

GUIDE TO THE GEOLOGY OF THE SLEEPING GIANT STATE PARK

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About this Guide

Danny A. Brass, *SGPA Hiking Committee Chairperson*

The main purpose of the self-guided geology trail through the Sleeping Giant is to provide interested hikers with an easy and enjoyable means of gaining a better understanding of and appreciation for the many and varied geological features within the Park. This guide serves as the principal reference for the self-guided trail. Following a brief overview of the Park's geological history, the guide is largely a trail-by-trail description of individually numbered stations.

The overview provides a general summary of major geological processes of the distant past that led to the creation of what would one day become the Sleeping Giant as well as the effects of more recent forces that have had a major impact on the geology of the Park. Because of its interesting origin as an underground magma chamber, effects of periodic tectonic activity, subsequent sculpting by the inexorable movement of Ice Age glaciers, and the continued onslaught of erosion, the Giant has a number of interesting and unique geological characteristics. All of these processes have left distinct geological footprints throughout the Park that are clearly visible once a hiker knows what to look for. After reading the introductory material, hikers should have a good general understanding of the geological origins of the Park. This will provide a foundation for understanding the descriptions of individual stations.

A series of stations reflecting interesting and relevant geological features has been selected. These stations have been set up on each of the blazed trails running in an east-west direction (i.e., Blue, White, Orange, Green, Violet, and Yellow), the Red Circle (Gorge) Trail, and the Tower Trail. As shown in the accompanying figures, stations are marked by painted circles that are color coded to match the respective trail color (a tan-colored shade has been selected for the Tower Trail).¹ Station markers are numbered separately for each trail. Stations along the east-west trails are numbered chronologically from west to east (i.e., from the main parking lot on Mt. Carmel Avenue to Chestnut Lane). Stations along the Tower Trail are numbered from the parking lot to the Tower. Stations along the Red Circle Trail are numbered from north to south (i.e., from Tuttle Avenue to Mt. Carmel Avenue). Every effort has been made to make station markers clearly visible to hikers traveling in either direction. Whenever possible, stations have been marked with a single marker that can be readily seen from either direction. If two markers were required, these have been placed on opposite sides of the same foundation (e.g., rock or tree) whenever possible. Of necessity, due to the vagaries of individual trails, some markers had to be placed at varying distances from one another. Regardless of which direction you hike along a trail, it is important to note that any directional information provided in the guide (e.g., look to the right) should be considered in the context of hiking from the chronological beginning of the trail. Hikers should also note that the occasional arrow associated with a station marker (either inside the marker or next to it) is there to help direct one's attention to the actual geological object of interest. They are not trail markers.

Sites have been selected based on their representative character, uniqueness, diversity, quality, and general ease of viewing. A core of representative material has been selected on each of the blazed trails. However, many trails have uncommon or unique features that have been marked as well. Because it is not expected that most hikers will travel across all of the trails,

¹ Because stations are marked by colored circles, no stations have been set up along the Red Diamond, Red Hexagon, Red Triangle, and Red Square Trails, as this would cause too much unnecessary confusion.

there is a degree of repetition from trail to trail. However, individual geological features exhibit a wide range of appearances and observing similar geological features on different trails—and even along different sections of the same trail—will afford hikers an opportunity to see several variations on a theme. Cross-references within guide indicate where similar or related features can be observed along different trails, enabling hikers to appreciate the Park’s natural history in a broader geological context. Because many stations reflect ground-level features, such as rock outcrops located directly on the trail, some may be partially obscured by heavy autumn leaf fall, winter snow and ice, or seasonally active stream flow. Visibility of a few stations may be hampered by dense foliage in summer months. Of course, the number of stations varies from trail to trail and from one region of the Park to another.

The guide itself has been arranged by trail, allowing hikers to download and print a copy of the guide for the particular trails they are interested in hiking. A corresponding trail map shows the exact location of each of the different stations that have been set up. Distances between stations vary widely, so having a copy of this map will help ensure not missing one. Each station has one or more associated photographs and a high-resolution image can be observed by simply clicking on the link(s) at the end of each entry. The F11 key allows you to toggle between a standard and full-page view of each image. In addition, photographs have been gathered together as a collection of thumbnails for each individual trail and these can be printed along with the station descriptions to help with field identification of a particular feature. Displaying the bookmarks sidebar along the left margin of the page will enable you to jump immediately to any section of the text.

As you hike along the various trail systems throughout the Park, please stay on marked trails. Hike slowly and carefully, wear appropriate footwear and clothing, bring sufficient water and snacks as needed, carry a trail map (these are available in the kiosk near the main parking lot on Mt. Carmel Avenue as well as at the bulletin board by the Chestnut Lane trailheads), and stay well away from cliff edges. Running and jumping are not conducive to safety in wilderness travel. Furthermore, as you continue along the trails, it is hoped that you will make every effort to leave the Park in the same condition as you found it. In this regard, “Take nothing but pictures; Leave nothing but footprints; Kill nothing but time.”

It is hoped that this self-guided geology tutorial will stimulate an interest in natural history and geological processes, enabling hikers to recognize salient geological features throughout the Park on their own. Understanding something about the Park’s origin and physical evolution will afford hikers a greater appreciation for the unique environment of the Sleeping Giant and help foster a commitment to preserve this pristine natural wilderness.



Geological History of the Sleeping Giant

David M. Sherwood

The geological history of the Sleeping Giant begins about 210 million years ago, during the end of the Triassic period. At that time, eastern North America was much farther south than it is now and experiencing a semi-arid, equatorial climate, complete with seasonal monsoons. The Atlantic Ocean did not yet exist and the land that was destined to become Connecticut was embedded within a mountain range that was touching the northern edge of Africa, making it part of the single, large landmass that existed at the time: the supercontinent of Pangea.

The birth of the Atlantic Ocean began when tectonic forces (i.e., those related to movement of the Earth's crust) started pulling the supercontinent apart. This created an extensive series of rifts across the land, including the area that would one day become the eastern seaboard of North America. One of these rifts caused a great fault to develop in central Connecticut, essentially splitting the state in half. Geological forces associated with this process produced a tilt in the landmass, causing the central part of the state to actually sink. This led to the creation of a basin that is now called the Central Lowlands (and which extends from Massachusetts south to the New Haven Harbor). Over the course of time, seasonal rains washed sand and other sediments into the basin from the highlands on either side. As layer upon layer of sediment accumulated, natural processes gradually cemented them together to form the red, tan, and gray sandstone and conglomerate that can be found across central Connecticut. Eventually, the mountainous highlands were eroded down to the rolling hills that are now present east and west of the Central Lowlands.

Around 200 million years ago, at the beginning of the Jurassic period, enlarging rifts created great fissure systems across the landmass of Pangea (which, by then, was gradually beginning to break apart). These conduits allowed molten magma to flow towards the surface, where it poured out as lava over very extensive areas of land. Widespread volcanic eruptions were relatively common at this time, occurring on a global scale that has been observed in the rock record of our planet's history on only a handful of occasions. The isolated volcanic eruptions that we observe today seem puny by comparison.

A series of three separate lava flows—occurring over a vast geographic area and all within a period of less than a million years—flooded the Central Lowlands of Connecticut, as well as adjacent basins up and down the eastern seaboard.¹ In the region of the Park, the layers of ancient basalt (solidified lava) were gradually covered by fresh deposits of sandstone. Eventually, both the sandstone and the basalt were eroded away. During the first eruption, some of the molten magma did not reach the surface, but was caught in a vast underground magma chamber (Figures 1 and 2). This chamber was formed by hot molten rock intruding into the overlying sandstone, some of which was actually melted and incorporated into the magma. The mechanics underlying how the magma chamber was formed are still not completely understood by geologists. It is actually this huge, underground vault of magma that would one day become the Sleeping Giant.

The magma chamber subsequently cooled and eventually solidified approximately one mile beneath the ancient land surface. If magma reaches the surface, it is called lava. And when lava with this particular chemical composition cools, it is known as basalt. In areas of Connectic-

¹ These eruptions are associated with what is called the End-Triassic Mass Extinction, one of the “Big Five” mass extinctions of our planet's history, and may have contributed greatly to this major extinction event.

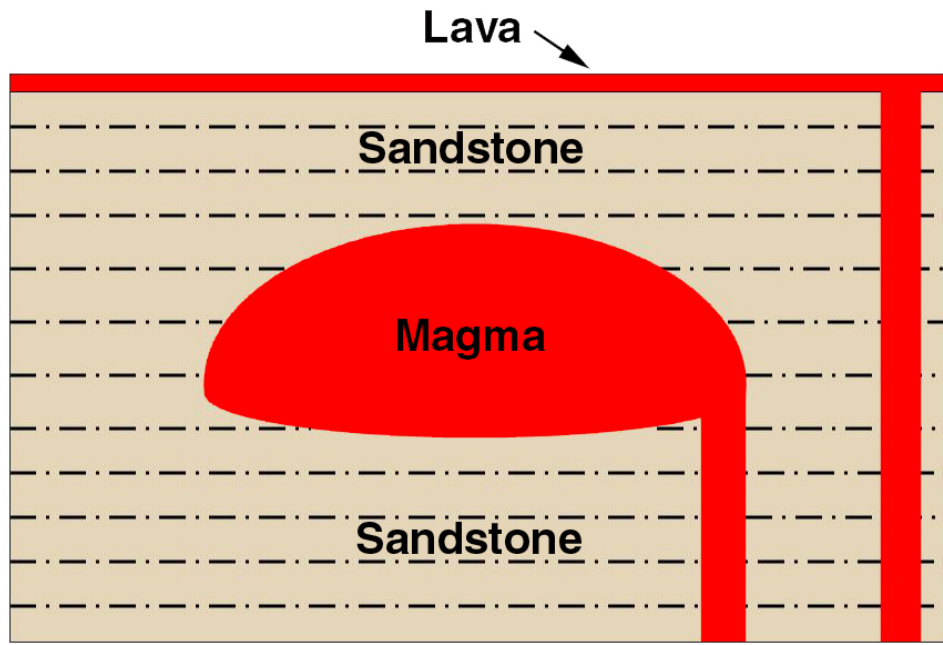


Figure 1

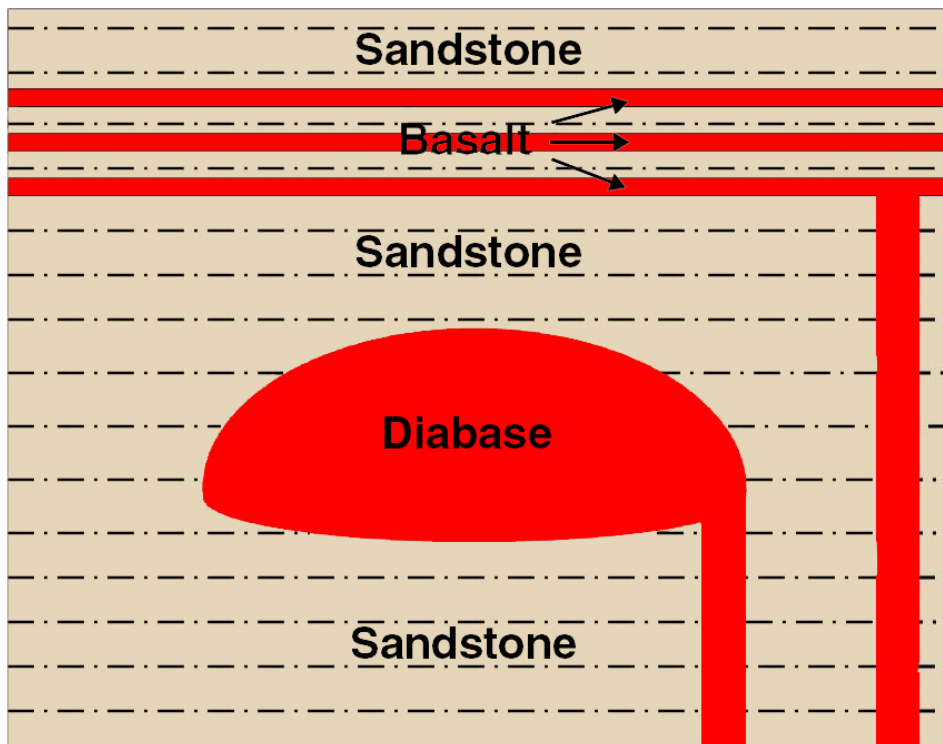


Figure 2

cut in which lava did flow to the surface, including Hartford, Meriden, and North Haven, visible deposits of basalt can still be found. Because the magma within the underground magma chamber of the Sleeping Giant never reached the surface before cooling and solidifying, it is called diabase. Diabase and basalt are chemically identical; the difference in terminology is based solely on whether it cooled and solidified above ground or below the surface.

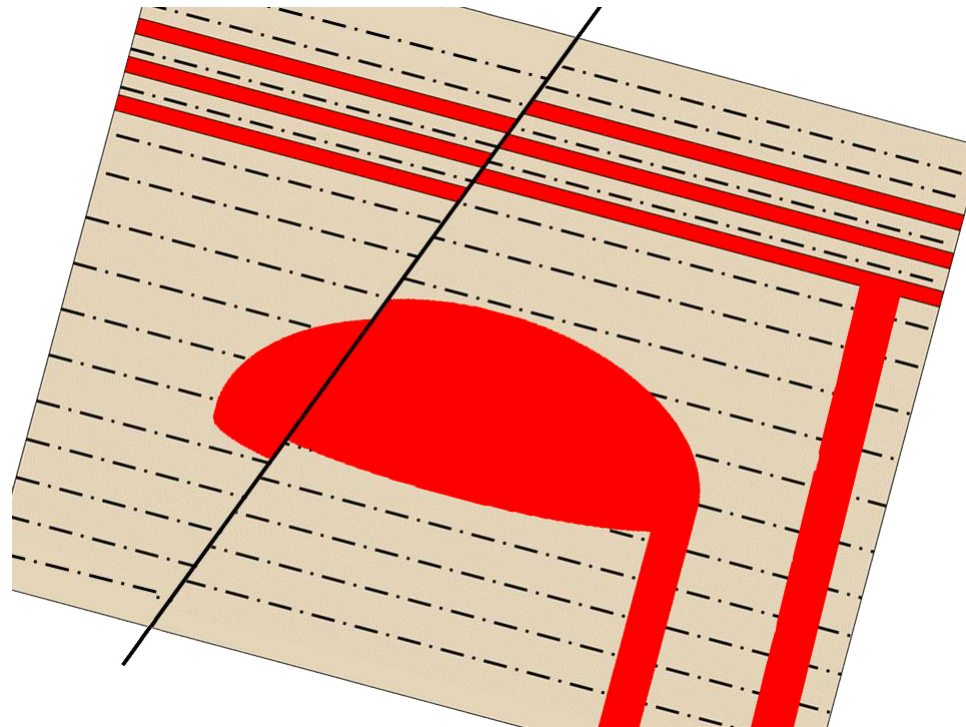


Figure 3

After the magma chamber solidified, continued tectonic activity created a series of faults and caused the central basin to sink even farther; however, this occurred unevenly. As a result, the entire basin tilted as much as 15° to 20° to the southeast (Figure 3). This tilt is visible today in the orientation of many sandstone outcrops within the Park and surrounding town of Hamden. Movement along one of the larger faults that developed caused what would one day be the Giant's Head to drop in relation to its Chest. This shift in landmass was responsible for creating the steep cliff of the Giant's Chin.

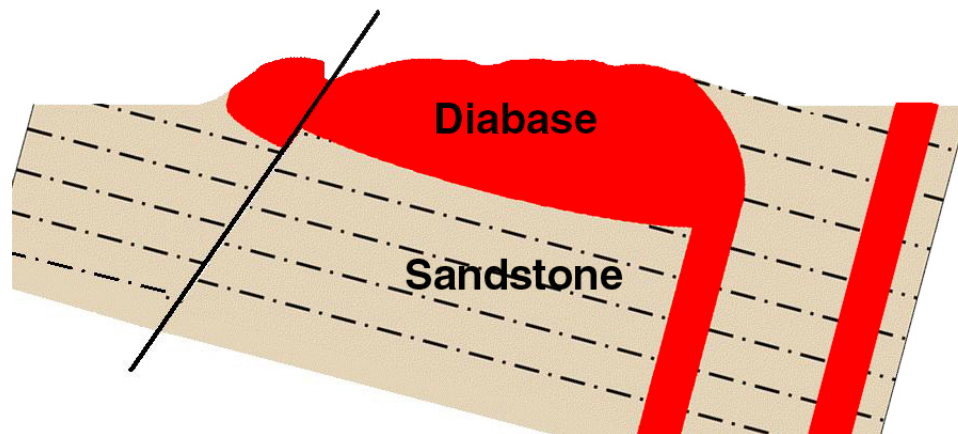
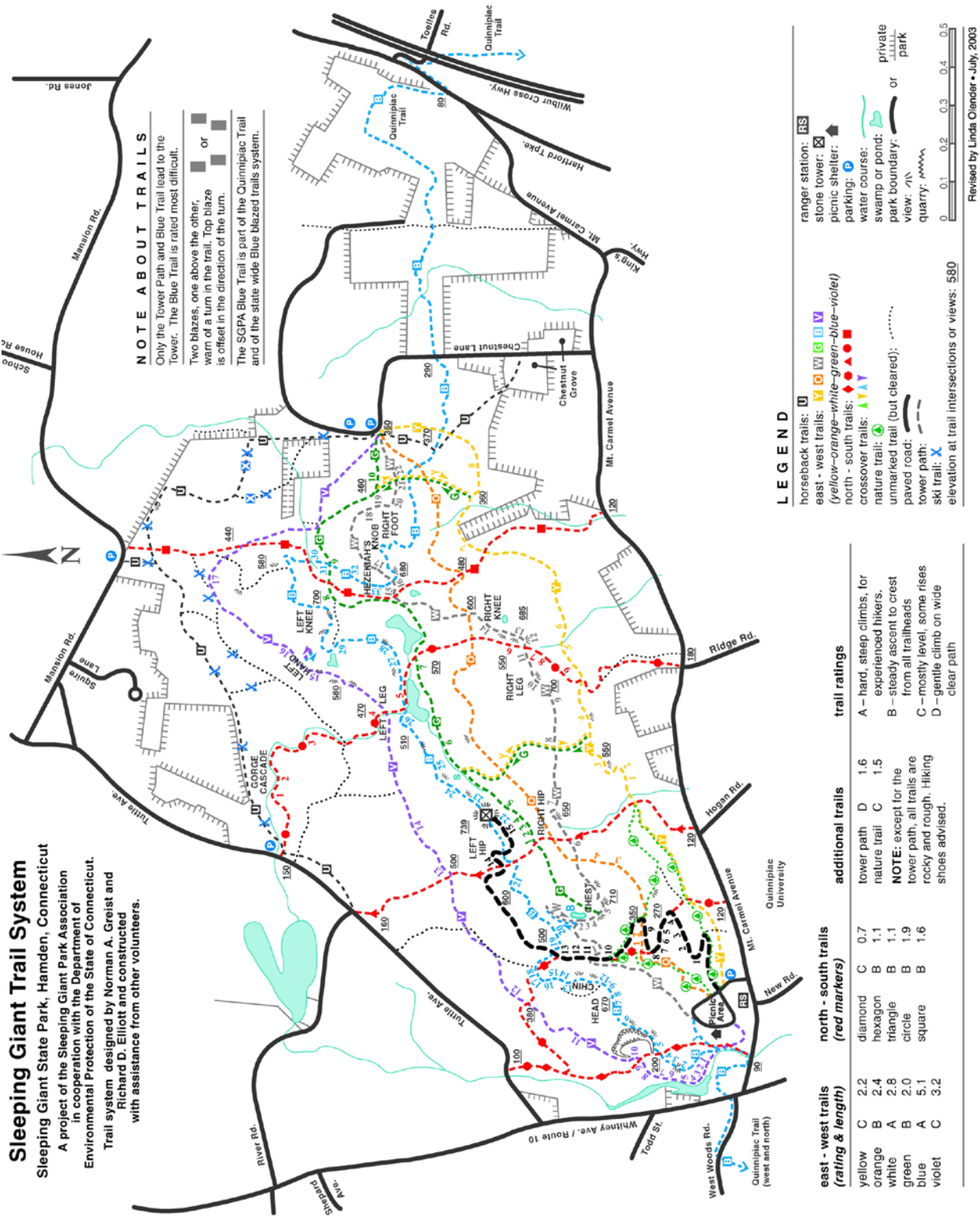


Figure 4

Over the course of tens of millions of years, the layers of soft sandstone above the Sleeping Giant were gradually eroded away. When the diabase forming the Giant was finally exposed, it eroded at a much slower rate. It is for this reason that the now-exposed magma chamber stands so much higher than the surrounding landscape.

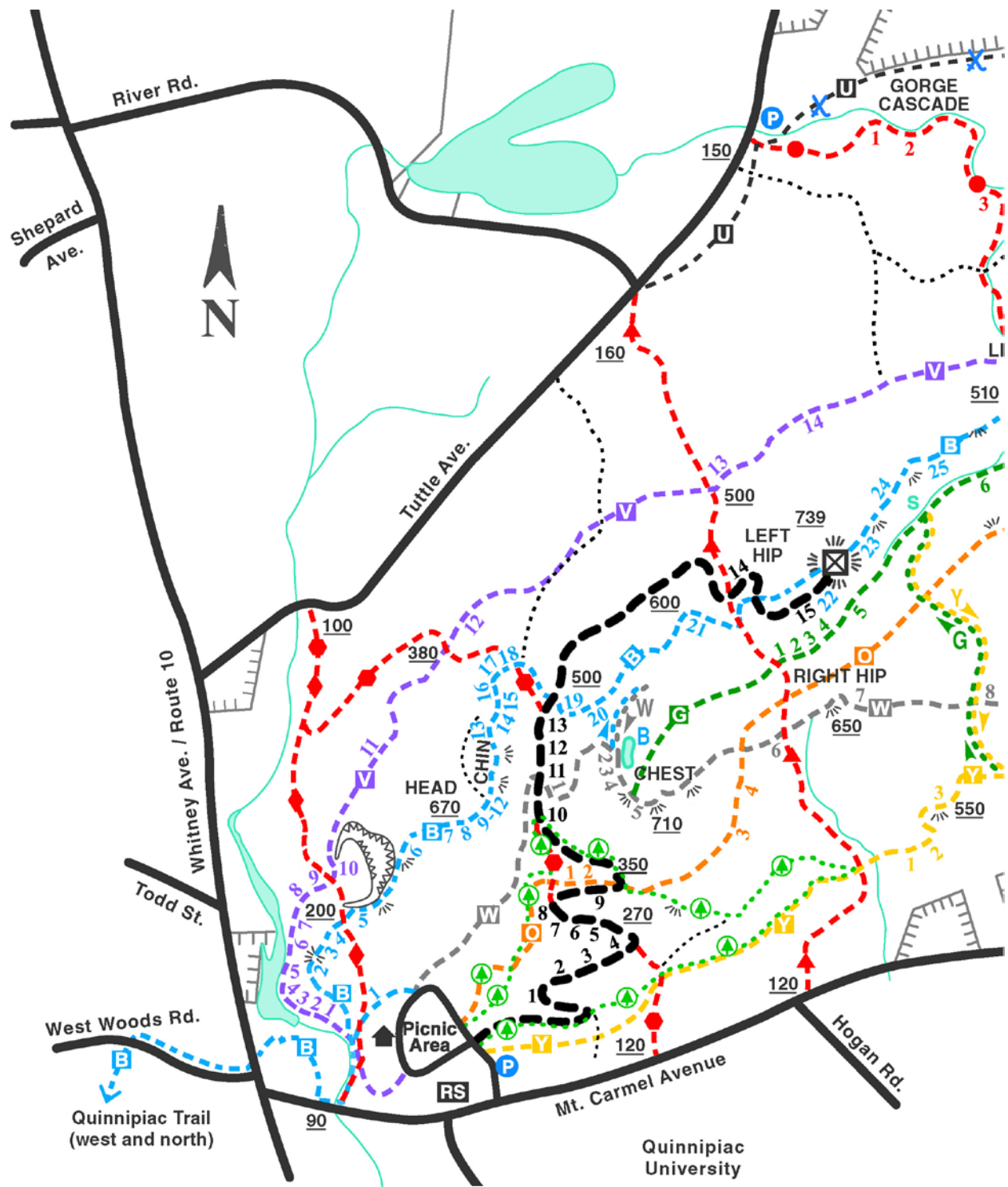
During the Pleistocene Epoch (2.5 million to 12,000 years ago), the world was plunged into an Ice Age. Connecticut experienced multiple cooling and warming cycles and continental glaciers periodically advanced and retreated across the state. During the peak of the last glacial advance, which occurred some 20 thousand years ago, Connecticut was buried under a sheet of ice that was half a mile or more thick. The moving ice carried chunks of rock that originated farther north and left them behind as pebbles and boulders that are now readily visible along all of the trails in the Park. In addition to depositing rocks, the glaciers also acted like large bulldozers, grinding away at the bedrock and pushing material even farther south. The enormous forces associated with movement of the glaciers dramatically altered the landscape, helping to sculpt the exposed magma chamber into the shape of the Sleeping Giant that we know today (Figure 4).

Location of Geology Stations

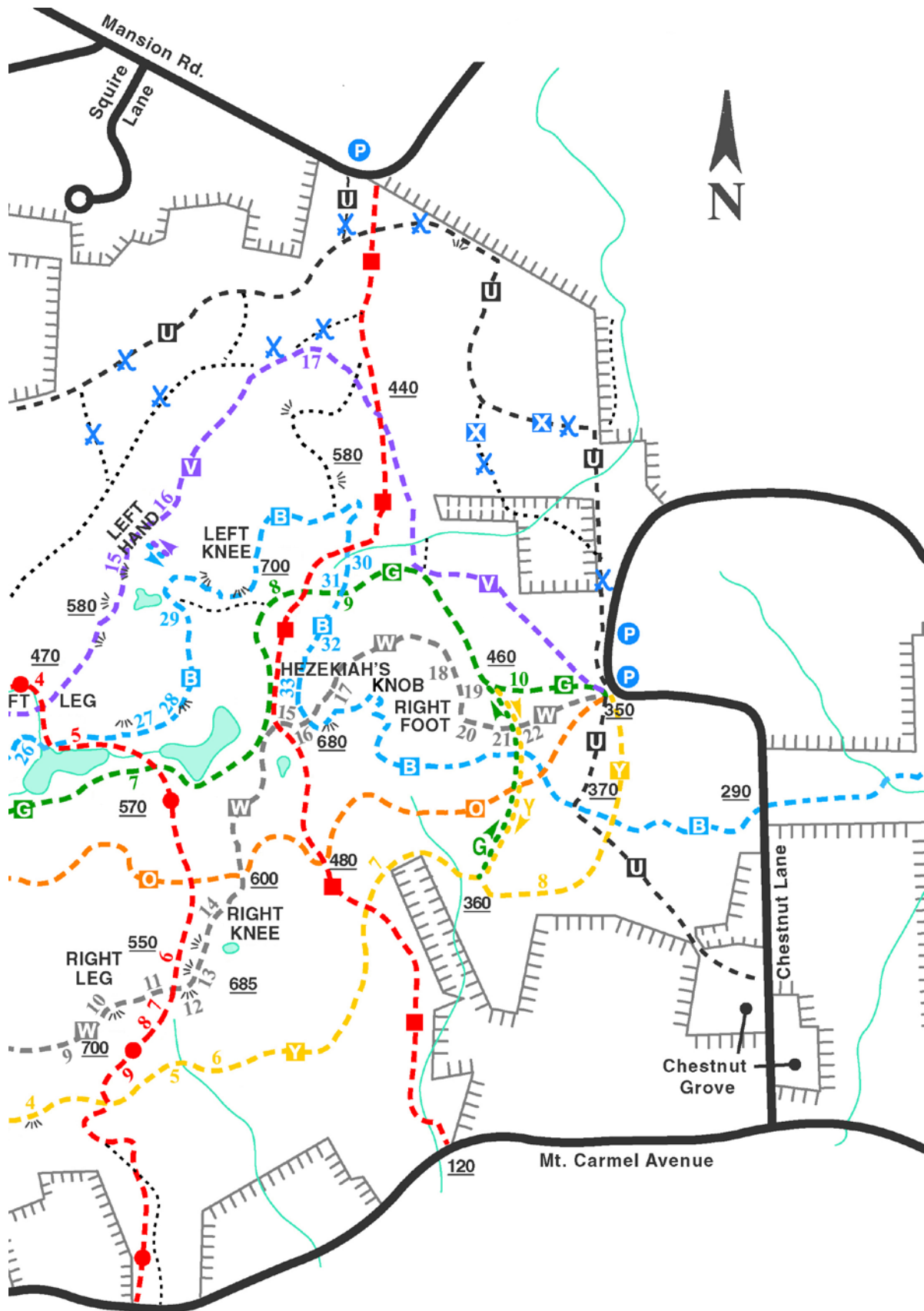


Revised by Linda Olander • July, 2003

Location of Geology Stations – Western Section of Park



Location of Geology Stations – Eastern Section of Park



Tower Trail – Geology Stations

T1 – The Sands of Time: As is the case for all of the sandstone found within the Park, the large sandstone boulder located 30 feet behind and to the left of the station marker was formed about 210 million years ago, during the end of the Triassic Period. All of the sand and pebbles that have been incorporated into this boulder originated in ancient mountain ranges. Over the course of time, as the mountains were worn down by erosional processes, sediments carried by streams were gradually deposited in layers within the Central Lowlands of Connecticut. As layer upon layer of sediments accumulated, they gradually became cemented together by natural geological processes.

The water in a moving stream naturally sorts material by size and weight. This is primarily related to stream size and rate of flow. The readily visible differences in pebble size between upper and lower layers of this sandstone boulder are related to the predominant size of material carried by ancient streams. Rapidly flowing water can carry larger rocks and pebbles than more slowly moving streams can, and this will be reflected in the composition of sediments that are deposited over time. The layers of large pebbles near the top of this boulder were formed from sediments deposited over time by rapidly flowing water, whereas the lower layers of sand and small pebbles were formed from sediments deposited by slowly moving streams that were incapable of carrying larger rocks.

A modern-day example of this process can be observed at station 1 along the Violet Trail. At this site along the Mill River, a clear gradation, from the bank to the center of the river channel, can be observed in the size of material carried and deposited by the Mill River. In turn, this can be related to the rate of flow, which is lower near the bank and higher in the center of the channel. In order for these sediments to form sandstone, this process would have had to continue for extremely long periods of time. Over the course of geologic time, the amount of water flowing in a stream may vary greatly and this, in turn, would significantly affect the size of rocks and pebbles incorporated into any sandstone boulders being formed. In this regard, the physical makeup of sedimentary rocks such as this sandstone boulder helps tell the story of changing environmental conditions over the long course of time during which its different layers were deposited. Such information opens a window onto this period of time in Earth's distant past, enabling geologists and paleontologists to better understand the nature of ancient ecosystems.

View high-resolution photo(s) at:

[T1 – Sandstone boulder](#)

[T1 – Sandstone boulder](#)

T2 – Glacial Moraine and Basalt Boulder: The low hill along the right side of the Tower Trail is a glacial moraine. It is a beautiful example of how material can be deposited by a glacier. Collectively, the extensive deposit of rocks and pebbles making up this hillside is called glacial till. This moraine was formed approximately 17 thousand years ago during the recession (melting back) of the last glacial ice sheet. As the ice melted, all of the sediment that was being carried or pushed by the ice was simply dropped in place. Unlike the arrangement of rocks and pebbles that had been incorporated into the sandstone boulder at the previous station, in which a very obvious organization according to size and weight could be seen, no such organization exists among the sediments in glacial till. The material in glacial till is unsorted and unconsolidated (i.e., loose), with no discernable organization or layering within the deposits. Particles ranging in size from

smaller than a grain of sand to large boulders were simply deposited in random fashion as the glacier melted. This moraine extends farther up the trail as the hillside continues. An excellent example of glacial till, beautifully displaying extensive deposits in cross-sectional view, can be seen at station RC2.

The very large boulder to the left of the station marker is a piece of basalt that poured out as lava from a large fissure in the Earth's crust approximately 200 million years ago. This occurred at the same time that the magma chamber that would eventually form the Sleeping Giant was solidifying belowground. The rounded shape of the boulder suggests that it was transported a considerable distance by the ice before finally coming to rest at this location. Since the movement of ice during the peak of the Ice Age was primarily southward, it can be deduced that this boulder originated from one of the exposed basalt outcrops north of the Park. Chunks of sandstone and other rocks that were carried here by the ice can also be found nearby. The small block of sandstone just in front of the basalt boulder contains a variety of pebbles that were deposited and gradually cemented in place over the course of time.

View high-resolution photo(s) at:

[T2 – Glacial till](#)

[T2 – Glacial till](#)

[T2 – Glacial till](#)

[T2 – Basalt boulder](#)

T3 – Root Casts and Molds: Areas of pale-green discoloration (squiggles) and deep grooves on the surface of these three sandstone slabs are the fossilized roots of long-extinct plants. These particular pieces of sandstone are composed of sediments that had probably once been soil from the bank of an ancient lake or stream. Over time, the sediments became cemented together to form slabs of sandstone. In the semi-arid environment that characterized the end of the Triassic period, plants mainly grew near bodies of water since the soil in these locales remained moist for considerably longer periods of time. Ancient plants known to have inhabited this area at that time include ferns, cycads, ginkgos, and a variety of conifers. *Neocalamites*, a larger relative of the modern horsetail, thrived in this type of moist habitat.

Fossilized roots can generally form in one of two ways: mineralization of root material or formation of casts and molds. The fossils at this station are examples of casts and molds. Following the death of a plant, portions of a root may become impregnated with minerals (i.e., mineralized) that fill pores and spaces within the original structure. However, even if a root decays before this happens, the root cavities left behind in the ground could still be filled with minerals that precipitated out of the groundwater to form what is called a cast. The root cast retains the shape of the original root. If the minerals that had formed either a cast or a mineralized fossil gradually eroded away (which could easily occur once the slab had been unearthed and exposed to the elements), only an impression (or mold) of the original root cavity would remain. This can be seen on the slab to the far right. The green discoloration is the result of a chemical reaction between the rotting plant material and iron that had been present in the soil.

View high-resolution photo(s) at:

[T3 – Fossil plant roots](#)

T4 – Quartzite: The two smooth, yellow and reddish-pink stones lying just to the left of the station marker are pieces of the metamorphic rock quartzite. Quartzite forms when sandstone is subjected to tremendous pressure, such as occurs when tectonic forces cause continents to collide and mountain ranges to be thrust upwards. Under these conditions, the quartz crystals making up the bulk of the sandstone are squeezed tightly against one another to form quartzite. Quartzite is not native to the region of the Sleeping Giant, and no outcrops of quartzite exist anywhere in the Park; however, smooth and rounded rocks like these are extremely common throughout the Giant, typically ranging in size from a few inches to several feet in diameter. They probably originated from areas far to the north of Connecticut and were carried here by the awesome power of the moving glacier. They were deposited in the area when the last glaciers to occupy Connecticut melted away, approximately 17 thousand years ago.

Place the palm of your hand across one of these quartzite specimens to get an idea of its temperature. Compare it to the darker-colored rocks to either side and you will readily notice how much cooler the quartzite is. Several factors account for the coolness of quartzite, including a lighter color, which does not absorb as much heat as dark-colored surfaces, and a capacity to transfer heat into the ground more effectively than other rocks. As a result of its coolness, water tends to condense across its surface on humid days, imparting a moist sheen to its appearance.

The appearance of quartzite may vary considerably. Colors commonly include shades of white and gray; however, pink, yellow, orange, and red may often be seen. The color depends on the amount of iron or other impurities that have been incorporated into the rock. Once you become familiar with the many appearances of quartzite, it is very easy to recognize. Keep an eye out for it along all of the trails within the Park. Numerous small chunks of quartzite can be seen embedded in the Tower Trail along its entire extent. Other stations featuring quartzite include B1, B18, B20, B30, O1, V13, Y2, and T6.

View high-resolution photo(s) at:

[T4 – Quartzite](#)

[T4 – Quartzite](#)

[T4 – Quartzite](#)

T5 – Hydrothermal Precipitate: Just to the right of the station marker are several small rocks with one surface coated with a white frosting. As you continue up the Tower Trail, you may see similar rocks scattered along the wall.

Quite commonly, when rocks are buried deep underground, cracks of varying size may develop. Such cracks may subsequently become conduits for hot, mineral-rich water to flow through. As a result of several complex processes, various minerals may slowly precipitate out of the water, covering the walls of these cracks with a profusion of crystals. This type of hydrothermal process is quite common and can sometimes decorate even large cavities with spectacular mineral deposits. A similar process may lead to the formation of geodes. If the rock subsequently fractures through one of these cracks, as occurred here, the mineral-rich surface will be exposed in cross section, allowing the minerals to sparkle in the sunlight. Some of the most common minerals that have been deposited throughout the Park by this process are quartz and various members of the zeolite mineral group. Other examples of hydrothermal precipitates can be seen at stations V5, V10, and Y1.

View high-resolution photo(s) at:

[T5 – Hydrothermal precipitate](#)

[T5 – Hydrothermal precipitate](#)

[T5 – Hydrothermal precipitate](#)

T6 – Garnet, Biotite, and Quartzite: Looking just to the right of the station marker, you will see three rocks (labeled A, B, and C) that have been incorporated into construction of this rock wall. A and B have a number of prominent crystals embedded in their surface. As is readily apparent, the appearance of these rocks is markedly different from that of the many other rocks used to make this wall.

Rock A is a block of amphibolite, a metamorphic rock formed deep belowground under conditions of high temperature and pressure. This specimen contains numerous small garnet crystals, which are liberally sprinkled across its surface. Although garnet is quite common in Connecticut, and is, in fact, the state mineral, it does not occur naturally in the Park. Even though garnet quarried from Connecticut has largely been used as an industrial abrasive, beautiful specimens can be collected at various sites across the state that are accessible to public collecting. The crystals visible at this station are rather lackluster compared to those found at garnet-rich sites throughout the state.

Rock B is a form of schist, another kind of metamorphic rock that formed deep belowground under conditions of high temperature and pressure. Because schists are rich in mica, their surface tends to flake into layers. This can be readily seen on close inspection of this rock. Also note the dark speckling across its surface. These are crystals of biotite. Biotite is a dark form of mica, similar to the muscovite mica that many of you will already be familiar with.

Rock C is an example of quartzite; however, its composition and appearance differ markedly from that of other quartzite specimens commonly seen throughout the Park. In particular, notice the many pebbles that are clearly visible on its surface. These are remnants of the various rocks that had been present in the original sandstone from which this metamorphic rock was formed. As the quartzite was smoothed and rounded during the course of its transit within the glacier, the pebbles were also worn flush with the surface.

Directly across the trail from these three metamorphic rocks are two more examples of quartzite. While the one to the left is very similar to those at station T4, the larger boulder just to its right is covered by a splotchy-looking growth of dark-colored lichen. If you look closely at the surface of the smaller rock, you may see several small, crescent-shaped cracks. This is a commonly seen feature in quartzite and is caused by the enormous pressure exerted on these rocks as they were carried along within the glacier. All four of the rocks labeled at this station were glacially transported. None is native to the area.

View high-resolution photo(s) at:

[T6 – Amphibolite and Biotite](#)

[T6A – Garnet crystals](#)

[T6B – Biotite](#)

[T6C – Pebbled quartzite](#)

[T6 – Quartzite](#)

[T6 – Lichen-covered quartzite boulder](#)

[T6 – Quartzite](#)

[T6 – Quartzite with crescent-shaped crack](#)

T7 – Diabase: This outcrop provides your first look at diabase, the rock that forms the bulk of the Sleeping Giant. This rock formed from cooling magma that was injected into an underground chamber approximately 200 million years ago. Diabase has the same chemical composition as basalt; however, basalt is formed from surface lava flows. When magma cools and solidifies underground, as occurred during the formation of the Sleeping Giant, the resulting rock is called diabase. Basalt outcrops do not exist within the Park although pieces of varying size can be found that had been carried here by glacial action.

View high-resolution photo(s) at:

[T7 – Diabase outcrop](#)

T8 – Oxidized Diabase: This broken chunk of diabase displays a striking difference in color between its outer surface and a freshly fractured face. The original color of the outer surface had been similar to that of the fractured face. The orange color on the outer surface is related to its high content of iron, which literally rusts (oxidizes) on long-term exposure to air and the elements. This oxidation process produces a range of colors and explains why much of the diabase in the Sleeping Giant appears to be a blend of its original dark color and varying shades of orange, red, and yellow. The original color of such rocks can only be observed on a freshly broken surface. In the course of time, this surface will slowly oxidize as well. Just to the right of this fractured boulder, note the smaller slab of diabase buried in the ground. Having been exposed to the elements for a longer period of time, this surface has already begun to oxidize.

View high-resolution photo(s) at:

[T8 – Oxidized diabase](#)

T9 – Diabase Columns and Tree-Root Wedging: Just beyond the station marker, note the small cliff along the right side of the trail. Rising above a small, rock- and tree-filled slope, this cliff face displays a network of vertical columns that frequently forms in cooling magma. The columns result from long, vertical fractures that develop in the rock. These fractures form as a result of contraction that accompanies the cooling and solidification of magma. This columnar arrangement is very common along the many diabase cliffs within the Park. The columns typically form multi-faced polyhedra (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park. A number of factors, including the rate at which the magma cools, play a role in determining the thickness of individual columns. Rapid cooling tends to result in relatively narrow columns, while slowly cooling columns are more likely to be thicker. The relatively thick columns within the Giant suggest that this magma chamber cooled rather slowly.

To the left of the station marker located on the cliff, you will see a large black birch tree growing out of the rock wall. Tree roots affect rocks and soil in a number of ways. By holding soil together, they help to prevent soil erosion. On the other hand, the growth of tree roots can actually dissolve rock, causing small cracks to form in solid rock. In the course of their growth, tree roots will also frequently exploit already-existing cracks present in rocks. As roots enlarge over the years, they exert tremendous pressure on the surrounding rock, ultimately splitting apart even large rocks. In conjunction with the effects of ice wedging, continued growth of roots favor ongoing expansion of such cracks. Erosion of rocks by the growth of tree roots is actually a very common process, and many examples can be seen in the Park, especially if one examines the

various trees growing in the vicinity of cliffs and rocky outcrops. Tree-root wedging is only one of the many ways in which rocks can be broken down across the ever-changing landscape of the Sleeping Giant. Other stations featuring tree-root wedging include B11, B13, B19, G1, RC5, and T12.

View high-resolution photo(s) at:

[T9 – Diabase columns](#)

[T9 – Tree-root wedging](#)

T10 – Glacial Striations: From this intersection of the Tower Trail and the Red Hexagon Trail, note the continuation of the latter along the left side of the Tower trail. You will also notice that the tree carrying the station marker for T10 also has a green pine tree painted on it. This is the symbol used to mark out the Nature Trail. Looking to the left down the Red Hexagon Trail, you will see a circular green marker with a white number painted in it. This is station 35 of the Nature Trail and is just over 30 feet away from the Tower Trail. Slowly walk down to this station, being especially careful not to slip on the loose gravel at the edge of the Tower Trail. On the flat slab of rock just to the right of the number 35, you can see a host of fine, parallel grooves that have been engraved into the surface of the rock. These are glacial striations and represent yet another remnant of Connecticut's glacial past. Glacial striations were produced by the scraping action of small rocks and gravel that had been trapped beneath the moving mass of ice. In this location, the direction of ice movement was strongly affected by local topography. The orientation of the scratches indicates that the ice sheet was moving almost directly south, parallel to the cliff that forms the Giant's Chin.

View high-resolution photo(s) at:

[T10 – Glacial striations](#)

[T10 – Glacial striations](#)

T11 – Mt. Carmel Fault and Thousands of Years of Crumbling: Directly across the trail from the station marker are the lofty cliffs that form the Sleeping Giant's distinctive Chin. Consider the various geological forces that may have been responsible for creating and subsequently sculpting it into the shape it has today.

A combination of geological events played a role in creating this particular feature of the Park. The most significant of these was the development of a large fault: the Mount Carmel Fault. A fault is a fracture in the crust of the Earth across which significant movement occurs. Formation of the Mount Carmel Fault occurred in association with the sinking and tilting of Connecticut's Central Lowlands (see discussion in introduction). As the land cracked open along this fault, the Giant's Head actually dropped down relative to its Chest. Over the course of time, the extensive sandstone deposits that had once covered the Sleeping Giant gradually eroded away. This exposed the fault and the diabase hillsides that would one day be the Giant's Head and Chest. The narrow corridor formed by activity within the fault set the stage for even more extensive erosion by glacial action. The immense power of the glacier flowing through this part of the Park ripped away material from both hillsides, widening the gap between them even further, sculpting the giant cliffs that loom above the Tower Trail, and ultimately creating the characteristic profile of the Giant's Chin and Neck that we recognize today. If not for this succession of geologic events in Connecticut's distant past, the Giant would probably never have developed either a Chin or a Neck. Without these distinctive features, the Sleeping Giant might not ever have attained its iconic status. Hikers need not be unduly concerned about walking along this fault.

The fault is not known to have moved for millions of years, and there is currently no major tectonic activity in the region that would suggest it will become active again any time soon.

Just like the small cliff observed at station T9, the massive cliff forming the Giant's Chin also displays columns. The fallen jumble of boulders at the base of this and other cliffs throughout the Park forms a talus slope (or scree slope). This consists of remnants of large columns that have crumbled away from the cliffs over long periods of time. Most of these rocks had been split off the cliff by extensive erosion since the passage of the last glacial ice sheet about 17 thousand years ago; however, some may have been ripped away by the ice sheet itself.

View high-resolution photo(s) at:

[T11 – Mt. Carmel Fault](#)

[T11 – Massive talus slope](#)

T12 – Plume and Tree-Root Wedging: In the upper left corner of this diabase block, note the area from which a large flake of rock has broken away. The growth of the ash tree just to the left of the block has fractured the block apart near its base, and its proximity to the left corner of the block may have also been partially responsible for prying off the flake near the top. The rock surface that has been exposed by delamination of this flake displays a characteristic series of grooves and ridges arranged in a feathery pattern. The pattern is called a plume. Plumes like this are formed as a result of the way in which many fine-grained rocks tend to break apart. The point from which all the lines diverge is the site at which the rock began to fracture. As a variety of erosional forces continued to act on the block, the fracture continued to grow steadily larger. Eventually, the flake simply peeled away from the rest of the block. Plumes are extremely common in the Park and can often be seen where broken fragments of diabase are plentiful. This type of feature is very useful to geologists attempting to reconstruct the series of events leading to formation of a particular landscape or trying to determine the nature and direction of tectonic forces that may have influenced geological processes in a region. An even larger plume can be seen at the next station.

View high-resolution photo(s) at:

[T12 – Tree-root wedging and plume](#)

[T12 – Tree-root wedging and plume](#)

T13 – Large Plume on Column Remnant: The numerous large boulders that form the extensive talus slope at the base of this cliff represent the broken remains of diabase columns. Despite being subjected to long-term erosion or being fractured after a fall from a great height, many of them preserve the original polyhedral structure of the parent column, and their characteristic flat-sided faces and sharply defined edges (i.e., polygons) can still be seen. There is no need to climb among the rubble of these giant boulders in order to view them. In fact, this is a very dangerous thing to do, as many of them are loose and precariously balanced and can unexpectedly shift position with little or no warning. As is the case for many of the fallen blocks, this particularly large example also displays a spectacular plume on its face. Plumes can also be seen at stations V3 and V10.

View high-resolution photo(s) at:

[T13 – Plume on massive column remnant](#)

[T13 – Posterized view of plume](#)

T14 – Granitic Vein: The light-colored stripe running across this rock face, 12 feet above the base, is the result of an event that happened while the underground magma chamber was still cooling. In areas at which the hot, molten magma came into direct physical contact with the overlying sandstone, the enormous heat given off by the magma actually melted some of the sandstone. Cooling of the magma chamber first occurred at its outer surface, resulting in the formation of a brittle shell. Cracks eventually developed in the shell, and the melted sandstone flowed into them, sometimes for considerable depths. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Although granitic veins formed at contact surfaces between molten magma and the overlying sandstone, melted sandstone filled cracks in the solidifying magma chamber to varying depths. This is why granitic veins can be found in areas at which the actual contact surface has since eroded away.

Granitic veins are fairly common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails. Although it is difficult to see from the vantage point of the station marker, this granitic vein is slightly raised with respect to the surface of the diabase with which it is associated. This is due to differential erosion of the two surfaces. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, the vein erodes far more slowly. A more dramatic example of this differential erosion can be seen just a little farther ahead at station B23, where the Tower Trail and Blue Trail cross just in front of the Tower.

View high-resolution photo(s) at:

[T14 – Granitic vein](#)

[T14 – Granitic vein](#)

T15 – Tower View: Just over 30 feet past the station marker, turn left onto a rocky trail that leads up to the Tower. As you start up this trail, look carefully at the rocky surface, and you will be able to see a series of glacial striations—similar to those at station T10—in the rock. At the Tower, walk up the ramp to the upper parapet.

Constructed from blocks of the Sleeping Giant diabase, the Tower affords hikers a 360° panoramic view of a large portion of Connecticut’s Central Lowlands (dense foliage will obscure the northern view in summer months). From the top of the Tower, the New Haven skyline can be clearly seen almost directly south. The hills just to the left of New Haven are portions of the East Rock Ridge, another diabase intrusion with a geologic history similar to that of the Sleeping Giant (note: it is a common misconception that East Rock, West Rock, and the Sleeping Giant were formed as extrusive volcanic eruptions).¹ The Long Island Sound is visible just beyond the New Haven skyline and on clear days, the shoreline of Long Island, New York, can be seen on the horizon across the Sound. Long Island itself is largely composed of loose rubble that had

¹ An extrusive volcanic event occurs when molten magma breaks through the crust and subsequently flows across the landscape as lava. As it cools and solidifies, lava forms basalt. An intrusive event involves the accumulation of molten magma within a chamber that remains underground. As magma cools and solidifies underground, it forms diabase. Diabase remains hidden underground unless exposed by erosion that wears away the overlying rock. This is how the diabase that makes up Sleeping Giant was exposed.

been pushed southward by the glacier. It represents the southernmost extent of the glacier's range.

If the direction of the New Haven skyline is assigned to a 12:00 position (as on the face of a clock), West Rock Ridge extends from about 1:00 to 2:00. This ridge is the remnant of a large, horizontal, sheet-like magma chamber called a sill. West Rock intruded and subsequently cooled around the same time as the Sleeping Giant, but was farther belowground. The series of hills at 3:00, along with the large continuous ridge that blocks the horizon from 4:00 to 5:00, is part of this same geologic formation.

In the 7:00 position, two closely spaced hills can be seen. These are the two ridges that make up Higby Mountain in Middlefield. At the 6:00 position are the Hanging Hills of Meriden, a view of which may be seasonally obscured by heavy foliage. Together, the Hanging Hills and Higby Mountain are exposed portions of the volcanic lava flows that poured across the land surface at the beginning of the Jurassic period. Unlike the Sleeping Giant, West Rock, and East Rock (all of which are intrusive features), Higby Mountain and Hanging Hills are extrusive features. The large basalt boulders at stations T2 and B19 most likely came from an exposed basalt outcrop similar to the ones at these sites, and may have originated from one of these very hills. It is also generally believed that the large, glacially transported, basalt boulder that came to rest atop West Rock, and in which Judges' Cave formed, originated from the Hanging Hills of Meriden.

View high-resolution photo(s) at:

[T15 – Glacial striations](#)

[T15 – Panoramic view from Tower](#)



T1 – Sandstone boulder



T1 – Sandstone boulder



T2 – Glacial till



T2 – Glacial till



T2 – Glacial till



T2 – Basalt boulder



T3 – Fossil plant roots



T4 – Quartzite



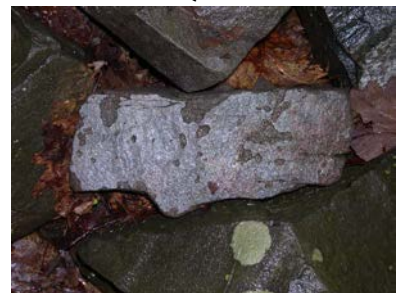
T4 – Quartzite



T4 – Quartzite



T5 – Hydrothermal precipitate



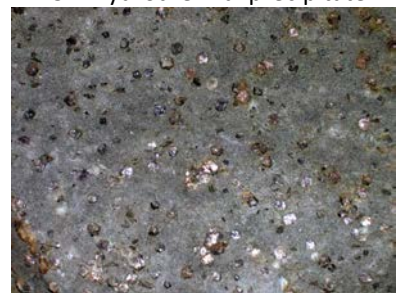
T5 – Hydrothermal precipitate



T5 – Hydrothermal precipitate



T6 – Amphibolite and Biotite



T6A – Garnet crystals



T6B – Biotite



T6C – Pebbled quartzite



T6 – Quartzite



T6 – Lichen-covered quartzite boulder



T6 – Quartzite



T6 – Quartzite with crescent-shaped crack



T7 – Diabase outcrop



T8 – Oxidized diabase



T9 – Diabase columns



T9 – Tree-root wedging



T10 – Glacial striations



T10 – Glacial striations



T11 – Mt. Carmel Fault



T11 – Massive talus slope



T12 – Tree-root wedging and plume



T12 – Tree-root wedging and plume



T13 – Plume on massive column remnant



T13 – Posterized view of plume



T14 – Granitic vein



T14 – Granitic Vein



T15 – Glacial striations



T15 – Panoramic view from Tower

Blue Trail – Geology Stations

B1 – Glacially Deposited Pegmatite and Quartzite: As you walk down the narrow path at the beginning of the Blue Trail, note the hill along the left side of the trail and the more distant hillside to the right. The hill on the left is primarily composed of sandstone, whereas that to the right is mostly made of diabase. These are the two rock types that are “native” to this area, and each will be discussed in more detail at other stations. Isolated examples of many other types of rock can be found along the Park’s many trails; however, these are not native to the area and have mainly been brought to the Park from areas farther north by glacial action.

To the right of the station marker, the large, sparkling rock to which the blue arrow points is a chunk of pegmatite. The name pegmatite is commonly assigned to many igneous rocks that are made up of large crystals. This pegmatite contains crystals of quartz, feldspar, and muscovite mica. Unlike the dark-colored pockets of pegmatite that can be observed at different locations along this and other trails (see, for example, stations B13, B33, W15, W16, and W17), this particular specimen had been carried to the Park by glacial activity. When the glacier melted about 17 thousand years ago, the rocks and gravel it had been carrying were simply left behind.

The smooth, cream-colored stone lying just to the left of the blue arrow is an example of the metamorphic rock quartzite. Like the pegmatite next to it, the quartzite had also been transported to the Park by glacial activity. Quartzite forms when sandstone is subjected to tremendous pressure, such as occurs when tectonic forces cause continents to collide and mountain ranges to be thrust upwards. Under these conditions, the quartz crystals making up the bulk of the sandstone are squeezed tightly against one another to form quartzite. Quartzite is not native to the region of the Sleeping Giant, and no outcrops of quartzite exist anywhere in the Park; however, smooth and rounded rocks like these are extremely common within the Giant, typically ranging in size from a few inches to several feet in diameter. Quartzite within the Park probably originated in areas far to the north of Connecticut and was carried here by the awesome power of moving ice. It was deposited in the area when the last glaciers that occupied Connecticut melted away.

The appearance of quartzite may vary considerably. Colors commonly include shades of white and gray; however, pink, yellow, orange, and red may often be seen. The color depends on the amount of iron or other impurities that have been incorporated into the rock. Once you become familiar with the many appearances of quartzite, it is very easy to recognize. Keep an eye out for it along all of the trails within the Park. Other stations featuring quartzite include B18, B20, B30, O1, V13, Y2, T4, and T6.

Rocks transported by glacial activity are subject to considerable stress as they are pushed along and tumbled about in the ice. Those that have been transported relatively short distances (such as this pegmatite boulder) tend to be somewhat angular in overall shape, whereas those transported over considerably larger distances (like the quartzite) may have a more rounded contour. The pegmatite boulder also appears to have been split in half; the other half is near the tree containing the station marker.

View high- resolution photo(s) at:

[B1 – Mica-encrusted pegmatite](#)

[B1 – Quartzite](#)

B2 – Contact Surface and Quarry View: Notice the “crinkly” appearance of the rocky surface on the top of this hill (which is sometimes referred to as the Dumpling). This surface pattern, which resembles a crumpled piece of paper, is characteristic of a contact surface between rapidly cooling magma (which cooled and solidified into a rock called diabase) and the original overlying rock. In the Giant, the latter was primarily sandstone, a rock native to the area and sometimes simply referred to as country rock. Before the sandstone that had once covered the Sleeping Giant eroded away—a process that occurred over the course of millions of years—the now-exposed contact surface on which you are standing had been the actual roof of the magma chamber and was in direct contact with the overlying sandstone. The characteristic appearance of the contact surface developed as hot magma along the roof of the magma chamber was cooled (i.e., “quenched”) by contact with the much cooler sandstone. This was a relatively rapid process, in contrast to the comparatively slow cooling that occurred at the core of the magma chamber. After the overlying sandstone eroded away, the diabase (i.e., the solidified magma) was exposed. Because it is much more resistant to erosion than sandstone, diabase does not erode away as quickly and therefore largely remains intact throughout the Park. Most of the diabase that is readily visible in the Park is not part of what had once been a contact surface. Rather, the diabase is present in areas at which the contact surface itself has gradually eroded away to a varying depth. Similar contact surfaces have been documented at several other locations throughout the Park, including stations B6, W20, V15, V16, Y3, and RC9.

This hilltop also offers a fantastic view of the rock quarry that was in operation between 1912 and 1930. During that time, more than one million tons of diabase (also called traprock) had been quarried away from the top of the Giant’s Head. This material was crushed and used as aggregate, primarily in the construction of roads. Looking along the Quarry wall, notice that some sections are relatively dark in color, while others have an orange hue. Many of the rocks at the Sleeping Giant have an overall orange tint. This is due to their high content of iron, which literally rusts (i.e., oxidizes) on long-term exposure to air. Apart from orange-colored sections of the wall that had long ago been exposed by the quarrying operations, various erosional forces (especially freeze-thaw cycles) periodically break large slabs of rock off the cliff. In time, many of these newly exposed surfaces will also gradually develop an orange coloration as the iron contained in the rock oxidizes on exposure to air.

View high-resolution photo(s) at:

[B2 – Contact surface](#)

[B2 – Quarry view](#)

B3 – Precursor to a Granitic Vein: Looking back from the B3 station marker towards the tree at station B2, you will see a long, sandy ditch. Closer to the B3 station marker, the ditch becomes a wide band of gnarled rock with a braided, rope-like appearance. This feature is the result of an event that happened while the molten magma was still cooling. Cooling of the magma chamber first occurred at its outer surface, resulting in the formation of a brittle shell. The band of rock visible at station B3 marks the location of a crack that formed in the shell of the solidifying magma chamber. The enormous heat given off by the magma actually melted some of the overlying sandstone, liquefying it just enough so that it could flow into this crack. It then solidified within the crack. Without appropriate equipment, however, it is virtually impossible for a field observer to tell that this rock used to be sandstone.

The partially melted sandstone visible at this contact surface had not been fully injected into cracks in the cooling magma and therefore represents a relatively early stage in the formation of

what is called a granitic vein. The latter is a dynamic geologic process and since any one station will only show a single snapshot in time of the entire process, different stages may be evident at different stations. A more mature stage in the process can be seen at the next station.

Continuing along the Blue Trail, the quickest way to reach the B4 station is to climb down the short cliff in front of you. Hikers unable or unwilling to negotiate this short climb can more easily reach the B4 station via the Red Diamond trail, which intersects the Blue Trail at the base of the cliff.

View high-resolution photo(s) at:

[B3 – Granitic vein precursor](#)

[B3 – Granitic vein precursor](#)

[B3 – Granitic vein precursor](#)

[B3 – Granitic vein precursor](#)

B4 – Granitic Vein: By climbing downhill, you have actually moved slightly deeper into the solidified magma chamber and thus farther from its original point of contact with the overlying sandstone. Here, the temperature was hotter than it was near the contact surface, and the magma took a longer time to cool. In this region of higher temperature, completely melted sandstone flowed deep into a crack in the cooling magma chamber. Afterwards, the melted sandstone also solidified. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Although granitic veins formed at contact surfaces, the melted sandstone filled cracks in the solidifying magma chamber to varying depths. This is why granitic veins can be found in areas at which the actual contact surface has since eroded away.

Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails. You'll note the raised appearance of this vein in relation to the surface of the diabase with which it is associated. This is due to differential erosion. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, the vein weathers far more slowly. The relative amount of erosion occurring in both the granitic vein and the surrounding diabase is highly variable. Note that quite a few granitic veins can be seen in the immediate area, all of which are parallel both to each other and to the crack on top of the Dumpling.

View high-resolution photo(s) at:

[B4 – Granitic vein](#)

[B4 – Granitic vein](#)

B5 – Eroding Quarry Slope: Extensive exposure of tree roots along this path is a reflection of the considerable soil erosion that has taken place as a result of quarry operations. The removal of enormous amounts of material from the hillside between 1912 and 1930 has made it unstable. Even after quarry operations ceased, the scarred and wounded hillside continued to slump, primarily as a result of gravity, weather, and continued human activities. Eventually, the slope will stabilize, but there is no telling how much material will have washed out before this happens. The threat to continued growth of vegetation is obvious. Erosion is a powerful geological force that can affect landscapes on many levels. Both natural forces and manmade influences may affect the degree of erosion that occurs in a particular area. This site is an

excellent example of how poorly planned human activities can continue to have grave ecological consequences even long after they have been discontinued. A less dramatic example of soil erosion can be seen at station Y2.

From this point onward, you will be ascending the Quarry Trail, the section of the Blue Trail that parallels the edge of the Quarry wall. It is one of the most difficult trails in the Park, so hike slowly, drink water as needed, and wear appropriate footgear. Also be sure that you are in good enough physical condition to safely undertake this ascent.

View high-resolution photo(s) at:

[B5 – Erosion](#)

B6 – Contact Surface: As you continue ascending along the Blue (Quarry) Trail, you are once again approaching a contact surface. This contact surface is considerably higher than the one observed at B2. In general, contact surfaces at higher elevations tend to be oriented on a considerable slant (like the pitched roof of a house), rather than on a horizontal plane. This is because the original magma chamber had a dome-like shape, much like the cap of a mushroom. Only on the actual top of the dome will the orientation of a contact surface have been more horizontal. Having said this, however, one needs to consider the horizontal orientation of the contact surface at B2 (along the top of the Dumping). This is simply due to irregularities in the shape of the dome.

From this location, hikers climbing along the right side of the Quarry Trail should follow the small B7 arrow (located within the station marker) approximately 12 feet to left, where the actual B7 station is located.

View high-resolution photo(s) at:

[B6 – Contact surface](#)

B7 – Granitic Vein: Two views of granitic veins can be seen at this station: a surface view and a cross section. Together, they provide a more three-dimensional perspective of a granitic vein. Each vein developed from a sheet of melted sandstone that filled a crack in the magma as it cooled and solidified. As you continue climbing upward from this station, this vein can be seen to continue for some distance. In fact, an abundance of granitic veins is readily apparent along this section of the cliff.

From this location, hikers climbing along the left side of the Quarry Trail should follow the small B8 arrow (located within the station marker) approximately 30 feet to the right, where the actual B8 station is located.

View high-resolution photo(s) at:

[B7 – Granitic vein in cross section](#)

[B7 – Granitic vein](#)

[B7 – Continuation of granitic vein](#)

B8 – Granitic Vein with Original Sand Grains: A number of large granitic veins can be seen in this area. The vein located just above and to the right of the station marker represents another “snapshot” in the formation of a granitic vein. Close examination will reveal that this granitic vein preserves original sandstone that had not completely melted. This is evident by the actual

presence of small, intact pebbles within the vein. When the sandstone melted and formed these veins, each sand grain melted first around its edge. The result was a soup of partially melted sandstone. While sandstone usually continued melting until everything was liquefied, this was not the case here. When this vein formed, only partial melting of the sandstone occurred.

View high-resolution photo(s) at:

[B8 – Granitic vein with intact pebbles](#)

B9 – Exfoliation: The superficial layers of this rock appear to be flaking apart in places. This is due to a process called exfoliation. When this rock initially solidified out of the mass of molten magma, the weight of an immense layer of sandstone—perhaps as much as a mile thick—was bearing down upon it. Having formed under conditions of such high pressure, this is the state under which the rock is most stable. As the overlying sandstone slowly eroded away over the course of time, the pressure exerted upon the underlying diabase was gradually decreased. As a consequence, a series of cracks developed in the surface of the rock. These formed in a plane that was perpendicular to the direction of the changing stress (i.e., parallel to the rock’s modern-day surface). The cracks undermined the surface of the rock, allowing sheets and slabs of stone to peel away from the surface. Even today, as the diabase continues to erode through natural processes, the rock is still exfoliating. Other nice examples of exfoliation can be seen at stations B24, W10, O4, Y4, and the rock upon which the T4 station marker is painted.

View high-resolution photo(s) at:

[B9 – Exfoliation](#)

B10 – Fractured Diabase Boulder: From the station marker at B10, walk 30 feet to the right to where the actual station is located. A large number of cracked and fractured rocks can be seen throughout the Park; varied geological processes are responsible. Some of the more common causes for cracks and fractures to develop in rocks within the Giant include falls from great heights (such as occurs when rocks tumble off cliffs and accumulate as talus slopes at their base), tree-root wedging, and ice wedging. A network of vertical cracks and fractures can also develop in solidifying diabase and is associated with contraction of the rock as it cools. Extensive vertical fractures lead to the formation of columns within the solidifying diabase. These will be clearly visible at other stations. As the solidified magma chamber was exposed following erosion of overlying layers of sandstone, the columns themselves became vulnerable to erosion. Any cracks already present in the rock would then have been exploited by a variety of ongoing erosional processes.

View high-resolution photo(s) at:

[B10 – Fractured diabase boulder](#)

B11 – Tree-Root Wedging: Twenty feet beyond the station marker, a large tree trunk can be seen lying across the trail. Just on the other side of this trunk, the B11 station can be seen on the left side of the trail. Note the large tree root that is acting in concert with other erosional forces to help split apart this rock. Heavy leaf accumulation in the fall may obscure one’s view into the crack. Tree roots affect rocks and soil in a number of ways. By holding soil together, they help to prevent soil erosion. On the other hand, the growth of tree roots can actually dissolve rock, causing small cracks to form in solid rock. In the course of their growth, tree roots will also frequently exploit already-existing cracks present in rocks. As roots enlarge over the years, they exert tremendous pressure on the surrounding rock, ultimately splitting apart even large rocks. In

conjunction with the effects of ice wedging, continued growth of roots favor ongoing expansion of such cracks. Weathering of rocks by growth of tree roots is actually a very common process, and many examples can be seen in the Park, especially if one examines the various trees growing in the vicinity of cliffs and rocky outcrops. Tree-root wedging is only one of the many ways in which rocks can be broken down across the ever-changing landscape of the Sleeping Giant. Other stations featuring tree-root wedging include B13, B19, G1, RC5, T9, and T12.

View high-resolution photo(s) at:

[B11 – Tree-root wedging](#)

[B11 – Tree-root wedging](#)

B12 – Looking Out Onto Connecticut’s Past: This beautiful overlook affords an excellent view of Quinnipiac University and southward towards downtown New Haven. The series of hills just to the left of the New Haven skyline is a portion of the East Rock Ridge, another diabase intrusion with a geologic history similar to that of the Sleeping Giant (note: it is a common misconception that East Rock, West Rock, and the Sleeping Giant were formed as extrusive volcanic eruptions).¹ The Long Island Sound is visible just beyond the New Haven skyline, and on clear days the shoreline of Long Island, New York, can be seen on the horizon across the Sound.

If you had been here approximately 15 thousand years ago, as the Ice Age was giving way to warmer temperatures, you would have been able to see two large freshwater lakes in the Quinnipiac and Mill River Valleys that stretch out before you. These lakes were formed as glacial meltwater flowed southward. Part of what is now the Quinnipiac River drainage basin, seasonally visible in the distance as the tan-colored marsh to the left of the East Rock Ridge (note: in summer months, the marsh is light green in color), had once been filled by Lake Quinnipiac. What is now the Mill River drainage basin, located directly south, had been partially submerged beneath the even larger Lake Connecticut. This extremely large lake occupied all of what is now the Long Island Sound, downtown New Haven, and the southern portion of Hamden. These two lakes eventually drained away. Saltwater filled the Long Island Sound approximately 11 thousand years ago. Long Island itself is largely composed of the loose rubble that had been pushed southward by the ice. It represents the southernmost extent of the glacier’s range.

View high-resolution photo(s) at:

[B12 – Looking out onto Connecticut's past](#)

[B12 – Looking out onto Connecticut's past](#)

B13 – Pegmatite Pockets, Oxidation of Diabase Surface, and Tree-Root Wedging: A range of colors can be observed on this rock face. The vivid blue and purple coloration is primarily due to exposure and oxidation of the various elements that have become concentrated within pockets

¹ An extrusive volcanic event occurs when molten magma breaks through the crust and subsequently flows across the landscape as lava. As it cools and solidifies, lava forms basalt. An intrusive event involves the accumulation of molten magma within a chamber that remains underground. As magma cools and solidifies underground, it forms diabase. Diabase remains hidden underground unless exposed by erosion that wears away the overlying rock. This is how the diabase that makes up the Sleeping Giant was exposed.

of pegmatite. It should be stressed that this pegmatite is a completely different type of rock than the glacially transported pegmatite boulder observed at station B1.

The magma within the ancient underground chamber that eventually formed the Sleeping Giant was composed of a wide array of elements. As the magma cooled, these elements combined to form an assortment of minerals. The rate at which different elements crystallized out of the cooling magma varied considerably. Some of the last elements to crystallize became concentrated in discrete pockets within the partially solidified magma. When these pockets did eventually cool and solidify, the mineral grains that formed were typically larger than those forming the bulk of the Sleeping Giant diabase. The mineral composition of the pockets also differed greatly from that of the rest of the rock. Areas of rock in which the colors are most pronounced are characterized by a larger grain size than is present in surrounding rock. This is a defining feature of pegmatite.

In addition to the bluish-purple pockets of pegmatite, the surface of this rock wall also displays orange-red oxidation of diabase exposed to air for a prolonged period of time. Just as occurred on sections of the Quarry wall, the orange coloration on this surface is due to the oxidation of iron-containing minerals within the rock, which may produce a range of colors.

As you face the cliff, move slightly to the left and look around the first corner. Near the top of the cliff, you can see another nice example of tree-root wedging.

The combination of these various features on this wall highlights the fact that geological processes do not occur in isolation from one another. Several different features may be seen at any given location by hikers taking the time to examine an area closely.

View high-resolution photo(s) at:

[B13 – Pegmatite pockets and oxidized diabase](#)

[B13 – Tree-root wedging](#)

B14 – Mt. Carmel Fault: Looking to the right from this promontory atop the Giant's Chin, note the hilltop in the distance. This is the Giant's Chest. Although not visible from this vantage point, the Tower Trail lies in the corridor that separates the Chin and Chest. A combination of geological events played a role in creating these particular features of the Park. The most significant of these was the development of a large fault: the Mount Carmel Fault.

A fault is a fracture in the crust of the Earth across which significant movement occurs. Formation of the Mount Carmel Fault occurred in association with the sinking and tilting of Connecticut's Central Lowlands. As the land cracked open along this fault, the Giant's Head actually dropped down relative to its Chest. Over the course of time, the extensive sandstone deposits that had once covered the Sleeping Giant gradually eroded away. This exposed the fault and the diabase hillsides that would one day be the Giant's Head and Chest. The narrow corridor formed by activity within the fault set the stage for even more extensive erosion by glacial action. The immense power of the glacier flowing through this part of the Park ripped away material from both hillsides, widening the gap between them even further, sculpting the giant cliffs that loom above the Tower Trail, and ultimately creating the characteristic profile of the Giant's Chin and Neck that we recognize today. If not for this succession of geologic events in Connecticut's distant past, the Giant would probably never have developed either a Chin or a Neck. Without these distinctive features, the Sleeping Giant might not ever have attained its

iconic status. Hikers need not be unduly concerned about walking in the vicinity of this fault. The fault is not known to have moved for millions of years, and there is currently no major tectonic activity in the region that would suggest it will become active again any time soon.

View high-resolution photo(s) at:

[B14 – Mt. Carmel Fault](#)

B15 – Quartzite: Of necessity, this station marker is actually located somewhat beyond the actual station location. From the tree containing the station marker, turn around and walk approximately 12 feet back the way you came until you notice three rocks embedded in the ground in the middle of the trail. The smooth-surfaced rocks on the left and right sides are examples of glacially transported quartzite. Their location on top of the Giant’s Head indicates that the sheet of ice covering the land at the height of the Ice Age had fully submerged the Sleeping Giant. In fact, all of the peaks in the Giant are now covered by a thin veil of glacial till. Till is the name given to the loose mixture of rock and sediment deposited as a glacier melts (excellent examples of glacial till can be seen at stations T2 and RC2).

Just beyond this station, the Blue Trail continues down a steep, uneven slope. Be careful picking your way down.

View high-resolution photo(s) at:

[B15 – Quartzite](#)

[B15 – Quartzite](#)

[B15 – Quartzite](#)

B16 – Step-like Fracture Pattern of Diabase: As you descend along the back of the Quarry Trail, you may have been aware of the characteristic pattern of rocks in this area. At the B16 station marker, turn around and look back over the rocky hillside you have just descended. Note the appearance of these rocks, which form a step-like pattern, much like a natural staircase. As vertical fissures formed within the cooling magma chamber, much of the solidifying rock was fractured into an extensive series of vertically oriented columns. At some sites, networks of horizontal cracks also developed, fracturing the diabase into regularly shaped blocks. Over the course of time, various erosional forces split many columns and blocks apart along lines of weakness created by the many cracks. If you look at many of the rocky cliffs and slopes throughout the Park, this block-like structure—including flat-sided surfaces with sharply defined edges—will be evident. In many instances, this fracture pattern combined with the effects of continued erosion results in a characteristic staircase-like appearance of the cliff face. It is from this characteristic feature that the term trap rock (from the Swedish term *trappa* meaning stairs) is derived.

View high-resolution photo(s) at:

[B16 – Step-like fracture pattern in diabase](#)

B17 – Plumes: The two markers at this station identify the location of closely spaced rocks having features demonstrating the same geological process. Looking at the surface of these rocks, note the feather-like pattern of grooves and ridges that appears to have been engraved on them. This characteristic feature is called a plume. Plumes like this are formed as a result of the way in which many finely grained rocks tend to break apart. The point from which all the lines diverge is the site at which the rock began to fracture. As a variety of erosional forces continued

to act on the block, the fracture continued to grow steadily larger. Eventually, the block simply peeled away from its point of attachment to the cliff and fell to the ground. Plumes are extremely common in the Park and can often be seen where broken fragments of diabase are plentiful. In fact, many can be seen along this rocky section of the trail. Plumes can also be seen along the inner surfaces of rocks that have been split apart by ice wedging. This type of feature is very useful to geologists attempting to reconstruct the series of events leading to formation of a particular landscape or trying to determine the nature and direction of tectonic forces that may have influenced geological processes in a region. Plumes can also be seen at stations V3, V10, T12, and T13.

View high-resolution photo(s) at:

[B17 – Two plumes](#)

[B17 – Plume](#)

[B17 – Plume](#)

B18 – White Quartzite: The quartzite specimen directly behind the tree on which the station marker has been painted is almost pure white in color. The lack of coloration in this almost snow-white specimen indicates that it contains very few mineral impurities.

View high-resolution photo(s) at:

[B18 – White quartzite](#)

B19 – Basalt Boulder and Tree-Root Wedging: It is quite easy for this very large chunk of rock along the left side of the trail to go unnoticed. At first glance, it looks like any other outcrop of diabase within the Park. But it is not an outcrop at all. This is actually a very large glacial erratic. This term is used by some geologists to refer to a very large, glacially transported boulder that rests atop bedrock of a different rock type from the boulder itself. This particular boulder is not composed of diabase, but rather basalt that poured out as lava from a large fissure in the Earth's crust. This occurred at the same time that the magma chamber (which would eventually form the Sleeping Giant) was solidifying belowground. Basalt has the same chemical composition as diabase; however, basalt is formed from lava that has flowed across the surface of the land. When magma cools and solidifies underground, as occurred during the formation of the Sleeping Giant, the rock is called diabase. Basalt outcrops do not exist within the Park and any basalt present today was carried here by glacial action. Since the movement of ice during the peak of the Ice Age was primarily southward, it can be deduced that this boulder originated from one of the exposed basalt outcrops north of the Park.

Roots of the maple tree growing on top of this boulder will act in concert with various other erosional processes to slowly widen cracks in its surface. Tree-root wedging is only one of the many processes of erosion that are constantly changing the landscape of the Sleeping Giant. At some point in the past, this boulder had split apart. Its other half can be seen as a large moss-covered slab directly across the trail.

View high-resolution photo(s) at:

[B19 – Basalt boulder](#)

[B19 – Tree-root wedging](#)

B20 – Quartzite Boulder: This boulder is another example of glacially transported quartzite. This specimen is covered in lichen and also displays many crescent-shaped cracks. Such cracks

are commonly seen in quartzite boulders and are caused by the enormous pressure exerted on these rocks as they were carried along within the glacier.

View high-resolution photo(s) at:

[B20 – Lichen-covered quartzite boulder](#)

B21 – Ice Wedging and Plume: Many rocks within the Park, such as the one located directly above the station marker, exhibit large cracks that have split the rock in half, almost as if it had been struck a powerful blow by an axe-wielding giant. Regrettably, the crack was actually caused by a more mundane geological process: erosion.

Here in New England, the freeze/thaw cycle of winter is one of the major forces of erosion responsible for breaking apart rocks. Unlike most other liquids, water expands when it freezes. When water seeps down into tiny cracks within a rock and subsequently freezes, the expanding ice will exert considerable outward force on the surrounding surfaces. Over the course of time, repeated freeze/thaw cycles will continue to widen the crack, gradually wedging the stone apart.

Recurring year after year, freeze/thaw cycles are responsible for many of the large cracks that can be seen in rocks throughout the Sleeping Giant. They are also responsible for breaking large slabs of rocks from vertical cliffs, as well as the destruction of many large diabase columns. A similar process can be blamed for the sudden appearance of potholes in crumbling, snow-covered roads.

The walls of cracks like these often display plumes, such as those observed at station B17. The orientation of a plume helps to provide information about the direction in which the rock actually split. If you peer up into the crack, you can see a portion of a plume along the wall (a similar example of a plume can be seen at station V14).

View high-resolution photo(s) at:

[B21 – Ice wedging and plume](#)

B22 – Isolated Diabase Columns: From the station marker, look to the right towards the edge of the cliff. This vantage point offers an excellent perspective of columns that naturally form in a cooling magma chamber. Directly across from the station marker, the top of one column rises as high as the level of the trail. To the left of this column and slightly below the level of the trail, a freestanding column sometimes called the Devil’s Pulpit can also be seen. It may be somewhat obscured by seasonal leaf growth. Like numerous other columns that are visible along the Park’s many high cliffs, these columns formed as a result of the extensive vertical fractures that developed in the magma chamber as it cooled and solidified. The columns typically form multi-faced polyhedra (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park.

View high-resolution photo(s) at:

[B22 – Isolated diabase columns](#)

[B22 – Diabase column](#)

[B22 – Diabase column](#)

B23 – Granitic Vein: Unlike the various granitic veins that you already observed along the Quarry Trail, this particular vein is embedded within an outcrop of diabase that had been deep within the magma chamber. The depth to which these veins are able to penetrate into the magma chamber is unknown, but even wide veins such as this one have been observed at locations that were probably considerable distances from the outer surface of the chamber.

View high-resolution photo(s) at:

[B23 – Granitic vein](#)

[B23 – Granitic vein](#)

B24 – Diabase Columns and a Haunted Compass: At the station marker, follow the short path to the right until you come upon a spectacular overlook. Be extremely careful at this location and stay away from the edge of the cliff. As you approach this overlook, note the thick granitic vein that runs to the edge of the cliff. With your eyes, follow this vein down the face of the cliff until it appears on the horizontal ledge directly below you. On this lower ledge, several examples of exfoliation can also be seen. These appear as patchy areas from which the surface of the rock has flaked away. To the right, the overlook provides yet another view of the columns that extend along the cliff. Towards the far left side of the lower ledge, an elongated trough can be observed running from left to right across the ledge. This is a glacial scour that had been gouged into the rock by passage of the glacier. Similar scours can be seen at stations W3, W19, and W21.

One fascinating anomaly that can be observed on top of some precipices within the Park is demonstrated at this very location. The high iron content of the Sleeping Giant diabase allows magnetic fields to become imprinted within the rock. At certain locations around this rocky ledge, a magnetic compass will give a false reading. In fact, if a compass is moved slowly above some points on the surface of this rock, the needle will jump and may even spin as if possessed by some unnatural force. It is not completely understood how these locations acquired such a strong magnetic field. One theory is that lightning strikes over past millennia imprinted their electromagnetic signatures onto the rock.

View high-resolution photo(s) at:

[B24 – Granitic vein](#)

[B24 – Granitic vein](#)

[B24 – Exfoliation and granitic vein](#)

[B24 – Exfoliation and granitic vein](#)

[B24 – Tops of diabase columns](#)

[B24 – Tops of diabase columns](#)

[B24 – Glacial scour](#)

B25 – Guano Deposits: Looking to the right, notice the white-stained columns along the edge of the cliff. This particular outcrop is a favored perching site for both black vultures and turkey vultures, and the birds can often be observed at this location. Over the course of time, their excrement (guano) has stained the rock.

View high-resolution photo(s) at:

[B25 – Guano deposits](#)

B26 – Eroded Columns: As you come upon the marker for station B26, turn around to observe the steep trail you have just descended. From this vantage point, the eroded bases of columns can

be seen to emerge from the slope itself. If the columns were intact, they would be tilted so that their tops pointed to the right (north). Because columns form perpendicular to the outer surface of a magma chamber, this orientation indicates that the roof of the chamber had a dome-like shape. As you continue down this slope, you may see a seasonal stream running along its base. This water continues farther north and eventually becomes the stream that carved the gorge along the Red Circle Trail.

View high-resolution photo(s) at:

[B26 – Eroded diabase columns](#)

B27 – Tilted Columns: The columns in this area are tilted to the north just like the ones at station B26. Unlike the columns at B26, however, these are largely intact. Correlations between the orientation of columns at these two stations provide additional support for the concept of a dome-like shape of the magma chamber that formed the Sleeping Giant.

View high-resolution photo(s) at:

[B27 – Tilted diabase columns](#)

[B27 – Tilted diabase columns](#)

B28 – Tops of Columns: From this station, it is possible to observe the exposed crowns of some columns. Note the characteristic polyhedral shape.

View high-resolution photo(s) at:

[B28 – Top of diabase column](#)

B29 – Sandstone Glacial Erratic and Diabase Cliffs: Sandstone is a native rock, quite common in the area. It can be found along virtually every trail within the Park. Sandstone is a sedimentary rock built up in successive layers by the gradual deposition of sediments. In many respects, this large sandstone boulder is quite similar to the many others that can be seen along this and other trails. Apart from its large size, however, it does display two other interesting features: 1) its presence in an area where only diabase bedrock exists and 2) its overall rounded contour. Both features are consistent with its being glacially transported to this location, making this rock an example of a glacial erratic (which generally refers to an extremely large rock that has been transported by glacial action). Furthermore, the rounded contour attests to the fact that the glacier had carried this boulder here from a considerable distance. Tumbled and rolled within the great moving ice sheet, the churning action of the glacier gradually molded this rock into its spherical shape. Considering how large the rock must have been before being ground down to this spherical shape, one can only marvel at the incredible power of glaciers to move rocks over great distances.

Directly ahead and continuing parallel to the trail as it turns to the left is an extensive diabase cliff. Many prominent columns can be seen. A number of factors, including the rate at which the magma cools, play a role in determining the thickness of individual columns. Rapid cooling tends to result in relatively narrow columns, while slowly cooling columns are more likely to be thicker. The relatively thick columns within the Giant suggest that this magma chamber cooled rather slowly.

View high-resolution photo(s) at:

[B29 – Sandstone glacial erratic](#)

[B29 – Diabase cliffs and columns](#)

B30 – Quartzite with Lichen: This small, glacially transported quartzite hosts black lichen on its surface. This type of lichen is very common on quartzites found throughout the Sleeping Giant.

View high-resolution photo(s) at:

[B30 – Quartzite](#)

B31 – Glacially Transported Sandstone Conglomerate: This attractive piece of sandstone boasts a high abundance of pebbles. Some of these pebbles have been rounded and smoothed from being carried over long distances by ancient streams. Others are more angular in appearance, indicating that they have not spent as much time being tumbled in a stream and have been transported a relatively short distance from their source. As the concentration and size of rocks and pebbles within sandstone increases, it may be referred to as a conglomerate. Many different minerals and rock types can be seen within the pebbles of this sandstone, including quartz, feldspar, and granite.

As is the case for many of the rocks along this segment of trail, this one was deposited by glacial action. The moving ice has faceted some of the pebbles embedded in this rock, grinding them smooth and flush with the surface.

View high-resolution photo(s) at:

[B31 – Pebbles in sandstone conglomerate](#)

B32 – Granitic Vein: Although this fairly thick granitic vein is conveniently located right in the middle of the trail, its visibility may be obscured by winter snow. Like many of the granitic veins within the Park, this one has been injected deep into the magma chamber, and is at a location that was probably far from the outer surface of the chamber. In this particular example, it is especially easy to see the effects of differential weathering. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, it erodes more slowly. This results in a raised appearance of the vein in relation to the surface of the diabase with which it is associated.

View high-resolution photo(s) at:

[B32 – Granitic vein](#)

B33 – Spheroidal Weathering: The round, spherical lumps of pegmatite eroding out of the outcrop just below Hezekiah's Knob are examples of spheroidal weathering. It is likely due to a combination of geological processes, including rapid erosion and the effects of exfoliation on the coarse-grained pegmatite. Because of its large concentration of chemically unstable minerals, pegmatite tends to erode much more quickly than does most of the diabase in the Park. As these rocks erode, exfoliation may govern the shape that they exhibit...the decreasing pressure allowing them to peel away layer by layer, much like an onion. Similar structures can be seen just around the corner, where the White Trail ascends to the Knob at station W16. Considered together, stations B33, W16, and W17 tell part of the interesting story of the rock cycle.

View high-resolution photo(s) at:

[B33 – Spheroidal weathering](#)

[B33 – Spheroidal weathering](#)



B1 – Mica-encrusted pegmatite



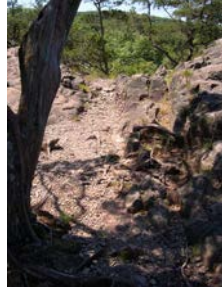
B1 – Quartzite



B2 – Contact surface



B2 – Quarry view



B3 – Granitic vein precursor



B3 – Granitic vein precursor



B3 – Granitic vein precursor



B3 – Granitic vein precursor



B4 – Granitic vein



B4 – Granitic vein



B5 – Erosion



B6 – Contact surface



B7 – Granitic vein in cross section



B7 – Granitic vein



B7 – Continuation of granitic vein



B8 – Granitic vein with intact pebbles



B9 – Exfoliation



B10 – Fractured diabase boulder



B11 – Tree-root wedging



B11 – Tree-root wedging



B12 – Looking out onto Connecticut's past



B12 – Looking out onto Connecticut's past



B13 – Pegmatite pockets and oxidized diabase



B13 – Tree-root wedging



B14 – Mt. Carmel Fault



B15 – Quartzite



B15 – Quartzite



B15 – Quartzite



B16 – Step-like fracture pattern in diabase



B17 – Two plumes



B17 – Plume



B17 – Plume



B18 – White quartzite



B19 – Basalt boulder



B19 – Tree-root wedging



B20 – Lichen-covered quartzite boulder



B21 – Ice wedging and plume



B22 – Isolated diabase columns



B22 – Diabase column



B22 – Diabase column



B23 – Granitic vein



B23 – Granitic vein



B24 – Granitic vein



B24 – Granitic vein



B24 – Exfoliation and granitic vein



B24 – Exfoliation and granitic vein



B24 – Glacial scour



B27 – Tilted diabase columns



B29 – Sandstone glacial erratic



B31 – Pebbles in sandstone conglomerate



B24 – Tops of diabase columns



B25 – Guano deposits



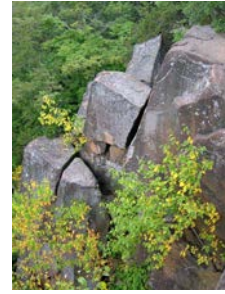
B27 – Tilted diabase columns



B29 – Diabase cliffs and columns



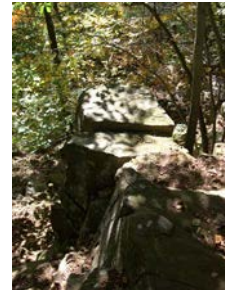
B32 – Granitic vein



B24 – Tops of diabase columns



B26 – Eroded diabase columns



B28 – Top of diabase column



B30 – Quartzite



B33 – Spheroidal weathering



B33 – Spheroidal weathering

White Trail – Geology Stations

W1 – Mt. Carmel Fault: As you step across the Tower Trail onto the White Trail and begin to work your way up to the Giant's Chest, look back towards the lofty cliff that forms the distinctive Chin. Consider the various geological forces that may have been responsible for creating and then sculpting it into the shape it has today.

A combination of geological events played a role in creating this particular feature of the Park. The most significant of these was the development of a large fault: the Mount Carmel Fault. A fault is a fracture in the crust of the Earth across which significant movement occurs. Formation of the Mount Carmel Fault occurred in association with the sinking and tilting of Connecticut's Central Lowlands (see discussion in introduction). As the land cracked open along this fault, the Giant's Head actually dropped down relative to its Chest. Over the course of time, the extensive sandstone deposits that had once covered the Sleeping Giant gradually eroded away. This exposed the fault and the diabase hillsides that would one day be the Giant's Head and Chest. The narrow corridor formed by activity within the fault set the stage for even more extensive erosion by glacial action. The immense power of the glacier flowing through this part of the Park ripped away material from both hillsides, widening the gap between them even further, sculpting the giant cliffs that loom above the Tower Trail, and ultimately creating the characteristic profile of the Giant's Chin and Neck that we recognize today. If not for this succession of geologic events in Connecticut's distant past, the Giant would probably never have developed either a Chin or a Neck. Without these distinctive features, the Sleeping Giant might not ever have attained its iconic status. Hikers need not be unduly concerned about walking along this fault. The fault is not known to have moved for millions of years, and there is currently no major tectonic activity in the region that would suggest it will become active again any time soon.

View high-resolution photo(s) at:

[W1 – Mt. Carmel Fault](#)

W2 – Esophagus and Pond: From this promontory, look back along the trail you just climbed. Can you see the small, seasonal brook that runs down the hill and across the trail? If it hasn't rained for a period of time, it may be dry. From this vantage point along the Giant's Chest, try to identify the brook's source.

A short distance to the right of the station marker is a wide slot, with high, parallel walls. This structure is variously referred to as the Giant's Throat or Esophagus. As the underground magma chamber that eventually formed the Sleeping Giant cooled and solidified some 200 million years ago, an extensive series of vertical fractures began to develop in the rock. These formed as a result of the contraction that accompanies the cooling and solidification of magma. After the overlying sandstone eroded away, these fissures were gradually widened by a combination of many erosional forces.

About 30 feet to the left of the station marker, note the elongated pond just below the promontory on which you are standing. In the first days of spring, the pond is easily located by simply following the raucous chorus of mating wood frogs. In summer months, it may be obscured by vegetation. This pond is the source of the small brook running across the trail just below. Much of the rainwater falling on the western side of the Giant's Chest is funneled into this pond, causing the water level to seasonally rise and fall. The diabase that forms the cliffs and

many rocky outcrops throughout the Park is very dense and is largely impermeable to water. Therefore, it does an excellent job containing the rainwater for long periods of time. Many other ponds within the Park were also formed within an impermeable depression of diabase. As you proceed to the next station, think about what geological forces might have hollowed out this depression in the rock.

View high-resolution photo(s) at:

[W2 – Small brook](#)

[W2 – Esophagus](#)

W3 – Glacial Scour: Just below the station marker, note the elongated trough that has been gouged into the rock. During the peak of the Ice Age, some 20 thousand years ago, a large glacier moved steadily across the state. As the gigantic sheet of ice progressed south, the mud, sand, gravel, and rocks of widely varying size that were trapped beneath the ice slowly gouged the rocky surface. The tremendous force exerted by this material carved out long depressions, called glacial scours, in the surface of the underlying rock. Finer grooves produced in similar fashion are called glacial striations (visible at stations W6, W11, T10, and T15). Because of the process by which they were formed, the many glacial striations and scours within the Park are all oriented in the same direction as the path known to have been taken by the glacier. A similar process, but on a larger scale, was responsible for the depression that formed the pond at station W2, which is oriented at the same compass heading as the scour. Glacial scours can also be seen at stations B24, W19 and W21.

When the glacier melted, about 17 thousand years ago, all of the rocks and gravel that had been pushed along beneath it were simply left behind as an unsorted jumble of debris, called glacial till. Digging through the soil of a till bank requires considerable effort, since it is full of rocks and gravel. Glacial till is quite prevalent throughout the Park (see stations RC2 and T2). Surrounding much of the pond at station W2, the till acts like a set of small dams and aids in the retention of water. The small brook that flows across the White Trail below station W2 spills out from a minor breach in one of these till dams. Similar processes probably account for many of the other bodies of water within the Park.

View high-resolution photo(s) at:

[W3 – Glacial scour](#)

[W3 – Glacial scour](#)

W4 – Granitic Vein: Note the light-colored vein running across the base (i.e., the side closest to you) of the large, triangular-shaped rock (a piece of diabase) just to the right of the station marker. This feature is the result of an event that happened approximately 200 million years ago, when the molten magma that subsequently formed the Sleeping Giant was still cooling. In areas at which the hot magma was in direct physical contact with the overlying sandstone, the enormous heat given off by the magma actually melted some of the sandstone. The melted sandstone then flowed into cracks that developed in the roof of the solidifying magma chamber. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Although granitic veins formed at contact surfaces between molten magma and the overlying sandstone, melted sandstone filled cracks in the solidifying magma chamber to varying depths. This is why granitic veins can be found in areas at which the actual contact surface has since eroded away.

Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails. You'll note the raised appearance of this vein in relation to the surface of the diabase with which it is associated. This is due to differential erosion. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, the vein weathers far more slowly. The relative amount of erosion occurring in both the granitic vein and the surrounding diabase is highly variable. Compared to many of the granitic veins at other stations throughout the Park, this one is relatively wide. Moreover, it exhibits both surface and cross-sectional views, offering a full three-dimensional perspective of its structure.

View high-resolution photo(s) at:

[W4 – Granitic vein](#)

W5 – Looking Out Onto Connecticut's Past: This spectacular overlook affords an excellent view of Quinnipiac University and southward towards downtown New Haven. The series of hills just to the left of the New Haven skyline is a portion of the East Rock Ridge, another diabase intrusion with a geologic history similar to that of the Sleeping Giant (note: it is a common misconception that East Rock, West Rock, and the Sleeping Giant were formed as extrusive volcanic eruptions).¹ The Long Island Sound is visible just beyond the New Haven skyline, and on clear days the shoreline of Long Island, New York, can be seen on the horizon across the Sound.

If you had been here approximately 15 thousand years ago, as the Ice Age was giving way to warmer temperatures, you would have been able to see two large freshwater lakes in the Quinnipiac and Mill River Valleys that stretch out before you. These lakes were formed as glacial meltwater flowed southward. Part of what is now the Quinnipiac River drainage basin, seasonally visible in the distance as the tan-colored marsh to the left of the East Rock Ridge (note: in summer months, the marsh is light green in color), had once been filled by Lake Quinnipiac. What is now the Mill River drainage basin, located directly south, had been partially submerged beneath the even larger Lake Connecticut. This extremely large lake occupied all of what is now the Long Island Sound, downtown New Haven, and the southern portion of Hamden. These two lakes eventually drained away. Saltwater filled the Long Island Sound approximately 11 thousand years ago. Long Island itself is largely composed of the loose rubble that had been pushed southward by the ice. It represents the southernmost extent of the glacier's range.

View high-resolution photo(s) at:

[W5 – Looking out onto Connecticut's past](#)

[W5 – Looking out onto Connecticut's past](#)

¹ An extrusive volcanic event occurs when molten magma breaks through the crust and subsequently flows across the landscape as lava. As it cools and solidifies, lava forms basalt. An intrusive event involves the accumulation of molten magma within a chamber that remains underground. As magma cools and solidifies underground, it forms diabase. Diabase remains hidden underground unless exposed by erosion that wears away the overlying rock. This is how the diabase that makes up the Sleeping Giant was exposed.

W6 – Glacial Striations: Another remnant of Connecticut’s glacial past is visible on the surface of this rock outcrop. The many closely spaced parallel lines that have been engraved into the surface of this rock are glacial striations. These were caused by the scraping action of small rocks and gravel that had been trapped beneath the moving mass of ice. The process is similar to that responsible for the glacial scour at station W3 and the pond at station W2. Because of the process by which they were formed, the many glacial striations and scours within the Park are all oriented in the same direction as the path known to have been taken by the glacier. Other examples of glacial striations can be seen at stations W11, T10, and T15.

View high-resolution photo(s) at:

[W6 – Glacial striations](#)

W7 – Granitic Vein: The light-colored stripe just to the right of the station marker is a granitic vein. It can be seen on both the horizontal and vertical faces of this rock. After passing beneath some soil and vegetation, it reappears on the horizontal surface you are probably standing on. Note how different in appearance this vein is from those at stations W4 and W18. Just to the left of the station marker, another granitic vein can be seen running parallel to the first one.

View high-resolution photo(s) at:

[W7 – Granitic vein](#)

W8 – Granitic Vein in Cross Section with Quartz Crystals: This particular rock has broken right across a granitic vein, providing a cross-sectional view of this geological feature. Close inspection of the exposed surface also reveals a small pocket of tiny quartz crystals that sparkle in direct sunlight. These crystals formed after the granitic vein had already been deposited. Open spaces within the vein allowed hot, mineral-rich water to flow across its surface. In a process similar to that which produces hydrothermal precipitates (as described for stations V5, Y1, and T5), the quartz crystals precipitated out of solution and were deposited on the surface of this granitic vein. Notice also the highly organized three-dimensional arrangement of this granitic vein in cross section. Most of the other readily visible granitic veins throughout the Park have a less-organized structure in cross section. The distinctive pattern visible at this station (as well as at station RC8) may be associated with surface features of the rocks that formed the crack into which the melted sandstone originally flowed, as these would have acted like a mold to shape the granitic vein as it solidified.

View high-resolution photo(s) at:

[W8 – Granitic vein in cross section](#)

[W8 – Granitic vein with quartz crystals](#)

W9 – Diabase Block: As vertical fissures formed within the cooling magma chamber, much of the solidifying rock was fractured into an extensive series of vertically oriented columns. At other sites, networks of horizontal cracks fractured the diabase into regularly shaped blocks. Over the course of time, various erosional forces split many columns and blocks off the cliffs and their remains now lay shattered on the ground. On looking at many of these remnants, their original polyhedral nature can be appreciated (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). Both of these features (polyhedron and polygon) are evident in this block of diabase. The site where this particular block originated from is not clear and it is likely that it was simply

transported to where it now rests by glacial action. Keep a watchful eye out for additional remnants of blocks and columns as you hike through the Park.

View high-resolution photo(s) at:

[W9 – Diabase block](#)

W10 – Exfoliation: From the station marker along the trail, follow the small arrow a short distance to the right until you come to the actual W10 station. In addition to providing a spectacular view southward, this station displays an example of yet another way in which diabase can break apart. The surface of the rock in this area appears to be flaking apart into sheets and slabs. When this rock initially formed by the cooling and solidification of molten magma, the weight of a massive layer of sandstone—perhaps as much as a mile thick—was bearing down upon it. Having formed under conditions of such high pressure, this is the state under which the rock is most stable. As the overlying sandstone slowly eroded away over the course of time, the pressure exerted upon the underlying diabase was gradually decreased. As a consequence, a series of cracks developed in the surface of the rock. These formed in a plane that was perpendicular to the direction of the changing stress (i.e., parallel to the rock’s modern-day surface). The cracks undermined the surface of the rock, allowing sheets and slabs of stone to peel away from the surface, a process called exfoliation. Areas of exfoliated rock and undermined surfaces are both readily apparent at this site. The flakes still remaining in place are quite fragile. Please help to preserve this natural feature by resisting the temptation to stand on or peel away these thin slabs of stone. Other nice examples of exfoliation can be seen at stations B9, B24, O4, Y4, and the rock upon which the T4 station marker is painted.

You can also see a thin granitic vein that runs across the surface adjacent to the area of exfoliation. Its presence highlights the fact that many different geological features may be seen at any given location by hikers taking the time to examine an area closely.

View high-resolution photo(s) at:

[W10 – Exfoliation](#)

[W10 – Exfoliation and granitic vein](#)

W11 – Glacial Striations: This area of the Park was once a major corridor for ice flow during the peak of the Ice Age. Untold tons of rocks and debris were swept along by glacial action, helping to sculpt and shape this region. Similar to those at station W6, these closely spaced glacial striations were engraved in the rock by small rocks and gravel trapped beneath the moving mass of ice. As you continue past this outcrop, also note the narrow granitic vein that encircles the rock on which the station marker is painted.

View high-resolution photo(s) at:

[W11 – Glacial striations](#)

[W11 – Glacial striations](#)

W12 – Cliff with Large Column Remnant: As you approach the base of this large cliff along the White Trail, note the many large blocks of diabase that litter its base. The jumble of boulders at the base of this cliff forms a talus slope (or scree slope). Most of these rocks had been split off the cliff by extensive erosion within the last 17 thousand years; however, some may have been ripped away by passage of the glacial ice sheet.

This cliff face displays the extensive network of vertical columns that frequently forms in cooling magma. The columns result from long vertical fractures that develop in the rock. These fractures form as a result of contraction that accompanies the cooling and solidification of magma. This columnar arrangement is very common along the many diabase cliffs within the Park. The columns typically form multi-faced polyhedra. On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park. A number of factors, including the rate at which the magma cools, play a role in determining the thickness of individual columns. Rapid cooling tends to result in relatively narrow columns, while slowly cooling columns are more likely to be thicker. The relatively thick columns within the Giant suggest that this magma chamber cooled rather slowly.

The large block at station W12 is all that now remains of what was once a large, diabase column. From the intersection of the White and Red Circle Trails, a short walk of about 70 feet to the left along the Red Circle Trail will bring you to an even larger column remnant. Other remnants of columns displaying a characteristic polyhedral structure can be seen at stations V7 and T13. Continuing farther along the White Trail necessitates climbing the cliff that looms before you. Exercise considerable caution in doing so. Hikers not comfortable climbing this cliff can bypass it by continuing along the Red Circle and Orange Trails. Consult a trail map for the exact route to get back to the White Trail.

View high-resolution photo(s) at:

[W12 – Diabase cliffs and talus slope](#)

W13 – Coarse-Grained Red Soil: As you step carefully onto the top of the cliff, think about the obvious change in the character of the soil, which is red colored and very coarse grained in this section of the Park.

The magma within the ancient underground chamber that eventually formed the Sleeping Giant was composed of a wide array of elements. As the magma cooled, these elements combined to form assorted minerals. The rate at which different portions of the magma cooled was highly variable and was dependent on multiple factors. As a result, the rates at which different elements crystallized out of the cooling magma also varied considerably. Some of the last elements to crystallize became concentrated in discrete pockets within the partially solidified magma. When these pockets did eventually cool and solidify, their mineral composition differed from that of the bulk of the Sleeping Giant diabase. This area atop the cliff was formed from one of these pockets, and the coarse-grained rocks at this location are referred to as pegmatite. The accumulation of large amounts of iron—as much as 20%, compared to only 11% in other areas of the Park—and its subsequent oxidation on exposure to air are responsible for the rust color of both the soil and many of the nearby rocks. As this iron-rich rock erodes away, it is broken down into a coarse-grained soil that is rich in the iron oxide minerals hematite (usually red) and limonite (usually orange or yellow).

View high-resolution photo(s) at:

[W13 – Coarse-grained red soil](#)

W14 – Ice Wedging: Here in New England, the freeze/thaw cycle of winter is one of the major forces of erosion responsible for breaking apart rocks. Unlike most other liquids, water expands when it freezes. When water seeps down into tiny cracks within a rock and subsequently freezes, the expanding ice will exert considerable outward force on the surrounding surfaces. Over the

course of time, repeated freeze/thaw cycles will continue to widen the crack, gradually wedging the stone apart.

Recurring year after year, freeze/thaw cycles are responsible for many of the large cracks that can be seen in rocks throughout the Sleeping Giant. They are also responsible for breaking large slabs of rocks from vertical cliffs, as well as the destruction of many large diabase columns. A similar process can be blamed for the sudden appearance of potholes in crumbling, snow-covered roads.

View high-resolution photo(s) at:

[W14 – Ice wedging](#)

W15 – Pegmatite Pockets: Notice the vivid blue and purple coloration that adorns the vertical surface of these rocks. Like the coarse-grained soil at station W13, these darkly colored rocks were also formed as pockets of pegmatite in the cooling magma. The striking colors are due to both the wide variety of elements and minerals that have been concentrated within the solidifying matrix as well as to the subsequent effects of oxidation following exposure to air. In those areas of the rock where the colors are most vivid, the individual grains that make up the rock are considerably larger than those in the surrounding rock. This is a defining feature of pegmatite.

View high-resolution photo(s) at:

[W15 – Pegmatite pockets](#)

[W15 – Pegmatite pockets](#)

W16 – Spheroidal Weathering: The round, spherical lumps of pegmatite eroding out of the outcrop just below Hezekiah's Knob are examples of spheroidal weathering. It is likely due to a combination of geological processes, including rapid erosion and the effects of exfoliation on the coarse-grained pegmatite. Because of its large concentration of chemically unstable minerals, pegmatite tends to erode much more quickly than does most of the diabase in the Park. As these rocks erode, exfoliation may govern the shape that they exhibit...the decreasing pressure allowing them to peel away layer by layer, much like an onion. Similar structures can be seen just around the corner, where the Blue Trail ascends to the Knob at station B33.

View high-resolution photo(s) at:

[W16 – Spheroidal weathering](#)

W17 – Coarse-Grained Soil: The coarse-grained, granular soil in the vicinity of Hezekiah's Knob is derived from eroding chunks of pegmatite. If you pick up a few grains, you can see that they resemble the individual grains that are still imprisoned within the adjacent rocks. This coarse-grained soil is similar in many respects to that seen atop the cliff at station W13. Considered together, stations W16, W17, and B33 tell part of the interesting story of the rock cycle.

View high-resolution photo(s) at:

[W17 – Coarse-grained soil](#)

W18 – Granitic Vein: This station displays multiple granitic veins embedded within cracks in the diabase. These light-colored veins can be clearly seen as pink-tinged stripes running across

the rock's surface. The more you look at the ground in this area, the more veins you will find. Some are visible in surface view and some in cross-sectional view.

View high-resolution photo(s) at:

[W18 – Granitic vein](#)

W19 – Glacial Scour: The surface of this rocky outcrop contains two glacial scours, similar in general appearance to the one at station W3. The first scour is at the top of this outcrop, where the exposed surface forms a horizontal shelf. Note the elongated, concave depression that extends across its surface. The second scour is located just below the first, on the sloping face of the outcrop. Like other glacial features within the Park, they are oriented in the same direction as the path known to have been taken by the glacier.

View high-resolution photo(s) at:

[W19 – Glacial scour](#)

[W19 – Glacial scour](#)

W20 – Contact Surface: Notice the “crinkly” appearance of this rocky slope. This surface pattern, which resembles a crumpled piece of paper, is characteristic of a contact surface between rapidly cooling magma and the original overlying rock. In the Giant, the latter was primarily sandstone, a rock native to the area and sometimes simply referred to as country rock. Before the sandstone that had once covered the Sleeping Giant eroded away—a process that occurred over the course of millions of years—the now-exposed contact surface on which you are standing had been the actual roof of the magma chamber and was in direct contact with the overlying sandstone. The characteristic appearance of the contact surface developed as hot magma along the roof of the magma chamber was cooled (i.e., “quenched”) by contact with the much cooler sandstone. This was a relatively rapid process, in contrast to the comparatively slow cooling that occurred at the core of the magma chamber. After the overlying sandstone eroded away, the underlying diabase (i.e., the solidified magma) was exposed. Because it is much more resistant to erosion than sandstone, the diabase does not erode away as quickly and, therefore, largely remains intact throughout the Park. Most of the diabase that is readily visible in the Park is not part of what had once been a contact surface. Rather, the diabase is present in areas at which the contact surface itself has gradually eroded away to a varying depth. The roof of the original magma chamber had a dome-like shape, much like the cap of a mushroom. Because the portion of the roof in this particular area was below the top of the dome, it is oriented on a slant (like the pitched roof of a house), rather than on a horizontal plane. Similar contact surfaces have been documented at several other locations throughout the Park, including stations B2, B6, V15, V16, Y3, and RC9.

View high-resolution photo(s) at:

[W20 – Contact surface](#)

W21 – Glacial Scour: This glacial scour, located just above the station marker, was formed in the vicinity of a contact surface between the rapidly cooling diabase and the overlying layer of slightly older sandstone. Unlike the contact surface at station W20, this one preserves a thin layer of original sandstone that still adheres to the surface of the diabase. The remnants of this layer of sandstone can be appreciated as scattered pebbles embedded in the rock along the lower portion of this sloping outcrop.

View high-resolution photo(s) at:

[W21 – Contact surface and glacial scour](#)

[W21 – Glacial scour](#)

[W21 – Glacial scour](#)

W22 – Sandstone Boulders: As the white trail comes to an end, an abundance of sandstone boulders can be seen scattered around the area. Many of these boast a high proportion of stream-worn pebbles. Some of these pebbles have been rounded and smoothed from being carried over long distances by ancient streams. Others are more angular in appearance, indicating that they did not spend as much time being tumbled in a stream and were transported a relatively short distance from their source. As the size and concentration rocks and pebbles within sandstone increases, it may be referred to as a conglomerate.

View high-resolution photo(s) at:

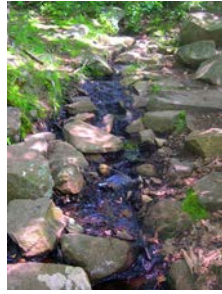
[W22 – Sandstone](#)

[W22 – Sandstone](#)

[W22 – Sandstone](#)



W1 – Mt. Carmel Fault



W2 – Small brook



W2 – Esophagus



W3 – Glacial scour



W3 – Glacial scour



W4 – Granitic vein



W5 – Looking out onto
Connecticut's past



W5 – Looking out onto
Connecticut's past



W6 – Glacial striations



W7 – Granitic vein



W8 – Granitic vein in cross section



W8 – Granitic vein with quartz
crystals



W9 – Diabase block



W10 – Exfoliation



W10 – Exfoliation and granitic vein



W11 – Glacial striations



W11 – Glacial striations



W12 – Diabase cliffs and talus slope



W13 – Coarse-grained red soil



W14 – Ice wedging



W15 – Pegmatite pockets



W15 – Pegmatite pockets



W16 – Spheroidal weathering



W17 – Coarse-grained soil



W18 – Granitic vein



W19 – Glacial scour



W19 – Glacial scour



W20 – Contact surface



W21 – Contact surface and glacial scour



W21 – Glacial scour



W21 – Glacial scour



W22 – Sandstone



W22 – Sandstone



W22 – Sandstone

Green Trail – Geology Stations

G1 – Tree-Root Wedging: Tree roots affect rocks and soil in a number of ways. By holding soil together, they help to prevent soil erosion. On the other hand, the growth of tree roots can actually dissolve rock, causing small cracks to form in solid rock. In the course of their growth, tree roots will also frequently exploit already-existing cracks present in rocks. As roots enlarge over the years, they exert tremendous pressure on the surrounding rock, ultimately splitting apart even large rocks. In conjunction with the effects of ice wedging, continued growth of roots favor ongoing expansion of such cracks. Weathering of rocks by growth of tree roots is actually a very common process, and many examples can be seen in the Park, especially if one examines the various trees growing in the vicinity of cliffs and rocky outcrops. Tree-root wedging is only one of the many ways in which rocks can be broken down across the ever-changing landscape of the Sleeping Giant. Other stations featuring tree-root wedging include B11, B13, RC5, T9, and T12.

View high-resolution photo(s) at:

[G1 – Tree-root wedging](#)

[G1 – Tree-root wedging](#)

G2 – Granitic Vein: The light-colored vein running through this piece of diabase (solidified magma) is the result of an event that happened approximately 200 million years ago, a time when the molten magma that subsequently formed the Sleeping Giant was still cooling. In areas at which the hot magma came into direct physical contact with the overlying sandstone, the enormous heat given off by the magma actually melted some of this sandstone. Cooling of the magma chamber first occurred at its outer surface, resulting in the formation of a brittle shell. Cracks eventually developed in the shell, and the melted sandstone flowed into them, sometimes for considerable depths. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Although granitic veins formed at contact surfaces between molten magma and the overlying sandstone, melted sandstone filled cracks in the solidifying magma chamber to varying depths. This is why granitic veins can be found in areas at which the actual contact surface has since eroded away.

Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails. You'll note the raised appearance of this vein in relation to the surface of the diabase with which it is associated. This is due to differential erosion. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, the vein weathers far more slowly. The relative amount of erosion occurring in both the granitic vein and the surrounding diabase is highly variable.

Along this section of the Green Trail (stations G2 and G4), a differential erosion of the granitic vein and associated diabase is especially pronounced. On the left side of the trail, directly across from the boulder at G2 is a small piece of diabase on which a granitic vein in cross section can be seen. A similar feature can be seen at G3.

View high-resolution photo(s) at:

[G2 – Granitic vein](#)

[G2 – Granitic vein](#)

[G2 – Granitic vein in cross section](#)

G3 – Granitic Vein in Cross Section: The small block of diabase that hosts this granitic vein has broken right along the fracture that was filled by melted sandstone. The fractured surface reveals a granitic vein in cross section. An entire surface of the diabase can be seen to be coated with a sheet of granite-like rock. Such views make it easier to appreciate the three-dimensional organization of this geological feature.

View high-resolution photo(s) at:

[G3 – Granitic vein in cross section](#)

G4 – Granitic Vein: This thick granitic vein encircles this diabase boulder, allowing it to be observed from multiple angles.

View high-resolution photo(s) at:

[G4 – Granitic vein](#)

[G4 – Granitic vein](#)

G5 – Diabase Columns: During the peak of the great Ice Age, some 20 thousand years ago, a large continental glacier moved slowly, but forcefully across Connecticut. Guided in part by local topography, the ancient ice flow passed through this corridor as it moved southward. For thousands of years, the ice scraped away at the underlying rock, sculpting the great cliff to your left (note: these cliffs may be partially obscured by dense foliage during the summer months). In the ensuing millennia since the end of the Ice Age, other erosional processes, such as annual freeze/thaw cycles, continued to split chunks of diabase out of the cliff. The end result of this weathering and erosion is the jumble of boulders (called a talus slope or scree slope) at the base of the cliff.

This cliff face displays the extensive network of vertical columns that frequently forms in cooling magma. The columns result from long vertical fractures that develop in the rock. These fractures form as a result of contraction that accompanies the cooling and solidification of magma. This columnar arrangement is very common along the many diabase cliffs within the Park. The columns typically form multi-faced polyhedra (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park. A number of factors, including the rate at which the magma cools, play a role in determining the thickness of individual columns. Rapid cooling tends to result in relatively narrow columns, while slowly cooling columns are more likely to be thicker. The relatively thick columns within the Giant suggest that this magma chamber cooled rather slowly.

View high-resolution photo(s) at:

[G5 – Diabase cliffs and talus slope](#)

G6 – Diabase Block in Streambed: The many diabase boulders that litter the streambed and the base of the nearby crags have been torn off the cliffs by extensive erosion, occurring primarily over the past 17 thousand years. However, some of these rocks may have been ripped from the cliffs by passage of the glacial ice sheet. Many of these blocks, such as the rhomboid-shaped, polyhedral boulder lying in the stream directly across from the station marker, reveal another feature that can sometimes be observed: chunky blocks of diabase that form as a result of horizontal fractures in the cliff. Like remnants of fallen columns, the appearance of these blocks

is often characterized by flattened surfaces (called polygons) and sharply defined edges. If you look into the woods along the far side of the stream, you will see a large number of diabase polyhedra with polygonal-shaped faces.

View high-resolution photo(s) at:

[G6 – Remnant of diabase polyhedron in stream](#)

[G6 – Diabase polyhedra across stream](#)

G7 – Unusual Location for Quartzite: Hidden within the fork of this large tree, located directly across the trail from the station marker, is a smooth, pink-colored piece of quartzite. Although quartzite is quite common in the Park, it is not native to the area. This boulder originated somewhere north of Connecticut and was transported to the Park—along with enormous quantities of other rocks and boulders—by glacial action.

Although it is tempting to speculate that a young tree, germinating from a seed located beneath the stone, carried the rock upwards as it grew, this is really not the case. Trees grow in height only from the tips of their stems and branches, which explains why initials carved in a tree do not migrate upwards as the tree grows. The most likely scenario is that this rock had been placed in the crotch of the tree when it had been just a sapling. Within a few centuries, however, after the tree has died and decomposed, this rock will return to the ground again.

View high-resolution photo(s) at:

[G7 – Quartzite embedded in tree](#)

[G7 – Quartzite embedded in tree](#)

G8 – Ice Wedging: At the edge of this heavily wooded area, approximately 35 feet to the right of the station marker, is a large, rounded boulder. A sizeable crack has split it completely in half. The smooth and rounded contour of this boulder—the result of being tumbled over and over beneath a sheet of slowly moving ice—attests to the fact that it had been carried here by glacial action long ago. While this boulder had been deposited here during the course of the Ice Age, more recent action of water and ice was probably responsible for its current condition.

Here in New England, the freeze/thaw cycle of winter is one of the major forces of erosion responsible for breaking apart rocks. Unlike most other liquids, water expands when it freezes. When water seeps down into tiny cracks within a rock and subsequently freezes, the expanding ice will exert considerable outward force on the surrounding surfaces. Over the course of time, repeated freeze/thaw cycles will continue to widen the crack, gradually wedging the stone apart.

Recurring year after year, freeze/thaw cycles are responsible for many of the large cracks that can be seen in rocks throughout the Sleeping Giant. They are also responsible for breaking large slabs of rocks from vertical cliffs, as well as the destruction of many large diabase columns. A similar process can be blamed for the sudden appearance of potholes in crumbling, snow-covered roads.

View high-resolution photo(s) at:

[G8 – Ice wedging](#)

G9 – Sandstone: Sandstone is a sedimentary rock built up in successive layers by the gradual deposition of sediments. Scattered along the ground surrounding this station marker are several blocks of sandstone, each containing a variety of stream-worn pebbles.

Some of these pebbles have been rounded and smoothed from being carried over long distances by ancient streams. Others are more angular in appearance, indicating that they have not spent as much time being tumbled in a stream and have been transported a relatively short distance from their source.

To complicate this picture even further, these entire blocks of sandstone were transported to this area by glacial action. Most of the rocks at this station originated north of Sleeping Giant and were simply deposited here along with all the other rubble carried by the glacier.

View high-resolution photo(s) at:

[G9 – Sandstone](#)

G10 – Sandstone Boulder in Rock Wall: As our tour along Green Trail comes to its end, we are reminded of the many manmade structures still evident within the Park and their relationship to a rich local and regional history. Many of the rocks that make up this stone wall are pieces of sandstone that boast a high abundance of pebbles. As the size and concentration of rocks and pebbles within sandstone increases, it may be referred to as a conglomerate.

View high-resolution photo(s) at:

[G10 – Sandstone boulder in rock wall](#)



G1 – Tree-root wedging



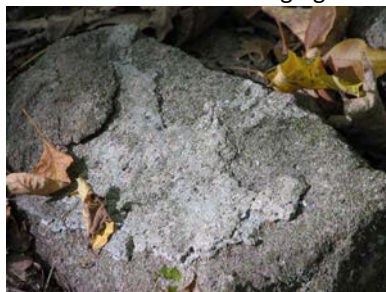
G1 – Tree-root wedging



G2 – Granitic vein



G2 – Granitic vein



G2 – Granitic vein in cross section



G3 – Granitic vein in cross section



G4 – Granitic vein



G4 – Granitic vein



G5 – Diabase cliffs and talus slope



G6 – Remnant of diabase polyhedron in stream



G6 – Diabase polyhedra across stream



G7 – Quartzite embedded in tree



G7 – Quartzite embedded in tree



G8 – Ice wedging



G9 – Sandstone



G10 – Sandstone boulder in rock wall

Orange Trail – Geology Stations

O1 – Quartzite Boulder: The tour of the Orange Trail begins with a large quartzite boulder in the middle of the trail. A smaller one is located right in front of it. Quartzite is a metamorphic rock that forms when sandstone is subjected to tremendous pressure, such as occurs when tectonic forces cause continents to collide and mountain ranges to be thrust upwards. Under these conditions, the quartz crystals making up the bulk of the sandstone are squeezed tightly against one another to form quartzite.

Quartzite is not native to the region of the Sleeping Giant, and no outcrops of quartzite exist anywhere in the Park; however, smooth and rounded rocks like these are extremely common throughout the Giant, typically ranging in size from a few inches to several feet in diameter. They probably originated from areas far to the north of Connecticut and were carried here by the awesome power of the moving glacier. They were deposited in the area when the last glaciers to occupy Connecticut melted away, approximately 17 thousand years ago.

Place the palm of your hand across one of these quartzite specimens to get an idea of its temperature. Compare it to the darker-colored rocks to either side and you will readily notice how much cooler the quartzite is. Several factors account for the coolness of quartzite, including a lighter color, which does not absorb as much heat as dark-colored surfaces, and a capacity to transfer heat into the ground more effectively than other rocks. As a result of its coolness, water tends to condense across its surface on humid days, imparting a moist sheen to its appearance.

The appearance of quartzite may vary considerably. Colors commonly include shades of white and gray; however, pink, yellow, orange, and red may often be seen. The color depends on the amount of iron or other impurities that have been incorporated into the rock. Once you become familiar with the many appearances of quartzite, it is very easy to recognize. Keep an eye out for it along all of the trails within the Park. Other stations featuring quartzite include B1, B18, B20, B30, V13, Y2, T4, and T6.

View high-resolution photo(s) at:

[O1 – Quartzite boulder](#)

O2 – Granitic Vein: As you pass by the large, flat chunk of diabase lying in the center of the trail, notice the thin, white stripe running across its surface. This rock was once been part of the nearby cliffs, but was ripped away by any of a variety of erosional processes. The white stripe is a granitic vein. Granitic veins formed in areas at which the hot magma came in contact with the overlying sandstone. The enormous heat given off by the molten magma actually melted some of the overlying sandstone. The melted sandstone then flowed into cracks that were developing in the roof of the solidifying magma chamber. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails.

View high-resolution photo(s) at:

[O2 – Granitic vein](#)

[O2 – Granitic vein](#)

O3 – Granitic Vein: The granitic vein that meanders across the surface of this rocky outcrop is considerably larger than the one seen at station O2. Also note the raised appearance of this vein in relation to the surface of the associated diabase. This is due to differential erosion. Because the granitic vein is considerably more resistant to erosion than the surrounding diabase, the vein weathers far more slowly. The relative amount of erosion occurring in both the granitic vein and the surrounding diabase is highly variable.

View high-resolution photo(s) at:

[O3 – Granitic vein](#)

[O3 – Granitic vein](#)

O4 – Exfoliation: Rocks are continually being broken apart by a variety of erosional forces. Just below the station marker, note the area from which a large flake of rock has been eroded away. When this rock initially solidified out of the mass of molten magma, the weight of an immense layer of sandstone—perhaps as much as a mile thick—was bearing down upon it. Having formed under conditions of such high pressure, this is the state under which the rock is most stable. As the overlying sandstone slowly eroded away over the course of time, the pressure exerted upon the underlying diabase was gradually decreased. As a consequence, a series of cracks developed in the surface of the rock. These formed in a plane that was perpendicular to the direction of the changing stress (i.e., parallel to the rock’s modern-day surface). The cracks undermined the surface of the rock, allowing sheets and slabs of stone to peel away from the surface. The process is called exfoliation. Other nice examples of exfoliation can be seen at stations B9, B24, W10, Y4, and T4 (the rock upon which the station marker is painted).

About 2 feet above the station marker, you can also see a thin, white-colored stripe running across the surface of this diabase outcrop. This is another example of a granitic vein. Its presence in association with the exfoliating diabase highlights the fact that geological processes do not occur in isolation from one another. Several different features may be seen at any given location by hikers taking the time to examine an area closely.

View high-resolution photo(s) at:

[O4 – Exfoliation](#)

[O4 – Thin granitic vein](#)



O1 – Quartzite boulder



O2 – Granitic vein



O2 – Granitic vein



O3 – Granitic vein



O3 – Granitic vein



O4 – Exfoliation



O4 – Thin granitic vein

Violet Trail – Geology Stations

V1 – The Mill River: The stream flowing beside the trail is the Mill River. From this vantage point, it is easy to observe some of the local influences a modern river can have on geological processes. At some time in the past, all of the sand, pebbles, rocks, and cobbles that now litter the riverbed were parts of larger rocks, boulders, and hillsides. Over the course of time, many of the fragments from larger rocks that had been broken apart by various erosional processes ended up in the river and were gradually transported downstream. This is an ongoing process and continues today. Water flowing in a river naturally sorts the material it transports by size and weight. Bulky material, such as large pebbles and cobbles, is deposited in areas of fast-moving water, whereas finer material, such as sand and small pebbles, is deposited in areas of slower flow. Due to the effect of friction between the water and riverbank, water flowing near the edge of a river moves more slowly than the water in its center. In this regard, note that the sediment along the margin of this river is largely composed of sand, whereas towards the center of the river, a variety of larger rocks and cobbles can be seen. Depending on water clarity on any given day, a gradation in pebble size (with larger material towards the center) across the breadth of this river may be apparent. Over the course of geologic time, ancient sediments deposited by rivers may become cemented together forming sandstone. Because the composition of a sandstone outcrop will be determined by the nature of the sediments from which it was formed, the influence of streams and rivers becomes apparent. This process, the effects of which can be better appreciated when considered in relation to the Mill River, is responsible for the gradations in pebble size that are apparent in the sandstone boulder at station T1 along the Tower Trail.

Effects of the river on erosion are also quite apparent at this station. Along the edge of the river, the roots of several trees have been exposed and some have been undermined as flowing water slowly erodes away the riverbank. In time, these trees will fall victim to erosion and topple into the river. In addition, about 50 feet downstream of the station marker, a small branch of the river has actually begun to carve a narrow channel alongside the river, claiming a portion of the Violet Trail in the process. As a result, a small island is being formed. In due time, this island may be completely swallowed up by the river.

View high-resolution photo(s) at:

[V1 – Mill River](#)

[V1 – Rocks and cobbles in Mill River](#)

[V1 – Erosion along riverbank](#)

[V1 – Erosion along riverbank](#)

[V1 – Mill River downstream](#)

V2 – Talus Slope: To the right of the trail, a jumble of boulders can be seen at the base of this small hill (which is often referred to as the Dumpling). This collection of boulders is called a talus slope (or scree slope). Some of this rubble has also accumulated along the riverbed to the left of the trail. Most of these rocks had been split off the cliff by extensive erosion since the passage of the last glacial ice sheet about 17 thousand years ago; however, some may have been ripped away by the ice sheet itself.

View high-resolution photo(s) at:

[V2 – Talus slope](#)

V3 – Rock Plumes: Just to the left of the station marker (following the direction of the arrow) is a large rock with a beautiful series of grooves and ridges that appears to have been engraved on its surface. If you step back and examine the entire surface, the feather-like shape of this engraved pattern will be apparent. This characteristic feature is called a plume. Plumes like this are formed as a result of the way in which many finely grained rocks tend to break apart. The point from which all the lines diverge is the site at which the rock began to fracture. As a variety of erosional forces continued to act on the block, the fracture grew steadily larger. Eventually, the block simply peeled away from its point of attachment to the cliff and fell down the talus slope.

Plumes are extremely common in the Park and can often be seen where broken fragments of diabase (i.e., the solidified magma) are plentiful. In fact, another large plume is visible on the large block of diabase within the river, just a few feet from the riverbank. Plumes can also be seen on the inner surfaces of rocks that have been split apart by ice wedging (see station V14 on this trail). Plumes are useful features for geologists attempting to reconstruct the series of events leading to formation of a particular landscape or trying to determine the nature and direction of tectonic forces that may have influenced geological processes in a region. Plumes can also be seen at stations B17, V10, T12, and T13 as well as at some of the stations featuring ice wedging, such as B21 and V14.

View high-resolution photo(s) at:

[V3 – Plume](#)

[V3 – Plume in water](#)

V4 – Polished Diabase: Along the short section of trail between the station marker and the screened-in staircase (which is located just before the Park’s popular swimming hole), a number of polished diabase boulders can be seen. Polishing is a common feature along popular hiking trails subjected to heavy traffic and results from continued scuffing of the rock by countless hikers over several decades. Polished surfaces can also be seen at station Y4.

View high-resolution photo(s) at:

[V4 – Polished diabase](#)

[V4 – Polished diabase](#)

V5 – Hydrothermal Precipitate: The patches of light-colored stone adhering to the vertical surface of this outcrop are the remnants of mineral veins that had been deposited within cracks in the diabase. As the magma chamber that formed the Sleeping Giant gradually cooled and solidified about 200 million years ago, cracks began to form in the hardening rock. These cracks ultimately became conduits for mineral-rich water to flow through. As a consequence of several complex processes, various minerals slowly precipitated out of the water, covering the walls of many cracks with a profusion of crystals. This type of hydrothermal process is quite common and can sometimes decorate even large cavities with spectacular mineral deposits. A similar process may lead to the formation of geodes. If the rock subsequently fractures through one of these cracks, as occurred here, the mineral-rich surface will be exposed in cross section, allowing the minerals to sparkle in the sunlight. The dominant mineral that had been deposited within these cracks is quartz. Other examples of hydrothermal precipitates can be seen at stations V10, Y1, and T5.

View high-resolution photo(s) at:

[V5 – Hydrothermal precipitate](#)

[V5 – Hydrothermal precipitate](#)

V6 – Quartz-filled Veins and Differential Erosion: Numerous ridges cover the surface of this diabase outcrop, crisscrossing the exposed face in what appears to be a very haphazard fashion. Just like the mineral precipitates visible at station V5, these ridges are actually mineral veins filled with precipitated quartz. However, unlike the cross-sectional view evident at station V5, the view at this station reveals the same structure from a surface perspective. Because quartz is much more resistant to erosion than the surrounding diabase, these veins do not erode away as quickly as the diabase. As a consequence, they tend to stand out in relief as thin ridges on the surface of the diabase.

View high-resolution photo(s) at:

[V6 – Differential erosion](#)

V7 – Polyhedron Boulder: This diabase boulder is a large polyhedron—a remnant of what had once been an even larger diabase column. Diabase columns result from long vertical fractures that develop in the rock. These fractures form as a result of contraction that accompanies the cooling and solidification of magma. This columnar arrangement is very common along the many diabase cliffs within the Park.

The columns typically form multi-faced polyhedra (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park.

After long periods of exposure to the elements, the columns themselves begin to erode and break apart. Fallen chunks of diabase make up the talus slopes at the foot of many cliffs. In much of this rubble, the original polyhedral structure of the parent column is preserved and their characteristic flat surfaces and sharply defined edges can be readily seen. How many sides do you count on this boulder? Is it a pentagon, hexagon, or other?

View high-resolution photo(s) at:

[V7 – Diabase polyhedron](#)

V8 – Blocky Diabase Cliff: As you approach this open field, look to your right. Just beyond the cement ruins of the old quarry works (from the quarrying operations that took place during the early part of the 20th century) is an overhanging cliff composed of diabase. Unlike many of the other diabase cliffs within the Park (e.g., B22, B24, B26-B29, W12, G5, RC5, RC6, T9, and T11), this one is not made up of a series of vertical columns. Rather, it has been fractured into a set of flat, four-sided blocks. Instead of forming a columnar structure, the development of horizontal fractures in the cooling magma can sometimes result in the formation of this kind of block-like arrangement.

View high-resolution photo(s) at:

[V8 – Blocky diabase cliff](#)

V9 – In the Region of a Contact Surface: Although it may be difficult to appreciate from a distance, the rocky outcrop to the left of the trail is composed of sandstone. A closer examination will reveal the small rocks and pebbles embedded in its surface. The close association of this outcrop with the diabase cliff at station V8 suggests that a contact surface—which has long since eroded away—used to be located somewhere between them. The presence of the contact surface

once marked the edge of the magma chamber. A similar relationship between adjacent diabase and sandstone outcrops can be seen at station Y5.

View high-resolution photo(s) at:

[V9 – Sandstone outcrop](#)

V10 – The Quarry: As you stare in awe at the immense rock wall before you, think about the enormous amount of rock that must have been removed by quarrying operations and the permanent scar that was subsequently left on the landscape. Between 1912 and 1930, more than one million tons of rock had been quarried away from the top of the Giant’s Head. This was crushed and used as aggregate, primarily in the construction of roads. In fact, crushed stone from the Quarry was used in the construction of the original Tower Trail. The many years of blasting opened up a window into the Giant’s Head, revealing some of the dynamic features that can form in a cooling magma chamber.

On the far left side of this rock wall, partially obscured by trees, the upper contact surface of the magma chamber is still intact, although it is buried beneath the original sandstone that still lies directly above the diabase. Direct contact with the relatively cold sandstone caused this portion of the magma to cool more rapidly than the core. As a result of rapid cooling, the diabase at this location is composed of smaller-sized grains, whereas magma that cooled deeper within the chamber is composed of more coarsely grained rock.

Most of the diabase making up the left half of the quarry face displays a blocky texture, similar in appearance to that seen at station V8. Compare this to the portion of the cliff making up the right wall of the Quarry. At this location, you can see distinct columns. In looking at these columns, notice that their orientation is such that their uppermost portions are tilted to the right. When columns develop in the solidifying magma, they form perpendicular to the surface of the magma chamber. The tilt of these columns is consistent with a sloping surface of the magma chamber. In fact, the slope of the magma chamber’s roof at this location was once parallel to that of the currently exposed land surface. This can be documented by simply hiking up the Quarry Trail (i.e., the Blue Trail), which continues up the slope along the right side of the Quarry. Almost all of the sandstone along this path has eroded away, and almost directly above these columns an intact contact surface can be seen at station B6 (see descriptions of a contact surface at stations B3 and B6). The slope of this surface is perpendicular to the orientation of the columns along the Quarry wall, reflecting the dome-shaped roof of the magma chamber.

As you meander through the Quarry, you can readily observe a number of other geological features, both along the Quarry wall as well as in the talus slope at the base of the cliff. Foremost among these are columns and column remnants, plumes, hydrothermal precipitates, granitic veins, and surface oxidation.

Many large plumes can be seen among the fractured boulders littering the base of the cliff. When the sun is suitably oriented, even larger plumes, including the largest one identified in the Park, can be seen along the Quarry wall itself.

Entire surfaces of some talus blocks are encrusted with minerals. These frosted surfaces are the result of minerals precipitating out of the mineral-rich water that had once bathed these rocks.

The process is similar to that responsible for the mineral deposition seen at stations V5, V6, Y1, and T5.

Granitic veins can often be seen in diabase blocks. These are visible as white- to pink-colored stripes running across the surface of the rock. They formed from melted sandstone that had been forced into cracks in the solidifying magma chamber.

Looking along the Quarry wall, notice that some sections are relatively dark in color, while others have an orange hue. Many of the rocks at the Sleeping Giant have an overall orange tint. This is due to their high content of iron, which literally rusts (i.e., oxidizes) on long-term exposure to air. Apart from orange-colored sections of the wall that long ago had been exposed by quarrying operations, various erosional forces (especially freeze-thaw cycles) periodically break off large slabs of rock from the cliff. In time, many of these newly exposed faces will also develop an orange coloration, as the iron contained in the rock oxidizes on exposure to air.

It should be noted that these features can all be easily seen from the safety of the Quarry floor. There is no necessity to climb among the giant boulders in order to view them. In fact, this is a very dangerous thing to do, as many of these boulders are loose and precariously balanced. Even large boulders can unexpectedly shift position with little or no warning.

Quarrying operations in the early part of the 20th century were intimately related to the early history of the Sleeping Giant and its eventual establishment as a state park. In her excellent book *Born Among the Hills* (2004), published by the Sleeping Giant Park Association, Nancy Sachse recounts the fascinating story of the Park's early history, from long- and hard-fought battles to rescue the land from the devastation of quarrying and logging operations to its final inception as a wonderful state park. She provides readers with plenty of regional history and pays tribute to the devotion and perseverance of a small group of dedicated individuals who worked tirelessly to breathe life into the land—local visionaries who saw their chance to pursue a dream and make it a reality. A nice collection of historical photographs of the Park can also be found in Julie Hulten's *Sleeping Giant – Then* (2011), My Publisher.

View high-resolution photo(s) at:

[V10 – Quarry](#)

[V10 – Left Quarry wall](#)

[V10 – Right Quarry wall](#)

[V10 – Block-like texture of sheared-off columns](#)

[V10 – Colossal plume on Quarry wall](#)

[V10 – Giant plume on Quarry floor](#)

[V10 – Hydrothermal precipitate on Quarry floor](#)

[V10 – Hydrothermal precipitate on Quarry floor](#)

[V10 – Granitic vein on Quarry floor](#)

V11 – Baked Sandstone: The surface of the rocky outcrop along which you are walking is composed of sandstone that had been baked by hot magma. When the molten magma came into contact with the relatively cool overlying sandstone, a large amount of heat was transferred to the sandstone. This caused individual grains of sand to melt and fuse together. The heat also caused some minerals to break down, after which they re-crystallized into different kinds of minerals. As a result of this process, significant changes occurred in the appearance of the original sandstone. This can make it difficult to even recognize what the original rock was. On this

particular outcrop, the minerals making up the individual grains have been melted and re-crystallized into a dark-gray rock having a finer texture than that of the original sandstone. Because of this finer texture, the individual crystal grains are almost impossible to see with the naked eye.

View high-resolution photo(s) at:

[V11 – Baked sandstone](#)

[V11 – Baked sandstone](#)

[V11 – Baked sandstone](#)

V12 – Sandstone Boulder: Close examination of this boulder reveals the many pebbles and individual grains of sand that are characteristic of sandstone. In contrast to the sandstone present at station V11, these features are readily visible in this rock, indicating that it is an example of sandstone that had not been baked by heat transfer from underlying molten magma.

Most of the sand grains contributing to the formation of this boulder were once part of an ancient mountain range. Broken apart by the inexorable forces of erosion and carried away from their source by ancient streams, they were gradually deposited as successive layers of sediment within the central lowlands of Connecticut. The various layers of sediment were gradually “cemented” together to form sandstone, an example of a sedimentary rock.

This particular boulder probably originated from the small hill just to the right of the trail, as suggested by the rich deposits of sandstone present along the hillside. It is likely that the entire hill is composed of sandstone, although most of it remains buried beneath the soil. Sometimes, even soil-covered bedrock can be broken apart by a host of erosional forces. Once pried from the ground, this boulder most likely rolled downhill before coming to rest at its current location.

View high-resolution photo(s) at:

[V12 – Sandstone boulder](#)

[V12 – Sandstone boulder](#)

V13 – Vein of Quartz Within a Quartzite Boulder: This large, light-gray boulder is an example of quartzite. Quartzite forms when sandstone is subjected to tremendous pressure, such as occurs when tectonic forces cause continents to collide and mountain ranges to be thrust upwards. Under these conditions, the quartz crystals making up the bulk of the sandstone are squeezed tightly against one another to form quartzite. Quartzite is not native to the region of the Sleeping Giant, and no outcrops of quartzite exist anywhere in the Park; however, it is extremely common within the Giant, typically ranging in size from a few inches to several feet in diameter. Quartzite within the Park probably originated in areas far to the north of Connecticut and was carried here by the awesome power of moving ice. It was deposited in the area when the last glaciers that occupied Connecticut melted away, approximately 17 thousand years ago. The appearance of quartzite may vary considerably. Colors commonly include shades of white and gray; however, pink, yellow, orange, and red may often be seen. The color depends on the amount of iron or other impurities that have been incorporated into the rock. Once you become familiar with the many appearances of quartzite, it is very easy to recognize. Keep an eye out for it along all of the trails within the Park. Other stations featuring quartzite include B1, B18, B20, B30, O1, Y2, T4, and T6.

This particular quartzite boulder is especially interesting because of the light-colored stripe running across its exposed face. This stripe is actually a vein of quartz, somewhat similar to those observed at station V6. Even though the entire rock is composed of the mineral quartz, the quartz crystals present in this vein originated from water that once flowed through a crack that long ago formed in the rock. As the water flowed along this crack, quartz crystals precipitated out to form this lighter-colored vein. The crystals of quartz in this vein are considerably larger than those found in the rest of the rock.

View high-resolution photo(s) at:

[V13 – Quartzite boulder with quartz vein](#)

[V13 – Quartzite boulder with quartz vein](#)

[V13 – Quartzite boulder with quartz vein](#)

[V13 – Quartzite boulder with quartz vein](#)

V14 – Ice Wedging and Plume: The most characteristic feature of this large, diabase boulder is the vertical crack splitting it in half, almost as if it had been struck a powerful blow by an axe-wielding giant. Regrettably, the crack was actually caused by a more mundane geological process: erosion.

Here in New England, the freeze/thaw cycle of winter is one of the major forces of erosion responsible for breaking apart rocks. Unlike most other liquids, water expands when it freezes. When water seeps down into tiny cracks within a rock and subsequently freezes, the expanding ice will exert considerable outward force on the surrounding surfaces. Over the course of time, repeated freeze/thaw cycles will continue to widen the crack, gradually wedging the stone apart.

Recurring year after year, freeze/thaw cycles are responsible for many of the large cracks that can be seen in rocks throughout the Sleeping Giant. They are also responsible for breaking large slabs of rocks from vertical cliffs, as well as the destruction of many large diabase columns. A similar process can be blamed for the sudden appearance of potholes in crumbling, snow-covered roads.

The walls of cracks like these often display plumes, such as those observed at station V3. The orientation of a plume helps to provide information about the direction in which the rock actually split. Close examination along the inner surfaces of this crack reveals a portion of a plume (also see station B21).

View high-resolution photo(s) at:

[V14 – Ice wedging and plume](#)

15 – Contact Surface: This blocky, fractured slope is the remnant of a partially eroded contact surface near the edge of the magma chamber. The pattern visible on this diabase surface is characteristic of a contact surface between rapidly cooling magma and the original overlying rock. In the Giant, the latter was primarily sandstone, a rock native to the area and sometimes simply referred to as country rock. Before the sandstone that had once covered the Sleeping Giant eroded away—a process that occurred over the course of millions of years—the now-exposed contact surface that forms the face of the cliff at this station had been the outer surface of the magma chamber and in direct contact with the overlying sandstone. The characteristic appearance of the contact surface developed as the hot magma was cooled (i.e., “quenched”) by

contact with the much cooler sandstone. This was a relatively rapid process, in contrast to the comparatively slow cooling that occurred at the core of the magma chamber.

After the overlying sandstone eroded away, the underlying diabase was exposed. Because it is much more resistant to erosion than sandstone, diabase does not erode away as quickly and, therefore, largely remains intact throughout the Park. Most of the diabase that is readily visible in the Park is not part of what had once been a contact surface. Rather, the diabase is present in areas at which the contact surface itself has gradually eroded away to a varying depth. The roof of the original magma chamber had a dome-like shape, much like the cap of a mushroom. Because the portion of the roof in this particular area was below the top of the dome, it is oriented on a slant (like the pitched roof of a house), rather than on a horizontal plane. Similar contact surfaces have been documented at several other locations throughout the Park, including B2, B6, W20, V16, Y3, and RC9.

View high-resolution photo(s) at:

[V15 – Contact surface](#)

V16 – Contact Surface: This slope represents a continuation of the contact surface seen at station V15; however, the rock is more heavily eroded here than at the previous station. As you continue along this ridge, note the remnants of degraded crowns of diabase columns in the middle of the outcrop. At the eastern edge of the outcrop, upper segments of diabase columns can be seen. The columns contributing to the formation of this contact surface are tilted slightly to the north. Columns within a magma chamber typically form perpendicular to the outer surface (shell) of the chamber. The tilt observed at this outcrop, along with the orientation of other columns throughout the Park, is further indication that the roof of the magma chamber had a dome-like shape.

View high-resolution photo(s) at:

[V16 – Contact surface](#)

[V16 – Crown of diabase column](#)

[V16 – Crown of diabase column](#)

[V16 – Tilted diabase columns](#)

V17 – Northern Extent of the Magma Chamber: The hillside that can be seen to the right of the trail and just beyond the trees is the northernmost extent of the magma chamber that makes up the Sleeping Giant. From this point until the end of the Violet Trail at Chestnut Lane, all of the bedrock beneath the soil as well as most of the rocks scattered along the trail are sandstone.

View high-resolution photo(s) at:

[V17 – Northernmost extent of magma chamber](#)



V1 – Mill River



V1 – Rocks and cobbles in Mill River



V1 – Erosion along riverbank



V1 – Erosion along riverbank



V1 – Mill River downstream



V2 – Talus slope



V3 – Plume



V3 – Plume in water



V4 – Polished diabase



V4 – Polished diabase



V5 – Hydrothermal precipitate



V5 – Hydrothermal precipitate



V6 – Differential erosion



V7 – Diabase polyhedron



V8 – Blocky diabase cliff



V9 – Sandstone outcrop



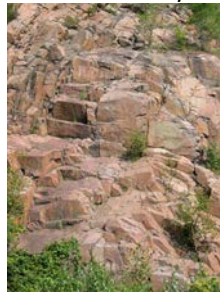
V10 – Quarry



V10 – Left Quarry wall



V10 – Right Quarry wall



V10 – Block-like texture of sheared-off columns



V10 – Colossal plume on Quarry wall



V10 – Giant plume on Quarry floor



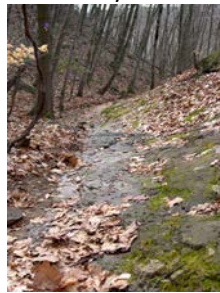
V10 – Hydrothermal precipitate on Quarry floor



V10 – Hydrothermal precipitate on Quarry floor



V10 – Granitic vein on Quarry floor



V11 – Baked sandstone



V11 – Baked sandstone



V11 – Baked sandstone



V12 – Sandstone boulder



V12 – Sandstone boulder



V13 – Quartzite boulder with quartz vein



V13 – Quartzite boulder with quartz vein



V13 – Quartzite boulder with quartz vein



V13 – Quartzite boulder with quartz vein



V14 – Ice wedging and plume



V15 – Contact surface



V16 – Contact surface



V16 – Crown of diabase column



V16 – Crown of diabase column



V16 – Tilted diabase columns



V17 – Northernmost extent of magma chamber

Yellow Trail – Geology Stations

Y1 – Hydrothermal Precipitate: As the magma chamber that formed the Sleeping Giant gradually cooled and solidified about 200 million years ago, cracks began to form in the hardening rock. These cracks ultimately became conduits for mineral-rich water to flow through. As a consequence of several complex processes, various minerals slowly precipitated out of the water, covering the walls of many cracks with a profusion of crystals. This type of hydrothermal process is quite common and can sometimes decorate even large cavities with spectacular mineral deposits. A similar process may lead to the formation of geodes. If the rock subsequently fractures through one of these cracks, the mineral-rich surface will be exposed, allowing the minerals to sparkle in the sunlight. Other examples of hydrothermal precipitates can be seen at stations V5, V10, and T5.

View high-resolution photo(s) at:

[Y1 – Hydrothermal precipitate](#)

[Y1 – Hydrothermal precipitate](#)

[Y1 – Hydrothermal precipitate](#)

Y2 – Trail Erosion and Quartzite: The dense canopy of tall trees shades much of the forest floor, limiting the growth of low-level shrubs and other plants. Roots of these plants are necessary to help prevent soil erosion. Due to the combination of constant use and relative lack of significant plant cover, this steep slope has been subject to considerable soil erosion. A series of staircases constructed by Boy Scouts as Eagle Scout Leadership Service Projects not only make it easier for hikers to travel safely up and down the slope, but will also go a long way towards preventing further trail erosion. Significant erosion can also be seen at station B5.

At the top of the uppermost staircase, notice the large chunk of quartzite. Quartzite is a metamorphic rock that forms when sandstone is subjected to tremendous pressure, such as occurs when tectonic forces cause continents to collide and mountain ranges to be thrust upwards. Under these conditions, the quartz crystals making up the bulk of the sandstone are squeezed tightly against one another to form quartzite.

Quartzite is not native to the region of the Sleeping Giant, and no outcrops of quartzite exist anywhere in the Park; however, smooth and rounded rocks like this one are extremely common within the Giant, typically ranging in size from a few inches to several feet in diameter. Quartzite within the Park probably originated from areas far to the north of Connecticut and was carried here by the awesome power of moving ice. It was deposited in the area when the last glaciers that occupied Connecticut melted away, approximately 17 thousand years ago.

The appearance of quartzite may vary considerably. Colors commonly include shades of white and gray; however, pink, yellow, orange, and red may often be seen. The color depends on the amount of iron or other impurities that have been incorporated into the rock. Once you become familiar with the many appearances of quartzite, it is very easy to recognize. Keep an eye out for it along all of the trails within the Park. Other stations featuring quartzite include B1, B18, B20, B30, O1, V13, T4, and T6.

View high-resolution photo(s) at:

[Y2 – Trail erosion at staircase](#)

[Y2 – Quartzite](#)

[Y2 – Quartzite](#)

Y3 – Contact Surface and Granitic Vein: Notice the “crinkly” appearance of the rocky slope to the right of the station marker. This surface pattern, which resembles a crumpled piece of paper, is characteristic of a contact surface between rapidly cooling magma and the original overlying rock. In the Giant, the latter was primarily sandstone, a rock native to the area and sometimes simply referred to as country rock. Before the sandstone that had once covered the Sleeping Giant eroded away—a process that occurred over the course of millions of years—the now-exposed contact surface on which you are standing had been the actual roof of the magma chamber and was in direct contact with the overlying sandstone. The characteristic appearance of the contact surface developed as hot magma along the roof of the magma chamber was cooled (i.e., “quenched”) by contact with the much cooler sandstone. This was a relatively rapid process, in contrast to the comparatively slow cooling that occurred at the core of the magma chamber. After the overlying sandstone eroded away, the underlying diabase (i.e., the solidified magma) was exposed. Because it is much more resistant to erosion than sandstone, diabase does not erode away as quickly and, therefore, largely remains intact throughout the Park. Most of the diabase that is readily visible in the Park is not part of what had once been a contact surface. Rather, the diabase is present in areas at which the contact surface itself has gradually eroded away to a varying depth. The roof of the original magma chamber had a dome-like shape, much like the cap of a mushroom. Because the portion of the roof in this particular area was below the top of the dome, it is oriented on a slant (like the pitched roof of a house), rather than on a horizontal plane. Similar contact surfaces have been documented at several other locations throughout the Park, including B2, B6, W20, V15, V16, and RC9.

Directly below the station marker is a small block of diabase with a light-colored stripe running across its exposed surface. This is a granitic vein. As is the case for contact surfaces, granitic veins formed in areas at which the hot magma came in contact with the overlying sandstone. The enormous heat given off by the molten magma actually melted some of the sandstone. The melted sandstone then flowed into cracks that were developing in the roof of the solidifying magma chamber. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein. Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails.

View high-resolution photo(s) at:

[Y3 – Contact surface](#)

[Y3 – Contact surface](#)

[Y3 – Granitic vein](#)

Y4 – Looking Out Onto Connecticut’s Past: This lookout provides a spectacular view south towards downtown New Haven. The series of hills just to the left of the New Haven skyline is a portion of the East Rock Ridge, another diabase intrusion with a geologic history similar to that of the Sleeping Giant (note: it is a common misconception that East Rock, West Rock, and the Sleeping Giant were formed as extrusive volcanic eruptions).¹ The Long Island Sound is visible

¹ An extrusive volcanic event occurs when molten magma breaks through the crust and subsequently flows across the landscape as lava. As it cools and solidifies, lava forms basalt. An intrusive event involves the accumulation of molten magma within a chamber that remains underground. As magma cools and solidifies underground, it forms diabase. Diabase remains hidden underground unless exposed by erosion that wears away the overlying rock. This is how the diabase that makes up the Sleeping Giant was exposed.

just beyond the New Haven skyline, and on clear days the shoreline of Long Island, New York, can be seen on the horizon across the Sound.

If you had been here approximately 15 thousand years ago, as the Ice Age was giving way to warmer temperatures, you would have been able to see two large freshwater lakes in the Quinnipiac and Mill River Valleys that stretch out before you. These lakes were formed as glacial meltwater flowed southward. Part of what is now the Quinnipiac River drainage basin, seasonally visible in the distance as the tan-colored marsh to the left of the East Rock Ridge (note: in summer months, the marsh is light green in color), had once been filled by Lake Quinnipiac. What is now the Mill River drainage basin, located directly south, had been partially submerged beneath the even larger Lake Connecticut. This extremely large lake occupied all of what is now the Long Island Sound, downtown New Haven, and the southern portion of Hamden. These two lakes eventually drained away. Saltwater filled the Long Island Sound approximately 11 thousand years ago. Long Island itself is largely composed of the loose rubble that had been pushed southward by the ice. It represents the southernmost extent of the glacier's range.

The rocky surface that you are walking on is not a contact surface like the one at station Y3. Rather, it was formed from a region of the magma chamber that cooled well below the contact surface. The original contact surface eroded away long ago. As magma cools and solidifies, it also contracts, taking up far less volume than it had in the molten state. As a consequence of this contraction, an extensive network of vertical fractures develops in the solidifying magma. Once the rock is exposed, these fractures become lines of weakness that are exploited by various erosional processes. The continued widening of vertical fractures ultimately leads to the creation of huge columns. On average, these tend to be six sided in nature although remnants of columns of different size and configurations can be observed throughout the Park. If you carefully look around the surface at this station, you may be able to make out the boundaries of several polyhedra (mostly hexagons), each about two or three feet across and outlined by cracks in the rock. A polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons. The rock upon which the station marker is painted is an example of such a polyhedron. It is the exposed crown of a diabase column that extends deep into the solidified magma chamber.

In addition to the crowns of columns, sections of polished diabase and patchy areas of exfoliation can also be seen. Polishing is a common feature along popular hiking trails subjected to heavy traffic and results from continued scuffing of the rock by countless hikers over several decades. Polished surfaces can be seen about 6 feet to the right of the station marker (as you are walking along the trail). Very nice examples of polished rock surfaces can also be seen at station V4.

Just in front of the polished surface is an area in which several small layers of diabase have flaked away. When this rock initially solidified out of the mass of molten magma, the weight of an immense layer of sandstone—perhaps as much as a mile thick—was bearing down upon it. Having formed under conditions of such high pressure, this is the state under which the rock is most stable. As the overlying sandstone slowly eroded away over the course of time, the pressure exerted upon the underlying diabase was gradually decreased. As a consequence, a series of cracks developed in the surface of the rock. These formed in a plane that was perpendicular to the direction of the changing stress (i.e., parallel to the rock's modern-day surface). The cracks undermined the surface of the rock, allowing sheets and slabs of stone to peel away from the

surface, a process called exfoliation. More extensive areas of exfoliation can be seen at stations B9, B24, W10, and O4.

View high-resolution photo(s) at:

[Y4 – Looking out onto Connecticut's past](#)

[Y4 – Looking out onto Connecticut's past](#)

[Y4 – Diabase polyhedron](#)

[Y4 – Exfoliation and polished diabase](#)

Y5 – In the Region of a Contact Surface: Opening a window onto geological events that transpired near the edge of the magma chamber, this station offers a somewhat different perspective of a contact surface than that which is visible at station Y3. To the left of where you are standing, note the high cliff, which is composed of diabase. On the other hand, the entire hill to the right is composed of sandstone. The close association of these two outcrops suggests that a contact surface—which has long since eroded away—used to be located somewhere between them. A similar relationship between adjacent diabase and sandstone outcrops can be seen at station V9.

If you look down at the margin of the stream where it crosses the trail, you can see another smooth and rounded piece of glacially transported quartzite.

View high-resolution photo(s) at:

[Y5 – Diabase cliff](#)

[Y5 – Quartzite in streambed](#)

Y6 – Sandstone Outcrops and the Rock Cycle: Stepping up onto the rocky outcrop that forms this promontory, note the smooth quartz pebbles that are scattered across its face, characterizing the rock as a form of sandstone. This particular station marks a boundary within the Park. West of this site, most of the rock within the Giant consists of exposed diabase. Along the section of the Yellow Trail east of this station, on the other hand, any remaining diabase is still buried underground and visible rock outcrops are predominantly composed of sandstone.

Sedimentary rocks like sandstone are built up by the deposition of successive layers of sediment. The separation between individual layers is marked by a series of horizontal planes within the rock. In this particular outcrop, these planes are difficult to visualize; however, many of the easily visible cracks that mar its face have formed parallel to the original horizontal planes. Any deviation from the horizontal generally reflects movement of the overall rock itself. As a result of tectonic activity that occurred after solidification of the magma chamber, the Central Lowlands of Connecticut actually tilted as much as 15° to 20° to the southeast. This is reflected in the orientation of the various cracks in this outcrop, which ranges from 10° to 15° with respect to a horizontal plane. The orientation of such planes in the sandstone bedrock can be more easily observed at station RC3.

Looking down the embankment to the right, note the large blocks of sandstone on the far side of the creek. At some time in the Giant's relatively recent past, these had been split off from a sandstone outcrop farther up the hill. Taken as a whole, this vista illustrates several geological processes that cause erosion. After being undercut by moving water of the stream, the sandstone outcrop was more vulnerable to ongoing destructive forces associated with other mechanisms of erosion, such as ice wedging and tree-root wedging. Unlike the predominant erosion of soil that

was seen at station Y2, the erosion demonstrated here has dislodged large chunks of solid rock. Over the course of time, they will eventually tumble into the stream, where they will be slowly broken down by the constant action of flowing water. Approximately 210 million years ago, sand and pebbles that had been deposited in this area by ancient streams were gradually cemented together, forming the sandstone outcrop visible today. In time, the sandstone will be broken down into its constituent sand and pebbles, which will, once again, be washed downstream. They will eventually be deposited at some distant site, where the formation of sandstone may commence again, beginning anew this portion of the larger rock cycle.

View high-resolution photo(s) at:

[Y6 – View of sandstone outcrop](#)

[Y6 – Sandstone outcrop and boulders](#)

[Y6 – Sandstone outcrop and boulders](#)

Y7 – Beautiful Sandstone Cluster: Sandstone is hardly ever considered to be an attractive rock. However, one's view may change on observing this exquisite cluster of sandstone specimens, which may very well be the finest such aggregate in the Park. In particular, it boasts a high abundance of pebbles. Some of these pebbles have been rounded and smoothed from being carried over long distances by ancient streams. Others are more angular in appearance, indicating that they had not spent as much time being tumbled in a stream and had been transported a relatively short distance from their source. As the size and concentration of rocks and pebbles within sandstone increases, it may be referred to as a conglomerate.

View high-resolution photo(s) at:

[Y7 – Sandstone cluster](#)

[Y7 – Sandstone cluster](#)

[Y7 – Sandstone cluster](#)

Y8 – Quartzite Boulder: As the yellow trail nears its end, we are left with one last look at a large, glacially transported piece of quartzite. How many others did you find?

View high-resolution photo(s) at:

[Y8 – Quartzite boulder](#)

[Y8 – Quartzite boulder](#)

[Y8 – Quartzite boulder](#)



Y1 – Hydrothermal precipitate



Y1 – Hydrothermal precipitate



Y1 – Hydrothermal precipitate



Y2 – Trail erosion at staircase



Y2 – Quartzite



Y2 – Quartzite



Y3 – Contact surface



Y3 – Contact surface



Y3 – Granitic vein



Y4 – Looking out onto Connecticut's past



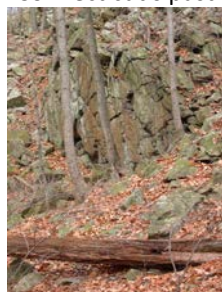
Y4 – Looking out onto Connecticut's past



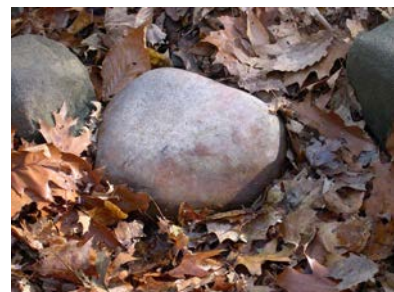
Y4 – Diabase polyhedron



Y4 – Exfoliation and polished diabase



Y5 – Diabase cliff



Y5 – Quartzite in streambed



Y6 – View of sandstone outcrop



Y6 – Sandstone outcrop and boulders



Y6 – Sandstone outcrop and boulders



Y7 – Sandstone cluster



Y7 – Sandstone cluster



Y7 – Sandstone cluster



Y8 – Quartzite boulder



Y8 – Quartzite boulder



Y8 – Quartzite boulder

Red Circle Trail - Geology Stations

RC1 – The Gorge: As you stare into this enormous gorge, consider how it could possibly have been carved by the tiny brook flowing through it. Worldwide, many similar gorges, and even large canyons, are known to have been carved by comparatively small streams over the course of time. Each one has its own unique and fascinating story.

Towards the close of Ice Age, some 17 thousand years ago, this gorge most likely did not yet exist. The stream probably flowed over a small waterfall farther north (i.e., closer to what is now the trailhead at Tuttle Avenue). The turbulent flow at this waterfall was more efficient at eroding the soft underlying bedrock than the gently flowing water farther upstream. Rapid erosion at the waterfall cut deeply into the bedrock. As the lip of the waterfall eroded away, the location of the waterfall migrated farther upstream. Rapid erosion by the waterfall's turbulent water then occurred in this area. Retreat of the waterfall continued until it attained its current position. Continued erosion due to the effects of weather and gravity has caused the sides of the gorge to slump, gradually widening it. At the waterfall's previous location, considerable widening of the gorge has occurred and its sides are currently much less steep than they had once been. This is why the older section of the gorge, closer to Tuttle Avenue, is much less steep than the portion directly in front of you.

The turbulent water in the deep section of the gorge at this station is still actively eroding the bedrock. As this process continues, the rapids and falls will continue migrating upstream. In a few thousand years, if allowed to evolve naturally, the portion of the gorge in front of you will likely be wider and less steep than it is now and the rapids will have migrated farther upstream, expanding the length of the gorge.

Also note also the large, rounded boulder located 10 feet beyond the edge of the bridge that you just crossed over. This rock is not native to the area. It was carried here by glacial action and left behind as the glacier retreated, probably shortly before the stream began to carve the gorge.

View high-resolution photo(s) at:

[RC1 – The Gorge](#)

RC2 – Glacial Till Overlying Sandstone: The far side of the riverbank displays a boundary between two separate sediment deposits. Because the deposits are of significantly different ages (i.e., referring to when they had been deposited) with no sediment currently between them to bridge the gap in time, this type of boundary is called an unconformity.

The red-colored rock forming the lower layers is sandstone, a sedimentary rock built up in successive layers by the gradual deposition of sediments. It was formed about 210 million years ago, during the end of the Triassic Period. All of the sand that makes up this sandstone originated in ancient mountain ranges. Over the course of time, as the mountains were worn down by erosional processes, sediments carried by streams that no longer exist were gradually deposited in layers within the area that would one day be the Central Lowlands of Connecticut. As layer upon layer of sediments accumulated, they gradually became cemented together to form sandstone.

The jumbled mass of pebbles, sand, and other sediments that lies directly on top of the sandstone is called glacial till. As the last glacier melted approximately 17 thousand years ago, all of the sediment that was being carried or pushed along by the ice was simply dropped in place. The time gap represented by the boundary between these two deposits is enormous. Unlike the sandstone, till is loose rubble, composed of rocks and pebbles of varying size that have not been cemented together. At one time, there had been more layers of sandstone above those that now remain. These upper layers had been gradually eroded away over the intervening time between deposition of the sandstone and that of the glacial till. Another excellent example of glacial till can be seen at station T2.

View high-resolution photo(s) at:

[RC2 – Glacial till overlying sandstone](#)

RC3 – Orientation of Layers in Sandstone Bedrock: Sediments contributing to the formation of sandstone are typically deposited in horizontal layers. Any deviation from the horizontal generally reflects subsequent movement of the overall rock itself. As a result of tectonic activity that occurred after the deposition of sandstone in the Central Lowlands of Connecticut, the central Connecticut basin actually tilted as much as 15° to 20° to the southeast.

From the station marker along the trail, follow the small arrow (located within the station marker) approximately 25 feet to the left to where the actual RC3 station is located. On the far side of the stream, note the sandstone outcrop contributing to the formation of a seasonal waterfall.

Because the sandstone contributing to this feature is an outcrop of rock that tilted as the basin itself tilted, determining the angle of these layers (with respect to a horizontal plane) provides a measure of the tectonic movement in this particular region. Measuring the orientation of these layers showed them to be angled approximately 20° to the southeast, consistent with the tilting known to have occurred in the region. Once a piece of sandstone breaks away from an outcrop, it can assume any orientation and its relationship to the tilt of the central basin is no longer valid.

View high-resolution photo(s) at:

[RC3 – Orientation of layers in sandstone bedrock](#)

RC4 – Sandstone with Faceted Pebbles: Many pebbles of varying size and composition have been incorporated into this sandstone outcrop. Like the sand itself, these pebbles also originated in ancient mountain ranges that surrounded the region of the Central Lowlands during the end of the Triassic period. Many of these pebbles had been stream-worn and smoothed as they were washed into the Lowlands by ancient streams. More recently, many of the pebbles visible on the surface of this outcrop were faceted by glacial action. The exposed portions of pebbles protruding above the surface were ground down by the moving wall of ice and are now flush with the surface.

Between this point in the Park and station RC9, all of the bedrock along the Red Circle Trail is diabase. Diabase makes up the bulk of the Sleeping Giant Park. It is an igneous rock that formed from cooling magma that had been injected into an underground chamber approximately 200 million years ago—some 10 million years after the sandstone had been deposited. Much of the overlying sandstone has long since eroded away.

View high-resolution photo(s) at:

[RC4 – Faceted sandstone](#)

[RC4 – Faceted sandstone](#)

RC5 – Tilted Diabase Columns, Tree-Root Wedging, and Wetlands: This station affords hikers an excellent opportunity to observe columns that have formed within a cooling magma chamber. Columns like these result from long, vertical fractures that developed in the rock. These formed as a result of contraction that accompanied the cooling and solidification of the magma. This columnar arrangement is very common along the many diabase cliffs within the Park. The columns typically form multi-faced polyhedra (a polyhedron is a three-dimensional structure having multiple faces; the faces are flat surfaces with straight edges and are called polygons). On average, these tend to be six sided (i.e., hexagonal) in nature; however, polyhedra with varying numbers of faces can be found within the Park. A number of factors, including the rate at which the magma cools, play a role in determining the thickness of individual columns. Rapid cooling tends to result in relatively narrow columns, while slowly cooling columns are more likely to be thicker. The relatively thick columns within the Giant suggest that this magma chamber cooled rather slowly.

The columns that make up this cliff are tilted slightly to the north. Columns within a magma chamber typically form perpendicular to the outer surface (shell) of the chamber. The tilt observed at this outcrop, along with the orientation of other columns throughout the Park, indicate that the roof of the magma chamber had a dome-like shape.

Near the top of the cliff, you will see a tree growing out of a crack in the rock. Tree roots affect rocks and soil in a number of ways. By holding soil together, they help to prevent soil erosion. On the other hand, the growth of tree roots can actually dissolve rock, causing small cracks to form in solid rock. In the course of their growth, tree roots will also frequently exploit already-existing cracks present in rocks. As roots enlarge over the years, they exert tremendous pressure on the surrounding rock, ultimately splitting apart even large rocks. In conjunction with the effects of ice wedging, continued growth of roots favor ongoing expansion of such cracks. Weathering of rocks by growth of tree roots is actually a very common process, and many examples can be seen in the Park, especially if one examines the various trees growing in the vicinity of cliffs and rocky outcrops. Tree-root wedging is only one of the many ways in which rocks can be broken down across the ever-changing landscape of the Sleeping Giant. Other stations featuring tree-root wedging include B11, B13, B19, G1, T9, and T12.

To the right of the trail, one of the many wetlands present throughout the Park can be seen. The diabase that forms the Giant is very dense and largely impermeable to water. Because of this, it does an excellent job containing rainwater for long periods of time. Like the pond at station W2, a large depression had been gouged into the diabase in this region by glacial action. Deposits of glacial till that surround this depression help to retain water at this site. One of the major outlets for the water in this wetland is the stream that cut the gorge.

As you pass station RC5, look for a small boulder field (i.e., a talus slope) about 200 feet down the trail. In this wasteland of broken diabase, several large polyhedra with wonderfully displayed polygonal faces can be seen. Continuing farther along the Red Circle Trail, an even larger talus slope will be visible along the left side of the trail, just before reaching station RC6.

View high-resolution photo(s) at:

[RC5 – Tilted columns and tree-root wedging](#)

RC6 – Diabase Polyhedron and Granitic Vein: Over the course of time, erosion has broken many blocks and columns off the cliffs and their remains now lay shattered on the ground. The fallen jumble of boulders at the base of this and other cliffs throughout the Park forms a talus slope (or scree slope). This consists of remnants of large columns that have crumbled away from the cliffs over long periods of time. Most of these rocks had been split off the cliff by extensive erosion since the passage of the last glacial ice sheet about 17 thousand years ago; however, some may have been ripped away by the ice sheet itself. Looking at many of these blocks, their original polyhedral structure—including flat-sided, polygonal surfaces with sharply defined edges—can be seen. Both of these features are evident in this large diabase block.

On the small piece of diabase located about 4 feet in front of the block containing the station marker, note the light-colored stripe running across its exposed surface. This is the result of an event that happened approximately 200 million years ago, when the molten magma that subsequently formed the Sleeping Giant was still cooling. In areas at which the hot magma was in direct physical contact with the overlying sandstone, the enormous heat given off by the magma actually melted some of the sandstone. The melted sandstone then flowed into cracks that developed in the roof of the solidifying magma chamber. When the sandstone melted, the physical arrangement of its component minerals was altered, leading to the formation of a rock very similar to granite. Hence, this feature can be referred to as a granitic vein.

Granitic veins are extremely common throughout the Park; however, their appearance in both surface and cross-sectional views may vary considerably from one to another. Several examples of granitic veins have been labeled along different trails. For example, compare the surface view seen at this station with the cross-sectional view of a granitic vein seen at station RC8. Notice the slightly raised appearance of this vein in relation to the surface of the diabase with which it is associated. This is due to differential erosion. Because the granitic vein is more resistant to erosion than the surrounding diabase, the vein weathers far more slowly.

Continuing approximately 70 feet down the Red Circle Trail, you will reach the intersection with the White Trail. As you pass by this rocky section of the White Trail, look down at the diabase surface to the right at station W11. The numerous parallel scratches engraved on its surface are glacial striations, yet another remnant of Connecticut's glacial past. Glacial striations were produced by the scraping action of small rocks and gravel that had been trapped beneath the moving mass of ice. This area of the Park was once a major corridor for ice flow during the peak of the Ice Age, about 20 thousand years ago. Many tons of rock and debris were swept along by the flowing ice, which helped to sculpt the overall shape of the land in this region. In this location, the direction of ice movement was strongly affected by local topography. The orientation of the scratches indicates that the ice sheet was moving almost directly south. You can also walk 30 feet to the right along this trail to see a nice example of a granitic vein encircling the rock on which the westernmost of the two W11 station markers is painted.

View high-resolution photo(s) at:

[RC6 – Large polyhedron remnant](#)

[RC6 – Granitic vein](#)

[RC6 – Diabase cliffs and talus slope](#)

RC7 – Blasting for a Carriage Road: The star-like shape that appears to have been punched into this rock face is the result of a man-made blast that fractured the stone in a radial pattern around a drill hole. A second drill hole that was not blasted can be seen directly to the left of the station marker, and another blast star can be seen on the ground just about 10 feet to the right of the first.

These blasts are most likely related to excavations made in 1887 by J. H. Dickerman for a carriage road leading to one of the peaks. During these excavations, Mr. Dickerman recorded the discovery of a vein containing pure native copper. Although Dickerman himself had considerable doubt about there being a sufficient quantity of copper in the region for establishment of a successful mining operation, there is evidence that multiple mine shafts had been sunk at various locations around the Park during the early to mid 1800s. It is rumored that the moss-covered inlet just about 70 feet farther down the Red Circle Trail might have been one of these mineshafts.

View high-resolution photo(s) at:

[RC7 – Blast star](#)

RC8 – Granitic Vein in Cross Section: This is another example of a granitic vein. Unlike the rock at station RC6, this one has fractured along the vein itself, displaying a cross-sectional view. In this example you can clearly see the pink coloration of the granitic vein. Notice also the highly organized, three-dimensional arrangement of this granitic vein in cross section. Most of the other readily visible granitic veins throughout the Park have a less-organized structure in cross section. The distinctive pattern visible at this station (as well as at station W8) may be related to surface features of the rocks that formed the crack into which the melted sandstone originally flowed, as these would have acted like a mold to shape the granitic vein as it solidified.

View high-resolution photo(s) at:

[RC8 – Granitic vein in cross section](#)

RC9 – Contact Surface: This location represents the point at which the Red Circle Trail emerges from the southern edge of the magma chamber. The hill directly ahead is composed of sandstone. The rocky segment of trail near the station marker displays a very irregular, lumpy appearance. This is an example of a contact surface between rapidly cooling magma and the original overlying sandstone. Before the sandstone that had once covered the Sleeping Giant eroded away—a process that occurred over the course of millions of years—the now-exposed contact surface on which you are standing had been in direct contact with the overlying sandstone. The characteristic appearance of the contact surface developed as hot magma along the edge of the magma chamber was cooled (i.e., “quenched”) by contact with the much cooler sandstone. This was a relatively rapid process, in contrast to the comparatively slow cooling that occurred at the core of the magma chamber. Similar contact surfaces have been documented at several other locations throughout the Park, including stations B2, B6, W20, V15, V16, and Y3.

View high-resolution photo(s) at:

[RC9 – Contact surface](#)



RC1 – The Gorge



RC2 – Glacial till overlying sandstone



RC3 – Orientation of layers in sandstone bedrock



RC4 – Faceted sandstone



RC4 – Faceted sandstone



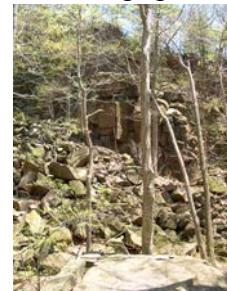
RC5 – Tilted columns and tree-root wedging



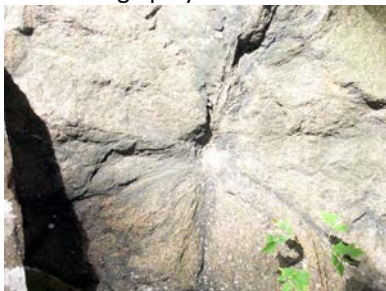
RC6 – Large polyhedron remnant



RC6 – Granitic vein



RC6 – Diabase cliffs and talus slope



RC7 – Blast star



RC8 – Granitic vein in cross section



RC9 – Contact surface