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# GEOLOGY OF THE BOTTLE LAKE COMPLEX, MAINE

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## Introduction

The Bottle Lake Complex consists of two late Paleozoic, massive granitic plutons exposed in an area of about 1100 $km^2$ in the Scraggly Lake, Springfield, Winn, Wabassus Lake, Nicatous Lake, and Saponac 15-minute quadrangles, and located between U.S. Rts. 6 and 9 in east-central Maine (Figure 1). The Complex comprises two overlapping, subcircular, generally east-west trending bodies intruding greenschist facies metamorphic rocks of the Merrimack Synclinorium. The bodies have a granitic extension striking to the northeast (Figures 1, 2).

Larrabee and others (1965) mapped the granitic and metamorphic rocks in the Big Lake region in reconaissance. Their study of the granitoid rocks represented by the Bottle Lake Complex made no field or petrographic distinctions between these rocks except for the possibility of an internal contact between the main body of the Complex and the large northeast-trending granitic protuberance (Topsfield facies). Observed field and petrographic differences were ascribed to secondary processes, mainly as a result of country-rock assimilation. However, Ayuso (1979) recognized several map-pable petrographic types that exhibited a consistent arrangement and indicated the presence of two separate intrusive granitoid plutons. From east to west, the two granitoid plutons consist of the granite of Whitney Cove and the granite of Passadumkeag River, respectively. The Topsfield facies is assigned to the Whitney Cove pluton because of similarity in their petrographic and field relations and absence of internal contacts (Figure 2).

Metamorphic rocks in the region are presently under intensive scrutiny by A. Ludman (1978a, 1978b) and coworkers in the area to the northeast and east of the Complex, and by Wones (1979) in the Norumbega fault region to the south. Detailed mapping by Olson (1972) to the south-west of the Complex and the reconaissance work of Doyle and others (1961) and Cole (1961) concentrated respectively, to the southwest and north. As summarized by Ludman (1978b), metamorphic rocks in this area are in the greenschist facies and exhibit variable age and lithology (Figure 2). These rocks range in age from Cambro-Ordovician (?) to Siluro-Devonian, and from almost monomineralic sandstones to andesitic volcanics. Most traverses from country-rock toward the granite show well-developed mineral zonation as a result of the contact metamorphic effects (Ayuso, in press).

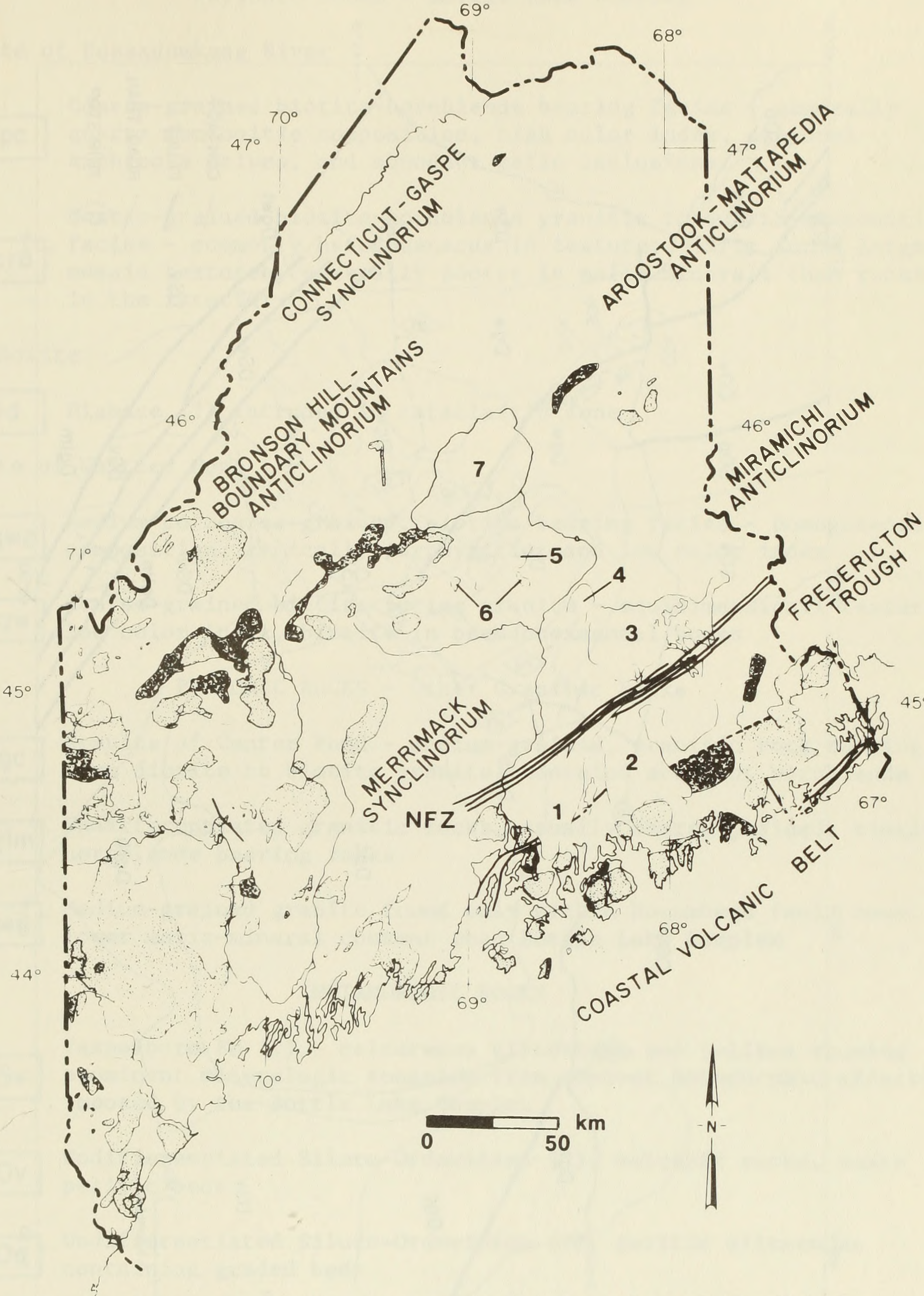



Figure 1 - State of Maine showing the location of the Bottle Lake Complex. Light stipple - granite and granodiorite; dark stipple - diorite and gabbro. 1-Lucerne pluton; 2-Lead Mountain pluton; 3-Bottle Lake Complex; 4-Center Pond pluton; 5-Seboeis foliated granitoid; 6-Seboeis non-foliated granites; 7-Katahdin pluton. NFZ-Norumbega Fault Zone. (from Loiselle and Ayuso, 1980).

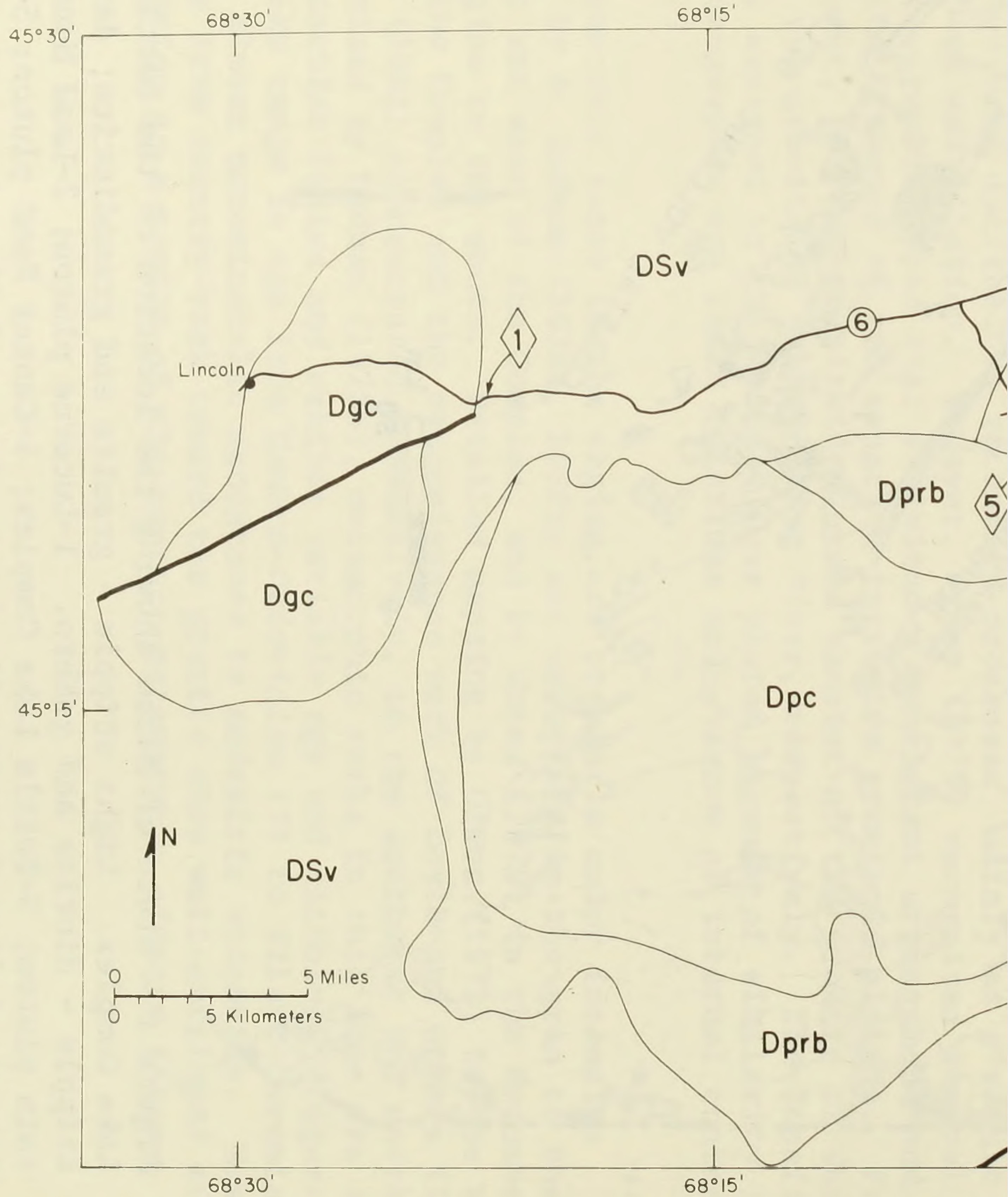
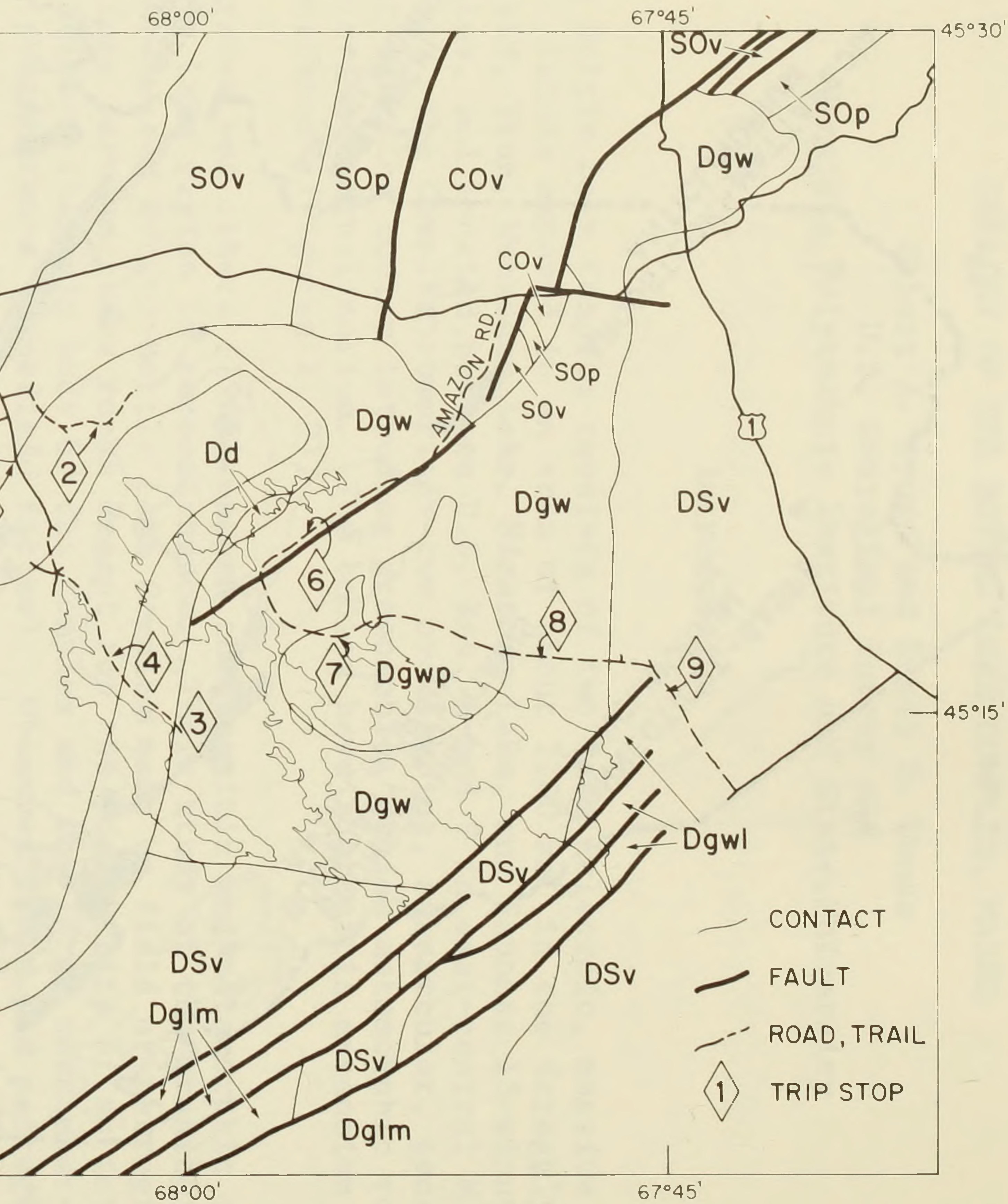



Figure 2 - Generalized geologic map of the Bottle




Lake Complex. Field trip stops are also shown.

PLUTONIC ROCKS - Bottle Lake Complex

Granite of Passadumkeag River

| | |
|---|---|
| Dpc | Coarse-grained biotite-hornblende bearing facies - generally quartz monzonitic composition, high color index, euhedral amphibole prisms, and abundant mafic inclusions |
| Dprb | Coarse-grained biotite-hornblende granitic to quartz-monzonitic facies - commonly heterogeneous in texture; quartz forms large mosaic textures, generally poorer in mafic minerals than rocks in the interior |

Amphibolite

| | |
|---|---|
| Dd | Diabase (?) intruded in cataclastic zone |

Granite of Whitney Cove

| | |
|---|---|
| Dgwp | Medium to coarse-grained, biotite bearing facies - homogeneous in composition, typically porphyritic, and low color index |
| Dgw | Coarse-grained biotite facies granite - equidimensional texture, low color index, biotite in pseudohexagonal books |

PLUTONIC ROCKS - Other Granitic Rocks

| | |
|---|---|
| Dgc | Granite of Center Pond - medium-grained, granitic rock ranging from diorite to biotite granite; contains abundant hornblende |
| Dglm | Undifferentiated granitic rocks, usually coarse-grained, biotite-hornblende bearing rocks |
| Dwl | Medium-grained granite found only within Norumbega fault zone, lower mafic-mineral content than Bottle Lake Complex |

METAMORPHIC ROCKS

| | |
|---|---|
| DSv | Vassalboro Fm (?) - calcareous siltstones and pelites showing prominent mineralogic zonation from contact metamorphic effects imposed by the Bottle Lake Complex |
| SOv | Undifferentiated Siluro-Ordovician (?), volcanic rocks, rusty pelitic beds |
| SOp | Undifferentiated Siluro-Ordovician (?), pelitic siltstones containing graded beds |
| COu | Graywakes, siltstones, slates are the main lithologies |

Geology by R. A. Ayuso and assistants (1977,1978,1979); based on fieldwork by D. Larrabee and assistants (1965), A. Ludman (1978a,b), D. R. Wones (1979), and Scambos (1980).

## Field Relations

Field and petrographic contrasts between the Whitney Cove and Passadumkeag River plutons include their strikingly different textures and mineralogy, particularly the kind and abundance of ferromagnesian phases, abundance of aplites and pegmatites, and abundance and type of inclusions. Field relations are summarized in Ayuso (in press). With the exception of amphibole, both granites are generally coarse-grained, consist of two feldspars, biotite and quartz, with minor amounts of primary sphene, zircon, allanite, apatite, oxides (magnetite and ilmenite) and sulfides. Sharp internal contacts, dikes and inclusions of older in younger granite are notably absent, but the relative sequence of intrusion may be established from mapping petrographic types, cross-cutting relationships of faults, and preliminary age determinations.

### The granite of Whitney Cove

The granite of Whitney Cove covers an area of about 400 $km^2$. Its mineralogy is consistently granitic (Streickeisen, 1973), has relatively low total ferromagnesian mineral content, lacks amphibole and shows either a predominant seriate (rim facies) or porphyritic (core facies) texture. Aplites and pegmatites are generally common in most exposures, while mafic inclusions are smaller and less common than in the Passadumkeag River pluton.

This pluton consists of three units: 1) Topsfield facies, 2) rim facies, and 3) core facies. The generalized geologic map shown on Figure 2 does not separate the Topsfield facies from the rim facies of the Whitney Cove pluton because of their similarity in field relations and absence of an internal contact between them. The Topsfield facies is commonly a medium to coarse-grained, reddish rock of low color index, approximately 400 m.y. old as determined by U-Pb work on zircons (R. Zartman, pers. comm.). Away from the main body of the pluton of Whitney Cove, it becomes finer-grained, progressively pinker, lower in color index and more intensely sheared. The rim facies is a pink, medium to coarse-grained, hypidiomorphic, seriate rock of low color index. No mineralogical characteristics distinguish the core from the rim, but textural differences are, however, significant and may be used to delineate the extent of each; contacts between the two are for the most part gradational. Within the core rocks, biotite is sometimes present as phenocrystic clots, but it is more abundant as fine-grained aggregates disseminated through the rock. The predominant phenocrysts are alkali-feldspars (up to 3.5 cm) and these are usually euhedral but also show edges embayed by biotite, plagioclase and quartz; some of the alkali-feldspars show rapakivi textures. Plagioclase mantled by alkali-feldspar (anti-rapakivi texture) is rarely present in these rocks. Quartz is usually constrained to the matrix, however, it is also present as a phenocryst (up to 1 cm) phase. Biotite is characteristically enclosed within subhedral, phenocrystic (up to 2.5 cm) plagioclase; less commonly, biotite forms euhedral phenocrysts similar to those found in the rim facies. Fine-grained biotite and plagioclase make numerous clusters in the matrix and give this rock an easily recognizable speckled appearance.

The consistently granitic composition of the Whitney Cove pluton is shown in Figure 3, where the modal variation obtained by counting stained slabs is displayed. The quartz-plagioclase-alkali feldspar ternary shows complete overlap between core and rim facies, and this is reinforced in the accompanying ternaries between mafic and felsic minerals. Also note the low scatter in total ferromagnesian content and the absence of a clear concentration gradient of mafic-poor to mafic-rich rocks from rim to core (Figures 4,5). Both facies have approximately 4% total mafic mineral content. The general mineralogical homogeneity of the pluton is further shown by its lack of correlation between alkali-feldspar and mafic-mineral content in Figure 5.

## The granite of Passadumkeag River

The two facies in the pluton of Passadumkeag River are the rim and core (Figure 2). Generally pink rocks of seriate to equidimensional texture, finer-grained and lower in color index characterize the rim. Amphibole is not abundant but it is usually present, at least in trace quantities. The low content of ferromagnesian phases and many of the textures are reminiscent of the rim facies of the Whitney Cove granite. Preliminary Rb-Sr isotopic determinations on whole-rock samples suggests an age of about 360 $\pm$ 16 m.y.

In contrast, rocks found in the interior of the pluton are invariably mafic-rich, commonly showing abundant, euhedral amphibole, and numerous mafic-schist, metasedimentary, and quartz-dioritic inclusions. Characteristically, this facies consists of gray porphyritic rocks with prominent subhedral to euhedral alkali feldspar phenocrysts (3 to 5 cm) that are usually embayed and mantled by plagioclase in a typical rapakivi texture. Many of these phenocrysts contain inclusions of euhedral plagioclase, quartz, and ferromagnesian minerals which help to delineate several growth zones. Euhedral phenocrysts of plagioclase (3 to 5 cm) are commonly filled with inclusions; together with fine-grained ferromagnesian minerals, plagioclase forms clots that alternate with quartz-rich clusters in the matrix. A common characteristic of the Passadumkeag River granitoid is that euhedral amphibole (0.5 cm) commonly encloses biotite.

In contrast to the Whitney Cove pluton, marked variations exist between the rim and core facies of the granite of Passadumkeag River (Figure 3). In this case, a granitic rim envelops a quartz monzonitic core of consistently higher plagioclase and mafic-mineral content. As shown in Figure 4, the core facies has almost double the mafic-mineral content of the rim; this zonation is clearly exhibited in the reversed correlation of alkali-feldspar and mafic content between rim and core (Figure 5).

The Whitney Cove pluton generally contains more felsic dikes (aplites, pegmatites, granophyres) than the granite of Passadumkeag River. These dikes are typically less than 0.7 cm wide, exhibit diffuse contacts, and are concentrated near the granite-country rock and granite-granite contact.

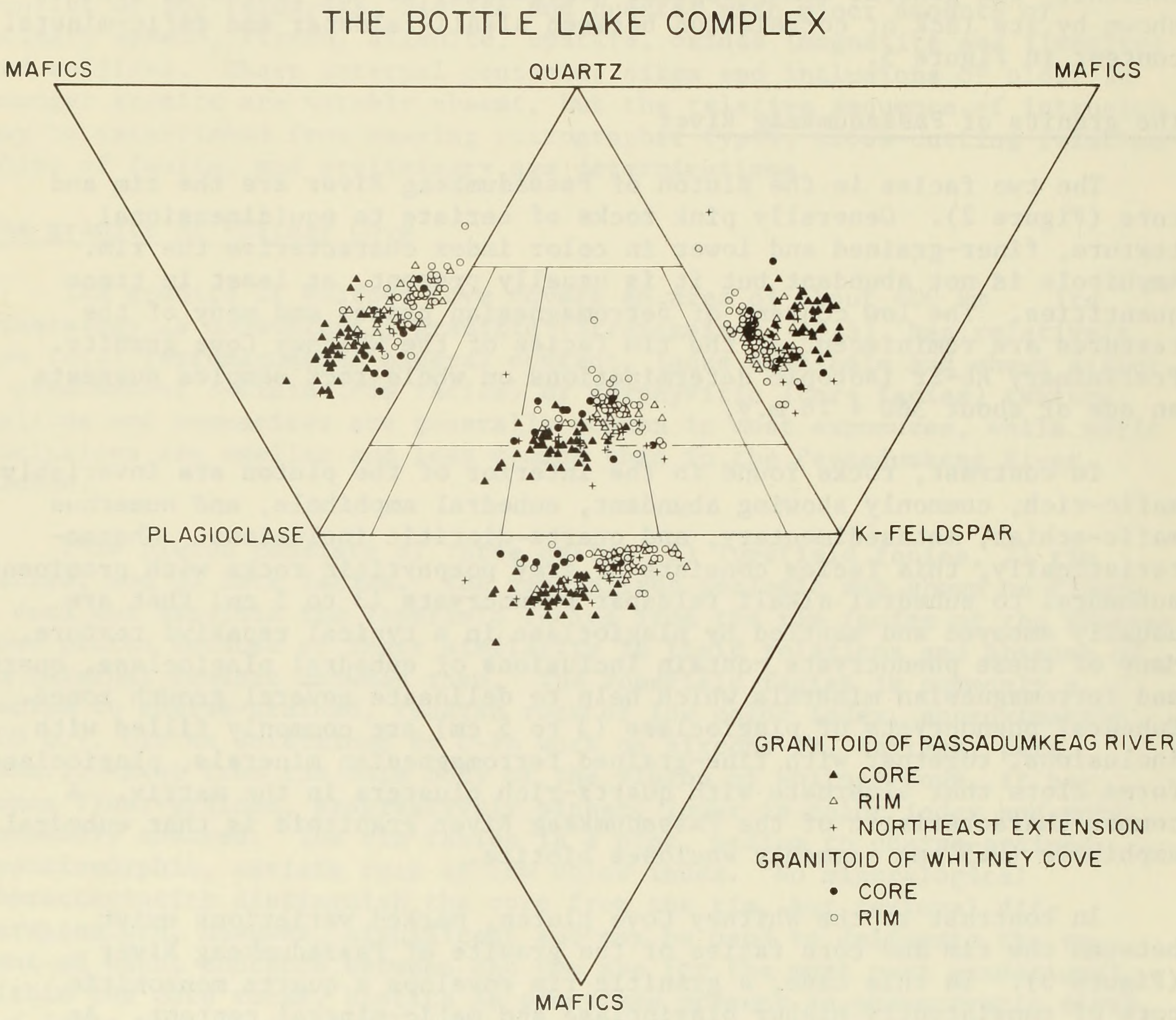



Figure 3 - Modal mineralogy of the Bottle Lake Complex. Northeast extension refers to the granitic rocks of the Passadumkeag River pluton intruded north of the cataclastic zone.

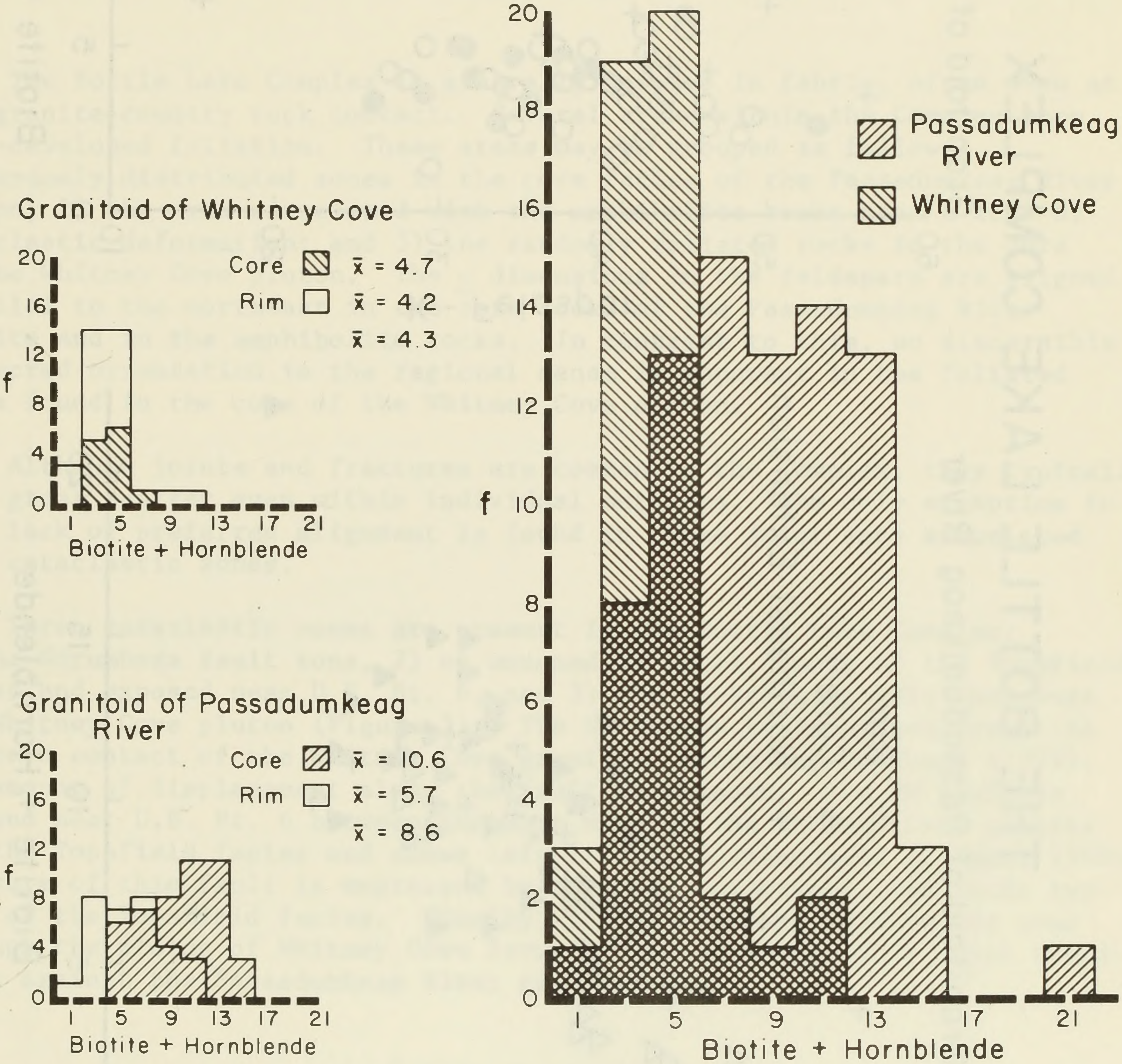



Figure 4 - Histogram of the total abundance of mafic minerals in the Bottle Lake Complex

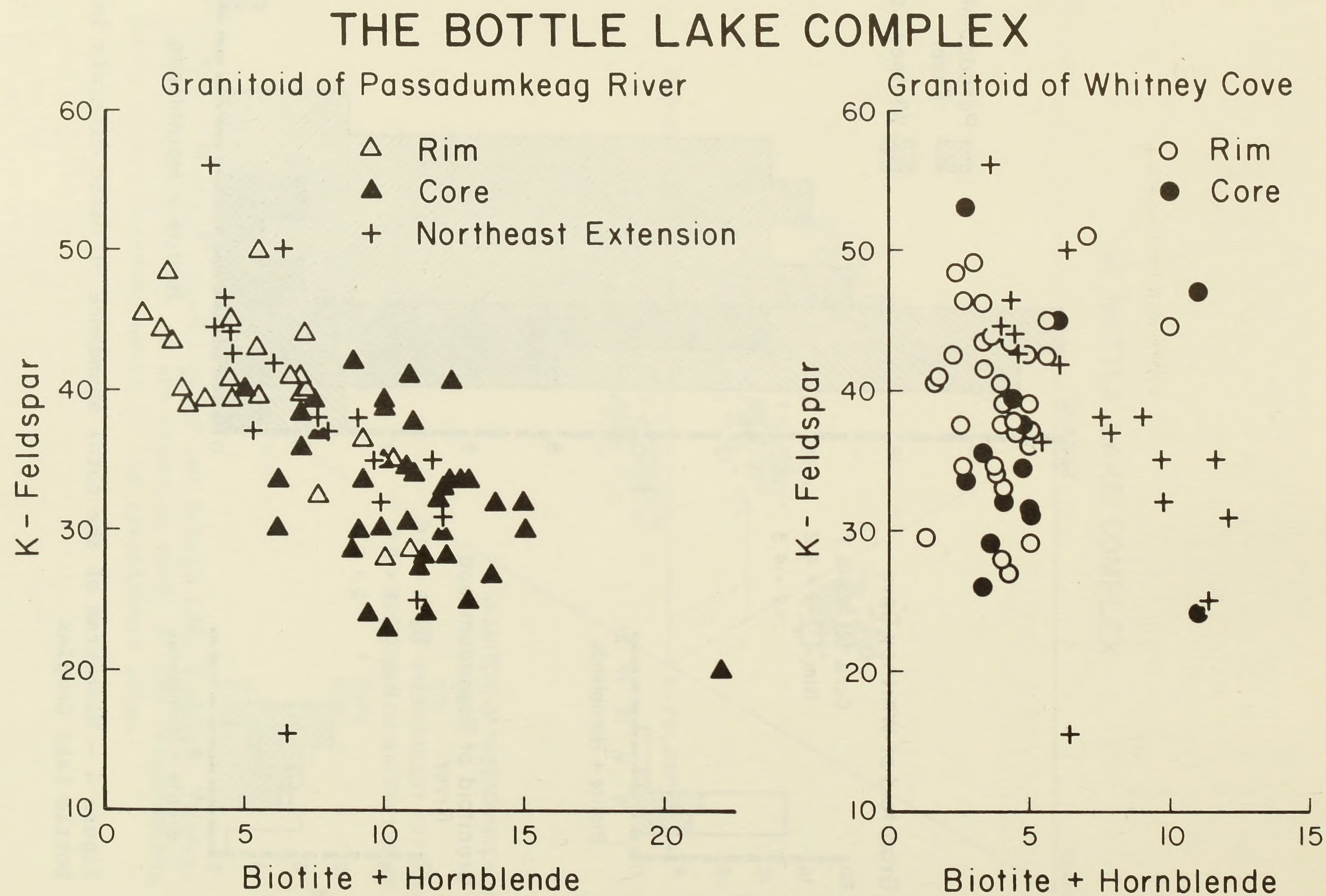



Figure 5 - Plot of alkali-feldspar vs. mafic mineral content of the Bottle Lake Complex. Northeast extension refers to the granitic rocks of the Passadumkeag River pluton intruded north of the cataclastic zone.

An amphibolite unit of limited length outcrops between the two plutons (Figure 2), and it is concentrated near the fault zone that cuts the Whitney Cove pluton. Typical rocks associated with this unit range from black to green in color and contain prominent orange feldspar phenocrysts; these rocks are intimately mixed with granitic rocks of the Whitney Cove pluton. Aplites, pegmatitic pods and large inclusions of variable lithology (from felsic to mafic mineralogy) are commonly found within the amphibolite unit.

## Structures

The Bottle Lake Complex is generally massive in fabric, often even at the granite-country rock contact. Several areas within the Complex show well-developed foliation. These areas may be grouped as follows: 1) randomly distributed zones in the core facies of the Passadumkeag River pluton; 2) the area associated with the amphibolite rocks near a zone of cataclastic deformation; and 3) the randomly foliated rocks in the core of the Whitney Cove pluton. The c dimensions in the feldspars are aligned parallel to the northeast in the core rocks of the Passadumkeag River granite and in the amphibolite rocks. In contrast to this, no discernible preferred orientation in the regional sense is apparent in the foliated rocks found in the core of the Whitney Cove pluton.

Although joints and fractures are common in the Complex, they typically show great scatter even within individual outcrops. The only exception to this lack of preferred alignment is found in those joint sets associated with cataclastic zones.

Three cataclastic zones are present in the Bottle Lake Complex: 1) the Norumbega fault zone, 2) an unnamed EW fault, south of the Topsfield facies and exposed near U.S. Rt. 6, and 3) the NE-trending belt that cuts the Whitney Cove pluton (Figure 3). The Norumbega fault system forms the southern contact of the Whitney Cove granite. According to Wones (1979), the amount of displacement along the fault is unknown. The EW fault is exposed near U.S. Rt. 6 between the main mass of the Whitney Cove granite and the Topsfield facies and shows left-lateral displacement (Ludman, 1978b). Exposure of this fault is expressed by sheared, epidotized, red rocks typical of the Topsfield facies. Finally, the NE-trending cataclastic zone through the pluton of Whitney Cove forms a wide band (1.5 km?) which terminates against the Passadumkeag River granite.

## Bulk Chemistry

Preliminary major and trace element X-ray fluorescence analyses of the Bottle Lake Complex are shown in Figure 6. In spite of the significant mineralogical contrasts between the two plutons, the data suggests a re-

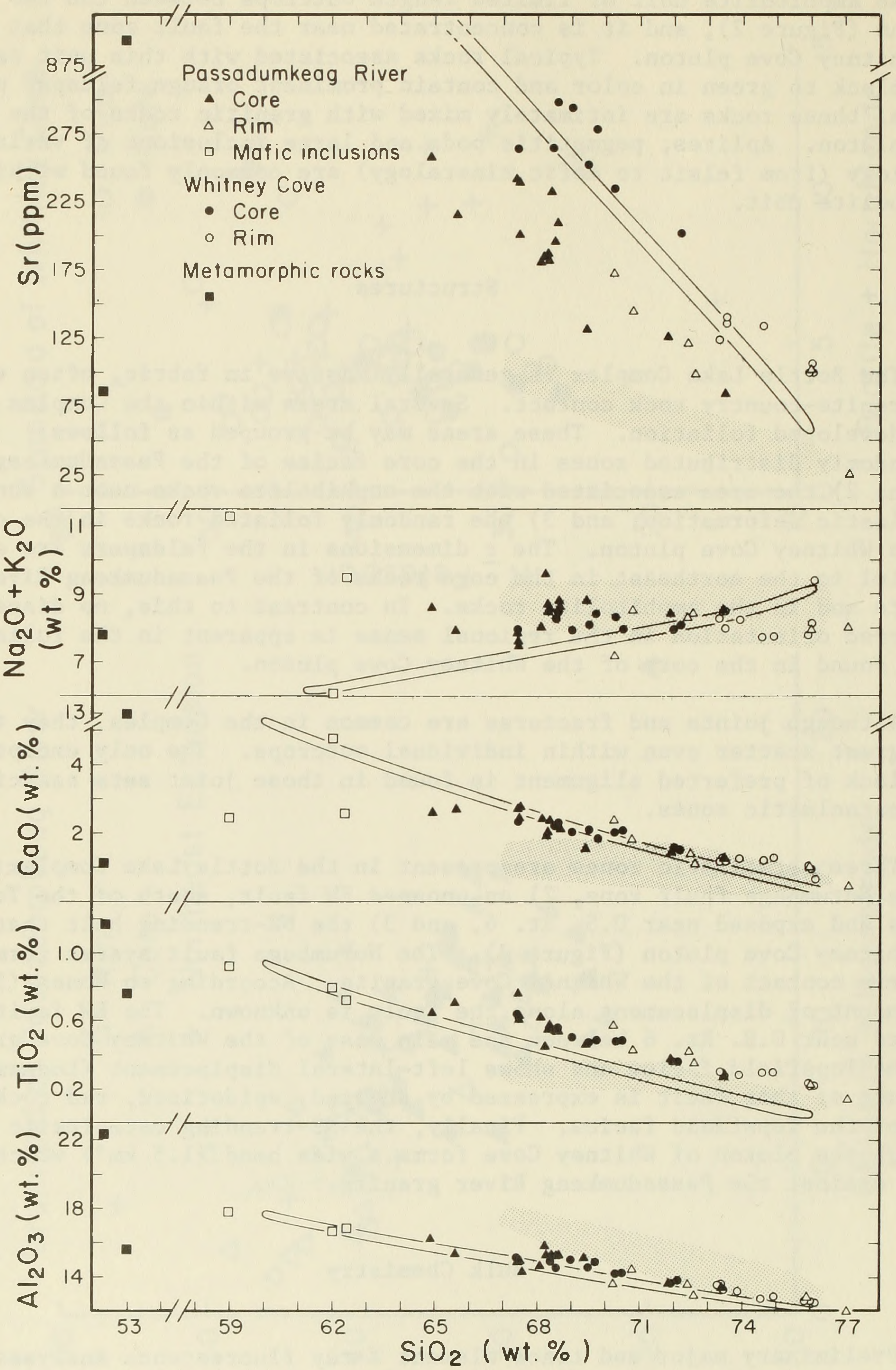



Figure 6 - Silica variation diagrams of selected oxides and strontium of the Bottle Lake Complex. Stippled field represents analyses of the Lucerne and Lead Mountain granites; field outline represents the Center Pond pluton (Scambos, 1980).

markable colinearity in the trend of both granitoids, showing similar ranges in $SiO_2$ content, and complete ovelap between data for samples from the two cores and rims. As expected, the core of the Passadumkeag River granite is less silica-rich and more mafic in character than its rim; the pluton shows reverse zonation. However, the Whitney Cove core facies, despite its mineralogical similarity to the rim, is extremely unlike it in composition, and instead resembles the core of the Passadumkeag River pluton. Reverse zonation is chemically expressed in both plutons, but it is mineralogically evident only in the Passadumkeag River granitoid.

Strontium concentrations reinforce the contrast between core and rim of these plutons (Figure 6). As in the major element trends, a reverse zonation is clear as cores are substantially enriched in strontium compared to the rims. Unlike the major element plots, however, a difference is suggested in the core of the Whitney Cove pluton which consistently shows higher strontium content compared to the Passadumkeag River core. An additional suggestion from this data is, in spite of the overlap, that each pluton describes parallel but distinct evolution trends from strontium-rich to strontium-poor rocks.

## Mineral Chemistry

Biotite is the most common ferromagnesian phase in the Bottle Lake Complex; in spite of the different petrographic character among the rocks of the Complex, no consistent differences are expressed in its optical properties. However, on the basis of microprobe analyses of representative samples from each granitoid, biotite shows distinct compositional variations and trends. In general, biotite in the Whitney Cove pluton is lower in Fe/(Fe + Mg) ratio (0.55 to 0.65) than that in the Passadumkeag River granite (0.60 to 0.80). Also, biotite from Whitney Cove tends to have higher F, but lower $TiO_2$. Figure 7 shows that both plutons have decreasing Ti with increasing $Al^{VI}$ and overlap between cores and rims. Biotite in the Passadumkeag River pluton shows a larger range in $Al^{VI}$ compared to that in Whitney Cove; near the granite-country rock contact, it tends toward extreme enrichment in $Al^{VI}$.

Amphibole is concentrated within the Passadumkeag River pluton and generally shows a lack of correlation in traverses from the edge of the core toward the interior. As in biotite, amphibole shows a limited range in Fe/(Fe + Mg) from 0.55 to 0.75 without a distinct range within each facies. Figure 8 shows that amphibole compositions tend to increase in $Al^{IV}$ with increasing A site content. A prevailing feature of the Passadumkeag River pluton is the common intergrowth and inclusion of biotite in amphibole. According to the studies of Wones and Dodge (1977) on potassic magmas, crystallization of biotite prior to amphibole is facilitated by water deficient conditions.

Preliminary work on feldspar compositions show that plagioclase ranges from pure albite to $An_{50}$ for the Complex as a whole. Most plagioclase cores are usually richer in anorthite, show normal zonation, and are enveloped by strongly zoned albitic rims. Between the two plutons, the Whitney

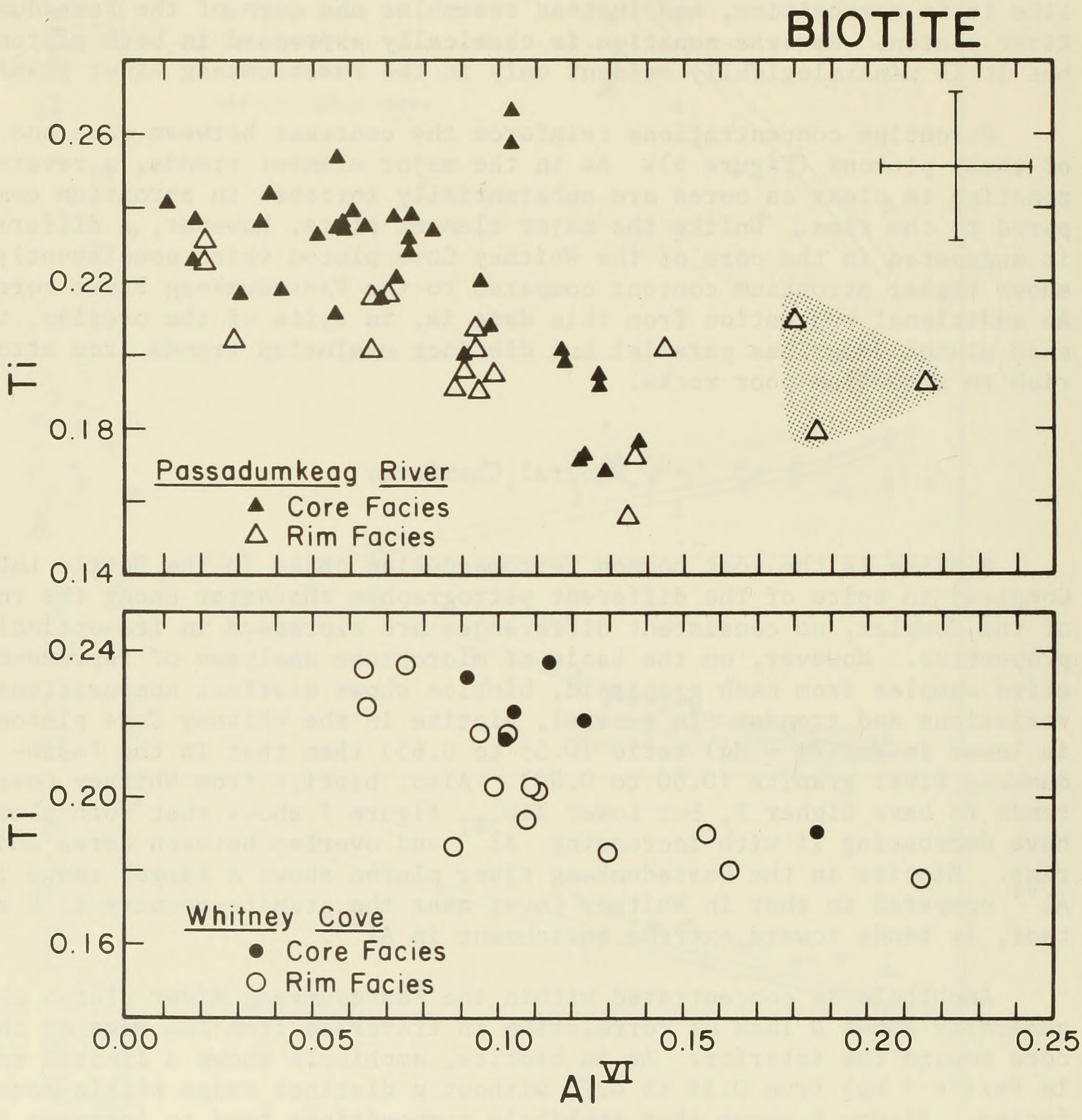



Figure 7 - Representative microprobe analyses of biotite from the Bottle Lake Complex showing cation proportions of Ti and $Al^{VI}$ in one-half of the formula unit. The stippled field represents biotite near the granite-country rock contact. Error in determinations shown approximately at 2σ level.

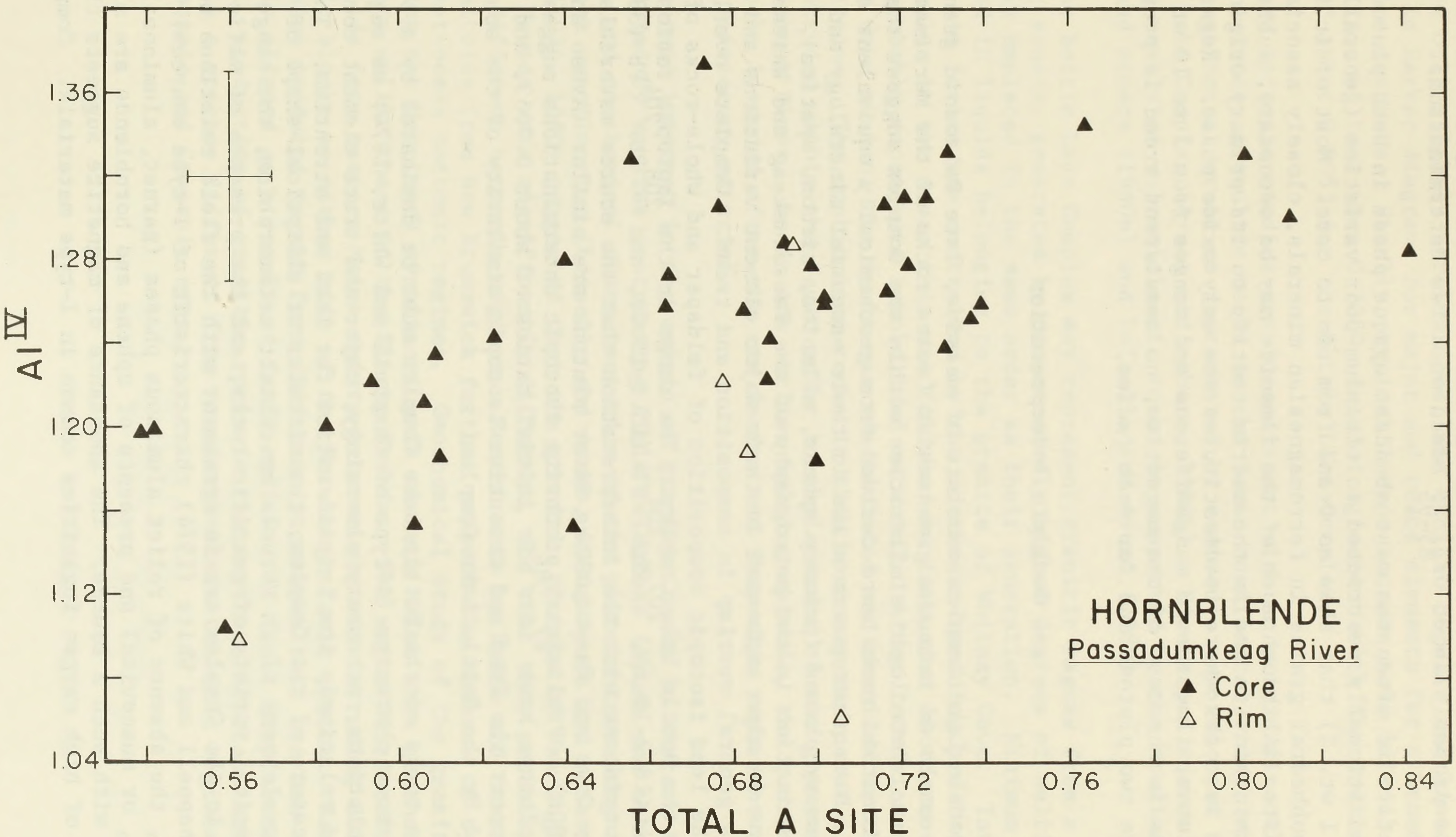



Figure 8 - Representative microprobe analyses of hornblende in the Passadumkeag River pluton, showing $Al^{IV}$ and total A site cation abundances in one-half of the formula unit. Error in determinations shown approximately at $2\sigma$ level.

Cove core facies tends to be highest in anorthite component. In general, no pattern exists toward albite-rich plagioclases. Bulk composition of alkali feldspar is probably about $Or_{85-95}$ based on a few determinations.

Magnetite is often the most abundant opaque phase in both plutons. It is compositionally restricted to titanium-poor varieties (generally less than 1 wt. %) that show no trend from rim to core. Most of it is found as subhedral grains in ferromagnesian minerals, closely associated with ilmenite. Although much of the ilmenite may be secondary, subhedral grains within biotite and in the matrix testify to its primary origin, especially in rocks where it constitutes the only oxide phase. Regardless of pluton, ilmenite is manganiferous and ranges from 3 to 10 wt % in MnO. As in the case of the magnetite, no consistent trend is present between the two plutons and for each facies.

## Geologic Interpretation

The Bottle Lake Complex consists of massive, late Paleozoic granitic intrusives emplaced into the greenschist facies rocks of the Merrimack synclinorium. Petrologic similarities within the Complex suggest that the two main granitoid rocks were derived from geochemically equivalent source materials. Both plutons are alike in their essential mineralogy and key index accessory phases (primary sphene, allanite, zircon, apatite). This lack of distinction in the petrography of the Passadumkeag and Whitney Cove plutons is also expressed in their major element variations and abundances by a general overlap in composition and trend. Complete overlap is shown by the lead isotopic composition of feldspar and whole-rocks of both plutons in the Bottle Lake Complex. The range in the isotopic ratios of $^{206}Pb/^{204}Pb$ (18.2-18.6), $^{207}Pb/^{204}Pb$ (15.6-15.7), and $^{208}Pb/^{204}Pb$ (38.2-39.2) is consistent with the interpretation that the source materials for the Whitney Cove and Passadumkeag River plutons are similar (Ayuso and others, 1980b). Preliminary strontium isotopic determinations suggest that both plutons have $^{87}Sr/^{86}Sr$ initial ratios of about 0.7053, and further support the lead and strontium isotopic similarity of the sources represented by the Bottle Lake Complex.

Source rocks of the Bottle Lake Complex must be dominated by a protolith of igneous character (I-type of Chappell and White, 1974) as suggested by field relations, accessory mineralogy, major and trace element composition, and relatively low initial ratios for lead and strontium. The composite nature of the Complex, the circular or elliptical shape of the plutons, development of an aureole by contact metamorphism, the range in the lithological variety of granitic rocks, and the presence of mafic-rich inclusions in the Complex are in agreement with the field relations outlined by Chappell and White (1974) characteristic of I-type sources. Additionally, the absence of relict aluminous phases (garnet, aluminosilicates, cordierite, or muscovite) and presence of sphene and hornblende are also concordant with such a source. The abundance of magnetite suggests the prevalence of high oxygen fugacities common in I-type materials. Compositionally, these plutons are also consistent with an I-type source, as they are only slightly peraluminous, and exhibit regular and linear variation in Harker diagrams for major and trace elements for a broad range of silica contents. Finally, typical I-type sources have initial $^{87}Sr/^{86}Sr$ ratios of less than 0.7080, in good agreement with the preliminary value of about 0.7053 for the Bottle Lake Complex.

Lead isotopic studies are inconsistent with an origin directly from mantle sources, granulite rocks in the lower continental crust, or from upper continental crust as represented by sediments exposed near the Bottle Lake Complex (Ayuso and others, 1980b). However, a source consisting mostly of volcaniclastic rocks is supported by the studies of Ayuso and others (1980b) and Loiselle and Ayuso (1980).

The Bottle Lake Complex may represent granitic magmas from a volcaniclastic source, generated by progressively higher degrees of melting and probably emplaced in the same order as their generation. Minimum melting resulted in liquids belonging to the granite of Whitney Cove. Intrusion of the rim facies was controlled by the northeast-trending pre-Late Paleozoic faults in the area; this was followed by intrusion of the core facies which probably represents remobilized material. After intrusion of the Whitney Cove pluton, the fault was reactiviated and resulted in the cataclastic zone. The amphibolite rocks in this zone may represent a diabase dike intruded within the fault prior to emplacement of the granite of Passadumkeag River. As in the earlier melting episode, the quartz-monzonitic rocks intruded after the rim facies and they also represent remobilized, refractory material.

Renewed interest in the origin of granitic rocks in eastern Maine is exemplified by studies contrasting field relations (Ayuso and others, 1980a), and geochemical characteristics of the plutons intruding the Merrimack synclinorium (Loiselle and Ayuso, 1980; Ayuso and others, 1980b). Wones (1976, 1980) suggested that the granitic plutons of New England and Sierra Nevada were significantly different, and that they probably represented different tectonic regimes. Recent work by Fyffe and others (1980) on granitoids from New Brunswick further support the absence of typical continent-ocean tectonic regimes. Geochemical study of the granitoids intruding the Merrimack synclinorium in eastern Maine show geochemical gradients unlike those in the Sierra Nevada. The major distinction in granitoids from eastern Maine exists between plutons intruding different tectonic blocks on either side of the Norumbega fault system. Each block could have produced magmas from different processes that are now coincidentally aligned as a result of fault motion. If fault displacement is minimal, production of granitic rocks in the northern Appalachians may indicate a process different from continent-ocean tectonic regimes during the Mesozoic and Cenozoic eras.

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## ROAD LOG

Assemble at 8:30 AM in the parking lot of the Lincoln Post Office, just directly across from the First Bible Baptist Church. Most of the trip will follow unimproved, two-lane dirt roads almost exclusively used for hauling timber. Please remember that truckers expect unimpeded access and the right-of-way in these narrow, shoulder-less roads. Because of limited maneuverability and safe-parking in these roads, up to five vehicles will be accomodated on the trip. Participants should bring a bag lunch and expect two short hikes, mostly along trails.

| Mileage | | |
|---|---|---|
| 0 | 0 | From Post office, go north on Fleming St. |
| 0.1 | 0.1 | Turn E (right) on Depot St. |

| | | |
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| 0.2 | 0.1 | Continue past the traffic light. Follow signs to U.S. Route 6. |
| 0.3 | 0.1 | Turn E (left) at the stop sign at intersection with U.S. Route 6, also known as Lee St. |
| 1.0 | 0.7 | Note the abundant, low-lying outcrops of the granite of Center Pond. |
| 1.9 | 0.9 | More exposures of similar granitic rocks. |
| 2.4 | 0.5 | Same type of rocks are exposed here. |
| 2.8 | 0.4 | Continue east on U.S. Route 6 and note on the left side of the road the sign for Schrite's Caribou Pond Cabins. |
| 3.0 | 0.2 | Outcrops on both sides of road belong to the Center Pond pluton. |
| 3.5 | 0.5 | Same type of granitic rocks |
| 4.6 | 1.1 | STOP 1: CONTACT OF COUNTRY ROCKS WITH THE GRANITE OF CENTER POND |

This outcrop shows the prevalent mineralogy and mode of intrusion of the Center Pond pluton. Many of the field relations and petrographic features exemplified by this outcrop are also common in the granite of Passadumkeag River. Both plutons are hornblende-biotite rich, two feldspar granitoids, exhibiting similar accessory mineralogy and textures. Granite-country rock intrusive relationships between the Center Pond pluton and the Vassalboro Fm. are typically transitional in nature and are exemplified in this exposure. The transitional character of the contacts is also common in the Passadumkeag River granite, although knife-edged transitions and others where numerous pegmatites and aplites crisscross the country rock are also well represented. Take a moment to study this outcrop on the opposite side of the road before approaching the outcrop to inspect it more closely. Note that country rock is clearly predominant on one end (eastern) of the outcrop, and that it grades into a transitional or mixed zone on the opposite end (western). On the eastern end of the outcrop, the Vassalboro Fm. exhibits a typical pin-striped, shaly, slightly rusty, and heavily-jointed appearance at the contact with the granite of Center Pond. The purple color developed in these rocks reflects the titaniferous biotite formed during contact metamorphism. Immediately adjacent to the granite-country rock contact, the Vassalboro Fm. consists of pin-striped bands of differing mineralogy. Dark and light bands correspond to biotite and calcite-rich zones, respectively, coexisting with diopside, amphibole, epidote, and quartz.

Large blocks (3 m) of country rock and granite are common within the transition zone and typify the mode of intrusion prevalent in both the Center Pond and Passadumkeag River plutons. Inspection of individual blocks of metasedimentary origin suggest that the pluton intruded in a lit-par-lit manner, disaggregating blocks of various sizes. Aplitic stringers intrude along the bedding planes. Several examples of this relationship are present in this outcrop in elongated blocks about 1 m in size, still exhibiting orientation similar to that in the country rock. This rock shows extreme deformation close to the cataclastic areas and this is expressed by intense recrystallization of quartz, kinking and smearing of biotite, and dislocation of feldspars. Most biotite is red from hematite stain, and it is commonly rimmed by finer-grained opaque minerals. In spite of the intense rotation, grinding, and kinking in plagioclase, these feldspars retain evidence of a large core rimmed by a clear, optically continuous rim. Hornblende still shows subhedral to anhedral outlines with abundant biotite inclusions. Sphene, allanite, apatite, zircon, and opaque oxides are present elsewhere in this pluton; however, they are not conspicuous in this crop. This outcrop also shows cataclastic textures interpreted by Scambos (1980) as part of a NE-trending fault zone through the pluton with an offset of 2 km in a right lateral manner. Note the strongly foliated character of the rock (N80° E, 60-90 SE) as expressed by the feldspars and mafic minerals on the western end of the exposure. This fault zone may also be evident in the granite and country rocks by the abundance of joints oriented generally to the NE, and by a few thin (<5 cm) quartz veins.

Granitic rocks are generally gray in color, lack a porphyritic or quench marginal zone at the contact with the country rock, and preserve a nearly equidimensional character in their fabric. While xenoliths of metasedimentary origin decrease in the granitic rocks away from the transition zone, small clusters (<10 cm) of mafic minerals (biotite + amphibole + sphene) and plagioclase are common throughout the granite. These clusters probably do not represent fully digested country rock as suggested by their mineralogy, texture, and lack of alignment. Because pegmatites and miarolitic cavities are absent and aplitic rocks are uncommon in rocks near the contact, the magma probably intruded without being saturated with volatile constituents. The contact metamorphic effects are constrained to within 1.5 km of the contact. In spite of the cataclastic deformation in these rocks, it is still possible to ascertain that at the time of intrusion, the liquid was probably saturated with respect to all the major mineral phases. This relationship is evident in the nature of the inclusions in alkali feldspars (plagioclase, biotite, amphibole, quartz) and the general subhedral nature of the phases to each other in samples away from the fault zone.

| | | |
|---|---|---|
| | | Proceed E on Route 6. |
| 5.6 | 1.0 | Lee township line. Continue E on Route 6. Hornfels in the contact aureole of the Bottle Lake Complex form prominent hills, regardless of lithology and especially in the immediate envelope around the pluton. Marshy land and streams are commonly found on the slopes facing away from the intrusive, while the opposite slope commonly contains exposures of the granite-country rock contact. As we proceed to the east on U.S. Route 6, keep in mind that the row of nearby prominent hills on the right side of the road consists of the contact aureole of the Bottle Lake Complex. |
| 6.2 | 0.6 | Outcrops of Vassalboro Fm. on left side of road. |
| 6.5 | 0.3 | Intersection with South Rd. Continue E on Rt. 6 and notice outcrops on right side of road. |
| 7.1 | 0.6 | More outcrops on left side of road. |
| 7.5 | 0.4 | Jefferson Ski Area Slope is directly ahead. |
| 7.8 | 0.3 | Continue E on Rt. 6 and through the flashing light at the intersection of Rt. 168 and Rt. 6. Lee Academy and Lee Post Office are on opposite sides of street to your left. |
| 8.2 | 0.4 | Outcrops of Vassalboro. |
| 8.6 | 0.4 | Maine Forest Service station to your right. Continue E on Rt. 6. |
| 10.3 | 1.7 | Springfield town line. Continue E on Rt. 6. |
| 10.9 | 0.6 | Note the outcrops across from the AMOCO station. |
| 13.9 | 3.0 | Continue E on Rt. 6. Go by Springfield Post Office on your right, and intersection of Rt. 169 and 170 with Rt. 6. |
| 14.6 | 0.7 | Turn S (right) on Dead River Co. road (Dead River Tree Farm). We are now approaching the contact between the Bottle Lake Complex and country rock, essentially at right angles. Note the progressive increase in size and abundance of granitic rock boulders in the next several miles. |
| 16.2 | 1.6 | Almanac Mountain is directly ahead of us. It is the most prominent topographic feature in the vicinity and may be identified by the firetower and relay antenna on its pinnacle. |
| 16.5 | 0.3 | Continue S and go by Springfield Cemetery on your right. |
| 17 | 0.5 | Outcrops of Pre-Silurian sulfidic schist on the right side of road. |

17.1 0.1 Continue S past the intersection of road going to the east. You may be able to see Duck Lake and Bottle Lake directly ahead and on the left side of the road.

17.6 0.5 Lakeville town line. Turn left (E) at the intersection with road going to Duck Lake.

18.5 0.9 Turn right (S) at fork on road going to Duck Lake.

19.2 0.7 Turn left (E) at fork with Getchell Mtn. gravel road. Note the abandoned school at the intersection (Gowell School).

19.6 0.4 Cross Getchell Brook

20.2 0.6 STOP 2: RIM FACIES OF THE PLUTON OF PASSADUMKEAG RIVER.

Please turn around and try to park as safely and as far off the road as possible. Mr. H. Snow owns this land and needs free access to the road.

This stop exhibits pavements and low ridges forming essentially continuous granitic outcrop to the top of Getchell Mtn. (1041 ft.). Outcrops are generally fresh and very extensive. The road ends within 1500 ft. from the granite-country rock interface and about 4500 ft. from Getchell gravel road. Because of its orientation at right angles to the contact and abundance of fresh outcrop, this traverse constitutes an outstanding opportunity to study the field relations, fabrics, mineralogy and interaction of the granitic and country rocks. Walk up the mountain to the end of the road, and on the way down inspect the outcrops.

Granitic rocks on Getchell Mtn. belong to the rim facies of Passadumkeag River. The incompletely developed rim facies of the pluton may be subdivided into smaller domains on mineralogical and textural grounds. Note in Figure 2 that the rim facies is absent in a large area near the northern contact. All Getchell Mtn. rocks are hornblende-bearing, two-feldspar granites constrained roughly to the area in contact with pre-Silurian (?) sulfidic schist. Schlieren, different types of inclusions, mafic segregations, and irregular felsic masses are common in this traverse. In most cases, the long dimension in the mafic segregations, schlieren, and mafic inclusions strike roughly N 50°E, parallel to the granite-country rock contact. This preferred alignment is also expressed by the long dimension of the alkali feldspars along the traverse. All the granitic rocks show a prominent and consistent NE-trending alignment. Note the presence of seemingly irregular masses of granitic rocks of markedly porphyritic nature surrounded by the more typical rim facies rocks in many of the outcrops. In addition to these felsic inclusions, aplitic dikes and pegmatitic pods are also numerous and exhibit no difference with proximity to the contact. No consistent orientation is expressed by these dike rocks as they show significant variation in thickness, and contrast with the uniform orientation of the mafic concentrations. The latter attain lengths up to 1 m and show cyclic mineralogic variations from mafic to felsic-rich layers. Mafic inclusions show a great range in size, shape, and mineralogy. They range from the small (5-10 cm), ovoidal, fine-grained, and randomly oriented biotite and plagioclase masses common throughout the pluton, to biotite-rich aggregates, and finally to prominently porphyritic quartz-diorite rocks. Note that in spite of the apparent randomness in orientation of these inclusions, their long axes are commonly oriented roughly to the northeast. Pegmatitic zones up to several meters in thickness are also exposed on the western slopes of the mountain and these consist chiefly of feldspar (15-20 cm), massive quartz (white and rose), pseudohexagonal biotite books (5 cm) and sulfide minerals.

Major textural changes are exhibited by granitic rocks near the contact, but unfortunately these are not exposed along the road. A zone of fine-grained and phenocryst-rich rocks is present at the granite-country rock contact; these rocks are associated with numerous aplitic dikes and pegmatites that randomly crisscross the country rock. Study of individual blocks of country rock reveals that the magma also intruded by sending dikes in a lit-par-lit fashion. Gradual changes in color, texture, and mineralogy are evident with distance from the contact. At the contact, the granite is strikingly porphyritic, mafic-poor, and grayish in color. Toward the bottom of the mountain it becomes seriate, richer in mafic minerals and pinker. Amphibole is rare near the contact, but it progressively increases in abundance, grain size and development toward the interior.

Accessory and varietal minerals consist of allanite, sphene, apatite, zircon and opaque oxides and they show a sympathetic increase in abundance toward the interior of the pluton. Intergrowths of biotite with either plagioclase or hornblende are common, especially near the bottom of the mountain. Interfaces where large, inclusion-rich biotite flakes join plagioclase are characterized by a zone of fine-grained albitic plagioclase, quartz, and Fe-Ti oxides. Biotite and euhedral hornblende form intimately related clots suggestive of coprecipitation; however, it is also common to find subhedral biotite inclusions within hornblende. The probable sequence of crystallization near the granite-country rock contact may be generalized as follows: zircon, opaque oxides (magnetite), apatite, allanite and sphene, followed by biotite, amphibole, plagioclase, quartz and alkali-feldspar. Even most outcrops near the granite-country rock contact show this order of crystallization, except for the absence of hornblende. Myrmekite and graphic textures, together with the formation of chlorite, sericite, hematite, minor epidote, secondary sphene and opaque oxides are also evident through the traverse.

Textural and mineralogic changes are less striking between the rocks along the traverse compared to those near the granite-country rock contact. Granitic rocks of the rim facies progressively attain the mineralogy and texture typical of the quartz-monzonitic core rocks. This type of gradual change toward the core of the pluton is common; however, in the region north of Upper Sysladobsis Lake the transition from felsic rim to core is substantially more abrupt.

Continue W on Getchell Road to Gowell School, retracing route toward Dead River Co. Road.

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|---|---|---|
| 21.2 | 1.0 | Turn right (N) at the fork. |
| 21.9 | 0.7 | Turn left (W) at the fork. |
| 22.8 | 0.9 | Turn left (S) on Dead River Co. Road. |
| 22.9 | 0.1 | Continue straight, past the road to the firetower on Almanac Mtn. |
| 23.5 | 0.6 | Almanac Mtn. is immediately to our right; note that directly in front are Sysladobsis, Bottle, and Keg Lakes. |
| 23.9 | 0.4 | Contact between the Complex and country rock is approximately here. |
| 24.7 | 0.8 | Continuous outcrops of the core facies of Passadumkeag River pluton on both sides of the road. At this location the rocks are similar to the granitic outcrops near the bottom of Getchell Mtn. |
| 25.1 | 0.4 | Continue straight (S) on this road. Keg Lake is at your left and Bottle and Sysladobsis Lakes are directly ahead. |
| 25.4 | 0.3 | At the fork, take dirt road on the right. The other road is only .3 miles long and ends at Bottle Lake boat ramp. |
| 26.9 | 1.5 | This is a five-way intersection. Take a left on dirt road going south that is a continuation of the Dead River Co. Dump Road. Starting at this point, Sysladobsis Lake will be on the right and we may be able to glance at the lake on the way to the next two stops. This road is the main access for the great number of cottages on the lake. |

27.3 0.4 Pug Hole in Sysladobsis Lake is on the right.

29.2 1.9 This road transects a hill with abundant exposures of the core facies of the Passadumkeag River pluton.

32.8 3.6 Next stop is about 1300' from the fork in the road. Parking and turning around is difficult in this area, especially after a downpour. All vehicles should be turned around and parked on the same road that was used coming into the fork. Occupants should then congregate at the fork for a short hike. Proceed E along the dirt road on the northeast slope of Porcupine Mtn. for approximately 1300' and note outcrops on both sides of road. These are essentially continuous for about 1000' to the east, and extend to the top of Porcupine Mtn.

STOP 3: RIM FACIES OF THE GRANITE OF WHITNEY COVE

This outcrop exemplifies the rim facies of the pluton of Whitney Cove and it consists typically of pink granitic rocks of low color index and seriate texture. Note the abundance of aplites, pegmatites, quartz veins, and granophyre dikes in this area. Also note the relative depletion and limited range of lithologies in these mafic inclusions compared to the previous stop. Felsic dikes are variable in attitude and thickness, exhibiting a tendency to subdivide and crisscross within a single outcrop. Pegmatitic masses in this area contain coarse-grained feldspars (5 cm) and quartz, and form pods without a consistent orientation.

This exposure is mineralogically similar to most rocks belonging to the rim facies and consists of microcline, plagioclase, biotite, quartz, and accessory minerals. Intergrowths of biotite and plagioclase are reminiscent of the rocks on Getchell Mtn.; however, they are more abundant in this area and the zone of interaction is substantially wider. Myrmekitic and micrographic textures are ubiquitous as is the granulated appearance (mortar texture) enveloping many of the alkali-feldspars. Allanite is conspicuously euhedral, zoned, and very abundant in this area; euhedral opaque oxides are more common than in the rim rocks of the Passadumkeag River pluton and include magnetite, ilmenite, and pyrite.

Return to cars.

Continue N on this road.

36.0 3.2 STOP 4: CORE FACIES OF PASSADUMKEAG RIVER PLUTON

Continuous outcrop extends to the top of the hill as pavements, typically with smooth surfaces and covered by a thick lichen carpet. Exposures are also abundant in the opposite direction, close to the shores of nearby Sysladobsis Lake. Note the abundance of mafic inclusions, aplite dikes, and the marked increase in the color index of this rock. In addition to the ovoidal, fine-grained, biotite and plagioclase-rich clusters randomly dispersed in the granitic matrix, note the fine-grained, porphyritic, and hornblende inclusions. The latter are usually the largest mafic inclusions in this facies, and generally show a wide distribution of sizes. A preferred orientation to the northwest is commonly expressed by their long dimensions, although this contrasts with the easterly alignment of the ovoidal clusters and the overall massive fabric in the rock. Mafic-rich bands consisting of abundant biotite and hornblende and striking to the northeast are also abundant in this area; notice that in contrast to the prophyritic inclusions, these bands show an intermingling with granitic material and indefinite boundaries. Mafic content of the prophyritic inclusions varies extensively, sometines resulting in rocks of lower color index than the surrounding granitic rock. However, note that large euhedral hornblende and alkali feldspar are common to the granitic envelope and porphyritic inclusions. Pods of felsic rocks showing aplitic texture are easily distinguishable from the abundant inclusions of high color index by their mineralogy and amorphuous appearance. Few aplitic dikes are exposed in this facies of the pluton; however, several dikes outcrop in this area, varying in thickness, color, and orientation even over small distances. Joints are generally well-developed and in some cases they are strongly stained by hematite.

This outcrop also exemplifies the mineralogical and textural contrast between the core facies of the Passadumkeag River and the Whitney Cove pluton. Amphibole is a common phase in this stop, and it is commonly present as large, euhedral, black prisms. Together with biotite, they impart the characteristic high color index found throughout the core of the Passadumkeag River pluton. Alkali feldspars are prominently displayed, often mantled by plagioclase and enclose all other essential minerals. Two or more growth zones punctuated by oriented mineral inclusions are commonly shown by the larger alkali feldspars. Plagioclase contains abundant biotite and hornblende inclusions; in most cases plagioclase grains are smaller than alkali feldspar and form plagioclase-rich areas that alternate with quartz-rich clusters.

As in the case of biotite, hornblende forms at least two generations distinguishable by texture, size, and abundance. Euhedral hornblende commonly forms large, inclusion-rich (biotite, sphene, apatite, opaque oxides, zircon), randomly distributed grains; however, note that smaller hornblende is also abundant in the fine-grained plagioclase and biotite-rich clusters. As in the Getchell Mtn. case, the relationship between biotite and amphibole is of mutual intergrowths and imply coprecipitation from the magma.

Return to cars.

Continue straight (N) toward the 5-way intersection.

40.2 4.2 Back at the 5-way intersection. Turn right on the same dirt road used coming in and proceed toward paved road.

41.7 1.5 Turn N (left) at the paved Dead River Co. road.

44.4 2.7 Turn W (left) on gravel road leading to firetower on Almanac Mtn.

46.0 1.6 STOP 5: CONTACT BETWEEN PASSADUMKEAG RIVER PLUTON AND COUNTRY ROCK

Park in the small parking lot, find a comfortable place to relax and eat lunch.

Extensive outcrops of the contact relations between country rock and the Passadumkeag River pluton are exposed on the southern slopes of Almanac Mtn.; these exposures are essentially continuous to the marked break of slope that envelopes the mountain. We will inspect an area about 100 m. (S20°W) from the firetower. Please follow the trip leader as we proceed toward these outcrops and stay with the group. This stop serves as an example of the type of relationships associated with the granite-country rock contact. As in the case of the pluton of Center Pond, the intrusive contact is expressed along a transition zone characterized by intermingling of country-rock and granitic blocks and lit-par-lit disaggregation; however, small (<10 cm) pegmatites, pods and aplitic stringers of variable thickness are also abundant, and these randomly crisscross the country rock resulting in a brecciated appearance.

Several types of granitic rocks are evident near the granite-country rock contact in the vicinity of Almanac Mtn. These range from strongly foliated, equidimensional, medium-grained, mafic-poor rocks, to poorly foliated, porphyritic, and more mafic. A common attribute of all granitic rocks is, however, that foliation parallels the intrusive contact. Mafic inclusions are relatively scarce, as compared to the core facies, and they apparently consist mostly of small (< 10 cm) ovoidal, plagioclase and biotite clots.

Granitic rocks immediately adjacent to the contact are notably poorer in mafic minerals compared to the core of the pluton. Feldspars, biotite and quartz are often subhedral even at the contact, and suggest that the granitic magma was already saturated with respect to them at this intrusive level. Note, however, that amphibole is rarely present in these rocks, and that the small concentrations of black minerals are dominated by commonly euhedral biotite.

Hornfelsic rocks are generally rusty on weathered surfaces and purple in fresh cut. Many of the outcrops on Almanac Mtn. show evidence for remobilization and plastic deformation probably related to intrusion of the Bottle Lake Complex plutons.

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|---|---|---|
| 47.6 | 1.6 | Turn N (left) on Dead River road going toward intersection with Rt. 6. |
| 50.8 | 3.2 | Turn E (right) on Rt. 6 going toward the town of Topsfield. |
| 51.6 | 0.8 | Carroll Townline, continue E on Rt. 6. |
| 55.2 | 3.6 | Bowers Mtn. is at your right and consists of both hornfels and granitic rocks of the Passadumkeag River pluton. Hornfels are well exposed on the top and continue down to the southeast limb of the mountain. |
| 57.2 | 2.0 | Pre-Silurian (?) Sulfidic schist outcrops. |
| 57.9 | 0.7 | Kosuth townline, continue E on Rt. 6. |
| 62.2 | 4.3 | Continue E on Rt. 6, past the dirt road going to Maine Wilderness Canoe Basin campground on Pleasant Lake. |
| 64.2 | 2.0 | The lake directly ahead and on the left side of the road is East Musquash Lake; East Musquash Mtn. is the highest mountain in the vicinity and it is identified by the firetower on the top. |
| 64.8 | 0.6 | Turn S (right) at the intersection with dirt road, sometimes known as Amazon Road. Note the two signs at the entrance identifying it as property of Georgia-Pacific Corp., and also giving directions to the cottages on the shores of Pleasant Lake. |

68.7 3.9 Continue S on Amazon Rd. Orie Lake is at your left and also notice that East Musquash Mtn. is in the background.

69.4 0.7 Pavements of country rock are almost continuously exposed near the road, grading into granitic rocks of the rim facies of the Whitney Cove pluton. Granite-country rock contact is constrained within 200 m. Granitic rocks are foliated parallel to the contact.

69.9 0.5 Continue S on Amazon Rd.; trail to the left goes to West Musquash Lake.

70.4 0.5 Pavement of rim facies of granite of Whitney Cove.

72.1 1.7 Continue straight on Amazon Rd.; trail to the right ends at Pleasant Lake.

73.2 1.1 STOP 6: CATACLASTICALLY DEFORMED RIM FACIES ROCKS OF THE GRANITE OF WHITNEY COVE

This outcrop shows the cataclastically deformed granitic rocks in the fault zone transecting the pluton of Whitney Cove and continuously exposed in a belt approximately 1.5 km wide from Orie Lake to Junior Lake. The fault zone is cut by the pluton of Passadumkeag River on its southwest extension, and it may connect with the north-trending fault through the country rocks mapped by Ludman (1978a). The Norumbega fault system and the fault zones through the Bottle Lake Complex and Center Pond plutons show the same northeast trending orientation, and probably represent rejuvenated, major tectonic lineaments in the region.

Note the markedly splintery, jointed, greenish appearance of this outcrop as a result of fault motion after intrusion of the Whitney Cove pluton. Cataclastic outcrops are commonly cut by numerous epidote and quartz-filled dikes, striking generally in the northeast direction, but commonly exhibiting substantial variation in attitude. The fault zone in this area is characterized by granitic rocks that show brittle deformation confined to narrow zones. Stresses are apparently dissipated in the immediate vicinity of the zones of maximum deformation, and are exemplified by spindle-shaped quartz grains within the epidote-rich dikes. Right lateral motion along many of the east trending joint sets is generally confined to less than 50 cm of displacement, and it is best displayed in the transected aplitic dikes. Even the mylonitic dikes are displaced by a few centimeters by this set of joints. Although the fault belt is delineated by a zone of abundant cataclastic rocks in this area, this zone is also expressed by ubiquitous epidote-filled dikes throughout the Whitney Cove pluton; this is especially applicable to the area between this fault zone and the Norumbega fault system.

Note the prevasive and massive alteration recorded by these rocks. Even those feldspars away from the cataclastic dikes are crisscrossed by thin, epidote-rich veins, and show marked alteration effects; biotite is completely chloritized and forms random clusters in the matrix. Granitic textures are obliterated near the epidote-filled veins and are characterized by feldspars showing gradual disintegration, shearing, rotation, and offset; note that the feldspars are immersed within plastically deformed bands of recrystallized quartz and biotite. Many of the exposures in this area are characterized by aplitic dikes that are commonly lined by silicified dikes dotted by fine-grained sulfide minerals, up to 10 cm in thickness, and oriented to the northeast. Foliation in granitic rocks is often well-developed and in good agreement with the orientation of epidote-filled veins.

| | | |
|---|---|---|
| 74.3 | 1.1 | Cross Rainey Brook |
| 75.0 | 0.7 | Continue straight on Amazon Road; trail to the right goes to a state campground along the south shore of Scraggly Lake on Hasty Cove. |
| 75.5 | 0.5 | Note the abundance of cataclastically deformed granitic boulders in this area. |
| 75.9 | 0.4 | Pavement of rim facies of Whitney Cove pluton rocks. |
| 76.4 | 0.5 | Continue straight at the intersection. |
| 76.7 | 0.3 | Continue straight at intersection. |
| 77.3 | 0.6 | Continue straight at intersection. |
| 78.1 | 0.8 | Pug Lake in Junior Bay is at your right. |
| 79.3 | 1.2 | Continue straight at the intersection; road to the right goes to Whitney Cove in Grand Lake. |
| 79.5 | 0.2 | Exposures of the porphyritic core facies of the Whitney Cove pluton. |
| 80.0 | 0.5 | STOP 7: PORPHYRITIC FACIES OF THE GRANITE OF WHITNEY COVE PLUTON |

Outcrops of this facies are best exposed along the shores of Whitney Cove in Grand Lake. Contacts between the core and rim facies of this pluton are rarely sharp, but rather exhibit a gradual and progressive transition into the rim facies where observed in the large outcrops near Pork Barrel Lake.

Distinction between the rim and core facies of the pluton depends on the development of strongly porphyritic and fine-grained character of the core rocks. Mafic minerals are predominantly biotite, and as in the rim facies, hornblende is absent; also in common with the rim facies, biotite locally forms conspicuously euhedral, and larger pseudohexagonal plates. Ovoidal clusters of fine-grained biotite and plagioclase are generally small (< 5 cm) but more abundant than in the rim facies. Metasedimentary and quartz-dioritic inclusions are relatively rare.

Phenocryst mineralogy is dominated by the feldspars, but quartz and biotite are also represented as subhedral grains; alkali feldspar is clearly predominant in size, abundance and development over inclusion-rich (biotite) plagioclase. Alkali feldspar encloses all other phases and it is sometimes decorated by them along growth zones. In samples where the porphyritic texture is best developed, plagioclase is nearly absent from the rock, and euhedral alkali feldspar is abundant; in spite of their idiomorphic nature, most alkali feldspars show minor development of scalloped edges resulting from embayment by the fine-grained matrix. Rapakivi texture is typically present but it is never abundant.

Biotite is the first major phase to crystallize as evidenced by the abundant pseudohexagonal grains and common inclusions within plagioclase; biotite rims of these larger grains are often ragged and intermingled with feldspars. A second generation of biotite is generally ragged in appearance, fine-grained, and forms an interlocking net around all other phases. Accessory and minor phases are represented by allanite, apatite, sphene, opaque (magnetite and ilmenite) and sulfide minerals. Crystallization of biotite, plagioclase, quartz and alkali feldspar followed the accessory minerals, and this sequence probably represents the generalized order of appearance. The only common occurrence of muscovite in the core facies is in wide (>50 cm) aplitic dikes that are numerous in the area surrounding Whitney Cove.

Return to cars.

Continue on Amazon Road.

| | | |
|---|---|---|
| 82.1 | 2.1 | Outcrops of porphyritic granite. |
| 83.0 | 0.9 | Note Georgia Pacific sign. |
| 83.1 | 0.1 | Cross stream. |

84.2 1.1 Granitic rocks of core facies.

84.7 0.5 Nice pavements of granitic rocks of Whitney Cove granite.

85.2 0.5 Extensive outcrops on the right, almost continuous.

85.7 0.5 STOP 8: RIM FACIES OF THE GRANITE OF WHITNEY COVE

Large exposures of this facies are common on most hilltops, and these are exemplified by the massive outcrops exposed on the Pineo Mountains, directly to the south and by the outstanding exposures common on the cliffs and islands of Grand Lake. In spite of the relatively abundant outcrop coverage, most rocks are deeply weathered and difficult to sample appropriately. This stop is close to the internal contact of the rim and core facies, as well as to the unexposed eastern granite-country rock contact. Note however, that this rock retains an overall massive appearance except where the long dimensions of feldspar suggest a preferred orientation to the north. Metasedimentary inclusions are progressively more numerous in this rock with proximity to the contact. However, in addition to these inclusions, note those of quartz-dioritic composition and restitic texture exhibit markedly inhomogeneous distribution even at the scale of the outcrop.

Although most rim rocks show remarkable textural homogeneity, a few pods of variable size are reminiscent of the finer-grained core facies. Epitote-filled fractures and joints are common in many of these exposures and serve as the principal fractures from which numerous secondary fractures originate. Close to these fractured areas, quartz has strongly undulatory extinction and both biotite and plagioclase show kink bands. Note the thick (∿60 cm) gray, aplitic dike showing indistinct margins with the granitoid and remarkable zonation from rim to core. Mafic minerals, chiefly biotite, are concentrated at the margin with the granite and are replaced by a felsic band followed by a pegmatitic seam (felsic and mafic minerals) toward the central portion.

Contrast the color, texture, and mineralogy of this outcrop with the previous stops. These rocks are undisputably pink, equidimensional in texture and consist of subhedral biotite (apatite + zircon + magnetite + ilmenite) in discrete clusters in the matrix, usually in close relationship with plagioclase. Feldspar mineralogy is still overwhelmingly dominated by alkali feldspar; to, mostly as subhedral and typically deeply embayed grains. Plagioclase, biotite and quartz are commonly found as inclusions in alkali feldspar, typically in random orientations without crystallographic control. Rapakivi textures are not abundant, but where present, they consist of peculiarly skeletal and embayed alkali feldspars, enveloped by a wide rim of plagioclase; inclusions of biotite and plagioclase are common in these alkali-feldspar cores. Idiomorphic, gray quartz clearly embays and predates not only alkali-feldspar but also some plagioclase; clusters of quartz mosaics tend to form an essentially monomineralic and interconnected net that intermingles with feldspar clots. Plagioclase shows polysynthetic twinning and a generally euhedral, homogeneous core enveloped by a progressively more albitic rim. Together with biotite and Fe-Ti opaques, plagioclase exhibits peculiar intergrowths and deep embayments indicative of a reaction relationship.

88.0 2.3 Cross stream and continue straight.

88.5 0.5 Continue straight at intersection.

88.9 0.4 Pavements of granite of Wabassus Lake.

STOP 9: (OPTIONAL) WABASSUS LAKE GRANITE

This medium-grained granite is found only within the Norumbega fault zone. It is finer-grained than either the rocks of the Whitney Cove pluton to the north or the Cranberry Lakes pluton to the south. It is more altered than either of those plutons, and has fewer mafic minerals. It does not correspond to either of the three plutons south of the Norumbega fault zone (Lucerne, Lead Mountain, Cranberry Lakes) or to the Whitney Cove pluton north of the fault. As a result, we have been unable to obtain a meaningful estimate of movement on the Norumbega fault zone.

92.2 3.3 Turn E (left) at intersection with paved road and continue to the intersection of U.S. Rt. 1.

93.4 1.2 Cross Big Musquash and continue E.

95.7 2.3 Continue E (straight). Road at your right goes to Peter Dana Pt.

97.3 1.6 Turn N (take left) at intersection with Rt. 1 and continue N to Presque Isle.

END OF TRIP