Self-Guided Geologic Tour of the Skyline Trail in the Middlesex Fells Reservation (Part 6)

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Some general information before starting a tour in the Middlesex Fells:

1. The tour of the Skyline Trail has been broken into seven parts. You should not try to do the whole tour in one day (~7 miles or 11 km). It is a lot of hiking and a lot to comprehend in one dose. It's recommended that you do parts of the tour in order, moving counterclockwise around the park. Each tour and its stops are marked on the geologic maps with each part. PLEASE FOLLOW the maps as you go. ***It will be handy to have a sense of direction from the sun, remembering that at noon the sun is due South, in the morning it is to the southeast, and by late afternoon it is to the southwest.***

2. At many times of the year and on weekends, parking areas fill, especially at Bellevue Pond, so start early.

3. The tours require hiking over some steep and rocky trails. It is recommended that you have sturdy hiking or trail shoes. I don't recommend sandals or heeled shoes.

4. Make sure you have enough food and water with you. In the Fells, there is nowhere to get water and spring water in the Fells is NOT drinkable.

5. In compliance with DCR rules, please stay on official marked trails as indicated on DCR maps. This is also a way of avoiding poison ivy and ticks. In making the geologic map, special permission was obtained from the DCR to go off the trails. See the DCR's official Middlesex Fells Reservation Trail Map (last updated in March 2020). This map accurately shows trails, except where they have been refurbished, and it has the numbered intersection designations indicated in the guide. The DCR map is online at: https://www.mass.gov/doc/middlesex-fells-reservation-trail-map/download and it is sometimes available at kiosks at Fells parking areas.

6. In wet or winter weather, some rock surfaces are very slippery. DO NOT venture out onto frozen ponds and reservoirs. The ice may be too thin to support your weight, and it is unpredictable!

7. Do not collect rocks on the tour or deface outcrops by writing on them. It is against DCR regulations. Please remove your own trash and follow other DCR rules. Leave no trace!

Some Fundamental Geology to Get Started:

1. The self-guided tours of the Fells focus primarily on **bedrock geology**. This is a characterization of the solid rock that occurs beneath our feet as viewed from above. Exposures of the **bedrock** surface are called **outcrops** or **exposures**. Loose rock debris (or **float**), sediment, and soils on top of the bedrock make up the **surficial geology**.

2. **Rocks** are naturally occurring solids made of minerals and non-mineral materials. **Minerals** are naturally-occurring, inorganic, crystalline solids that have a specific chemical formula and unique properties that allow us to tell them apart. A **crystalline material** is one in which atoms have a repeated regular pattern (i.e., crystals or crystal structure). Minerals have names in addition to their chemical formulas. For example, sodium chloride ($NaCl$), which is the main ingredient of table salt, is known as the mineral **halite**, while silicon dioxide (SiO_2) is **quartz**. The most common mineral at Earth's surface is **feldspar**, an aluminosilicate containing sodium, potassium, and calcium. Non-mineral materials in rocks include **natural glass**, which is non-crystalline and organically-produced materials.

3. Rocks are divided into three main types:

   Igneous rocks – rocks formed by the solidification of molten rock, or **magma**. Magmas can invade older rock units in the subsurface and then crystallize to form **intrusions** or **intrusive igneous rocks**, which may later be exposed by erosion at Earth's surface. Magma can also escape to Earth's surface before hardening to form **extrusive** or **volcanic igneous rocks**. Examples of these are **lava flows**, or magma explosively ejected into the air that later settles to produce **pyroclastic rocks**.

   Sedimentary rocks – rocks formed by the accumulation or deposition of particles produced by the breakdown and erosion of older rocks. This often happens in oceans and lakes or on river flood plains. Sedimentary rocks also include the accumulation of organically-produced sediment, such as clam shells and coral reefs (limestone) and plant material (coal), or chemical precipitates such as salt beds. **Fossils** occur in sedimentary rocks.

Metamorphic rocks – rocks resulting from exposure of existing rocks to increased temperatures or pressures that change the mineral composition and arrangement of mineral grains. We say these rocks are **metamorphosed**.

4. Solid materials (rocks and minerals) have been in existence on Earth for about 4.5 billion years. This time in Earth's history defines the expanse of **geologic time**. Geologic time (**geologic time scale**) is subdivided based on past events represented by changes preserved in the rock record. Radiometric dating techniques are then used to place precise numerical ages on rock units and time unit boundaries. A geologic time scale can be found at: https://www.geosociety.org/documents/gsa/timescale/timescl.pdf.

5. On a geologic map, bedrock is classified into units known as **formations**, characterized by their rock types and age. Formations are sometimes assembled into **groups** that have a well constrained age range or association with each other. Formations and groups have proper names from a place where they are well exposed or first defined. Sometimes, single formations are split into mappable units called **members**. The boundaries between geologic units are known as **contacts**. On geologic maps, formations and members are given their own colors and/or patterns so they can be distinguished from each other. They also have abbreviations that consist of a capital letter for the unit's geologic time period (when it was formed) and lower-case letters that abbreviate for the unit's name. For example, "Zsg" = the Late Proterozoic (Z) Spot Pond Granodiorite (sg). Time period abbreviations in the Fells are Z (Late Proterozoic), T**R** (Triassic), and Q (Quaternary). If a rock unit does not have a known age or formal name, only lower-case letters are used as an abbreviation. (For example: "d" stands for dolerite dikes). Also shown on maps of the Fells are areas where the geology is concealed by human-made deposits, defined as **artificial fill** (af).

6. On the geologic maps in this guide, geographic north is shown with an arrow. **Compass directions** are given in the guide as degrees W or E of either N or S. For example, N50°E is 50 degrees east of north.

7. **Geologic symbols** on the maps are used to convey information; for example, on the maps here, blue lines are faults. Symbols at stops on the tour are explained, but a complete description of all rock units and a listing of symbols on the map are given in map explanations at: https://sites.tufts.edu/fellsgeology/

8. The maps in the guide present detailed mapping of the Fells and introduce new formation names. It is an ongoing research project. Things have changed periodically, and this will continue with more field work and precise age determinations. Updates of the bedrock map, its explanation, and associated surficial geologic map and tours will be posted as changes occur. We welcome feedback at: https://sites.tufts.edu/fellsgeology/.

Skyline Trail in the Middlesex Fells Reservation version: May 27, 2025

Part 6: Molly's Spring Road to the South Reservoir Outlet Total distance: 2 miles (3.23 km) round trip.

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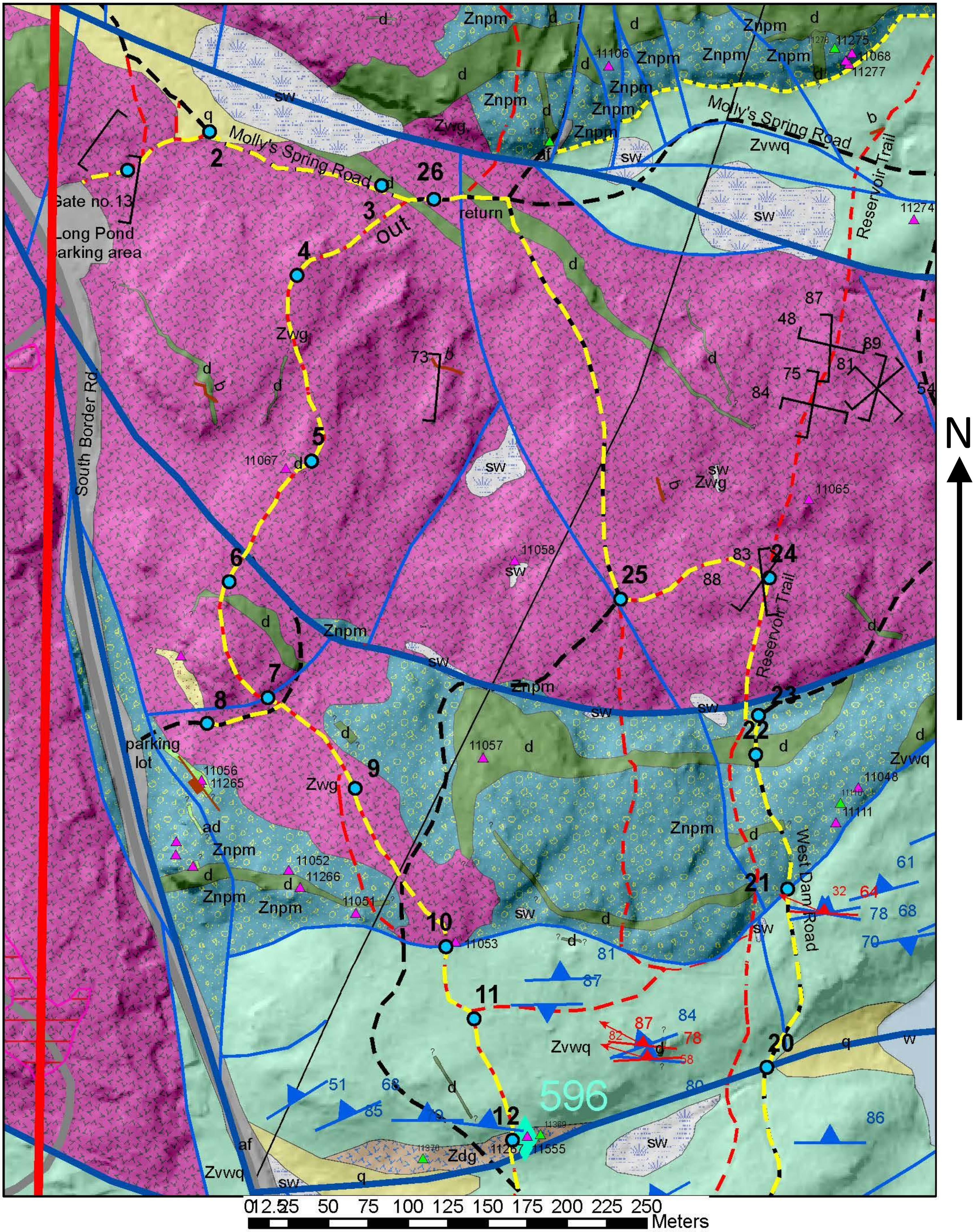
Starting point: Long Pond Parking Area (DCR Gate no. 13) on South Border Road in Winchester. Follow the trail on the geologic maps as you go. Stops are shown with blue circles and black numbers. Follow the white trail markers in the field and yellow dashed path on the geologic maps. In the guide, trail junction numbers are given that appear on the official DCR trail map and are marked with signs in the field. Part 6 begins with Stop 1 on Map SKY-6A.

To get to the first stop on the tour: **Follow Map SKY-6A**. Head east (away from South Border Road) up the stone stairs from the Long Pond parking area at DCR Gate no. 13. Having a hand lens or magnifying glass can be helpful. Hope you enjoy the geology! Have fun!!

Part 6 focuses on the Neoproterozoic Westboro Formation, Nanepashemet Formation and Winchester Granite. The Neoproterozoic Era was 1000 – 541 million years ago. You will also see younger dolerite dikes, faults, and some glacial features.

NOTE: Polished rock images are cut rock slabs photographed under water. Scale bars are in centimeters. In pictures of rock surfaces, there is often a camera lens cap, pencil, or rock hammer for scale.


Molly's Spring Road
Gate no.13
Long Pond parking area
South Border Rd
out
return
Reservoir Trail
West Dam Road
parking lot
Zwg
Znpm
Zvwq
Zdg
sw
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596
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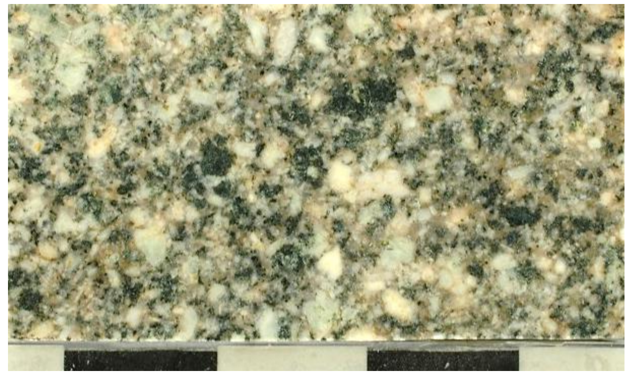
0 12.5 25 50 75 100 125 150 175 200 225 250
Meters

STOP 1: At the top of the steps leaving the Long Pond parking area are outcrops of the Winchester Granite (Zwg). Granite is a coarse-grained igneous rock in which 20-60% of the light-colored mineral grains are quartz and the remaining light minerals are about half plagioclase feldspar and half alkali feldspar (image below to left). On the image, quartz is gray, while plagioclase and alkali feldspar are tannish- to pinkish-white, and difficult to visually differentiate on the image. The mafic (dark-colored) minerals are amphibole (hornblende) and biotite (black) mica that are both partly altered to chlorite. The large white patches are pine sap on the rock surface. The Winchester Granite varies from place to place in the ratio of plagioclase to alkali feldspar, the color of the alkali feldspar (creamy pink to brownish-red), and the abundance of mafic minerals, which can comprise up to half of the rock. The granite here is relatively light in color with faintly pink alkali feldspar. It is an intrusion, which is a rock formed by the crystallization of magma (molten rock) that invaded existing rocks in the subsurface. The Winchester Granite intrusion has a large irregular shape that we call a pluton. For more on how plutons form see: Plutons. The granite has an age of about 609 Ma (mega-annum, or millions of years ago). This places the rock in the Neoproterozoic Era. This age was determined through measurements of naturally-occurring trace amounts of radioactive isotopes of uranium and the lead isotopes to which they decay within tiny zircon crystals. Zircon (zirconium silicate) is a mineral used for determining radiometric ages of rocks because it is impervious to all except the most extreme heating and deformation and provides accurate results on a rock's age. For more on how ages are determined for rocks see: RockAges. **Continue to Molly's Spring Rd.**

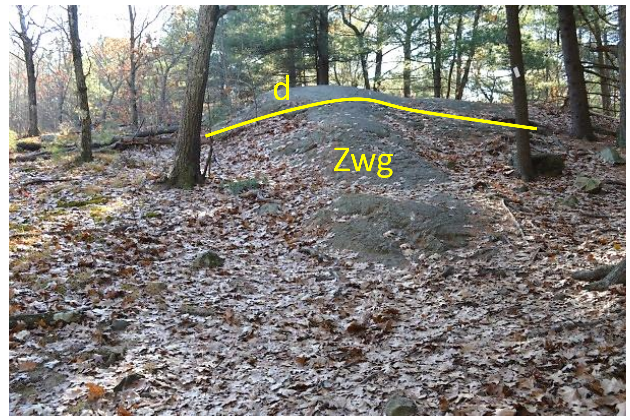
STOP 2: At the junction (B4-3) of the trail and Molly's Spring Road, the wide valley and wetland in front of you (image above to right) is the Molly's Spring Road Fault. It is not unusual for a large fault to be a series of branching displacement surfaces, rather than a single large fault plane. We refer to this as a fault zone. The fault zone here (see also Part 5) is a major E-W trending fault zone that displaced rocks on its south (right) side upward relative to rocks to the north. We don't yet know the dip direction of the fault in the subsurface, but it is steep. The fault zone cuts through the Winchester Granite (Zwg) at this stop, while further east down Molly's Spring Rd., the fault separates the Winchester Granite to the south from older rocks to the north in the Nanepashemet Formation (Znpm) and the Westboro Formation (Zvwq). Wetlands are common in fault zones because the rocks are heavily fractured and easily eroded. Here, glacial erosion removed rock to below the water table, and fractures allow the discharge of groundwater that forms a swamp. **Head east (right) on Molly's Spring Road.**

STOP 3: Just before the Skyline Trail crosses the road at junction B4-4 are outcrops of a dolerite dike (d, image to right at arrows). A dike is an intrusion where magma squeezed its way into a fracture as the sides separated. When it crystallized, it took the form of a large slab. Dikes can be irregularly shaped, but they usually have roughly parallel sides and are traceable over at least short distances. Dolerite is a mafic (dark-colored) igneous rock with crystals that are sand-sized. This is intermediate between what we consider coarse- and fine-grained. On the image of dolerite cut on a rock saw (below on right), the faintly purple to green grains are pyroxene which has mostly been altered to chlorite and amphibole, both of which have a dark green color. Small gray grains are plagioclase. This sample has fractures and veins filled with epidote and quartz. On map SKY-6A, you will see that this dike is offset east of here by a N-S trending minor fault in the valley south of the road. Spring water seeps out of fractures along this fault to create Molly's Spring. East of the fault the dike pinches out. **From junction B4-4, follow the Skyline Trail south (hard right) to the top of the steep slope.**

STOP 4: After arriving at the top of the steep slope, note the knobby terrain of the Winchester Granite (Zwg), especially southeast (to the left) of the trail (no image). Glacial erosion smoothed the knobs, while fractures that separate the knobs were more deeply eroded. **Continue about 125 m to where the trail bends west (right).**



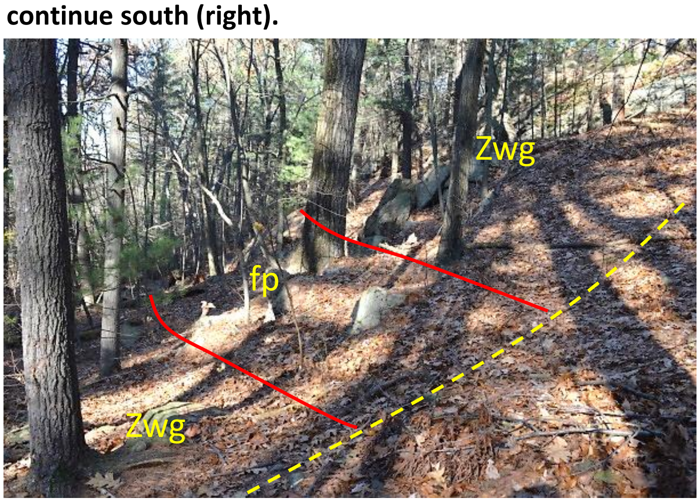
STOP 5: The Winchester Granite (Zwg) on this upland is finer-grained than in most other areas (image to right). It may represent the finer, outer part or chilled margin (chill zone) of the pluton where the granite cooled more rapidly, perhaps in the top of the pluton. For more on how plutons form see: Plutons. On the image, large white to pale grayish-white grains are plagioclase while the gray quartz and pink alkali feldspar form finer crystals in between. The mafic (dark) grains are biotite (black) mica and amphibole (hornblende) that were partly altered to green chlorite. **Continue about 75 m to a small valley.**

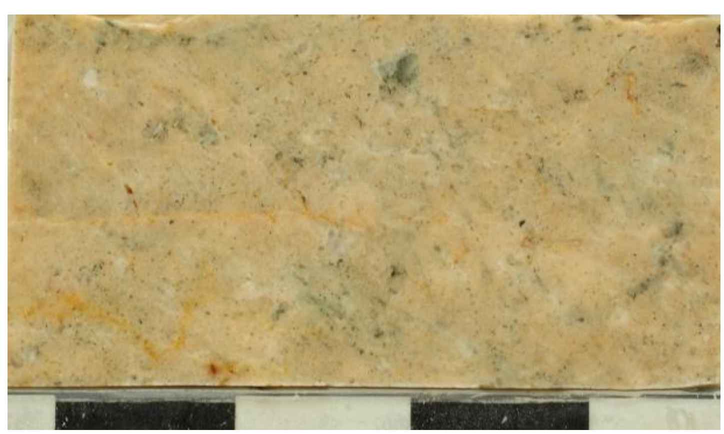


STOP 6: The small valley at junction B4-8 is a major fault. After crossing this valley, you will see a steep slope (image to right) of Winchester Granite (Zwg) intruded by a dolerite dike (d). The dike pinches out to the west (see Map SKY-6A). Both rock types were smoothed by glacial erosion. The trail runs south across the rock surface in the image and continues across the top of a small granite hill. **The trail then descends into a valley on the south side of the hill to Stop 7.**

STOP 7: In the small valley at trail junction B4-9 (image to right, view east from trail in the valley) is a minor fault that cuts through the Winchester Granite (Zwg) and truncates dolerite (d) and porphyritic rhyolite (fp) dikes (see Map SKY-6A). This suggests a more significant displacement than for most minor faults in the area. The approximate trace of the fault is shown on the image. **Head west 50 m in the valley on a side trip toward South Border Road (see map SKY-6A).**

STOP 8: The side trip will allow you to see a porphyritic rhyolite dike (fp) cut off by the minor fault (image below left, view north). Rhyolite is a light-colored, fine-grained igneous rock with the same chemical composition as granite and it has a light, creamy-pink color (image below to right). Porphyritic means that the rock has two different grain sizes: coarser crystals (phenocrysts), which are here plagioclase feldspar and are difficult to see in the field, and finer surrounding crystals that make up the ground mass. The dike intruded the Winchester Granite (Zwg), parallels the side of the hill, and is highly fractured into blocks, making it difficult to spot outcrops. **Return to the Skyline Trail at junction B4-9 and continue south (right).**





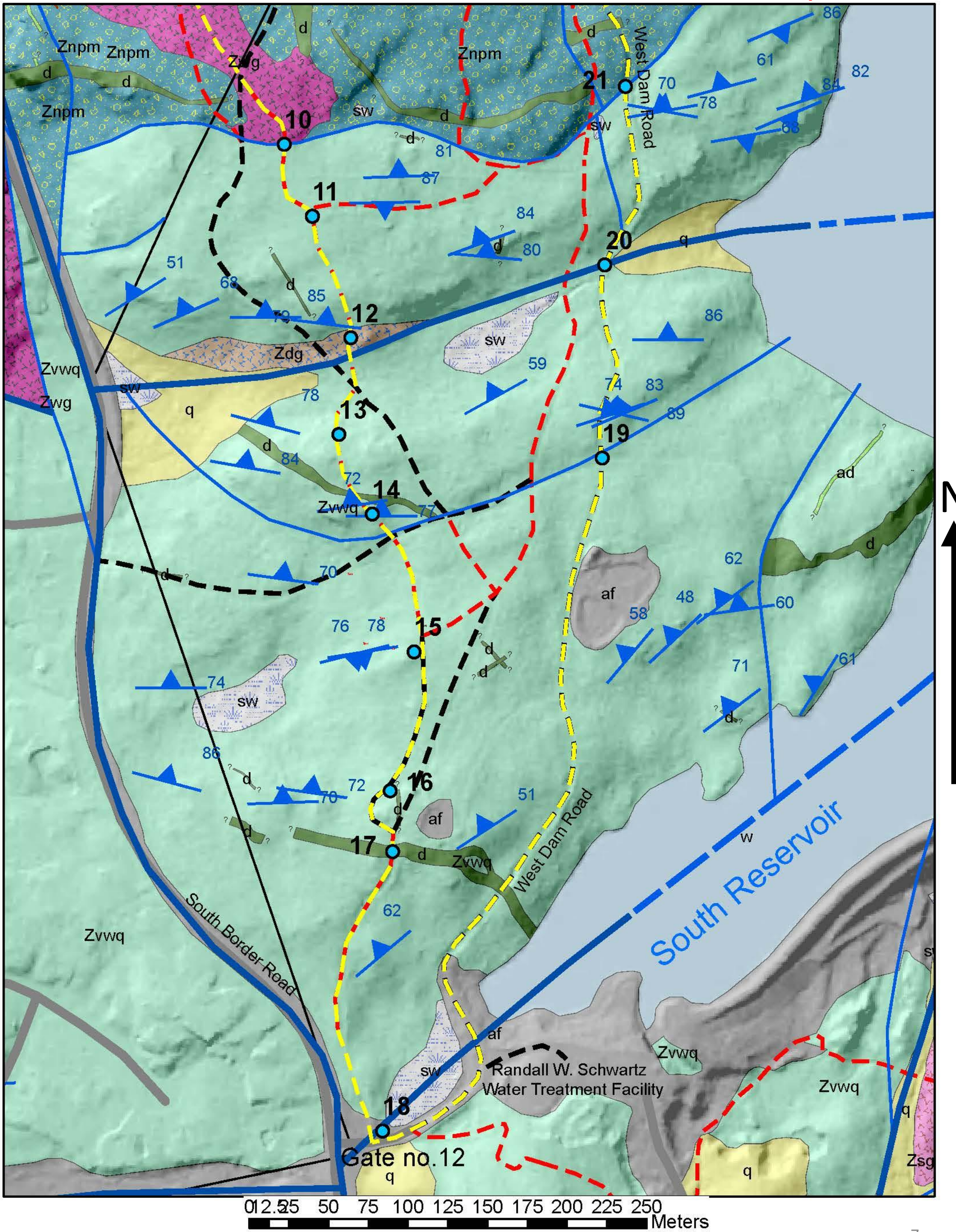
STOP 9: The trail climbs a slope underlain by Winchester Granite (Zsg) that occurs as a projection south of the minor fault you saw at Stops 7 and 8 (image to right, see Map SKY-6A). This arm of granite intrudes basaltic hornfels (see Part 5) of the Nanepashemet Formation (Znpm). The rock exposed in the trail is a mixture of medium- and fine-grained granite, both finer-grained than at Stop 1 and more like Stop 5. The granite here is in the chill zone of the pluton, where it cooled more rapidly along the contact with the Nanepashemet, not allowing many large crystals to form. For more on how plutons form see: Plutons. **Continue to the top of the hill where the trail crosses the Mountain Bike Loop (green markers) at junction B4-12. Outcrops of the Nanepashemet Formation (Znpm) are visible to the east (left). Continue south.**

STOP 10: Shortly after crossing the Mountain Bike Loop (junction B4-12), the Skyline Trail crosses a small E-W trending escarpment (image to right). This is a fault that separates the Winchester Granite (Zwg) and Nanepashemet Formation (Znpm) to the north from the Westboro Formation (Zvwq) to the south. Displacement on the fault is thought to be nearly vertical, with the south side moving upward relative to the north side. The line on the image shows the approximate position of the fault as you look east (left). The Westboro to the south does not leave very good outcrops and has a relatively low, flat surface.
Continue south (right) at trail junction B4-13 (image on right below, follow arrow).

STOP 11: This is an area of poor outcrops in the Westboro Formation (Zvwq). The Westboro is composed of alternating layers of dark gray, rusty argillite and white metasandstone. Argillite is hardened and lightly metamorphosed mudstone, while metasandstone is metamorphosed sandstone. The Westboro has been deformed (stretched and folded) by regional metamorphism, which resulted from plate tectonic activity that is responsible for ancient mountain building. Small outcrops of the metasandstone can be seen in the trail just before, and a little ways after junction B4-13. The Westboro is also heavily baked by heat from the nearby Winchester Granite (Zwg) pluton that intruded it. This type of metamorphism is contact metamorphism, and it created hornfels in the argillite layers. Hornfels is hard and brittle rock created by the baking of fine-grained rocks, which often have clay, much like firing pottery in a kiln. To summarize: the Westboro experienced both regional and contact metamorphism, causing it to be deformed and later recrystallized.

Continue the tour on Map SKY-6B. Continue south about 80 m to where the trail overlooks a valley.

Map SKY-6B


Znpm
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West Dam Road
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ad
d
Zvwq
Zvwq
Zvwq
Zvwq
Zsg
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South Reservoir
South Border Road
West Dam Road
Randall W. Schwartz
Water Treatment Facility
Gate no.12
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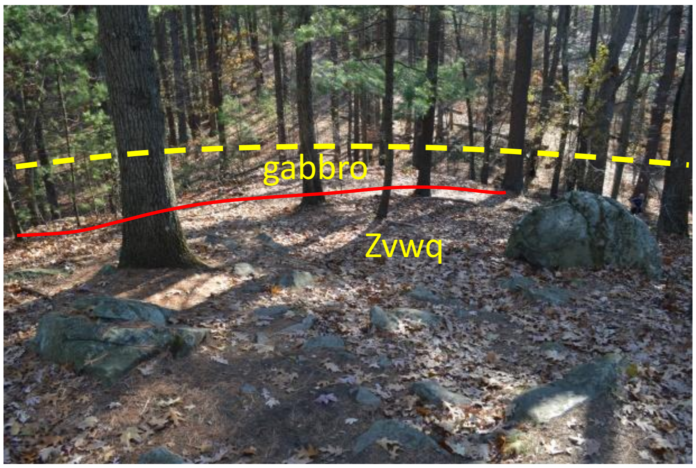
Meters

STOP 12: As the trail descends a steep slope, it makes a sharp bend to the west (right). Along the trail are boulders from areas of granite to the north. These boulders are true glacial erratics, not only having been glacially transported but also now resting on a different rock unit than the one in which they originated. At the bend in the trail (image below to left, view to south) is a small body of gabbro (Zdg) that intruded the Westboro Formation (Zvwq). The red line on the image marks the contact of the Westboro to the north (back up trail) and the gabbro to the south (ahead). On its south side, the gabbro forms a steep ledge. At the bend in the trail and to the east is a baked metasandstone outcrop and the trail then runs along the top of the gabbro ledge. Gabbro is a coarse-grained igneous rock in which the light minerals are plagioclase and there are abundant mafic (dark) minerals, in this case amphibole (hornblende). The amphibole is partly altered to chlorite (image below on right). The rock has no significant quartz or alkali feldspar. In this regard the gabbro does not appear to be like any other plutonic igneous rock unit in the Fells and appears to be an igneous body mostly hidden in the subsurface. This unit has occasional inclusions of metasandstone from the adjacent Westboro Formation. Beyond the gabbro outcrop, the trail descends to the valley where the gabbro is cut off on its south side by a major fault (yellow line on image below). **Continue into the valley below.**



STOP 13: After crossing the major fault and a road at junction B4-14, the trail climbs a steep hillslope (image on right). Looking back to the north is a view of the ledge where the gabbro was exposed at Stop 12. At Stop 13, the steep slope is underlain by the Westboro Formation (Zvwq), which is a very hard mixture of argillite and metasandstone. In this area, layering in the Westboro is preserved well enough to take measurements of the orientation of layering (see the next stop). **Cross over the top of the hill to its far side.**

STOP 14: Descending the south side of the hill is an outcrop of the Westboro Formation (Zvwq). On the east (left) side of the trail, the Westboro has a thinly-spaced metamorphic foliation. Foliation is any planar feature in a rock. Here, the alignment of mineral grains and layers due to tectonic compression and shearing during regional metamorphism has produced the foliation. The foliation has an E-W trend and dips steeply to the north (image to right, line is foliation trace), as indicated by the blue symbol (bar with triangle) on the map. Note how the foliation symbols on the map parallel each other, indicating a uniform deformation of the rocks in this area. Some of the shearing that oriented the mineral grains may be related to shearing along a fault that occurs in the small valley just ahead. At this point, the displacement on the fault remains unknown. Also look for evidence of the dolerite dike (d) that runs E-W a few meters north of the foliated Westboro outcrop.

Continue ahead to junction B5-1, which is at an E-W trending fault, and then up a gentle slope for 50 m to a small knob at the junction with the Reservoir Trail.

STOP 15: At this stop it is possible to see the two main rock types (image to right) that make up the Westboro Formation (Zvwq), if not as an outcrop, then at least as scattered boulders on the side of the outcrop. On the left in the image are blocks of white to light gray metasandstone. On the right is rusty dark gray argillite. Look for foliation in these rocks. The Westboro is between 910 and 609 Ma as determined using radiometric dating. This places the rock unit in the Late Proterozoic. For more on how ages are determined see: RockAges. **Continue another 100 m.**

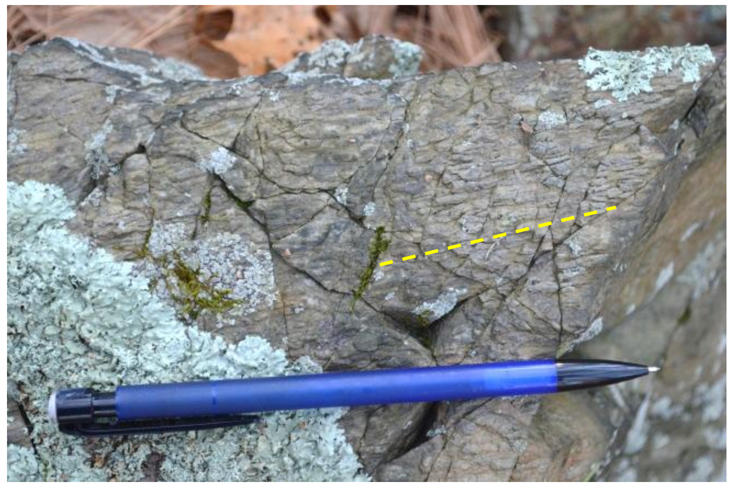
STOP 16: Here is another knob of metasandstone in the Westboro Formation (Zvwq). This knob is on the left side of the trail and on the left side of the image shown below to the right, which is a view looking south along the trail. You may be able to spot the two rock types seen at the last stop on this knob. **Continue to the far side of the knob.**

STOP 17: As the trail starts to descend the far side of the knob to junction B5-4 (same image to right), it crosses an E-W trending dolerite dike (d). The image shows the northern contact of the dike with the Westboro (dashed line) viewed from the north. South of the dike on the trail are abundant blocks of light gray metasandstone. **Follow the trail downhill to South Border Road and the pond and small dam at the outlet of South Reservoir.**

STOP 18: On the east side of the pond (image to right) is the driveway to the Randall W. Schwartz Water Treatment Facility, which serves the Winchester reservoirs. Beneath the southwest arm of South Reservoir and going beneath the dam and outlet pond is a major N-S trending fault (line on image). The valley here is the result of very heavily fractured rock along the fault that facilitated glacial erosion. Since the fault crosses beneath a dam, it is important to mention that this fault has not been active for millions of years. Near the end of the driveway, you will also see a huge Winchester Granite (Zwg) boulder. This is a true glacial erratic because it was not only transported by glacial ice but was also transported to an area where the bedrock is not granite. Behind the boulder is a small boulder-covered hill (not the larger bedrock hill in the background), which is a remnant of an end moraine deposited by the last glacier as it receded. An end moraine is a deposit in the form of a pile of sediment left at the edge of a glacier. The moraine may have once plugged the valley, but it was cut away by glacial meltwater flowing south from the glacier during its northward recession.

From Stop 18, the tour will head back to the Long Pond parking area by a different route, making a few stops on the way. This will take the tour away from the Skyline Trail. Head northeast on the driveway to the small dam at South Reservoir. Cross over the dam to West Dam Road (west side of South Reservoir) and take this road northeast, paralleling the shore of the reservoir for about 350-400 m. Please be aware that this is a restricted area and leaving the road is forbidden. On Map SKY-6B, note how the foliation symbols in the Westboro Formation (Zvwq) near South Reservoir bend to the northeast to parallel the trend of the major fault in the Reservoir.

STOP 19: On West Dam Road (image below on left), you will come to the first of two fault escarpments cutting through the Westboro Formation (Zvwq). An escarpment is a sharp break in slope, in this case formed by different rates of erosion on opposite sides of a fault. The line on the image shows the approximate location of the trace of the fault. This is the same fault that you saw on the south side of Stop 14. Rocks along the north side of the fault are heavily foliated (image below on right, line parallels the trend of foliation). The foliation is defined by stretched quartz crystals. Displacement on the fault is not yet known from field evidence, but it is thought to follow the same pattern as nearby E-W faults that have areas to the south moving steeply upward relative to areas to the north. The image of foliation below is from the rock outcrops on the east (right) side of the road at the top of the escarpment north of the fault. On the map you will see two blue symbols (blue bars with triangles) indicating the orientation of the foliation, which trends E-W and dips steeply to the north. The trace of the foliation is approximately parallel to the trace of the fault. Although the metamorphism here is not likely at a high enough temperature to alter zircon crystals and the radiometric age of the rock, most geologists would not make this their first choice as a place to collect a rock sample for an age determination. There are many other places in the Fells that are better candidates.



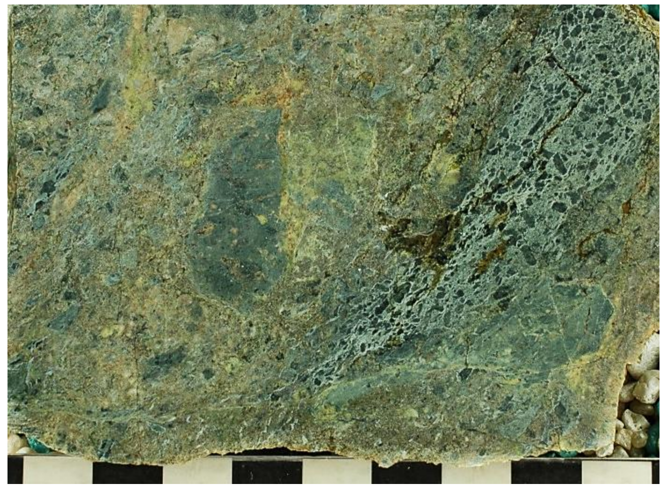
Continue on West Dam Road for another 100-150 m north to another escarpment.

STOP 20: At this stop is a second fault escarpment (image to right, view to north, line is trace of fault) cutting through the Westboro Formation (Zvwq). The fault here is in a small valley at the base of the escarpment. This is the same fault seen at Stops 12 and 13. Again, the fault is thought to be steeply dipping with the south side moving upward relative to the north side, but this remains uncertain. West Dam Road crosses the valley in which this major fault occurs before climbing the escarpment on the north side. Along the fault on the east side of the road is a valley that descends to the reservoir and is filled with glacial sediment (yellow q unit on the map). At the top of the escarpment, look for very hard gray outcrops of metasandstone exposed in the road.

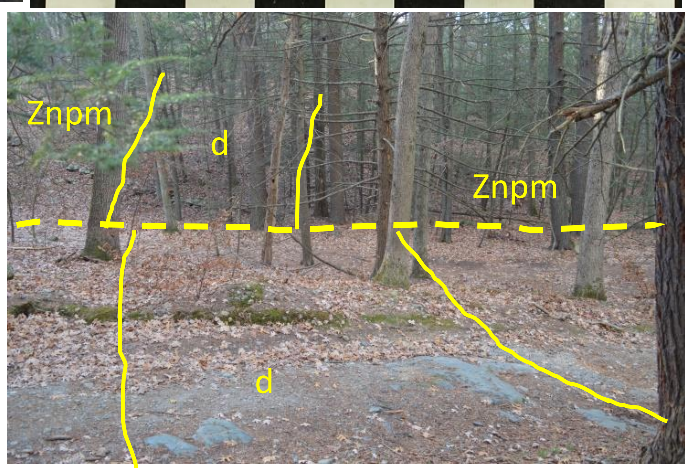
Continue to follow the tour on Map SKY-6A.

Continue north on West Dam Road to the top of the escarpment and then another 25 m to where the road levels off.

STOP 21: The road crosses the fault contact of the Westboro Formation (Zvwq) to the south and the Nanepashemet Formation (Znpm) to the north (see Map SKY-6A). This is the same fault seen at Stop 10. The trace of the fault can be seen east of West Dam Road (image below on left). This fault appears to be steeply dipping with displacement of areas to the south upward relative to areas to the north. The outcrops of the Nanepashemet Formation in this area are predominantly a heavily altered basaltic volcanic breccia (image below on right). The unit has many fragments of different types of altered basalt surrounded by finer sediment that has abundant epidote (pistachio green color) in it and may be altered basaltic ash. Breccia is a sedimentary rock made of particles larger than 2 mm that have angular shapes. In the image, you can see the volcanic rock fragments and highly altered surrounding fine sediment with epidote. There is still much work to be done to determine the exact origin of this rock formation. Lichens covering the rock surface and the unit's alteration do not help this situation. **Continue another 80 m north on West Dam Road.**

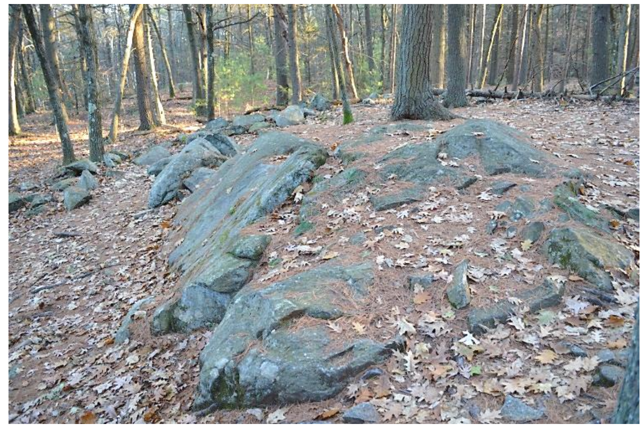


STOP 22: West Dam Road is crossed by a dolerite dike (d) that is exposed in the road surface (image to right, view west or to left) and cuts across the Nanepashemet Formation (Znpm). The solid lines on the image show the approximate contacts of the dike on both sides as it cuts across the road and up a steep fault escarpment. The fault is shown with a dashed line west of the road. The dolerite dike is challenging to trace across the Nanepashemet Formation, which has a very similar greenish-gray color and fine grain size. It is not displaced very far by the fault at the escarpment. **Continue north on West Dam Road to a bend to the east (right).**



STOP 23: At the bend, the road begins to follow another E-W trending major fault (dashed yellow line on image to right). The fault separates the Winchester Granite (Zwg) to the north (ahead) from the Nanepashemet Formation (Znpm) to the south. This fault is thought to be steep, with rocks on the south side displaced upward relative to rocks on the north side, although this remains uncertain. South of the fault and running along the crest of the hill is the dolerite dike (d) seen at Stop 22. There is also a very large (3 m) glacial erratic of Winchester Granite at the southeast corner of the bend in the road. This boulder is just barely an erratic, since it sits on the Nanepashemet Formation only 30 m away from its source rock north of the fault. **From this stop, the tour will skip 10-15 m west (left) to the Reservoir Trail (orange markers) and cross the footbridge heading north on the Reservoir Trail. The bridge sits roughly where the fault on East Dam Road crosses the Reservoir Trail. After crossing the bridge, the trail ascends the Winchester Granite north of the fault. Continue to the first high spot in the trail at junction B4-11 .**

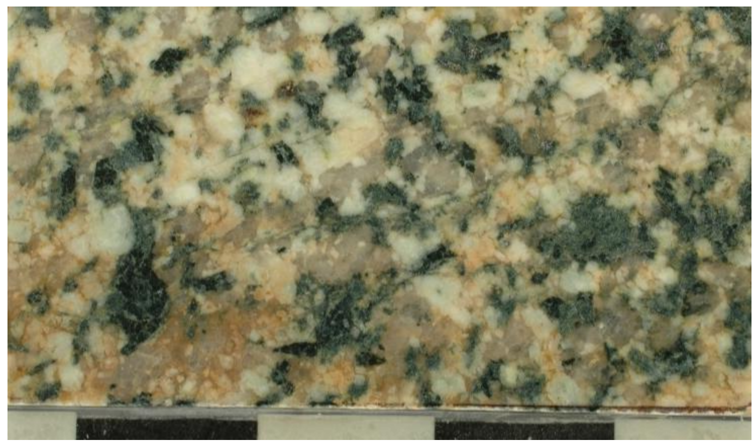
STOP 24: At junction B4-11 are outcrops of the Winchester Granite (Zwg). The granite has some large fractures, also called joints, which have been measured for their orientations (image to right, view east). The orientations are shown on the map with a symbol (**[**). The tic marks, or small bars, on the symbol point in the dip direction of the joints, and a nearby number records the dip as degrees from horizontal. Both joint sets recorded here are very steep (83° and 88°).



If you continued north (straight ahead) on the Reservoir Trail, it would bring you to Stop 22 of Part 5 of the tour and Molly's Spring Road. If you want to learn more about the Molly's Spring Road Fault, see Stops 20 -23 of Part 5 of the Skyline tour.

To complete this tour, head west (left) from junction B4-11 to trail junction B4-10 at the Mountain Bike Loop. Head north (right) from junction B4-10 for about 50 m.

STOP 25: On the Mountain Bike Loop at junction B4-10 and for another 50 m is a view northwest (to left), down a small valley, which is the axis of a minor fault leading down to a wetland in the distance (see Map SKY-6A). Although this is a minor fault, the fracture system associated with it in the subsurface allows groundwater to discharge from the surrounding Winchester Granite (Zwg) hills to form Molly's Spring. Water from Molly's Spring then flows north (parallel to Mountain Bike Loop) in a small valley. The image to the right is of the Winchester Granite (Zwg) near Stop 25 (sample collected just west of this stop) for comparison to Stops 1, 5 and 12. The granite here is relatively coarse and likely further from the margins of the pluton. For more on how plutons form see: Plutons.



Continue north on the Mountain Bike Loop (green markers) to Molly's Spring Road at junction B4-5. At Molly's Spring Road, head west (left) to where the Skyline Trail crosses Molly's Spring (just before junction B4-4).

STOP 26: About 10-20 m before junction B4-4 where the Skyline Trail departs south (left) from the road and up the steep slope of Winchester Granite seen early in the tour is where Molly's Spring flows out of the lowland to the south and crosses beneath Molly's Spring Road. This is a small, seasonal spring that was much drier from 2018-2020 than in decades past, perhaps because of warmer and drier conditions than earlier. At the time this tour was compiled, there had been a few summers (2016-2018) of drought conditions, and Molly's Spring was completely dry due to a low water table in the surrounding granite hills. The spring was vigorously flowing in the summer of 2021 and again in 2023.

To return to the Long Pond parking area, continue west on Molly's Spring Road to junction B4-3. At this junction, a trail heads west (left) to the parking lot, while Molly's Spring Road continues northwest (bares to right) at the western end of the large wetland.

END OF PART 6

Below is a listing of all the rock units you have seen on Part 6 of the Skyline Trail tour. Can you make a list of the relative order in which the rock units and major faults (E-W and N-S) formed? Use the relationships seen on the map as well as information gathered in the field.

diorite (dr)
dolerite (diabase) dikes (d)
porphyritic dolerite dike (dp)
rhyolite dikes (fp)
major N-S trending faults
major E-W trending faults
Nanepashemet Formation (Znpm)
Westboro Formation (Zvwq)
Winchester Granite (Zwg)

Here is a summary of the features and vocabulary for Part 6 of the Skyline Trail tour:

minerals:
- quartz
- plagioclase feldspar
- alkali feldspar
- mafic rocks and minerals
- pyroxene
- amphibole – hornblende
- chlorite
- biotite mica
- zircon
- pyrite
- epidote

igneous rocks:
- coarse-grained vs. fine-grained
- dolerite
- diorite
- granite
- porphyry, porphyritic
  - (phenocrysts + ground mass)

magma – molten rock, magma chamber
- intrusion
- dike
- pluton - For more on how plutons form see: Plutons.
- inclusion (xenolith)
- chill zone or chilled margin
- crosscutting

sedimentary rocks:
- conglomerate and breccia
- sandstone
- mudstone

metamorphic rocks:
- regional metamorphism
- argillite
- metasandstone
- foliation
- contact metamorphism
- hornfels

time abbreviations:
- Ma = mega-annum

radiometric dating - For more on how ages are determined for rocks see: RockAges.
Neoproterozoic Era
contacts

fracture planes or joints
fault, fault displacement, fault zone
fault escarpment

weathering – surface breakdown of rocks
erosion - removal of weathered material
glaciation or ice age
glacial striations and grooves
glacial erratic