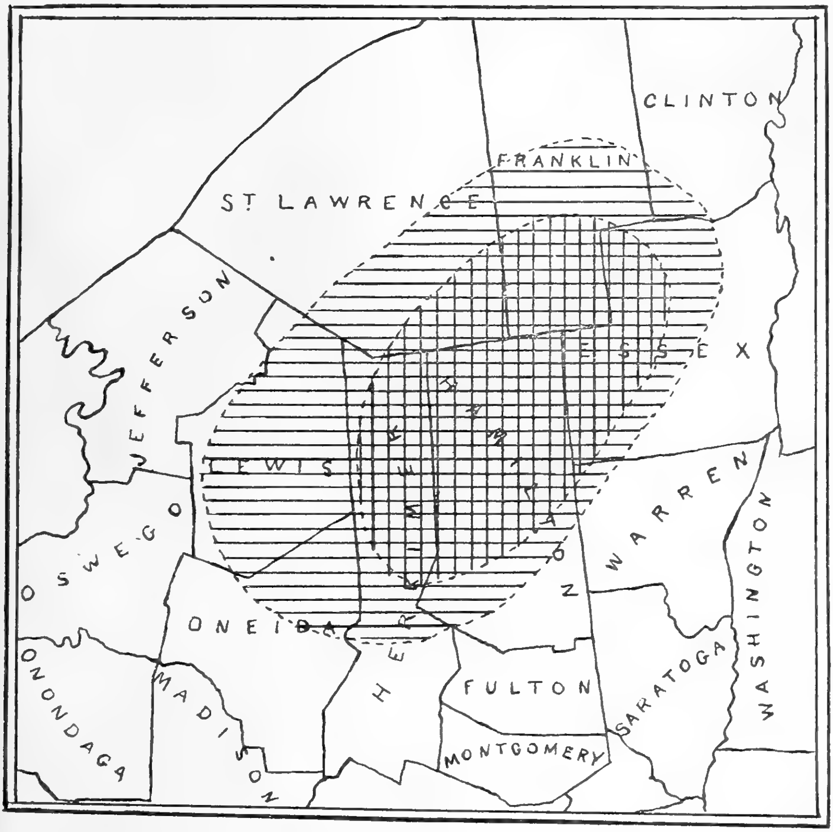


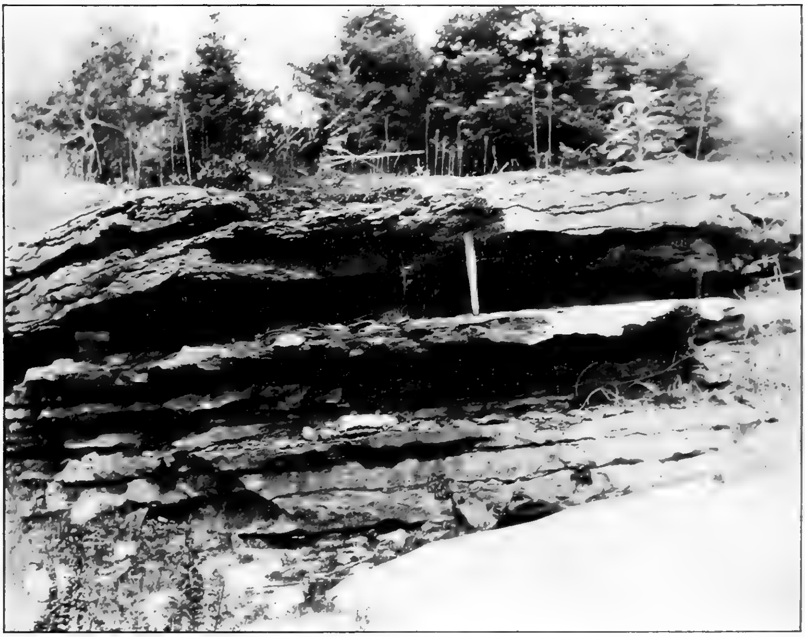
Fig. 8 Sketch map of the Adirondack region showing the general relations of land and water during the Cambrian and Ordovician periods. Horizontal lines: land area during late Cambrian time; cross lines: area of land during the middle of the Ordovician. (W. J. M.)

mum extent of the sea in the mid-Ordovician (figure 8) the evidence is decidedly against complete submergence of the Adirondack region. Occurrence of typical mid-Ordovician (Trenton) limestone and shale in the outlying mass at Wells (Hamilton county) indicates the presence of the Ordovician sea over that portion of the Adirondacks. But, after making every possible allowance for the former extension of Ordovician strata (since removed by erosion) into the Adirondack region, we are forced to conclude that the central Adirondack area never became submerged under the Ordovician sea. Furthermore, in northern New York there are known to have been various oscillations of level bringing the districts around the persistent central Adirondack dry land now above, and now below, sea level on one side or another. Omitting such details, however, we may say that, except for the Adirondack island, northern New York was mostly below sea level during the Ordovician period.

Surrounding the Adirondacks, the principal Ordovician formations include the *Beekmantown, Chazy, Black River* and *Trenton* limestones overlain by the Trenton (*Canajoharie*), *Utica, Frankfort and Schenectady* shales and sandstones. It should be made clear, however, that these formations are not all present in unbroken succession all the way around the Adirondacks, because the oscillations of level above mentioned occasioned certain interruptions in the deposition of the strata. These rocks are all typical marine deposits, well stratified, in nearly horizontal position and rich in organic remains. They are the old sea limes, muds and sands which have merely been hardened. The fact that the earlier formations are all limestones indicates relatively clearer ocean waters for that time because the nearest lands were small and low, but in the later Ordovician, muds and sands were washed in from higher, reelevated, adjacent lands.

In the strata of Cambrian age in northern New York, animal or plant remains (fossils) are comparatively rare, while the Ordovician rocks throughout fairly teem with fossils. If any formation deserves special mention, it is the Trenton limestone which is exceedingly rich in fossils. The type locality, at Trenton Falls in Oneida county, is justly famous as a collecting place for Ordovician fossils. As already stated, Trenton strata occur in the valley at Wells (Hamilton county) fully 15 miles within the southeastern Adirondacks and these rocks contain numerous fossils. Among plants, none above very simple seaweeds are known to have existed. Among animals, hundreds of species have been described as occurring within the Ordovician strata of northern New York. These species represent all the more important classes of animals below the vertebrates. Especially prominent are corals, graptolites, echinoderms (so-called star fishes), brachiopods, gastropods and

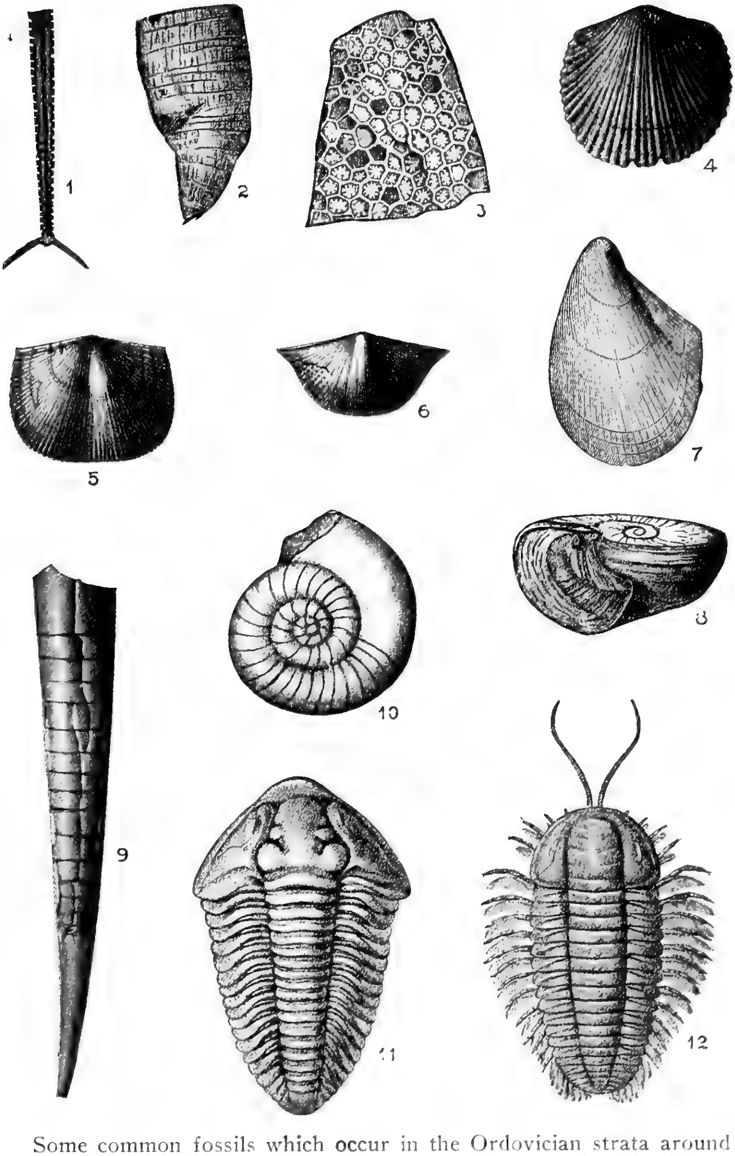
Plate 18



W. J. Miller, photo

An exposure of Lower Trenton (Ordovician) limestone near Wells, Hamilton county. This rock contains many fossils.

Plate 19



Some common fossils which occur in the Ordovician strata around the borders of the Adirondacks. Creatures like these lived in the sea which spread over much of the Adirondack area during mid-Ordovician time. 1, Graptolite; 2, Cup coral; 3, Honey-comb coral 4, 5, 6, Brachiopods; 7, Pelecypod; 8, Gastropod; 9, Cephalopod (Orthoceras); 10, Cephalopod (Trocholites); 11, 12, trilobites (restored forms).

trilobites. All the organisms mentioned lived in the sea water, and if land forms existed we know nothing of them. It must be borne in mind that not a single species of that time lives today, so complete has been the evolutionary change since Ordovician time. Certain remarkable classes of animals, like the graptolites and trilobites, which often fairly swarmed in the Ordovician sea, have been wholly extinct for millions of years.

At or toward the close of the Ordovician period, a great compressive force was brought to bear upon a thick mass of sediments which reached from north of New England to Virginia, the strata having been highly folded, tilted and elevated far above sea level into a magnificent mountain range known as the Taconic mountains. Accompanying this notable physical revolution, the Adirondack region appears also to have been raised well above the sea though without any folding of the strata. The facts that no post-Ordovician strata occur in or close to the Adirondacks and that there is a distinct break in the sedimentary record between the Ordovician and succeeding Silurian in central New York, strongly support the idea of Adirondack uplift at that time. At about the close of the Ordovician or the opening of the Silurian period, therefore, all northern New York was dry land with the great Taconic range standing out prominently just to the east.

Later Paleozoic history. Early in the Silurian period, sea water encroached upon central New York and kept that area submerged during most of the period. How much, if any, of the Adirondack region was covered by the Silurian sea? The total absence of any rocks later than the Ordovician shales around the Adirondacks and just across the St Lawrence valley strongly suggests that those areas continued as dry land not only during the Silurian but ever since, except for a very brief local submergence after the Ice Age. For the southern Adirondacks the case is somewhat different. Extensive outcrops of Silurian strata just south of the Mohawk river make it certain that these rocks formerly reached farther northward, having since been removed by erosion. But how far northward they extended is a very difficult matter to decide since not a scrap of Silurian strata now occurs north of the Mohawk river. All we can say is that the Silurian sea probably overspread the southern border of the Adirondacks, the sediments there deposited having since been removed by erosion. Abruptly truncated (by erosion) and only slightly tilted Silurian strata on the south side of the Mohawk valley render this view practically certain. In a similar manner the succeeding Devonian sea may have spread over a portion of the southern Adirondacks, though proofs are wholly lacking. There is no reason whatever to think that any of northern New York was submerged during the last two periods of the Paleozoic era.

The Paleozoic era was brought to a close by one of the most profound physical disturbances in the history of North America. It has been called the Appalachian revolution because at this time the Appalachian mountain range was borne out of the sea by folding and upheaval of the strata. The effect of this revolution upon northern New York is of fundamental importance because the whole region was then raised well above sea level, though without folding of the strata but with moderate tilting toward the south, and true marine conditions never again prevailed over any part of the area.

Mesozoic History

The vast plain of erosion. During all the Mesozoic era most of the eastern portion of the United States was above water and undergoing erosion, so that, by the close of this very long period of wear, the region was reduced to the condition of a more or less monotonous plain near sea level (peneplain). This vast plain extended over the areas of the Appalachian mountains, Piedmont plateau, New York State, the Berkshire hills and the Green mountains. Its most perfect development was in the northern Appalachians. Farther northward, over New York and western New England, its development was less perfect so that certain masses of harder rock stood out more or less prominently above the general level of the plain. In the central and eastern Adirondacks many low mountains of resistant rock rose above the peneplain surface. Hence this second definitely known peneplain of northern New York was not so perfectly developed as that of very early Paleozoic time already described. In a similar manner an occasional low mountain stood out in western New England, and it is probable that the hard sandstones of the Catskills also rose notably above the peneplain.

In the eastern United States the Mesozoic era was closed, or the Cenozoic era opened, by an important physical disturbance which produced an upwarp of the peneplain for from two to three thousand feet following the trend of the Appalachians thence through northern New York. This upward movement was unaccompanied by folding of the rocks, the effect having been to produce a very broad, low arch sloping gently eastward and westward. We are now prepared to make the important statement that the major topographic (relief) features of northern New York, including the Adirondacks, as we see them today have been largely produced by the erosion or dissection of this upraised peneplain. This being so, are there any remnants of that upraised surface still visible? Where best developed, in the northern Appalachians, the upraised plain has trenches or valleys cut in the belts of weak rock to below the surface of the plain, while the ridge summits at concordant altitudes practically represent portions of the old peneplain surface. In New York State the concordant altitudes are not so well shown both because the peneplain was there not so well developed and because the attitude of the rock masses was largely unfavorable to the production of long, distinct ridges. Remnants of the peneplain are, however, unmistakably present in New York as, for example, on a very large scale over the southwestern plateau district covering thousands of square miles where the highest points mostly reach altitudes of about 2000 feet. The summit of the Tug Hill plateau, just west of the Black River valley also lies at about 2000 feet and is clearly a remnant of the upraised peneplain which formerly connected with the southwestern plateau. As one looks out over the western slope of the Adirondacks from the summit of the Tug Hill plateau, he is impressed by the remarkably even sky line there shown at an altitude of a little over 2000 feet. The central and east-central Adirondacks are exceptional because considerable masses there stood out above the general level of the old peneplain. It is important to note that, as a result of the long time of erosion before and during the Mesozoic era, the Paleozoic strata, which had been deposited well over the borders of the Adirondacks, were considerably removed.

Since the actual work of erosion or dissection of the upraised peneplain in northern New York took place during the next or Cenozoic era, further discussion of this subject is reserved till the consideration of that era.

The great fractures (faults) of the southeastern Adirondacks. Examination of the detailed topographic maps of the eastern and southeastern half of the Adirondacks shows that there are many ridges and valleys, streams and lakes, which trend in a north-northeast by south-southwest direction. What is the explanation of these features? This region has been extensively fractured or faulted. In fact, the major relief features are largely dependent upon this faulted structure. A few words of explanation regarding faults are here in order. Whenever a fracture has developed in the earth's crust and one portion of the earth has slipped by or been pushed over the other along the fracture, we have what is called a fault. In short, a fault is a fracture in the earth along which there has been slipping. If one portion of the earth simply drops down with respect to the other we have a normal fault, and if one portion has been pushed over the other we have a reversed or thrust fault. Actual movements along a fault surface are sudden, the amount of slipping generally varying from a fraction of an inch to 20 or even 50 feet at a time, though the sum total of all slipping (called "displacement") along large faults, during a long time, often amounts to hundreds or even thousands of feet. Each sudden, notable slipping produces an earthquake. Definitely traced faults vary in length (that is, across country) up to a hundred miles or more. Along such fractures the rocks are often more or less broken or crushed thus affording relatively easy work for stream erosion, so that streams often follow such fault zones of weakness. The eastern and southeastern Adirondacks have been literally chopped to pieces by numerous faults, all of the ordinary normal fault type with fracture surfaces in practically vertical position. No single fault has been proved to extend across the whole region, but rather there is a prominent series of many roughly parallel fractures few of which have been definitely traced as much as 20 miles and none more than 30 or 40 miles. The greatest number are only a few miles long. The total amount of displacement along these fracture lines in the very ancient Adirondack rocks can not be determined, but frequently it is at least 500 to 2000 feet. This series of faults cuts through the early Paleozoic strata along the shores of Lake Champlain and in the Mohawk valley, and in these regions, due to marked differences in the character of the strata, it has been possible to determine the amounts of displacement with considerable accuracy.

In addition to this great series of north-northeast by south-southwest faults, there are many others, mostly minor ones, which trend in various directions, though chiefly approximately at right angles to the major series. Accordingly, the eastern and southeastern Adirondack region is really a mosaic of earth blocks and ridges. Since their origin most of these blocks and ridges have of course been appreciably modified by erosion. Sometimes there is no positive evidence of any notable displacement, though the rocks in the fault zone are badly broken. The geologic map of the Lake Pleasant quadrangle affords an excellent illustration of numerous faults and their evident influence upon the topography in the very

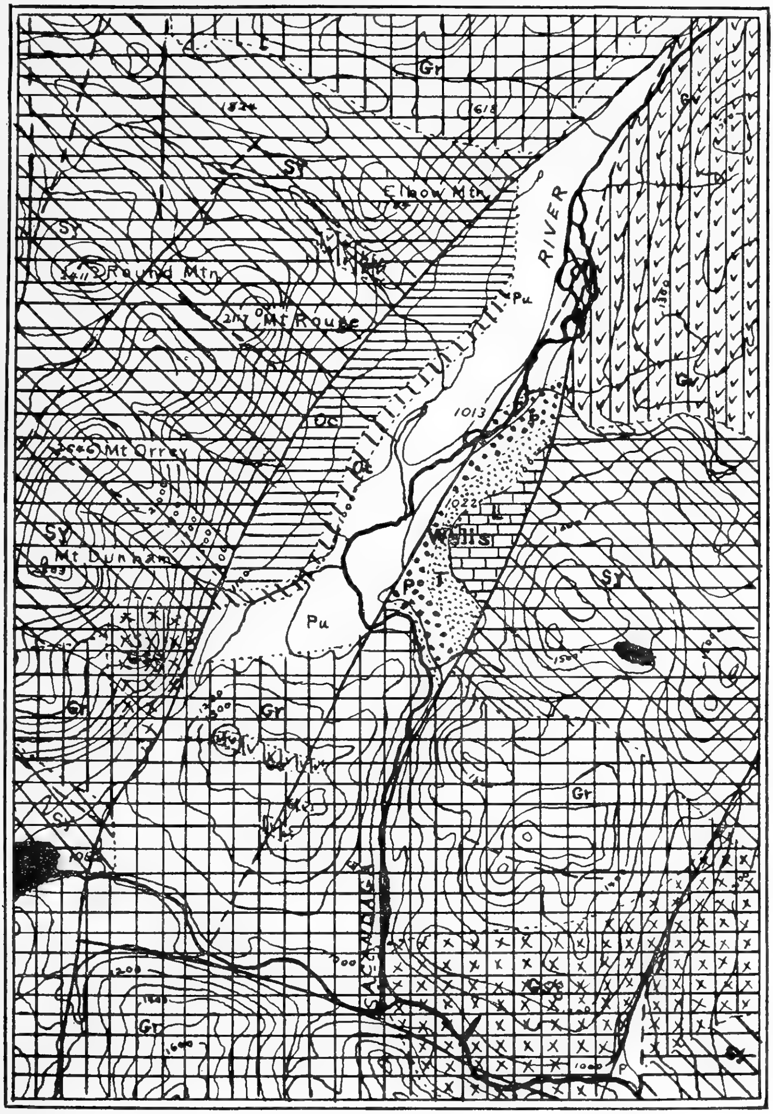


FIG. 9 Geologic and topographic map of the vicinity of Wells showing the relations of various rock formations and several conspicuous faults. Contour interval: 100 feet. Positions of faults represented by heavy black lines. Gv=Grenville strata; Sy=syenite; Gr=granite; Gsg=Grenville-syenite-granite mixed rocks; black areas=gabbro or diabase; P=Potsdam sandstone; T=Theresa formation; L=Little Falls limestone; O=Lower Trenton limestone; Oc=Canajoharie (Trenton) shale; Pu=Paleozoic strata. Geology by W. J. Miller.

midst of that part of the Adirondacks here considered. The small outlying mass of Paleozoic strata at Wells, so far separated from the main body of similar strata, lies within a valley of the Lake Pleasant quadrangle. This valley and its immediate surroundings exhibit perhaps a greater variety of important geologic phenomena than any other small area within the whole Adirondack region (see map figure 9). A fault whose total length in over 30 miles passes along the western side of the valley where the mountain wall of pre-Paleozoic rock (see figure 9) rises 1000 to 1500 feet, while the

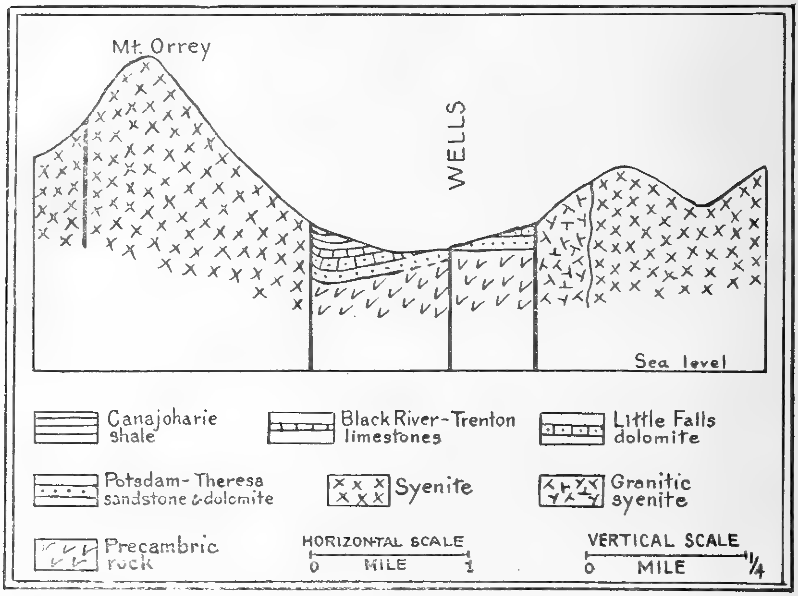


FIG. 10 Detailed structure section across the valley at Wells, Hamilton county. This represents a vertical slice through the earth's crust at this locality. The dolomite, sandstone, limestone and shale are Paleozoic strata. Heavy vertical lines show positions of faults. (By W. J. M.)

eastern or valley side of the fault represents a portion of the earth's crust which has moved downward at least 2000 feet (figure 10). The Paleozoic strata in the valley were formerly at a level corresponding nearly to the present mountain tops just to the west of the fault. Having dropped down so near sea level, these strata, now about 500 feet thick, have been protected against complete removal by erosion to the present time. Another, though smaller, fault bounds the valley on the east, so that the valley really represents a block of earth which has dropped down between two faults.

Of course the topographic outlines have been notably modified by weathering and erosion. This valley at Wells has been referred to somewhat in detail because it so clearly illustrates the principles of Adirondack faulting.

When were the faults developed? That at least some fracturing occurred in Prepaleozoic time has been established, but, so far as known, such faults have relatively little influence upon the existing relief features. Also it is probable that fault movements took place during the Paleozoic era, but if so the old fault cliffs or ridges must have been practically obliterated by erosion during the Mesozoic era concluding with the development of the great plain of erosion already described. If so, how do we account for the present Adirondack ridges and valleys which owe their existence chiefly to faulting? Accompanying the uplift of the peneplain there was either much faulting for the first time, or renewed faulting along old lines of fracture, or, as a result of unequal erosion due to differences in rock character on opposite sides of old faults, new cliffs or scraps began to be produced. That much of the faulting actually dates from the uplift of the peneplain, or possibly even later, is proved by the existence of certain steep cliffs in perfectly homogeneous rock masses and by the distinct tilt of many of the fault blocks, both of which features have been scarcely modified by erosion since their development.

Cenozoic History not Including the Ice Age

Development of existing major relief features. The uplift of the great peneplain was an event of prime importance for northern New York because it literally furnishes us with the beginning of the history of most of the principal existing relief features of the region. Hence we reassert with emphasis that the chief topographic features of the State have come into existence since the uplift of the peneplain because they have been produced by the dissection of that upraised surface. This dissection was largely the work of erosion, though, as already explained, faulting produced notable topographic effects in the eastern and southeastern Adirondacks. Also it should be borne in mind that the central to east-central Adirondack area stood out with many masses above the general peneplain level. Since the uplift, however, this area has been deeply trenched and made very rugged as we see it today. All the great valleys around the Adirondacks — the St Lawrence, Champlain, Mohawk and Black river — have been carved out of the upraised peneplain, though faulting has no doubt been a notable factor in the production of the Champlain valley. The numerous lakes, gorges and waterfalls of the Adirondacks have all come into existence during Cenozoic time, most of them since relatively late Cenozoic time.

During the Cenozoic era, still more of the Paleozoic strata which rested upon the Prepaleozoic rocks and extended over the present borders of the Adirondacks were stripped off by erosion until the present condition has been reached. This removal of Paleozoic strata around the Adirondacks is still going on, thus gradually enlarging the area of the very ancient Prepaleozoic rocks. The little masses of Paleozoic strata well within the Adirondack borders such as those at Wells, Schroon Lake, North River, etc., are merely erosion remnants of the mantle of Paleozoic sediments which formerly spread over all the southeastern Adirondack area.

Of much greater influence than the faulting in the production of the present-day Adirondack relief features has been the difference in character of the rock masses. Thus the relatively weaker Grenville strata (especially limestone) have almost invariably been worn down to form the valleys, while the harder and more resistant anorthosite, granite and syenite have stood out better against the weathering and erosion to form the mountains. It will be recalled that the Grenville strata and the igneous rocks are very irregular or "patchy" in their distribution. For this reason the valleys and mountains have been carved out in a most irregular manner throughout the Adirondack region except where the faulting has had a notable influence. In many instances in the faulted region, streams have cut relatively straight channels for greater or lesser distances along the broken-rock fault zones. But by no means all the relief has developed either as a result of differences of rock character or faulting, because even in large masses of very homogeneous hard rocks many streams have developed channels of varying size and shape in a most irregular manner.

The evolution of drainage. Almost nothing is definitely known about the positions of drainage lines in northern New York before the Cenozoic era began. Since the uplift of the peneplain in the late Mesozoic or early Cenozoic, however, the drainage history of the Adirondacks is fairly known. As already pointed out, the present Adirondack streams show a very marked tendency to radiate from the central portion of the district. The Adirondack region is now a broad, relatively low, domelike mass fully a hundred miles across with altitudes commonly ranging from 1000 to several thousand feet, the central to east-central portion being the highest.

This domelike character of the Adirondacks has apparently been a very persistent feature for many millions of years, or at least since the beginning of the Paleozoic era, and this in spite of profound erosion. It will be recalled that the interior of the region was a large, low island in the midst of the early Paleozoic seas. Uplift of northern New York toward the close of the Paleozoic era, and consequent removal by erosion or much of the bordering Paleozoic strata, no doubt renewed the prominence of the Adirondack dome. Next, during the long time of the Mesozoic era, the region was worn down to a fairly good peneplain except from the central to the east-central portion. Then came the late Mesozoic or early Cenozoic uplift of this peneplain, apparently with greatest elevation corresponding roughly to the present north-northeast by south-southwest main axis (see above) which extends across the Adirondack region. Naturally the streams which began to operate upon this newly upraised domelike surface flowed outward from the highest or central to eastcentral Adirondack district. During the long Cenozoic time, the weak Paleozoic strata were still further removed from the sides of the ancient dome of the Adirondack (Prepaleozoic) rock, thus accentuating it as a topographic feature and permitting the streams to adjust themselves to a more and more perfect radiation in all directions from the higher central portion. Certain important drainage changes have been brought about by the recent Ice Age and these will be described below, but they do not seriously affect the conclusions just reached regarding the drainage.

Immediately after the uplift of the peneplain, some of the easterly headwaters of the Susquehanna river came out of the southwestern Adirondack district. Among the evidences are the following: The Mohawk valley had not then come into existence the slope of the upraised peneplain surface was there southward; and the numerous sources of the Susquehanna which now rise at the very brink of the Mohawk valley on the south side strongly suggest that these streams once started some miles farther northward. As a result of the development of the Mohawk valley, these upper waters of the Susquehanna in the southern Adirondacks have been captured and diverted into the Mohawk river.

The Great Ice Age

Ice extent and direction of movement. The Quaternary is the last period of earth history and it still continues for it has led up to the present-day conditions. This period was ushered in by the spreading of vast ice sheets over much of northern North America and Europe. This event takes rank as one of the most interesting and remarkable occurrences of geological time.

Some of the proofs for the former presence of the great ice sheet are the following: (1) polished and scratched rock surfaces which are precisely like those produced by existing glaciers, and which could not possibly have resulted from any other agency; (2) glacial boulders called "erratics" which are often somewhat rounded and scratched, and which have often been transported many miles from their parent ledges; and (3) glacial deposits, including true moraines (see below) and the widespread heterogeneous glacial débris, both stratified and unstratified, which is clearly ice transportated material usually resting by sharp contact upon the bedrock.

An area of nearly 4,000,000 square miles of North America was covered by ice at the time of maximum glaciation and also there were three main centers of ice accumulation and dispersal, namely, the Labradorean, Kewatin and Cordilleran. It was the Labradorean ice sheet which spread southward to cover all of the Adirondacks. The directions of flow of the ice have been determined by noting the directions of the glacial scratches (so-called "striae").

When the Labradorean ice sheet spread out southward as far as northern New York, the Adirondack mountains stood out as a considerable obstacle in the path of the moving ice. Hence the tendency was for the ice to divide into two currents or portions, one of which passed southwestward up the low, broad St Lawrence valley, and the other due southward through the deep, narrow Champlain valley. As the ice kept crowding from the rear, part of the St Lawrence ice lobe pushed into the Ontario basin, while another portion pushed its way up the deep Black River valley and finally into the Mohawk valley in central New York. At the same time the Champlain ice lobe found its way into the Hudson valley and sent a branch lobe westward up the Mohawk valley. The two Mohawk lobes, the one from the west and the other from the east, met in the Mohawk valley not far from Little Falls. As the ice sheet continued to push southward, all the lowlands of northern New York were filled, and finally the whole Adirondack region was buried under the ice. The highest, or central to east-central, Adirondacks were the last to become submerged under the ice. The general direction of movement at this time of greatest ice extent was southward to southwestward with perhaps some undercurrents determined by the larger topographic features.

The accompanying maps (figure 11) depict three important stages in the retreat of the ice sheet from northern New York. It

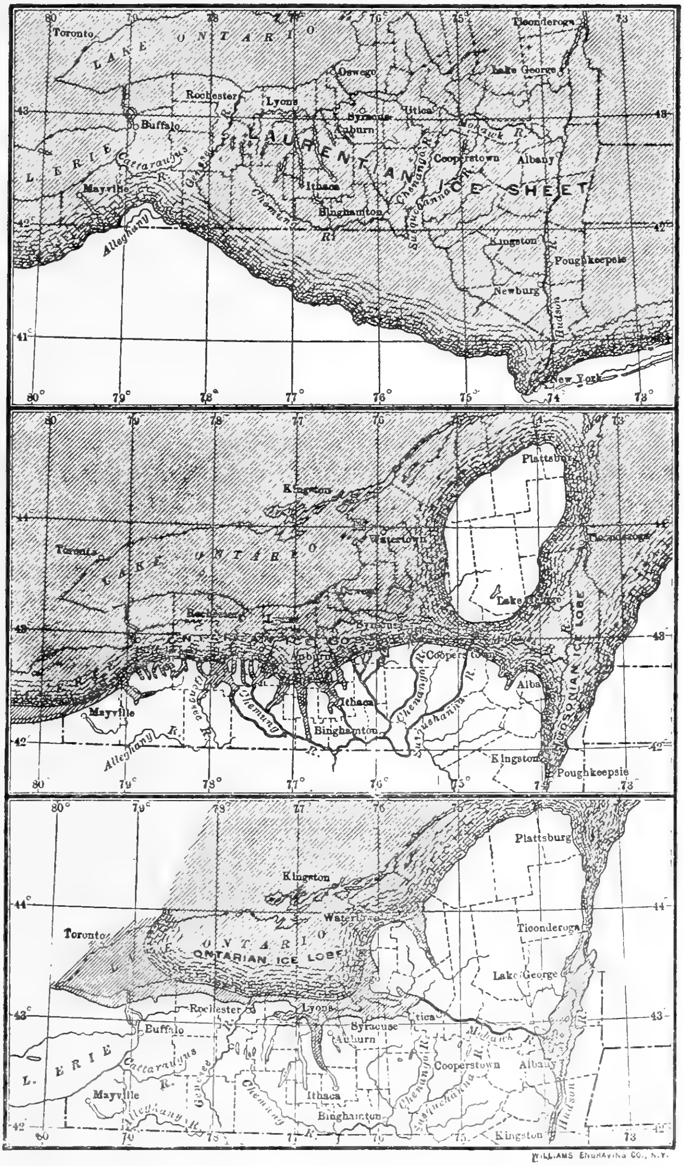


FIG. 11 Maps showing three stages in the recession of the great ice sheet from New York State. Upper figure: the Adirondack mountains completely buried under the ice; middle figure: the Adirondacks largely freed from the ice; lower figure: the Adirondacks wholly freed from the ice. Note the position of the large lake in the Black River valley; standing water in the Hudson valley and in the Lake George depression; and the outlet of the Great Lakes through the Mohawk valley. (After H. L. Fairchild, from Tarr and Martin's "College Physiography," by permission of The Macmillan Company).

will be seen that the central Adirondacks, the last to be buried, were the first to be freed from the ice, the much thicker ice in the surrounding valleys requiring a longer time for melting. Taken in reverse order, these maps in a general way show three stages in the advance of the ice over New York State.

Ice erosion. Glacial ice, like flowing water, has very little erosive effect upon rocks unless it is properly supplied with tools. When flowing ice is shod with hard rock fragments, the power to erode is often pronounced because the work of abrasion is mostly accomplished by the rock fragments rather than by the ice itself. A little search will reveal polished and scratched rock surfaces in the Adirondacks, and the freshness and hardness of the surface rock proves that the ice eroded off all the preglacial soil and rotten rock and often more or less of the fresh rock. During the very long preglacial time, rock decomposition must have progressed so far that rotten rock, including soils, had accumulated to considerable depths as is the case in the southern states today. Such soils are called "residual" because they are derived by the decomposition of the very rocks upon which they rest. But now one rarely ever sees rotten rock or residual soil in its original position in the Adirondacks because such materials were nearly all scoured off by the passage of the great ice plow, mixed up with other soils and ground up rock materials and deposited elsewhere. Such are called transported soils.

Ice shod with hard rock fragments, and flowing through deep, comparatively narrow valleys of relatively soft rock, is particularly powerful as an erosive agent, because the tools are supplied, the work to be done is easy, and the increased depth of ice where crowded into such a valley causes greater pressure on the bottom and sides of the valley. Many of the valleys of northern New York were thus favorably situated for ice erosion, as, for example, the Champlain, St Lawrence and Black River valleys as well as many of the north-south valleys of the Adirondacks.

Most of the Adirondack mountain peaks, especially the more isolated ones, were thoroughly scraped off and rounded down to the very fresh rock, while the favorably situated valleys were vigorously glaciated by the removal of all the rotten rock and at least some of the fresh rock, especially when this latter was comparatively soft, Grenville limestone. Such phenomena are particularly well exhibited in Warren county where the landscape is characterized by numerous glaciated rock domes which rise conspicuously above the valleys of weak Grenville. In some cases where the ice moved directly across deep valleys, like that between Lake George village and Warrensburg, the rotten rock to a considerable depth may still be seen in its original place.

In conclusion we may say that, while many comparatively small local features were produced by ice erosion, the major topography of the Adirondacks was essentially unchanged by ice erosion.

Local mountain glaciers. Certain mountainside valleys have been notably modified by small so-called Alpine or valley glaciers which existed either just prior to or just after the great Ice Age in northern New York. On first thought it seems reasonable to assume that such valley glaciers were lingering remnants of the vast sheet of ice. But the absence of anything like distinct moraines produced by such glaciers strongly argues for their existence just before the Ice Age, such morainic deposits having been obliterated by the passage of the great ice sheet. Excellent examples of valleys once occupied and modified by local glaciers are the deep, nearly U-shaped trenches down the eastern and northern sides of Whiteface mountain and down the northern end of the Sentinel range, all within the Lake Placid quadrangle.[1]

Glacial deposits. The vast amount of débris transported by the great ice sheet was carried either on its surface, or frozen within it or pushed along under it. It was exceedingly heterogeneous material ranging from the finest clay, through sand and gravel, to boulders of many tons weight. The deposition of these materials as we now see them took place during both the advance and the retreat of the ice, but chiefly during the retreat. Most of the deposits made during the ice advance were obliterated by ice erosion, but those formed during the ice retreat have been left intact except for the small amount of postglacial erosion.

Whenever, during the great general retreat, the ice front remained stationary for some time because the forward motion of the ice was just counterbalanced by the melting, all the ice reaching the margin dropped its load of débris to build up a *terminal moraine.* This is usually a distinct ridge of low hills consisting of very heterogeneous, mostly unstratified, débris. Such moraines are not commonly well developed in the Adirondacks.

A very extensive glacial deposit, called the *ground moraine,* is simply the heterogeneous, typically unstratified débris from the bottom of the ice which was deposited mostly during the melting and retreat of the ice. When it is mostly very fine material with

[1] Prof. D. W. Johnson has recently noted a moraine in one of the valleys of Mt. Whiteface and he argues that it was produced by a local glacier which existed after the retreat of the great ice sheet.

pebbles or boulders scattered through its mass, it is known as *boulder clay* or *till*. The pebbles or boulders of the till are commonly faceted and striated as a result of having been rubbed against underlying rock formations. Such ground moraine deposits are exceedingly widespread throughout the Adirondacks.

An interesting type of glacial deposit is the *drumlin* which is, in reality, only a low, rounded hill of ground moraine material or till. These are practically unknown in the Adirondacks, though some excellent examples occur on the southern border in the vicinity of Gloversville (Fulton county).

Glacial boulders, or so-called *erratics,* have already been referred to. They are simply blocks of rocks or boulders from the top of the ice or within it which have been left strewn over the country as a result of the melting of the ice. They vary in size from small pebbles to those of many tons weight and are naturally most commonly derived from the harder rock formations. Erratics are very numerous throughout the Adirondacks. They are most numerous on the lower lands, though by no means rare on the mountains. Sometimes they have been left stranded in remarkably balanced positions. The writer has frequently noted boulders and pebbles of Potsdam (Cambrian) sandstone, derived from the St Lawrence valley, at altitudes of from 3000 to 4000 feet in the central and east-central Adirondacks. Boulders of anorthosite from Essex county are not rare at the southern border of the Adirondacks.

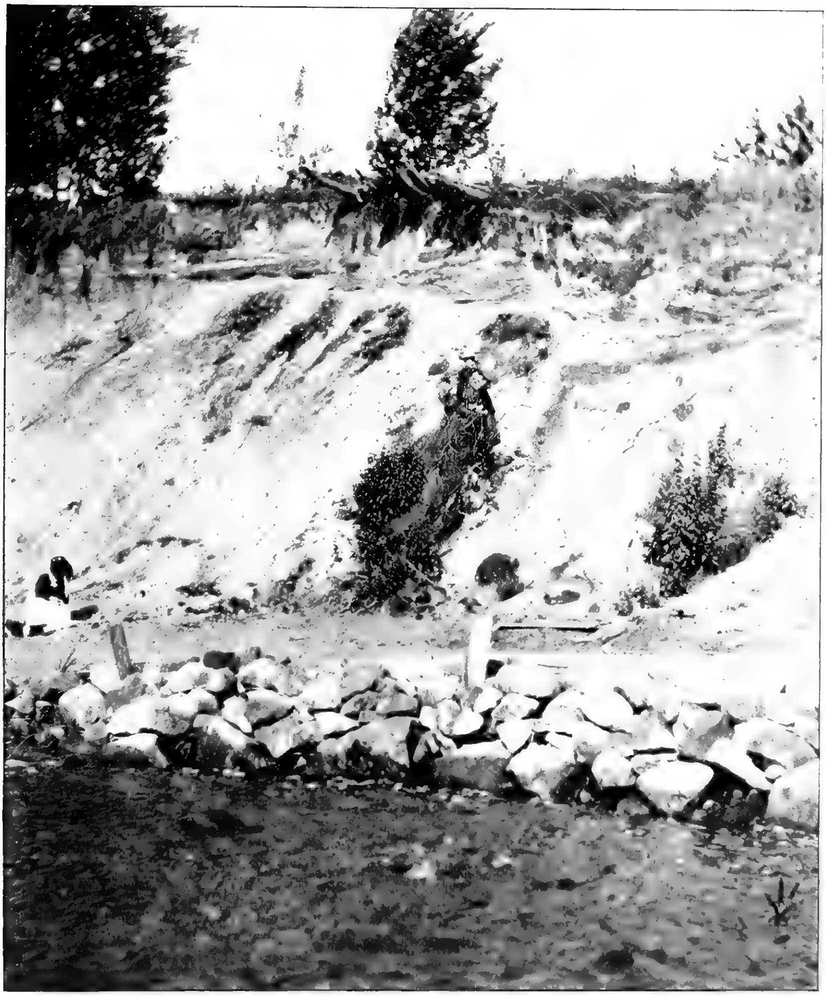
Another type of glacial deposit in the low hill or hillock form is the *kame* which, in contrast with the drumlin, always consists of stratified (water-laid) material. Kames are seldom as much as 200 feet high, and typically they have nearly circular bases though frequently they are very irregular in shape. At times they exist as isolated hills or in small groups, but often they are associated with the unstratified morainic deposits. They were formed by débris-laden streams emerging from the margin of the ice, the water sometimes having risen like great fountains because of pressure. Such deposits are now in process of formation in Alaska. Kames are very common in the Adirondacks.

The *esker* also consists of stratified glacial material, but it is in the form of a low, winding ridge formed near the ice margin either by subglacial streams or in cracks in the ice. Eskers may occasionally be seen in the Adirondacks, an exceptionally fine one having a highway at its summit in Thirty-four marsh just east of Blue Mountain lake. Another fine one, about a mile long, lies just west of Schroon Lake village.

W. J. Miller, photo

A great glacial boulder near Loch Muller, Essex county. The rock is anorthosite, and it has been carried some miles at least from its parent ledge. Its dimensions are approximately 33 feet long, 27 feet wide, and 25 feet high. Due to weathering and freezing of water along a natural fracture (so-called "joint") the boulder has been split open since it was left by the ice.

Plate 21.



H. P. Cushing, Photo.

Bluff produced in kame sand ridge at Moody, Tupper Lake shore. Cross-bedding shows midway at the top.

Like glacial erosion, the deposition of glacial materials has not changed the major topographic features of northern New York. The general tendency of ice deposits has been partially to fill depressions and thus to diminish the ruggedness of the relief.

Origin of the lakes. The numerous Adirondack lakes constitute one of the most striking differences between the geography of the present and that of preglacial time. Before the Ice Age practically none of the lakes was in existence, the bodies of water having been produced either directly or indirectly by glacial action. Among the methods of lake basin formation were building dams of glacial débris across old river channels or valleys; ice erosion; and the production of depressions by irregular accumulation of glacial débris or by the melting of large blocks of ice which were more or less submerged under glacial débris.

Most of the lakes were formed by dams of glacial material thrown across valleys. It is quite the rule to find the outlets of these lakes flowing through loose materials of this sort. By ice erosion, many of the favorably situated valleys were somewhat modified, but there are few, if any, lake basins produced wholly by that process. There are many examples of ponds and small lakes which occupy depressions below the general level of certain sand flats, the sands having been deposited in glacial lakes during the retreat of the ice, and the depressions resulted from the subsequent melting of blocks of ice which were surrounded by the sand deposits. Numerous examples of such ponds occur within the St Regis quadrangle and on the great sand plain along the eastern side of the Black River valley.

Sometimes small lakes or ponds are situated well up on high mountains. Examples are on Crane mountain (North Creek quadrangle) at 2620 feet; Morgan pond on Wilmington mountain (Lake Placid quadrangle) at 3020 feet; on the mountain 1½ miles due north of Indian pass (Santanoni quadrangle) at 3550 feet; and the Wall Face ponds 1 mile northwest of the same Indian pass at 3040 feet. Perhaps highest of all is Lake Tear, sometimes called Lake Tear of the Clouds, at 4300 feet close to the divide between Mt Marcy and Mt Skylight. This is one of the sources of the Hudson river.

Many of the Adirondack lakes were formerly larger, as proved by delta deposits above the present lake levels. Two examples which have recently come under the writer's observation are Schroon lake and Piseco lake. The water of Schroon lake was once fully 70 feet higher when it extended some 8 or 10 miles farther up the Schroon valley with an arm reaching over the area of the present Paradox lake, and also some 6 or 8 miles southward covering all the lowland around Chestertown and an arm extending over the area of the present Brant lake. Piseco lake was at one time 20 feet higher, when it reached several miles farther northward. Both of these lakes lie in valleys which are largely due to faulting as explained above. The waters of both are now held up by dams of loose glacial débris across the south ends.

Lake George is justly famous because, from the standpoint of length and depth in proportion to width, no other lake in the State occupies such a remarkable valley. This depression has been produced by a combination of faulting and erosion. There was a pre-Glacial divide at the present location of the "Narrows." This divide may have been considerably lowered by ice erosion when the deep, narrow body of ice plowed its way through the valley. The waters are now held up by glacial deposits at each end.

Lake Placid occupies the bottom of an irregular preglacial valley. The lake has been formed by heavy glacial deposits across the valley on the south. The very low neck of land separating it from Mirror lake is also glacial material.

The Saranac lakes, Big Tupper lake and Cranberry lake are large bodies of water of very irregular shape in shallow basins resulting from the accumulation of glacial débris across broad, preglacial valleys.

Raquette lake, with its exceedingly irregular shore line, lies in the bottom of a broad, shallow preglacial valley or rather portions of several adjacent valleys. Heavy glacial deposits on the south act as a dam.

Both Long lake and Indian lake, two fine examples of the linear type of lake, lie in the bottoms of very straight valleys which have been carved out by erosion along fault zones of weak rock. Much of the present extent of Indian lake is due to an artificial dam across the northern end.

The Fulton chain of lakes are the result of irregular damming of prominent preglacial stream valleys by glacial débris.

Blue Mountain lake, Lake Pleasant and Sacandaga lake all lie in the bottoms of valleys which appear to have been carved out of relatively weak Grenville strata, the waters being held up by glacial débris dams. A low, narrow neck of glacial material serves to separate Lake Pleasant and Sacandaga lake.

Extinct lakes. Hundreds of extinct glacial lakes are known to be scattered throughout the Adirondacks. Some of these existed only during the time of the ice retreat where the ice acted as dams across valleys, while others existed for a greater or lesser time after the Ice Age. The locations of many such extinct lakes are easily recognized by the more or less well-preserved, typical, flat-topped delta deposits of stratified sands, gravels and clays. Such flat-topped deposits, always free from boulders and at concordant altitudes in the valleys, mark the former lake levels. The sites of many other extinct lakes are now marked by flat meadow lands or swampy areas, the lakes having been filled by sediments or plant accumulations or by both. Swamps and meadowlands of this sort are exceedingly common throughout the Adirondacks, and constitute one of the characteristic features of the region.

Perhaps the finest example of a large, wholly extinct glacial lake in the State has been called Black lake which occupied a good portion of the bottom of the Black River valley in the western side of the Adirondacks. The water was held up by a wall of ice during the retreat of the great ice sheet (see figure 11). The former presence of this lake, which covered many square miles, is conclusively proved by the extensive development of delta sand plains on the eastern side of the valley, the delta materials (chiefly sand and gravel) having been brought into the lake by streams loaded with débris from the newly ice-freed Adirondacks. These delta deposits became more or less merged and they now form an extensive sand plain over 30 miles long, several miles wide and fully 200 feet thick on the steep western side (figure 12).

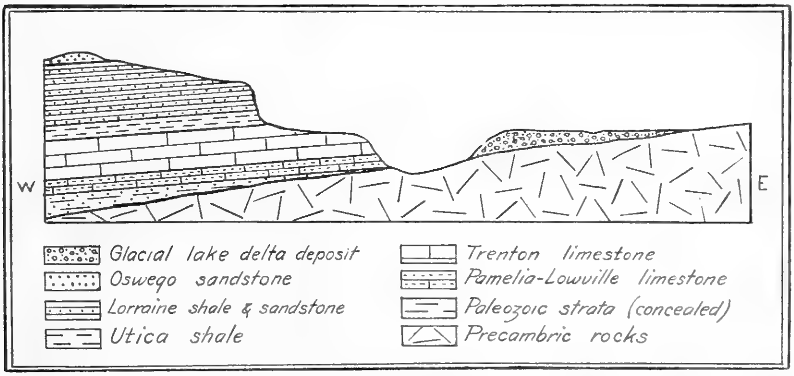


FIG. 12 East-west section across the Black River valley, 2½ miles north of Lyons Falls, showing the terraced character of the Paleozoic strata and their relations to the Adirondack rocks. On the east side, the position of the glacial lake delta deposit is shown. Length of section 12½ miles. Vertical scale greatly exaggerated. (By W. J. M.)

Another fine example of a large extinct lake has been called Glacial Lake Sacandaga. It covered many square miles of the bottom of the broad valley in which Johnstown, Gloversville and

Northville are located. During the general ice retreat, but when the Mohawk valley lobe of ice was still present, morainic deposits accumulated along the ice margin across the mouth of the valley thus ponding the waters over the valley bottom and causing the Sacandaga river to find an outlet over the low divide at Conklingville. Perfect delta sand plains may now be seen at approximately 780 feet above sea level. This lake persisted for a good while after the disappearance of the ice because of the effective morainic dam, and even today in the spring of the year a wide swamp becomes flooded. The lake was drained by cutting down the outlet at Conklingville. Construction of the proposed Sacandaga reservoir, by means of a dam at Conklingville, would almost exactly restore this former glacial lake.

Great terraces and sand flats show the former existence of a large body of water in the valley around Corinth (Saratoga county), and another in the vicinity of Warrensburg (Warren county).

The former extensive lake, called Glacial Lake Pottersville, of which Schroon, Brant and Paradox lakes are remnants, has already been described. Numerous excellent delta sand flats mark the old lake level. Construction of the Schroon lake reservoir, as proposed by the State, would almost exactly restore this great lake.

A well-defined glacial lake filled the bottom of the valley at Wells (Hamilton county).

In the northeastern Adirondacks there were, according to Mr H. L. Alling, several extensive high-water lakes, the principal ones having been in the Saranac lakes valley with water levels ranging from 1600 to 1450 feet (present altitudes); in the broad valley south and southeast of Lake Placid with water levels from 1875 to 1800 feet; and in the broad valley around Wilmington with waters at from 1150 to 1100 feet.

The above-described extinct lakes are only some of the more important ones which have been studied in the Adirondack region.

Drainage changes due to glaciation. Drainage changes due to the Ice Age are common in the Adirondacks, though many of these have not yet been worked out in detail. Some of the more prominent changes which have been studied will be briefly described. As a result of long preglacial erosion, it is certain that deep, narrow gorges and waterfalls must have been very rare if present at all. Like lakes, such features are ephemeral because, under our conditions of climate, gorges soon (geologically) widen at the top, and waterfalls disappear by retreat or by wearing away the hard rock over which they fall.

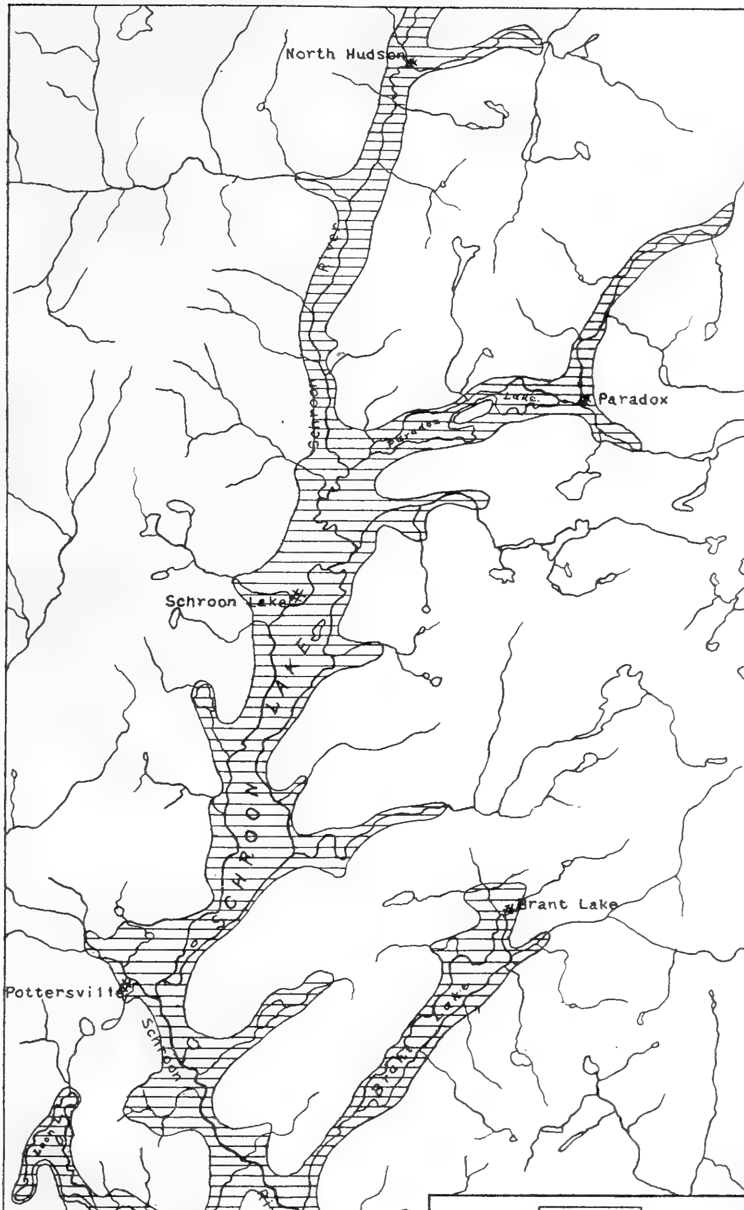


FIG. 13 Sketch map to show the extent of Glacial Lake Pottersville in Warren and Essex counties during the waning of the ice sheet from the Adirondack region. (By W. J. M.)

In the southeastern Adirondacks, it is no exaggeration to say that the larger drainage features have been revolutionized as a result of glaciation. The accompanying sketch map (figure 14) gives a fair idea of the changes, but the interested reader should also refer to the topographic maps of the region. At the southeastern border of the Adirondacks, two prominent valleys extend southward for some miles, one from Northville toward Gloversville, and the other from Corinth toward Saratoga Springs. Each valley is underlain with Paleozoic strata and each is bounded on east and west by highlands of hard prepaleozoic rocks. It is certain that these valleys contained normal preglacial rivers which flowed southward out of the mountains. Now, however, the Sacandaga river enters the north end of the first-named valley only to make a very sharp turn back on its course to flow across the mountains and into the Hudson river at Luzerne. A preglacial divide was located at Conklingville as shown by the gorge there; the perfectly graded condition of the valley bottom westward from that place; and the increasing width of the valley westward. This remarkable deflection of the river was caused by the building of a broad morainic blockade across the valley through Gloversville and Broadalbin as already explained. For a long time a lake occupied the valley bottom just north of the blockade dam.

The Hudson river now flows through a gorge fully a thousand feet deep just north of Stony Creek station, and thence to the north end of the prominent Paleozoic rock valley at Corinth where it turns abruptly to the northeast to flow across the Luzerne mountain ridge. The preglacial Hudson certainly did not flow through the Stony Creek gorge, but rather, where the gorge now is, there was an important divide. The Hudson and Schroon rivers both make anomalous turns to the southwest and join to flow through a highland region of hard rocks instead of continuing southeastward through one of the low passages in the vicinity of Warrensburg and into the Lake George basin as shown on the map. The now extinct Luzerne river started on the Stony Creek divide, flowed southward past Corinth and thence through the broad, low Paleozoic rock valley to the west of Saratoga Springs. The cause of the passage of the Hudson over the Stony Creek divide was due chiefly to the fact that during the ice retreat the glacial lobe in the Lake George basin forced the river to take a more westerly course where the channel was cut down deep enough so that the river kept that course even after the melting of the ice. The deflection of the river over the Luzerne mountain divide was caused by heavy glacial accumulation in the valley at Corinth.

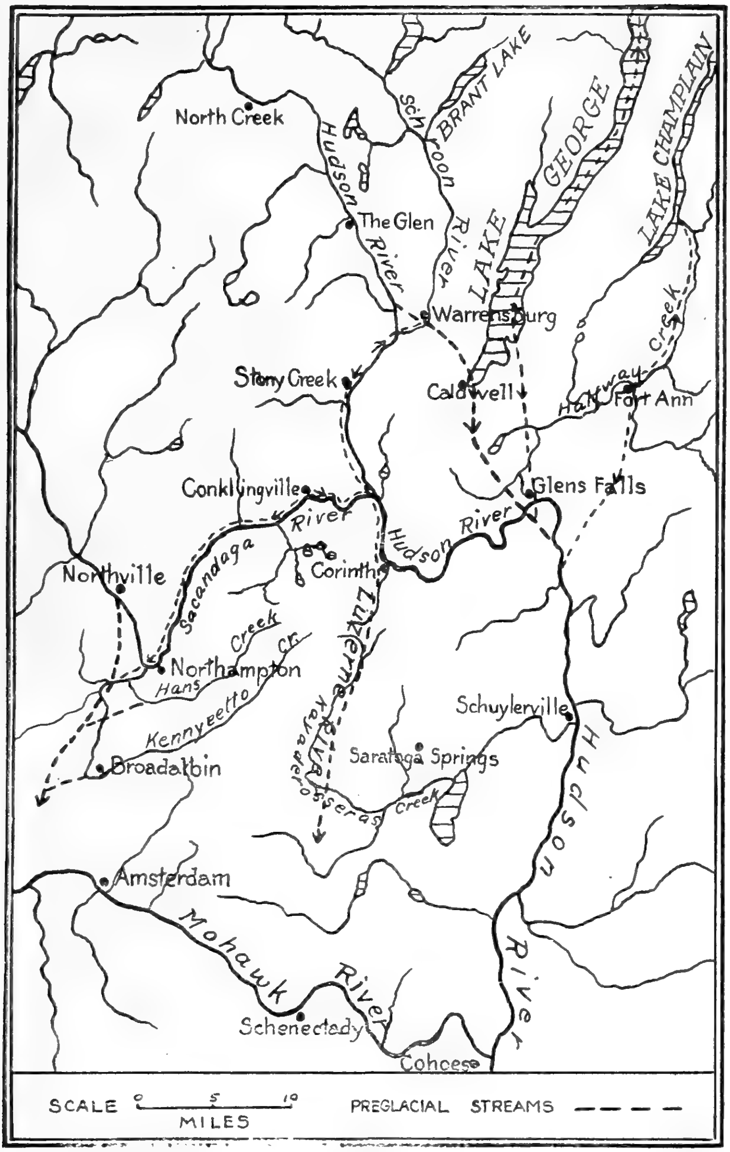


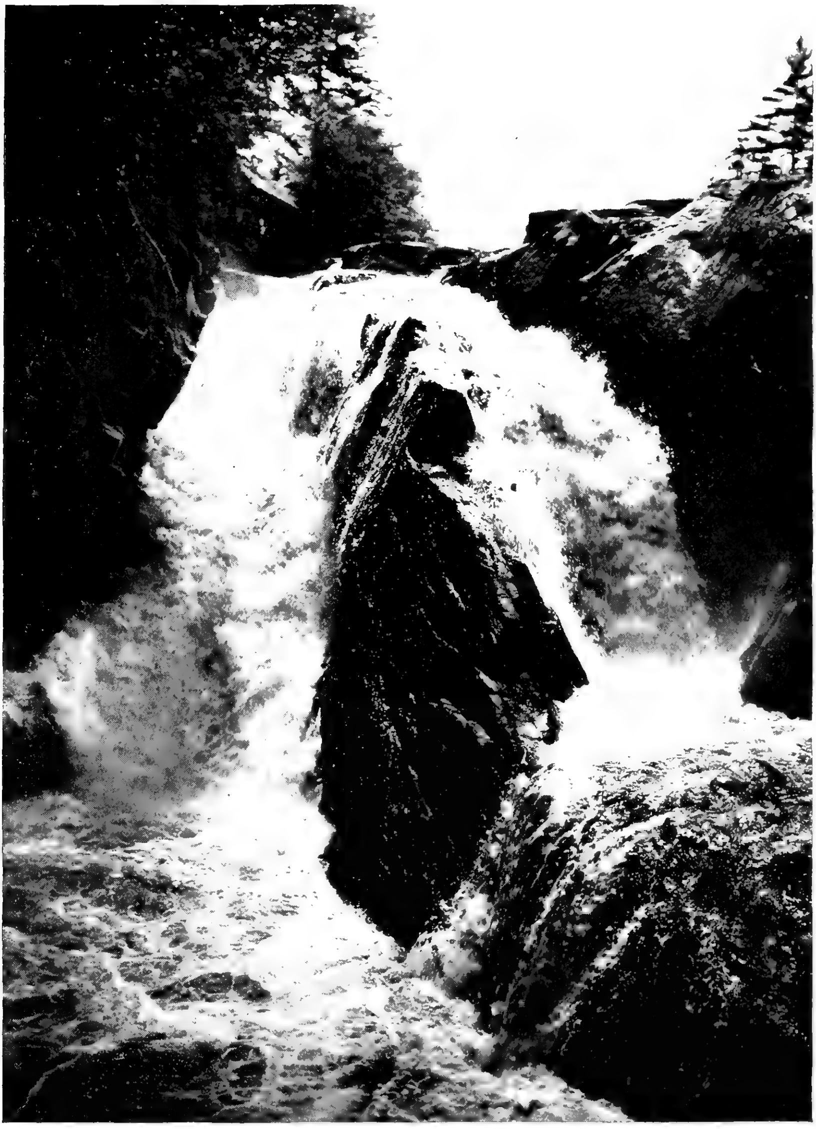
FIG. 14 Sketch of the southeastern Adirondack region, showing the relation of the preglacial drainage to that of the present. Preglacial courses shown only where essentially different from present streams. (By W. J. M.)

Other conspicuous drainage changes have taken place in the heart of the Adirondacks. Before the Ice Age the basins now occupied by Blue Mountain and Eagle lakes quite certainly drained eastward into the Hudson river by way of Rock river instead of westward as at present through Raquette lake and thence northward into the St Lawrence. Evidence in support of this view is twofold, namely, the rock barrier at the western end of Utowana lake and the loose glacial débris dam at the eastern end of Blue Mountain lake. Loose material only separates Utowana and Eagle lakes. Thirty-four marsh and Rock river come to within a half mile of Blue Mountain lake and they are about 20 feet lower than the lake surface, the intervening space being occupied by loose sands and gravels. It would be a simple matter, by shoveling out a trench not over 20 feet deep, to cause Blue Mountain and Eagle lakes to drain eastward. Years ago such an attempt was made but stopped by law. Thus the movement of water here must have been eastward in preglacial time.

That the preglacial drainage through the Utowana lake basin passed westward into the basin now occupied by Raquette lake is certain, there being only loose material across the western end of Utowana lake. From the Raquette lake basin the preglacial drainage was almost certainly southwestward by way of the valleys now occupied by the Fulton chain of lakes. A maximum thickness of less than 100 feet of glacial deposits just north of Eighth lake is all that is necessary to account for the blockade of the southwesterly preglacial channel with resultant ponding of the waters to form Raquette lake. Further evidence for the southwestward course lies in the fact that between Forked lake and Long lake, Raquette river descends more than 100 feet in about 3 miles, mostly by a series of cascades over rock ledges which extend across the narrow channel. Apparently a preglacial divide was situated not far below what is now the outlet of Forked lake, the drift deposits southwest of Raquette lake being sufficient to cause the ponded waters of Raquette and Forked lakes to overflow this divide.

The depression now occupied by Long lake was certainly a preglacial stream channel, and there is also strong evidence that the drainage from this channel passed eastward into the Hudson river rather than northward by way of Raquette river and into the St Lawrence as at present. At Raquette falls, on the river a few miles below the outlet of Long lake, there was a divide with a north-flowing and a south-flowing stream from it. Thus, in preglacial time two streams drained into the depression now occupied by Long

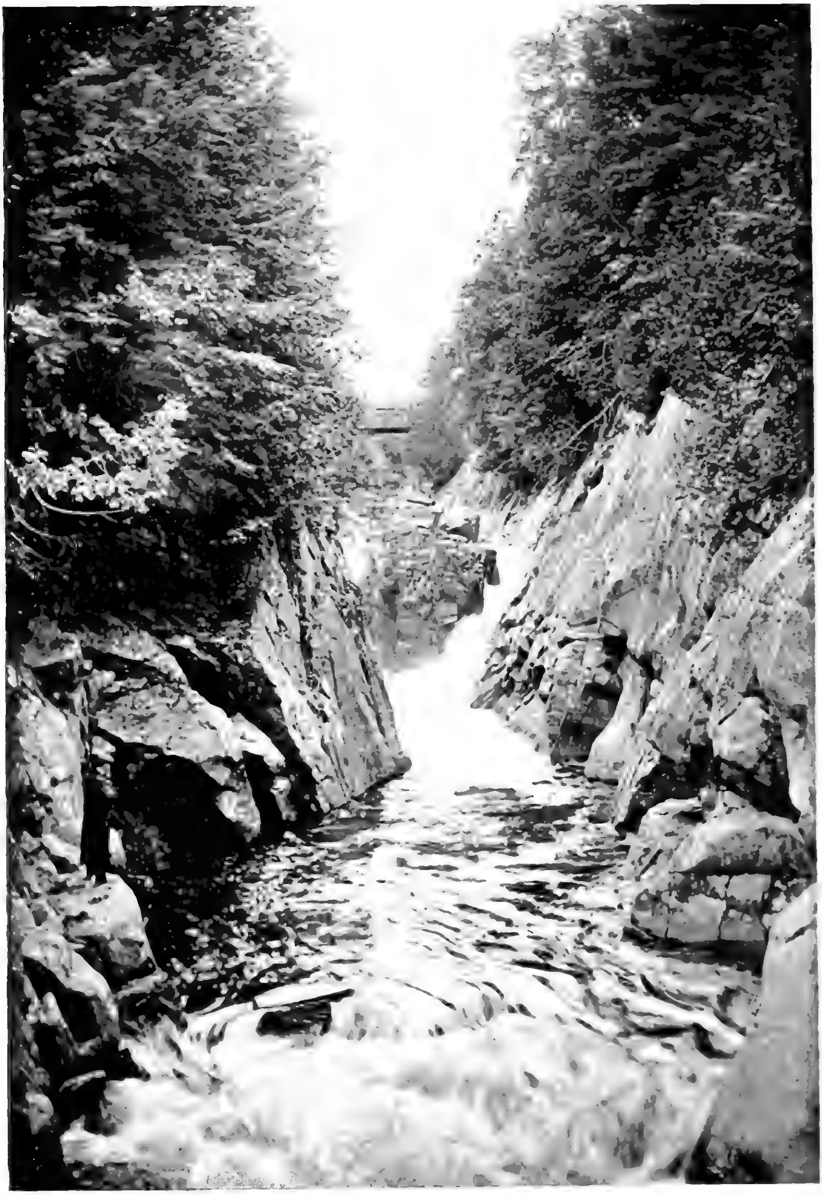
Plate 22



Photograph loaned by J. D. Washer

High Falls of the West Branch Ausable river near Wilmington Notch, Essex county. Height of falls, 50 feet. The river here follows a post-glacial course along a fault zone of weakness in the rock.

Plate 23



Courtesy of A. Alletag, New York City

The Flume — a gorge through which flows the West Branch of Ausable river 2 miles southwest of Wilmington, Essex county. This gorge has been formed since the Ice Age.

lake, one north-flowing from the divide near the outlet of Forked lake, and the other south-flowing from the divide at Raquette falls. These streams met to flow eastward into the Hudson river, as Professor Cushing has suggested, either through the Sixmile-Fishing Brook valley in the northeastern part of the Blue Mountain quadrangle, or through the Catlin Lake-Round Pond valley in the southeastern part of the Long Lake quadrangle. In the writer's opinion the best evidence favors the latter channel. Years ago an attempt was actually made to cut a trench through this divide in order to drain Long lake into the Hudson river.

The famous Ausable chasm in Clinton county is a fine illustration of a narrow gorge cut 200 feet deep into Potsdam sandstone by the Ausable river since the Ice Age. The river was deflected from its preglacial channel by a heavy blockade of glacial débris and forced to erode this new channel.

In the Lake Placid quadrangle there is a remarkable gorge known as the Wilmington notch through which flows the West branch of the Ausable river. The south wall of the gorge rises precipitously 600 to 800 feet, while the north wall is more than 1500 feet high and very steep. In preglacial time there was a low divide instead of the notch, with a south-flowing and a north-flowing stream from it. The big glacial lake (see above) which occupied the valley south and southeast of Lake Placid had its waters (known as upper Lake Newman during an earlier stage) held up by the northward retreating ice sheet whose front still filled the Wilmington notch. Further retreat of the ice permitted a lower stage of Lake Newman to connect through the notch with waters in the Wilmington and Keene valleys. During this stage the connecting water flowed southwestward through the notch and into a great lake in the Saranac Lakes valley. With still further retreat of the ice, Lake Newman disappeared; the standing water in the Wilmington valley (Wilmington lake) discharged eastward; and the drainage of that portion of the basin of Lake Newman south and southeast of Lake Placid, where much sediment had accumulated, was northeastward as a stream flowing through the Wilmington notch. Thus was inaugurated the flow, through the notch, of the present stream which, aided by the broken up character of the rocks due to faulting and excessive jointing, has cut a considerable gorge since the Ice Age.

Duration of the Ice Age and time since. Estimates of the duration of the Glacial epoch by the most able students of the subject vary from 500,000 to 1,500,000 years. Such estimates are based upon amount of erosion and weathering of the earlier glacial deposits in the Mississippi valley, times necessary for the various advances and retreats of the various ice sheets, etc. Thus, from the standpoint of geological history, the Ice Age was of short duration, but, from the standpoint of human history, it was very long.

Estimates of the length of time since the close of the Ice Age are perhaps more satisfactory, though it must be remembered that the close of the Ice Age was not the same for all places. The ice retreated northward very slowly and when, for example, southern New York was free from ice, northern New York was still in the Ice Age. The best estimates for northern New York are based upon the rate of recession of Niagara Falls. The falls came into existence by the plunge of the newly formed river over the limestone cliff at Lewiston, 7 miles below the present falls, immediately after the melting of the ice sheet from that locality. Careful study of all the data has led a number of students of the subject to give estimates of from 8000 to 50,000 years since the ice left the Niagara region, an average being about 25,000 years. Approximately, then, the ice disappeared from the Adirondacks about 20,000 to 30,000 years ago. When we consider the slight amount of weathering and erosion of the latest glacial materials, we are also forced to conclude that the time since the close of the Ice Age in northern New York is to be measured only by some thousands of years. The kames, lake deltas, eskers and moraines have generally been very little affected by erosion since their formation.

Most recent subsidence and elevation. At about the beginning of the Glacial epoch the region of New York State, especially along the eastern side, was much higher than it is today, positive proof for this being afforded by the submerged Hudson river channel which must have been cut when the land was higher. Toward the close of the Ice Age and shortly after the land had subsided to a level even lower than that of today. It was during this time of subsidence that the lower Hudson and St Lawrence channels were submerged and the sea coast was transferred to more nearly its present position. But the land was enough lower than now to allow a narrow arm of the sea (estuary) to extend through the Hudson and Champlain valleys to join a broad arm of the sea which reached up the St Lawrence valley and probably even into the Ontario basin (see figure 15). Beaches, sometimes containing marine shells and bones of walruses and whales, have been found at altitudes of about 400 feet near the southern end of Lake Champlain and 500 feet or more at its northern end. The present altitudes of these tide-water beach deposits show how much lower the land was during the time of greatest submergence, and that the subsidence was most toward the north.

The most recent movement of the earth's crust over the area of northern New York was the very recent gradual elevation which expelled the tide waters and left the land at its present altitude. The increasing altitudes of the beaches northward prove that the greatest upward movement was on the north. This recent elevation is also clearly registered by the delta sand plains which were formed in the larger glacial lakes of northern New York as, for example, Black lake and Lake Pottersville already described. The delta deposits of these extinct lakes gradually increase in altitude several feet a mile northward.

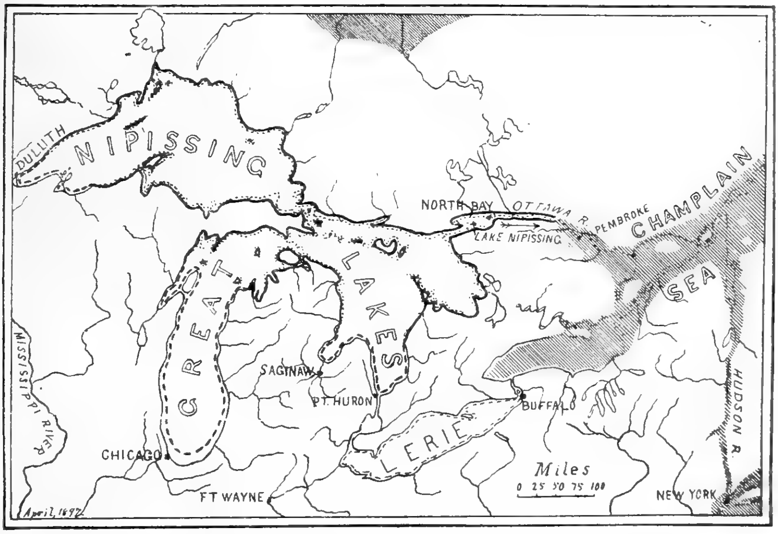


FIG. 15 The time of the Nipissing Great Lakes and Champlain submergence. The shaded area on the east was covered by sea water.
(After F. B. Taylor)

HUMAN HISTORY AND INDUSTRIES

The Indians

Before the coming of the white man, northern New York was occupied solely by Indians. There is no evidence, however, that the Adirondack wilderness ever had many permanent Indian settlements. Doubtless there were a few more or less well-defined trails through the wilderness, but the great Indian traffic ways between East and West, and North and South, were the low valleys surrounding the Adirondacks.

The Indians which occupied northern, central and much of western New York were known to the French as the "Iroquois," to the English as the "Five Nations," and they were called by themselves "Ho-de-no-sau-nee" meaning the "People of the Long House." The Five Nations constituted an Indian league or confederacy which became very powerful. Comprising the nations of the league were the Mohawks, Oneidas, Onondagas, Cayugas and Senecas, with rather definite property lines separating them. The Mohawks claimed much of the Mohawk valley and all the Adirondack region except a little of the western side which latter came within the territory of the Oneidas. A Canadian tribe of Algonquin descent, however, also claimed the northern portion of the Great Wilderness which slopes off toward the St Lawrence river. This Canadian tribe was derisively known to the Iroquois as the "Adirondacks" meaning "Tree-eaters." The disputed territory was very bloody battleground according to old Indian traditions.

As Sylvester has said: "Among all the Indians of the New World, there were none so politic and intelligent, none so fierce and brave, none with so many germs of heroic virtues mingled with their savage vices, as the true Iroquois — the people of the Five Nations. They were a terror to all the surrounding tribes, whether of their own or of Algonquin speech. In 1650 they overran the country of the Hurons; in 1651 they destroyed the Neutral Nation (on the west); in 1654 they exterminated the Eries (on the west); in 1672 they conquered the Andastes (on the south) and reduced them to the most abject submission. They followed the warpath, and their war cry was heard westward to the Mississippi, and southward to the great gulf. The New England nations, as well as the river tribes along the Hudson, whose warriors trembled at the name of Mohawk, all paid them tribute. The poor Montagnais on the far-off Saguenay would start from their midnight sleep, and run terror-stricken from their wigwams into the forest when dreaming of the dreadful Iroquois. They were truly the conquerors of the New World, and were justly styled 'the Romans of the West.'"[1]

In 1715 the Tuscaroras of the Carolinas joined the Iroquois who then were known as the "Six Nations."

The Adirondack wilderness was one of the greatest of the Indian hunting grounds and called by the Iroquois "Couch-sach-ra-ge." On Pownal's map of the northern British colonies in 1776, the following explanation is written across that portion representing the Great Northern Wilderness: "This Vast Tract of Land, which is the Antient Couchsachrage, one of the Four Beaver Hunting Countries of the Six Nations, is not yet Surveyed." The northern portion of the wilderness was much resorted to by hunting bands of the Adirondack tribes. Old maps show two Indian villages there, probably mostly occupied only during the summer season. One of these was in the vicinity of North Elba just south of Lake Placid, and the other near the Indian carry between Upper Saranac lake and the Raquette river. Traces of this latter village may yet be seen.

Early White Settlers

John Brown's tract. In 1794, James Greenleaf of New York purchased a tract of land containing 210,000 acres on the western slope of the Adirondacks extending from northwestern Hamilton county across northern Herkimer county and into Lewis county. Greenleaf soon mortgaged the property, and in 1798 John Brown [not the John Brown of Harper's Ferry fame] bought the whole tract for $33,000 at a mortgage sale. In 1799 Brown went to his possessions, made some improvements and established the family of one of his agents on the property. But in 1803 Brown died and the tract was deserted.

About 1812 Herreshoff, who married John Brown's daughter, began a settlement on the tract. "He cleared over two thousand acres, built thirty or forty new buildings, drove in cattle and a flock of three hundred merino sheep. He built a forge and worked a mine of iron ore. He spent his own fortune there and all the money that he could borrow from his friends. But the rugged old wilderness would not be subdued. When he entered the forest he made this declaration to a friend: 'I will settle the tract or settle myself.' He settled himself" (N. B. Sylvester). In 1819, utterly

[1] N. B. Sylvester. Northern New York and the Adirondack Wilderness, 1874, p. 17–18.

discouraged, he killed himself, and the settlement was deserted. Nathaniel Foster and his family lived in the Herreshoff settlement from 1832 for a few years. In 1837 Otis Arnold moved in and raised a large family there.

Number Four, on Beaver lake through which Beaver river flows, is situated in the western part of John Brown's tract, and it is one of the oldest permanent settlements in the Great Wilderness. The first fishing party visited the locality in 1818, and in 1820 Ephraim Craft made a clearing there as first settler. Through efforts of Governor Francis in 1822, ten families settled at Number Four. Many improvements were made, and by 1832 there were seventy-five settlers. But climate, soil and distant markets were against them, so that by 1853 only three families remained.

About 1820, Daniel Smith settled at Stillwater, 12 miles up the river from Number Four. In 1830 he moved still farther up the river to settle at a lake now known as Lake Lila (formerly Smith's lake). He lived a wild hermit's life there for fifteen years.

Lake Bonaparte. Early in the nineteenth century, Count de Chaumont owned several hundred thousand acres in northern New York. In 1815, Joseph Bonaparte, former King of Naples and of Spain and brother of the famous Napoleon, purchased of the Count de Chaumont over 150,000 acres on the western side of the Adirondacks. After his flight to America, Joseph Bonaparte lived in splendor near Bordentown, N. J. In 1828 he built a hunting lodge on Lake Bonaparte within his forest possessions. For several summers he made trips to his property. According to Sylvester: "He went in great state, accompanied by a large retinue of friends and attendants. . . . When on his way, he cut a road through the forest and often went in to his lake in his coach drawn by six horses, with great pomp and ceremony. . . . Upon these excursions he was often accompanied by the friends of his better days, who, like himself, were then in exile. Sometimes in going and returning, he would stop by the wayside to dine under the shade of the primeval pines, and his sumptuous repasts were served on golden dishes with regal splendor." In 1835 he sold his wilderness property.

North Elba and John Brown of Ossawattamie. The vicinity of the present village of North Elba, a few miles south of Lake Placid, has an interesting history. For many years, until the close of colonial days, Adirondack Indian hunting parties made summer homes in that broad valley between the mountains.

Very early in the nineteenth century a number of white families settled in this valley, in the far-off dense wilderness. They called the valley the "Plains of Abraham."

In 1810, McIntyre and several friends from Albany built the North Elba Iron Works which was operated rather unsuccessfully for sixteen years.

But the early settlers had no legal right to their lands, and in 1840 a land speculator forced them out of their homes. Very shortly afterward, Gerrit Smith bought a large tract of land, including North Elba and the Plains of Abraham. His purpose was to settle the lands with free colored people, offering each family forty acres for encouragement. In 1849 Smith made a present of 350 acres to John Brown of Ossawattamie. This land lay on the opposite (western) side of the Ausable river from North Elba. Enthusiastic with the idea of a negro colony, John Brown moved his family into the wilderness. With the help of colored people, he made many improvements in the mountain hamlet. He purposed to make it a home for the persecuted black people, but his colonization scheme was a failure. Though wild in spirit, John Brown was very religious, and had visions of great armies which were to march out to free the slaves. When the Kansas slavery troubles started, he and his sons soon got into the thickest of the fight. So, for nearly ten years or until his execution in 1859, he spent comparatively little time at his Adirondack home. In 1859 he made his famous attempt to free the slaves by force of arms. Failing in his attempt to capture the arsenal at Harper's Ferry, Virginia, he was captured and sentenced to death. Sylvester quotes a writer in "Old and New" for September 1870, as follows: "The house is unpainted and plain, though equal to the ordinary farmhouses of the region. It stands well up the hills, separated from the wilderness by a few cleared fields, commanding a majestic view of the mountain world. A few rods in front, a huge boulder, surrounded by a plain board fence, is the fit monument of the fierce old apostle of liberty. At its foot is the grave. The headstone was brought from an old graveyard in New England, where it stood over the grave of his father, Captain John Brown, who died in New York in 1776. The whole stone is covered with the family inscriptions. . . . Above the little grassy inclosure towers the mighty rock, almost as high as the house, and on its summit is cut in massive granite characters the inscription 'John Brown, 1859.' Standing on top of this monumental rock, for the first time I felt that I comprehended the character of the man whose name it commemorates. I could well understand how such a man, formed in the mold of the old Scotch Covenanters and English Puritans, brooding over the horrors of slavery, foreseeing the impending struggle for liberty, maddened by the murder of his son and friends in Kansas, with the mighty northern hills looking down upon him, the rush of strong rivers, and the songs of resounding tempests, and the mystery of the illimitable wilderness all about him, should easily come to think himself inspired to descend like a mountain torrent, and sweep the black curse from out the land. I reverently raised my hat, and sung, 'John Brown's body lies a-mouldering in the grave; his soul goes marching on.'"

The John Brown farm is now owned and kept up by the State of New York.

Mines and Quarries.

Adirondack village and Iron Works. One of the most interesting and dramatic chapters in the history of the Adirondacks is that dealing with Adirondack village and the Iron Works. S. R. Stoddard in "The Adirondack" says: "The history of the Adirondack (village) is brief and sad. Messrs. Henderson, McMartin and McIntyre, who, in 1826, owned and operated iron works at North Elba, were shown a piece of ore of remarkable purity by an Indian, which, he said, came from a place where 'water run over dam, me find plenty all same.' The services of the Indian were secured at once, at the rate of two shillings and what tobacco he could use per day, to conduct them to the place spoken of, where they found, as he had said, where the water literally poured over an iron dam. A tract of land embracing the principal ore beds in that vicinity was promptly secured, forges built, and the road cut from the lower works to Lake Champlain. But the expense of transportation to market swallowed up all the profits and the enterprise proved a financial failure. The work, however, was persevered in until the death of Mr Henderson, who was killed in 1845 by the accidental discharge of his pistol."[1] Three years after his death the iron works were abandoned.

Another blast furnace was installed in 1853 but operated only till 1856. A few years ago, after an idleness of nearly sixty years, some thousands of tons of ore were taken out and shipped, via North Creek to the Port Henry blast furnaces in Essex county. Whether mining of the ore is now being carried on, the writer does not know. It is magnetic iron ore and the deposits are extensive.

[1] R. S. Stoddard. The Adirondacks, 1893, p. 176–77.

Other iron mines. Aside from the locality just described, there are many places where magnetic iron ores have been more or less mined during the last one hundred years, but only the more important ones are considered.

The greatest iron mines in New York State are in the vicinity of Port Henry, Essex county. Of these the oldest is what is now called the Cheever mine (north of Port Henry) which was first worked late in the eighteenth century. But still greater ore deposits, known as early as 1835–40, are at Mineville, 6 miles northwest of Port Henry, where two companies own property. All the mines mentioned are now in operation, their total production to date being no less than 25,000,000 tons. The ores are crushed and then concentrated by a magnetic separation process. They are very pure and of high grade. Approximately 1,000,000 tons a year are now taken out.

In the vicinity of Hammondville, Essex county, are other considerable iron ore mines, the first of which was worked in 1824. These mines were most active from 1873 to 1890, ceasing to operate in 1893. About 2,000,000 tons of ore have been taken out.

In southern Clinton county (near Ausable Forks) there are several magnetic iron ore deposits, especially the Arnold Hill and Palmer Hill mines, the former having been intermittently worked from 1806 to 1906, and the latter between 1825 and 1890. Altogether about 2,000,000 tons of ore have been removed.

The Lyon Mountain magnetic iron ore mines are situated near Dannemora in Clinton county. Mining began there in 1871, and still continues very actively. The ores are extensive and of high grade. Approximately 4,000,000 tons of ore have been mined.

Though early known, systematic operations did not begin at the Benson Mines in southern St Lawrence county till 1889. Work has been rather intermittent since then. Several hundred thousand tons of ore have been removed.

Graphite mines. As already stated, flakes of graphite (so-called "black lead") are of common occurence in certain strata of Grenville age. At several localities much graphite has been mined.

By far the most important mine is that owned and now operated by the Joseph Dixon Crucible Company at the village of Graphite in Warren county. A hard quartzite rock, distinctly stratified in relatively thin layers, contains the graphite. This rock is mined by underground methods, crushed, and the flakes of graphite separated by mechanical means. This is one of the most important graphite mines in America, and has been in operation many years. It produces two to three million pounds a year.

Several smaller mines have been operated from time to time in Essex, Warren and Saratoga counties.

Garnet mines. Since 1882, garnet for abrasive purposes has been mined in northwestern Warren county. It is the common red garnet used to manufacture garnet paper and cloth instead of ordinary quartz sandpaper. The oldest working is the Rogers mine on Gore mountain where the numerous garnets are from an inch to a foot or more in diameter, embedded in a gray rock. The work is all done by hand.

The North River Garnet Company has a large mine in operation on Thirteenth lake. There the garnets are smaller but the production larger. The rock containing them is crushed, and the crushed garnet is removed by machinery.

The total output of the garnet mines is several thousand tons a year.

Stone quarries. Building stones of excellent quality are exceedingly abundant in the Adirondacks. Whole mountains are commonly made up of such materials, especially granite, syenite and anorthosite. Because of lack of transportation facilities and distance from markets, these stones have been quarried at very few localities except for local use. Some of the principal stone quarries are as follows: granite, syenite and anorthosite near Ausable Forks; anorthosite near Keeseville; and granite near Dannemora. Considerable shipments are made from these places.

Green marble (so-called verde antique) of Grenville age was formerly quarried near Thurman, Warren county, and in the vicinity of Port Henry, Essex county.

Forests and Lumbering

Much of the Adirondack region is heavily wooded, though very little of the virgin forest now remains. " By far the greater part of the forest is of deciduous growth, about 20 per cent only of the trees being conifers. Of the deciduous trees, the most common species are the maple, birch and beech, with their varieties. Next in the order of quantity, come the poplar, ash, cherry, ironwood, basswood, willow, elm, red oak, butternut, sycamore and chestnut. The smaller species of trees or shrubs are represented by the mountain ash, alder, mountain maple, elder, striped, dogwood, shadbush, sumach and 'witch-hopple.' The chestnut is very rare throughout the Adirondack plateau; although growing close to the foot of the

Plate 24

H. P. Cushing, photo

A general view, looking south from southern Franklin county into northern Hamilton county, illustrating the densely wooded character of the Adirondack region

Plate 25

Courtesy of the New York Central Lines

Densely forested mountains near Saranac lake in the northern Adirondacks

hills, it disappears on the higher altitudes of the Great Forest. For the same reason the oaks are rare and stunted. Among the conifers are found the spruce, hemlock, balsam, tamarack and white cedar. Some white pine of original growth remains, but this noble tree, which once grew thickly throughout the whole region, is now limited to a few small patches of inferior quality."[1]

The principal commercial soft woods are spruce, balsam, pine and tamarack (larch), and the principal hard woods are birch, beech, maple and cherry.

When a tract of land has been "lumbered over" this does not necessarily mean that all trees of considerable size have been removed. In by far most cases, the method is to "lumber" a district for certain kinds of trees. Thus, a tract of land may be "lumbered over" for certain soft woods, later for certain hard woods, and again for other soft woods or even for a second growth of soft woods. If, for example, the spruce has been cut, a new growth of marketable size is looked for in about fifteen or twenty years. Twenty years after going over a tract of land for spruce, the casual observer would scarcely know that the tract had been "lumbered."

Much of the Adirondack region is now owned by the State and, according to the present law, lumbering operations are not allowed on state lands. The time should soon come when certain mature trees can be removed from the state forests, thus allowing the benefit of the use of such trees without injury to the forests themselves.

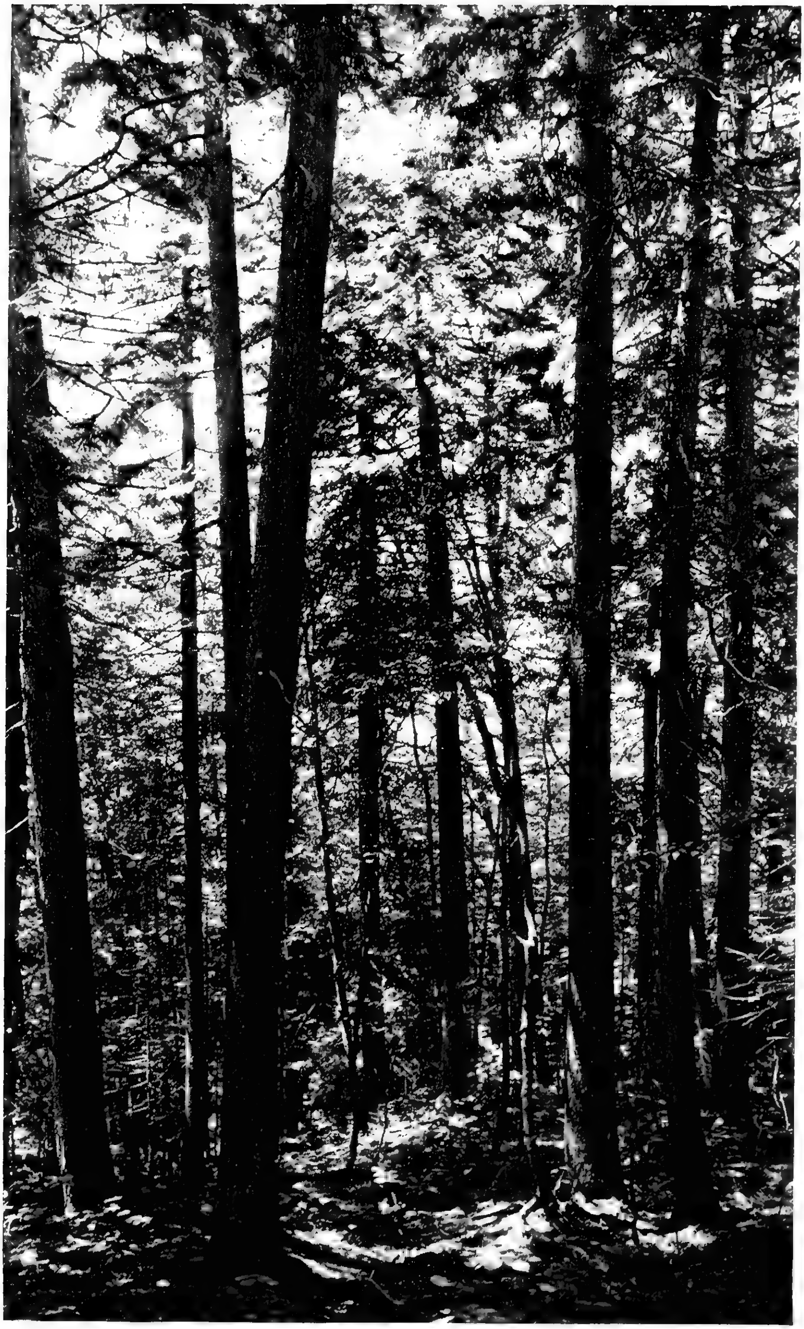
In the Adirondacks, the usual method of lumbering is to cut the logs into lengths of 13½ feet and drag them into great piles in the woods. When the snow is deep enough, the logs are usually moved from the woods in big loads on runners. Some are taken to local sawmills, but most of them are dumped into certain streams. In some cases the logs are sent down the mountain sides to the streams through chutes or flumes. During the spring, when the ice has gone out and the water is high, the logs are "driven" downstream, often for many miles, to saw, pulp and paper mills. Each company has its own mark stamped into the end of each of its logs to serve as a means of identification. Logs are thus "driven" down nearly all the principal Adirondack streams. The "log-drivers" often become very expert, and their profession is one of the most characteristic of the woods and is well paid. Large reservoirs are commonly constructed for the purpose of rushing a big volume of water

[1] New York Forest Commission, 1891, p. 103.

down stream in a short time to facilitate the transit of the logs. Sometimes thousands of logs form great " jams " against obstacles in the streams, and much labor is required to break up such " jams."

Forest fires have wrought havoc in the Adirondacks. Hundreds of square miles have been burned over, often leaving nothing of value. In such cases, a second growth of any use requires many years. In certain severe fires, forested mountains have been so thoroughly denuded that even the sod has been consumed, leaving nothing but mountains of barren rocks. One of the most severe fires of this kind in recent years devasted many square miles in the vicinity of Long Lake West on the Adirondack Division of the New York Central Railroad in 1908. Shortly after this great fire, the State adopted a system of fire watchmen on various prominent peaks throughout the Adirondacks. During the season when fires are likely, these watchmen, supplied with maps, field glasses and telephone, scan the forests in all directions. Immediately upon the discovery of a fire, the nearest fire warden, notified by telephone, goes out, with assistants if necessary, to fight the fire. Since this plan has been adopted, disastrous fires have been very notably reduced.

Plate 26



Courtesy of Warwick Carpenter, Albany, N. Y.

A view in the virgin forest near West Canada lake in the southern Adirondacks

Plate 27

Courtesy of Warwick Carpenter, Albany, N. Y.

Lumberman's refuse which becomes tinder for a forest fire

Plate 28

Courtesy of Warwick Carpenter, Albany, N. Y.

A scene of desolation where dense woods have been ravaged by a forest fire

Plate 29

Courtesy of the New York Central Lines

Road through an Adirondack pine forest

Plate 30

Courtesy of the New York Central Lines

Adirondack white birches

APPENDIX

SOME COMMON ADIRONDACK MINERALS

A *mineral* is a homogeneous, natural substance with a definite chemical composition, and usually in solid form. Nearly a thousand well-defined species are known.

A *crystal* is a mineral with a regular external form bounded by plane faces and possessing a definite internal structure. Crystals commonly develop from ordinary solutions or during the cooling of molten masses of rock.

Mineral cleavage is the tendency of certain minerals to break along more or less smooth, plane surfaces in one or more directions.

Amphibole. Crystals usually in short stout prisms, the prismatic faces meeting at 124 degrees. Two good cleavages at 124 degrees. Color commonly brown to black, but sometimes white or green. Some varieties can just be scratched by a knife, others can not. *Hornblende,* the most common variety, is a silicate of lime, magneisa, iron, aluminum etc., and is dark colored. *Tremolite* is a silicate of lime and magnesia, and is white.

Hornblende is very abundant in the Adirondack region, being a prominent constituent of the syenite-granite series; some dark phases of the anorthosite; gabbro; and many of the Grenville gneisses. Well-formed crystals are not common. Tremolite is much rarer, but occurs locally in certain Grenville strata, especially those associated with limestone.

Apatite. Crystals are hexagonal prisms capped by six-sided pyramids. Just hard enough to scratch glass. No good cleavage. Color, greenish, bluish green or brown. Composition, a phosphate of lime.

Well-formed microscopic crystals are common in the Adirondack igneous rocks and in certain of the Grenville gneisses. Locally, crystals from a fraction of an inch to several inches long are developed in the Grenville limestone.

Asbestos. See sepentine.

Augite. See pyroxene.

Biotite. See mica.

Calcite. Commonly called "calc-spar." Crystals show many variations, though all have a threefold development such as three-sided prisms, pyramids or rhombohedrons. Very perfect cleavage in three directions yielding fragments with faces which meet at 105° and 75°. Color, white when pure. Relatively soft, can be scratched with a copper coin. Composition, carbonate of lime.

Calcite is the chief constituent of the Grenville limestone, generally making 75 to 95 per cent of the mass and is therefore very abundant in the Adirondacks.

Chalcopyrite. Commonly called "copper pyrites." Rarely in crystals. No cleavage. Color, deep brass-yellow. Relatively soft, can be scratched by a copper coin. Composition, sulphide of copper and iron.

Fairly widespread as a very minor constituent of the anorthosite and often clearly visible to the naked eye.

Coccolite. See pyroxene.

Feldspar. There are several important varieties of feldspar with certain features in common as follows: two well-defined cleavages at or near 90°; scratched by quartz or flint but not by a knife; crystals in prismatic forms usually making angles of 120°; composition, silicate of aluminum with potash, soda or lime. Color, white, pink, or greenish gray. *Orthoclase* is a white to pinkish potash feldspar with two cleavages at exactly 90°. *Microcline* is much like orthoclase except for cleavages at 89° 30′ and crossed striations when viewed as a thin slice under the microscope. *Albite* is a white soda feldspar with cleavages at 86° 24′. *Oligoclase* is a greenish white soda-lime feldspar with cleavages at 86° 32′. *Labradorite* is a greenish gray to dark gray lime-soda feldspar with cleavages at 86° 4′, and it sometimes exhibits a play of colors on one cleavage face. *Anorthite* is a white lime feldspar with cleavages at 85° 50′. *Plagioclase* includes albite, oligoclase, labradorite and anorthite, and these nearly always exhibit well-defined striations on one of the cleavage faces.

Orthoclase is a very prominent constituent of the syenite-granite series and pegmatite, but is rare in the other igneous rocks. It is common in many of the Grenville gneisses. Albite and anorthite seem to be uncommon in the Adirondacks. Microcline and oligoclase in smaller amounts generally accompany orthoclase. Labradorite is the chief constituent of the anorthosite, gabbro and diabase. It also occurs in some of the Grenville gneisses.

Garnet. Exists in several varieties differing in color and composition. Most common in the Adirondacks is *almandite* garnet which often occurs as good, very symmetrical crystals with twelve or twenty-four faces or a combination of the two. Hardness, greater than that of quartz or flint; color, red to reddish brown; very brittle; and only imperfect cleavage. Almandite is a silicate of aluminum and iron.

Garnet occurs as an accessory mineral in many Adirondack formations. In some phases of the anorthosite, syenite-granite and gabbro, it is often clearly visible to the naked eye. Some of the Grenville gneisses are rich in garnets, individual crystalline masses frequently attaining diameters from an inch to a foot or more in certain hornblende gneisses as, for example, at the garnet mines near North Creek and at Thirteenth lake in Warren county.

Graphite. Often called "black lead." Seldom appears as good crystals, but nearly always as thin, shiny-black, flexible flakes with one almost perfect cleavage. It is opaque, easily scratched by the finger nail, and leaves a black mark on paper. Composition, pure carbon.

Certain of the Grenville gneisses, schists and quartzites, and most of the limestone contain graphite in clearly visible flakes in amounts up to 10 or 12 per cent. Rarely, small veins of graphite have been found. Graphite-rich schists are mined on a large scale for the mineral at the village of Graphite in northeastern Warren county. Smaller mines have been operated in other parts of Warren county and in Saratoga county. Small masses of graphite have occasionally been noted in pegmatite. Good six-sided tabular crystals may sometimes be seen in the limestone.

Hornblende. See amphibole.

Hypersthene. See pyroxene.

Ilmenite. Commonly called "Titanic iron ore." It is an oxide of iron and titanium. Seldom in well-defined three or six-sided thick tabular crystals. In many respects much like magnetite (see below), but it is only slightly magnetic and gives the chemical test for titanium.

Ilmenite occurs in small amounts as scattering grains in most of the Adirondack igneous rocks, but at Lake Sanford, Essex county, there are tremendous deposits of this mineral.

Limonite. This is a hydrous oxide of iron commonly called "bog iron ore." Many of the Adirondack rocks, when weathered, show brown or yellowish brown colors due to the presence of limonite which has formed during the decomposition of iron-bearing minerals. Thus the typical, fresh, greenish gray syenite often has a brown outer zone.

Magnetite. This mineral, commonly called "magnetic iron ore," is one of the oxides of iron. Often found in good crystals, either regular octahedra or dodecahedra forms, but more often as irregular grains. It is black, with a metallic luster; about as hard as steel; and strongly attracted by the magnet. Generally closely resembles ilmenite (see above).

Magnetite is widespread throughout the Adirondacks, being found as scattering grains in the anorthosite, syenite-granite, gabbro and diabase, as well as in some of the Grenville gneisses. Locally, the magnetite makes up extensive ore bodies, as at Mineville, Essex county, and at Lyon Mountain, Clinton county.

Mica. This is a family name including several important members, all of which possess a very perfect cleavage in one direction whereby the mineral peels off in exceedingly thin layers. Mica most often appears as thin flakes scattered through rocks, but sometimes in good six-sided tabular to prismatic crystals. All micas are silicates of aluminum, and all are relatively soft, being easily scratched by a copper coin.

Muscovite is a potash mica, transparent in thin sheets. It occurs in relatively large masses in some of the pegmatite, and in small, shiny flakes in certain Grenville gneisses and quartzites.

Biotite is an iron-magnesia mica, dark colored but translucent in thin sheets. As small flakes it often occurs in many types of the Adirondack rocks and in certain of the Grenville gneisses.

Phlogopite is a magnesia mica, brown and translucent in thin layers. It occurs only in certain Grenville gneisses, schists, quartzites and limestones.

Microcline. See feldspar.

Muscovite. See mica.

Orthoclase. See feldspar.

Phlogopite. See mica.

Pyrite. Usually known as "iron pyrites" or "fools gold." It often shows good crystal forms as cubes, octahedrons, pyritohedrons, or combinations of these. It is a sulphide of iron; scratched by quartz but not by a knife; of pale brass-yellow color with a metallic lustre; very brittle; and has practically no cleavage.

Pyrite occurs, in small amounts, as irregular grains or specks in anorthosite, gabbro, diabase, and certain of the Grenville gneisses and schists.

Pyroxene. This is a family name including, in the Adirondacks, *augite,* (a silicate of magnesia, lime, aluminum and iron); *hypersthene* (a silicate of magnesia and iron); and *coccolite* (a silicate of lime and iron). All these have two fairly well-defined cleavages meeting at nearly 90°. Augite and hypersthene are dark green to black and usually in good crystalline forms difficult to distinguish (without the microscope) from hornblende except by differences in cleavage directions. Augite is common in the anorthosite, syenite-granite, gabbro and diabase. Hypersthene is rare except in the gabbro, anorthosite and diabase. Coccolite (or hedenbergite) is a grayish green pyroxene abundant in certain Grenville gneisses.

Pyrrhotite. Commonly called "magnetic pyrites." It is a sulphide of iron somewhat like pyrite, but is softer than a knife, has a bronze color, and it attracted by the magnet.

It exists as small scattering grains in certain Grenville limestones and gneisses, and in the anorthosite.

Quartz. This very common mineral is an oxide of silicon which often crystallizes in characteristic hexagonal prisms capped by six-sided pyramids. It is notably harder than steel; clear and glassy looking when pure; very brittle; and without cleavage.

It is very abundant as distinctly visible grains in all the granites and most of the syenites and pegmatites of the Adirondacks. It also largely constitutes the Grenville quartzites and is prominent in many of the lighter colored Grenville gneisses and limestones.

Serpentine. A dull green to yellowish green mineral usually in irregular massive form. Never crystallized. It is a hydrous silicate of magnesia with a greasy luster and is easily scratched by a knife. A fibrous variety is known as serpentine *asbestos* which is rarely found in small veins in Grenville limestone as near Thurman P. O. in Warren county.

Serpentine at times occurs in considerable quantity in the Grenville limestone, causing the rock to have a grayish green or mottled green and white appearance. Such rock is variously called "serpentine marble," "ophicalcite," or "verde antique," the serpentine having resulted from the chemical alteration of pyroxene in the limestone. Such serpentine marble has been quarried at several localities in Warren and Essex counties.

Tourmaline. The chemical composition of this mineral is very complex, it being a silicate of baron and various metals. It often appears in good prismatic crystals which are usually triangular or with faces in multiples of three. It is transparent to opaque; harder than quartz or flint; without good cleavage; and, in the Adirondacks, is nearly always either black or brown.

Black tourmaline crystals, from a fraction of an inch to several inches long, are fairly common in the coarse grained pegmatite dikes. Brown tourmaline in small crystals may sometimes be seen in the Grenville limestone.

Tremolite. See amphibole.

Zircon. This is a silicate of zirconium harder than quartz or flint; of brown color; without good cleavage; and usually crystallized as four-sided prisms capped by four-sided pyramids.

Crystals up to one-half of an inch long are rarely seen in the pegmatite. Microscopic crystals are nearly always present in small amounts in the anorthosite, syenite-granite and gabbro.

There are, of course, many other minerals which are very rare or only locally developed in the Adirondack region, but the above list includes about all that are commonly met. Anyone further interested in the recognition of Adirondack minerals should consult some good book on mineralogy.

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