THE GEOLOGY OF THE
GILMANTON QUADRANGLE
NEW HAMPSHIRE

by

MILTON T. HEALD

Published by THE NEW HAMPSHIRE STATE PLANNING AND DEVELOPMENT COMMISSION

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Foreword

The story of the rocks in the Gilmanton quadrangle is presented in this pamphlet in as non-technical language as possible. Two maps are included in the pocket in the back cover. One is a three-color topographic map of the region, published by the United States Geological Survey. The other is a black-and-white map to show the geology. A section on how to read these maps is given in the latter part of this pamphlet. Although both maps show roads, numerous differences are apparent. The topographic map shows all the roads as they existed in 1917. Some of these roads no longer exist, and new roads have been built. The cost of correcting this map would be prohibitive. The roads as shown on the geological map have been brought up to date (1954), but minor roads have been omitted in order that the symbols to show the geological formations may be as clear as possible.

The geological study of the Gilmanton quadrangle was carried out in 1949 and 1950 under the auspices of the Department of Geology of West Virginia University, the Division of Geological Sciences of Harvard University, and the New Hampshire Planning and Development Commission. Field assistance was rendered by Mr. Thomas E. Garnar, Jr., and Mr. Donald O. Sowers. The photographs were taken by Mr. Garnar.

Geology of the Gilmanton Quadrangle New Hampshire

By Milton T. Heald

THE SCENERY

The Gilmanton quadrangle is a popular vacation area for many reasons. The region is particularly well suited for those who enjoy fishing, boating, and swimming because there are over thirty lakes in the area. Crystal Lake, Loon Pond, and Suncook Ponds with their white sandy beaches are particularly appealing to bathers. The numerous hills and mountains provide the vacationist with excellent hiking opportunities. In the northern part of the quadrangle relief is moderate with the average hill rising 500 feet above the lower areas. The highest point (1800 feet) is at the midpoint of the northern boundary of the quadrangle. The lowest point (340 feet) is in the Suncook Valley at the southern boundary of the quadrangle.

In the following pages the geologic history of the Gilmanton quadrangle is traced. This is intended to aid the reader in understanding the formation of the rocks, hills, lakes, and other natural wonders of the area.

THE STORY OF THE ROCKS

The Geologic Map

The reader will more readily understand the story of the rocks in the Gilmanton quadrangle if he examines the geologic map at the back of the pamphlet. This map shows the distribution of the different types of rocks in the area, each type being designated by a given pattern and letter-symbol. Brief description of the rocks are given in Table 1. The cross sections at the bottom of the map portray the inferred relations of the rocks below the surface. These sections show how the rocks would appear along the sides of trenches cut down to a depth of 2,000 feet below sea level. More complete instructions on reading the topographic and geologic maps are given at the end of the pamphlet.

The Sea

The oldest rocks in the Gilmanton quadrangle are layered, like the sands and muds which are being deposited in some parts of the oceans today. It is therefore believed that the layered rocks in the area formed sands and muds which accumulated at the bottom of a sea. Studies in other localities have shown that this sea extended over all of New England. A landmass which occupied part of the present Gulf of Maine was being worn down at this time by waves and streams. The debris in the form of sand and mud was carried westward by streams and deposited in New Hampshire and areas to the west. It is not possible to determine directly when the sediments accumulated in the Gilmanton quadrangle because fossils of marine animals have not been preserved in the area. However, from fossil remains found near Littleton, New Hampshire, and other evidence, it can be shown that the oldest rocks in the Gilmanton quadrangle formed 330 million years ago during what geologists call the Devonian period. In New Hampshire the name Littleton formation has been applied to the rocks which formed from the sediments deposited in Devonian time.

The Littleton formation in the Gilmanton quadrangle has been subdivided into three units. The oldest unit, the Pittsfield member, is exposed in a large area in the central portion of the quadrangle. Originally this unit consisted of sandy muds which are now coarse-grained schists and gneisses. The gneiss consists of dark layers rich in biotite and light-colored layers and pods composed largely of quartz and feldspar (Fig. 1). Some of the best exposures of the gneiss may be seen at Sabattus Heights and along Pleasant Street in Loudon. In stagnant parts of the sea, black muds containing sulphur and carbonaceous material that were deposited are now pyritiferous schists. The outcrops of these schists are generally black because of staining from the weathering of the pyrite.

In the southeastern part of the area alternating thin layers of mud and sand accumulated which have been transformed into

Figure 1. Thinly banded gneiss of the Pittsfield member.

mica schists and quartz-mica schist. Some pyritiferous schist is interbedded with the other rock-types. These rocks comprise the unit referred to as the Jenness Pond member. Typical exposures of this member may be seen in the vicinity of Jenness Pond and along the road which runs north from the pond. On the hill 0.4 mile southwest of Jenness Pond, there are a few beds of quartz conglomerate which formed from gravels containing pebbles of quartz.

The Durgin Brook member represents the uppermost portion of the Littleton formation in the Gilmanton quadrangle. This unit consists of alternating layers of mica schist and quartz-mica schist which formed from layers of mud and sand. Unlike the Jenness Pond member, pyritiferous schists do not occur in this member. Outcrops of the Durgin Brook member may be seen in the northwestern corner of the quadrangle. Some of the best exposures are in the new road cuts near the village of Belmont.

As a result of the slow deposition of these sands and muds during early Devonian time, a thick series of sediments accumulated in the Gilmanton quadrangle (Fig. 2). A deep sea was not required because the bottom gradually sank as the sediments were laid down. By compaction due to the weight of overlying sediments and with rising temperature resulting from burial, the sediments were slowly converted into solid rock.

Table 1

Descriptions of Rock Formations in Gilmanton Quadrangle

LETTER SYMBOLS ARE THOSE USED ON MAP.

		Rhyolite *(r)*: Light-brown rhyolite with phenocrysts of microperthite in a dense groundmass composed of microperthite oligoclase, quartz, and biotite.
MISSISSIPPIAN ?	**White Mountain Magma Series**	Conway granite *(cg)*: Medium-grained, pink granite, composed of microperthite, quartz, oligoclase, biotite, and hornblende.
		Porphyritic quartz syenite *(pqs)*: Pink to light-gray quartz syenite with phenocrysts of microperthite and hornblende; fine-grained groundmass composed of microperthite, quartz, and hornblende.
		Granite porphyry *(gp)*: Pink to light-gray granite porphyry; phenocrysts of microperthite, quartz, and biotite; fine-grained groundmass composed of microperthite, quartz, and biotite.
		Albany porphyritic quartz syenite *(aqs)*: Medium-grained, pink to light-gray quartz syenite; phenocrysts chiefly microperthite; groundmass composed of microperthite, oligoclase, quartz, and hornblende.
		Augite monzodiorite *(am)*: Medium-grained, locally subporphyritic, gray monzodiorite composed of oligoclase, microperthite, hornblende, biotite, augite, and quartz. *amp,* porphyritic phase with large phenocrysts of microperthite.
ATE DEVONIAN ?	**New Hampshire Magma Series**	Pegmatite: Very coarse-grained rock composed chiefly of feldspar and quartz with some muscovite.
		Muscovite granite *(mg)*: Medium-grained white granite, composed of microcline, albite, quartz and muscovite.
		Concord granite *(cg)*: Medium-grained light-gray to pink granite, composed of potash feldspar, oligoclase, quartz, biotite, and muscovite.
		Winnipesaukee quartz diorite *(wqd)*: Medium-grained, gray quartz diorite including some granodiorite and granite. Composed of oligoclase or andesine, orthoclase, quartz, biotite, and muscovite.
		Meredith porphyritic granite *(mpg)*: Coarse-grained, light-gray, porphyritic granite with phenocrysts of potash feldspar in a groundmass of oligoclase, quartz, biotite, and muscovite.
LOWER DEVONIAN		Littleton formation: Durgin Brook member, *Dld,* composed of well-bedded schists, chiefly sillimanite schist, pseudo-sillimanite schist, and mica schist. Jenness Pond member *Dlj,* thin-bedded pseudo-andalusite schist, pyritiferous schist, and mica schist. Pittsfield member, *Dlp,* mica schist and pyritiferous schist; *Dlpg,* gneiss; *Dlpi,* areas in which schist is highly injected by Winnipesaukee quartz diorite, muscovite granite, and pegmatite.

Table 2

Geologic Time-Scale with Sequence of Events in the Gilmanton 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 till, 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	White Mountain magma series intruded.
Paleozoic	Devonian	330 million years ago	Erosion. Concord granite and pegmatite intruded. End of folding. Meredith porphyritic granite and Winnipesaukee quartz diorite intruded. Folding and recrystallization of the rocks began. Littleton formation deposited in inland sea. Durgin Brook member: layers of mud and sandy mud (now schist). Jenness Pond member: alternating thin layers of mud and sandy mud (now schist). Pittsfield member: mud (now schist and gneiss).
	Silurian	335 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

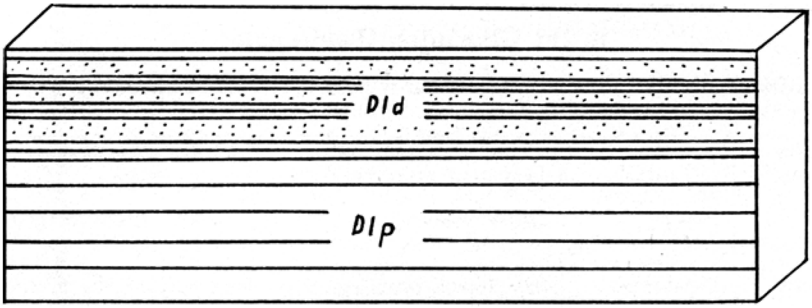

Figure 2. Sands and muds deposited in early Devonian time to form the Littleton formation *(Dlp* and *Dld).*

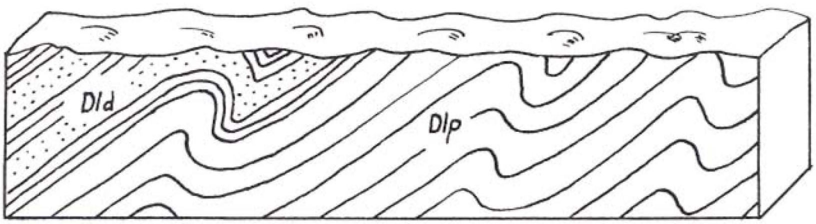

Figure 3. Folding of the rocks during middle Devonian (?) time.

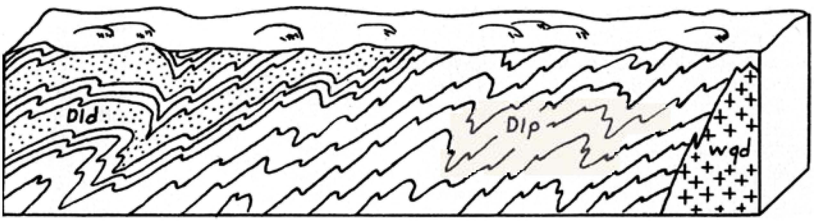

Figure 4. Additional folding and intrusion of the Winnipesaukee quartz diorite *(wqd)* during late Devonian (?) time.

Figures 2 - 6. Series of diagrams to show the story of the rocks in the Gilmanton 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.

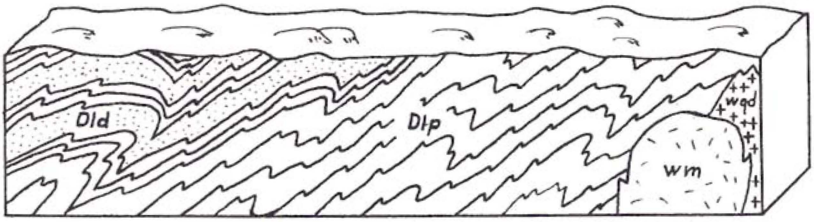

Figure 5. Intrusion of the White Mountain magma series *(wm)* probably in Mississippian time.

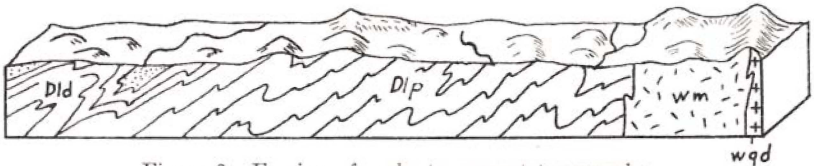

Figure 6. Erosion of rocks to present topography.

The Folding of the Rocks

Not long after the rocks had formed, they were subjected to great horizontal forces. The rocks did not shatter but yielded plastically because they were hot and under pressure due to deep burial. In this condition the rocks became tilted and intricately folded. Rocks which were once horizontal are now inclined at

Figure 7. Typical folds in the well-bedded schists of the Jenness Pond member.

various angles (Fig. 3). In the southeastern corner of the area the rocks have been tilted so that they are overturned. (See Structure Section BB'.) The folds range in size from many feet to a fraction of an inch across. Some of the best developed folds may be seen in the Jenness Pond member (Fig. 7). Small folds or crinkles are well-developed in the rocks exposed on the road running north from Jenness Pond. These folded rocks look very much like corrugated cardboard (Fig. 8). Regardless of

Figure 8. Specimen showing crinkles in schist of the Jenness Pond member.

the sizes of the folds in this area, they all have the same pattern. All the folds, therefore, have resulted from the same forces. The folding is not always apparent in rocks without conspicuous bedding. Folded quartz veins in these rocks, however, indicate that the rocks have not escaped deformation. Intricately folded quartz veins are conspicuous in the road cut on the south side of the highway half a mile southeast of the village of Belmont.

The Metamorphism

The original minerals in the sedimentary rocks were transformed into new minerals in late Devonian time due to higher temperature and pressure conditions accompanying the folding.

This transformation is called metamorphism and the new minerals which form are termed metamorphic minerals.

The sediments of the Pittsfield member were converted into schists and gneisses. White and black mica, red garnet, and white sillimanite were the most common new minerals to form. The quartz and feldspar which were in the original sediments recrystallized into large grains. The most common rock-type is schist in which there is a fairly even distribution of minerals. Locally gneiss formed as a result of the partial segregation of the light and dark minerals during the metamorphism. The light-colored portions are rich in quartz and feldspar, and the dark portions are rich in biotite. The light-colored minerals are not always concentrated in continuous bands but many occur in pods and irregular clots. These light-colored masses do not represent intruded material but have formed mainly from materials which were originally present in the rock. They should not be confused with pegmatites which are much coarser and have been intruded from below. Some of the best exposures of gneiss may be seen on Sabattus Heights. In addition to the minerals mentioned above, bluish green crystals of apatite about one-eighth of an inch in length occur in small amounts in the light-colored portions of the gneiss at this locality.

Silvery schists formed in the Jenness Pond member during metamorphism. The silvery luster is due to the arrangement of platy mica flakes along parallel plane surfaces. This arrangement also accounts for the property of the schist to split along nearly plane surfaces. Large andalusite crystals about an inch in length formed in some of the schists but during the later stages of metamorphism most of these crystals altered to aggregates of coarse mica. Long slender crystals of sillimanite grew in some of the schist on the hill 0.4 mile southwest of Jenness Pond. Many of the schists in the southeastern portion of the quadrangle are nearly black on weathered surfaces due to the oxidation of pyrite. This pyrite grew from iron and sulphur which were present in the original muds.

The alternating beds of shale and sandstone of the Durgin Brook member were transformed into mica schist and quartzose schist during the metamorphism. Many of the mica schists have a spotted appearance due to the formation of half-inch knots of sillimanite. Much of this sillimanite changed to large flakes of muscovite which gives the schists a spangled appearance. Where alteration was incomplete, slender needles of sillimanite remain as relics in the muscovite. Light-colored pods of feldspar with some garnet, tourmaline, green apatite, and green mica formed in some of the schists. The feldspar occurs in large crystals which have a moonstone-like sheen. Some of the best exposures of these pods are visible in the road cut half a mile southeast of the village of Belmont.

Intrusion of the New Hampshire Magma Series

After folding had largely ceased, magma of the New Hampshire magma series began to work its way upward. The Meredith porphyritic granite was the first rock to form from this magma. The largest exposures of the rock may be seen in the vicinity of Avery Hill in the northeast corner of the quadrangle. The Meredith has a distinctive appearance because of the presence of many tabular white feldspar crystals one to two inches in length. These large crystals are generally lined up parallel to each other and are embedded in a matrix composed of quartz, feldspar, and mica.

Shortly after the crystallization of the Meredith, the Lake Winnipesaukee quartz diorite was intruded in several places in the northeastern part of the quadrangle. This rock is light-gray, even-grained, and is composed of feldspar, quartz, and mica. The next magma of the series to be intruded was the Concord granite. This rock is very similar to the Lake Winnipesaukee quartz diorite and in some cases the two types can be distinguished only by microscopic study. Several bodies of Concord granite are exposed in the southwestern part of the area. It is light-gray to pink, fine-grained to medium-grained, and contains feldspar, quartz, and mica. This granite is similar to the stone which is quarried in the vicinity of Concord. A white granite composed of quartz, feldspar, and white mica occurs in small bodies in many parts of the quadrangle. The injections of this granite are particularly numerous on Whiteface Mountain and Avery Hill. The pegmatites were intruded as highly aqueous magma. The high content of water caused low viscosity; consequently the crystals, especially feldspar and quartz, grew to greater size.

Development of Silicified Zones

After the intrusion of the New Hampshire magma series, large fractures developed on Oak Hill, Nudds Hill, and along the Suncook River just northeast of Websters Mills. Silica-bearing solutions rising along these fractures deposited quartz in zones 200 to 600 feet wide. The silicified zones are marked by the symbol s on the geologic map. The silver-bearing galena which occurs at the old Silverdale mine near Websters Mills was probably introduced at this time. In other parts of New Hampshire, the rocks are generally faulted (offset) along silicified zones, but in the Gilmanton quadrangle it was not possible to determine whether offset had occurred.

Intrusion of the White Mountain Magma Series

Magma belonging to the White Mountain magma series was intruded approximately 275 million years ago, probably during Mississippian time (Fig. 5). Circular and arcuate bodies of this magma formed in the northeastern part of the area. The intrusives along the northern boundary of the quadrangle are parts of larger bodies which are exposed in the Belknap Mountains. The bodies on Pine and Rocky Mountains are smaller but are nevertheless arcuate. The rocks in these bodies are pink or less commonly light-gray and are somewhat similar to granite. The various types shown on the geologic map are due to small differences in the nature of the magma which was intruded at slightly different times.

The most remarkable feature of these bodies is their arcuate shape. The term "ring-dike" is sometimes applied to bodies of this shape. The crescent shape of the ridge running from Pine Mountain to Rocky Mountain in the northeast corner of the quadrangle is due to the resistant rock in these arcuate bodies. The origin of the curved fractures which became filled with magma is not completely known. Either settling of the crust in this area or pressure exerted upward might have caused the concentric fractures. It is interesting to note that although magma of this series has formed many bodies throughout northeastern United States, these bodies are always approximately circular or ring-like.

Sometime after the White Mountain magma had solidified, dark-colored magma entered straight fractures in various parts of the quadrangle. These dikes are a few feet thick and their contacts with the surrounding rock are sharp. One of these dikes is excellently exposed in the road cut half a mile southeast of the village of Belmont.

The Wearing Down of the Land

As the sea withdrew from the area, the rocks were subjected to weathering. Frost action caused the rocks to break up and decay set in due to chemical changes. Streams carried away the materials which had become dislodged by these processes. Although the area continued to rise gradually, the ceaseless action of the streams kept wearing down the land mass. Thus over a period of 200 million years, thousands of feet of rock were removed. Granites and other rocks which formed deep within the earth became exposed at the surface (Fig. 6).

Rocks vary considerably in their ability to withstand weathering and stream action. The igneous rocks in the area are more resistant than the schists because they have few planes of weakness. The crescent shape of the ridge from Pine Mountain to Rocky Mountain is due to the underlying arcuate bodies of igneous rocks which are tougher than the surrounding schists. The higher mountains along the northern border of the quadrangle are held up by similar igneous rocks. Many of the knobs in the vicinity of Belmont are due to bodies of pegmatite which are more resistant than the schists. Most of the smaller hills in the area are simply the result of variations in the toughness of the schists and gneisses.

The Great Ice Age

About a million years ago the climate became much colder in North America and large masses of ice and snow accumulated in Canada. As the ice sheet gradually enlarged it spread southward over New England toward Long Island. The top of the ice sheet was above the highest of the White Mountains when the southern margin was on Long Island.

Larger boulders from cliffs, as well as loose material on the surface, were carried southward by the ice. In this way rocks were carried miles from their source and were widely distributed over the land. Rocks frozen into the bottom of the ice sheet scratched and grooved the ledges over which they passed. The scratches formed in this way are called glacial striations. Excellent examples of striations may be seen on Catamount Mountain. The trend of the striations indicates that the ice sheet moved toward the southeast.

In many parts of the area, elongated hills known as drumlins formed. These are composed of a mixture of boulders and sandy clay deposited by the ice sheet and molded into hills shaped like the bowl of an inverted teaspoon. Leavitt Hill and the other elongate hills between the village of Pittsfield and Lily Lake are good examples of drumlins. Their shape substantiates the idea that the ice sheet moved to the southeast.

The great ice sheet gradually melted as the climate became milder at the close of the Ice Age. Lakes formed where meltwater was dammed by glacial deposits left in the valleys. Much of the bedrock along streams became covered as sands and gravels were washed into the lakes. In some places huge blocks of ice left from the ice sheet became buried by sand and gravel. As the ice melted, slumping occurred leaving circular depressions known as kettles. Good examples of kettles may be seen just south of Crystal Lake. Two of the largest ones are shown on the topographic map as nearly circular ponds a few hundred feet in diameter. Streams flowing beneath the ice or in large cracks in the ice formed long narrow mounds of sand known as eskers. There are a number of eskers in the valley of the Suncook River. One of the best developed of these is located just south of Pearls Corner.

Although approximately 25,000 years have elapsed since the close of the Ice Age, many of the glacial lakes have been only partially drained and much glacial material still remains in the river valleys.

INTERESTING LOCALITIES

Websters Mills: Mica schists are well-exposed in the bed of the Suncook River just north of the bridge at Websters Mills. The beds of schists strike 30 degrees east of north and dip 27 degrees to the northwest. Beryl crystals are common in one of the pegmatite dikes which cut the schist. The beryl is milky white and occurs in six-sided prisms. On casual inspection the beryl could be easily mistaken for quartz. A quarter of a mile northeast of Websters Mills there is a silicified zone. The silicified rock is white because it is composed of quartz and mica. An old silver mine, known as the Silverdale mine, was located at the southern end of the silicified zone. The openings are now filled but some of the minerals may be seen in the old dumps.

Oak Hill: The top of Oak Hill may be reached by walking up the old road on the southeast side of the hill. Along the road there are many outcrops of pink granite. This is the same type of rock as that quarried in the vicinity of Concord. On the south side of Oak Hill there is a silicified zone which averages 1000 feet in width. Small well-formed crystals of quartz may be obtained from the partially filled fissures in this rock. The fire tower on Oak Hill is just outside the limits of the Gilmanton quadrangle, but from the tower an excellent view of the southern part of the quadrangle is afforded. To the west, the wide valley of the Merrimack may be seen with Mt. Kearsarge and the mountains of the Hillsboro area in the background.

Whiteface Mountain: One of the easiest ways to reach the top of this mountain is to ascend along the southern spur. On this approach one encounters many injections of pegmatite and white granite. The name "whiteface" was applied to this mountain because the exposures of white granite are conspicuous even from great distances. At the summit there are many exposures of rusty brown, pyritiferous schist in addition to the bodies of pegmatite and granite. The view to the north is most spectacular because it includes a large part of picturesque Lake Winnipesaukee with numerous mountains rising abruptly in the background.

Pine Mountain: A hike up Pine Mountain is well worth while because of the superb view from the summit and the varied geologic features exhibited. The climb can be easily made by ascending the gentle north slope. About half way to the top one will encounter excellent exposures of granite and syenite typical of the White Mountain magma series in the Pine Mountain-Rocky Mountain range. The granite is pink with conspicuous crystals of quartz, whereas the syenite is more nearly white and has large white crystals of feldspar. These rock types are exposed nearly continuously to the summit. At the summit they are cut by several dark dikes. In one place the granite contains a 25-foot inclusion with large crystals of feldspar and quartz embedded in a dark matrix. On the western slope of Pine Mountain large masses of Meredith porphyritic granite crop out. This rock is characterized by large white crystals of feldspar 1 to 2 inches in length. On the eastern slope there are schists of the Littleton formation. Thus the magmas of the White Mountain magma series were intruded between the Meredith granite and Littleton schist. One may easily follow the crest of the range from Pine Mountain to Rocky Mountain, but outcrops are not very continuous and only occasional views are afforded because the range is heavily wooded. The entire range is underlain by resistant igneous rocks of the White Mountain magma series. Because the igneous rocks form an arcuate body, the range itself is arcuate.

Avery Hill: This hill may be easily climbed either from the east or the north. Most of the outcrops are at or near the summit. At the eastern rim of the hill, large masses of Meredith porphyritic granite are exposed. At the northern rim dense schists of the Littleton formation crop out. Over the rest of the summit the schist is highly injected by pegmatite and granite. Large sillimanite crystals have formed in some of the schist where it is in contact with pegmatite. Near the base of Avery Hill on the west, rocks of the White Mountain magma series are exposed.

Belmont Road Cuts: There are several road cuts half a mile southeast of the village of Belmont near the southern end of the highway that by-passes the village. In the southermost road cut well-bedded schists of the Durgin Brook member are excellently exposed. Red garnet and small knots of sillimanite are conspicuous constituents of the schist. White pods about one foot in length are common in the schists. The predominant mineral in the pods is feldspar which in some places has a moonstone-like sheen. Green mica, red garnet, black tourmaline, and bluish-green apatite are also present in these pods. Numerous quartz veins in the schist are intricately folded. A few hundred feet to the north is another deep road cut in which rocks are exposed on both sides of the highway. Schists and muscovite-rich pegmatites compose most of these outcrops. A dark-colored igneous dike is exceptionally well-exposed in this road cut. Inasmuch as the dike strikes nearly at right angles to the road, it can be seen on both sides of the road. The dips of most dikes are difficult to determine because the surfaces exposed are normally gently inclined. At this road cut, however, several tens of feet of the dikes are clearly exposed on a vertical face so that the dip, 67 degrees to the southeast, can be easily ascertained.

Jenness Pond: In the vicinity of Jenness Pond there are many exposures of the thin-bedded schists of the Jenness Pond member. Along the road running north from Jenness Pond to Tilton Hill, silvery gray schists and dark brown pyritiferous schists may be seen. These schists have the appearance of corrugated cardboard because of the regular development of many small crinkles. Other types of schists may be observed on the 1020-foot knob 0.4 mile southwest of Jenness Pond. The summit is easily reached along the southeast slope by first following the secondary road and then the trail to the top. Excellent specimens of sillimanite schist may be obtained from the ledges just below the summit at an elevation of 1000 feet. The sillimanite occurs in large white crystals one to two inches in length. The matrix of the schist is peppered with tiny red garnets. Large pegmatite bodies associated with this schist contain white mica and black tourmaline. A small prospect was developed in one of the pegmatites many years ago. At the summit of the hill dark pyritiferous schists are common. White beds of quartzite and quartz conglomerate crop out at the western rim of the hill. The quartzite formed from sand whereas the quartz conglomerate formed from gravel.

Catamount Mountain: There are several roads which pass close to the higher portions of Catamount Mountain. Typical schists of the Pittsfield member are exposed along the highway that passes between the eastern and central knobs of the mountain. Intricate folds are displayed at the road cut at the high point on this highway. A large body of pegmatite may also be seen here. From this point on the highway one may easily climb to the main peak on Catamount. Folded schists and gneisses are exposed almost continuously along the way. The views are exceptionally good because this mountain rises high above most of the surrounding area. To the north one is able to observe the major topographic features in the southern and central portions of the quadrangle.

Sabattus Heights: Excellent exposures of gneiss may be seen in the vicinity of Sabattus Heights. The light-colored portions of the gneiss are composed of feldspar and quartz, whereas the dark portions are rich in black mica. In some places the light-colored layers make up more than half of the rock. Although some pegmatite has intruded the gneiss, most of the light-colored layers have resulted from metamorphic processes without the injection of magmatic material.

USEFUL MINERALS

The pegmatites in the area are potential sources of feldspar and mica. Exploratory pits were opened in some of the bodies but no actual mining has been carried out.

An abandoned mine known as the Silverdale mine is located at the southern end of the silicified zone a quarter of a mile northeast of Websters Mills. Silver-bearing galena (lead sulphide) was mined to a small extent in the last century. The galena occurs as a filling in veins of milky quartz (Fig. 9). Although the mine openings have been covered, specimens of the ore may be collected from the old dumps.

Iron ore of the bog ore type was worked in the vicinity of Gilmanton Iron Works in early days. No signs of the pits are now visible but according to one of the residents of the area a deposit was worked at the present location of the lower dam below Crystal Lake.

A number of the granites in the quadrangle would make satisfactory cut stone. Although some granite has been quarried in the past, no stone is being obtained from the area today.

The sands and gravels which were deposited in large amounts during the Ice Age are used for road material.

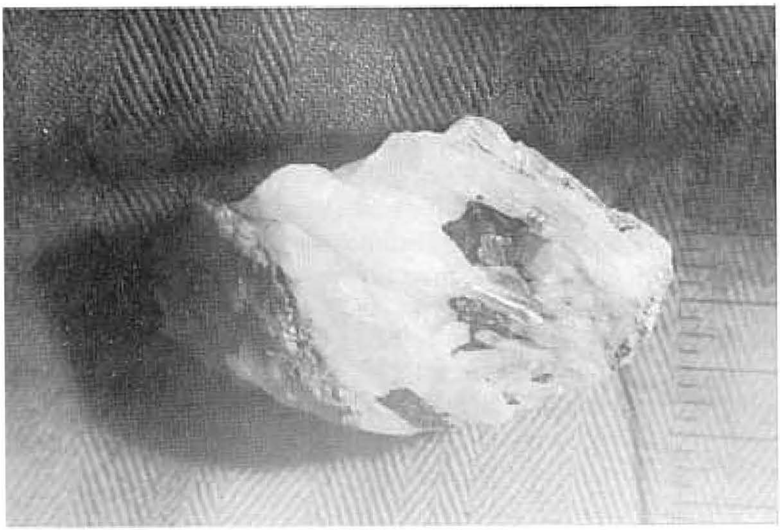

Figure 9. Specimen from the dump at the old Silverdale Mine, Websters Mills. Galena (dark) occurs in milky quartz.

HOW TO READ THE MAP

Two maps are folded in the pocket in the end of this pamphlet. One, in black, blue and brown, is a topographic map of the quadrangle, issued by the United States Geological Survey and surveyed in 1927. The second map, in black and white, is the geological map.

Topographic Map

The use of the topographic map may be discussed first. The scale at the bottom of the map shows that 1 inch is equal to approximately 1 mile on the ground. The culture—i.e., roads, houses, railroads, etc.—is shown as it existed in 1927. Roads are shown by double solid black lines. Poor roads are shown as double, dashed lines. Railroads, now abandoned, are shown by solid lines with crossbars. Houses are shown by black squares, schools by black squares with flags, and churches by black squares with crosses. Town lines are shown by dashes 0.2 inch long; county lines are shown by alternating dashes 0.1 and 0.3 inch long. Villages, lakes, and streams are labelled in black.

In order to determine the direction of true north with a compass a correction must be made for declination. In the Gilmanton quadrangle a compass needle will point about 15 degrees west of true north. The directions of true north and magnetic north are shown by a symbol at the bottom of the map. The direction of the long edges of the map is true north-south. It is possible to orient the map properly without a compass by lining up known features shown on the map with the actual features as seen in the field.

Features related to drainage are shown in blue. Small streams are shown by blue lines; larger streams and lakes by two or more blue lines; and marshes by blue tufts.

By studying the brown lines on the map one can determine the varying heights of the land surface. The brown lines are lines of equal elevation called contours. Thus if you were to follow one contour line you would neither go uphill or down but would remain at the same altitude. The vertical distance between contours is 20 feet. This is known as the "contour interval." The hundred-foot contours are shown in heavy brown and their altitudes are generally marked by small brown numbers. The spacing of the contours indicates the steepness of the slopes. On slopes which are steep the contours are close together, whereas on gentle slopes the contours are far apart. For instance, the steep north slope of Avery Hill in Alton is indicated on the map by very close spacing of the contours. In the flat area northwest of Suncook Ponds, on the other hand, contours are widely spaced. In closed depressions, such as the one west of Clough Hill in Loudon, the contours are hachured.

The altitudes of lakes and some of the hills and road intersections are given in brown numbers. The figure 625 shown on Crystal Lake means that the surface of this lake is 625 feet above sea level. The figure on Grant Hill indicates that the elevation of this hill is 1548 feet. Points where elevations have been accurately determined are called bench marks. These are shown by crosses accompanied by the letters "B. M." with the elevations given in black figures.

Geological Map

On the black-and-white geological map the rocks underlying the entire quadrangle are shown. Actual exposures of rock may be seen only under a small percentage of the area. Elsewhere the solid rock is covered by a veneer of loose glacial deposits or stream deposits which may range in thickness from a few feet to perhaps 100 feet or more. The geological map shows, therefore, not only what the geologist sees but also what he infers about the rocks beneath the loose covering material.

Each formation is shown by a separate symbol. To facilitate the comparison with the legend (on the right side of the map) letter symbols are also used. The legend is not only a key to the various formations but also it shows the relative age of the rocks, with the youngest at the top. For a more detailed description of the rocks, the reader should refer to Table 1. For example, a formation shown in solid black in the northeast corner of the quadrangle is labelled **cg**. The legend indicates that this is Conway granite. Reference to Table 1 shows that the Conway granite is a medium-grained, pink granite composed of microperthite (a feldspar), quartz, oligoclase (another feldspar), biotite, and hornblende.

Two structure sections are given at the bottom of the map. These sections 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' and B-B'. From these sections it can be seen that the metamorphic rocks are inclined to the west. The folds shown on these sections are not intended to be accurate in detail but portray the general nature of the folding. Section A-A' shows how the Pine Mountain-Rocky Mountain ridge is held up by igneous rocks which have risen vertically from below. The fact that these igneous rocks are not folded indicates that they were intruded after the period of deformation.

The strike and dip symbols on the map show the attitude of the layering in the rocks. The meaning of strike and dip may be explained by showing 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. Or in general, the strike of a plane surface is the direction of the line formed by the intersection of the surface and a horizontal plane. The dip of the roof would be its inclination or pitch. The strikes and dips of beds which have different attitudes can be visualized by placing a partially open book on a table so that it resembles the roof of a house (Fig. 10). In this case the strike of all pages would be the same—the direction of the binding. The dips of the pages would be different. Those near the covers would have the least dip, whereas those near the center would have the greatest dip. The pages in the book would be analogous to successive layers of rock having different dips. The straight line of the symbols on the map represent the strike and the arrow the direction of the dip. An arrow pointing to the east, for instance, indicates that the bed is inclined toward the east. The numbers at the ends of the arrows show the amount of dip in degrees. A small number would indicate a gentle inclination and a large number would mean the beds were nearly vertical. If beds are overturned so that the original top now faces down, overturned symbol given in the legend is used. The attitude of the foliation is given by the foliation symbols.

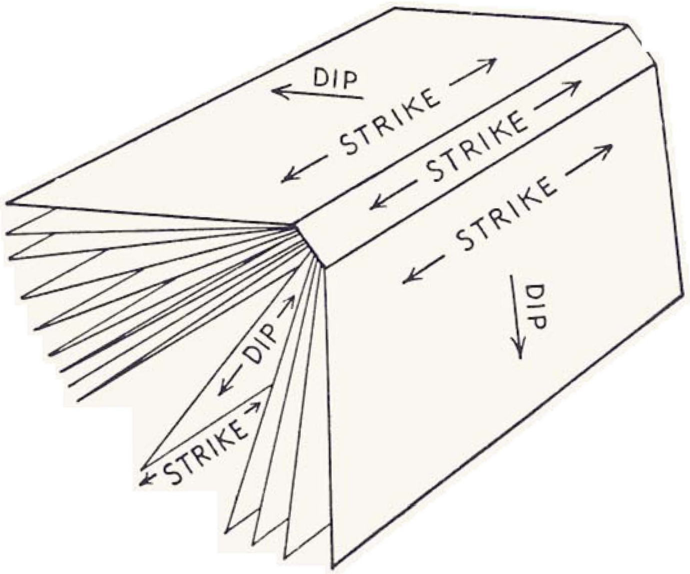

Figure 10. Diagram to illustrate strike and dip.

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of the
N. H. State Planning and Development Commission

All Geological publications are allowed a discount of 40% if purchased in quantities of 10 or more of the same publication.

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Geology of Mt. Pawtuckaway Quadrangle. Jacob Freedman. 1950. 34 p. illus. Map. $1.00.

Geology of Sunapee Quadrangle. Carleton A. Chapman. 1953. 32 p. illus. Map. $1.00.

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QUADRANGLE GEOLOGICAL MAPS

Maps of the following quadrangles may be purchased at 35 cents each. A 40% discount allowed in quantities of 10 or more of same map: Bellows Falls, Franconia, Keene-Brattleboro, Littleton, Lovewell Mountain, Mascoma, Monadnock, Moosilauke, Mt. Chocorua, Mt. Cube, Mt. Pawtuckaway, Mt. Washington, Percy, Plymouth, Rumney. Sunapee, Wolfeboro, and Woodsville quadrangle maps sell for 50 cents each regardless of number purchased. The following quadrangle maps are **out of print:** Cardigan, Winnipesaukee.

MINERAL RESOURCE REPORTS

New Hampshire Minerals and Mines. T. R. Meyers. 1941. 49 p. Map. 50 cents. **Out of print.**