PRELIMINARY REPORT ON THE GEOLOGY NORTH OF UPPER LAKE MELVILLE, LABRADOR [1]

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Abstract

Mapping at 1:100 000 scale of 3500 km² of the eastern Grenville Province suggests that Aphebian or earlier(?) granitic and tonalitic gneiss complexes, that include supracrustal remnants and metagranitoid rocks, are the oldest rocks of the area. The gneiss complexes were intruded by a late Hudsonian or early Paleohelikian granite pluton, as well as by Paleohelikian anorthositic rocks and later(?) plutons of granite to syenite. A southeast dipping mylonite zone that was probably the locus of thrust faulting coincides with the margin of a half graben filled with Hadrynian(?) conglomerate. Several uranium showings are associated with diatexite developed in parts of the granitic gneiss complex. Strain resulting from the Grenvillian Orogeny is either relatively weak or strongly heterogeneous.

Introduction

This report covers approximately 3500 km² of the eastern Grenville Province north of Lake Melville, mapped at 1:100 000 scale during the 1982 field season. It includes NTS 1:50 000 map areas 13F/16, 13G/13, 13G/14 and part of 13J/3 (Figure 40.1).

Eade (1962) and Stevenson (1967, 1970), as a result of reconnaissance mapping of various parts of the area, reported mostly tonalitic and granitic gneiss, commonly with a steeply dipping fabric, intruded by weakly deformed monzonite to granite bodies. Stevenson inferred that the rocks were of Helikian or Aphebian age, or both, and were all affected by the Grenvillian orogeny. Absolute age data remain unavailable. A half graben of Hadrynian (?) arkose and conglomerate (Double Mer Formation) was recognized along the shore of Lake Melville.

Recent systematic mapping of the adjoining areas has been carried out at 1:100 000 scale by Gower (1980), Gower et al. (1981; 1982a, b), Ryan et al. (1981) and Ryan (1982), and at 1:250 000 scale by Emslie (1976; personal communication, 1982). Approximately 200 km² of the present map area between Double Mer and Lake Melville, where several uranium showings occur, were mapped at 1:50 000 scale by Bailey (1980).

The area was selected because it provides a link between mapping by Gower et al. (1981) in the east and by Ryan et al. (1981) in the west, and because it contains recently reported uranium-bearing units.

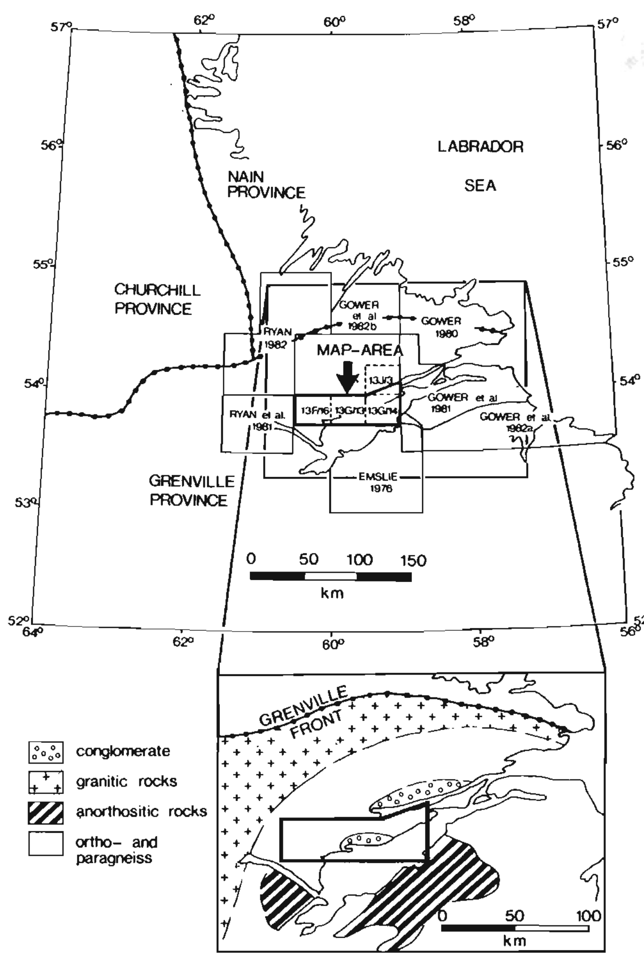

Figure 40.1. Location and setting of the map area. Regional geology is simplified from sources shown.

Setting and General Geology

The area lies approximately 100 km south of the Grenville Front, as defined by Gower et al. (1980), within an east-trending belt of Helikian or earlier(?) dominantly tonalite and granodiorite gneiss with supracrustal remnants, that extends through much of western and central Labrador. This belt separates rocks of an extensive, composite granitic batholith to the north, in which individual plutons have yielded ages from 1700-1650 Ma to 1450-1350 Ma (Wardle et al., 1982), from rocks of the Mealy Mountains anorthositic complex (dated at 1640 Ma, Emslie, 1982) to the south (Fig. 40.1). Small half graben filled with Hadrynian or later(?) conglomerate and sandstone are developed in the gneiss belt.

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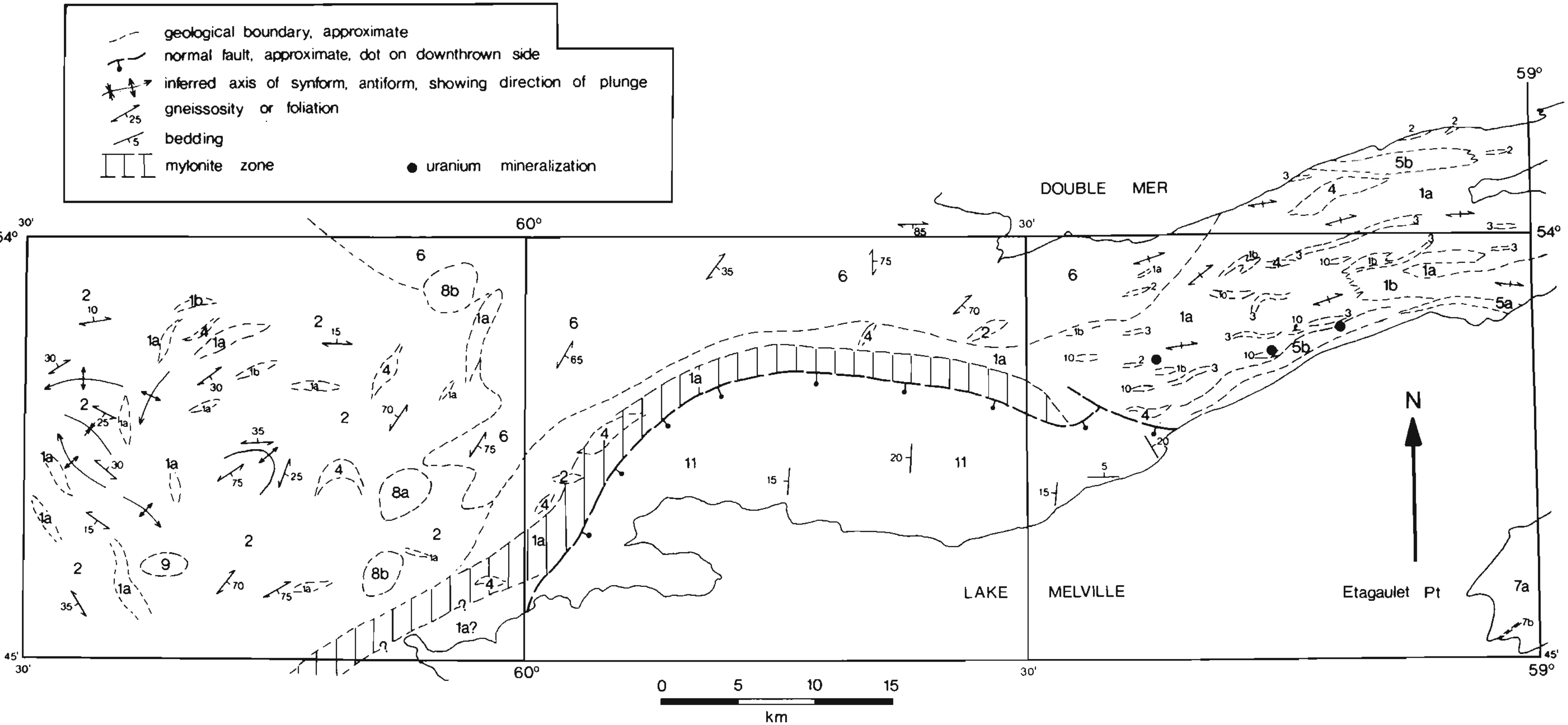

LEGEND

HADRYNIAN

11. **Double Mer Formation:** *Red arkose and polymictic, clast-supported conglomerate.*

HELIKIAN OR EARLIER

10. *Coarse grained, massive, equigranular, white-weathering quartzofeldspathic diatexite.*

9. *Coarse grained, massive metagabbro and hornblendite.*

8. a. *Pink, coarse grained, massive to weakly foliated biotite syenite to quartz syenite.*
   b. *Massive, buff, coarse grained biotite quartz monzonite to granite.*

7. **Mealy Mountains Intrusive Suite (Paleohelikian)**
   a. *Coarse grained, massive, dark gray leuconorite and anorthosite.*
   b. *Fine grained diabase.*

6. *Coarse grained, pink-to-buff granite; massive to strongly foliated.*

5. a. *Coarse grained, pink, megacrystic (K-spar) biotite granodiorite; weakly foliated.*
   b. *Coarse grained, gray augen (K-spar) biotite granite; moderately foliated.*

4. *Medium grained, dark, hornblende dioritic to quartz dioritic gneiss.*

3. *Medium grained amphibolite, micaceous amphibolite and amphibolite gneiss.*

APHEBIAN OR EARLIER (?)

2. *Medium grained, gray (black and white) biotite tonalite to granodiorite gneiss; well banded, migmatitic.*

1. a. *Pink-to-red-to-buff, medium to coarse grained, well banded biotite granitic gneiss; commonly migmatitic and with amphibolite enclaves.*
   b. *Salmon-to-cream colored, fine grained aplitic gneiss to microgranite; with amphibolite enclaves; migmatitic in places.*

Figure 40.2. *Generalized geology of the area north of upper Lake Melville.*

Because of extensive forest cover, and drift in low lying areas, exposure in the map area is generally poor, and contacts are not visible. Exceptions are the shoreline and some ridge tops at the eastern extremity of the area, where exposure is excellent.

About two-thirds of the area (Fig. 40.2) are underlain by well layered and strongly folded, partially interlayered granitic gneiss in the east and tonalitic gneiss in the west. As both gneiss units contain interbanded amphibolite, hornblende dioritic gneiss, and granodiorite in various amounts, they constitute gneiss complexes rather than homogeneous units on the scale of the map.

A biotite granite pluton is inferred to intrude both gneiss complexes in the northern portion of the area. It is weakly foliated when compared with the intruded gneiss, which suggests either that Grenvillian deformation was relatively weak in the area, or that strain was heterogenous.

Three small, pre-Grenvillian, almost unstrained plutons of quartz monzonite to granite appear to truncate the foliation in the surrounding gneiss.

A gently southeast-dipping mylonite zone, at least 50 km long and 5 km wide (apparent map width), developed across the gneiss complexes, coincides in part with the northern boundary of the downfaulted block of Double Mer sedimentary rocks, but its formation predated the block faulting.

Map Units

Unit 1 includes granitic and aplitic gneiss. Subunit 1a is a pink to reddish to buff, medium- to coarse-grained, well banded biotite granitic gneiss. It is commonly migmatitic, and includes abundant layers and lenses of amphibolite; where extensive, the amphibolite is differentiated on the map as unit 3. Some amphibolite layers are conformably interbanded and others are crosscutting; thus, it is clear that at least two (and possibly more) protoliths exist. From these characteristics, the amphibolite bodies are interpreted as being in large part relict dykes. Pegmatite veins and dykes truncate the gneissosity and are themselves folded. A sliver of garnetiferous rock composed of coarse grained micaceous amphibolite and fine grained, well layered quartzofeldspathic gneiss interlayered over a few metres, thought to be of supracrustal origin, occurs within the gneiss complex on the shore of Double Mer. It is included in the western exposure of unit 2 on the map. Subunit 1b is a salmon to cream, fine grained aplitic gneiss to microgranite. Rock types intermediate between subunit 1a and 1b "end members" constitute most of the granitic gneiss complex. It appears that units 1 and 2 contain rocks of differing protolith (i.e. metagranitoid, metasediment, mafic dykes, etc.). They may also contain rocks of more than one age, and are likely to have had a prolonged deformation history which includes both Hudsonian and Grenvillian components. Unit 1 is correlated with parts of the granodiorite gneiss terrane to the east (unit 5 of Gower et al., 1981), and is interpreted as an early granitic terrane of pre-Grenvillian age.

Unit 2 is a medium grained, grey or black and white, strongly banded, migmatized biotite tonalitic to granodioritic gneiss. It commonly contains minor garnet, epidote and muscovite. In contrast to unit 1, amphibolite is rare. Enclaves of granitic gneiss, from 1 to 100 m across strike, that are interlayered in unit 2, are included in unit 1 on the map because of broad lithological similarity. However, these enclaves could also be of sedimentary origin, as suggested by the fine grained sillimanite and kyanite tentatively identified in two outcrops, near the eastern and western boundaries of 13F/16 map area; they may be equivalent to distinctive aluminosilicate-bearing gneiss mapped farther west (unit 2 of Ryan et al., 1981). The tonalite gneiss of unit 2 is correlated with similar rocks to the west, for which Ryan et al. (1981; units 1 and 13) propose an Aphebian or earlier age. The relative ages of units 1 and 2 are unknown. On the basis of interdigitation with unit 1, unit 2 is interpreted to be of Helikian or earlier age. Its protolith may have been mostly tonalite or granodiorite, or it may have been sedimentary strata.

Unit 3 includes medium grained amphibolite, amphibolite gneiss and micaceous amphibolite. Both early, partially digested layers and lensoid heterogeneous boudins with nebulitic margins, and later, more homogeneous cross-cutting, but folded, dykes can be recognized in the eastern part of the area; similar features characterize the map-scale bodies. Protoliths of unit 3 are considered to be mafic dykes of Aphebian to Grenvillian age.

Unit 4 is dark, dense, medium grained hornblende (and minor pyroxene) dioritic to quartz dioritic gneiss, commonly garnetiferous. It occurs as small, isolated lenses interleaved with units 1 and 2, and is gradational in part to unit 3 (amphibolite). Its age relative to units 1, 2 and 3 is unclear; it may be Aphebian or younger. The unit could represent diorite intrusions into the "basement gneiss" of units 1 and 2, or it may itself be part of the basement complex.

Unit 5 includes distinctive, coarse grained augen (K-feldspar) foliated granitoid rocks and augen gneiss. It is divided into subunit 5a, a pink megacrystic biotite granodiorite that is only moderately foliated, and subunit 5b, a grey augen biotite granite gneiss with a strong foliation. A few nearly rectiplanar crosscutting pegmatite dykes occur near the centre of the orthogneiss bodies; amphibolite layers are rare, and confined mostly to the margins. Unit 5 is interleaved with units 1 and 2, and has sharp contacts. The bodies may be intrusions of Paleohelikian age, emplaced into the older gneiss terrane, and foliated before or during the Grenvillian Orogeny. They are correlated with elongate megacrystic granodiorite bodies occurring to the east (unit 6 of Gower et al., 1981).

Unit 6 comprises coarse grained, pink to buff biotite granite. It occurs as a pluton at least 50 km across in an east-west direction. It is nearly massive in its centre but is strongly foliated at its margins, where it is difficult to distinguish from its gneissic host because of strong boundary deformation. Garnet occurs sparingly in many outcrops. Amphibolite does not occur in the unit. Pending radiometric dating, unit 6 is correlated with granite plutons of similar character occurring to the north (Benedict Mountains Suite, Gower, 1981), that have yielded Paleohelikian K-Ar and Rb-Sr ages (Gower, personal communication, 1982).

Unit 7 is exposed on the south shore of Lake Melville. Subunit 7a comprises dark grey, massive, coarse grained leuconorite and anorthosite. It is part of the Mealy Mountains complex of Paleohelikian age (Emslie, 1982). A small, rectiplanar northeast-striking diabase dyke (subunit 7b) intrudes the anorthosite near Etagaulet Point; it is correlated with the olivine diabase dyke swarm mapped by Emslie (1976), of Elsonian age (Emslie, 1370 Ma age determination, unpublished data; Gittins, 1972).

Unit 8 occurs as three intrusive bodies, each less than 3 km across, that appear to truncate the regional foliation sharply. Subunit 8a is pink, coarse grained, massive to weakly foliated biotite syenite to quartz syenite; subunit 8b is massive, buff, coarse grained biotite quartz monzonite to granite. The northern body of unit 8b contains garnet; in both bodies, quartz is characteristically dark grey to brown. From their generally massive and discordant character, the bodies of unit 8 are interpreted to be of Elsonian or younger age, and show evidence of only weak Grenvillian deformation.

Unit 9 comprises coarse grained, massive metagabbro and hornblendite occurring as a small intrusive body, about 2 km across, that appears to truncate the regional foliation sharply in surrounding rocks of unit 2. Based on this apparent

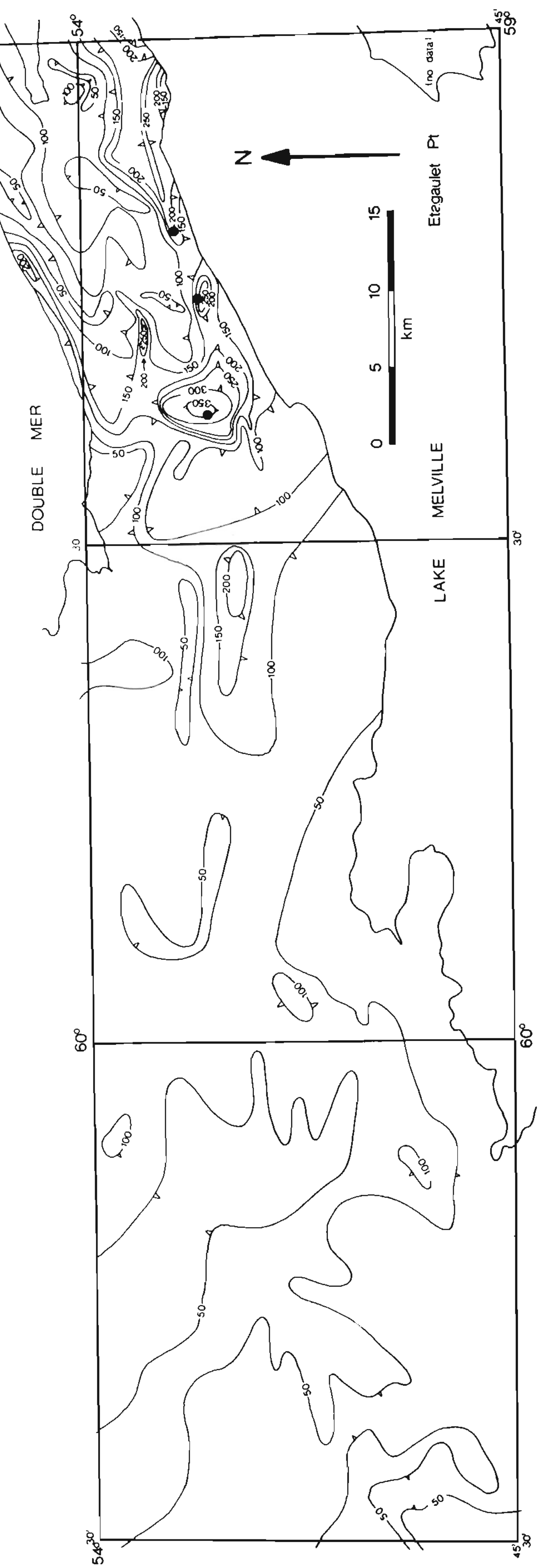

Figure 40.3. *Radioactivity within the map area. Isorads are based on total count per second readings, taken at every geological station during mapping.*

regional truncation and on the low strain in the rocks, unit 9 may be of the same age as unit 8, assuming that strain was homogeneous in this part of the area.

Unit 10 occurs as elongate, discontinuous, lensoid bodies interbanded within unit 1. It comprises chalky white weathering, equigranular, coarse grained, leucocratic quartzofeldspathic rock of migmatitic origin. The largest masses are differentiated on the map, but almost every outcrop of unit 1 in the region where bodies of unit 10 are shown on the map includes amounts of partial melt substantially higher than elsewhere in the area (over 50% is common). These nearly homogeneous masses of diatexite invariably have radioactivity above regional background levels; three uranium showings are known in the area (see below). Gower (personal communication, 1982) identified sillimanite in a thin section of a sample of the unit, cut from drill core obtained by Northgate Exploration Ltd. at the central uranium showing (see Fig. 40.3). Sillimanite-bearing paragneiss has been mapped by Gower et al. (1981) on strike to the east, across Lake Melville, where it is also associated with uranium mineralization; the paragneiss is thought by Gower (personal communication, 1982) to be derived from a pre-Hudsonian protolith. This suggests that the diatexite in the present area may have developed in part from Aphebian or earlier metasedimentary rocks, assuming that strain was heterogeneous in this part of the area. The unit is assumed to be of Neohelikian or Grenvillian age.

Unit 11 is the Double Mer Formation (Kindle, 1924). It is a succession of reddish brown arkosic sandstone and clast-supported polymictic conglomerate of post-Grenvillian age. It occurs as a nearly homoclinal, gently west-dipping sequence, in a lowland bounded on the north by a scarp up to 200 m high. Samples of sandstone from five localities were processed for palynomorphs, but proved to be barren of recognizable microfossils (E. Erdmer, personal communication, 1982). The unit is suspected to be of Hadrynian age.

Structure

The dominant fabric element of units 1 and 2 is a marked gneissosity. In outcrops of unit 1 on the Double Mer Peninsula, this fabric is commonly affected by contorted, irregular, tight folds ranging from 10 cm to over 10 m in amplitude. Highly distorted, local superimposed folding patterns are present in outcrops where the folding is less extreme. Although this folding somewhat obscures regional trends, an east-northeast vertical grain is dominant. In unit 2, open vertical folds inferred on the map suggest an interference pattern of domes and basins, elongated in a northwesterly direction near the western boundary of the area. This style of deformation was recognized farther west by Ryan et al. (1981).

The amphibolite and dioritic gneiss of units 3 and 4 have a foliation parallel to their contacts, and are structurally concordant.

The homogeneity of units 5a and 5b and the fact that the type of surrounding rocks varies suggest that the megacrystic granodiorite and granite are structurally younger, although now nearly structurally concordant.

Notwithstanding its foliated margins, the large pluton of unit 6 is regionally apparently discordant relative to the intruded gneiss. The intrusive rocks of units 8 and 9 are clearly crosscutting from map patterns, and only weakly foliated near their margins.

The mylonite zone in the western half of the area is characterized by strong, shallowly southeast- to south-plunging rodding and mullion structure, flattened and drawn out quartz and feldspar grains visible in hand specimen, and comminuted micas resulting from cataclasis. These features are overprinted by another deformation recorded in epidote coated fractures, chloritic, very fine grained, sheared friable rock and hematite veining. A tentative interpretation is that these later, brittle features resulted from normal faulting at shallow depth associated with, or postdating the deposition of the Double Mer sediments, and that the mylonite was developed previously from "basement" gneiss at considerable depth. The mylonite outlines a zone of high strain interpreted as the trace of a (pre-?) Grenvillian, shallowly southeast-dipping fault that was reactivated by normal faulting.

To the west of the map area, Ryan et al. (1981) recognized a gently southeast-dipping mylonite zone associated with a thrust fault, whose strike extension matches the trace of the present mylonite zone. This suggests continuity of the structure; it is thus likely that mylonite is also associated with thrust faulting north of lake Melville.

Metamorphism

With the exception of the Double Mer Formation, all units in the map area, including the mylonite, are recrystallized. A sugary, friable texture characterizes many of the quartzofeldspathic rocks.

A partial melt phase, in the form of small lenses and strips of quartzofeldspathic material a few centimetres wide, is developed between the folia of most rocks of units 1 and 2. Kyanite and sillimanite have been tentatively identified in slivers of inferred supracrustal gneiss included in unit 2. Unit 1 contains the assemblage quartz-K-feldspar-plagioclase-biotite-hornblende-garnet. The tonalite gneiss of unit 2 contains the assemblage quartz-plagioclase-biotite-muscovite-garnet-epidote; a coarse grained, equigranular rock containing the assemblage quartz-garnet-clinopyroxene-plagioclase is interbanded in unit 2 near the centre of 13F/16 map area. Sillimanite, biotite, quartz and K-feldspar occur in at least one outcrop of diatexite (unit 10); this places the rock above the muscovite "breakdown" curve (with quartz), in the stability field of sillimanite, which implies a minimum temperature of 620°C, and pressure greater than 200 MPa (equilibrium curves after Holdaway, 1971, and Helgeson et al., 1978).

Chlorite, and/or sericite are present in many outcrops as retrograde minerals.

This evidence suggests that metamorphic grade in the crystalline rocks is at upper amphibolite facies, with some retrograde overprinting in the greenschist facies.

Economic Potential

No new surface occurrences of economic minerals were found and, with the exception of uranium in unit 10, the region has attracted little exploration interest.

Recent work by McConnell (1979) determined the presence of anomalous uranium concentrations in lake sediments; uranium mineralization, showing as a yellow uranophane(?) stain on outcrop surfaces, occurs in three localities. Uraninite has been identified as the primary uranium mineral (Kerswill and McConnell, 1982). Northgate Exploration Ltd. carried out exploratory trenching and drilling at the central showing in 1979.

A scintillometer survey carried out during the present mapping reveals that regional radioactivity peaks in the general area of known showings (Fig. 40.3). Although they occur over a wide area, higher total counts are low in absolute terms (a few hundred counts per second); this suggests that mildly uraniferous partial melt (unit 10) is the major source of radioactivity. As this unit occurs over a relatively extensive area, and several other positive anomalies occur, it is possible that additional uranium concentrations exist. On the basis of the occurrence of unit 10 and higher radioactivity, prospective mineralization sites may be located a few kilometres north and east of the known showings, within areas bounded by the 250 counts per second isorads on Figure 40.3.

Summary

The geological infrastructure of the area appears to include the following elements. Two compositionally distinct, heterogeneous, highly deformed gneiss complexes, of possible Aphebian or earlier age, contain remnants of inferred supracrustal origin, whose age is unclear but may be close to that of the gneiss, and younger(?) metaplutonic rocks. The complexes were intruded by a late Hudsonian or early Paleohelikian granite pluton, as well as by Paleohelikian anorthositic rocks and by structurally late plutons of granite to syenite. Northwesterly directed thrusting may be of Grenvillian or Neohelikian age, as inferred by Ryan et al. (1981) for the area to the west. The thrust fault zone was reactivated as a normal fault during or following deposition of the postorogenic Double Mer sediments.

The broad, open folds and shallowly dipping foliation that characterize the western part of the area suggest that the latest deformation was relatively weak; this is in contrast to the marked east-northeast vertical grain in the east, where strain is considerably higher. This suggests either that deformation during the Grenvillian Orogeny was inhomogeneous, or that it was very weak and was superimposed on a heterogeneously (previously) deformed area.

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