Self-Guided Geologic Tour: Rock Circuit Trail in the Middlesex Fells Reservation (Part 2)

Prepared by Jack Ridge, Prof. Emeritus, Dept. of Earth and Climate Sciences at Tufts University, Medford, MA

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

1. The Rock Circuit tour has been broken into three parts. You can do the whole tour in one day, but it is a lot of hiking (~5 twisting miles, ~8 km) and a lot to comprehend in one dose. It's recommended that you do parts of the tour in order, Part 1 to Part 3. The beginning of each part is at the end of another part. 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 along the Fellsway East, so start early.

3. The tours require hiking over some steep and rocky trails, so plan ahead. 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 the spring water 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 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**. Loose rock debris (or **float**), sediment, and soils on top of the bedrock comprise 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 organically-produced materials and **natural glass**, which is non-crystalline.

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 at least 4 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 rock types and age. Formations have proper names from a place where they are well exposed or first defined. Sometimes, single formations are split into a sequence of 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 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), P (Pennsylvanian), 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). 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, the 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 will likely change with more field work and age determinations. Updates of the bedrock map, its explanation, and associated surficial geologic map and tours will be posted as they occur. We welcome feedback at: https://sites.tufts.edu/fellsgeology/.

Rock Circuit Trail in the Middlesex Fells Reservation version: May 27, 2025
Part 2: Cross Fells Trail to near Hemlock Pool

Tufts UNIVERSITY

Total distance for just Part 2: approximately 3 miles (~5 km) from the Flynn Rink parking area and back.

Prepared by Jack Ridge, Emeritus Professor, Dept. of Earth and Climate Sciences, Tufts University

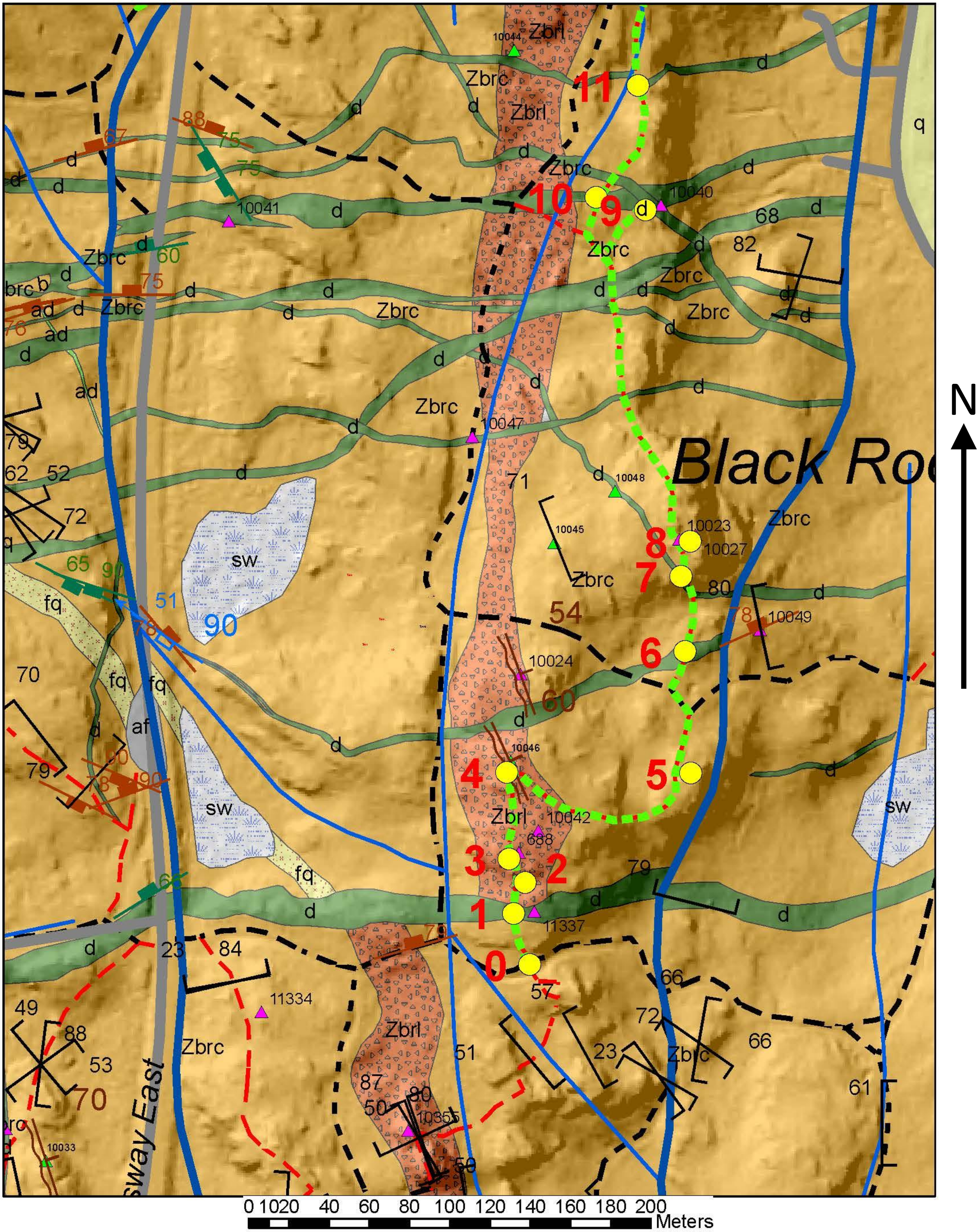
Starting point: You can start Part 2 at two different places, depending on whether you combine it with Parts 1 or 3. Trail intersection numbers, posted on signs in the Fells and on the official DCR trail map (link above), are given.

Just Part 2: I suggest parking at the Flynn Rink and starting your tour by walking across the Fells to the Fellsway East at Gate no. 53. The hike will end near the Flynn Rink. **To start:** After crossing Woodland Road to Gate no. 33 take Woodland Path east past junctions E4-7, E4-8 (cross over Rock Circuit Trail), E4-12 (stay to right), and then to Hemlock Pool Path at E4-13 (stay left). Follow Hemlock Pool Path east to Hemlock Pool Road at junction E4-15. Follow Hemlock Pool Road southeast (right) to F5-1 and take a right (south) to F5-4, where you bear left. At F5-6, head east (left) on Jerry Jingle Road. Follow it past junction F5-7 to the Fellsway East at Gate no. 53. Cross the Fellsway East to Gate no. 52 and follow the fire road past the Rock Circuit Trail on the right. Continue past roads on the right at junction F5-10 and on the left at G5-4 (Black Rock Path). Beyond G5-4, Part 2 starts at the Rock Circuit Trail (junction G5-5) heading north (left).

Combining Parts 1 and 2 (and 3): Start at the Fellsway East, Gate no. 53 parking area and follow the instructions given with Parts 1 and 2. At the end of Part 2 follow the instructions above for just Part 2 from E4-8 (junction of Rock Circuit and Cross Fells trails) to return to the Fellsway East parking area or continue with Part 3.

Combining Parts 2 and 3: This is a relatively long hike but more efficient. Start at the Fellsway East, Gate no. 53 parking area. Head south from the parking lot to Gate no. 53, cross the Fellsway East to Gate no. 52 and follow the fire road past the Rock Circuit Trail on the right. Continue past roads on the right at junction F5-10 and on the left at G5-4 (Black Rock Path). Beyond G5-4, Part 2 starts at the Rock Circuit Trail (junction G5-5) heading north (left). Part 3 ends at Gate no. 53.

Map RC-2A


Black Roc
Zbrl
Zbrc
sw
fq
af
q
ad
d
11
10
9
8
7
6
5
4
3
2
1
0
10044
10040
10041
10047
10048
10045
10023
10027
10049
10024
10046
10042
688
11337
11334
10355
10033
N
0 10 20 40 60 80 100 120 140 160 180 200
Meters

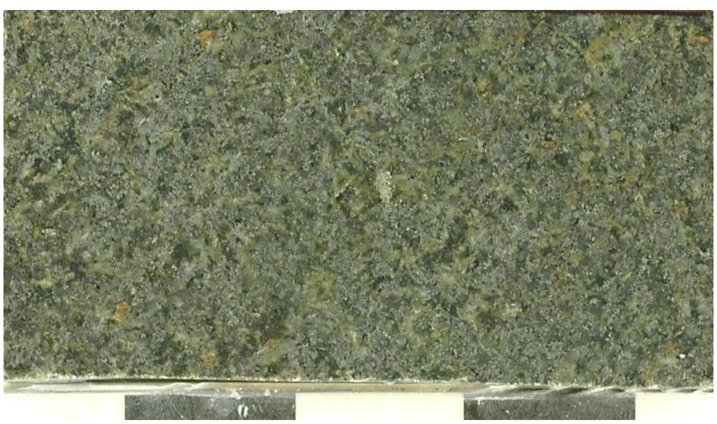
From Stop 0 (on Map RC-2A, junction G5-5) follow the trail on the geologic maps as you go. In the guide, trail junction numbers are given that are marked with signs in the park and are on the DCR trail map. On the geologic maps, stops on the tour are symbolized with yellow circles and red numbers. Follow the white trail markers in the field and dashed lime green path on the map. Having a hand lens or magnifying glass can be helpful. Hope you enjoy the geology! Have fun!!

This trip focuses on the Neoproterozoic rocks of the Boojum Rock Tuff and other units in the Lynn Volcanic Complex, and the Spot Pond Granodiorite as well as younger dolerite dikes. The Neoproterozoic Era was 1000 to 541 million years ago. The trip will also point out how these rocks were deformed by faults and fractures and will highlight 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.

At junction G5-5 (Stop 0 on map RC-2A), follow the Rock Circuit Trail (white markers) up the slope to the north (left) toward Black Rock for about 30-40 m.

STOP 1: The trail crosses a wide, E-W trending dolerite dike (d on the map). Look for the rusty, weathered surface of this unit. This is the same dike mentioned at the beginning of Part 1, that can be seen when crossing the Fellsway East. A dike is an intrusion of magma that fills a fracture and then crystallizes, in this case producing dolerite. Dolerite is an igneous rock of intermediate (sand size) grains made of mafic (dark-colored) minerals and plagioclase feldspar (gray, image below on left). Usually, these dikes have the mafic minerals pyroxene (faintly purplish-green mineral in image), which is partly altered to chlorite and amphibole, and magnetite. A high iron content gives the rock sample a dark color. The rusty surface of outcrops is from the oxidation of iron. Just a few meters west (left) of the trail, the rock surface has glacial grooves created by the last glacier sliding across the land surface (image below right). As the base of the glacier slid across the rock, it dragged rocks and sand across the surface and scratched and gouged the dolerite. The grooved surface is not polished because dolerite weathers too quickly, which removes the polish and fine scratches, but faint grooves are still preserved. The orientation of the grooves (red arrow) at S29°E indicates the flow direction of the generally south-southeast moving ice sheet. During the last glaciation (ice age) the glacier covered the land surface from about 35,000 to 17,000 yr ago.

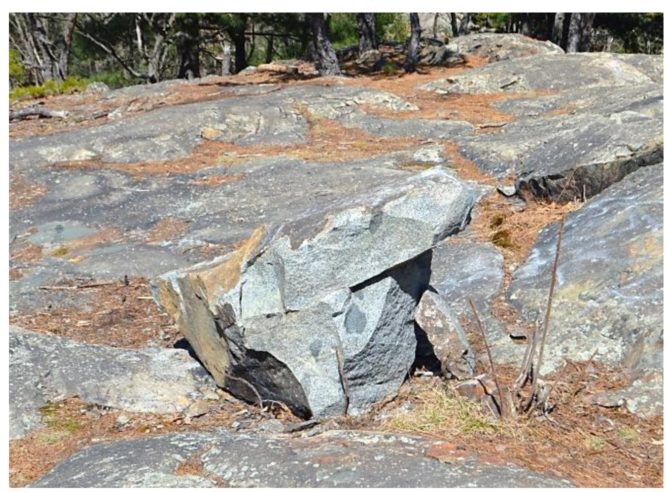


STOP 2: 10 m uphill from the dike and on the east (right) side of the trail is an example of flake weathering exhibited by the Boojum Rock Tuff (image to right). This gives the rock surface a patchy mosaic-like coloration pattern. The rock here is welded lithic crystal tuff (Zbrl, see Stop 3). Flake weathering results from initial chemical weathering that produces a light tan-colored outer weathered zone, or weathering rind, that is usually 2-3 mm thick, which likely creates very fine pore spaces in the otherwise solid rock. The pores may allow lichen growth and water to penetrate and freeze in the rock, causing expansion. Other mechanisms are likely involved, such as periodic fires, but we don't yet know what role they play. Flake weathering is widespread on the Boojum Rock Tuff but does not occur on any other volcanic units in the Fells.

STOP 3: 10-15 m uphill from the last stop and on the west (left) side of the trail is a good exposure of welded lithic crystal tuff in the Boojum Rock Tuff (Zbrl, image below on left) in the Lynn Volcanic Complex. This unit is exposed across the top of the hill and is the same unit that we traced northward from Pinnacle Rock on Part 1 of the tour. This unit is a pyroclastic volcanic rock, meaning it was ejected into the air prior to accumulating upon landing. Pyroclastic rocks can have 4 components in them: 1) ash, or fine (microscopic), broken glass shards that may have still been molten when they landed; 2) crystals which are mineral grains that had started to crystallize in the magma prior to eruption; 3) large pieces of glass and pumice (bubbly glass), which may still have been molten when they landed; and 4) lithic fragments, which are fragments of pre-existing rock, either from prior volcanic eruptions or any older rocks through which the magma passed in the subsurface. The rocks exposed here are welded lithic crystal tuff. Tuff is any pyroclastic rock with ash in it. The term welded means that the ash and glass/pumice fragments were at least partly molten (liquid), so they adhered to each other when they landed. Hot and sticky! The tuff here has crystals, which are small (usually 1-3 mm), broken, white plagioclase feldspar grains, as well as abundant, sub-centimeter lithic fragments, which are volcanic and occasionally metasandstone (image below on right). Also, glass that remains at high temperatures after it solidifies will slowly convert to a crystalline solid composed of very fine-grained quartz and feldspar. This change of hardened glass to quartz and feldspar (crystalline material) is called devitrification, and this material gives the rock its greenish-gray color on fresh surfaces. The larger devitrified glass fragments, including pumice, that are up to 2 cm, were also soft when they landed. As a result, they were flattened under the weight of accumulating material above. The flattened fragments, best seen in a microscope, blend in with the surrounding devitrified ash.

Continue uphill. At the top of the hill, the trail makes a sharp bend to the east (right).

STOP 4: At the bend, you can see a broken glacial erratic from the Stoneham Granodiorite (Zst, image to right), a rock formation in the northern Spot Pond area. Granodiorite is an intrusive, coarse-grained igneous rock almost entirely made of plagioclase feldspar and quartz with lesser alkali (potassium) feldspar and scattered to sometimes abundant mafic (dark) minerals. To be a glacial erratic the boulder must be glacially transported and end up resting on a different rock formation than the one it came from. Here, the underlying rock is the same lithic crystal tuff as at Stop 3. The erratic has been broken, to reveal fresh, unweathered surfaces. The granodiorite contains dark patches called inclusions. When the magma that would later form the granodiorite intruded subsurface rocks, pieces of another rock formation with a mafic composition (basalt) broke off into the magma and were later frozen into the granodiorite. The inclusions indicate that the mafic rocks are older than the granodiorite.



After the sharp turn east (right) the trail descends a steep slope to a bare knob.

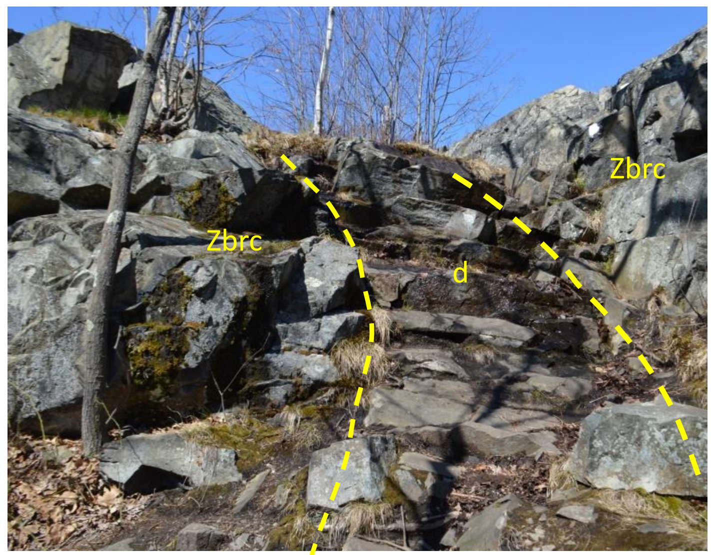
STOP 5: The bare knob (no image) is made of welded crystal tuff in the Boojum Rock Tuff (Zbrc). This rock is like the welded lithic crystal tuff at Stop 3, but without the abundant lithic fragments. We will discuss this rock unit more thoroughly at Stop 7. The tuff here is heavily fractured near the major faults that run along the base of the cliff that forms the eastern edge of the hill. This is essentially the eastern boundary of the Fells. From this spot you can see the athletic fields and Pine Banks Park in Malden and Melrose. You may also hear the Orange Line at Oak Grove Station.

Follow the trail downhill (north) to a dirt road at junction G5-2. The trail follows the road a short distance west (left) before continuing north (right) in the woods.

STOP 6: The trail crosses a small E-W trending dolerite dike (image to right) that forms a knob in the trail. This dike is like the dike at Stop 1.

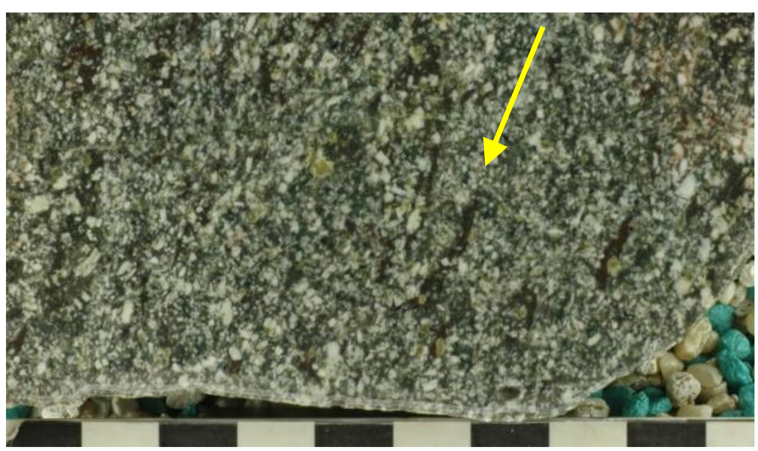
Continue north to a steep rock face, which is the southern end of Black Rock.

STOP 7: The trail heads up the face on what looks like a crude staircase (image to right). This is a small, NW-SE trending dolerite dike, but with a finer grain size than the dikes at Stops 1 and 6. Fractures crossing the dike perpendicular to its sides have a different orientation and density than fractures in the surrounding crystal tuff and do not cross into the tuff. The fractures are cooling joints (fractures) that resulted from contraction of the dolerite as it continued to cool. Intrusion of the magma to form this dike took advantage of large fractures in the surrounding tuff. The dike has been traced about 700 m to the northwest before it pinches out; it is cut off by a fault to the southeast. When you arrive at the top of the hill, look for the dike heading off to the northwest.



Follow the trail up the steep slope of the dike and then to the highest point on Black Rock.

STOP 8: At the top of Black Rock is a great view of north suburban Boston and a great exposure of welded crystal tuff in the Boojum Rock Tuff (Zbrc). If you find a freshly exposed face, you can see many white plagioclase feldspar crystals surrounded by very fine, greenish-gray devitrified glass and occasional dark lithic fragments (image below left). If you find a fresh vertical face that is trending E-W you may also see some parallel, dark reddish-gray remnants of what were flattened glass or pumice fragments that dip downward to the east. These fragments are very hard to see on an outcrop face (image below left, parallel to arrow). The elongated fragments are more easily seen in a rock surface cut vertically and trending E-W (image below at arrow).

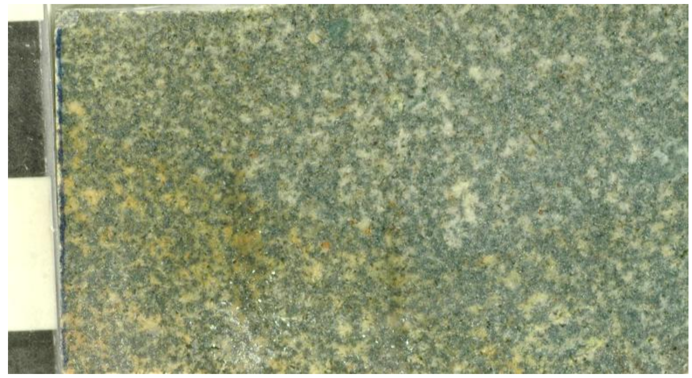


Descend Black Rock northward to the center of the broad valley below where you will eventually see a small trail marked with yellow markers that leads down to a waterfall called "The Cascade" at junction G4-4.

STOP 9: About 12 m before the small trail, the trail crosses an E-W trending ridge that is a dolerite dike. The waterfall is formed over intersecting, heavily fractured dolerite dikes. The fractures allowed easier erosion by a small intermittent stream that drains wetlands to the west. You can go down to see the waterfall but **BE CARFUL!! The wet rock here can be slippery in the winter because of ice and in the summer because of algae.** In most summers, the stream and waterfall are almost dry. The waterfall can also be approached from the other side of the stream.

After seeing the waterfall, return to the Rock Circuit Trail and continue north over the small bridge crossing the stream. Continue for another 15-20 m.

STOP 10: At this position is one of the dikes that intersects at the waterfall. This dike is badly fractured, so several boulders have broken off it. It has a lighter, grayer, less rusty color than most dolerite dikes in the Fells (image to right), and a higher plagioclase percentage. Most of the original pyroxene has been altered to chlorite and biotite.



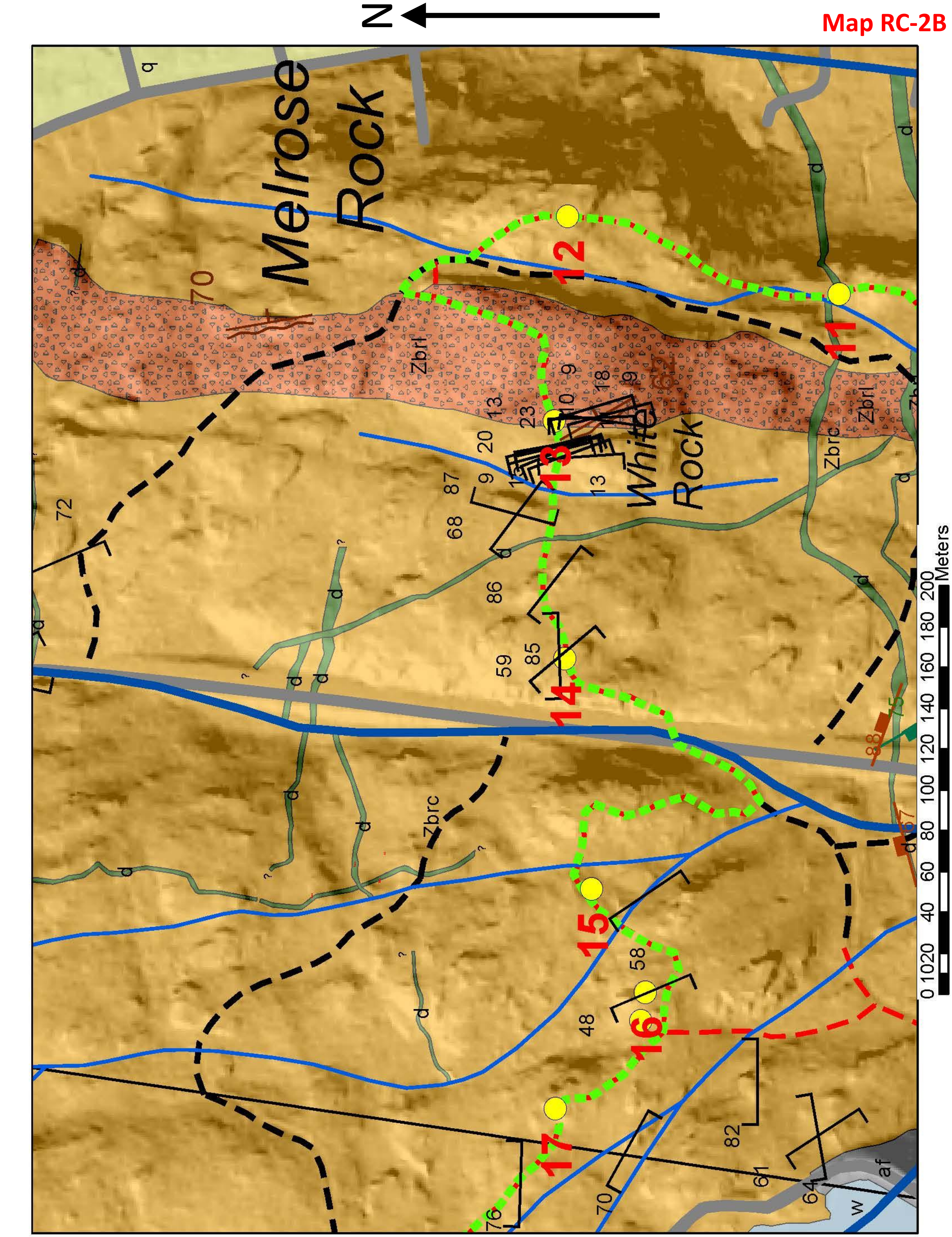
Continue the tour north on Map RC-2B.

STOP 11: In a short distance, the trail ascends a ledge of welded crystal tuff in the Boojum Rock Tuff (Zbrc). On fresh surfaces, this is a good spot to look for the white plagioclase crystals surrounded by fine, greenish-gray, devitrified glass. At the north end of the outcrop, the trail descends a small, steep face and lands on another dolerite dike (image to right) The circular holes in this dike are gas bubbles or vesicles.

Continue north on the trail across a valley and then up the steep southern slope of Melrose Rock.

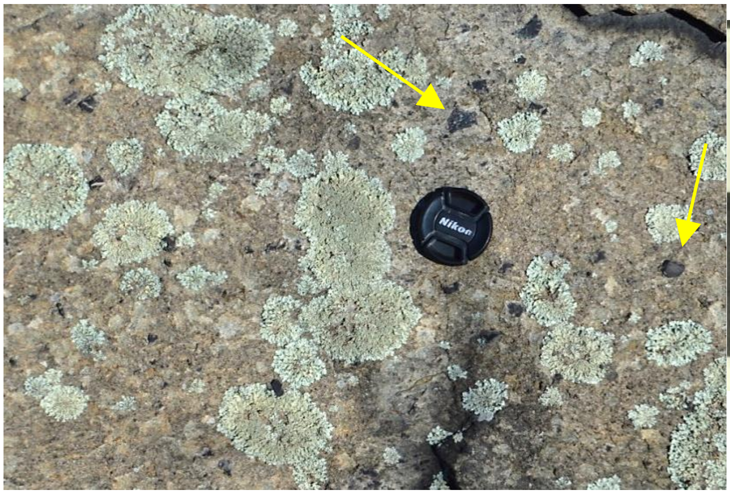
STOP 12: Melrose Rock is heavily-fractured, welded crystal tuff in the Boojum Rock Tuff (Zbrc). Fractures on Melrose Rock frequently have a sparkly, metallic, steely-gray mineral on their surfaces (image to right). This is specular hematite, which is formed by precipitation of iron oxide (Fe_2O_3) from hydrothermal (hot water) solutions that circulated through fractures. Hematite is common in the Boojum Rock Tuff and occurs in many parts of the Fells. It post-dates the Neoproterozoic rock formations, having formed at a time either during or after the rocks were fractured. I have not seen hematite in fractures in the dolerite dikes, so it may predate them. Melrose Rock also has a spectacular view across Melrose to the north all the way to the Boston skyline in the south (panoramic view below). Near the middle is a pine covered hill (left arrow). This is Pine Banks Park in Malden and Melrose. Further south (right arrow) is Waitts Mount in Malden.

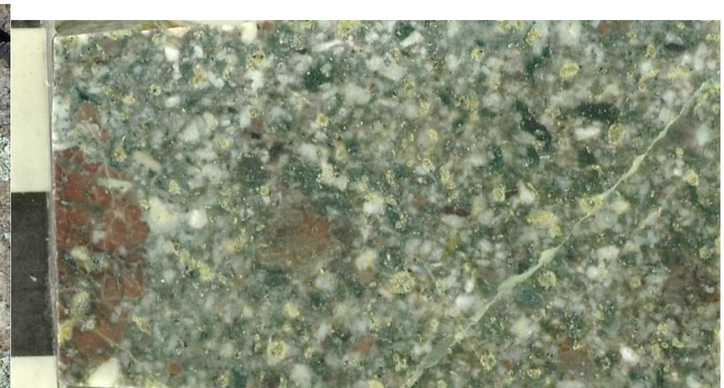
Map RC-2B


N
Melrose Rock
White Rock
11
12
13
14
15
16
17
Zbrl
Zbrc
af
w
0 10 20 40 60 80 100 120 140 160 180 200 Meters

Head down the steep north (far) side of Melrose Rock to White Rock Path (junction G4-2), which follows a fault. Continue north on the path to junction B4-1. Head west (left) to the top of White Rock, which looks down (east) over Melrose Rock. The rock here is the same lithic crystal tuff unit (Zbrl) seen at Stop 3. From the top of White Rock head west (right) down into a linear hollow formed by fractures and then up the gentler opposite side.

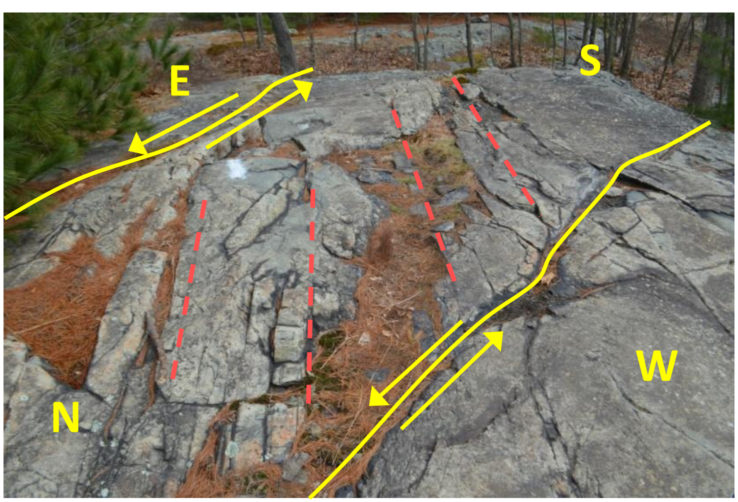
STOP 13: Close to the next hilltop and at a slight bench, the trail crosses the contact of lithic crystal tuff (Zbrl) to the east and crystal tuff (Zbrc) to the west, both in the Boojum Rock Tuff. Note on the map that the lithic crystal tuff has been traced from the southern end of the Fells (see Part 1) to here. The lithic tuff is a N-S trending, steeply east-dipping layer in the tuff. Just before reaching the crest of the hill, the exposed bench to the south (left) and east is lithic crystal tuff. Walking out onto this high spot you will notice that the volcanic lithic fragments (image below to left at arrows) project above the weathered surface of the rock because they are more resistant to weathering. They appear black in the field, but on cut rock surfaces, many of the fragments are dark reddish-brown (image below on right). The ridge top to the west (ahead on the trail) has none of these fragments and is underlain by the crystal tuff.

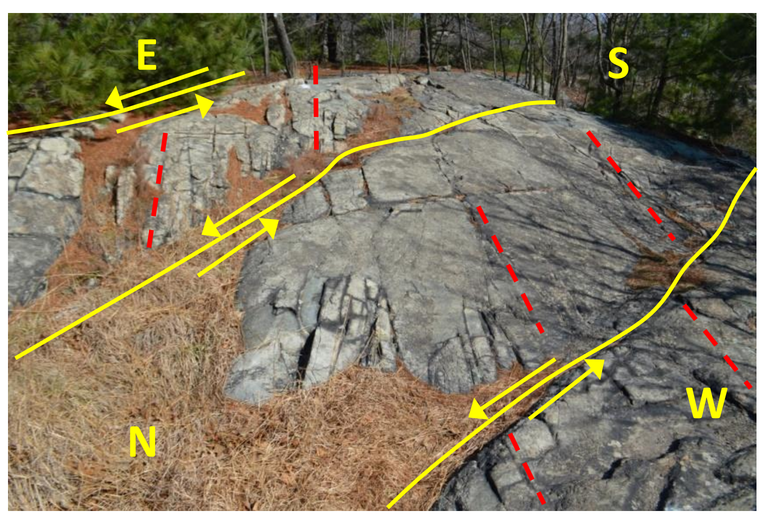




Continue west into the next ravine, which follows a fault, and up to the top of the next hill. After crossing the crest of the hill, you will cross an irregular platform. Before descending into a narrow, steep-sided hollow, the west end of the hilltop has some interesting fracture patterns.

STOP 14: The top of this hill has sets of parallel fractures angled between sets of longer N-S trending fractures that run the length of the hill. This fracture pattern is known as Riedel shears and is caused by the fracturing of rock between two separate but parallel shear or displacement planes. On the images below (views back to east), the larger shear planes are outlined in yellow with arrows showing relative displacement on opposite sides of them. Dashed red lines show the fractures in between the larger shear planes. Letters indicate compass directions. This configuration indicates that areas to the west are moving south relative to areas to the east or there is left lateral displacement in which areas viewed across a shear are moving to the left. In addition to occurring in association with N-S trending faults in this area, Riedel shears occur across the entire area of the Boojum Rock Tuff where there are other major N-S trending faults .

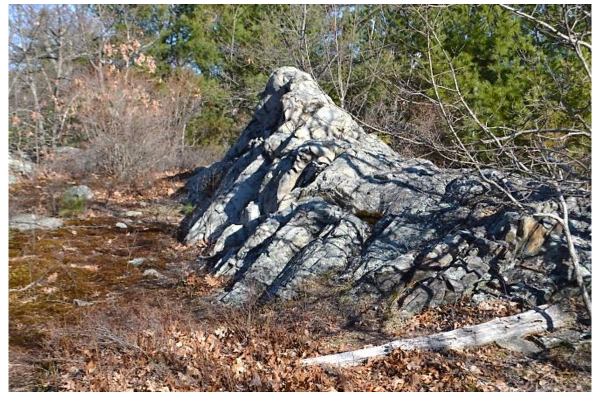




Follow the trail across the Fellsway East, and after about 30 m make a sharp turn to the north (right), to the top of a steep knob.

STOP 15: The knob overlooks the Fellsway to the east, which follows a major fault. The knob is heavily fractured crystal tuff in the Boojum Rock Tuff (Zbrc). The trail continues west and descends into a fault valley with a vernal pool. Vernal means seasonal (in the spring). However, water stays in this pool through most summers because it is constantly being fed by groundwater seepage from the upland to the west.

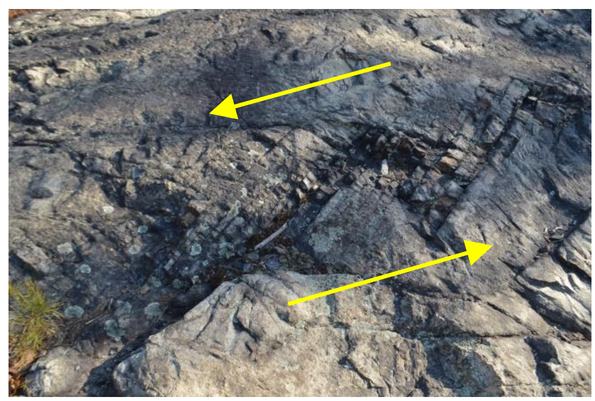
From the vernal pool, the trail climbs westward and then makes a bend northward (right) on a relatively flat bench.

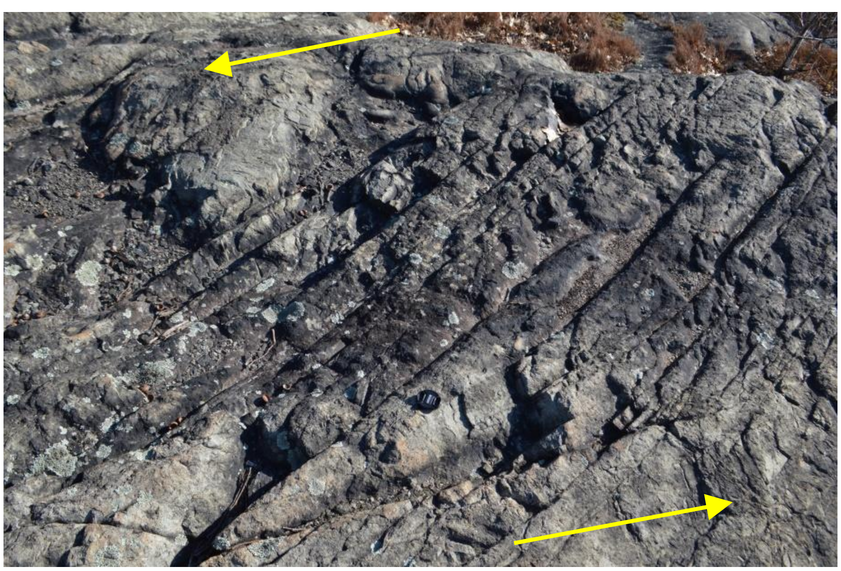


STOP 16: After the bend there is a small knob shaped by fractures dipping to the west (image to right, view ahead). As you make your way past the knob and view it to the right (image below right), look for the tannish orange, highly polished, glacially striated surface (arrow). We have seen striation patches before, but this one is unusual because of the direction of the striations. Striations on nearby surfaces to the north and south are S32-37°E, while this surface has striations at S73°E. The striations are best seen when the rock surface is wet. It remains uncertain, but this may be a set of striations preserved from a glaciation that pre-dates the last one, when an ice sheet had a more easterly flow. It does not look like ice flow during the last glaciation (SSE) was deflected at this site, and the very hard tuff may have resisted weathering, which allowed long-term preservation of older striations.

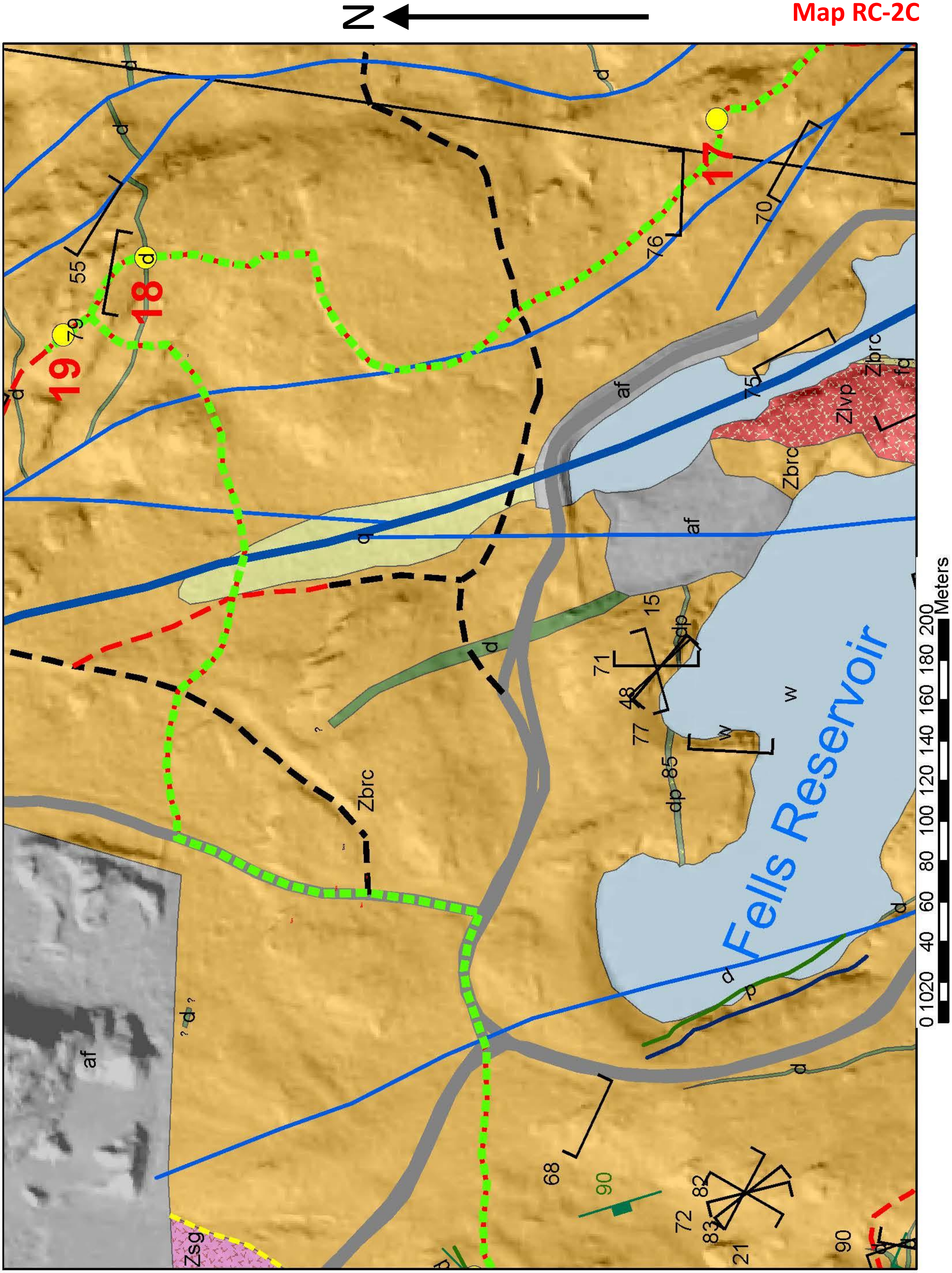
Continue north (ahead) on the trail to a large, gently tilted bench.

STOP 17: On the bench are several sets of closely spaced, parallel fractures. The fractures are in the form of parallel sets of tension gashes (images on right) in response to shear (arrows). They are like the Riedel shears at Stop 14 but without the major N-S shear planes. There are finer sets of parallel fractures perpendicular to and between the larger gashes (below right). On the east side of the outcrop and further from the trail) are angled fractures of what appear to be Riedel shears (below). This outcrop also has small, remnant patches with glacial striations.





Continue tour on Map RC-2C.


N
17
18
19
Fells Reservoir
af
Zbrc
Zlvp
Zsg
dp
w
Meters
0 10 20 40 60 80 100 120 140 160 180 200

Continue north on the trail and cross Wyoming Path at junction F4-8 to a relatively flat area on crystal tuff (Zbrc). The trail winds through outcrops as it makes its way north.

STOP 18: The trail eventually comes to a large, split metasandstone boulder (image to right). This is a glacial erratic from the Westboro Formation, which occurs north of here in Virginia Wood. The north (far) end of the boulder is also resting on a small dolerite dike that is hard to trace. **Continue beyond the boulder for about 30-40 m to a bench.**

STOP 19: The bench is crystal tuff in the Boojum Rock Tuff (Zbrc). Scattered across the top of the bench are remnant, orange (iron)–stained, polished striation surfaces with striations oriented S30°E. A little further west along the last 30 m of the Crystal Spring Trail (red markers) where it joins the Rock Circuit Trail (junction F4-4) from the north (image to right) are striations oriented S55°E that represent ice flow deflected eastward as the glacier tried to move up the slope.

From this site continue west on the Rock Circuit Trail down a steep slope into a valley. Follow the trail through an area of heavily fractured and faulted rock in the crystal tuff with deep linear hollows (faults) and isolated knobs covered by angular rock debris. Continue west crossing a wood walkway, a trail, and then a road (Melrose Path, junction F4-2). The trail then joins Pipeline Road at the edge of the Fells (junction F4-1). Follow Pipeline Road north (left) to Wyoming Path. Follow Wyoming Path west (right) to junction F4-5, where the trail heads into a wooded area.

Continue the tour on Map RC-2D.

STOP 20: After crossing a wooden walkway, the trail curves around a mound, which is a porphyritic dolerite dike. Porphyritic rocks have two distinct grain sizes: fine crystals that make up most of the rock, or the ground mass, and a second set of larger crystals called phenocrysts. In this dike, the phenocrysts are slender, white plagioclase feldspar (image to right). You will have to look closely to see the them. Although we haven't yet seen any porphyritic dikes along the Rock Circuit Trail, they are common in the Fells.

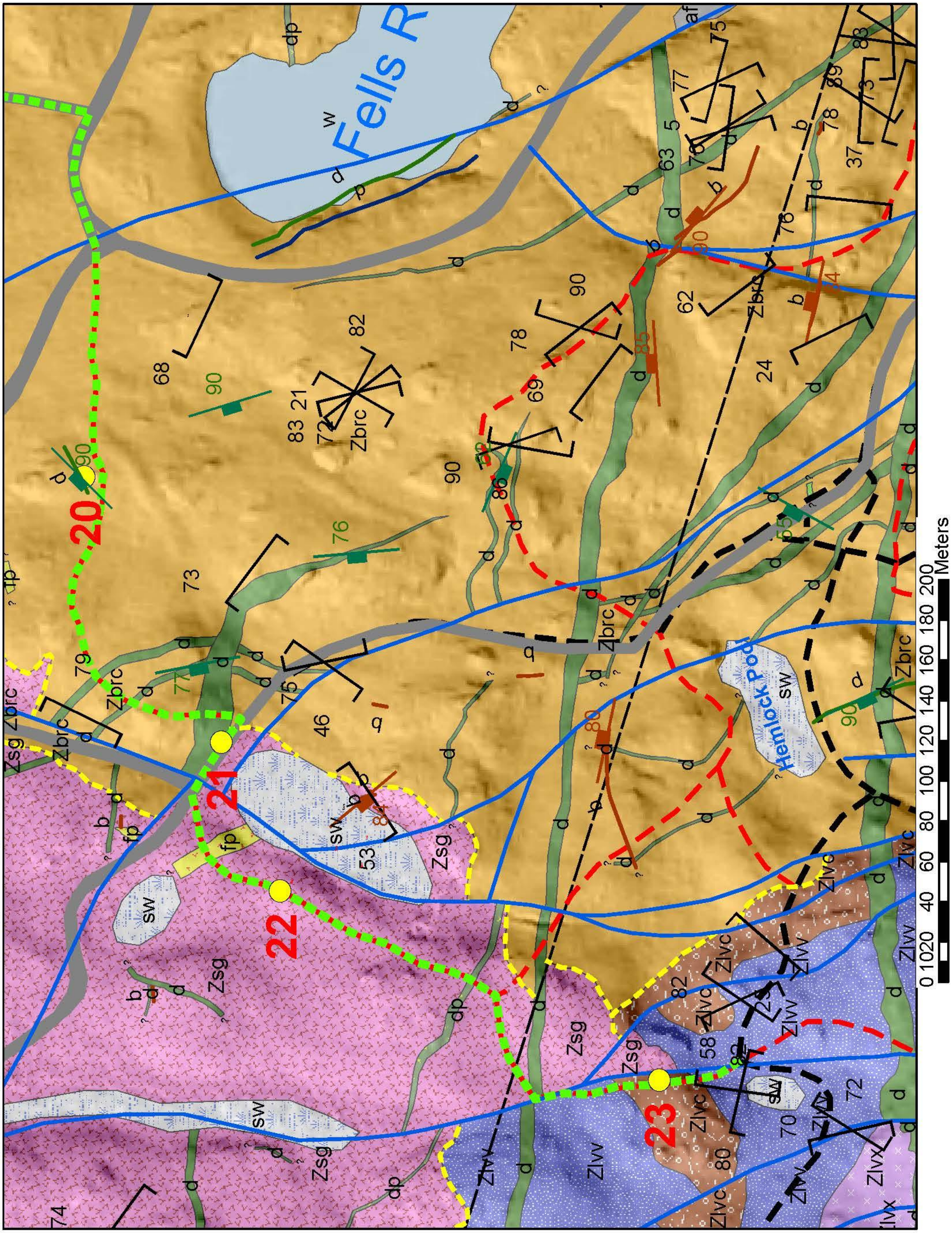
Continue west (ahead) on the trail. As the trail starts to bend to the south (left), rocks across the road below are the Spot Pond Granodiorite (Zsg). The trail descends a steep slope to Hemlock Pool Road at junction E4-5. The trail joins the road and heads northwest (right).

STOP 21: Shortly after junction E4-5 on the northeast (right) side of the road is a dolerite dike with many holes (image to right). The holes are vesicles, or gas bubbles that were trapped in the cooling magma.

The road bends to the west (left) at the next road junction, and a little way after, the trail branches off to the south (left) at junction E4-4. Continue south.

N

Map RC-2D



Fells R
Hemlock Pond
20
21
22
23
Zbrc
Zsg
Zlvc
Zlvv
Zlvx
sw
fp
dp
af
w
Meters
0 10 20 40 60 80 100 120 140 160 180 200

STOP 22: The first outcrops ahead on the trail are in the Spot Pond Granodiorite (Zsg), which is part of the Dedham Complex, a group of graniticrocks dating about 609-610 Ma in the Fells area. This area is recognizable by the somewhat rounded, glacially streamlined outcrops and lower fracture density (image below to left). Granodiorite is a coarse-grained intrusive rock in which the light-colored minerals are mostly quartz and plagioclase feldspar with smaller amounts of alkali (potassium) feldspar. Alkali feldspar is easy to spot because of its pink color. When the rock surface weathers, it develops a knobby surface (image below to right), because the quartz crystals tend to resist weathering more than feldspar. The Spot Pond Granodiorite is exposed over large areas at the southern end of Spot Pond and in the southern Fells west of Rt. 93. Although the contact between the Spot Pond Granodiorite and Boojum Rock Tuff is exposed here the contact is difficult to interpret for relative ages of the units. However, radiometric ages for the units, the granodiorite being 609.1 Ma and the tuff being 596.3 Ma, indicate that the tuff is younger. **Continue ahead to junction E4-9 and then turn west (right). After about 50 m the trail turns south (left) in a small valley.**

STOP 23: The small valley is the location of a fault that separates the Spot Pond Granodiorite (Zsg) on its east (left) side from units in the Lynn Volcanic Complex (Zlvc and Zlvv) on its west (right) side that is a younger part of the Lynn than the Boojum Rock Tuff. The younger volcanic rocks of the Lynn will be explored in detail on Part 3 of the tour. The trail passes a steep E-W trending scarp on the east (left) side of the trail that marks the contact between the granodiorite to the north and the volcanic rocks to the south. On the west (right) side of the trail, only the volcanic rocks are exposed. The image to the right shows the fault valley viewed from the south near Woodland Path (back up the trail). The dashed line shows the approximate location of the fault separating the two rock units.

END of Part 2: Part 2 ends at Woodland Path (junction E4-8), which is where Part 3 begins. To start Part 3, cross over Woodland Path and continue to follow the Rock Circuit Trail. See the directions for Part 3.

To return to the Flynn Rink parking lot: Take the Cross Fells Trail (also Woodland Path) as it winds westward (to right) to Woodland Road. Cross Woodland Road to the parking lot.

To return to the Fellsway East parking lot: Take Woodland Path east (left) from junction E4-8 and past junction E4-12 to Hemlock Pool Path at junction E4-13. Follow Hemlock Pool Path east (to left) along Hemlock Pool, then through an intersection to Hemlock Pool Road at junction E4-15. Follow Hemlock Pool Road southeast (slowly turning to right) to junction F5-1 and take a right (south) to junction F5-4, where you should bear left. At junction F5-6, head east (left) on Jerry Jingle Road and follow it past junction F5-7 to the Cross Fells Trail near the Fellsway East at Gate no. 53. The parking area is about 100 m north along the Cross Fells Trail (blue markers).