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Cataclastic and Plutonic Rocks within and West of the Clinton-Newbury Fault Zone, East-Central Massachusetts

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Trips A-15 & B-15

CATACLASTIC AND PLUTONIC ROCKS WITHIN AND WEST OF THE CLINTON-NEWBURY FAULT ZONE, EAST-CENTRAL MASSACHUSETTS

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Introduction

This trip will examine the Clinton-Newbury fault zone and adjacent rock units exposed in the southern two thirds of the Ayer 7½ minute quadrangle, Massachusetts.

The Clinton-Newbury fault zone is the dominant geologic feature of this area. It separates and includes contrasting lithologic elements. West of the zone, the bedrock is dominated by the Ayer Crystalline Complex(Gore, 1976), a series of closely related, predominantly felsic plutonic rocks, and a series of clastic metasediments. East of the zone is the Tadmuck Brook Schist(Bell and Alvord, 1974), a series of clastic and volcano-clastic(?) rocks. A fault sliver containing the type locality of the Harvard Conglomerate exists within the wide imbricate zone in the vicinity of Harvard Center.

Tadmuck Brook Schist

The Tadmuck Brook Schist is a rusty schist unit that can be traced continuously from Shrewsbury to Lowell Massachusetts. The unit is a coarse muscovite schist containing varying amounts of biotite, quartz, pyrite and sillimanite or andalusite. Secondary sulfates may be found along joint surfaces. Thin beds of semipelitic rock are often present.

In weathered outcrops this unit displays a distinct rusty brown color. This distinct appearance has led some workers to assume that a time equivalence exists between many of these euxinic schists at different locations in New England.

Clinton-Newbury Fault Zone

The Clinton-Newbury fault zone shows considerable variation in width and character where it crosses Harvard and Littleton Massachusetts. The zone is between 3000 to 5000 feet wide in the vicinity of Harvard Center and is characterized by Protomylonite(?), blastomylonite, mylonite gneiss, and narrow zones of mylonite or mylonite schist. These cataclastic units grade into or sharply cut the large slivers or blocks of plutonic and metasedimentary material that dominates the bulk of this zone.

Two miles to the northeast of Harvard Center the fault zone narrows to less than 800 feet wide and contains both finely

laminated and nonlaminated mylonite and blastomylonite.

The zone widens again so that in Littleton, 2.4 miles further northeast, it is over 2000 feet wide and is dominated by mylonite gneiss, blastomylonite and minor mylonite schist. None of the finer grained cataclastic rocks seen here show the pronounced fine laminations seen in the narrow segment of the fault zone.

Harvard Conglomerate at Pin Hill

The Harvard Conglomerate at Pin Hill has been the subject of much debate in arguments concerning regional correlation. Emerson(1917), Jahns(1952) and Hansen(1956) all dated the surrounding units of the Ayer Crystalline Complex as Pennsylvanian or post Pennsylvanian based on their belief that the Harvard Conglomerate was intruded by these plutonic units.

Grew and Robinson(in Grew, 1973) interpreted the contact on the west side of Pin Hill as an unconformity.

During the mapping of the Ayer quadrangle(Gore, in preparation), it was discovered that a narrow zone of cataclastic rock occasionally accompanied by silicification separates the Harvard Conglomerate from plutonic rocks on the east side of Pin Hill. The conglomerate on the west side of Pin Hill is also separated by a fault(Gore, 1976) from the adjoining plutonic rock but the zone of cataclasis is narrow and silicification is not as prominant as on the east side. These faults appear to be splays of the Clinton-Newbury fault zone.

The presence of these faults does not necessarily preclude the earlier interpretations as major slippage along contacts is not uncommon. However, the presence of similar cataclastic rock on three sides of Pin Hill(east, west and north) strongly suggests that on a macroscopic level the Harvarvard Conglomerate at Pin Hill is a fault splinter.

Ayer Crystalline Complex

The Ayer Crystalline Complex lies in a belt which runs southwest to northeast through the center of the Ayer quadrangle. The rocks vary in composition from quartz diorite to granite, with the majority of the rocks falling within the narrow composition band between granite, close to the quartz monzonite boundary, to granodiorite.

The complex is composed of three major facies, the Clinton Quartz Monzonite, the Devens-Long Pond Gneiss and the Chelmsford Granite. Other facies exist but these generally appear to be border and/or residual phases directly related to the three major facies.

Within this belt are rock bodies, some of significant size (mappable on a 1:24,000 base), such as fine grained, banded biotite gneiss and quartz diorite. The relationship of these rocks to units of the Ayer Crystalline Complex is still uncertain.

Clinton Quartz Monzonite: The predominant subfacies is a porphyritic, slightly to moderately foliated, coarse-grained rock. Local zones of intense foliation have been observed.

The megacrysts are microcline microperthite averaging 5 cm in length with 10 cm lengths not uncommon. The other major minerals are saussuritized plagioclase(albite to sodic oligoclase), quartz, and biotite. Accessory minerals are apatite, zircon, an un unidentified opaque, sericite, muscovite(well developed flakes), epidote, allanite, clinozoisite(?), chlorite, and a carbonate mineral.

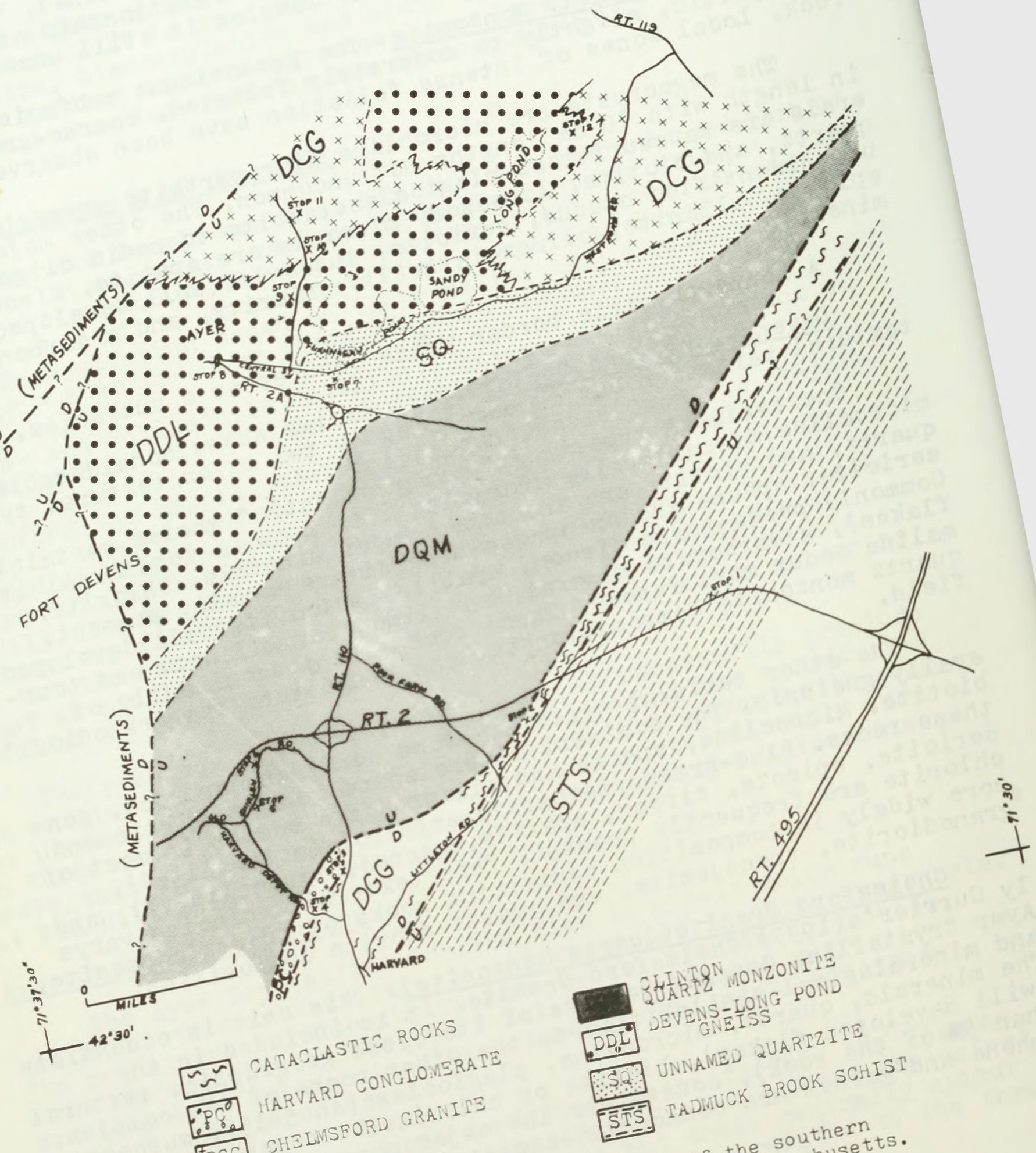
A nonporphyritic border phase occures as a subfacies.

Devens-Long Pond Gneiss: This facies shows considerable textural variation but is dominated by two major textural types.

One textural type is a "porphyroblastic" gneiss containing microcline microperthite averaging 1 to 2 cm in length. Albite, quartz, and biotite are the other major minerals. Chlorite, sericite, sphene and an opaque mineral are usually present. Commonly present are zircon, apatite, muscovite(well developed flakes), a carbonate mineral, and limonite. Allanite and tourmaline occur more rarely. These rocks are predominantly of quartz monzonite composition but can range into the granodiorite field.

The other textural type is a more equigranular rock, generally gneissic. The dominant minerals are quartz, albite and biotite. Microcline, sphene and allanite are common in most of these rocks. Blue-green pleochroic amphibole(actinolite?), sericite, epidote, zircon, apatite, garnet, tourmaline(?), and chlorite are frequently present. This textural subfacies varys more widely in composition cantaining rocks of quartz monzonite, granodiorite, trondjemite, and quartz diorite composition.

Chelmsford Granite(Quartz Monzonite): This unit is essentially Currier's(1937) Chelmsford Granite. It is included in the Ayer Crystalline Complex because of its close geographic, textural and mineralogical similarities to the other rocks of the complex. The minerals, quartz, microcline, plagioclase(An 5-13), muscovite (will developed flakes), biotite or chlorite(both generally less than 5% of the rock), constitute the major phases. Epidote, zircon, sphene and garnet are common accessories.



Generalized Geologic and location map of the southern portion of the Ayer $7\frac{1}{2}$ minute quadrangle, Massachusetts.

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ROAD LOG

All stops on this trip are located on the Ayer 7½ minute quadrangle, Massachusetts.

This trip begins at the first rest area on Route 2(west), approximately 1 mile west of the intersection with Interstate 495. A sign reading "1500 ft. rest area" alerts the driver to the rest area.

Mileage

0.00 Intersection of rest area exit road and Route 2.

Proceed west on Route 2.

0.40 Stop 1: Curbing ends at the west end of the first large road cut. Pull over onto shoulder at this point. Here, the Tadmuck Brook Schist contains some siltstone intercalations which may show thickening and thinning and boudinage.

The brown rust color seen on some joint surfaces and near the top and east end of the outcrop is brighter but more characteristic of the color seen in natural exposures.

Some vein quartz is present both parallel and at an angle to the foliation.

Continue west on Route 2

1.90 Optional Stop: Second rest area. Clinton Quartz Monzonite close to main trace(about 1000 feet to the east) of Clinton-Newbury fault. Narrow zones of shearing can be seen along the length of exposure.

Proceed west on Route 2.

2.85 Take Routes 110-111 exit toward Ayer(north).

3.35 Turn right(east) from Route 110 onto Poor Farm road.

3.80 Many of the stones in these walls are examples of the poorly exposed coarse non-porphyritic subfacies of the Clinton Quartz Monzonite.

4.65 Turn left(north) onto Littleton road.

5.10 Stop 2: Park on the shoulder just north of the dip in the road beyond the white barrier posts where the road starts up toward a turn.

Walk into the low area just west of the white barrier posts. Large natural exposures can be found on both sides of this low area. This series of outcrops is an almost complete section across a narrow portion of the Clinton-

Newbury fault zone. This cataclastic rock suite (see text) contains some finely laminated mylonite gneiss (hartschiefer) which could easily be mistaken for a finely layered sedimentary rock.

Reverse direction and head south on Littleton road.

7.1 Road ends at intersection with Route 110, turn right (north) toward Ayer.

7.35 Optional Stop: Outcrop along Route 110.
A plutonic rock probably consanguineous with one of the units of the Ayer crystalline complex. It is cut by numerous shear zones containing protomylonite(?).

Continue north on Route 110.

7.75 Road goes into hallow bounded by white sheet metal deflection barriers. About 50 feet beyond the end of the barriers as the road starts up hill, turn sharply left onto an abandoned road and park. (Careful of traffic coming over hill when turning!)

Stop 3: Walk north along the road to outcrop.
This plutonic rock, probably part of the Ayer crystalline complex, borders the Harvard Conglomerate on the east. Narrow shear zones cut this outcrop.
Walk back to old road. Proceed down old road until approximately opposite the barriers on the main road.
On a bearing of N40-45W proceed to base of closest steep face of Pin Hill. Along the base of this slope is the sharp contact between the Harvard Conglomerate and a cataclastic rock.
The conglomerate can be seen to good advantage up the slope from the contact. Look on the underside of protruding outcrops and boulders. Distinct tectonic stretching of the pebbles is common.
Moving northeast along the contact some concentrations of hydrothermal quartz can be seen. This contact can be followed around the hill to the northeast side.

Return to car and proceed south back along Route 110.

8.05 Turn right(west) onto Harvard Depot road.

8.30 Stop 4: In roadcut at high point in road opposite Tensitron sign.
The two faults bounding the Harvard Conglomerate at Pin Hill can be seen here but not to best advantage.
Notice that on the west side of the exposure, the metasediments rapidly give way to a relatively homogeneous green-grey schistose rock with small red patches and small knots of grey, glassy quartz. Megascopic examination

will reveal that this material is similar to the cataclastic rock at stop 3. Microscopic examination clearly establishes the cataclastic origin of this rock.

Return to car. Continue along Harvard Depot road.

8.50 Intersection of Mill road. Continue straight ahead. Outcrop on NW corner shows the porphyritic phase of the Clinton Quartz Monzonite.

8.70 Bear right onto Craggs road.

9.07 Intersection of old Shirley road. Turn right(north)

9.25 Stop 5: A typical exposure of the dominant porphyritic subfacies of the Clinton Quartz Monzonite. This location is near the narrow transitional boundary with the non-porphyritic subfacies.

Proceed north along old Shirley road.

9.50 Stop 6: Outcrop of the non-porphyritic subfacies of the Clinton Quartz Monzonite.

Continue along old Shirley road.

10.00 Old Shirley road ends at the intersection with Route 110. Turn left(north)

12.30 Entering rotary. Exit rotary along Route 2A(west) toward Ayer. Immediately upon leaving rotary, turn right into driveway marked by "Cains" sign.
Follow driveway around through parking lot toward the back of the building. At road intersection just before railroad tracks, turn right onto road paralleling the railroad tracks.

12.67 Stop 7: A small outcrop in the clearing to the right of the road.
This quartzite outcrop appears to show rhythmic sedimentation and possible penecontemporaneous deformation. This unit is one possible source for the clasts seen in the Harvard Conglomerate. (No hammers please)
Question: which way toward tops?

12.78 Continue along this service road to intersection, turn right and return to rotary. Exit rotary as before but proceed along Route 2A(west) past Cains property.

Continue over railroad bridge into Ayer Center.

13.88 Turn right(north) onto Washington St. Street marked by large "H"(hospital) sign.

13.92 Turn right onto Newton St. Park in municipal parking lot.

Stop 8: Large outcrop(No Hammers) on the southeast side of lot. This is an outcrop of the "porphyroblastic" subfacies of the Devens-Long Pond gneiss. Notice the shear zone cutting the outcrop and the thickening and thinning of the feldspathic veins.
The simplest explanation for the origin of this material and its mesoscopic texture would be intrusion under syntectonic conditions. However, some evidence(Gore, 1976) exists to support the hypothesis that this material may be the result of K-feldspathization and blastisis of a possible volcanic sequence.

Drive to the end of the street. Turn right onto Columbia St. and then turn left onto Central St.

14.22 Optional Stop: Large road cut in the "porphyroblastic" subfacies of the Devens-Long Pond Gneiss.

14.40 Turn left(north) at intersection onto Harvard-Groton road.

14.90 Stop 9: Road cut on west side of road.
"Porphyroblastic" subfacies of the Devens-Long Pond Gneiss cut by pegmatities and dikes of fine Chelmsford Granite. Thin section examination will reveal myrmekite rims around most of the K-feldspar from this location.

14.98 Optional Stop: Devens-Long Pond Geniss cut by coarse pegmatitic phase of the Chelmsford Granite.

15.20 Stop 10: Contact phase of the Chelmsford Granite.
Abundance of pegmatoid bodies a common feature of Chelmsford Granite contacts.

15.40 Stop 11: Under transmission lines.
Ledges on hill on the north side of the transmission line clearing are typical Chelmsford Granite.

Reverse direction and return to Central St.

16.40 Turn left(east) onto Central St.

18.25 Bear left at fork following Westford road sign.

19.25 Turn left(West) onto dirt road at sign "SRC"- Shanklin Research Corp. Park at the back of parking lot or if in rugged vehicle drive west on dirt road.
Stop 12: Along southwest side of Rocky Hill.
Different varieties of the Devens-Long Pond Gneiss can be examined in the ledges north of the road. Pegmatites and Chelmsford Granite cut the Devens-Long Pond Gneiss.

Be sure to go at least as far as the large smooth steep outcrop that runs in an almost continuous ramp from the top of the slope down to the bottom.

To return to Route 495, continue north on Westford road.

20.00 Turn right(east) onto Route 119 and continue until reaching Interstate Route 495.