46. GEOLOGY AND U-Pb GEOCHRONOLOGY OF PARTS OF THE LEITH PENINSULA AND RIVIÈRE GRANDIN MAP AREAS, DISTRICT OF MACKENZIE

Project 820009

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Abstract

This report describes the geology of parts of the Hottah Terrane and Great Bear Magmatic Zone, Wopmay Orogen, which were mapped during the 1982 field season. On Leith Ridge the Hottah Terrane comprises schists, orthogneiss, and foliated granitoid plutons. One of the deformed plutons is 1902 ± 4 Ma. These rocks are cut by plutons of the Great Bear batholith. At Hottah Lake, rocks of the Hottah Terrane include metasedimentary and metavolcanic rocks plus a variety of deformed plutons, one of which is 1914 ± 2 Ma. Unconformably overlying the Hottah Terrane in the Hottah Lake area is a varied and complex sequence of sedimentary rocks, subaerial siliceous to mafic lava flows, ash-flow tuff, and pillow basalts – all intruded by mafic sills. The Hottah Terrane and its cover sequence were later intruded by granitoid plutons of the Great Bear batholith. Regional geological and geochronological considerations suggest that the Hottah Terrane is allochthonous with respect to the Coronation margin and was accreted about 1900-1890 Ma.

Introduction

This paper reports the results of 1982 field work and U-Pb zircon chronology done in parts of the Rivière Grandin (86E) and Leith Peninsula (86D) map areas. The two map sheets span the western boundary of the Canadian Shield (Fig. 46.1) and include flat lying lower Paleozoic rocks, Proterozoic clastic and carbonate rocks of Hornby Bay Group, and early Proterozoic rocks belonging to two tectono-stratigraphic zones of Wopmay Orogen: the Great Bear Magmatic Zone and the Hottah Terrane.

The early Proterozoic rocks of the Rivière Grandin sheet and those in the southeastern part of the Leith Peninsula sheet were mapped at 1:250 000 scale by McGlynn (1975, 1979), who discovered a deformed and metamorphosed basement complex unconformably beneath rocks of the Great Bear Magmatic Zone in the Hottah Lake area (Fig. 46.1). Additional exposures of pre-Great Bear rocks were subsequently found by Hildebrand (1981, 1982) in the Conjuror Bay area (Fig. 46.1) who designated all deformed rocks in the basement complex as the Hottah Terrane (Hildebrand, 1981).

Recent tectonic models for the development of Wopmay Orogen have inferred that the Hottah Terrane is allochthonous with respect to the Coronation margin (Hoffman and St-Onge, 1981; Hildebrand, 1981; Hoffman et al., 1982). They suggested that the terrane may have been a volcanic arc or microcontinent beneath which the leading edge of Coronation margin was subducted. Since much of the Hottah Terrane remained unmapped, the models could not be tested and our understanding of the true nature and significance of the Hottah Terrane with respect to the rest of Wopmay Orogen remained enigmatic. The current project was undertaken to identify and characterize rocks of the Hottah Terrane, to establish the spatial and temporal relationships of their metamorphism and deformation with respect to the rest of Wopmay Orogen, and to continue Hildebrand's earlier investigations (1981, 1982, in press) into the oldest and westernmost rocks of the Great Bear Magmatic Zone.

Field work, from late May to early September, was carried out by ground-based 1:16 000 scale and 1:50 000 scale geological mapping. Work during the first six weeks of the

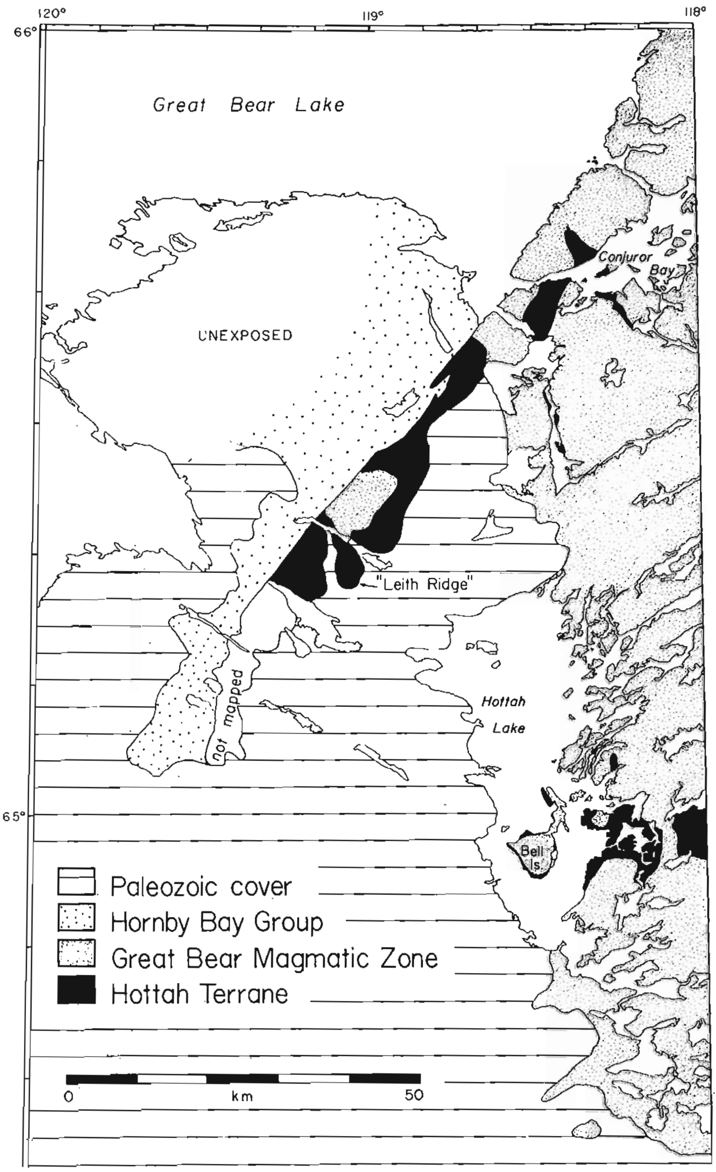

Figure 46.1. *Sketch map showing major tectono-stratigraphic units of the project area and location of major geographical features mentioned in text.*

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Table 46.1

Analytical data for zircons from Hottah Terrane

Sample Fraction	Concentration[1] U(ppm)	Concentration[1] Pb(ppm)	Observed Pb Isotopic Ratios[2] 204/206	Observed Pb Isotopic Ratios[2] 207/206	Observed Pb Isotopic Ratios[2] 208/206	Calculated Isotopic Ratios[3] 206Pb*/238U	Calculated Isotopic Ratios[3] 207Pb*/235U	207Pb*/206Pb* age (Ma)
RSH 82-2								
A′	219.6	80.8	0.001101	0.130314	0.16825	0.3276	5.2165	0.11548 (1888)
A	262.3	100.5	0.002168	0.144381	0.21363	0.3174	5.0407	0.11517 (1882)
B	287.6	99.2	0.000882	0.126100	0.16436	0.3072	4.8380	0.11420 (1867)
C	282.9	93.1	0.000670	0.122721	0.15531	0.2970	4.6558	0.11368 (1859)
VS 79-104								
A(+200)	457.7	154.7	0.000209	0.118792	0.11944	0.3165	5.0607	0.11598 (1895)
C(200-270)	613.9	188.6	0.000483	0.120651	0.13358	0.2828	4.4508	0.11414 (1866)
C(+200)	644.5	182.4	0.000361	0.117768	0.12425	0.2636	4.1026	0.11289 (1847)
E(-270)	734.0	195.4	0.000320	0.116175	0.13123	0.2470	3.8089	0.11185 (1830)

[1]Corrected for blank.
[2]Uncorrected for blank.
[3]Corrected for blank, non-radiogenic Pb.
*Radiogenic Pb.

field season focused on the northern half of Leith Ridge (Fig. 46.1), while the remaining eight weeks were spent in the Hottah Lake area (Fig. 46.1).

U-Pb analyses were done at University of Kansas using an automated 22.5 cm radius, single-filament mass spectrometer. Zircon analyses (Table 46.1) followed the general method of Krogh (1973). Analytical blanks range from 0.6 to 1.2 nanograms total Pb. Corrections for non-radiogenic Pb were made using model Pb compositions of Stacey and Kramers (1975). All data reduction and age calculations were done using the constants recommended by Steiger and Jaeger (1977). Concordia intercept ages were derived using a York (1966) least-squares fit for the discordia lines and calculating the intercept ages from the mean slope and the ± 1 sigma slope. Uncertainties are reported at the 1 sigma uncertainty level.

Acknowledgments

We were capably assisted in the field by Wanda Sheldrick and Monzo Spethmann and are all grateful for the high-quality, efficient expediting of Winifred Bowler and Martin Irving (DIAND). Discussions in the field with M.R. St-Onge and M.E. Bickford were especially beneficial. S. Hanmer and M.R. St-Onge critically read the manuscript. Geochronological work was supported by NSF grants 79-19544 and 81-18234 to W.R. Van Schmus.

Leith Ridge

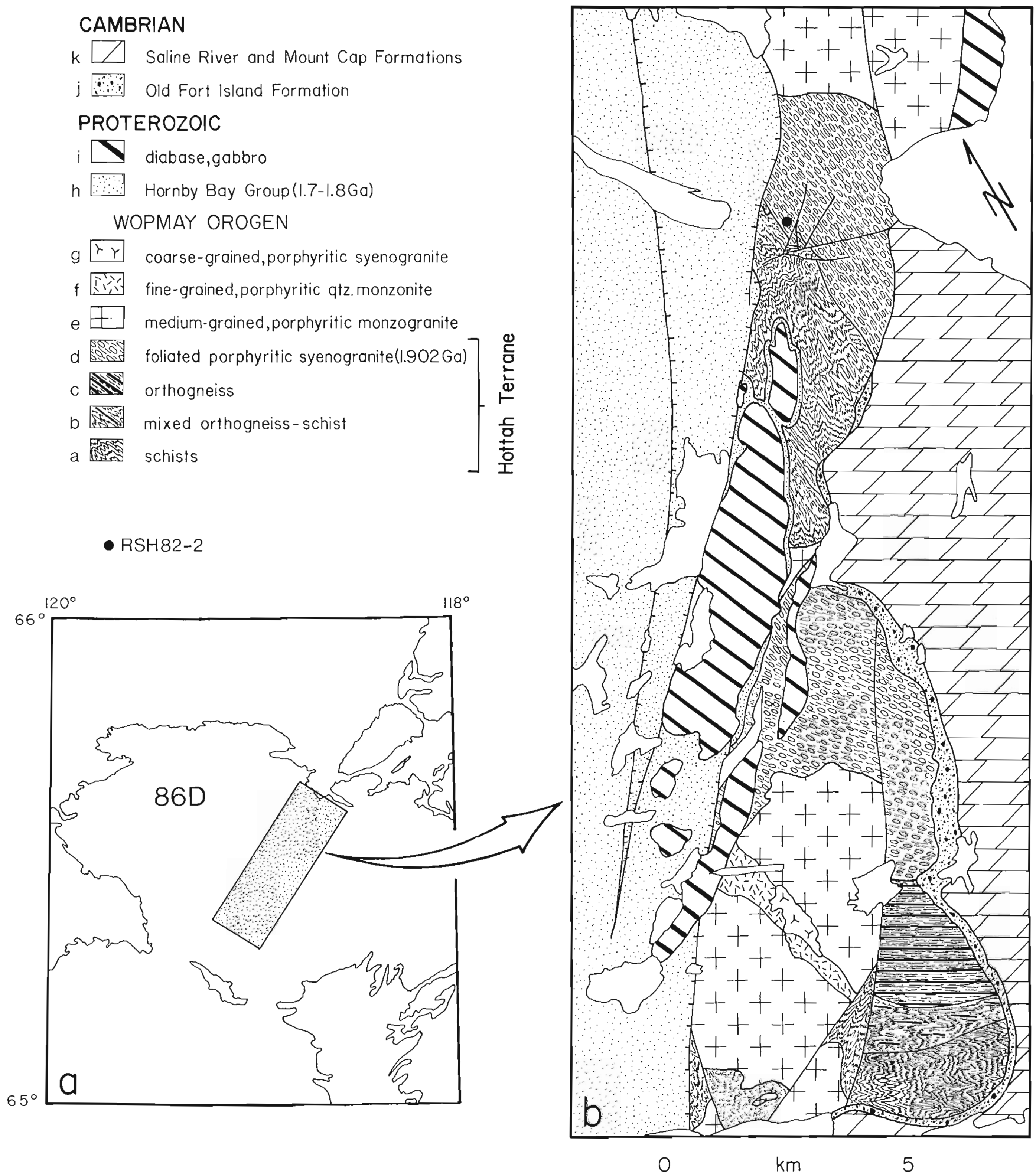
Leith Ridge, named by Balkwill (1971), is a topographically high-standing ridge of early Proterozoic rocks about 5 km wide and nearly 75 km long. It is a continuation of the rugged, deeply incised eastern shoreline of Great Bear Lake. The ridge is flanked on the southeast by swampy lowlands underlain by very poorly exposed, flat-lying lower Paleozoic rocks. The northwestern side of the ridge (Fig. 46.2), and likely the entire eastern shoreline of Great Bear Lake, is bounded by northeast-trending, northwest side down, normal faults which place Hornby Bay Group sedimentary rocks against older Proterozoic rocks.

Hottah Terrane

The oldest rocks of Leith Ridge are deformed rocks of the Hottah Terrane (units a-d; Fig. 46.2). Age relations between units a,b,c and d are unknown and their order on the figure legend is purely arbitrary.

Unit a is a mixed unit of quartz-plagioclase-biotite ± muscovite schists (sedimentary protolith), with minor garnet amphibolite, intimately intruded by sheets, dykes, and irregularly-shaped bodies of undeformed to slightly foliated granitoid rocks. The maximum phase assemblage is quartz-plagioclase-biotite+sillimanite+granitic melt. The first appearances of sillimanite and granitic melt were mapped in the field. Original compositional layering in the schists has been completely transposed and primary sedimentary structures obliterated. The transposed fabric is isoclinally folded with shallowly plunging axes and vertical to gently inclined axial planes. Granitic pods are isoclinally folded and the trace of the first appearance of granitic melt in the schists is also tightly folded.

Orthogneiss of dioritic, quartz dioritic, quartz monzonitic, and granitic compositions make up the bulk of unit c and parts of unit b. Hornblende and biotite are the dominant ferromagnesium minerals. Virtually all the rocks of unit c are L/S tectonites with shallowly plunging lineations and steep to gently inclined planar fabrics. In general the planar element dominates, but locally only a lineation defined by stretched crystals is present. Local zones of gabbro and clinopyroxenite also occur within this unit and are only slightly deformed. Contacts between all rock types parallel the planar fabric and may be tectonic.



a. Sketch map of Leith Peninsula (86D) map area showing that part of Leith Ridge mapped during the 1982 field season.

b. Geological sketch map showing distribution of major map units.

Figure 46.2

A peculiar rock, probably best termed a lenticular or flaser-like gneiss, occurs as lenses 3-4 m thick and 40-50 m long in the northern part of this map unit. The gneiss is a plagioclase-quartz-potassium-feldspar-biotite rock in which the biotite forms lenses 2-3 cm long and less than 1 cm thick. The lenticular nature of this rock was probably generated by isoclinal folding and extreme flattening of a rock containing alternating quartzofeldspathic and biotite bands. Sillimanite, perhaps pseudomorphing kyanite, forms sparse, blocky porphyroblasts 1 cm across.

The planar fabric of rocks included in unit c is transposed by ductile shear zones of dominantly sinistral sense (Fig. 46.3). They commonly trend east-west.

All of the above rocks are intruded by undeformed aplite dykes. Crosscutting relationships, visible in some outcrops, indicate at least three generations of these intrusions and there does not appear to be any spatial relationship between the shear zones and dykes.

Coarse grained, foliated porphyritic biotite syenogranite (unit d) is the most common lithology of the Hottah Terrane on Leith Ridge (Fig. 46.2) and similar rocks occur in the Conjuror Bay area (Hildebrand, 1982). The granite is variably deformed, ranging from virtually undeformed to strongly mylonitic. Most typically the unit is an L/S tectonite with the planar fabric defined by biotite and the lineation by stretched potassium feldspar megacrysts. The lineation is gently plunging, while the foliation is steep to gently inclined. A deformed sample of this unit was collected for U-Pb zircon geochronology during the 1982 field season and has yielded an age of 1902 ± 4 Ma (Fig. 46.4). This is interpreted as the emplacement age.

Figure 46.3. Sinistral, ductile shear zones in orthogneiss of Hottah Terrane cut by fine grained biotite granite. GSC 203695-N

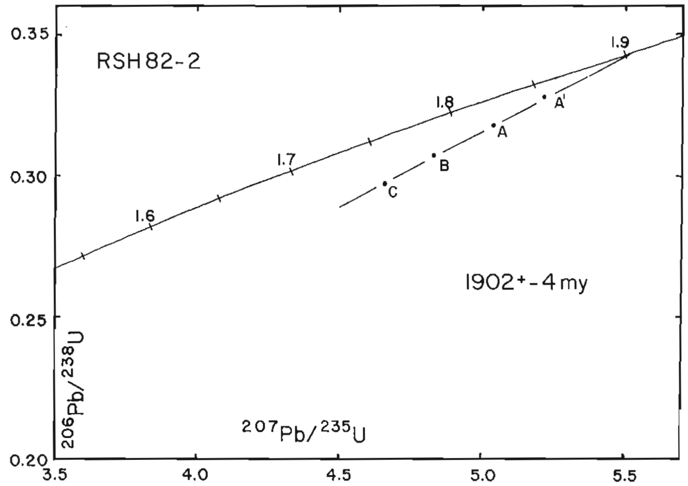


Figure 46.4. Concordia diagram for deformed syenogranite of Leith Ridge.

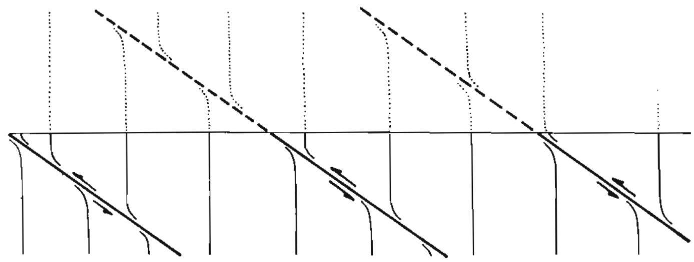


Figure 46.5. Diagramatic cross-section showing relationship of foliations and contacts on Leith Ridge.

The contacts of units a through d generally dip less than 40 degrees and are zones of intense mylonitization. For example, the foliated porphyritic syenogranite (unit d) becomes progressively deformed to a mylonitic gneiss over 3 or 4 m as the contact with the schists (unit a) is approached. Planar fabrics in both units shallow into the plane of the contacts and are almost always concordant to the same. Within the mylonitic zones mineral lineations lie within the plane of the foliation and are nearly orthogonal to the strike of the foliation. A schematic cross-section of relations at the contacts is shown in Figure 46.5. Rotation of the foliations into the shear zones indicates that the structurally higher blocks have moved over the lower blocks. Therefore the shear zones are tentatively interpreted as ductile thrust zones.

An interesting feature of the tectonites occurring on Leith Ridge is the abrupt change in strike of foliations across younger, nearly vertical, faults of unknown displacement (Fig. 46.2). As mineral lineations and/or fold axes are nearly horizontal in each block it is difficult to attribute the rotations to movement along the younger faults by dip-slip, reverse-slip, or strike-slip displacement. Rotations therefore occurred prior to the generation of the faults, possibly during a younger collisional event, which is suggested by paired gravity anomalies to the west (Hoffman et al., 1982).

Great Bear Magmatic Zone

Rocks of the Hottah Terrane on Leith Ridge are intruded by plutons similar to plutons of the Great Bear Magmatic Zone. The most common are bodies of grey-weathering, medium grained, hornblende-biotite syenogranite to monzogranite containing pink phenocrysts of potassium feldspar to 4 cm. They have sharp contacts with their wall rocks, and often contain numerous xenoliths. The northernmost pluton shown on Figure 46.2 is cut by myriads of aplite and pegmatite sheets. The mapped contact dips shallowly to the north, suggesting that it is the lower contact of the body.

The two large bodies exposed near the south end of the mapped area (Fig. 46.2) are similar in composition yet are probably two different plutons. Potassium feldspar phenocrysts in the northern body are generally much smaller than those in the southern one and those in the northern body often contain abundant inclusions of quartz, plagioclase and biotite while those in the southern body do not. The southern body contains few enclaves while they are especially numerous in the northern body. In fact, the more northerly of the two bodies has a marginal zone about 200 m wide containing abundant enclaves of schist and gneiss with foliations that are still parallel to the regional fabric of the Hottah Terrane. This suggests that the enclaves are roof pendants, and that the two granites are indeed two separate bodies, the southern one of which intruded to a higher structural level than the northern.

The thin strip of fine grained, hornblende-biotite quartz monzonite (unit f) also contains abundant enclaves of country rocks, most of which also have a fabric parallel to the regional trend. This body is compositionally very diverse, with irregular zones of varying dimensions which contain blue quartz, perhaps xenocrystic, subhedral to euhedral crystals of plagioclase up to 1 cm long, and potassium feldspar crystals to 2 cm. Contacts with both large bodies of granite are sharp and nearly vertical. In places along the contact potassium feldspar phenocrysts protrude from the granites and appear to be in the process of being plucked.

Both the northern granite and the quartz monzonite are intruded by a coarse grained, hornblende-biotite, potassium feldspar porphyritic syenogranite (unit g). This pluton is virtually xenolith-free, weathers pinkish red, and has sharp external contacts.

Other Rocks

Sedimentary rocks of Hornby Bay Group (unit h) occur mostly in west-side down fault blocks along the western side of Leith Ridge but locally sit unconformably upon older rocks on the ridge itself (Fig. 46.2). Doubtless they once covered the entire ridge but were eroded away, except where protected by gabbro sills.

Much of the Hornby Bay Group within the area of Figure 46.2 is a fine grained, mature quartz arenite which weathers white, or where cemented by hematite, red. It is mostly crossbedded with both planar and trough sets, but stratigraphically lower parts tend to be planar bedded with rippled surfaces. Paleocurrent measurements (>200) indicate that sediment transport was toward the west-southwest.

Most beds of the Hornby Bay Group strike northeast-southwest and dip less than 10 degrees to the northwest but in gaps between normal faults bedding strikes northwest-southeast and dips close to vertical. Where the Hornby Bay Group sits on older rocks, weathering of the basement is limited to within 10 or 15 m of the unconformity. A more comprehensive treatment of the Hornby Bay Group is presented in Kierens et al. (1981). The reader is referred to that paper for further details.

Two swarms of diabase occur within the area but are not shown on Figure 46.2. The oldest are east-west trending diabase dykes which cut rocks of the Hottah Terrane and the younger granitoids. They are part of a regional swarm of east-west trending dykes mapped by Hildebrand (1981, 1982, in press) all along the eastern shore of Great Bear Lake and termed Cleaver Diabase by Hoffman (1982). They are not known to cut the Hornby Bay Group and are considerably altered. The second set of diabase dykes trend north-south, weather recessively, and are found in the north end of the map area where they intrude rocks of the Hornby Bay Group. Similar north-south trending dykes occur farther east in the Great Bear Magmatic Zone where they are mapped by Hoffman (1978) in the Sloan River map area and McGlynn (unpublished) in the Calder River map area.

Gabbro sheets (unit i) which dip gently northwestward intrude both the Hornby Bay Group and the older Proterozoic rocks. There are two sheets at different structural levels. The lower sheet appears to be a continuation of the Gunbarrel Gabbro (Hildebrand, 1982).

Map units j and k are lower Paleozoic sedimentary rocks of the Old Fort Island and Saline River-Mount Cap formations. They are generally poorly exposed and because they are outside the realm of this project the reader is referred to Balkwill (1971) for detailed descriptions of those units. It is, however, worth mentioning that the Old Fort Island Formation contains, at its base adjacent to Leith Ridge, abundant feldspar fragments probably derived from the early Proterozoic granitoid rocks.

Of particular interest to geologists working on Quaternary problems is the occurrence of spectacular sets of raised beaches up to 215 m above the present level of Great Bear Lake. The beaches are comprised of local debris and are cobbly to bouldery, except in protected paleobays, where they are composed of sand.

Hottah Lake Area

Most of the area in the Hottah Lake region mapped during the 1982 field season is shown on Figure 46.6. The oldest rocks of the belt are rocks of the Hottah Terrane. They are overlain unconformably by a varied sequence of subaerial to submarine volcanic and sedimentary rocks (McTavish Supergroup). Granitoid plutons of the Great Bear batholith intrude both the basement and the volcano-sedimentary sequence.

Hottah Terrane

Rocks of the Hottah Terrane in this area are diverse and include metamorphosed sedimentary and volcanic rocks plus a wide spectrum of intrusive rocks. The highest grade of metamorphism attained in the rocks was amphibolite facies but locally they show retrogression to greenschist facies. Age and structural relations between many units within the terrane are unknown due to extremely heterogeneous strain, intrusion by younger granitoid rocks of the Great Bear batholith, folding, and at least two generations of younger faults. In addition, many exposures occur on the hundreds of islands in Hottah Lake, thus critical contacts are often under water.

Isoclinally-folded and sheared metasedimentary rocks in which bedding has been completely transposed occur on Bell Island and a few small islands to the east. These rocks are fine grained assemblages of plagioclase-biotite-amphibole-quartz and chlorites. They were intruded prior to folding by swarms of granitoid sills and dykes which have compositions ranging from alkali feldspar granite to quartz diorite. Many of the granitoids are protomylonitic and a few are ultramylonitic. Fold axes are generally gently plunging and foliations, parallel to the nearly vertical limbs of isoclinal folds, strike about 300 degrees on the east side of the island and nearly north-south on the southern part. Most of the folds have been completely disrupted, probably due to extreme elongation after their formation. The fabric in the mylonitic rocks is parallel on horizontal surfaces to the disrupted limbs of folds. One of the deformed granitoids, a strongly flattened granodiorite, was collected by RSH, SAB, and WRVS during the summer of 1979. It yielded zircons, considered to be magmatic, dated at 1914 ± 2 Ma (Fig. 46.7).

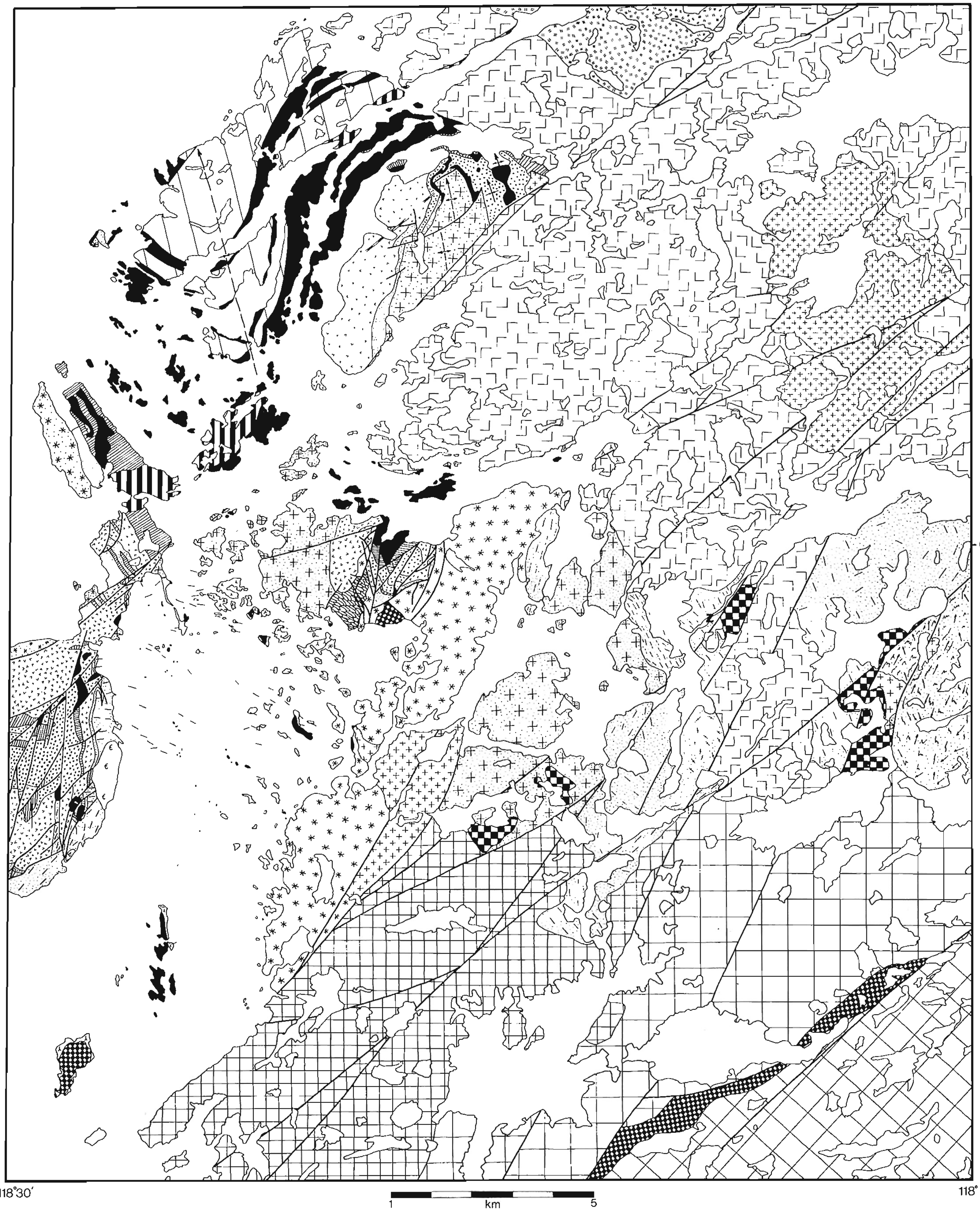


Figure 46.6. *Generalized geological map of the Hottah Lake area mapped during 1982.*

LEGEND FOR FIGURE 46.6

Hottah Terrane:

(a) metasedimentary rocks, mylonitic granitoids, gabbro, minor gneiss;

(b) dioritic gneiss;

(c) pillow basalt, breccia;

(d) fine-grained diorite, quartz diorite, agmatite;

(e) biotite-hornblende granodiorite;

(f) leucocratic monzogranite and granodiorite;

(g) biotite-hornblende granodiorite and quartz diorite;

McTavish Supergroup:

(h) sandstone, conglomerate, lithic tuff, basaltic lava flows;

(i) basalt, sandstone;

(j) siliceous lava flows;

(k) ash-flow tuff;

(l) pillow basalt, gabbro, diabase;

(m) gabbro, diabase, microgabbro, minor pillow basalt;

Great Bear Batholith:

(n) porphyritic biotite granite;

(o) biotite granite;

(p) quartz diorite, quartz monzodiorite, diorite;

(q) hypabyssal porphyries;

(r) Zebulon granodiorite;

(s) biotite granite-alkali feldspar granite;

(t) biotite-hornblende quartz monzonite;

(u) fine-grained biotite granite;

Younger rocks:

(v) gabbro, diabase;

(w) Old Fort Island Formation;

Z = Zebulon River (geographic locality)

Agmatite-like rocks occur on many islands east of Bell Island. They comprise blocks of fine grained diorite and medium- to coarse-grained gabbro surrounded by fine- to medium-grained quartz diorite. Some of the gabbroic blocks contain clots of clinopyroxene 15 cm in diameter. These rocks range from slightly flattened (Fig. 46.8) to intensely flattened (Fig. 46.9), with steep foliations trending close to 300 degrees. The transition between the two strain states is remarkably abrupt, often occurring over one metre or less, and usually exhibits material continuity. The gabbro blocks, being more competent than the diorities, are often angular or slightly necked, while adjacent diorite blocks are strongly flattened (Fig. 46.10). Locally, ultramylonitic zones are found in these rocks (Fig. 46.11). Their trend parallels that of the regional foliation.

Numerous bodies of medium- to coarse-grained granodiorite-monzogranite cut the agmatite-like rocks. Their deformation (Fig. 46.12) is similar to that of their host rocks.

All of the above were intruded by numerous dykes and sills of fine- to medium-grained biotite granite and alkali feldspar granite. Many of the intrusions lie within the foliation or are perpendicular to it. They are undeformed to weakly foliated.

A large body of coarse grained, leucocratic monzogranite occurs on Bell Island beneath the unconformity, on many islands northeast of there, and on the mainland east of Hottah Lake. It is usually undeformed or at most only weakly foliated.

On the mainland east of Bell Island and on a few islands to the south, deformed pillow basalts were found. In a few places they are only slightly flattened, but elsewhere they are ribbon-like in cross-section and are 1 or 2 cm thick by 3 to 4 m long. Minor deformed breccia is associated with the lavas.

A belt of metasedimentary rocks, mostly quartzites, occurs on the peninsula that juts out into the large bay east of Hottah Lake. They are strongly flattened and boudinaged. A few scattered outcrops of pelitic schist with tiny melt pods (1-2 cm) occur just north of Zebulon River. There are two sets of folds and a later crenulation cleavage present in these rocks. The crenulation cleavage trends close to north-south and dips 40-50 degrees to the west. The enveloping surfaces of the second generation folds trend about 300 degrees.

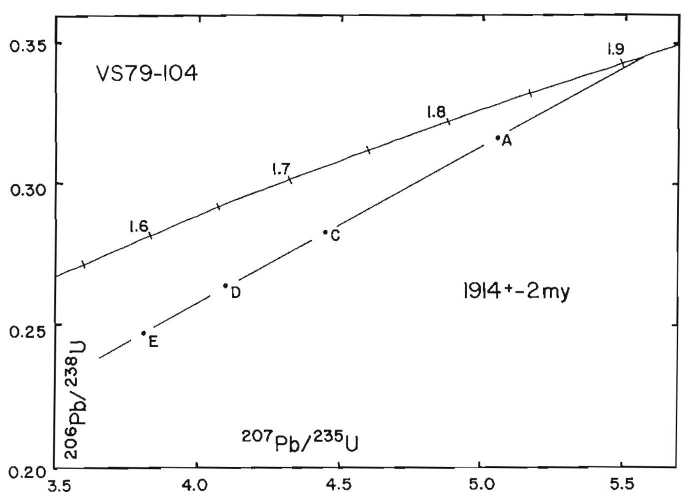
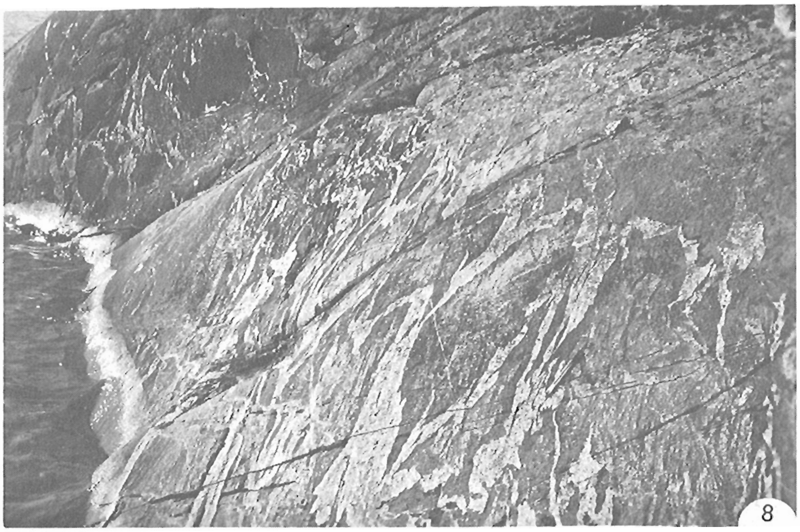
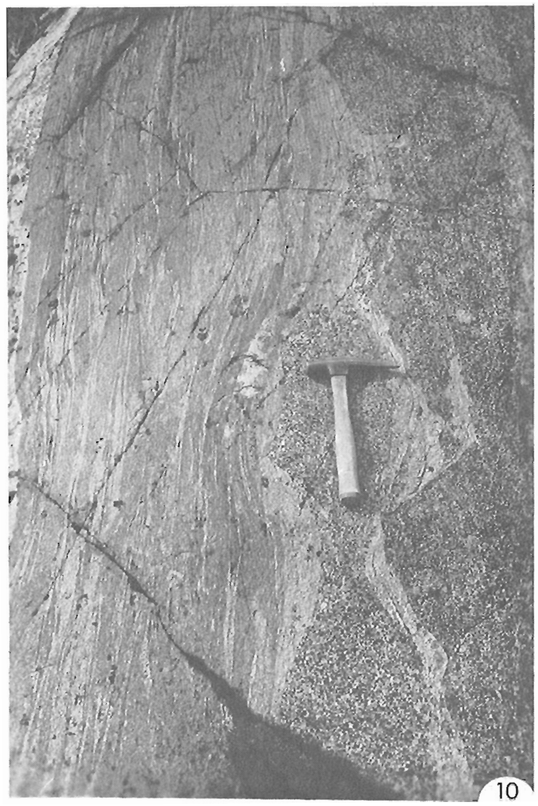
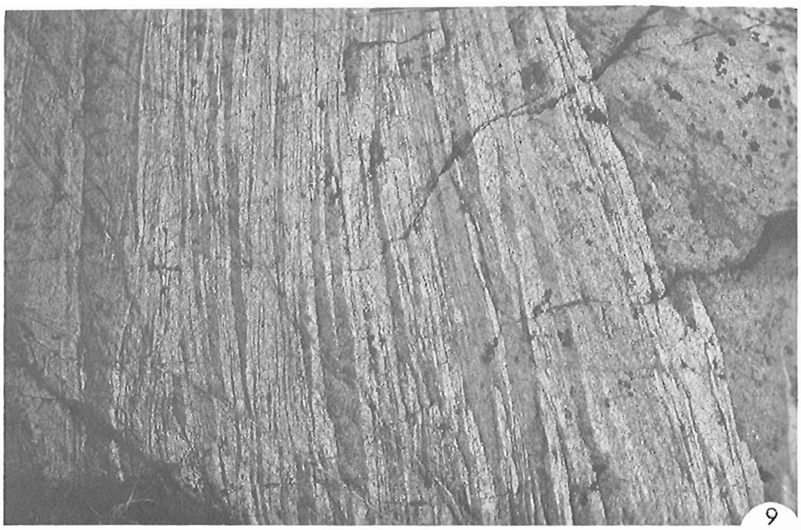


Figure 46.7. *Concordia diagram for deformed granodiorite, Bell Island.*







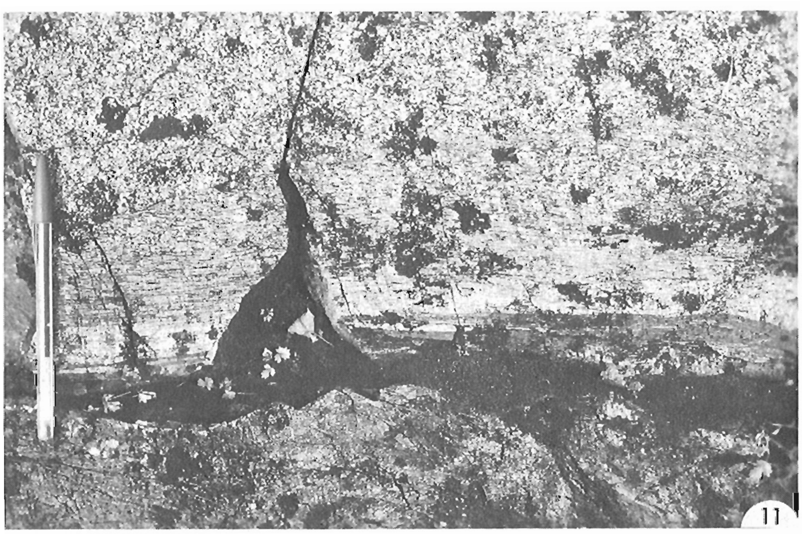


***Figure 46.8**. Slightly deformed, agmatite-like rock comprising diorite blocks surrounded by quartz diorite. Pen in lower right for scale. GSC 203695-R*

***Figure 46.9**. Strongly-deformed equivalent of rock shown in Figure 46.8. Pen in top centre for scale. GSC 203695-U*

***Figure 46.10**. Diorite and gabbro blocks showing pinch-and-swell structure related to competence contrast. GSC 203695-Q*

***Figure 46.11**. Transition from undeformed gabbro (top) to ultramylonite (bottom). GSC 203695-O*

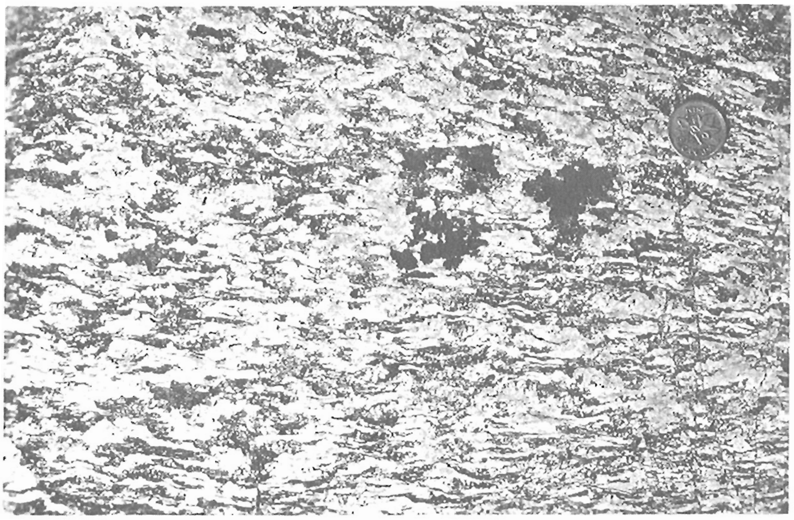


Figure 46.12

Typical texture of flattened granodiorite-monzogranite. GSC 203695-M

Figure 46.13

Unconformity between steeply-foliated granitoid rocks of the Hottah Terrane and pebbly, arkosic sandstone, eastern Bell Island. GSC 203695-V

A unit of dioritic L tectonite occurs in the extreme western part of the mapped area. It is intimately intruded by younger undeformed granitoid rocks of the Great Bear batholith.

A large area of medium grained, biotite-hornblende granodiorite to quartz diorite, usually undeformed or only weakly foliated, occurs on the eastern side of Hottah Lake where it is unconformably overlain by supracrustal rocks. Another undeformed, medium grained biotite-hornblende granodiorite was found along the northwestern side of Bell Island. Relationships with the supracrustal rocks are unclear, but this pluton may also be part of the basement complex.

McTavish Supergroup

Unconformably overlying the Hottah Terrane in the Hottah Lake area is a varied sequence of sedimentary rocks, subaerial mafic to siliceous lava flows and breccias, ash-flow tuffs, and pillow basalts. The unconformity is well exposed at numerous localities and exposures on Bell Island are superb (Fig. 46.13). There, highly strained metasedimentary and intrusive rocks with a near vertical foliation are overlain by a shallowly dipping, cobbly to pebbly, granular arkose that reaches its maximum thickness of about 100 m on the western side of the island. The unit thins rapidly to the east and northeast, where it is generally less than 10 m thick and commonly absent. The arkose is poorly bedded near its base and fines upward to well bedded, fine grained arkosic sandstone. The lower part of the unit contains abundant pebbles and cobbles of basement lithologies and undeformed volcanic fragments ranging from subangular to rounded. Locally, there are lenses and 0.5 m thick planar beds holding angular quartz fragments to 20 cm. In general, the lower part of the unit is massive with sparse trough crosslamination, while the upper, fine grained part of the section is ubiquitously trough-crossbedded with westward directed paleocurrents.

On western and northern Bell Island the sandstone contains several subaerial basaltic lava flows, probably filling paleovalleys, and minor lenses of lithic tuff. The sandstone is interpreted to record deposition in a fluvial environment, probably an alluvial fan complex, with a westward paleoslope.

Overlying the sandstone is a complex sequence of thinly bedded pyroclastic flows and a variety of siliceous lava flows. On eastern Bell Island several siliceous flows are underlain by yellowish green weathering tuff, typically one or two metres thick, containing dark green to black vitreous rock fragments and pink to orange felsophyric volcanic rock fragments. The tuffs are inversely graded with respect to size of lithic fragments. The overlying lava flows, at this locality, are

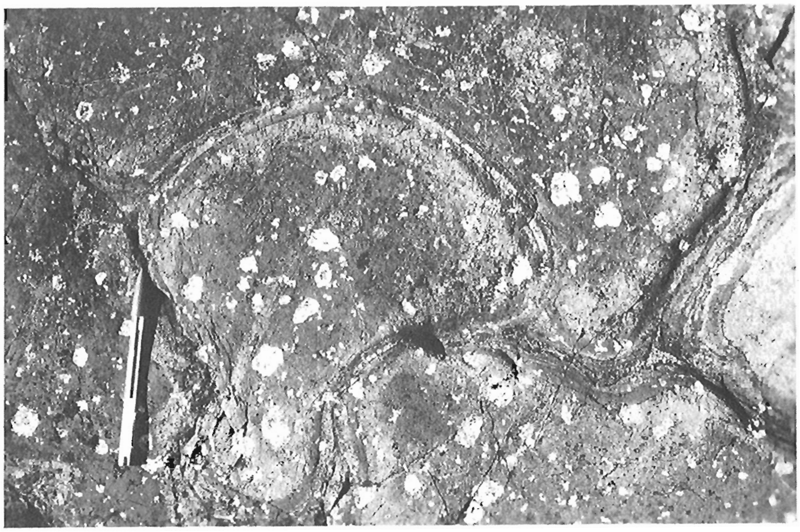


Figure 46.14

Plagioclase glomeroporphyritic pillow basalts. GSC 203695-T

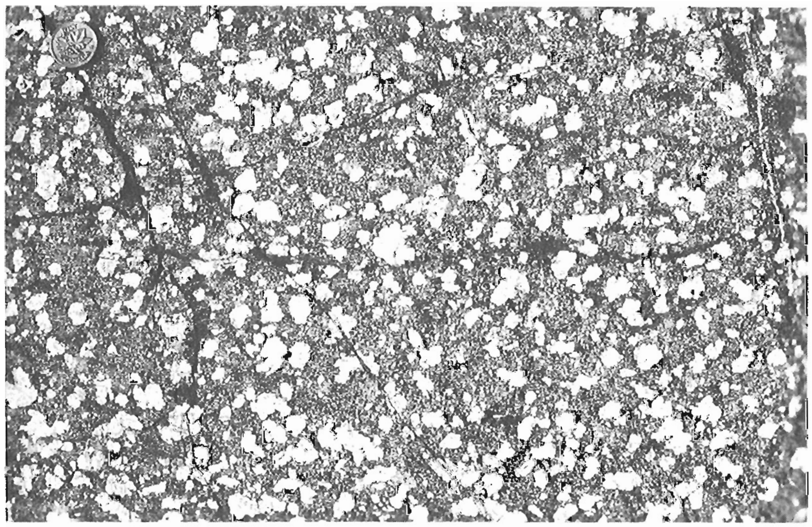


Figure 46.15

Plagioclase glomeroporphyritic gabbro sill, northeast Bell Island. GSC 203695-K

best termed block flows as they are almost entirely fragmental, consisting of 90 per cent red weathering, aphanitic volcanic fragments up to 1 m in diameter and 10 per cent yellowish green tuff-like fragmental material. In the matrix there is a continuous gradation from microscopic particles to fragments which can be considered small blocks. The larger blocks are often flow-banded and/or spherulitic. These lavas are similar to Tertiary rhyolite flows seen east of Death Valley, California by the senior author and described by Haefner (1969). A thick, strongly flow-banded, flow folded, and partially brecciated lava complex occurring just above the arkose on northern Bell Island may be a more proximal facies of this pile of lavas.

Another type of siliceous lava occurring above the arkose-basalt sequence contains abundant silica amygdules, many of which are stretched and outline flow folds. These lavas weather reddish brown. Other siliceous lava flows, which occur at the same stratigraphic horizon northeast of Bell Island, contain peculiar spherical to semi-spherical bodies which appear similar to rounded cobbles in outcrop. They range in size from 5 cm to 0.5 m and in places overlap one another. Locally, flow banding can be traced directly through the bodies. The spherical bodies are clearly not spherulites as they do not have a spherulitic texture. Their origin is, however, problematic. Identical bodies were found in Tertiary siliceous lavas by Bowring (1980) in the Datil-Mogollon volcanic field of New Mexico.

Locally on Bell Island an interval of basaltic lava flows overlies the siliceous lavas and in turn are overlain by a simple cooling unit of ash-flow tuff up to 75 m thick. The tuff weathers reddish orange and contains less than 10 per cent broken crystals of plagioclase-potassium feldspar, quartz, and ferromagnesium minerals. Near the top and bottom it is strongly eutaxitic, with flattened pumice to 6 cm. In places on Bell Island a discontinuous lithic-rich ash-flow tuff containing less than 5 per cent shattered plagioclase phenocrysts fills paleovalleys cut into the underlying tuff. This tuff is overlain either by another amygdaloidal, siliceous lava flow or by an amygdaloidal basalt flow with well developed columnar jointing.

On central Bell Island the next highest unit in the sequence is a quartz-phyric, brick-red weathering lava that is mostly massive, but occasionally flow-banded. The lava is at least 100 m thick, commonly columnar-jointed, and may be part of a dome complex. Elsewhere this lava is absent from the sequence and the ash-flow tuffs are overlain by subaerial basaltic lava flows, volcanogenic sandstones of mafic composition, or by mature quartz arenite.

The above units are, in turn, overlain by a thick sequence of amygdaloidal pillow basalts. The pile is probably at least 1 km thick but contains numerous mafic sills which make thickness estimates unreliable. The pillow basalts are of three main types: aphyric, plagioclase porphyritic, or

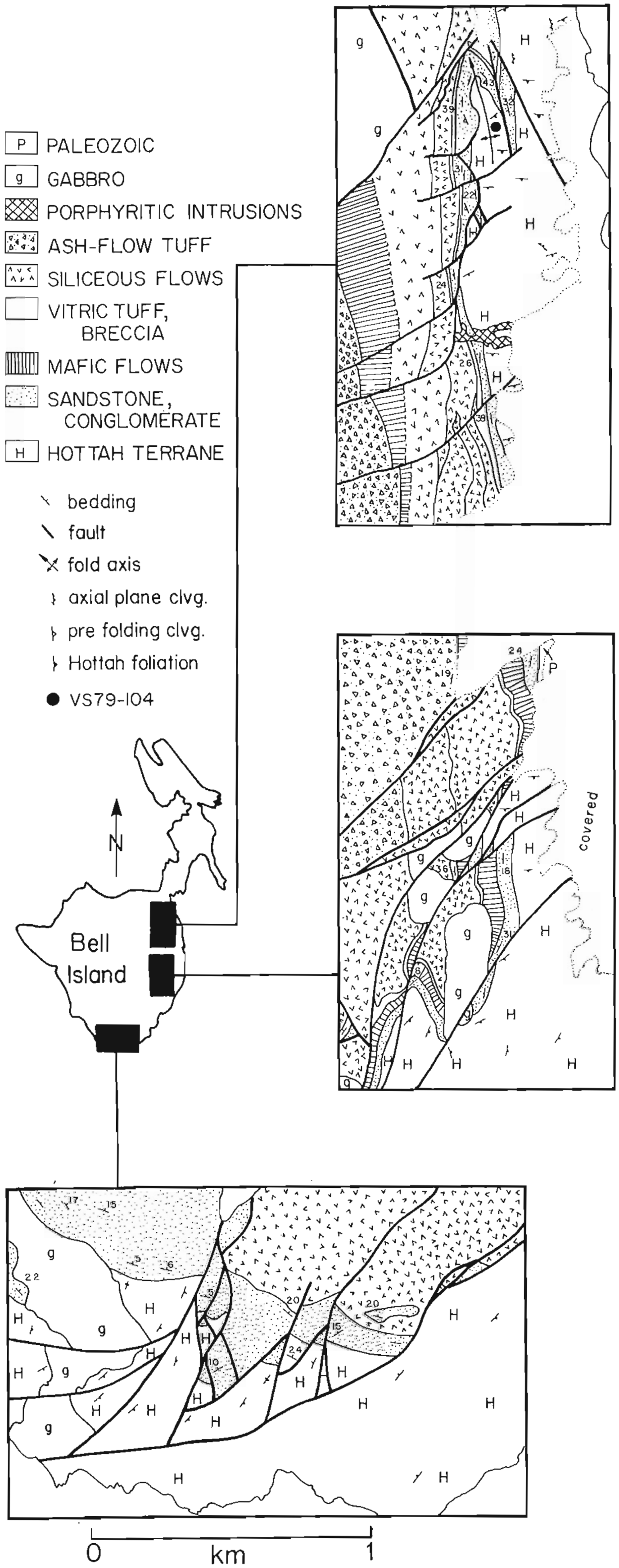


Figure 46.16. Detailed sketch maps of geology on eastern and southern Bell Island showing complexity of structure and facies.

plagioclase glomeroporphyritic (Fig. 46.14), which form mappable, wedge-shaped to planar units at 1:16 000 scale. Many of the pillows have round hollow cores partially filled with silica and epidote. In places the cavities are lenticular in cross-section. Spectacular 3-dimensional exposures of these lavas, showing the typical branching bulbous form, occur along the western shoreline of the largest island north of Bell Island.

Plagioclase glomeroporphyritic intrusions of ophitic to subophitic gabbro and diabase (Fig. 46.15) are very common throughout the area and cut all rocks except granitoids of the Great Bear batholith. Where they intrude rocks of the Hottah Terrane they most commonly form dykes, but where they intrude supracrustal rocks of the McTavish Supergroup they form sills. The glomeroporphyritic clots are typically 1-2 cm in diameter, normally consist of 2-5 intensely fractured and saussuritized plagioclase crystals, and commonly make up to 60 per cent of the rock. In a few places fist-size clots are common and in one locale northeast of Bell Island a football-shaped clot 20 cm long was found.

Locally a weakly developed mineralogical banding occurs in the groundmass and in areas rich in glomeroporphyritic clots there are typically irregular to planar zones in which there are no clots. One large sill, which occurs at the base of the thick pile of pillow basalts, contains oikocrysts of pyroxene up to 3 cm across in its lower half while the upper half contains clots of plagioclase. This sill has a fine grained upper border phase several tens of metres thick which contains sparse silica filled cavities up to 15 cm in diameter.

The occurrence of identical plagioclase clots in both the sills and the pillow basalts suggests that the two are comagmatic. Therefore, the intrusions may have been the magma chambers from which the pillow basalts were erupted.

Similar sills, also cutting a thick pillow basalt pile, occur in the Conjuror Bay area where they are unconformably overlain by rocks of the LaBine Group (Hildebrand, 1982). If the pillow basalts and sills in the Conjuror Bay and Hottah Lake areas are the same age, as suggested by Hoffman and McGlynn (1977), then the thick pre-basalt sequence of lava flows and sedimentary rocks of the Hottah Lake area are older than the LaBine Group and are the oldest known supracrustal rocks of the Great Bear Magmatic Zone.

Great Bear Batholith

The Zebulon granodiorite is the largest body of granitic rock mapped during the field season. It is typically a medium grained biotite-hornblende granodiorite and is distinctive in that it nearly always contains euhedral prisms of hornblende up to 1 cm long. Virtually every outcrop contains fist-sized, rounded xenoliths of partly digested country rock.

The contact of the pluton with its wall rocks is irregular on nearly every scale. A narrow aureole of contact metamorphism appears to range up to hornblende hornfels facies. Locally, spectacular intrusion breccias (Fig. 46.17) occur at the contact. In the Zebulon river area, where the pluton intrudes rocks of the Hottah Terrane, there are marginal zones rich in quartz, up to 1 cm across, and biotite. In these areas the pluton is clogged with xenoliths in varying states of assimilation.

An oval-shaped pluton of fine grained equigranular biotite monzogranite intrudes the Zebulon granodiorite. The monzogranite weathers a fleshy pink colour. The contact with the granodiorite is sharp and no border phase was evident in the field but locally, within 20 m of the contact, sheets of the monzogranite cut the granodiorite.

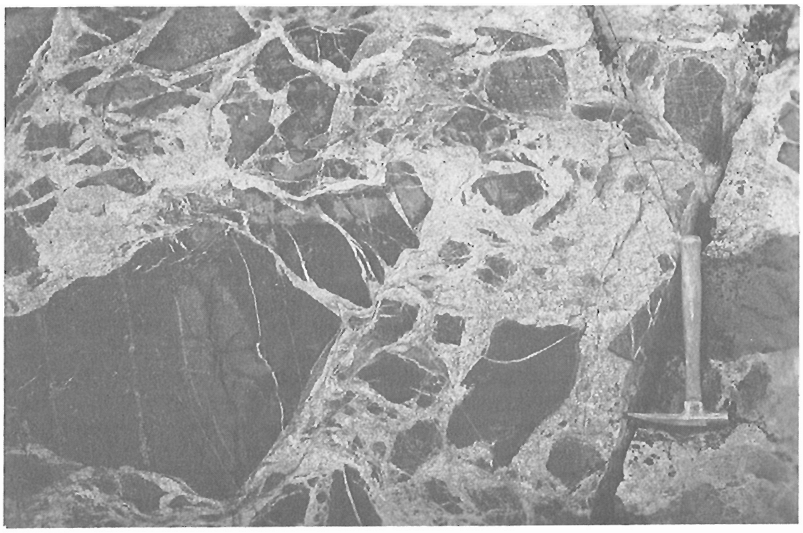


Figure 46.17. *Intrusion breccia at contact of Zebulon granodiorite. GSC 203695-S*

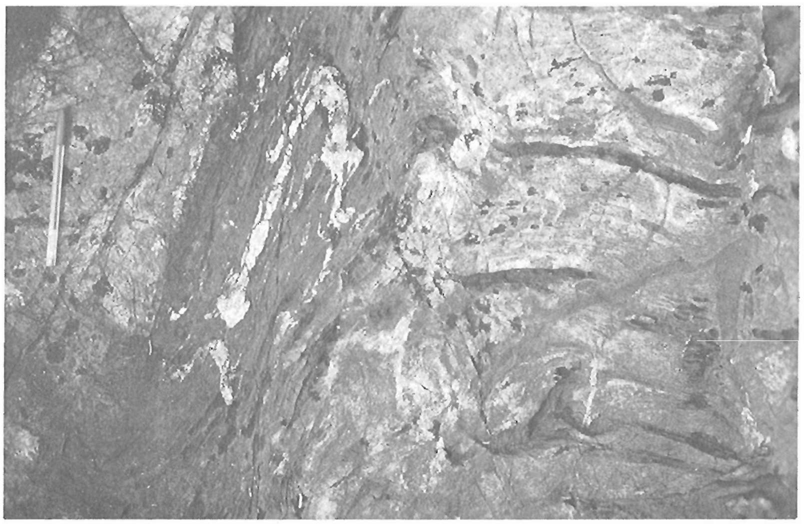


Figure 46.18. *Flattened pillow basalts of Hottah Terrane (right) cut by post-Great Bear folding shear zone (left). GSC 203695-L*

Tuffaceous units within the sequence record the next deformational event which is the development of a low-angle cleavage that dips to the west at 30-40 degrees with respect to horizontal bedding planes. This suggests a component of bedding parallel simple shear, top side over bottom. The basement, the cleavage, and all of the supracrustal rocks were folded about gently-plunging axes that trend approximately north-south. These folds, part of the regional set which affects most of the Great Bear Zone, are rather broad, open folds with second order folds on their limbs (Fig. 46.6, 46.16). A second cleavage, nearly vertical and trending north-south, is well developed in lithologies such as tuffs, and protomylonitic granites, and is thought to be axial planar to the north-south folds.

A broad north-south zone of ductile shear zones trending 320 degrees to 40 degrees which postdate the folding but predate most granitoid intrusions of the Great Bear batholith cuts both the supracrustal and basement rocks along the east side of Hottah Lake (Fig. 46.18). The zones are steep dipping, less than 1 m wide, and are spaced several metres to tens of metres apart. They may form a conjugate set as both dextral and sinistral zones occur.

A swarm of northeast-trending, right-lateral transcurrent faults (Fig. 46.5) typical of those found throughout the entire Great Bear Magmatic Zone postdates emplacement of the granitoid rocks. On Bell Island they appear to be splaying into north-south faults with vertical displacement. Because the transcurrent faults were not found on Leith Ridge, the western boundary of the fault system may lie between Hottah Lake and Leith Ridge.

Many of the strike-slip faults east of Hottah Lake were apparently reactivated, probably as dip-slip faults at a later date, perhaps during deposition of the Hornby Bay Group. Numerous normal faults with limited displacement not necessarily of the same age as the above, are found where stratigraphy is well developed (Fig. 46.6, 46.16) and doubtless many more exist throughout the area. Their age relations to the transcurrent faults is unclear at present.

At the north end of the mapped area a fine grained, biotite-hornblende quartz monzonite intrudes the Zebulon granodiorite. This pluton is an even grained and massive rock which weathers pink. The extent of this body is unknown as only the southern contact was mapped during 1982.

Other intrusive bodies of the Great Bear batholith found in the southern part of the mapped area (Fig. 46.6) were described by McGlynn (1979) and will not be discussed here.

Structure

The structure of the supracrustal rocks in the area is complex and reflects a long history of tectonism. The oldest known tectonic event appears to have been a period of extension, probably active prior to, and during extrusion of the thick pile of pillow basalts since the faults cut the lower part of the volcanic pile but are themselves cut by the glomeroporphyritic gabbro sills. These relations are best seen in the extreme northern part of the mapped area.

Younger Rocks

North-south trending, altered diabase dykes and northeast-trending gabbro sheets cut the faults. The sheets are relatively fresh and display well-developed columnar jointing. They are probably part of a regional swarm found on Leith Peninsula (i.e. Gunbarrel Gabbro), in the Calder River map area (McGlynn, unpublished), and the Hardisty Lake map area (Fraser, 1967).

Nearly flat lying lower Cambrian sandstone and conglomerate of the Old Fort Island Formation unconformably overlie the early Proterozoic rocks on eastern Bell Island. This unit ranges from massively-bedded conglomerate containing 90 per cent rounded cobbles and pebbles of the underlying basement to fine grained, crossbedded quartz arenite. Rocks of this unit are weakly indurated.

Tectonic Implications

One of the principal objectives of the study was to understand the relationship of the Hottah Terrane to the rest of Wopmay Orogen. Possibilities include the following: (1) the Hottah Terrane represents part of the Coronation margin, which is the west-facing sedimentary wedge overlying the Slave Craton; (2) it represents a fragment torn from the Slave Craton during initial rifting; (3) the terrane represents an arc beneath which the Coronation margin was subducted; (4) it is a block of unknown provenance which collided with the margin; or (5) some combination of the above.

The emplacement of granitoid intrusions in the Hottah Terrane at about 1914 Ma and 1900 Ma appears inconsistent with the terrane being part of the Coronation margin because the age of initial rift volcanism in the margin is bracketed between 2010 Ma and 1900 Ma (Bowring and Van Schmus, 1982) and it is unlikely that voluminous high-K granitic magmatism was taking place adjacent to, and oceanward of, a newly rifted and actively subsiding continental margin. If the age of rifting is close to the minimum age of 1900 Ma then the Hottah Terrane must be either a continental fragment torn from the Slave Craton or a block of unknown provenance. To date there is no indication of the existence of Archean basement in the terrane and therefore a model in which the Hottah Terrane is allochthonous with respect to the Slave Craton and of unknown provenance is favoured. Only if the age of initial rift volcanism is older than 1914 Ma could the Hottah Terrane represent part of an arc complex beneath which the Coronation margin was subducted. Even so, it would still be allochthonous with respect to the margin.

If the Hottah Terrane is allochthonous with respect to the Coronation margin and was accreted to it then the ages of deformation in both zones should be roughly synchronous. Deformation in the Hottah Terrane must, at least in part, postdate 1902 ± 4 Ma, the age of the youngest known deformed pluton in the terrane, and predate magmatism of the Great Bear Magmatic Zone which probably initiated at about 1875 Ma (Bowring and Van Schmus, 1982). Metamorphic isograds, postdate the major pulse of eastward vergent thrusting in the rise-prism sequence of Coronation margin (Hoffman et al., 1980) and are considered to be related to the Hepburn plutonic suite (St-Onge and Carmichael, 1979) whose mean age is 1885 Ma (Bowring and Van Schmus, 1982). This indicates that the age of deformation in the Coronation margin occurred between 1900 Ma, the U-Pb zircon age of porphyries that intrude the initial rift sequence but predate thrusting, and 1890 Ma - 1880 Ma, the age of the Hepburn intrusive suite. Thus, the age of deformation in both the Coronation margin and the Hottah Terrane is roughly synchronous. This is consistent with a model in which the Hottah Terrane was accreted to the Coronation margin between about 1900 Ma and 1890 Ma.

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