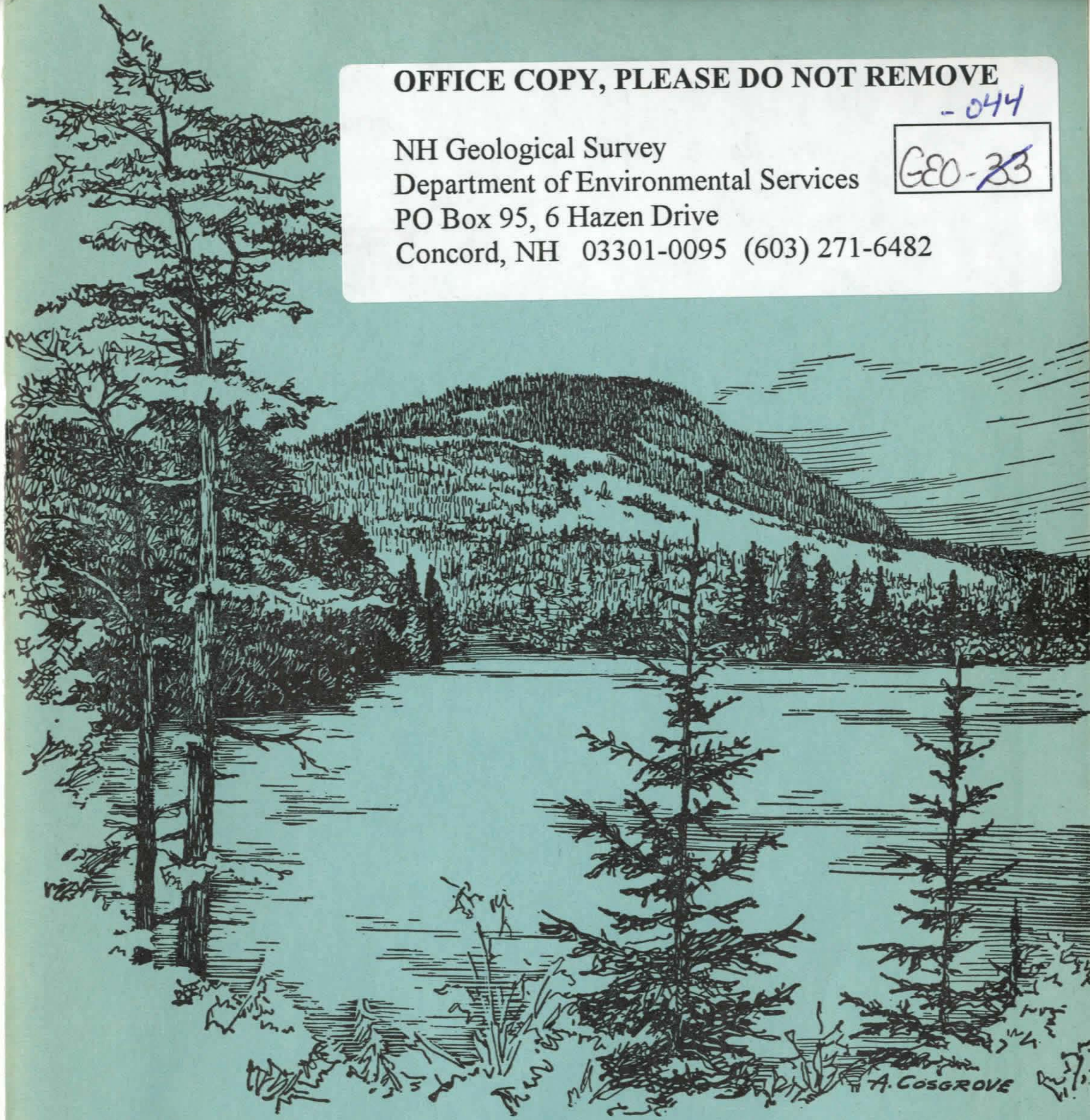

THE GEOLOGY OF THE Lovewell Mountain Quadrangle New Hampshire

by

MILTON T. HEALD

PUBLISHED BY THE NEW HAMPSHIRE PLANNING AND DEVELOPMENT COMMISSION

1950

Fig. 1 — Lovewell Mountain

The Geology of the Lovewell Mountain Quadrangle

New Hampshire

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FOREWORD

This pamphlet presents the story of the rocks in the Lovewell Mountain quadrangle in simple language for the layman. The topography and geology of the area are shown on the map accompanying the pamphlet. The reader need concern himself only with the formation names in the legend. A study of the detailed rock descriptions is not necessary for understanding the interesting story of the rocks.

The geological study of the Lovewell Mountain quadrangle was carried on in 1946 and 1947 under the auspices of the Division of Geological Sciences at Harvard University. The cost of the study was partially financed by grants from the R. W. Sayles Fund, Harvard University.

The publication of the geological map in the pocket at the end of the pamphlet was financed by the New Hampshire State Planning and Development Commission, the New Hampshire State Highway Department, and the Geological Society of America.

Geology of the Lovewell Mountain Quadrangle New Hampshire

By Milton T. Heald

THE SCENERY

The Lovewell Mountain quadrangle lies in southwestern New Hampshire. For those who enjoy vacationing in the country, the area is ideal because it is sparsely populated; yet is served by excellent roads. Fine trails leading from the highways enable the vacationist to take in the beauty of the more mountainous sections.

Nearly forty lakes and ponds add to the charm of the area. Highland Lake, which is 5 miles long, is the largest lake. Most of the western part of the quadrangle is drained by tributaries of the Connecticut River, whereas the eastern half is drained by tributaries of the Merrimack. The drainage divide extends through the central part of the area from Fletcher Hill in the south, through Morrison Hill, Pitcher Mountain, Oak Hill, Ames Hill and Sunapee Mountain.

The total relief is about 1600 feet but the average relief is only 400 feet. Lovewell Mountain (Fig. 1), with an elevation of 2473 feet, is the highest peak. The lowest point, 860 feet, lies four miles southeast of Lovewell Mountain at the eastern boundary of the area.

The origin of many of the natural wonders in the region can be better understood from a study of the rocks. The history of the area, as revealed by the rocks, is presented in the following pages.

THE STORY OF THE ROCKS

The Geologic Map

To more easily understand the story of the rocks, the reader should first examine the colored geologic map at the back of the pamphlet. Each color and pattern refer to different types of rocks which are briefly described in the legend on the map. All the types of rocks found in the area are listed in the legend with the oldest rocks at the bottom and the youngest at the top. The structure sections at the foot of the map show what kinds of rocks would be found in trenches cut down through the earth to 10,000 feet below sea level.

The Sea

The oldest rocks in the Lovewell Mountain quadrangle occur in layers or beds similar to the layers of sand and mud which are accumulating in the oceans today. Therefore, it is concluded that the layered rocks in the area formed from sands and muds which were deposited in a sea. Evidence from other regions indicates that this sea covered all of New England during the Devonian period, some 330 million years ago. During this period, a land mass stood far to the east in which is now the Atlantic Ocean. Westward flowing streams carried mud and sand from this land to the inland sea. The rocks in New Hampshire which formed from the sediments laid down in early Devonian time have been named the Littleton formation.

The Littleton formation in the Lovewell Mountain quadrangle has been subdivided into three units. The oldest unit, the Hubbard Hill member, is exposed in the northwestern and southwestern part of the area. This unit originally consisted of alternating layers of sand and mud which are now quartzites and mica schists (Fig. 2). Sillimanite, mica, black tourmaline, and garnet are conspicuous in many of the schists. Gravels with large pebbles of quartz were deposited locally during periods of greater stream activity in Devonian time. The quartz conglomerates which formed from the gravels, are well-exposed on Marlow Hill. During periods of quiescence, a small amount of limy mud accumulated which changed to white massive rock with small grains of green diopside and actinolite. Excellent exposures of this rock may be seen on Marlow Hill and at the road cut near Gee Mill.

FIG. 2 — Typical bedded schists of the Hubbard Hill member, summit of Silver Mountain. The rock has been smoothed and striated by the Continental Ice sheet which moved from right to left.

The May Pond member lies above and to the east of the Hubbard Hill member. It originally consisted of sandy muds which have been transformed into banded gneiss (Fig 3). The gneiss is composed of alternating light-colored layers rich in feldspar and quartz, and dark layers composed of biotite and garnet with subordinate amounts of quartz and feldspar. Typical outcrops of the gneiss are exposed along the roads leading into the village of Marlow and on Route 31 in Washington 600 feet south of the bridge over the Ashuelot River.

The youngest portion of the Littleton formation in the area is named the Dakin Hill member. Originally this member consisted of a thick accumulation of mud which has changed into massive gneiss. The lack of pronounced bedding and scarcity of sandy layers indicate that the streams which flowed into the sea were very sluggish. In stagnant portions of the sea, muds rich in sulphur and carbonaceous material accumulated. These muds are now graphite-bearing pyritiferous gneisses. The weathered outcrops of the pyritiferous gneiss are distinctive because they are stained dark brown or black due to the alteration of the pyrite.

Fig. 3 — Banded gneiss of the May Pond member.

Good exposures of the pyritiferous gneiss may be seen along Route 123 (Forest Road) between the villages of Stoddard and Marlow.

Thus during early Devonian time, a thick series of sediments accumulated in the Lovewell Mountain quadrangle (Fig. 4).

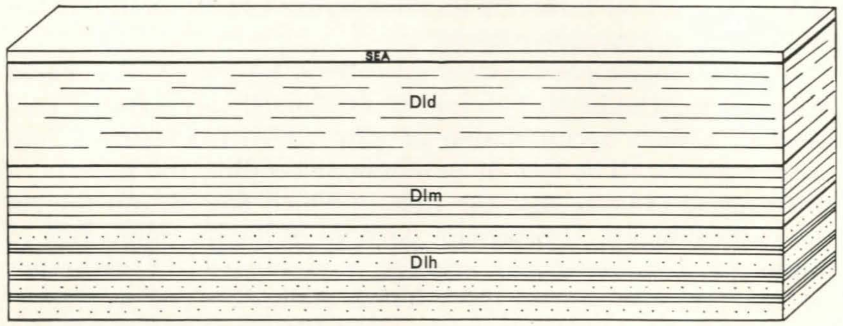

Fig. 4 — Sands and muds deposited in early Devonian time to form the Littleton formation (Dlh, Dlm, and Dld).

The Folding of the Rocks

The rocks in the area were subjected to tremendous horizontal forces during middle, or late Devonian time, some 300 million years ago. The beds in the western part of the quadrangle were tilted to the east and the rocks in the central part of the area were thrown into a series of tight folds (Figs. 5 and 6). Under the higher temperature conditions which existed at this

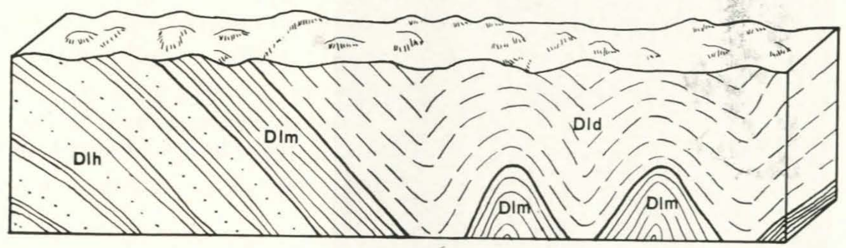

Fig. 5 — Folding of the rocks during middle Devonian (?) time.

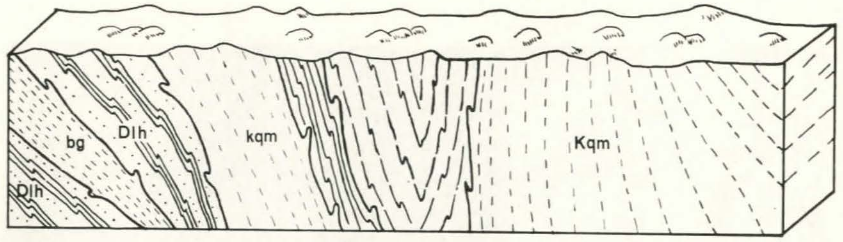

Fig. 6 — Additional folding and intrusion of the Bethlehem gneiss (bg) and Kinsman quartz monzonite (kqm) in the Devonian (?) time.

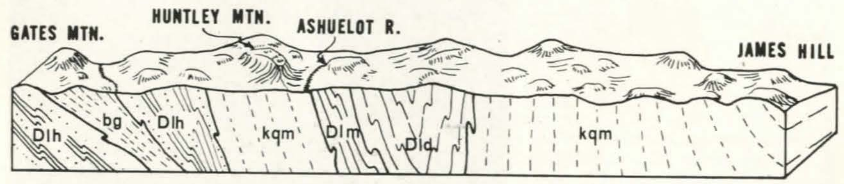

Fig. 7 — Erosion of rocks to present topography.

Figs. 4-7 — Series of diagrams to show the story of the rocks in the Lovewell Mountain quadrangle. The cross-sections are imaginary trenches a mile or so deep across the quadrangle from west on the left to east on the right. The sections show successive stages in the development of the region.

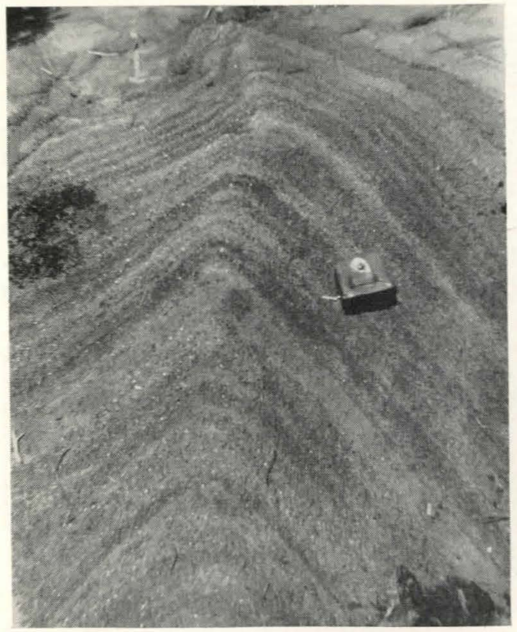

Fig. 8 — Folds in schists of the Hubbard Hill member. (Photo by J. R. Williams.)

Fig. 9 — Folded quartz veins and schists of the Hubbard Hill member. (Photo by J. R. Williams.)

time, the original sandstones and shales were transformed into quartzites, schists, and gneisses.

Superimposed upon the larger folds are many minor folds. Some of the folds extend across whole exposures; others are so small that they can be seen only under the microscope. Folds may be easily seen in many parts of the thinly bedded Hubbard Hill member (Figs. 8 and 9). Quartz pebbles in the conglomerates were drawn out into cigar-like forms during the folding (Fig. 10). These stretched pebbles indicate that the rocks have undergone a large amount of deformation because some of the pebbles which were originally nearly spherical are now sixteen times as long as they are thick.

After the rocks had been folded, they cracked in many places along nearly plane smooth surfaces called joints. The most prominent joints trend north-northeast and west-northwest. Solutions carrying silica deposited quartz in many of the joints (Fig. 11).

Fig. 10 — Stretched pebbles in quartz conglomerate. (Photo by J. R. Williams.)

Fig. 11 — Quartz veins emplaced along joints.

Geologic Time-Scale with Sequence of Events in the Lovewell Mountain Quadrangle

OLDEST EVENT IS AT BOTTOM OF CHART; YOUNGEST IS AT TOP

Era	*Period*	*Time-scale (age of beginning of period)*	*Sequence of geological events*
	Recent	25,000 years ago	Slight erosion, chiefly of glacial deposits.
Cenozoic	Pleistocene	One million years ago	Ice sheet covered the area depositing glacial drift, sands, and gravels.
	Tertiary	60 million years ago	Uplift and renewed erosion.
	Cretaceous	120 million years ago	Erosion.
Mesozoic	Jurassic	150 million years ago	Erosion.
	Triassic	175 million years ago	Erosion.
	Permian	210 million years ago	Erosion.
	Pennsylvanian	255 million years ago	Erosion.
	Mississippian	290 million years ago	Erosion.
Paleozoic	Devonian	330 million years ago	Erosion. Small granite bodies intruded. End of folding. Kinsman quartz monzonite and Bethlehem gneiss intruded. Folding and recrystallization of the rocks began. Littleton formation deposited in inland sea. Dakin Hill member: 10,000 feet of sandy mud (now massive gneiss). May Pond member: 5,000 feet of sandy mud (now banded gneiss). Hubbard Hill member: 6,000 feet of mud and sand (now schist and quartzite).
	Silurian	355 million years ago	No record.
	Ordovician	415 million years ago	No record.
	Cambrian	515 million years ago	No record.
Pre-Cambrian		More than one thousand million years ago	No record.

The Rise of Magma

During the closing stages of the folding in late Devonian time, molten magma rising from below intruded the rocks in the form of huge sheets approximately parallel to the bedding (Fig 6). These rocks belong to the New Hampshire magma series. The Bethlehem gneiss, which is the oldest igneous rock in the area, has wedged apart the northern portion of the Hubbard Hill member to form a large sill-like body. Two small bodies of Bethlehem gneiss occur in the west-central part of the area. The Bethlehem gneiss differs from ordinary granite in that the mica flakes in the gneiss are aligned parallel to each other thus facilitating the splitting of the rock along nearly plane surfaces. For this reason the Bethlehem gneiss was used to some extent by the early settlers for building purposes.

Shortly after the Bethlehem gneiss was emplaced, masses of Kinsman quartz monzonite intruded the metamorphosed sedimentary rocks. The mass of Kinsman quartz monzonite in the eastern portion of the area is part of one of the largest bodies of igneous rocks in New Hampshire. This body extends southward for 7 miles into the Monadnock quadrangle, eastward for at least 8 miles into the Hillsboro quadrangle, and northward for several tens of miles, probably into the Cardigan quadrangle. A large tabular body of Kinsman quartz monzonite occurs between the Hubbard Hill and the May Pond members in the northwestern part of the Lovewell Mountain quadrangle. Bodies too small to be shown on the geologic map are common in the metamorphic rocks near the large bodies.

The Kinsman quartz monzonite is coarser and generally lighter in color than the Bethlehem gneiss. Most of the Kinsman quartz monzonite has a distinctive appearance because of the presence of tabular white feldspar crystals which are one to three inches long. The large crystals are embedded in a medium-grained groundmass consisting of quartz, feldspar, and mica. The large feldspar crystals are commonly aligned parallel to one another, but the micas rarely exhibit a parallel orientation. In many places, large red garnet crystals which average one inch in diameter are common. Cordierite, an iron-magnesium-aluminum silicate, occurs in many of the outcrops along Route 123 south of Island Pond. This mineral has been reported in only a few localities in New Hampshire. Fresh cordierite is light gray and glassy in appearance so that it may easily be mistaken for gray quartz. Most of the cordierite in the Lovewell Mountain quadrangle has partially altered to mica and has a distinctive bluish green color.

Small dikes are common throughout the area especially in the igneous bodies. The rock in these dikes is similar to the granite which is quarried in the vicinity of Concord, New Hampshire.

During the final stages of the igneous activity, tabular and lens-shaped bodies of pegmatite were emplaced. A pegmatite is a very coarse, light-colored granite composed principally of feldspar, quartz, and mica. The liquids which formed the pegmatites were the end products of the crystallization of the igneous masses in the area. These residual liquids were rich in volatiles which decreased the viscosity of the liquid and facilitated the growth of the large crystals in the pegmatites. Tourmaline and beryl are found where some of the rarer elements were concentrated in the residual liquids. As shown on the geological map, pegmatites are more numerous in the western part of the quadrangle.

The Metamorphism

The original sedimentary rocks in the area were metamorphosed (transformed) during late Devonian time as a result of higher temperature and pressure conditions. The fine-grained shales and sandstones of the Hubbard Hill member became coarse-grained schists and quartzites. Sillimanite, red garnet, black and white mica, quartz, and feldspar formed in the schists. The slender sillimanite crystals, which are an inch or more long, commonly stand out conspicuously on weathered outcrops. The mica flakes crystallized while the rocks were being folded, and thus the flakes became aligned parallel to one another. Because of this arrangement of the mica flakes, the schists readily split along nearly plane surfaces.

The rocks of the May Pond member, which were originally mainly shales, became banded gneisses as a result of the partial segregation of the light and dark minerals during the metamorphism (Fig 3). The light-colored layers of the gneiss are rich in quartz and feldspar, and the dark layers are rich in biotite and garnet. Although the light-colored layers are somewhat similar to granite, the composition of the rock indicates that no appreciable amount of granitic material was introduced. Solutions moving through the rocks probably facilitated the reorganization of the constituents, but did not change the bulk composition of the rocks.

The rocks of the Dakin Hill member apparently recrystallized after the period of folding because banding in the gneiss is poor and the minerals show only a vague parallel orientation. In the black shales, which were originally rich in sulphur and carbonaceous material, the sulphur combined with the iron in the rock to form pyrite and the carbonaceous material changed to graphite. The pyrite apparently was not introduced because the rocks are no richer in iron than the non-pyritiferous gneisses. In the rocks which were subjected to the highest temperature conditions, white mica disappeared and large tabular crystals of feldspar formed. The feldspar crystals are one to two inches long and commonly contain unreplaced grains of quartz and black mica. One of the best places to see these feldspar crystals is at the outcrop 500 feet south of the junction of Routes 10 and 123 in Marlow. Farther to the east, most of the large feldspar crystals have been replaced by quartz and muscovite under the lower temperature conditions which prevailed during the closing stages of the metamorphism. On casual inspection, many of the rocks of Dakin Hill member which have large crystals of feldspar appear to be similar to the feldspar-rich phases of the Kinsman quartz monzonite. The history of the two rocks, however, was vastly different. In the evolution of the Dakin Hill member, muds were converted to gneiss while the rock remained in the solid state. The Kinsman quartz monzonite formed from liquid which rose from below. The feldspar grew in the liquid at the same time as the other minerals in the rock.

The Wearing Down of the Land

Rocks thousands of feet thick were removed by erosion as a result of the gradual emergence of the area after Devonian time (Fig. 7). The rocks were broken and removed through the action of weathering and running water nearly as fast as they rose above sea level.

A surface of fairly low relief apparently developed at one stage in the erosion of the land, but it became highly dissected following later uplift. The flat areas such as those at or near the top of Hubbard Hill in Stoddard, Hodgeman Hill, and Bald Mountain may represent remnants of this old rolling plain. Many of these flat areas have been cleared of timber for the development of pasture land and therefore are favorable localities for observing large exposures of bedrock.

Some of the most prominent mountains in the area are held up by the Kinsman quartz monzonite or quartz-rich metamorphic rocks. Lovewell Mountain, Bald Mountain, and many of the other higher peaks in the eastern part of the quadrangle are composed of Kinsman quartz monzonite. Where large streams, such as the North Branch, have been actively eroding the Kinsman quartz monzonite for thousands of years, flat areas have developed adjacent to the streams.

Tough quartz-rich schists are responsible for Lempster Mountain. The northeasterly trend of this mountain is due to the constant northeast trend of the schists. The local thickening of beds of quartzite and quartz conglomerate account for the existence of Marlow Hill. The relatively weak Bethlehem gneiss is responsible for the area of lower relief in the northwestern part of the quadrangle. Some of the best farm land in the area occurs in this section. The Bethlehem gneiss is mechanically weak because it readily splits parallel to the layers of mica, and is chemically unstable because of the large content of easily weathered feldspar.

The Great Ice Age

After the major topographic features had developed, great ice sheets, thousands of feet thick, invaded the area. The ice sheets began forming about one million years ago in Canada and moved southward across the whole of New England to Long Island. A record of only the last advance is found in the Lovewell Mountain quadrangle, but evidence from other parts of the country indicate that the sheets advanced and retreated several times. Between the periods of ice advance, the climate was warmer than it is today.

Scratches on bedrock known as glacial striations indicate that the last ice sheet which passed over the area moved toward the southeast. The striations were produced by boulders carried along at the bottom of the ice sheet. An excellent development of glacial striations may be seen at the summit of Silver Mountain (Fig. 2). Considerable material was picked up by the ice and deposited to the southeast. Many of the huge boulders of Kinsman quartz monzonite in Hancock are glacial "erratics" which were brought in by the ice sheet from ledges to the northwest. The southeastern slopes of many hills, such as Proctor Hill and Holmes Hill, have been steepened by the quarrying action of the ice sheet. This process was particularly effective in the well-jointed rocks where blocks were loosened by the freezing of water in the fractures. Inasmuch as the southeastern slopes were on the lee sides of the hills, blocks were more easily removed from these slopes as the ice sheet moved toward the southeast.

As the climate became warmer toward the close of the Ice Age, the ice sheet gradually melted and dropped material known as glacial drift over most of the area. Much of this material was carried into lakes by streams issuing from the melting ice sheet. Lakes commonly formed in stream valleys which were dammed by blocks of ice. The large sand and glacial deposits along the Ashuelot River and Dodge Brook were laid down in large lakes which occupied these valleys near the close of the Ice Age. The surface of the lakes must have risen high above the valley floors because deposits occur 100 to 200 feet above the old stream beds. Most of the streams in the area have not removed all the material which was deposited in their channels, so that the bedrock is still concealed along these streams. The courses of some of the streams were altered where the channels were obstructed by blocks of ice. Outcrops are numerous along these newly cut valleys.

Even though about 25,000 years have elapsed since the close of the Ice Age, the configuration of the land has not changed markedly since that time. Lakes which formed as a result of glacial action are numerous although they are somewhat smaller today. Well-preserved glacial striations at the summits of the hills and in the valleys indicate that the major topographic features have undergone little change.

INTERESTING LOCALITIES

Lovewell Mountain. The highest point in the area, 2473 feet, at the summit of Lovewell Mountain, is easily reached by following the trail up the gentle southern slope. Nearly continuous outcrops of Kinsman quartz monzonite may be seen along the trail. Large tabular crystals of feldspar and garnets an inch across are common in this rock. Small dikes of pegmatite and granite cutting the Kinsman quartz monzonite are well-exposed. At the top of the mountain there are conspicuous joints trending north-northeast and west-northwest. The view from Lovewell Mountain is spectacular. On a clear day twenty-two lakes and many distant mountains are plainly visible.

Gates Mountain. On this mountain the contact between the Bethlehem gneiss and schist is clearly exposed. The contact is best observed on the southern and western slopes a few hundred feet from the summit. The contact dips gently to the east with the Bethlehem gneiss overlying the schist. At the summit of the mountain there are numerous exposures of Bethlehem gneiss cut by dikes of pegmatite.

Marlow Hill. Some of the best exposures of quartzite, quartz conglomerate, and actinolite-bearing rocks may be seen on Marlow Hill. The outcrops on the western knob are easily reached from the road at the top of Marlow Hill. The appearance of the massive white rocks containing actinolite is somewhat similar to that of quartzites. In this area, however, the quartzites generally have at least a few pebbles of quartz and may be stained brown due to the weathering of pyrite. The drawn-out quartz pebbles in the quartz conglomerates are striking. Many of the pebbles are about a foot in length and only an inch or two thick. Sills of pegmatite are common in some of the outcrops. Tight folds with wave lengths ranging from a few inches to several feet are common in this area.

Silver Mountain. At the summit of this mountain, there are extensive outcrops of well-bedded schists. Beds of medium-grained quartzose schist alternate with beds of coarse mica schist containing large knots of sillimanite and white mica. The average thickness of individual beds is one inch. Lenticular pods of pegmatite occur between some of the beds and the schist adjacent to the pegmatite contains large crystals of red garnet and black tourmaline. Thin quartz veins cut the schist approximately at right angles to bedding. Prominent glacial striations and grooves on the outcrops indicate that the ice sheet was moving to the south-southeast as it passed over the summit of Silver Mountain. The schists are very resistant to weathering inasmuch as the

glacial markings are well-preserved even though they developed over 25,000 years ago.

Mack Hill. Several interesting geologic features may be observed on this hill. The Kinsman quartz monozite which is exposed at the top of the hill contains numerous inclusions of schist, quartzite, quartz conglomerate, and gneiss. Most of the inclusions are unaltered and have sharp contacts. Some of the schist inclusions are folded and the pebbles in the conglomerate have been greatly stretched; yet the enclosing Kinsman quartz monzonite is only slightly deformed. This indicates that the magma invaded the metamorphic rocks near the close of the period of folding. In some of the tongues of Kinsman quartz monzonite which extend into the inclusions, large feldspar crystals comprise nearly half the rock.

Pitcher Mountain. This mountain is the highest peak in the southern half of the quadrangle. The summit may be easily reached by following the trail which leads off Route 123. Along the trail there are continuous outcrops of massive gray gneiss which is typical of much of the Dakin Hill member. The gneiss is peppered with tiny crystals of garnet and magnetite. Ellipsoidal nodular masses known as concretions are common in the gneiss at the summit of the mountain. As a result of differential weathering, odd-shaped depressions occur where portions of the concretions have been removed. Sometimes these depressions are erroneously considered to be fossil footprints of prehistoric animals. At the northern edge of the platform on Pitcher Mountain, typical pyritiferous gneiss is well-exposed. The weathered outcrops are dark brown or black with streaks of light yellow alteration material. In fresh specimens metallic specks of pyrite (iron pyrites) are visible. The contact between the Kinsman quartz monzonite and the gneiss is exposed at an elevation of 1950 feet on the southern slope of the mountain. Large inclusions of folded schist occur in the Kinsman quartz monzonite near the contact. An excellent view is afforded in all directions from the fire tower at the summit. On clear days, mountains as far away as the Belknaps near Lake Winnipesaukee may be seen.

USEFUL MINERALS

Feldspar and mica occur in the large veins of pegmatite which are common in the western part of the area. These minerals have been mined at eight localities, but the mines are not in production at the present time. Feldspar was the principal mineral obtained from these mines with the exception of the Nims Mine in Sullivan which produced mica. Minor amounts of beryl and spodumene occur in some of the pegmatites. The Russell, Turner, and Windham Mines are the largest mines in the area. The Russell Mine, located 0.2 mile south of Gustin Pond, and the Turner Mine, 0.6 mile southeast of Baker Corner, are in pegmatite veins which have intruded schists along bedding planes. Large crystals of black tourmaline have formed in the schists adjacent to the pegmatites from solutions emanating from the pegmatites. The pegmatite which was worked at the Windham Mine, 0.4 mile west of Tinker Pond, is intrusive into the Kinsman quartz monzonite. The eastern side of the vein is bordered by schist that occurs as an inclusion in the Kinsman quartz monzonite.

The sand and gravel which were deposited in large amounts along the main streams during the Ice Age are used for road material.

HOW TO READ THE MAP

The map in the envelope in the back of this pamphlet shows the topography and geology of the area. The colors and patterns are explained in the legend at the right of the map. The geologic structure sections at the bottom of the map are an aid in understanding the geology.

Geological data have been added to the regular topographic map based on surveying in 1926-1927. One inch on the map is equal to approximately one mile on the ground. Improved roads are shown as double solid black lines; secondary roads as double dashed black lines; township boundaries as heavy dashed lines. Houses are shown as black squares; schools as squares with flags; churches as squares with crosses.

Black numbers at the tops of hills, on lakes, and along roads indicate the altitude above sea level. As an example, the figure 1831 marked on Robb Mountain in Antrim means that the summit of this mountain is 1831 feet above sea level. The surface of Highland Lake is 1296 feet above sea level. The letters "BM" accompanying the number indicate a station called a bench mark where the altitude has been accurately determined.

The brown lines on the map are lines of equal elevation or contours which show the configuration of the land surface. The contour interval is 20 feet; that is, the vertical distance between adjacent contours is 20 feet. The altitudes of the hundred-foot contours, printed in heavy brown, are shown by small brown numbers. The steepness of slopes may be ascertained by noting the spacing of the contours. Slopes are steep where contours are close together and are gentle where the contours are far apart. The spacing of the contours on Lovewell Mountain show that the eastern slope is much steeper than the western slope.

The approximate mean declination in the area is 15 degrees. Compass readings must be corrected because the compass needle will always point 15 degrees west of true north in this region. As shown by the symbol at the bottom of the map, true north is parallel to the longer edges of the map.

Each color on the map represents a certain type of rock. The meaning of the different colors is explained in the legend at the right of the map. Different letter symbols as well as different colors are used to indicate the various kinds of rocks. For example, the mass of Bethlehem gneiss in the northwestern part of the area is shown on the map in orange with the letters *bg*. The area in the eastern part of the map shown in pink with the letters *kqm* represents a body of Kinsman quartz monzonite. Even where bedrock lies hidden below a soil cover, color is shown on the map because the nature of the concealed rock has been deduced from nearby outcrops. Where the boundaries between rock-types have been accurately located, they are shown by solid black lines. Where the location of the boundary is not precisely known because of poor exposure, a dashed black line is used. Gradational boundaries are shown by dotted lines.

The structure sections at the bottom of the map show how the rocks would probably look along the walls of deep trenches across the area. The locations of the sections on the map are shown by lines labelled A-A′, B-B′, and C-C′. It can be seen from these sections that the rocks are inclined steeply to the east except in the northwestern part of the area where tilting has been gentle.

The strike and dip symbols on the map indicate the attitudes of the layering in the rocks. In some cases, the layering is due to the bedded nature of the rocks; in others it is due to the concentration of minerals in bands. The meaning of strike and dip is more easily understood if one considers how the terms would be used to indicate the attitude of the roof of a house. The strike of the roof would be the direction of the ridge pole, a horizontal line. Thus the strike is the direction of the line formed by the intersection of a plane and the horizontal plane. The inclination of the roof is the dip. A slightly inclined surface would have a small dip, whereas a steep surface would have a large dip. The dip of a horizontal plane is 0 degrees; the dip of a vertical plane is 90 degrees. The straight line of the symbols represents the strike and the arrow the direction of the dip of the layering. An arrow pointing east, for instance, indicates that the layering is inclined toward the east. The numbers at the ends of the arrows show the amount of dip in degrees.

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Note: Maps of the following quadrangles may be purchased at a charge of 25c each: Lovewell Mtn., Mt. Chocorua, Mt. Cube, Mascoma, Mt. Washington, Plymouth, Bellows Falls, Keene-Brattleboro, Monadnock, and Percy.

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