THE GEOLOGY OF THE GRAND LAKE AREA, LABRADOR
13F/10, 11, 14, 15

by

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Regional geological mapping at 1:100,000 scale was conducted in the Grenville Structural Province in the vicinity of Grand Lake during the 1980 season. Previous mapping in the study area has been minimal, being confined to the early reconnaissance work of Scott and Conn (1949) and the 1:250,000 mapping by the Geological Survey of Canada (Stevenson, 1967). Hudbay Uranium carried out a uranium exploration program in the area in 1977 (Fenton, 1978), but no new lithological data were made available by this survey. Preliminary reconnaissance work carried out in the northern part of the area by the author in 1979 (Ryan, 1980) indicated that much of the terrain shown by Stevenson (1967) as chiefly "black and white gneisses and gneissic granite of probably sedimentary origin" could be subdivided into several major units. Many of the rocks were found to be very weakly foliated granitoids with no indication of a sedimentary protolith such as was suggested by Stevenson (1967). The granitoids were separated from the apparently earlier gneissic rocks, and it was suggested that the area contained elements which may range from Archean to Helikian in age. This year's work has refined last year's initial results north of Grand Lake, and has provided new data for the area south of the Susan River - Grand Lake corridor. Figure 1 is a generalized sketch map of the coverage area; some brief attributes of the units are outlined below.

The area may be divided into autochthonous and allochthonous elements, the primary relationship between which is uncertain. Units 1-11 are considered to be autochthonous, whereas Unit 12 and Units 13-16 represent two overlying thrust sheets. Relative and absolute ages of rock units are in many cases unknown.

AUTOCHTHONOUS ROCKS

Unit 1 - Foliated tonalite, tonalitic gneiss, migmatite

Gray weathering, foliated, porphyritic tonalite and well-layered tonalitic to quartz dioritic gneisses outcrop between Grand Lake and the Cape Caribou River. Zoned plagioclase phenocrysts and pale green clinopyroxene are present in the weakly foliated portions of the unit but, for the most part, the unit is strongly foliated to gneissic, with quartz, feldspars, biotite and hornblende being the chief phases.

Several thin garnetiferous amphibolite bands were noted in the unit. These occasionally exhibit a relict gabbroic texture and may have been dikes. However, they are pretectonic, exhibiting all the deformation features seen in the surrounding gneiss. Clinopyroxene and scapolite are present in some of these amphibolites.

North of Grand Lake, there occurs a series of similar gneisses which exhibit a pervasive migmatization attributed to the Grenvillian Orogeny. These are characterized by a network of quartzo-feldspathic veins, containing stubby hornblende and garnet porphyroblasts, which parallel and crosscut the gneissic layering and commonly exhibit diffuse contacts with the surrounding rocks. It is unclear at present whether these

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LEGEND

ELSONIAN

16 Granite, monzonite, syenite.
15 Anorthosite
14 Gabbro

APHEBIAN OR EARLIER

13 Quartzofeldspathic gneiss and amphibolite.

----------THRUST CONTACT----------

APHEBIAN ?

12 Quartzofeldspathic gneiss, amphibolite, gray quartzite.

----------THRUST CONTACT----------

NEOHELIKIAN (AND LATER?)

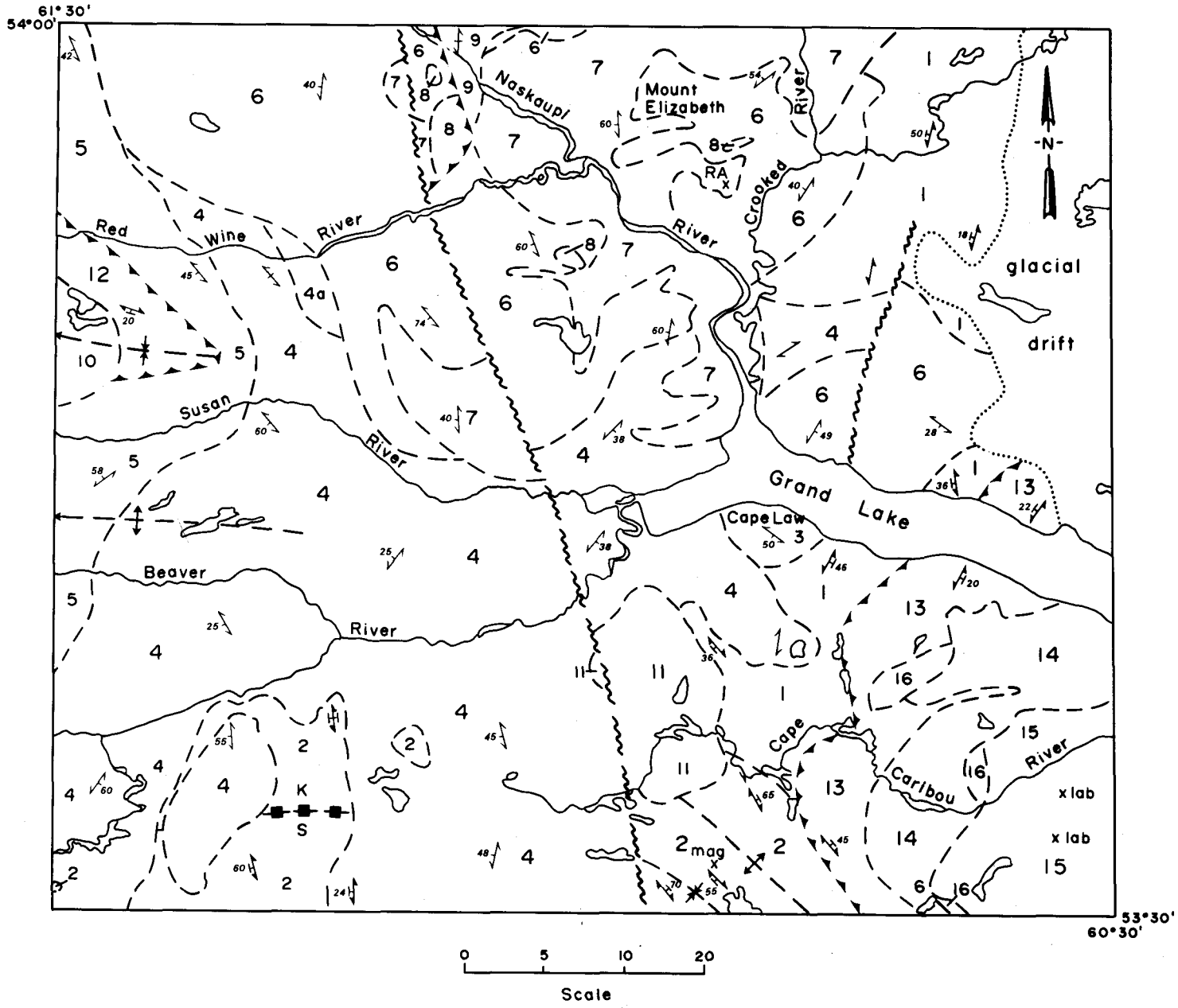
11 Gabbro, syenite, granite.
10 Diorite
9 Sericitic white quartzite (Seal Lake Group)

PALEOHELIKIAN

8 Gabbro
7 Aplite
6 Biotite monzonite and granodiorite
5 Megacrystic granodiorite
4 Biotite & hornblende tonalite; 4a garnetiferous diorite.

APHEBIAN OR EARLIER

3 Garnetiferous leucogabbro
2 Sillimanite and kyanite bearing biotite-muscovite-quartz-feldspar gneiss.
1 Tonalite, tonalitic and quartz dioritic gneiss, amphibolite.


61° 30'
54°00'
Naskaupi
River
Mount
Elizabeth
RA
Crooked
River
-N-
Red
Wine
River
glacial
drift
Susan
River
Grand
Lake
Cape Law
Beaver
River
Cape
Caribou
River
x lab
x lab
K
S
2 mag
53°30'
60°30'
0
5
10
20
Scale

migmatites were derived from the gneisses of the Cape Caribou River area or whether they may be migmatitic and gneissose equivalents of some of the other rocks in the area. They are tentatively correlated with Unit 1, but this is open to reinterpretation pending future work.

Unit 2 - Kyanite and sillimanite bearing gneiss

Rocks of assumed metasedimentary origin are interleaved with Unit 1 south of the Cape Caribou River, and occur as rafts in a younger granitic pluton south of the Beaver River. The annular one records a kyanite to sillimanite transition from north to south. The metasedimentary rocks vary from granoblastic with a weak mica foliation to well layered gneisses. The most widespread mineral assemblage is quartz-feldspar-garnet-biotite with either sillimanite or kyanite. Muscovite is widespread in the kyanite zone, but is less common in the sillimanite zone. Textural relationships suggest that kyanite is later than sillimanite and thus records an increase in pressure to the north. Thin amphibolite units are also locally present in the metasediments, but no marbles or quartzites such as those described by Gower (this volume) were observed.

Dikes and sheets of foliated pink granite are present locally, as are posttectonic quartzofeldspathic pegmatites with books of muscovite and biotite up to 10 cm in diameter. One small plug of serpentinized ultramafic rock exhibiting a discordant contact with the gneisses was also observed south of the Beaver River.

Unit 3 - Garnetiferous leucodiorite

This unit underlies Cape Law on the south shore of Grand Lake. It is a medium grained rock which locally displays a compositional layering interpreted to be a primary feature. Its chief minerals are hornblende, garnet, plagioclase and biotite with locally abundant scapolite. The relationship of this rock to the previously described gneisses is uncertain. It is mineralogically similar to and may be the equivalent of banded diorites along the Red Wine River interpreted as a marginal phase of Unit 4 but, pending future work, the Cape Law rocks are designated separately.

Unit 4 - Tonalite and quartz diorite

This unit occupies a major portion of the area between the Susan River and the southern margin of the map area. It is a gray and white weathering rock but, in border zones, it is pinkish weathering. Texturally, it varies from massive to gneissose. It is locally porphyritic, especially where it outcrops in the core of the metasediments south of the Beaver River. Hornblende $\pm$ biotite, plagioclase, quartz and scapolite are the chief minerals, but microcline is present locally.

As noted from the 1979 survey (Ryan, 1980), the tonalite is locally characterized by anatectic melts which occupy dilation fractures and parallel the foliation, thus imparting a migmatitic character to the rock. This migmatization is identical to that observed in gneissic rocks north of Grand Lake which are tentatively correlated with Unit 1.

Narrow dioritic marginal zones are present adjacent to the eastern boundary of the annular metasedimentary unit. A more extensive unit of massive to banded gray to black, medium to fine grained, garnetiferous diorite outcrops north and south of the Red Wine River. It comprises hornblende-plagioclase-garnet rocks similar to Unit 3.

Unit 5 - Megacrystic granodiorite

Very coarse grained megacrystic granodiorite outcrops along the western margin of the map area between the Susan

and Beaver Rivers; it corresponds to the "porphyritic veined augen gneiss" of Stevenson (1967). This granitic body is composed of pink, twinned microcline megacrysts and recrystallized megacrysts up to several centimetres in maximum dimension set in a medium grained matrix of quartz, feldspar and biotite. In several outcrops, hornblende was observed as a matrix phase accompanied by small red garnets. Lensoid basic inclusions occur locally. This granite varies from undeformed to augen textured to strongly schistose.

Unit 6 - Monzonite and granodiorite

This unit comprises white to pink weathering, medium to coarse grained, biotite-rich granitoid rocks which are the southern extension of a lithologically similar suite dated at 1500 Ma which intrudes the volcanic rocks of the Central Mineral Belt to the north (Ryan and Harris, 1978). These rocks vary from undeformed to strongly schistose. Textures in undeformed areas vary from equigranular to porphyritic to "blebby", the latter referring to a texture in which the biotite occurs as clots or clumps in a leucocratic matrix. Igneous layering was noted in this suite in the Mount Elizabeth area, the layering being defined by variations in the percentage of mafic minerals. These rocks commonly display a mottled greenish weathering appearance due to the development of epidote after biotite and the saussuritization of the plagioclase. Locally, these also exhibit an *in situ* migmatization.

Unit 7 - Leucocratic microgranite, aplite

Pink to white weathering, medium to fine grained, saccharoidal, leucocratic microgranite and aplite dikes and sheets transect all rocks in the area, and are no doubt of various ages. In most cases, these are too small to map at the present scale, but such rocks underlie a fairly extensive area in the vicinity of Mount Elizabeth, where they intrude the coarse granodiorites and monzonites of Unit 6. Border zones are characterized by complex sheeting and interfingering contacts with the surrounding rocks. Texturally, they vary from massive to gneissose, and were apparently misinterpreted as arkosic metasediments by Stevenson (1967). Although biotite is the chief mica in these rocks, muscovite is also widely distributed in some phases. Garnet and hornblende also occur locally.

Unit 8 - Gabbroic rocks

Gabbroic rocks intrude Units 6, 7 and 8. They underlie Mt. Sawyer, a prominent, flat mountain north of the Red Wine River, where they are greenish gray weathering, medium grained, subophitic textured rocks in which the pyroxene commonly is rimmed by pale green amphibole. A bald hill south of the confluence of the Red Wine and Naskaupi Rivers is underlain by brown weathering, cumulate textured, gabbroic rocks and layered ultramafics. The latter were previously interpreted as andesitic volcanic rocks by Stevenson (1967). It is unclear whether these gabbroic rocks should be correlated with the Michael Gabbro dikes which outcrop extensively in the area to the north and east (Greene, 1972) or with the Elsonian anorthosite suite.

Unit 9 - Sericitic white quartzite (Seal Lake Group)

White and gray, sericitic quartzite of the Bessie Lake Formation of the Seal Lake Group occurs as a septum in the north-central part of the area, where it has been overidden by a thrust sheet of Units 6, 7, and 8. The eastern contact is assumed to be an unconformity, but it is not exposed.

Unit 10 - Pyroxene gabbro

A massive to very weakly foliated, gray-green weathering, medium to fine grained, two pyroxene gabbro outcrops between the Red Wine and Susan Rivers.

It comprises plagioclase, clinopyroxene, orthopyroxene, biotite and hornblende. From the outcrop distribution in the area, the unit could be interpreted to intrude a Grenvillian thrust and, thus, may be of post-Helikian age. However, exposure is too poor to demonstrate this interpretation. The lithological similarity to Unit 11 and rocks associated with the anorthosite suite suggests that an Elsonian age is probably more likely.

Unit 11 - Gabbro, syenite, granite

A large composite plutonic body comprising gray weathering gabbro and pink to white weathering syenite and alkali feldspar granite occurs south of the west end of Grand Lake. These rocks are commonly orange or rusty on freshly broken surfaces. For the most part, the rocks are medium grained, but fine grained phases do occur. Most of the unit is massive, but a foliation is developed along its margins. A granular texture indicates recrystallization during metamorphism. The gabbroic members of the intrusion are composed of plagioclase, diopside, hypersthene, and perthite, with accessory (secondary) hornblende, biotite and garnet; garnet coronas are developed on the mafic constituents. Stevenson (1967) considered these rocks as closely related to the anorthosite series.

ALLOCHTHONOUS ROCKS

Unit 12 - Mylonitized granitic and supracrustal rocks

An openly folded thrust sheet comprising pink and white weathering, mylonitized granitoids, garnetiferous, gray weathering semipelitic gneiss, garnetiferous amphibolite and gray quartzite occurs south of the Red Wine River. The contact with the megacrystic granite may be a remobilized intrusive one.

Unit 13 - Gray gneiss, amphibolite, mylonite

Gray tonalitic gneisses and amphibolites into which a gabbro/anorthosite suite (Units 14, 15) has intruded outcrop in the vicinity of the Cape Caribou River. This unit is mylonitized at the base of the thrust. The mylonites north of the Cape Caribou River contain orthopyroxene, a feature noted by Bourne (1978) in his discussion of Grenville Province metamorphism. Felsic gneisses from this complex contain a quartz-feldspars-hornblende-plagioclase-clinopyroxene-garnet assemblage with biotite and scapolite present locally.

The mylonites have undergone postkinematic recrystallization, which has eradicated much of the mylonitic microstructure.

Unit 14 - Gabbro, diorite

Massive to well layered leucrocratic to melanocratic metagabbro and metadiorite intrude the gneisses of Unit 13. These are usually nonschistose, but locally possess a strong lineation. Garnet is a common component in the metagabbros, and may also occur in the host gneisses adjacent to the contact. This feature is apparently due to aluminum metasomatism during metamorphism. The gabbros tend to be melacratic rocks which grade into ultramafic and leucogabbroic variants. Plagioclase-clinopyroxene-hornblende-garnet±biotite± scapolite is a common assemblage but orthopyroxene is present locally; a clinopyroxene-orthopyroxene-olivine-spinel assemblage has been observed in the ultramafics.

Unit 15 - Anorthosite

Medium to coarse grained, gray to white weathering anorthosite and norite occupy the southeast corner of the map

area. Very coarse phases occur locally, containing bronzite crystals up to 50 cm in maximum dimension. The anorthositic rocks are commonly recrystallized and amphibole rims are visible on the pyroxenes in hand specimen.

Unit 16 - Monzonite, syenite and granite

These rocks are similar in all respects to those of Unit 11, to which they are probably equivalent. A strong lineation is commonly present and, locally, a planar fabric is developed.

ECONOMIC GEOLOGY

No major new occurrences of economic mineralization were found, but minor concentrations were noted. These include the presence of restricted seams and disseminations of magnetite in the metasedimentary rocks, the occurrence of anomalous radioactivity plus fluorite and molybdenite in the pink aplites west of the Crooked River (Ryan, 1980), and the localized occurrence of blue labradorite in the least recrystallized parts of the anorthosite.

STRUCTURE AND METAMORPHISM

The area is characterized by a generally north-south trending structural grain which has been affected by later east-west trending open folds. Such northerly trends are strongly discordant to the general trend of the Grenville Structural Province. It appears that this is an early Grenvillian feature, predating the more widespread east-west and northeast trending fabrics commonly associated with the Grenvillian Orogeny.

The emplacement of the thrust sheets is considered to have been a Grenvillian event since it affects rocks of the Elsonian suite. Post-thrusting folding is apparent both on regional scale and in outcrop.

A north-south trending fault transecting the area is the southerly extension of the Pocketknife Lake Fault, a prominent structural break in the area to the north (Smyth *et al.*, 1978).

Metamorphic assemblages vary across the area and are in part compositionally and probably age controlled. For instance, there is no obvious change in the mineralogy of the Unit 4 tonalite corresponding to the kyanite-sillimanite isograd in the metasediments of Unit 2 which it intrudes. This may be due to the fact that the tonalite does not contain index minerals indicative of high grade metamorphism. Alternatively, the metamorphic isograd in the metasediments is a pre-Grenvillian feature. In general, metamorphic mineral assemblages reflect amphibolite facies metamorphism, with the exception of the monzonitic rocks along the northern fringe of the area, which are at greenschist grade. Granulite facies assemblages in the mylonites south of Grand Lake predate the thrusting.

SUMMARY

The map area comprises allochthonous and autochthonous elements, but for the most part relative and absolute ages are unknown. The chronology outlined on the accompanying legend is very tentative. However, it appears that all rocks, with the possible exception of Units 10 and 11, are pre-Seal Lake Group in age, *i.e.* pre-Neohelikian.

Systematic prospecting of the aplitic rocks may produce more indications of radioactivity, and labradorite may be more widely distributed in the anorthosite than indicated by the scale of this survey.

Investigations are continuing on the metamorphism and structure in order to more completely evaluate the character of the Grenvillian Orogeny in this area.

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REFERENCES

Bourne, J.H.
1978: Metamorphism in the eastern and southwestern portions of the Grenville Province. *In* Metamorphism in the Canadian Shield, Geological Survey of Canada, Paper 78-10, 315-328.

Fenton, J.
1978: Final report on project generation, Labrador project area. private report, Hudbay Uranium Ltd.

Greene, B.A.
1972: Geological map of Labrador. Newfoundland Department of Mines, Agriculture and Resources, St. John's.

Ryan, B.
1980: Preliminary reconnaissance study of the northern Grenville province, Naskaupi River area, Labrador. *In* Current Research. *Edited by* C.F. O'Driscoll and R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 80-1, pages 147-153.

Ryan, B. Harris, A.
1978: Geology of the Otter-Nipishish-Stipec Lakes area, Labrador (13K/2,3,6,7). *In* Report of Activities for 1977. *Edited by* R.V. Gibbons. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 51-58.

Scott, H.S. and Conn, H.K.
1949: Geology of the Goose Bay area, Labrador. Photographic Survey Corporation, 70 pages.

Smyth, W.R., Marten, B.E., and Ryan, A.B.
1978: A major Aphebian-Helikian unconformity within the Central Mineral Belt of Labrador: definition of new groups and metallogenic implications. Canadian Journal of Earth Sciences, volume 15, pages 1954-1966.

Stevenson, I.M.
1967: Goose Bay map area (13F). Geological Survey of Canada, Paper 67-33.