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Trips A-3 & B-3

THE BLUE HILLS IGNEOUS COMPLEX

BOSTON AREA, MASSACHUSETTS

by

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The essential rock units of the Blue Hills Igneous Complex are the following:

(1) Aporhyolite (felsic volcanics, partially devitrified),

(2) Blue Hills Porphyry (microperthite, quartz porphyry with varying amounts of fine-grained matrix),

(3) Quincy Granite (microperthite, quartz, hornblende, aegirite, medium- to coarse-grained, peralkaline, holocrystalline granite).

The Aporhyolite and the Blue Hills Porphyry are well exposed in the Blue Hills highlands, whereas the Quincy Granite underlies the lowlands immediately to the north. To the north of the Blue Hills lies the (Upper Devonian (?)) Boston Basin and to the south lie the (Carboniferous) Norfolk and Narragansett Basins.

Our work, and hence this field-trip, is concerned chiefly with the units discussed above. An earlier N.E.I.G.C. Trip (Chute, 1964) provides a broader sampling of the units exposed in the area. The units are mapped and described by Chute (1966 and 1969), the latter reference being a 7½-minute geologic map of the trip area. Although we do not disagree with the correlation, we prefer to retain the earlier name, "Aporhyolite," for the felsic volcanics of the Blue Hills area rather than lumping them with the Mattapan Volcanics as Chute did. Also, we prefer the usage "Blue Hills Porphyry" to Chute's "Blue Hills Granite Porphyry."

Like so many units in the Boston area, the Blue Hills units have proved very hard to date. Three recent papers (Bottino and others, 1970; Zartman and Marvin, 1971; and Lyons and Kreuger, 1976) discuss isotopic ages for these rocks. As we will see, the age-patterns are complex and even after considerable interpretation cannot be wholly reconciled with the field data. We are concerned that heretofore there has been insufficient interaction between the field and isotopic data. Chute's publications are based on fieldwork substantially completed in the thirties; he had access only to the preliminary isotopic results of Bottino (1963) and of Zartman (written communication). The mission of Sayer's thesis (Sayer, 1974) under Naylor's supervision was to re-examine the critical field relationships in light of the isotopic data. In so doing, we have found it profitable to focus on the Blue Hills Porphyry.

THE PORPHYRY PROBLEM

Earlier workers in the Blue Hills area (Warren, 1913; Chute, 1940) believed that the Blue Hills Porphyry was a chilled border phase of the Quincy Granite and that the Aporhyolite was an extrusive expression of the same series of magmas. Our study supports this conclusion.

The possibility exists, however, that the Blue Hills Porphyry might be a significantly younger unit. Taken at face value, the Rb-Sr data of Bottino and others (1970) suggest an age of 280 million years (m.y.) for the Blue Hills Porphyry, whereas all the isotopic data suggest the Quincy Granite is considerably older. Noting the apparent conflict with the field relationships, the geochronologists have mostly concluded that the Porphyry has been disturbed -- that its apparent isotopic age probably does not reflect the true age of intrusion. It is interesting to note, however, that several of the field geologists concerned with the problem have taken the opposite stance. Influenced by the isotopic results, Chute (1969) pointed out that the field relationships do not provide conclusive data for determining the age of the Blue Hills Porphyry relative to the Quincy Granite, and reversed his earlier conclusion that the Porphyry was the older of the two units. In a similar vein, D.R. Wones and D.K. Riley (1971, personal communication) suggested to us that at least part of the Blue Hills Porphyry might be of Carboniferous age. They were influenced partly by the Rb-Sr data (the isochron for the Porphyry is remarkably straight for a disturbed system) and partly by their interpretation of the contact relationships of the Porphyry with the Carboniferous Pondville Conglomerate as seen at the large roadcut at the intersection of Routes 28 and 128 (STOP 7). Some features of this roadcut, constructed after the completion of most of Chute's fieldwork, can be interpreted to suggest that the porphyry grades into the Pondville Conglomerate. This would suggest a Carboniferous age for the Porphyry, compatible with the 280 m.y. isochron.

One of the earliest results of Sayer's field work was to show the lack of any lithologic basis for separating a Carboniferous porphyry unit from the main body of the Blue Hills Porphyry. Although the unit is highly variable in character, there are no consistant areal differences and the entire unit appears to be of the same age. Warren (1913) had noted that the Blue Hills Porphyry and the Quincy Granite are closely similar in their major-element chemistry and in their mineralogy. Both are alkaline or peralkaline in chemistry and both contain distinctive minerals like riebeckite and astrophyllite. Sayer (1974) analyzed the Blue Hills Porphyry for trace-elements and showed that it has the same distinctive trace-element distribution patterns as the Quincy Granite (Buma, Frey, and Wones, 1971). The close similarity of the Blue Hills Porphyry and the Quincy Granite in so many distinctive features strongly suggests that they are co-magmatic and hence should be similar in age.

To resolve this controversy it would be helpful if one could prove the earlier contention that the Blue Hills Porphyry pre-dates the Quincy Granite. We have been unable to prove this, and agree with Chute (1969) that the contact relationships are inconclusive on this point. Several of the lines of evidence are discussed in the descriptions of STOP 2 and STOP 4 of this trip. We can only say that there is a considerable body of evidence suggesting that the Blue Hills Porphyry and the Quincy Granite are consanguinous, and that, except for the Rb-Sr isotopic data, we can find no evidence to the contrary.

THE AGE PROBLEM

Because we conclude that the Blue Hills Porphyry and the Quincy Granite are comagmatic and of about the same age, we must explain the apparent conflict between this conclusion and the isotopic age results.

Bottino and others (1970) determined a sixteen point Rb-Sr whole-rock isochron with an age of 282 ± 8 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.717 for the Blue Hills Porphyry and a six point isochron with an age of 365 ± 7 m.y. with an initial Sr^{87}/Sr^{86} ratio of 0.703 for the Quincy Granite. Zartman and Marvin (1971) determined an eight point Rb-Sr whole-rock isochron with an age of 313 ± 22 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.731 for the Quincy Granite, with two points for the Blue Hills Porphyry lying on the same line. Each of the isochrons shows some scatter of the data and, because of generally high Rb/Sr ratios owing to the alkalic character of the rocks, the initial Sr^{87}/Sr^{86} ratios are not well defined. As an exercise we tried combining and "cleaning" these data. "Cleaning" involved removing several samples collected near alteration zones, several samples with poor analytical reproducibility, and several samples whose locations are uncertain. Some of Bottino's data were measured on samples previously collected by Billings for petrographic work rather than for age determination, and these samples were also dropped in the "cleaning" process. Our result was a thirteen point Quincy Granite isochron with an age of 319 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.725, and an eight point Blue Hills Porphyry isochron with an age of 281 m.y. and an initial Sr^{87}/Sr^{86} ratio of 0.722 ($\lambda Rb^{87} = 1.39 \times 10^{-1}$ yr^{-1}).

Zartman and Marvin (1971) reported K-Ar ages of 430 to 458 m.y. on six samples of riebeckite from the Quincy Granite and 301 m.y. on one sample of riebeckite from the Blue Hills Porphyry. They also dated one sample of zircon from the Quincy Granite with the following results: Pb^{207}/Pb^{206} age 437 ± 32 m.y.; Pb^{207}/U^{235} age 416 ± 15 m.y.; and Pb^{206}/U^{238} age 413 ± 8 m.y. We attempted to date the Blue Hills Porphyry but failed to obtain sufficient zircon from an 80 kg sample for an analysis.

We interpret these data to conclude that an age of approximately 420 m.y. (Late? Silurian) gives the best estimate of the time of intrusion of the Quincy Granite and the Blue Hills Porphyry. This is close to the lead/uranium ages of the Quincy Granite zircon sample. The Pb^{207}/Pb^{206} age of 437 is a reasonable upper limit for the time of emplacement but it may appear slightly too old owing to inherited radiogenic lead. Radon (intermediate daughter) loss could lower the Pb^{206}/U^{238} age, but the pattern of discordance does not suggest this effect has been important. The Pb/U ages are sensitive to later disturbances, but the low metamorphic grade of the rocks suggests this effect is slight. Because riebeckite contains little potassium, inheritance of small amounts of radiogenic argon could make the riebeckite K-Ar ages appear slightly too old.

How then do we explain away the Rb-Sr results. If the Blue Hills Porphyry and the Quincy Granite are comagmatic, both isochrons cannot be correct, and our conclusion is that neither is correct. Despite the fact that the "cleaned" isochrons are relatively straight (show relatively little scatter) we conclude that both isochrons are profoundly disturbed and suggest the following explanation. It is well-known that Rb-Sr mineral ages are easily disturbed and that radiogenic Sr^{87} readily migrates from Rb-rich minerals during very slight disturbances. Normal granites appear to behave as closed systems during such disturbances only because they contain minerals like plagioclase, apatite, and epidote that take up the labile Sr^{87} before it can leave the rock system. The alkalic Quincy Granite and Blue Hills Porphyry are notably lacking in such Sr-acceptor phases, hence it seems quite likely that radiogenic Sr^{87} could migrate entirely out of these rocks during even slight disturbances (and possibly may even continuously diffuse out of these rocks). If radiogenic Sr^{87} is not reabsorbed by the rock, it could be lost in direct proportion to the Rb-content of the rocks (the factor governing the place and rate at which radiogenic Sr^{87} is produced) hence, even though highly disturbed, the isochrons could appear straight and show little scatter.

NATURE OF THE IGNEOUS COMPLEX

Kaktins (1976) has shown that the Aporhyolite can be subdivided internally into a number of stratigraphic units, many of which appear to be of ignimbritic, ash-flow origin.

The Blue Hills Porphyry and the Quincy Granite are probably plutonic expressions of the same magmas that produced the Aporhyolite. These magmas appear to have been rather hotter and drier (see Buma, Frey, and Wones, 1971) than normal for granitic rocks, and they appear to have been emplaced at relatively shallow depths. Note that the plutonic rocks crystallized above the feldspar solvus to produce one-feldspar rocks. Aplite veins and pegmatites are rare, suggesting a hot, dry magma, although the Quincy Granite probably approached saturation with water in the latest stages of crystallization. The Quincy Granite (Buma, Frey, and Wones, 1971), and the Blue Hills Porphyry (Sayer, 1974) show considerably less depletion of the heavy rare-earth elements than is typical for granites. Such depletion is one of several indices of overall differentiation, hence these magmas appear relatively primative compared to other New England granites. We believe it is possible that the Blue Hills magmas are mantle-derived and have interacted only slightly with crustal materials.

REGIONAL RELATIONSHIPS

The Blue Hills Igneous Complex is probably part of a major belt of Late Silurian and Early Devonian volcanic and intrusive rocks along the southeastern margin of the Northern Appalachian Mountains. Gates (1969) has shown that the volcanic rocks of this belt include the Lynn Volcanics (Boston North Shore), the Newbury Volcanics, and the Pembroke, Edmunds, Eastport, and other volcanic units exposed on the east coast of Maine from Penobscot Bay to Eastport. We consider the Aporhyolite to be a volcanic member of this same belt.

As in the Blue Hills, the following alkaline, hypersolvus granites are probably closely related to the same general episode of igneous activity: the Peabody and Cape Ann Granites (Boston North Shore); Cadillac Mountain, Tunk Lake and related granites in the Bar Harbor area, coastal Maine; Red Beach and St. George Granites (Passamaquoddy Bay area, Maine and New Brunswick); and possibly the St. Lawrence and related granites in southeastern Newfoundland.

We would suggest that Rb-Sr dates on these granites (see Metzger, 1975; and Bell, 1974) may be subject to the same interpretive problems as encountered in the Blue Hills area. In terms of plate-tectonic reconstructions, this belt may indicate the presence of a major subduction zone in Late Silurian through Early Devonian time.

Chute (1969) correlated the Aporhyolite with the Mattapan Volcanics underlying the Boston Basin. While we prefer to retain the older name, Aporhyolite, for the volcanics of the Blue Hills area, we do not disagree with this correlation. Most, if not all, of the Mattapan Volcanics are probably of Late Silurian to Early Devonian age and are probably part of the volcanic belt discussed above. Why then have the Mattapan Volcanics commonly been assigned a younger age? The Brighton Volcanics interfinger with the sedimentary rocks of the Boston Basin, which are probably Upper Devonian or younger. Many previous workers (see for example, Billings, 1929) have inferred a gradational contact between the Brighton Volcanics and the underlying Mattapan Volcanics, and have used this relationship to "pull up" the inferred age of the Mattapan Volcanics. From the regional relationships we believe it is more likely that the Mattapan Volcanics lie unconformably beneath the Brighton Volcanics and the other units of the Boston Basin, and that there is no compelling reason to assign an age younger than Late Silurian or Early Devonian to the Mattapan Volcanics.

Finally, we would like to stress the relatively unmetamorphosed condition of the Siluro-Devonian (and even of the Late Precambrian) volcanic and igneous rocks along the east coast of New England and Maritime Canada. This places strict limits on the intensity of Acadian and post-Acadian metamorphism throughout much of this belt, although only a short distance to the northwest very intense Acadian metamorphism is widespread. As D.B. Stewart has so succinctly observed, there appears to be very little Acadian disturbance in Acadia itself. We believe that failure to appreciate this observation has prejudiced many previous attempts to date units along the southeastern margin of the Appalachians. The observation also raises the question as to whether this belt was as close to the Appalachian mainland in Siluro-Devonian time as it is today.

We conclude with some remarks on the dating of the Boston Basin units, for which we believe the most probable age is Late (?) Devonian. Most previous workers have correlated the Boston Basin with the nearby Norfolk and Narragansett Basins of Carboniferous age, but we can find no compelling reasons for doing so. We note similarities between the units of the Boston Basin and those of the Perry Basin (Eastport area, Maine) dated as Upper Devonian by plant fossils. Not far from the Perry Basin are clastic, red-bed units ranging in age from Mississippian through Triassic with which the Perry Basin no doubt would have been correlated had it not yielded Upper Devonian fossils. We know of no fossil evidence from the Boston Basin to contradict an age as old as Upper Devonian. It has long been appreciated that the Roxbury Conglomerate at the base of the Boston Basin sequence contains abundant clasts of felsic volcanics resembling those of the Mattapan Volcanics and the Aporhyolite. The Roxbury, however, lacks clasts of the deeper-seated Blue Hills Porphyry and Quincy Granite, whereas clasts of the Blue Hills Porphyry are abundant in the Norfolk Basin deposits. These observations could be explained simply by unroofing to progressively deeper levels if the Roxbury Conglomerate were regarded as pre-Carboniferous.

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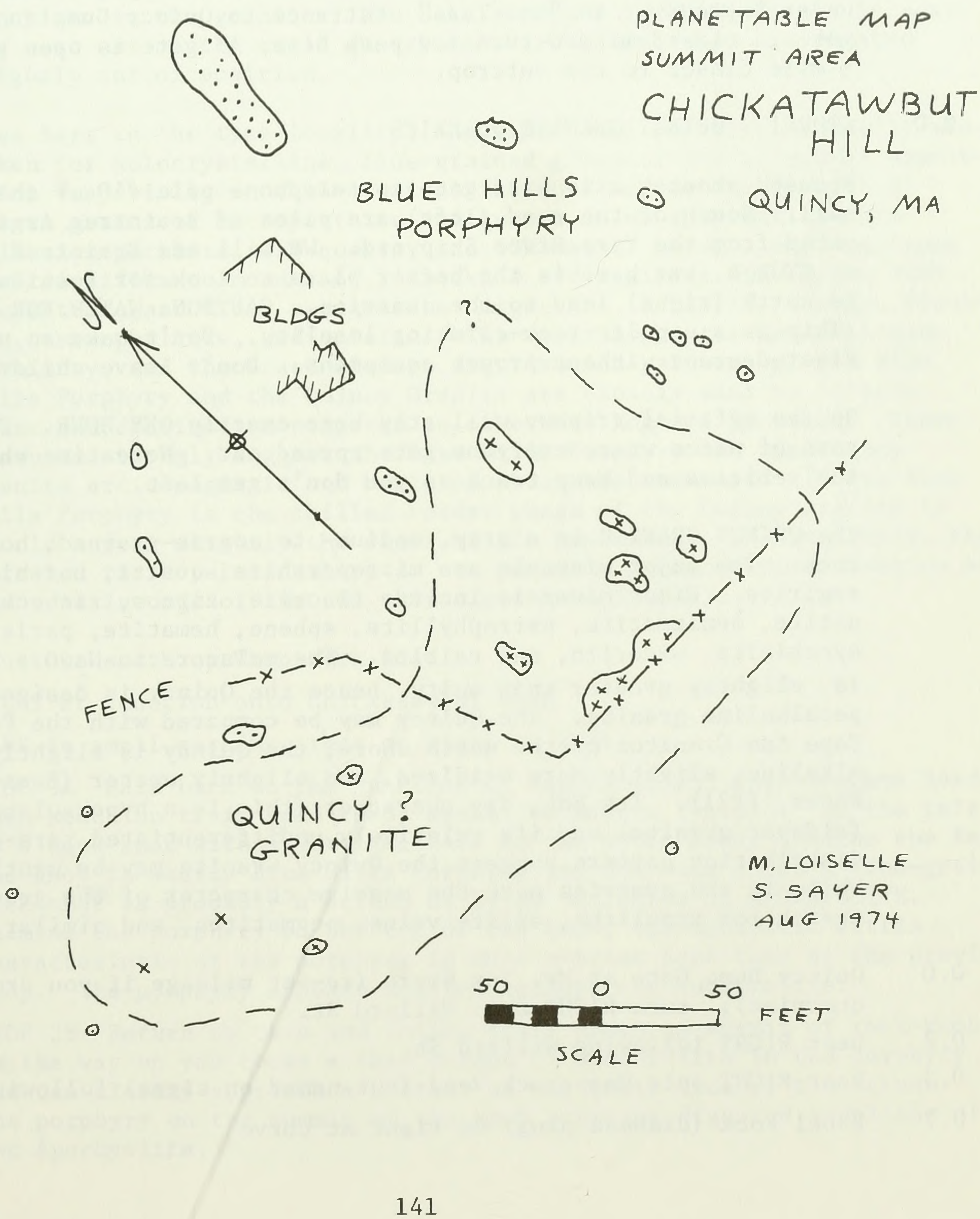
Sketch map to accompany STOP 4



ROAD LOG

MILES

Mileage count for this trip begins on leaving STOP 1. To reach STOP 1 from BOSTON UNIVERSITY proceed eastward on Commonwealth Ave to Massachusetts Ave; RIGHT (don't drop into underpass) onto Massachusetts Ave, thence south about 1½ miles to SOUTHEAST EXPRESSWAY SOUTHBOUND. (Massachusetts Ave passes under hospital and there may be construction detours; follow signs to Expressway.) Leave Expressway at EXIT 24, noting "Mr. Tux" Store on your right. This is your destination, but you are not allowed to backtrack on Willard St. to get there directly. Merge onto Willard St southbound then turn LEFT at interchange, passing under Expressway then back north following signs for Willard St. Turn LEFT onto Willard St (don't get back on Expressway), thence back under Expressway to "Mr. Tux." Entrance to Quincy Dump on right. If gate is closed make U-turn and park here; if gate is open you can drive ½ mile closer to the outcrop.

0.0 STOP 1 QUINCY GRANITE QUARRIES

Proceed about ½ mile past gate to telephone pole #10 at the top of the hill. South of the road (left) are piles of Braintree Argillite excavated from the Fore River Shipyard. We will see Braintree in place at STOP 6, but here is the better place to look for fossils. Trails to north (right) lead to the quarries. CAUTION: WATCH FOR SHEER DROPS! (This is a popular rock-climbing locality. Don't make an unanticipated first-descent without proper equipment. Don't leave children unattended.)

On the official trip we will stay here exactly ONE HOUR. This is the sort of place where everyone gets spread out. Note time when you leave the vehicles and keep track so you don't get left.

The QUINCY GRANITE is a grey, medium- to coarse-grained, holocrystalline rock. The major minerals are microperthite, quartz, hornblende, and aegirite. Minor minerals include fluorite, zircon, riebeckite, magnetite, aenigmatite, astrophyllite, sphene, hematite, parisite, synchisite, siderite, and calcite. The molar ratio $Na_2O + K_2O/Al_2O_3$ is slightly greater than unity, hence the Quincy is designated as a peralkaline granite. The Quincy may be compared with the Peabody and Cape Ann Granites of the north shore; the Quincy is slightly more alkaline, slightly more oxidized, and slightly wetter (Buma, Frey, and Wones, 1971). Its hot, dry character (this is a hypersolvus, one-feldspar granite) and its relatively undifferentiated rare-earth distribution pattern suggest the Quincy Granite may be mantle-derived. While in the quarries note the massive character of the granite and search for xenoliths, aplite veins, pegmatites, and similar features.

0.0 Quincy Dump Gate at Mr. Tux Store (re-set mileage if you drove into the quarries); turn RIGHT onto Willard St.

0.2 bear RIGHT following Willard St.

0.3 bear RIGHT onto Wampatuck Road (not named on signs) following MDC signs.

0.7 Babel Rock (diabase plug) on right at curve

1.0 PARK on right near beginning of straight stretch of road near wooden post inscribed "Rattlesnake Hill."

STOP 2 RATTLESNAKE HILL

The small quarry on the southeast side of the hill is the type-locality for the BLUE HILLS PORPHYRY. Somewhat back on the top of the hill the bedrock is Quincy Granite. To a first approximation the contact is gradational, the granite at this locality being somewhat porphyritic, but if your eyes become sufficiently attuned to the rock-types it is possible to locate a sharp line of contact. Over several meters the Quincy Granite grades through a fine-grained to porphyritic variety, thence over a few centimeters into true Blue Hills Porphyry. The actual line of contact is marked by an abundance of rhomb-porphyry xenoliths in the granite. The best exposure of this contact is near the west end of the small quarry in a loose slab that has rotated slightly out of position.

Even here in the type-locality, the BLUE HILLS PORPHYRY is easily mistaken for holocrystalline, fine-grained granite, but on closer examination (especially in thin-section) the rock is seen to consist of coarse grains of microperthite and quartz in an aphanitic matrix (41% microperthite, 12% quartz, and 47% matrix here). Thin-sections show significant amounts of riebeckite and aegirite intergrown with the matrix, and minor aenigmatite, magnetite, hematite, zircon, fluorite, astrophyllite, and calcite. The mineralogy, the major-element chemistry, and the trace-element distribution patterns of the Blue Hills Porphyry and the Quincy Granite are closely similar to each other and distinctive compared to other New England granites. These features strongly suggest the Blue Hills Porphyry and the Quincy Granite are comagmatic and hence of about the same age. If the Blue Hills Porphyry is the chilled border phase of the Quincy Granite it should appear slightly the older of the two units. Unfortunately, the detailed field relationships do not permit a clearcut determination of the relative age of the two units (see also STOP 4).

1.0 continue south on Wampatuck Road

1.5 RIGHT at junction onto Chickatawbut Road

1.6 PARK in small parking areas on right or left

STOP 3A Walk back to the junction of Wampatuck and Chickatawbut Roads, then south on trail (old road) about 100 meters (yards). To the left is a rock-knob with a vertical face on the south side; examine the face. The knob is mostly Blue Hills Porphyry but the face shows a fine-grained rock that is probably a screen or large inclusion of APORHYOLITE. Examine the porphyry on the top of the knob; the aphanitic matrix characteristic of the porphyry is more evident here than at the previous stop. The porphyry appears chilled against the Aporhyolite.

STOP 3B Return to cars and follow trail south to summit of rock-knob. On the way up you cross a thin screen of Aporhyolite in the porphyry and can closely approach a contact on the south side of the screen. The porphyry on the summit of the knob contains digested xenoliths of the Aporhyolite.

STOP 3C Return to parking area and follow trail north of road to summit of Wampatuck Hill. (Take LUNCH to eat on summit with good views over Boston.) The trail uphill is mostly in Blue Hills Porphyry then crosses a contact into the APORHYOLITE, which crops out on the top of the hill. The volcanics (Aporhyolite) here were designated by Kaktins (1976) as the Wampatuck Hill Ash Flow, which he subdivided into the following units: a basal clastic-rich eutaxitic zone; a densely-welded zone with few phenocrysts and few spherulites; a eutaxitic zone with abundant flattened pumice; and an upper phenocryst-rich zone with minor, but relatively uncompressed pumice. The uppermost unit is the one in contact with the porphyry, the probable top of the flow having been cut out here; down-section is to the north at this locality.

1.6 continue westward on Chickatawbut Road

1.8 Blue Hills Reservoir on Left

2.8 Chickatawbut Hill Road on LEFT (narrow paved road with "No Trespassing" Sign to optional Stop 4 (mileage not included in log). Obtain permission from the MDC Police (station about two miles west on Chickatawbut Road) to visit this stop. Also inquire at the Trailside Museum west of Blue Hill to see if you can get inside the fence once reaching the top of the hill.

STOP 4 (OPTIONAL) SUMMIT OF CHICKATAWBUT HILL Good views over Boston Basin. On south side of hill just inside fence is one of the critical localities for studying relationships between the Quincy Granite and the Blue Hills Porphyry (see sketch of plane-table map). This locality shows an elongated patch of fine-grained granite in the porphyry that can be interpreted either as a disjointed dike of granite cutting the porphyry or as xenoliths of granite included in the porphyry. We have not been able to conclude which. Even if this could be decided, it must still be determined whether the granite is true Quincy Granite. This situation typifies the difficulty of determining the age of the Blue Hills Porphyry relative to that of the Quincy Granite. Because the critical exposures are in brush, on a cliff, inside the fence, this stop is not suitable for large groups and will probably not be visited on the trip.

2.8 continue west on Chickatawbut Road

3.1 Park on LEFT at junction of Chickatawbut Road and Randolph Ave for

STOP 5 Blue Hills Porphyry near contact with Aporhyolite. Several outcrops of porphyry are exposed southeast of the intersection. The porphyry is variable in character, but typically shows an abundance of fine-grained matrix suggesting that it has been chilled in the vicinity of the Aporhyolite. The contact is mapped under Randolph Ave but good exposures of the Aporhyolite cannot be seen in the vicinity.

3.1 RIGHT onto Randolph Ave northbound; proceed north past golf course.

4.2 PARK on RIGHT at gravel road (don't block road) opposite yellow and white house on left. Walk about 200 meters (yards) east on gravel road to poorly marked trail going uphill (north) for

STOP 6 BRAINTREE ARGILLITE, outcrops of which are visible on the slope of the hill. The outcrops can be reached directly from where they are first seen from the gravel road but it is worth searching out the trail (beyond where the outcrops are first seen) to avoid traversing through brambles. (The description of this stop is based partly on the description of Chute (1964) Stop 14.)

The outcrops along the slope of the hill are hornfels representing the Middle Cambrian BRAINTREE ARGILLITE. This unit has yielded some of the largest trilobites known, Paradoxides harlani (the loose materials at STOP 1 being much better for possible collecting than the present stop, however). These are Acado-Baltic fossils whose faunal-province relationships are part of the evidence for the closing of the Iapetus ("proto-Atlantic") Ocean during the evolution of the Appalachian Mountains. It is generally agreed that the Braintree Argillite occurs as xenoliths and roof-pendants in the Blue Hills Igneous Complex, which is thus younger than Middle Cambrian. At this locality the Braintree Argillite is cut by diabase dikes that appear to be older than the Quincy Granite. Further uphill is a 30 m wide apophysis of fine-grained Quincy Granite with abundant inclusions of rhomb-porphyry and argillite, and at the top of the hill is the main body of the Quincy Granite marked by abundant inclusions and an intrusion breccia.

4.2 return to vehicles: U-TURN, returning south on Randolph Ave.

5.9 intersection of Randolph Ave and Chickatawbut Road; continue south on Randolph Ave (Route 28)

6.3 fifty meters (yards) past signs for Route 128 PARK on right or pull into parking loop on left (when you leave you will continue south on Randolph Ave).

STOP 7 CONTACT BETWEEN BLUE HILLS PORPHYRY AND PONDVILLE CONGLOMERATE at interchange between Routes 28 and 128. This roadcut, constructed after the completion of most of Chute's field work, is one of the most controversial outcrops in the Boston area. Walk south along the right side of Randolph Ave then proceed to the right up the exit from Route 128. Briefly examine the Blue Hills Porphyry, then work your way fairly quickly along the outcrop until you are well up into the Pondville Conglomerate. Now decide where you would put the contact between the two units (in a group it is instructive to put this to a vote).

The PONDVILLE CONGLOMERATE is the basal unit of the Norfolk Basin sequence, the higher members of which contain Carboniferous fossils. The conglomerate (here called the Giant-Pebble Conglomerate) contains clasts of Blue Hills Porphyry, felsite (presumably Aporhyolite), quartzite, and argillite. Clasts of normal Quincy Granite have not been reported, although clasts of fine-grained hornblende granite can be found. At the top of the section the clasts are well-differentiated from the matrix, and lower in the section one can find an irregular but discrete surface below which the clasts no longer "pop out" from the matrix. Most workers, ourselves included, regard this surface as a non-conformity separating the Carboniferous Pondville Conglomerate from an older Blue Hills Porphyry.

This leaves a curious zone with pseudo-cobbles (greenish spheroids of microperthite, quartz porphyry in a matrix of generally finer-grained reddish porphyry) separating the Pondville from the normal, massive variety of the Blue Hills Porphyry. Chute interpreted this as a zone of spheroidal weathering and residual soil below the non-conformity.

D.R. Wones drew our attention to features suggesting a certain amount of transport of the pseudo-cobbles. They differ from each other and from the matrix in the details of phenocryst abundance and composition, in such a way that it appears unlikely that all the differences could be caused by weathering. He raised the possibility that the porphyry at this locality might be a Carboniferous volcanic unit grading upwards into the true conglomerate through a zone containing volcanic clasts in a welded volcanic matrix, the outcrop possibly having formed as a lahar.

For the reasons given in the discussion, we conclude that the exposure contains a non-conformity separating Silurian (?) Blue Hills Porphyry from Carboniferous Pondville Conglomerate. We interpret the zone of pseudo-cobbles as an emplacement breccia within the porphyry -- a zone in which fragments were broken off from the porphyry and transported in a gas-rich matrix that subsequently chilled. Note how the clasts of porphyry appear to fit together as the pseudo-cobble zone grades downwards into the massive porphyry. By this interpretation it is only a coincidence that the zone appears directly beneath the non-conformity at this stop. Sayer has noted breccia-zones elsewhere in the porphyry although none are so evident as the one seen here. Perhaps some of the primary contrasts between the pseudo-cobbles and the matrix have been enhanced by weathering below the non-conformity.

If time and interest permit, one may see the overlying Wamsutta Formation on the opposite side of Route 128. Return to Route 28 and walk through the underpass, skirt the fence then backtrack to walk along the canal to the Wamsutta roadcut in the exit loop. Note the cross-beds, channel-fill, and other sedimentary features, and study the oxidation-reduction reactions represented in the red and green coloration. Can you decide if the reduced zones (green) are localized around carbon-rich plant-fragments?

The SHORTEST RETURN TO BOSTON is by Route 128 EASTBOUND; south on Randolph Ave under bridge, RIGHT for entrance to 128 Eastbound, thence eastward to Southeast Expressway Northbound. To return to Boston University exit at Massachusetts Ave and retrace route followed in the morning. (Note that the desired exits from both Route 128 and the Expressway are made from the LEFTHAND lanes.)

A considerably more distant route, but one that may save time in heavy traffic is to proceed WESTWARD on Route 128 (enter just beyond where cars are parked) backtracking into Boston on the Massachusetts Turnpike. Along this route you pass cuts of various units of the Blue Hills Igneous Complex, followed by cuts of the Late Precambrian Dedham Granodiorite, followed by cuts of Roxbury Conglomerate near the westward margin of the Boston Basin.