The Geology of
MT. MANSFIELD STATE FOREST

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Cover photo: Smugglers Notch looking north-east from the top of Mount Mansfield.
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Figure 1. Index mapping showing location of Mount Mansfield State Forest.

morphic rock\(^1\) of a particular composition and texture as described in the following paragraphs. The schist forms the cliffs at Smugglers Notch and the bare-rock faces exposed along the crests of the mountains and elsewhere. It varies slightly in appearance because of variation in the proportions of the different mineral constituents.

**Origin of the schist**

An understanding of the origin of the schist is fundamental to understanding the geology of the Mount Mansfield area. Many million years before the formation of the Green Mountains, northwestern Vermont was covered by a shallow sea into which fine-grained sediments were transported by the ancient rivers. As these sandy and shaly deposits accumulated on the bottom of the sea, they were buried by progressively younger sediments of different types. Many of these sedimentary layers

\(^1\) Rocks are classified as being either igneous, sedimentary, or metamorphic. **Igneous** rocks form by the solidification of molten material; **sedimentary** rocks form by the accumulation of sediments derived from older rocks; and **metamorphic** rocks form by recrystallization of older rocks under conditions of high temperatures and pressures.
contained shells of the animals that lived and died in these seas, with the shell remains of the older generations occurring in the bottom layers. By the time the sea had retreated, the older sediments were deeply buried beneath the younger sediments. During a period of mountain-making, these materials were subjected to high pressures and high temperatures. Physical-chemical changes took place within the sediments causing recrystallization to form the mica-albite-quartz schist. In other words, under conditions of heat and pressure the rocks became plastic and the elements which were dispersed through the sediments as sand and clay minerals reorganized into different and larger mineral grains. It is probable that some material was added to the rocks and some was removed by hot solutions migrating through the rocks. The overlying younger sediments were also converted to metamorphic rocks. Because the crystallization of the minerals occurred under the influence of pressure, platy minerals developed with their long dimensions at right angles to the pressure. Thus, the resulting rock developed a layered appearance by the parallel arrangement of the minerals. Where this layering or banding, which is called *foliation*, is coarse, the metamorphic rock is a *gneiss*; where it is fine but pronounced, the rock is called a *schist*. If the original rock was a limestone or sandstone, the metamorphic product is marble or quartzite, respectively. In the process of, or following the formation of the schists, the rocks were crumpled and folded by continued pressure.

During the 380 million years following the metamorphism and folding, this area has been above sea level and has been subjected to erosion. At various times the area was uplifted vertically which resulted in continued erosion of progressively older rocks until the present day when the overlying rocks have been removed to expose the mica-albite-quartz schist.

**Age of the mica-albite-quartz schist**

Some readers may wonder how the age of metamorphism can be stated so specifically—380 million years seems like a long period to be determined beyond a guess. Such a determination is based on a number of different factors. Sedimentary rocks can be placed in their general age sequence by their physical relationships—the rocks deposited on top must be the youngest. A study of the fossils of successive layers shows that they occur in a definite sequence with the simpler forms in the oldest layers and generally the more complex ones in the youngest layers. On the basis of the fossil evidence and the physical relations, the geologic
sequence of the layers can be established for any given area and their relative age can thus be indicated on the geologic time scale. Usually such sequences are established for rather large areas as, for example, northern Vermont or eastern New York State. In addition, actual age determinations can be made for some rocks. Many igneous rocks contain traces of uranium which has been decomposing at a known rate since its formation. By comparing the remnants of uranium with the decomposition products, one can assign an approximate age in terms of years to the igneous rock. By observing the relationship between the dated igneous rock and any sedimentary rocks in contact with it to determine their relative ages, it may be possible to assign an approximate age to the sedimentary rock and the fossils contained within it.

The general age of the original constituents of the mica-albite-quartz schist of the Green Mountains can be determined only by comparison to other rocks that can be dated. Any fossils present originally were destroyed during metamorphism. Igneous rocks containing uranium do not occur with the schist. However, elsewhere in Vermont, one can determine that the schist lies beneath rocks containing fossils of Ordovician age and lies above pre-Cambrian rocks known to be more than 500 million years old. The Cambrian and Ordovician periods on the geologic time scale are the oldest periods containing abundant fossils. The period of the metamorphism is based on evidence at other localities where unfolded rocks of known age lie over folded rocks. On the geologic time scale the mica-albite-quartz schist on Mount Mansfield is said to be Cambro-Ordovician in age, which may be from 380 to 500 million years ago.

In order that the geologist can talk about the sequences of rocks, layers having a similar age and appearance are assigned a formation name. The schists on Mount Mansfield closely resemble schists in southern Vermont which belong to the Pinney Hollow formation. However, because they can not be traced directly, it is possible that the two sequences are not exactly equivalent. For this reason some geologists assign the rocks in this area to the Camels Hump formation which has been named after their abundant occurrence on Camels Hump Mountain, south of the Mount Mansfield State Forest. Although it would be geologically correct to use these formational names, they will be omitted in favor of continued use of the name "mica-albite-quartz schist."

The formation which lies over the mica-albite-quartz schist may be seen in the vicinity of the village of Stowe where the rocks are either a black, shiny schist or a fine-grained green schist. The formation which
lies under the mica-albite-quartz schist is not exposed in the Mount Mansfield area.

**Description of the schist**

As the name implies, the mica-albite-quartz schist contains the minerals mica, albite, and quartz. These mineral constituents are found in all the schists in the area. Other minerals may be locally abundant or present in small amounts.

When the schist is examined without a hand lens or microscope, *mica* appears to be the most abundant mineral. It occurs as small colorless to white flakes which sparkle and shine in the sunlight. You may recognize this mineral as the one that is sometimes sold as artificial snow at Christmas time. Its species name is muscovite, and it has a chemical composition of $\text{KAl}_2\text{(AlSi}_3\text{O}_{10}(\text{OH})_2}$. *Muscovite* is found in various proportions in most of the rocks in the area. It is a deceptive mineral upon which to make a percentage estimate because it appears to be more abundant than it actually is. In most of the rocks it comprises less than 50 per cent of the minerals. *Biotite* is the other important member of the mica group and is distinguished from muscovite by its black or dark brown color. Biotite occurs in minor proportions in the rocks of the area, being most abundant on the western slope of Mount Mansfield. Like muscovite, biotite occurs as small flakes with smooth flat surfaces.

The orientation of the mica flakes accounts for the pronounced layering of most schists. All of the flakes are parallel and when folded and crumpled they give the rock its structure. Where the muscovite is most abundant, breakage along planes rich in mica produces smooth, shiny surfaces which may give the rock a slippery appearance. The layers rich in mica may show in a rather perfect manner the small-scale folding of the schist.

Albite and quartz are also important constituents of the schists. Together they are more abundant than mica in the average schist on Mount Mansfield but because they are not so "showy" they are more easily overlooked. Both minerals are white and granular. Quartz, which consists of silica or $\text{SiO}_2$, is the principal constituent of most beach sands. In the typical mica schist, quartz is glassy in appearance and occurs as small rounded or irregular grains without plane surfaces. *Albite* is a variety of plagioclase feldspar having the composition of $\text{NaAlSi}_3\text{O}_8$. It has a white chalky appearance and occurs in small equidimensional grains bounded by flat surfaces which break along plane surfaces that
reflect light in certain positions. On the west side of Mount Mansfield some of the rocks contain so much albite and so little mica that the rock is granular in appearance.

Chlorite, variety pennine, is an important mineral constituent of some of the schist. Chlorite is characterized by its green color and small amounts are responsible for giving a greenish cast to much of the schist. Like mica it occurs as thin sheets which reflect the folding of the schist.

Garnet and magnetite are locally abundant minerals in the schist. Garnet occurs as pin point to pea size. Most of the grains are rounded although a few occur as equidimensional crystals which have twelve equally developed faces. Garnet has a semi-transparent, glassy appearance and is harder than a knife blade. Magnetite occurs as bluish-black metallic masses with about the same size range as the garnet. Although most are rounded masses, crystal faces are developed on some. Perfectly developed crystals occur as octahedrons which is the form consisting of eight faces, as two four-sided pyramids with their bases together. The larger grains of magnetite have sufficient magnetic power to attract or deflect a compass needle. The garnet and magnetite usually do not occur together, but each may form localized concentrations as lenses or layers in the schist.

In smaller amounts, usually visible only with a hand lens or microscope, the schist also contains a green mineral called epidote, a white mineral apatite, and elongated black mineral called tourmaline. Locally, as on the Nose Dive ski run above the Toll Road on Mount Mansfield, slender needles of tourmaline are visible in the schist.

When a piece of rock is sawed and ground to a thickness of 0.03 millimeters, many of the minerals that appear opaque are found to be transparent. By their color and their optical properties the minerals can be accurately identified. On the basis of the amount of each present the mineral and chemical composition of the rock can be determined. Figure 2 shows the appearance of a thin section of the mica-albite-quartz schist from the Forehead of Mount Mansfield. The parallel orientation of the mineral grains is apparent even though the photomicrograph represents a very small area of the schist.

Other varieties of the schist occur less abundantly in the area. These contain the same minerals as the mica-albite-quartz schist but in different proportions. If the mica is most abundant, as it is locally on Mount Mansfield, the schist may be smooth or highly crinkled and have a very shiny appearance. If the albite is most abundant the schist is more
uniform and granular in appearance and the rocks are more massive. Small scale folding is usually absent. Such albite schists occur on the west side of Mount Mansfield, particularly along the lower part of the Maple Ridge Trail and in the cliffs south of the Forehead along the Long Trail.

If the quartz is most abundant, but mica and albite are present in considerable quantities, the rock may have a granular, layered appearance. Locally some of the rocks consist almost entirely of quartz and are classified as quartzite. These rocks have a dense, fine-grained, sugary appearance and generally are gray to bluish gray in color. They are hard rocks and often form minor ledges in cliff exposures or are the resistant...
rock at the top of small waterfalls in some of the creeks. Most of the quartzite in the area occurs in narrow layers less than a foot thick. Although these layers cannot be traced, they are most abundant on the east side of Mount Mansfield at various localities about one-third of the way up the mountain.

At places, vein-like masses of glassy, milky white quartz occur in the schist. In these, the quartz is massive and without evidence of individual grains and is often fractured unevenly. The quartz occurs as localized lenses in the schist, particularly at the noses of the folds. The small, white boulders of quartz of this type are conspicuous along some of the trails.

A special and somewhat unique type of rock occurring at Sterling Pond is described in the description of Spruce Peak and Sterling Pond.

Structure of the mountain and the rocks

The position of the Green Mountains is a function of the structure of the rocks and their resistance to erosion. At the same time that the mica-albite-quartz schist was being developed under conditions of heat and pressure the region was tightly folded by the same forces. It is likely that this folding continued after the metamorphism during the declining stages of mountain-making. This period of mountain-building probably raised the rocks to a higher level but it was the later repeated uplifts and erosion of the overlying rocks which finally produced the present mountain topography.

It is postulated that the folding and crumpling of the schists were accompanied by a westward movement of large masses or rock. That is, segments of the earth’s crust are believed to have been pushed westward by pressure from the east. Thus, it is believed by many geologists that the rock which now occurs in the Green Mountains may have been derived in early times from an area ten to forty miles to the east.

The basic structure of the Green Mountains is an anticlinorium, a large complex fold. An anticline is an upward fold in which individual rock layers if traced through the structure have a shape similar to that of an arch; the opposite structure is a syncline in which the individual layers are shaped like a trough or basin. An anticlinorium is a large anticline upon which are superimposed many smaller anticlines and synclines. Figure 3 is a diagrammatic sketch showing the relation of the topography to the structure of the rocks in the Mount Mansfield area. The structure of the rocks is reflected in the topography of Mount
Figure 3. Diagrammatic sketch showing the relation between the topography and the structure of the Green Mountains in the Mount Mansfield area. The section has been drawn to approximately pass through The Chin, Smugglers Notch, Spruce Peak and Sterling Pond, and looking N 20° W.
Mansfield, but such correspondence is not necessary for the form of any hill or mountain is a function of its erosional history and resistance of the rock to erosion. In some folded areas, the rock in the trough of a syncline is so resistant to erosion, that it persists in hills or mountains after neighboring anticlines have been more deeply eroded to form valleys.

The smaller folds are like “little fleas on bigger fleas on bigger fleas” in that many little folds may be superimposed on larger ones. These anticlines and synclines range in amplitude from fractions of an inch to thousands of feet. Many are miniature anticlinoria themselves and could be used as scale models of the structure of the entire mountain range. The small folds, or crenulations, in the schist has weathered differentially so that the more resistant layers stand out in relief, emphasizing the shape of the folds. The photograph in Figure 4 shows the small-scale folding. It will be noted that the anticlinal folds are asymmetrical with the west side dipping more steeply than the east side.

If a comparison is made between the structure of the mountain and that of an asymmetrical arch, to carry the simile one step further, it may be imagined that the axis of the arch may be either horizontal or inclined. The chances that it is inclined are much greater than the chance that it is exactly horizontal. Thus, most anticlines or anticlinoria are inclined along their axes and the amount of the dip of the line connecting the points along the crest of the fold is called the plunge.

Most of the folds in the Mount Mansfield area plunge about ten degrees to the south. This plunge is expressed in the dip of the crests of the minor folds, particularly in the crenulation of the mica layers. Viewed at a distance the trace of the fold-crests form a series of parallel lines on the smooth mica-rich surfaces. This type of structure is called the lineation and is expressed on the geologic map by small arrows. The dominant lineation is north-south. Although Figure 5 is a sketch of a small fold showing the different structural elements, it might be taken as a diagrammatic sketch of the regional structure.

Evidence that the structure of the rocks is even more complex is shown locally by the presence of east-west lineations. The intersection of this secondary lineation with the dominant south lineation produces a checker board appearance on some rock surfaces. A system of east-west trending folds is traced by some of the quartz lenses. The significance of the east-west structures is hypothetical, but they are believed to have been mostly obscured by the younger structural features.
The folds are asymmetrical with axial plane of the folding dipping east.

With the description of the rocks completed, the question which arises next is how to represent these three-dimensional contortions on the map. Figure 6 illustrates how the attitude of a particular layer may be expressed in terms of dip and strike. It is apparent that the dip of the rock layer may vary from 0° to 90° and is measured as the angle between its plane and a horizontal plane. Also, it is apparent that the trend of the bed, or the strike, may correspond to any direction of the compass and can be measured as the intersection of that plane and a horizontal plane. The maximum dip is always at right angles to the direction of the strike.

The dip and strike are used to measure the position and attitude of the layers of the rocks. In the case of the mica-albite-quartz schists these planes are called foliation planes. If the structure of the rock is an anticline, most of the strikes of the foliation are parallel, but the dips are in different directions on either side of the crest. At the crest of the fold the foliation is horizontal if the fold is not plunging. On Mount Mansfield where the plunge is about ten degrees to the south, foliation along the crest strikes about east-west and dips about 10° south. Away from the
Figure 5. Diagrammatic three dimensional sketch illustrating the relations between outcrop patterns of folds on vertical planes perpendicular and parallel to the trend of the folding (front and sides of the block) and on a horizontal surface (top of block). Cut-away section of the block shows the folds and lineation lines on a given foliation surface. These folds can be more clearly visualized if the upper portion of the diagram is covered.

crest, the dip of the sides of the anticline begin to be expressed in the readings so that the strike directions "swing back" toward the north-south direction. The majority of the layers on the east side of the mountain strike northeast and dip to the east with the angle of dip increasing away from the crest of the anticlinorium. On the west side of the mountain they trend to the northwest and dip to the west with the dips becoming steeper away from the crest. In addition to these variations in the dip and strike over the antclinal crest, the smaller folds give local abnormal readings. For these reasons many of the dips and strikes shown on the geologic map represent the averages of a number of readings, and those of the minor folds and crinkles have been omitted in order to simplify the picture.
Figure 6. Three dimensional diagrams showing variations in dip and strike. Plane in A strikes N 45° W and dips 45° SW; B strikes north-south and dips 60° east; and the plane in C strikes N 45° E and dips 30° SE.
Another structural feature of the schists is the breakage of the rocks along definite plane surfaces called *joints*. These usually occur in systems formed by a number of parallel joints. The joints formed as a result of stress and strain operating on the rocks during periods of mountain-making and vertical uplifts. Information as to the nature of these forces might be obtained if all the joints were carefully recorded and plotted on a map.

On Mount Mansfield some of the prominent topographic features appear to be controlled by joints. Much of the north-facing cliff on the Nose is controlled by a joint trending N. 65°W., and a similar face on the Lower Lip is controlled by a joint trending N. 60° W. Along the crest of Mount Mansfield a number of joints trend about north-south. Joints of this system in the steep cliffs on either side of the crest of Mount Mansfield have been separated further by the tendency of the rocks to creep down slope under the force of gravity. These joints form the canyons or narrow passageways which are traversed by some of the trails. On Maple Ridge at about 3300 foot elevation the trail crosses a joint trending N. 50° E. which is conspicuous for its four-foot width and the extent and the straightness of the break. A number of joints belonging to this system are found along Maple Ridge.

**GLACIAL HISTORY OF THE AREA**

**Introduction**

The geologic time division previous to the present one is called the Pleistocene or the "ice age." During this time, large continental glaciers advanced over the northern part of North America several times. The cause of the ice age is not known with certainty and whether geologic history will repeat itself is a matter of conjecture. However, it is established that these vast ice sheets covered New England and that the last ice sheet melted back from the Mansfield area about 12,000 years ago.

If one stands on the crest of Mount Mansfield and looks westward over the Champlain Valley, it is difficult to visualize this entire valley completely filled with ice of the continental glacier. Yet, the evidence shows that the ice sheet was so thick that it completely covered Mount Mansfield at one time.

**Evidences of glaciation**

Two types of evidence, glacial striae and erratics, show that Mount Mansfield was over-ridden by the continental glaciation. *Striae* are
scratches in the bedrock which were produced by the sharp edges of rocks protruding from the sole of the moving glacier. These scratches show the direction in which the glacier was moving at a particular spot and the average of many readings gives an accurate value as to the overall direction of movement of the ice sheet. On the Long Trail between the Mount Mansfield Hotel and the Chin on Mount Mansfield, striations may be observed at a number of places. Some of the positions where readings were made are indicated on the map by the triangular-pointed arrows. Faint striae may be seen near the entrance of the Mount Mansfield Hotel and more conspicuous ones are visible on the west side of the roadbed of the secondary road that intersects the Toll Road just below the Hotel. Figure 7 shows a photograph taken at Drift Rock in which the striae are clearly visible.

The average trend of the striae on Mount Mansfield is about N. 50° W. The movement of the ice is presumed to have been nearly north-south down the Champlain Valley which was deepened by the erosive action of the ice. These facts seem to suggest that the movement of ice over Mount Mansfield was marginal and nearly 45° to the axis of the main ice tongue.

Erratics are boulders moved and deposited by glaciers. Often these boulders are found in environments foreign to them. On the high parts of Mount Mansfield, a few boulders other than the mica-albite-quartz schist are found which have reached their present position by glacial transportation. A particularly interesting erratic is Drift Rock. One may note by referring again to Figure 7 that the glacial striae pass beneath the large boulders indicating that the boulders were not at their present position when the striae were formed. Thus, these boulders are aptly named for they must be considered erratics even though their composition is the same as the surrounding rocks. As a logical speculation it is probable that they were plucked out of the bedrock just a short distance to the northwest of their present position and it is possible that these were the very boulders that formed the striae.

Other evidence of glaciation is the presence of cirques which are the high mountain basins in which mountain glaciers originate. Small mountain glaciers probably existed on Mount Mansfield, particularly in the east side of the mountain where the topography has the suggestive form of cirque-like walls and basins.

Melting of a continental glacier causes deposition of the sand and gravel scooped up and transported by the glacier. Some of this material
is plastered beneath the moving glacier, some is simply let down as a blanket and terminal accumulations, and some is transported by streams of melt water to form deposits in which the sands and gravels are somewhat sorted in size by the action of the water.

The blanket type of glacial deposits probably were present over much of the Mount Mansfield area at one time, but have been removed from the upper mountain slopes by erosion. Such deposits are present at lower elevations but are only rarely discernible because of the heavy vegetation and soil cover. Sand and gravel deposits derived from post-glacial streams are located in some of the lower valleys as, for instance, along the highway north of Barnes Camp.

North of the old road and northeast of the camping area along one of the main streams on the west side of Mount Mansfield, fine-grained, sandy lake deposits occur at an elevation of about 1900 feet. The nature of the deposits indicates that they were formed in ponds marginal to the ice sheet when the continental glacier occupied the Champlain Valley but did not extend over the crest of Mount Mansfield.

Figure 7. Drift Rock, glacial erratics along the Long Trail on Mount Mansfield. Note the glacial striae trending away from the viewer and passing beneath the boulders.
DESCRIPTIONS OF INDIVIDUAL LOCALITIES

Spruce Peak and Sterling Pond

Spruce Peak is the mountain on the east side of Smugglers Notch. It may be reached by several trails or the ski lift. An excellent view of Smugglers Notch and the surrounding country is obtained from the summit. Near the summit along the access road to the ski lift, unweathered mica-albite-quartz schist is exposed and the folding can be clearly seen.

Sterling Pond lies to the northeast of Spruce Peak in a shallow depression along the divide of the mountain. This location is anomalous for a pond because the amount of higher land around it is so small that only a limited amount of drainage area is available for the accumulation of rain and snow. Yet, the outflow of water is almost continuous during the summer. The basin occupied by the pond was probably scoured out by the glacier.

The Sterling Pond area contains talc deposits which probably would be commercial if they were not so inaccessible for mining. These deposits have been studied by A. H. Chidester of the United States Geological Survey and a report is obtainable from the U. S. Government. The occurrence of the talc, as mapped by Chidester, is shown in the sketch of Figure 8.

Talc has the composition of $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ and is a soft flaky white mineral. The talc-bearing rocks in this area are white, light gray, or light green and usually are irregularly stained yellow-brown by the weathering of an iron-bearing mineral that occurs with the talc. Because of its extremely soft nature, the talc does not form prominent rock exposures. As shown by the figure, the talc can be most easily observed along the shore of Sterling Pond, south of the Green Mountain Club cabin, or along the trail to Smugglers Notch near the top of the first rise from the pond. Here the talc is exposed in the trail as low, rounded, slippery knobs of "messy looking" yellow-brown rock.

As part of the pond is underlain by talc, it is probable that the softness of the talc was a factor in the differential erosion of the basin by the continental glacier.

The talc is believed to have originated by the alteration of a body of ultramafic igneous rock, which is characterized by having a low silica content and a high magnesium content. Sometime during the mountain-building period, the ultramafic igneous rock invaded the pre-existing
Figure 8. Sketchmap showing the location of the talc-bearing rocks at Sterling Pond.
rocks from an unknown source within the earth's crust. It is believed that at a later date the original minerals in the igneous rock were altered to talc and other minerals by the action of hot ascending solutions composed principally of water.

The Long Trail passes by Sterling Pond, where the Green Mountain Club has erected a small cabin overlooking the pond. Figure 9 is the picturesque view of Mount Mansfield taken from the cabin.

**Smugglers Notch**

All of the rocks exposed at Smugglers Notch (Figure 10) are the mica-albite-quartz schist which locally contains garnet. The large rock boulders in the Notch were derived from the cliffs forming the walls of the Notch. The gradual processes of weathering and breaking up by freezing cause large slabs of the rock to become loose and eventually break off the cliff faces to careen down the mountainside to the valley below, just as King Rock did within historical time. At the north end of the Notch, the large accumulations of such boulders form a talus slope, the name for rock accumulations at the base of a cliff. The irregular stacking of these rocks have formed Smugglers Cave. Smaller openings extend further back under the “rock pile” to where the ground is considerably colder and where the heavier cold air has sunk. Drafts of this air escaping at the foot of the talus is noticeably cool.

The Smuggler's Face, Elephants Head, the Singing Bird, and the Hunter and His Dog are freaks of nature and a product of man's imagination. Their existence is due to the haphazard nature in which the rocks on the cliff faces have broken along joint surfaces.

The origin of the Notch is not completely known. The steep walls and the narrowness of the Notch suggest that it could not have been formed by the headward erosion of two streams or by glacial action. It seems most likely that it was formed by the erosive action of an ancient river that once flowed through the area. Because of the high elevation, the only time when such a river could have existed is when the Champlain Valley was filled with ice on the west side of Mount Mansfield, so that the normal drainage of water to the west was blocked by the ice. It is possible that the conditions were such that the water supplied by the melting glacier could only drain to the south through the Notch. After the ice retreated the drainage system was abandoned in favor of lower outlets and eventually the drainage was developed to Lake Champlain in the west. The Notch was modified by the headward erosion of the
Figure 9. The Chin and Bear Head on Mount Mansfield viewed from Sterling Pond.

Figure 10. View of Smugglers Notch and Spruce Peak from ski slope on Mount Mansfield.
present small streams. Except for the shape of the Notch, the only evidence for this hypothesis is the occurrence of a weakly-bedded, well-sorted deposit of sand at the north end of the Notch at an elevation of 2050 feet. Such a deposit of sand is characteristic of standing water, which occurring at this elevation indicates that some vastly different drainage system must have existed in the past.

**Big Spring**

On the south side of the Smugglers Notch road at an elevation of about 1800 feet is the Big Spring which furnishes a tremendous output of cold spring water. The source of the water is not known although it is likely that, like most springs, it is derived from an underground drainage system. The spring probably originates by the seepage of water derived from the winter snows and rainfall in Spruce Mountain through a joint system within the mountain. No buried stream channels could be located between the spring and the base of the massive overhead cliffs. The belief that the spring is related to Sterling Pond is unfounded. It is unlikely that surplus water could be drained from Sterling Pond because it already maintains a delicate balance between the supply of water from rain and snow and the output to the stream flowing to the north.

**Mount Mansfield**

The summit of Mount Mansfield when viewed from a distance has the resemblance of a face with an exaggerated distance between the nose and upper lips. Accordingly, these peaks are named, from south to north, the Forehead, Nose, Upper Lip, Lower Lip, Chin, and Adam's Apple. All these points are readily accessible by the Long Trail and the area of the Nose may be reached by the Toll Road or the Ski Lift. From all the points along the crest an excellent view may be obtained. On clear days Lake Champlain and the Adirondack Mountains in New York State may be seen to the west, and Mount Washington in New Hampshire may be seen to the east.

Of the local structures, good exposures of the mica-albite-quartz schist occur along the crest with magnetite and garnet locally abundant. The rocks on Sunset Ridge, which extends west from the Chin, can be seen clearly to be dipping at gentle angles to the west.

The Chin has an elevation of 4393 feet, which is the highest point in Vermont. Most of the schist in this area is nearly horizontal or dipping slightly to the west. However, minor folds are present everywhere and
an average reading is difficult to obtain. At the summit much of the schist contains large black grains of magnetite. The summit is reached by the Long Trail along the crest of the mountain from the Toll Road, by the Long Trail from Barnes Camp via Taft Lodge, or from the west by the trail up Sunset Ridge. An excellent view of the Lake of the Clouds and the Adam’s Apple is obtained a short distance north of the summit of the Chin.

Lake of the Clouds which lies north of the Adam’s Apple and Bear Pond which lies north of Bear Head Mountain are both small shallow
bodies of water. The slight depressions in which they occur were probably scooped out by the erosive action of the glacier.

Between the Chin and Mount Mansfield Hotel are a number of interesting trails. The Subway and Canyon trail on the west side of the mountain follow, for part of the way, joints in the rock which have been enlarged by the downhill slippage of the western block. Figure 11 shows the nature of one of these passageways. On the east side of the mountain, the Cliff trail passes through a similar joint called “Wall Street.” The Cave of the Winds, reached by a trail just north of the Lower Lip, has formed along another north-south joint. The block which has moved downhill has tilted into the mountain and rubble has filled the gap at the top to form the cave. Figure 12 shows the appearance of the cave as seen from the eastern slope of the Chin. This photograph shows smaller joints on the Chin which have just begun to be enlarged by slippage of the downhill block. It is possible that some of these open joints date back and partially owe their origin to glacial erosive action.

Drift Rock which is located along the Long Trail south of the Upper
Lip has already been described as an erratic boulder moved by the glacier. The glacial striae may be seen in the bedrock northwest of the boulders. Garnet crystals are very abundant in these boulders and specimens of the small red garnets may be obtained here.

The Nose is easily reached along the trail from Mount Mansfield Hotel. From the summit the view is excellent to the south towards Camels Hump, which is one of the prominent peaks of the Green Mountain range. The mica-albite-quartz schist on top of the Nose has many small folds and crenulations.

South of the Forehead along the Long Trail, cliffs of an albite-rich variety of the mica-albite-quartz schist form obstacles which have been surmounted cleverly by the Green Mountain trail-markers.

In the southern part of Mount Mansfield State Forest the Long Trail passes through Nebraska Notch in the vicinity of Taylor Lodge. This notch also was formed by the erosive action of an ancient river that flowed across the mountain at this point, but which has long since been abandoned.
The cliffs at Smugglers Notch as seen looking south from the west wall of the Notch.