Quartzite Hill: Garnets in the Clough Quartzite.

The outcrop belt of the Clough Quartzite and Littleton Schist extends from Cobalt, Connecticut, well north into Massachusetts and New Hampshire. In most places, the base of the Clough contains a metamorphosed (changed by heat/pressure) quartz-pebble conglomerate[1] which is overlain by beds of quartzite. The quartzite beds become progressively thinner and gradually become interbedded with mica schist as the Clough grades upward into the overlying Littleton Formation (mica schist). The schist was originally formed as mud on the sea-floor. The sea-floor mud later lithified (hardened) to form shale before being metamorphosed into schist.

Quartzite does not usually produce garnets during metamorphism because the rock composition normally does not contain enough aluminum and iron to form the garnet. The Clough however *is* garnet bearing. Indeed the garnets exceed a centimeter in diameter in some places. The iron and aluminum needed to form garnets most likely were derived from the interbedded schist (schist layered between the layers of quartzite). In places the schist apparently dissolved during the metamorphism, leaving only the garnets to bear testimony of its former presence.

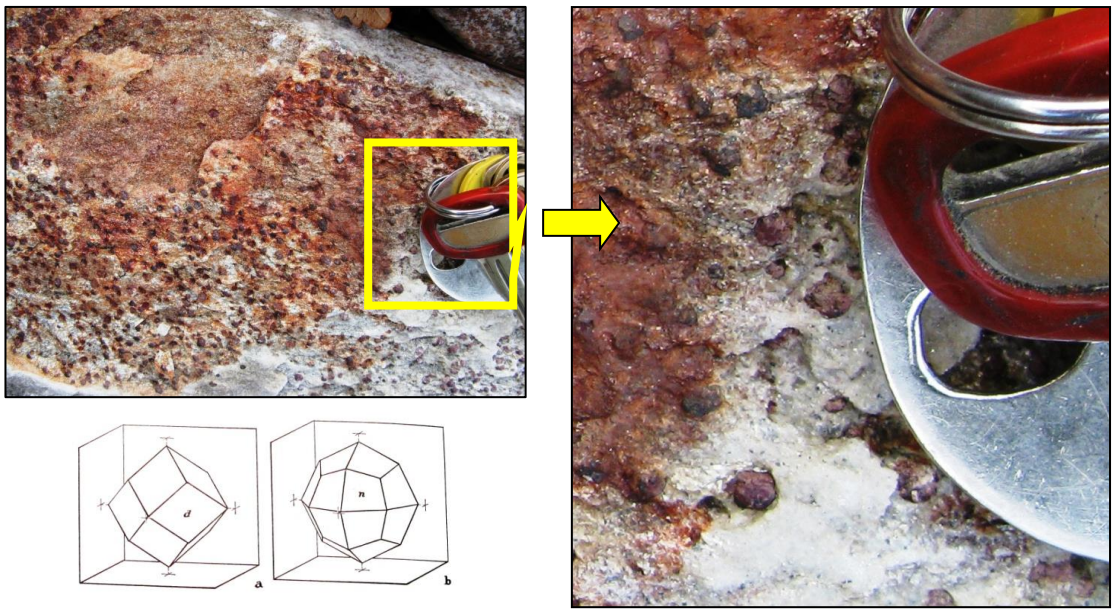

Figure 1. Rusty weathering garnet-bearing quartzite found at the top of Quartzite Hill. Garnet crystals are 1-2 mm in diameter. Garnets are associated with muscovite mica (pale orangish-brown color in upper left quarter of both the figure and the enlargement)) where the rock weathers rusty. Muscovite is absent in lower right view and the rock does not weather rusty. Disc partially visible beneath keys is 2" in diameter. Image on right is enlargement to show morphology of garnet crystals. Most appear to be trapezohedrons (labeled b. on diagram) rather than dodecahedrons (a. on diagram). No diamond shaped faces characteristic of the dodecahedron is seen.

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1. **Conglomerate:** A sedimentary rock composed of many clasts (pieces of other rocks) "stuck" together as the matrix (glue: ie mud) hardens.

Quartzite Hill

The name "Quartzite Hill" was given to this area in the 1990's by University of Connecticut geology students who were taught geologic field methods there. The Clough Quartzite underlies several hills including this one (Figure 2). These hills have steep (locally cliffed) east facing slopes and gentler west facing slopes. The hills stand high because the quartzite here resisted erosion from the glaciers during the last Ice Age better than the schist and gneiss of the overlying and underlying formations. This garnet trail involves a hike of about a mile and three-quarters over trails that locally are moderately rough and moderately steep. Cliffs, some more than 50 feet high, are present in the area and ***young children should be carefully supervised***. *NOTE*: *Neither water nor sanitary facilities are found in the area.*

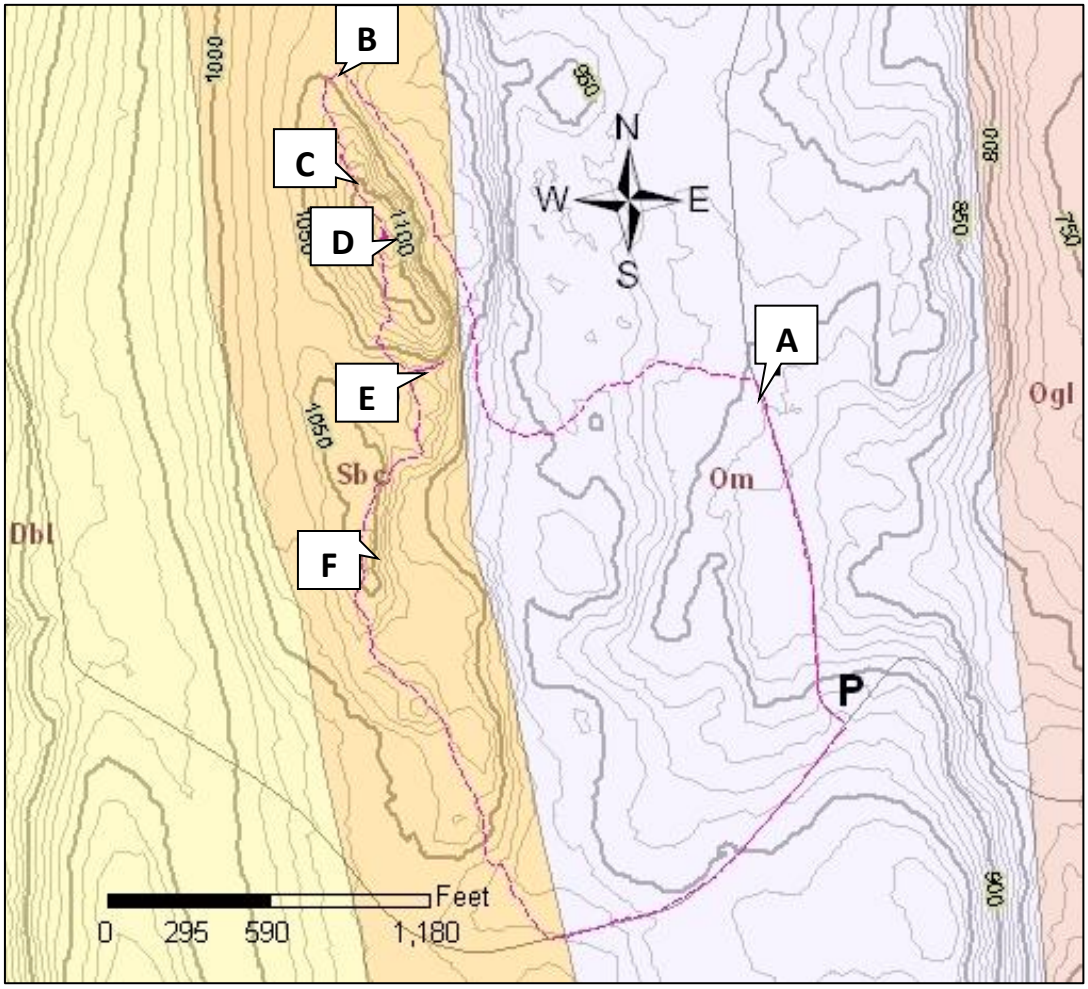

Figure 2. Geologic map (Rodgers, 1985) showing the trail and underlying geologic formations. The Monson Gneiss (very light grey, Om) and Glastonbury Gneiss (pink, Ogl) are the oldest rocks. They are unconformably overlain by the Clough Quartzite (orange, Sbc) which grades upward to the Littleton Formation (yellow, Dbl). P is the parking area off Crow Hill Road; the numbers refer to the way-points mentioned in the Trail Guide. Contour interval: 10 feet.

The Garnets

Garnets are found on many of the outcrops at the top of the cliffs. The best garnet locality we have found is the very top of the hill. A prominent mid-sized fold in the bedrock can be seen that is a product of the same metamorphism that formed these garnets (Figure 3a). These conditions allowed for the garnets and muscovite to grow along the fold. The garnets are up to 3mm in diameter (Figures 1 and 3c) and found in bands parallel to the foliation (layering) that is seen in the fold (Figure 3c and d). Muscovite is illustrated in the enlarged Figure 1 but may be easily seen by close inspection of the outcrop (see enlargement of Figure 1).

The garnets at the top of Quartzite Hill have a unique crystal shape. They appear to be "trapezohedral[2]" rather than the normal "dodecahedral" (or diamond) shape. Most of the garnets at Connecticut Garnet Trail localities elsewhere are "dodecahedral" and are different from these.

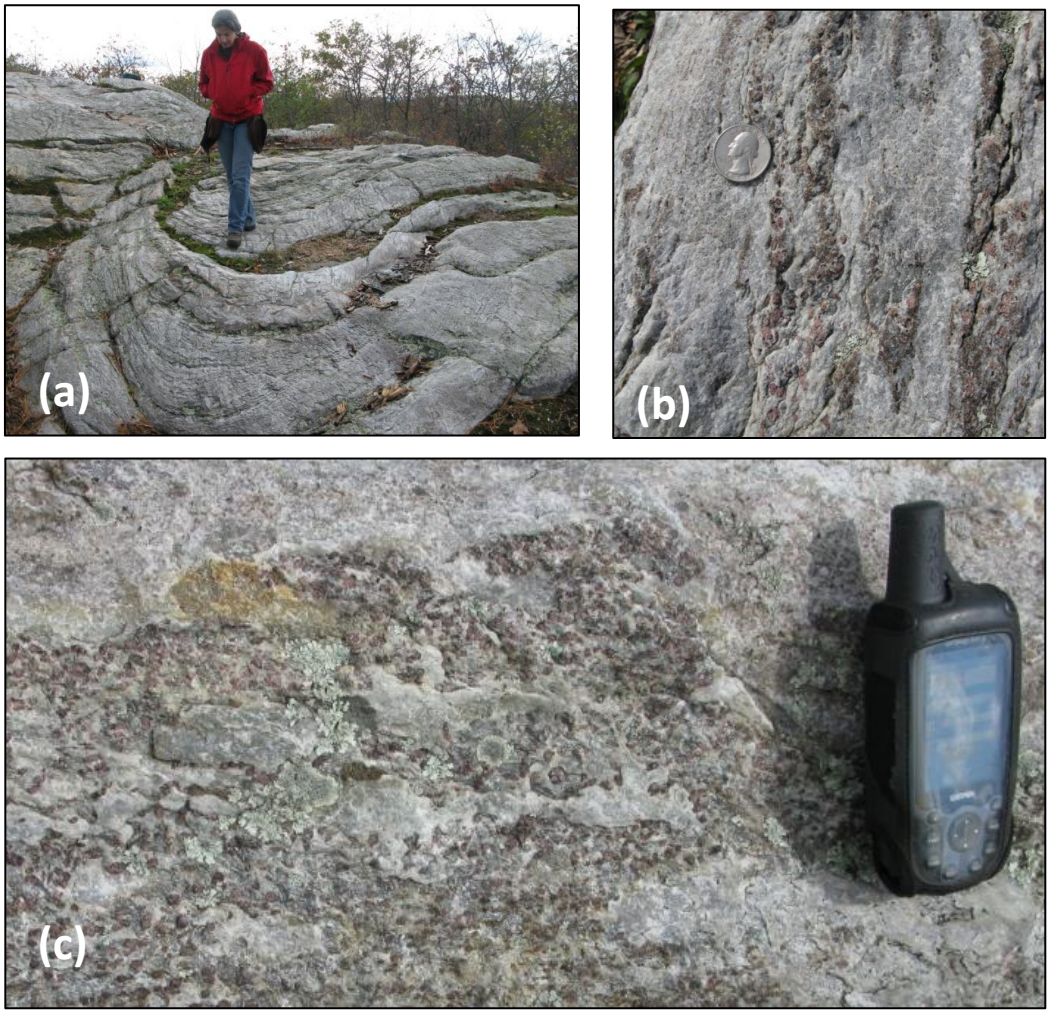

Figure 3. (a) The bedrock fold in quartzite near top of Quartzite Hill. The foliation ("layering") is visible below geologist's feet. (b,c) Detail of foliation. Garnets are 1-3 mm in diameter and line up with the foliation.

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2. **Trapezoid:** a shape that has 1 set of long/short parallel sides and 2 sides that open away from each other; a half hexagon).

Trail Guide

The parking area (labeled P on Figure 2) is located in front of a locked gate (at the following coordinates for those of you with a GPS unit: **N. 42º01.254', -072º20.322'**). Be sure to park out of the way as some days several cars may use this area. **Note* The area is open to hunting during the various seasons and bright clothing is recommended*. Figure 2 is a map of the area showing the trail. Follow the forestry service road north about a quarter mile to an intersection on the left with another service road (**way-point (A)**; Figure 2). Follow this second road west. It will gradually climb a gentle hill and the road will get rough in places. Do not take the small trails that branch to the left. In about a quarter mile the road will swing around to the north. If the trees are bare of their leaves you will notice cliffs (see Figure 4a) to your west (left). These cliffs are composed of Clough Quartzite. Eventually this trail will go around the end of the cliffs and climb a hundred feet to get to the top.

First, continue going north on this road for a little more than a quarter mile where the trail will branch. Turn sharply left at the branch (**way-point (B)**) and begin climbing the hill. The trail will swing around and head south as it climbs. A little more than 100 yards up the hill (**way-point (C)**) you will pass a huge boulder composed of Glastonbury Gneiss. It sits on top of the Clough Quartzite. This is a *glacial erratic*, or a bolder left out of place by the glaciers. It looks precarious but several groups of students have not found a lever sufficient to topple it.

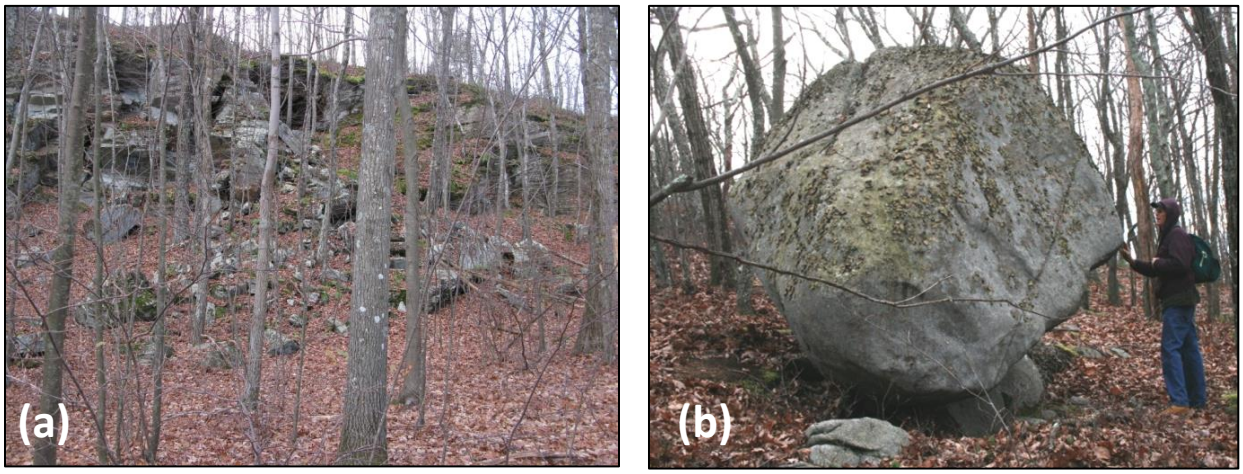

Figure 4. (a) Cliffs to west of trail prior to reaching way-point (B). This is near the northern end of the Quartzite Hill segment. Note rubble strewn at base of cliff, likely the result of a rock fall after the Ice Age glaciers had melted. (b) Glacial erratic composed of Glastonbury Gneiss perched on top of Clough Quartzite. Figure 4b by Gary Robbins.

Continue past the *erratic* and notice that the ledge is composed of quartzite. You may be able to find some with garnet and/or staurolite. You are near the top. Straight ahead you will notice the rock layers have been folded into a U-shape (see Figure 3a; **way-point (D)) N.**

42º01.535', -072º20.698'. This fold formed when the rock layers were deeply buried, allowing them to reach high temperatures. Because they were hot, instead of breaking or crumbling, they buckled. If you look carefully at the ledge in this area, you will find there are many small and mid-sized folds in the rock.

Here you will find garnets in abundance. Some of the concentrations have mica with the garnets, others do not. Although not confirmed at this time, it is possible that alternating beds of shale and schist once existed along many of the bedding planes of this rock but were dissolved during the metamorphic event. Original clay minerals in the shale could have provided the necessary chemical ingredients to form garnet (and muscovite mica), including iron and aluminum.

At this location the elevation is about 1125ft and there are cliffs to the east and steep hills to the west. To the west (Figure 5a) you can make out the Connecticut River Valley in the distance; it is about 30 miles away. The valley is underlain by sedimentary rocks that were more easily eroded by the glaciers and the river and hence form a low area in the landscape. Note that the highlands both east (closer) and west (further) of the valley have about the same general level (elevation). They are underlain by metamorphic rocks. To the east, you can look out over rolling hills (Figure 5b). On a clear day you can see faintly a distant gray mountain standing slightly higher than the near hills. This is Wachusetts Mountain (elev. 2006ft) which is about 40 miles away.

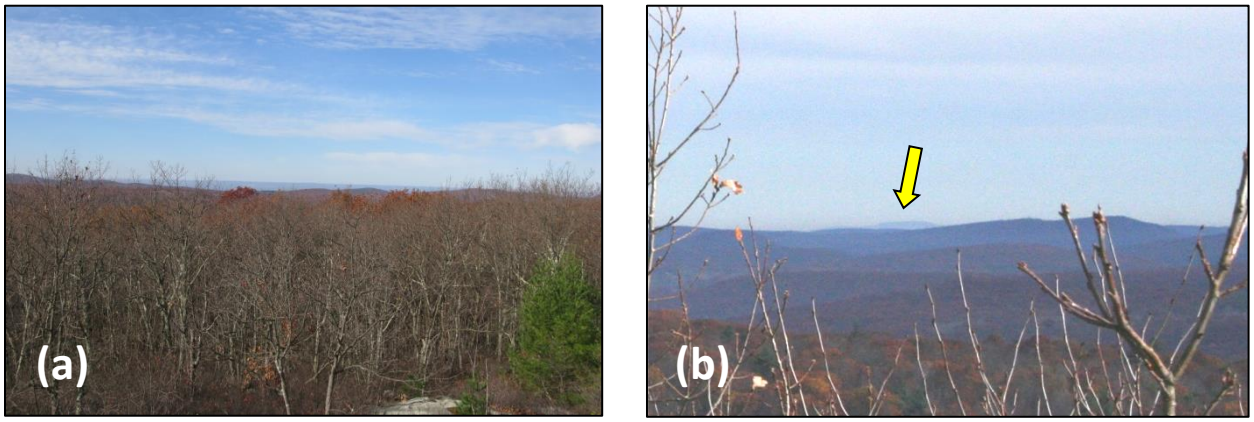

Figure 5. (a) View from Quartzite Hill to the west-southwest in the general direction of Windsor Locks. Soapstone Mountain is out of view on the left. The grey hills forming the distant skyline are the hills just east of Barkhamstead. The Connecticut Valley occupies the lowland west of Soapstone and east of Barkhamstead. (b) View toward the east-northeast in the general direction of Wachusetts Mountain in Massachusetts. The gray mountain peeking over the skyline in the middle is Wachusetts Mountain (yellow arrow). Figure 5b photograph by Gary Robbins.

When you continue south along the trail you will see the outcrops to your east. It is worth looking at some of these ledges, although the garnets included in the rock are neither as large

nor as plentiful as at the top of the hill. You will find the layers are folded, but not as dramatically.

Continue southward about 150 yards (**way-point (E)**) to where the hills to your east become lower (this may be difficult to see when the trees have leaves on them) and turn toward the east. There should be a path that goes east on nearly level ground and then drops off. There you will be at the base of 15-25' high cliffs that become higher toward the north. The layers exposed on the edge of the cliff have been folded into a broad mid-sized fold (Figure 4). The quartzite beds here are massive and several feet thick, suggesting it is near the bottom of the formation. Although the grain-size (size of individual "pieces") is medium-to coarse-grained, the rocks do not appear to be conglomerate or even pebbly (like the original rocks that the quartzite came from), so the lowest layers seen here are not the base of the formation.

Here you can take one of two routes, one is shorter, the other has more interesting features:

Shorter Route: Continue down the steep hill (note that the path loses its definition when the slope increases) and intersect the logging road that you came on from the parking area. This will be a little quicker, but you will miss seeing the pebble quartzite-conglomerate. This route requires caution because the hill is very steep and may be slippery when icy or muddy. It may also be rocky and this route is not recommended if you do not have sturdy foot wear. Turn south (right) when you get to the service road and retrace the trail back to the parking area.

Alternate Route: Go back (west) to the main ridge-top trail and turn south (left). Follow this trail about 50 yards over a gentle hill. Eventually you will come to a low ledge (large, flat exposed rock) that drops steeply down to the right. Leave the main trail and cross down the ledge. Another trail is at the bottom. Follow that trail west, down across small bridge over a seasonal brook and steeply up the next ridge. Once on top of the next ridge, head southward. In about another 100 yards the trail will traverse rockier quartzite ledges (**way-point (F)**). Notice, that these rocks are much more "pebbly" than those at the top of the hill (Figure 6). This quartzite is made up of quartz pebbles up to 2.5 inches in length that are shaped like stretched, oblong footballs. Quartz pebbles found on beaches and in rivers are not normally as oblong as these. We infer that they were stretched during deformation of the rocks here rather than deposition.

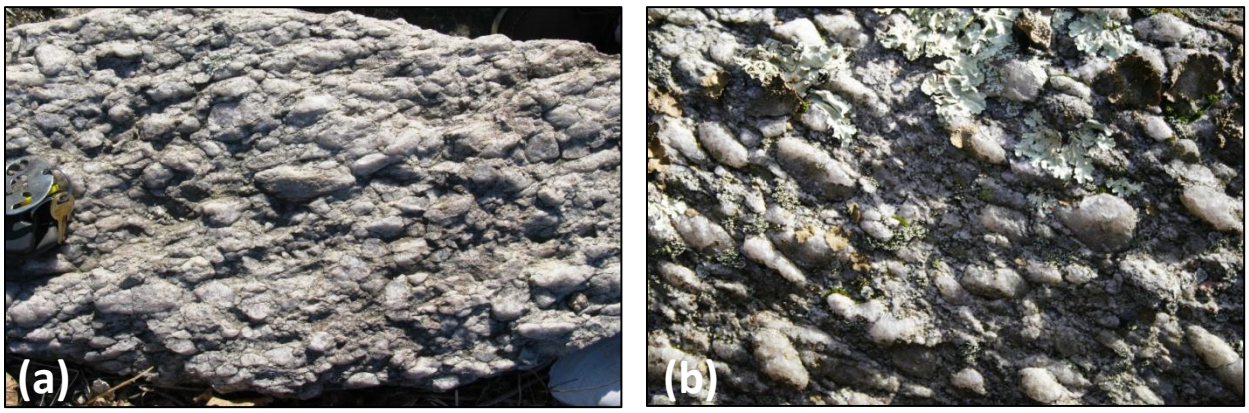

Figure 6. Quartz-pebble conglomerate. (a) Quartz pebbles are elongate to a greater amount than normally found in streams or along beaches. This in interpreted to be a result of the deformation undergone by this rock. Disc on key chain (left center) is approximately 2" in diameter. (b) Pebbles in this image are about 2" in length (maximum) and have up to a 3:1 ratio in the long:short axes of the grains. (Photograph 6b by Gary Robbins).

Follow the trail southward through mountain laurel forests, past a local quarry that produced a limited number of foundation and stoop stones, across a wet area that after rainfall and during the spring is practically swamp-like and eventually to Crow Hill Road. Your feet may get wet. Turn east (left) on Crow Hill Road and follow it back to the parking area.

Directions

The Quartzite Hill garnet location is north of Stafford Springs near the CT/MA border in part of the Shenipsit State Forest. To get there, take Rte. 32 N (exit 70 off I-84), through Stafford Springs, where it merges with Rte. 190 after the second exit off of the rotary. About a mile after merging, Rte. 190 bears left and Rte. 32 right: stay right on Rte 32. Continue about 3.75 mi north on Rte. 32 and look for Crow Hill Road on the left. It is immediately on your left when you first see State Line Pond on your right. If you miss it, take a left on State Line Road, which is about a long city block farther north: it will intersect Crow Hill Road. If you cross the state line and go into Massachusetts, turn around and come back. Follow Crow Hill Road about 1.25 miles and, nearing the top of a grade after a sharp left curve, find a parking area on the right at a Forestry Department service road. The trail initially follows service roads but later ascends a steep ridge and follows the ridge-top (there will be some spectacular views).

Reference:

Pepper, J.D., 1977, Bedrock Geologic map of the Monson Quadrangle, Massachusetts and Connecticut (1:24,000). U.S. Geological Survey. Geol. Quad. Map GQ-1374

Rodgers, John, 1985, Bedrock Geological Map of Connecticut (1:125,000). State Geological and Natural History Survey of Connecticut, Nat'l. Resource Atlas Series

Stone, J.R., Schafer, J.P., London, E.H., DiGiacomo-Cohen, M.L., Lewis, R.S., and Thompson, W.B., 2005, Quaternary Geologic Map of Connecticut and Long Island Sound Basin (1:125,000). U.S. Geological Survey. Sci. Invest. Map # 2784.

IMPORTANT: *Please do not collect the minerals. Collecting minerals is prohibited on state land. These minerals are for all of the citizens of Connecticut to enjoy. Please be considerate of others and take nothing but photos. Thank you for your cooperation!*

Garnet Trail funded through DEEP Greenways program (National Recreational Trails Program funding) to develop educational information on the Connecticut State Mineral, Almandine garnet. Locations chosen to promote a greater awareness of our State Mineral and showcase the variety of garnet occurrences on State Land.

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