31. GEOLOGY OF THE EARLY PROTEROZOIC ROCKS IN PARTS OF THE LEITH PENINSULA MAP AREA, DISTRICT OF MACKENZIE

Project 820009

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Abstract

On southern Leith Ridge a variety of deformed and undeformed granitoid intrusions cut deformed sillimanite-melt-bearing paragneisses. In the Hottah Lake-Fishtrap Lake area rocks of the Hottah Terrane are mostly cordierite-bearing paragneisses intruded by foliated plutons. The plutons are unconformably overlain by sedimentary and volcanic rocks of the MacTavish Supergroup and the supracrustal section was intruded by plutons of the Great Bear Batholith.

Résumé

Dans la partie sud de la crête Leith, une gamme d'instrusions granitoides déformées et non déformées traversent des paragneiss à sillimanite déformés. Dans la région des lac Hottah et Fishtrap, les roches du terrain de Hottah comprennent surtout des paragneiss à cordiérite coupés par des plutons feuilletés. Ces plutons reposent en discordance sous des roches sédimentaires et volcaniques du supergroupe de MacTavish; les plutons du batholite de Great Bear ont fait intrusion dans la section supérieure de la croûte.

INTRODUCTION

This paper reports the results of the second field season of a three-year project to map the early Proterozoic rocks of the Leith Peninsula (86 D) and Rivière Grandin (86 E) map areas in order to identify and characterize rocks of the Hottah Terrane, the poorest known of the tectonic zones of Wopmay Orogen. During the 1983 field season mapping of the Leith Peninsula map sheet was completed at 1:50 000 scale and 1:16 000 scale in selected areas. Earlier work in the area includes that of Kidd (1936), McGlynn (1976), Hildebrand (1983), and Hildebrand et al. (1983).

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GEOLOGY OF SOUTHERN LEITH RIDGE

The oldest rocks of the southern Leith Ridge area (Fig. 31.1) are metasediments of the Holly Lake metamorphic suite. They are intimately intruded by numerous small deformed and undeformed igneous bodies ranging in composition from alkali feldspar granite to gabbro. Larger plutons of deformed biotite syenogranite, little deformed to undeformed porphyritic biotite granite, and undeformed muscovite-biotite granite also occur in the mapped area.

Metasedimentary rocks of the Holly Lake metamorphic suite (Hildebrand et al., 1983) are mostly sillimanite migmatites which have a well developed foliation, and locally, a moderately developed lineation. The migmatites are typically well-banded rocks comprising layers rich in quartz-sillimanite and others containing dominantly quartz, feldspars, and micas. Most layers have an average thickness of about one centimetre. In many places, especially near younger fault zones, the rocks contain abundant chlorite, but elsewhere relatively fresh biotite and muscovite are the dominant micaceous minerals. Small (1-5 cm long) melt pods, some of which contain tiny garnets, occur throughout the northern half of the area but are absent in outcrops to the south. Locally, there are fist to football size spherical to lozenge-shaped bodies, probably boudins, of muscovite and/or sillimanite-garnet rocks included within the gneisses. Foliation within the gneisses trends near north or slightly north of west, but on a small scale is tightly to isoclinally folded about steeply plunging axes. A steeply dipping mineral lineation is locally well developed.

Myriads of pre-, syn-, and post-tectonic igneous bodies of too small a size to show on the map intrude the gneisses. They include gabbro, quartz diorite, diorite, granodiorite, quartz-feldspar porphyries, medium grained granite, pegmatite, aplite, and alkali feldspar granite. Age relationships between many of the small intrusions are complicated by multiple intrusive events and superimposed shearing and boudinage.

The oldest are probably gabbros which occur as boudins within the metasedimentary gneisses. The gabbros are fine- to medium-grained homogeneous rocks of variable strain states. Generally, the finer grained varieties have the strongest penetrative fabric, typically a foliation and weakly developed lineation. Many of the coarser grained gabbros have deformed marginal zones and minerals within a few centimetres of the contacts define a weak foliation.

Fine- to medium-grained equigranular alkali feldspar granite occurs mostly as irregular bodies up to 15 m across. Biotite is the dominant mafic mineral and makes up to 10% of the rock. Most bodies appear undeformed but some have a weak planar alignment of biotite flakes.

Dykes, sills, and podiform bodies of pegmatite up to a metre across are very common. Most are parallel to, or slightly oblique to, the fabric of the metasedimentary rocks. Many are sheared.

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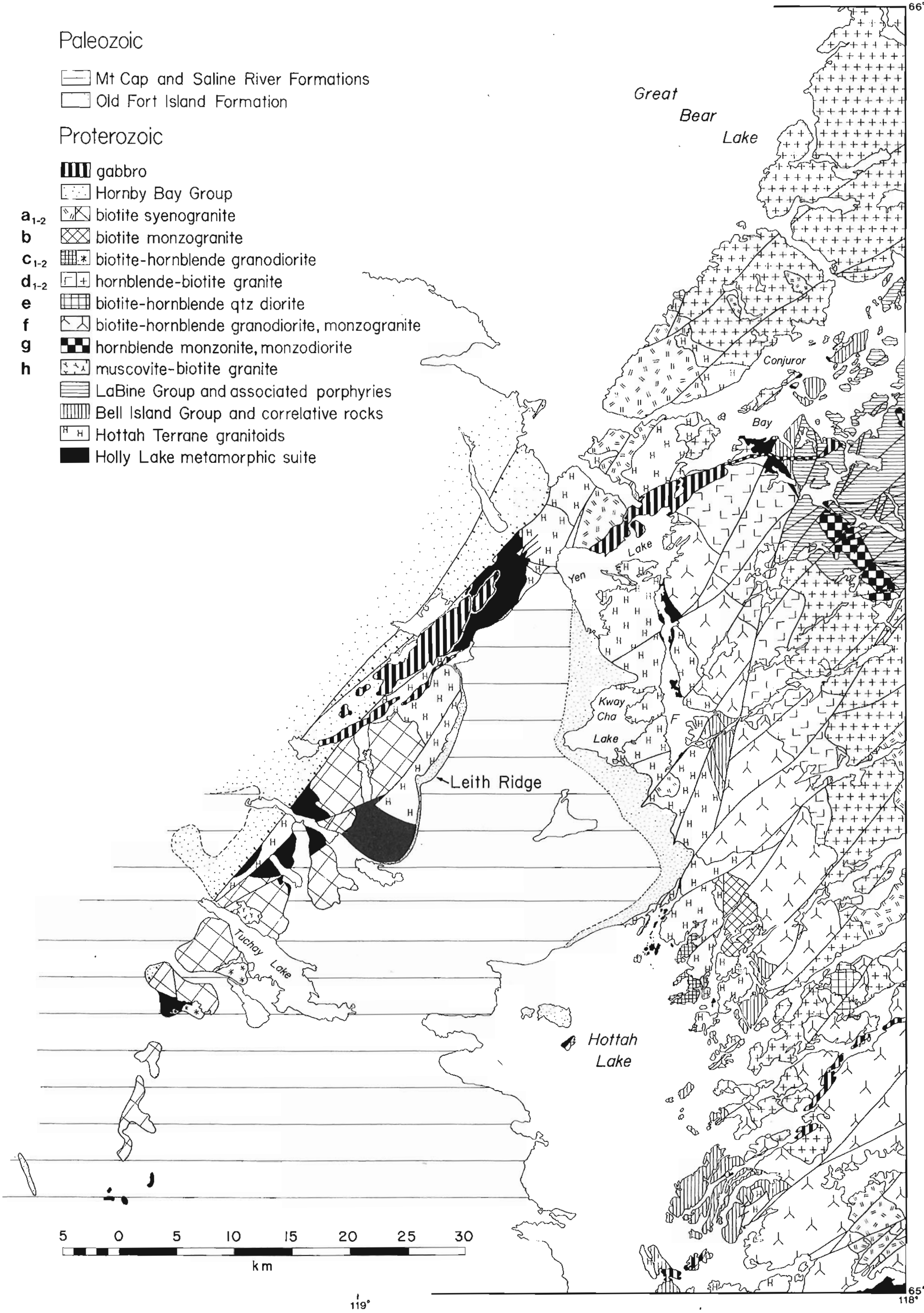

Figure 31.1. Generalized geological map of the Leith Peninsula map area. F = Fishtrap Lake.

Irregular intrusions of fine grained quartz diorite and diorite typically have a strong penetrative fabric defined by flattened quartz and aligned mafic minerals. Enclaves of metasedimentary rocks are especially abundant and in many places the country rocks are cut by numerous veins of quartz diorite.

Fine- to medium-grained biotite granodiorite intrusions range from small dykes or sills to larger bodies several hundred metres across. They exhibit a wide range of strain states: the larger intrusions generally do not have a penetrative fabric, while the smaller bodies are commonly foliated. Biotite and flattened quartz define the foliation which is more intense near the margins of many deformed intrusions.

Quartz-plagioclase porphyries too small to show on the map are not common but do occur throughout the area. They form semiconcordant bodies, or sheets, that have a well developed lineation defined by stretched phenocrysts.

Deformed coarse grained porphyritic biotite syenogranite identical to that mapped on the northern part of Leith Ridge in 1982 (Hildebrand et al., 1983), occurs southwest of Holly Lake and in a few scattered outcrops at the southern end of the ridge. The granite is typically an L/S tectonite with a planar element defined by biotite and a lineation defined by stretched potassium feldspar megacrysts.

The most common rock type on Leith Ridge is potassium feldspar porphyritic biotite granite (unit a_2). Its age relations with respect to rocks of the Great Bear Magmatic Zone are unknown. The granite contains 10-30% potassium feldspar phenocrysts up to 5 cm long enclosed in a fine- to medium-grained groundmass of quartz, plagioclase, alkali feldspar, and biotite. The more porphyritic phases are syenogranite, while the less porphyritic phases are monzogranite. Biotite, commonly forming clots to 1 cm, constitutes up to 10% of the rock. A few local zones contain a per cent or two of muscovite. In many places around Tuchay Lake the potassium feldspar phenocrysts define a weak lineation. The orientation is variable but trends from 090 to 150 predominate.

Sheets up to 10 m thick of fine grained biotite granite intrude the porphyritic granites north of Tuchay Lake. Local pegmatites contain books of muscovite 2-3 cm across.

South of Tuchay Lake, porphyritic granite is intruded by a medium grained muscovite-biotite granite (unit h) containing sparse tabular potassium feldspar phenocrysts to 3 cm. The sharp irregular contact abruptly truncates the lineation of phenocrysts in the older porphyritic granite, and dips shallowly toward the porphyritic granite. Numerous dykes and sills of the muscovite-bearing granite cut the porphyritic granite adjacent to the contact.

The muscovite-bearing intrusion is itself cut by a fine grained equigranular biotite granodiorite (unit c_2). The contact is razor sharp, very irregular in detail, and dips variably from 45° northward to nearly vertical. Locally the granodiorite contains potassium feldspar phenocrysts adjacent to the contact, probably plucked from the muscovite-bearing intrusions. A large number of angular to rounded enclaves of the muscovite-biotite granite also occur within 10 m of the contact.

On the north side of Tuchay Lake a biotite-muscovite to muscovite-biotite syenogranite (unit h) intrudes porphyritic biotite granite and cuts abruptly across the trend of lineated potassium feldspar phenocrysts. The contact is sharp. This intrusion contains sparse tabular phenocrysts of potassium feldspar.

All of the above rocks are cut by numerous faults of variable orientations. Faults showing the largest separation are usually northeast-trending. The fault zones contain brecciated, crushed, and altered fragments of the country rocks engulfed in quartz stockworks. The fault zones are cut by east-trending diabase dykes that are probably part of the Cleaver Diabase swarm (Hoffman, 1982; Hildebrand, 1982, 1983).

HOTTAH AND FISHTRAP LAKES AREA

The oldest rocks of this area are probably paragneisses of the Holly Lake metamorphic suite. They occur intermittently in a north-trending band from northern Fishtrap Lake southward to islands in the northern part of Hottah Lake. The metamorphic rocks are intruded by a suite of plutons, all of which are deformed to some degree. Rocks of the MacTavish Supergroup unconformably overlie the deformed plutons and are in turn cut by undeformed plutons of the Great Bear Batholith. Northeast-trending gabbro sheets intrude all of the above rocks.

Holly Lake metamorphic suite

Rocks of the Holly Lake metamorphic suite in the Fishtrap-Hottah Lakes area are generally well layered and almost everywhere strike about north and dip close to vertical. Layers are mostly quartzofeldspathic alternating with layers rich in cordierite porphyroblasts (~2 cm). The layers range in thickness up to 0.3 m but locally minor amphibolite bands are up to 1 m thick. The southeasternmost exposures of metasedimentary rocks in the northern Hottah Lake area are stretched pebble conglomerates containing quartz, mafic volcanic, and siliceous porphyritic pebbles in a medium grained sandy matrix. As the conglomerate occurs on islands surrounded by islands of granitic rocks, their relationship to the layered paragneisses is unknown.

The paragneisses have three well developed foliations. The oldest is a steeply-dipping, northeast-trending cleavage that appears to predate the growth of cordierite porphyroblasts. The second, and by far the most dominant, is a north-south, layer parallel fabric that is also steeply dipping. The third fabric defined by flattened porphyroblasts of cordierite trends northwest, also dips steeply, and is only locally well developed. This fabric may be an axial plane cleavage related to small scale folds of layering.

In some areas the metamorphic rocks are intruded by granitoid bodies up to 2 m thick that are generally concordant with the layering. They range up to 2 m thick and intrusions have a north-south penetrative fabric defined by flattened quartz and aligned biotites. Locally, near contacts of Hottah Terrane granitoid plutons, thin veins of granitic material are intruded along the traces of the first and second fabrics.

Hottah Terrane granitoid rocks

The oldest granitoid rock of the area is medium- to coarse-grained porphyritic biotite granite. It occurs on islands in northern Hottah Lake and its relationship to the paragneisses was never seen. The granite is generally an L/S tectonite with potassium feldspar megacrysts up to 4 cm long defining the lineation and about 10% aligned biotite flakes. Xenoliths of this rock occur in most of the younger Hottah Terrane plutons. On a few islands in northern Hottah Lake the deformed porphyritic granite occurs as xenoliths within a fine grained hornblende diorite which itself occurs as xenoliths within slightly foliated granodiorite. Outcrops of the diorite other than as xenoliths were not found.

The remainder of the granitoid rocks of the Hottah Terrane in the Hottah Lake area are mostly plutons of biotite-hornblende granodiorite, quartz diorite and tonalite that occur on islands too small to show on Figure 31.1. They generally have a north-south foliation.

In the Fishtrap Lake area a composite pluton of biotite monzogranite-granodiorite cuts rocks of the Holly Lake metamorphic suite and is probably a Hottah Terrane pluton. The pluton is medium- to coarse-grained, with the monzo granite being potassium feldspar porphyritic. Biotite, occurring in clots up to 1 cm across, is the sole ferromagnesiam mineral seen in hand specimen. The contact between monzogranite and granodiorite is gradational over several metres. The pluton is generally only weakly deformed except where cut by ductile shear zones up to 1 m wide. The relationship of this pluton to others of the Hottah Terrane at Hottah Lake is unknown due to transcurrent faults and Paleozoic cover.

MacTavish Supergroup (Bell Island Group)

Coarse grained to granular arkose that unconformably overlies rocks of the Hottah Terrane is the oldest stratigraphic unit of the Great Bear Magmatic Zone. Locally, a breccia containing angular blocks of quartz to 15 cm in a sandy matrix occurs just above the unconformity. The arkose is generally well-bedded, with common trough laminations defined by heavy mineral bands. Paleocurrents are mostly toward the west-southwest. The unit fines upward to medium grained arkosic sandstone. In places there are 2 m thick beds of volcanogenic sandstone. Only one complete section of the arkose (30 m thick) occurs in the area.

A 25 m thick siliceous lava flow occurs locally above the arkose. It is red weathering, aphyric, and has zones of autoclastic breccia at its top. Two amygdaloidal basalt flows overlie the siliceous lava. They have well developed flow top breccias and are intercalated with minor basaltic breccias of probable pyroclastic origin.

The lava flows are overlain by 20-40 m of ashstone, siltstone and sandstone. Beds range in thickness from 1-10 cm. The lower part of the section contains calcareous lenticles, concretions and beds which weather recessively, giving the rock a ribbed appearance on the outcrop. Most sedimentary rocks above the lava flows are metamorphosed, probably to albite-epidote assemblages, adjacent to a gabbro sill that intrudes the middle of the section.

At least 1 km of pillow basalts, pillow breccias, and silicified sedimentary rocks cut by gabbro sills overlies the sedimentary-volcanic section. The top of the pillow basalt pile is truncated by younger plutons of the Great Bear Batholith and therefore its original thickness in this area is unknown.

The entire sedimentary-volcanic sequence is similar to that found to the south and described by Hildebrand et al. (1983). The sections mapped during the past season are all northeast-facing monoclines that are part of the west limb of a large syncline, located to the southwest on Bell Island, and separated from it along right-lateral transcurrent faults. Total separation across the faults is about 30 km.

Great Bear Batholith

A pluton of massive, fine- to medium-grained, biotite-hornblende granodiorite (unit c_1) intrudes granitoid rocks of the Hottah Terrane on islands in Hottah Lake. Its age relationships with respect to other plutons of the Great Bear Batholith are unknown because the pluton only intrudes rocks of the Hottah Terrane. Since it is completely undeformed and very fresh in appearance it is considered to be of Great Bear age. The rock is distinctive in that it contains up to 10% prisms of hornblende up to 0.5 cm long and approximately 1% euhedral crystals of brown sphene. Biotite makes up to 5% of the rock. In many places near the contact well developed intrusion breccias containing foliated country rocks are surrounded by thin veins of granodiorite. Most blocks of country rock, which range up to 5 m across, are angular and show evidence of rotation. The granodiorite typically weathers white, but adjacent to joints is altered to pale red. Muscovite-bearing monzogranodiorite-granodiorite occurs on a few islands in the central parts of the pluton. The contacts are not exposed.

The largest pluton of the Great Bear Batholith is a medium grained biotite-hornblende granodiorite (unit f) that extends southward from Yen Lake to just beyond the southern boundary of the map area, a distance of 45 km. The pluton is characterized by euhedral prisms of hornblende up to 1.5 cm long and clots of quartz up to 1 cm across. It is fairly homogeneous in composition but locally there are up to 10% potassium feldspar phenocrysts that shift the modal mineralogy into the monzogranite field.

Other large granitoid plutons (units d_{1-2}) of biotite and hornblende-biotite granites are younger than the granodiorite. They are massive, medium grained rocks that vary from potassium feldspar porphyritic syenogranite to nonporphyritic monzogranite. Contacts between individual plutons are sharp and internal contacts between porphyritic and nonporphyritic phases are gradational. Mafic content varies from about 10 to 15%.

A small pluton of biotite-hornblende quartz diorite (unit e) intrudes both the large granodiorite and a syenogranite east of the north end of Hottah Lake. It cuts across the contact of the two larger plutons. The body is fine grained, slightly plagioclase porphyritic, and contains abundant enclaves of the two older granitoid plutons. The contact is very irregular in detail.

Another small pluton of medium grained, biotite monzogranite (unit b) intrudes granitoid rocks of the Hottah Terrane and the granodiorite at the northeast end of Hottah Lake. The pluton is medium grained and potassium feldspar porphyritic. The phenocrysts range up to 2 cm long and make up from about 3 to 15% of the rock. The contact is sharp and a fine grained border phase occurs adjacent to it.

TRANSCURRENT FAULTS

The eastern half of the map area is cut by numerous northeast-trending transcurrent faults typical of the rest of the Great Bear Magmatic Zone. They are part of a regional conjugate set that is found throughout Wopmay Orogen (Hoffman, 1982). In the externides of the orogen, slip along the faults can, for the most part, be accounted for purely by rotation of the faults (Hoffman and St-Onge, 1981). That is, the deformation is one of regional pure shear in which each element within the system rotates about a vertical axis away from the direction of principal shortening.

The system of transcurrent faults occurring along the eastern side of Hottah Lake (Fig. 31.1) provides some constraints on the large scale boundary conditions of faulting in the Great Bear Magmatic Zone. Figure 31.2 shows the faults, the unconformity between rocks of the Hottah Terrane and Great Bear Magmatic Zone exposed on the west side of a syncline, and the synclinal axis. Separation of a from b is about 30 km. If the fold axis, which can be used as a piercing point to solve for true displacement continues to plunge northwestward in the more northerly blocks, then the displacement must be even greater than the separation of a from b, for as shown on Figure 31.2b the distance x^1 is even greater than x. There could be a component of dip-slip movement on the faults but consider the relationships along the southernmost fault shown on the diagram. There, the distance from the unconformity to the trace of the fold axis is slightly greater along the north side of the fault than on the south side. This suggests a component of dip-slip movement, north side down, which makes the strike-slip component even larger than that suggested above.

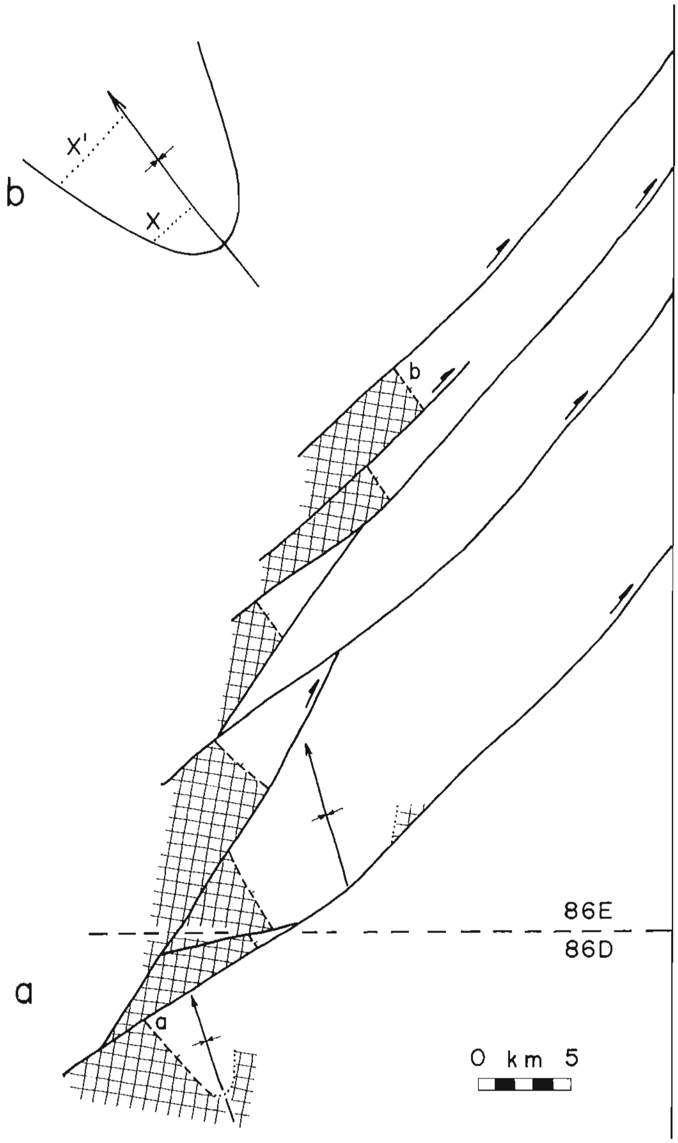

Figure 31.2. *a) Diagram showing transcurrent faults, northeast-dipping unconformity (dashed line) between Hottah Terrane (hatched pattern) and Great Bear Magmatic Zone, and synclinal axis along the east side of Hottah Lake. Separation of the unconformity from a to b is about 30 km. b) Sketch of an unfaulted syncline illustrating that true displacement must be even longer than separation of the fold limb because the distance x^1 is larger than x.*

In order to account for the fault activity within large scale pure shear boundary conditions, a counterclockwise rotation of the faults of about 90° is required. Since the regional direction of maximum shortening was roughly east-west (Hoffman and St-Onge, 1981) this would entail rotation through a principal plane of the finite strain ellipsoid. This being kinematicaly unacceptable, the boundary conditions must have included a component of simple shear and probably the operation of deformation mechanisms other than fault-slip alone.

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