GEOLOGY OF THE RED WINE MOUNTAINS AND SURROUNDING AREA, CENTRAL LABRADOR

by

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INTRODUCTION

During the summer of 1980, geological mapping at a 1:100,000 scale was carried out in an area bordering the Red Wine Mountains, 125 km northwest of Goose Bay, covering N.T.S. sheets 13E/10, 11, 15, and 13F/12, 13. Mapping was completed by helicopter supported foot traversing and reconnaissance style helicopter traversing. Exposure over much of the area is poor, with extensive boulder fields, sand plains and areas of string bog predominating.

The area has been previously covered at a scale of 1:253,440 (1 inch to 4 miles) by Stevenson (1967, 1969) and parts of sheets 13E/11 and 13E/15 at a more detailed scale by Geiger (1961). The Ptarmigan Complex within the Red Wine Mountains has been mapped by Emslie *et al.* (1978) and their work from N.T.S. sheets 13E/9 and 13E/16 has been compiled and included within this report. A recent study of the Red Wine Alkaline Intrusive Suite has been done by Curtis and Currie (in press). Rocks of the Seal Lake Group have been mapped at reconnaissance scale by Fahrig (1959), Brummer and Mann (1961), Roscoe and Emslie (1973) and at more detailed scale by Frobisher Ltd., Brinex and Cominco.

GENERAL GEOLOGY

The area immediately surrounding the Red Wine Mountains is underlain by a basement terrain consisting of Aphebian or older Hope Lake and Disappointment Lake gneisses. The basement gneisses are intruded by, and in fault contact with, late Hudsonian or Elsonian granitic rocks of the North Pole Brook Intrusive Suite. Late Aphebian or Paleohelikian Beaver gneiss is in concordant contact with the older gneisses; however, the contact with the granitic rocks is locally faulted and obscured by tectonism. In the western portion of the map area, quartz monzonite and monzonite of probable Paleohelikian age intrude rocks of the North Pole Brook suite. Highly deformed, granulite grade charnockitic gneiss and medium to coarse grained recrystallized gabbro, also of probable Paleohelikian age, are restricted to the Red Wine Mountains (Emslie *et al.*, 1978), the western boundary of which is marked by reverse faults.

Paleohelikian intrusive rocks also include the Shabogamo gabbro, Arc Lake Intrusive Suite and the associated metamorphosed agpaitic rocks of the Red Wine Alkaline Intrusive Suite. In the northwestern part of the map area, diabase and gabbro sills, basalt flows and quartzite of the Neohelikian Seal Lake Group unconformably overlie the granitic terrain. All rocks have been deformed and metamorphosed during the Grenville Orogeny but they are polydeformed and it is probable that relict pre-Grenvillian fabrics occur at least in parts of the map area.

Hope Lake gneiss (Unit 1)

Rocks of the Hope Lake gneiss underlie much of the Red Wine Mountains and have been described by Emslie *et al.* (1978). The gneiss weathers pink or beige, is primarily leucocratic with minor mafic zones and is fine to medium grained. It is banded on a small scale and normally foliated. Felsic quartz and feldspar rich bands alternate with more mafic bands comprising hypersthene, sillimanite, biotite, hornblende and sapphirine. Magnetite, pyrite and garnet are minor constituents. Also present

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LEGEND

NEOHELIKIAN

Seal Lake Group

14 **Bessie Lake Formation:** 14a, Amygdaloidal to massive green basalt flows interbedded with feldspathic to clean, gritty medium to coarse white quartzite.

Wuchusk Lake Formation: 14b, Gabbro sills, diabase dikes and sills,siltstone, shale, argillite and interbedded chert.

PALEOHELIKIAN

13 **Red Wine Alkaline Intrusive Suite:** 13a, Green pyroxenic-aenigmatitic gneiss; 13b, blue-black omphacitic and nephelinic gneiss; 13c, leucocratic, arfvedsonite, feldspar gneiss $\pm$ nepheline, pyroxene, eudialyte; 13d, malignite, nepheline syenite.

12 Peralkaline granite

11 **Shabogamo Gabbro:** Medium to coarse grained olivine bearing leucogabbro exhibiting fresh igneous texture.

10 **Gabbro:** Fine to medium grained massive to foliated and recrystallized pyroxene bearing gabbro, leucogabbro, norite and diabase.

9 Charnockitic gneiss

8 Coarse grained massive amphibolite

PALEOHELIKIAN - APHEBIAN

7 Quartz monzonite - monzonite

6 Tonalite gneiss

5 **North Pole Brook Intrusive Suite:** 5a, Megacrystic biotite granodiorite - quartz monzonite; 5b, equigranular biotite granodiorite - quartz monzonite; 5c, recrystallized megacrystic granodiorite - quartz monzonite; 5d, gneissic equivalents of above units; 5e, quartz diorite - diorite.

4 **Beaver Gneiss:** Banded to massive, medium grained, garnet-iferous amphibolite.

APHEBIAN - ARCHEAN

3 **Kyanite Gneiss:** Siliceous white kyanite, sillimanite, biotite, garnet, muscovite gneiss.

2 **Disappointment Lake Gneiss:** 2a, Pink sillimanite, biotite quartzofeldspathic gneiss, contains amphibolite pods and metadiabase dikes; 2b, chlorite, muscovite schist.

1 **Hope Lake Gneiss:** Pink to beige hypersthene, sillimanite, biotite, sapphirine bearing banded quartzofeldspathic gneiss, contains amphibolite pods and metadiabase dikes.

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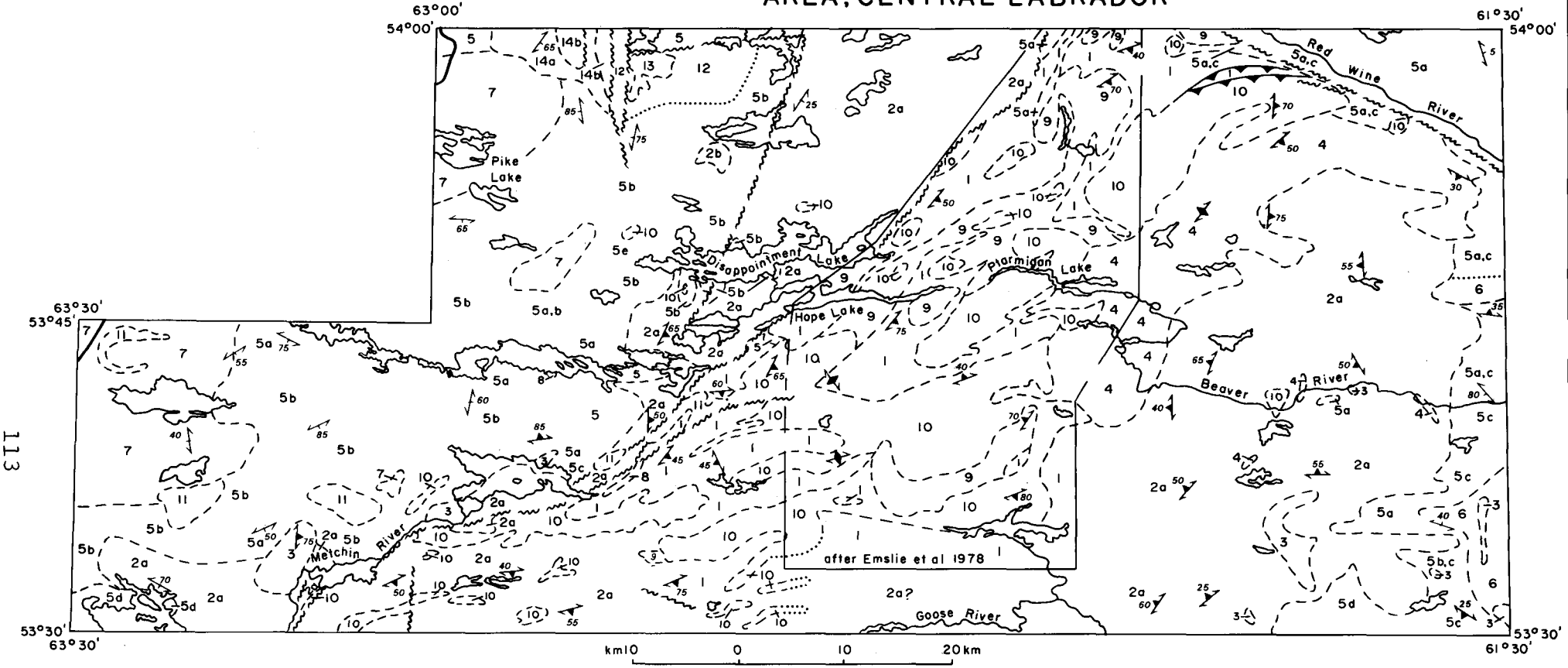

within the gneiss are amphibolite pods up to 2 m long by 0.25 m wide which represent metamorphosed boudins of diabase. The gneiss is considered to be a deeper crustal level equivalent of the Disappointment Lake gneiss. A Rb-Sr errorchron age of 1675 Ma* has been determined on Hope Lake gneiss and a U-Pb date of 1650 Ma has been determined on monzo-diorite closely associated with the gneiss (Emslie, personal communication, 1980). These dates indicate that the gneiss may constitute the relict deep level part of a Hudsonian mobile belt down the eastern side of the Labrador Trough. The gneiss may also be correlative with the Wilson Lake granulite, just south of the map area, which has given a preliminary K-Ar date on biotite (Gittens, personal communication, 1979) of 2200 Ma. Another possibility is that the gneiss in whole or in part represents high grade, tectonized equivalents of North Pole Brook Intrusive rocks which have been dated at 1654 Ma. The aluminous nature of the gneiss, exemplified by the common occurrence of sillimanite and sapphirine, suggests a sedimentary protolith for the unit and favors the first alternative.

Disappointment Lake gneiss (Unit 2)

Extensive exposures of Disappointment Lake gneiss (Unit 2a) occur in the eastern and northwestern parts of the map area on either side of the Red Wine Mountains. The gneiss has a granodioritic composition, is most commonly pink on fresh and weathered surfaces, fine to medium grained (0.5 to 2 mm) and uniformly banded on a small scale. Quartz and feldspar bands up to 2 cm wide alternate with anastomosing biotite, sillimanite, muscovite and magnetite bands of comparable width. Garnet and kyanite(?) are local accessory phases present in the gneiss on the eastern side of the Red Wine Mountains. Deformed leucocratic pink pegmatite zones and dikes are probably the result of *in situ* partial melting of the gneiss. Whereas dikes crosscut the banding, pegmatite sweat zones in some places crosscut and in others are parallel to banding. Highly contorted folds are often sheared parallel to and injected by pegmatitic material along their axial planes.

Within the gneiss, pods and aligned strings of pods of massive to banded amphibolite consisting of hornblende, biotite, plagioclase, magnetite and pyrite represent boudinaged metadiabase dikes. Several exposures of highly crenulated schist (Unit 2b) occur as rafts within granitoids adjacent to the gneiss terrain north of Disappointment Lake and have been included within the Disappointment Lake gneiss unit. The rock consists of chlorite, sericitic muscovite, magnetite and an unidentified, nearly isotropic, bladed mineral. It is extensively altered and deformed, exhibiting at least two periods of deformation.

The Disappointment Lake gneiss is thought to be Aphebian (see Thomas, 1980a) and to have been derived from a sedimentary protolith.

Kyanite gneiss (Unit 3)

This unit is minor in occurrence and is found in the southeast part of the area and west of the Metchin River. The rock consists of white to gray weathering, well banded, medium to coarse grained gneiss (grain size averages 0.2 to 0.5 cm). Mafic bands up to 0.5 cm in width consist of biotite and muscovite with minor euhedral garnet. These alternate with white

* All rubidium-strontium dates in this report are based on a ^{87}Rb decay constant of $\lambda = 1.42 \times 10^{-11}\ yr^{-1}$.

siliceous quartz, feldspar, kyanite and or sillimanite bands up to 2 cm in width which become locally pegmatitic.

The quartz-kyanite rich nature of this rock suggests a sedimentary protolith but, at the present time, its relationship to other gneiss units within the map area is unknown.

Beaver gneiss (Unit 4)

Melanocratic, medium grained, massive to banded amphibolite comprises the Beaver gneiss, which occurs along the southeastern margin of the Red Wine Mountains massif. The banding is most commonly developed on a centimetre scale but may vary up to a metre in width. Garnet and magnetite rich quartzofeldspathic layers alternate with locally garnetiferous mafic layers containing hornblende, pyroxene, biotite, minor magnetite and pyrite. Rarely, small (1 m long) ultramafic boudins, rich in chlorite and actinolite, are developed parallel to banding. Emslie *et al.* (1978) suggest that the gneiss is Aphebian in age and represents a fairly thick metasedimentary succession. Based on this study, Beaver gneiss is presently thought to be derived from a mafic igneous protolith, possibly related to the numerous gabbro and leuconorite bodies with which it is spatially associated.

North Pole Brook Intrusive Suite (Unit 5)

Rocks of this plutonic suite are intrusive into the older Hope Lake and Disappointment Lake gneisses (as evidenced by intrusive contacts and differences in intensity and style of deformation between the two units) although intense shearing and deformation near the contacts often obscures this relationship. They are found in the western and eastern parts of the map area on either side and north of the Red Wine Mountains massif. The suite is differentiated and comprises granite, granodiorite-quartz monzonite, quartz diorite and diorite. Compositional and textural variations are subtle and contacts between the various subunits are gradational.

Pink to buff weathering biotite-hornblende granodiorite-quartz monzonite is the most typical rock type found within the suite. It is commonly megacrystic (Unit 5a) with pink or purple microcline and orthoclase phenocrysts up to 4 cm by 3 cm set in a fine to medium grained, pink to gray, quartz, plagioclase, K-feldspar, biotite and hornblende groundmass. The phenocrysts may be zoned and are usually euhedral. Equigranular granodiorite-quartz monzonite (Unit 5b) consists of quartz, plagioclase (oligoclase-andesine), K-feldspar, biotite, magnetite, subordinate hornblende and rare muscovite. The grain size of this rock varies but averages approximately 0.5 cm.

Towards the southern part of the map area, rocks of the North Pole Brook Suite become progressively recrystallized and adopt a gneissic texture. Recrystallized megacrystic granodiorite-quartz monzonite (Unit 5c) is generally massive to moderately foliated but, instead of the igneous texture normally found in the remainder of the suite, polygonal texture dominates. The original euhedral shape of the phenocrysts is preserved. Gneissic equivalents of both equigranular and megacrystic North Pole Brook rocks (Unit 5d) occur in the extreme southeast and southwest parts of the map area. There, the rocks are banded quartzofeldspathic gneisses consisting of quartz, plagioclase, K-feldspar, biotite, hornblende, magnetite and garnet. Phenocrysts, though still identifiable, are stretched into lenticular augen or feldspathic bands up to 1 cm wide. Biotite and hornblende are also segregated into distinct mafic bands from 0.5 to 1.5 cm in width. Groundmass quartz and feldspar are recrystallized and contained in bands of comparable width. Gneissic equivalents tend to be more biotite rich than either of the

equigranular or megacrystic units. Quartz diorite and diorite (Unit 5e) constitute a volumetrically minor proportion of the suite and are confined to the western part of the map area. Their mineralogy is similar to that of the other rocks of the suite but the percentages of plagioclase, biotite and hornblende are greater. These rocks are gray and equigranular with a grain size averaging 0.2 to 0.5 cm. They are massive to weakly foliated and no gneissic equivalents of them have yet been found.

Rocks of the North Pole Brook Suite have been strongly foliated and/or cataclastically deformed in the vicinity of the faults that define the northwestern and northeastern boundaries of the Red Wine Mountains massif. The North Pole Brook Intrusive Suite has been dated at 1654 ± 22 Ma and possibly represents a band of late to post-kinematic Hudsonian granitoids probably related to rocks in the Churchill Structural Province to the north. It is emphasized here, however, that most if not all of the deformation in the unit resulted from the Grenville Orogeny.

Tonalite Gneiss (Unit 6)

A few outcrops of gray, medium grained, biotite-hornblende tonalite gneiss and quartz diorite were noted near the eastern margin of the map area. These rocks, which contain plagioclase, quartz, biotite, hornblende and an abundance of pink scapolite (Ryan, this volume) are most commonly foliated or gneissic, but may be locally massive. The unit is more widespread in occurrence within the adjoining map sheet to the east (see Ryan, this volume).

Quartz Monzonite - Monzonite (Unit 7)

Pink weathering, leucocratic, medium grained quartz monzonite to monzonite intrudes rocks of the North Pole Brook Suite in the extreme western part of the map area. It is massive to weakly foliated or sheared and contains plagioclase, K-feldspar, minor quartz, biotite, chlorite, muscovite and abundant epidote. Aplitic and pegmatitic phases are present and presumably in gradational contact with the more widespread medium grained rock type.

The quartz monzonite-monzonite is thought to be Paleohelikian in age and younger than granitoids belonging to the North Pole Brook Suite. However, this unit has a close spatial relationship with rocks of the North Pole Brook Suite and is similar in composition, suggesting a possible genetic link.

Massive Amphibolite (Unit 8)

This unit is relatively rare and occurs within the western granitoid terrain and within Hope Lake gneiss along the southwestern margin of the Red Wine Mountains massif. It is present as rounded bodies in granodiorite or as distinct layers within gneiss. Outside of the mountains, the rock is medium to coarse grained (up to 1 cm) and consists of hornblende, plagioclase, magnetite and minor quartz. Within the mountains, hypersthene and garnet are additional constituents. The rock is usually massive but, within the mountains, a strong lineation is defined by the alignment of hornblende and plagioclase crystals. The amphibolite is thought to represent early Paleohelikian mafic bodies and sills which have intruded into a pre-metamorphic granitoid - sediment succession now represented by Hope Lake gneiss.

Charnockitic gneiss (Unit 9)

Restricted in occurrence to the Red Wine Mountains massif, this rock is buff to greasy brown on fresh surface and commonly weathers a rusty brown color. It is medium grained (0.3 cm) and although locally massive, is most typically foliated or gneissic. Near faults within and at the borders of the Red Wine Mountains, the gneiss becomes cataclastic. Emslie *et al.* (1978) have

determined a compositional range from monzodiorite to quartz monzonite for the gneiss, which contains quartz, K-feldspar, plagioclase, orthopyroxene, clinopyroxene, biotite, hornblende, magnetite, minor pyrite and rare garnet. K-feldspar and hypersthene porphyroblasts are common, as are granitic sweats and localized pyroxene rich segregations. This gneiss is closely associated with gabbroic rocks in the mountains and may represent cataclasized hypersthene bearing plutonic bodies. At the present time, it is not known whether these bodies are related to rocks of the North Pole Brook Intrusive Suite.

Gabbro (Unit 10)

Large bodies of gabbro, leucogabbro, norite and diabase occur within the Red Wine Mountains massif, and to a lesser extent in the surrounding terrain. These rocks are generally fine to medium grained and foliated, although the centres of some of the larger bodies may be coarse grained and display relict igneous layering as well as ophitic to subophitic textures. The borders of most of the larger bodies are severely deformed.

Plagioclase, orthopyroxene, clinopyroxene and hornblende are the main minerals. Biotite, quartz, magnetite and pyrite are subordinate in amount, although localized magnetite and pyrite concentrations occur. The gabbroids are in intrusive contact with the surrounding gneisses. Chilled margins, baking of the gneiss resulting in garnet rich zones along the contacts, inclusions of baked gneiss within gabbro, and pyritiferous zones along the contacts are observed. Diabase dikes were found at one locality crosscutting a gabbro body and may constitute a late phase of Unit 10. In addition, angular blocks of diabase with concentric chilled margins and remnant igneous layering are abundant within quartzofeldspathic gneiss near the contact between the gneisses and gabbroids. These probably represent dikes which have been broken and brecciated by subsequent deformation. The gabbroid rocks within the massif are thought to be of Paleohelikian age and closely related to the Elsonian anorthosite bodies.

Shabogamo gabbro (Unit 11)

Gabbro and leucogabbro intrude the granitoid terrain in the western part of the map area. These rocks have been tentatively correlated with the Shabogamo gabbro in western Labrador. They are medium to coarse grained, massive, olivine bearing and exhibit fresh igneous textures. Plagioclase laths up to 8 cm long are ophitically enclosed in pyroxene and altered olivine. Interstitial magnetite - ilmenite crystals as large as 2 cm are present along with spinel. Corona textures are commonly developed and are characteristic of this unit. In general, pyroxenes weather in relief and the rock where extremely weathered is rusty and friable. Leucogabbro is blue-gray on fresh surface, composed almost entirely of plagioclase with minor pyroxene. The granitoid rocks in contact with the gabbro have been baked and leached to a white color. The relationship of Shabogamo gabbro to most of the gabbroids in the Red Wine Mountains massif is uncertain. Massive, coarse grained cores of the larger Unit 10 gabbro bodies in the Red Wine Mountains may be equivalent to Shabogamo gabbro, in which case the finer grained foliated varieties in the mountains may represent deformed Shabogamo gabbro. The age of the Shabogamo Intrusive Suite in western Labrador has been determined as 1390 Ma (see Geochronology, this volume).

Peralkaline granite (Unit 12)

A small amount of peralkaline granite belonging to the Arc Lake Intrusive Suite (Thomas, 1980b) outcrops in the extreme northwest corner of the map area. It consists of quartz, plagioclase, aegirine, arfvedsonite-

riebeckite, sphene and zircon. The rock is medium grained (0.3 cm) and sheared, exhibiting a moderate to strong foliation. Peralkaline granite is closely linked spatially, chemically and time-stratigraphically with rocks of the Red Wine Alkaline Intrusive Suite and Letitia Lake Group.

Red Wine Alkaline Intrusive Suite (Unit 13)

Rocks of this unit outcrop with peralkaline granite in the northwest corner of the map area. The terminology and description of these rocks is after Curtis and Currie (in press). Green melanocratic gneiss (13a) occurs as pods and bands peripheral to agpaitic plutons. It consists of jadeitic pyroxene, arfvedsonite, nepheline, feldspar, eudialyte, biotite, apatite, pectolite and aenigmatite. Blue-black melanocratic gneiss (13b) also occurs as elongate pods associated with green gneiss and consists of omphacitic pyroxene, arfvedsonite, albite, microcline, nepheline, pectolite, aenigmatite, eudialyte and fluorite. Strongly foliated and recrystallized lenticular pods of leucocratic gneiss (13c) consist of omphacitic to aegirinic pyroxene, arfvedsonite, albite, microcline, nepheline, pectolite, aenigmatite, eudialyte and fluorite. Malignite (nepheline syenite with a color index between 50 and 90) and nepheline syenite (13d) occur as large, irregular pods of coarse grained to pegmatitic rock with igneous or relict igneous textures. These rocks contain arfvedsonite, albite, microcline, nepheline, eudialyte, aenigmatite and aegirine. The Rb-Sr age determined by Curtis and Currie (in press) for this suite of rocks is 1392 $\pm$ 75 Ma.

Seal Lake Group (Unit 14)

Seal Lake Group rocks unconformably overlie granitoids of Unit 5 along the northwestern boundary of the map area, but only the lowermost two formations are exposed. The Bessie Lake Formation (14a) consists of 1280 m (Brummer and Mann, 1961) of amygdaloidal to massive, green basalt flows interbedded with coarse to medium grained, clean to arkosic white quartzite. Quartzite is more feldspathic, gritty and conglomeratic near the base of the formation.

The Wuchusk Lake Formation (14b) conformably overlies the Bessie Lake Formation and consists of approximately 6096 m (Brummer and Mann, 1961) of gabbro sills, diabase sills and dikes, siltstone, shale, argillite and interbedded chert. The sills comprise most of this unit and form prominent ridges, whereas sedimentary rocks weather more readily and are found as minor outcrops in the valleys.

Wanless and Loveridge (1978) have determined a Rb-Sr age of 1323 $\pm$ 92 Ma for rocks of the Seal Lake Group.

STRUCTURE

At least four periods of deformation are recognized within the map area. The first period (D_1) resulted in the formation of gneissic bands within the Hope and Disappointment Lake gneisses. East of the Red Wine Mountains, the gneisses were deformed by D_2 into regional, open to closed, asymmetrical folds. These F_2 fold axes generally trend in a north-south direction but, in the east-central part of the map area, undulate between northwest and northeast. F_2 axial planes normally dip towards the west at moderate to steep angles or are vertical.

Within the Red Wine Mountains, the F_2 structures are refolded by D_3 into regional isoclinal F_3 folds, so that both F_2 and F_3 folds are overturned to the northwest, have parallel or subparallel axial planes that trend northeast and dip steeply to the southeast, and have fold axes which plunge moderately to the southwest. F_2 fold axes have been rotated into parallelism with F_3 fold axes and an intense mineral stretching lineation

(L_x), is developed parallel to these. The lineation is termed L_x since it may incorporate both L_1 and L_2 components which are now parallel. D_3 is characterized by a large amount of strain and a northerly or north-northwesterly transport direction is indicated.

The fourth period of deformation (D_4) has resulted in a gentle open warping about east-west trending axes; this forms a mushroom type interference pattern between major folds within the area. In addition, this deformation has caused L_x lineations to vary from a gentle northerly plunge, through horizontal, to a gentle southerly plunge.

Structural deformation in the area culminated in moderate to high angle reverse faulting. Granitoid terrain northwest and north of the Red Wine Mountains has acted as a buttress against which the gneisses and gabbroids have been thrust, so that major fault zones occur along the Red Wine River valley and along the western margin of the Red Wine Mountains massif. The granitoids have reacted to tectonism by shearing and recrystallizing.

Most of the deformation is of Grenvillian age; however, there is limited evidence (such as contrasting styles, intensities and orientations of deformation) that the D_1 gneissic banding and some of the granitoid fabrics in the North Pole Brook Intrusive Suite are pre-Grenvillian (presumably Hudsonian).

METAMORPHISM

Rocks within the Red Wine Mountains massif have been metamorphosed to granulite grade, as demonstrated by hypersthene + sillimanite + quartz ± garnet ± biotite and sapphirine + quartz ± garnet assemblages (Emslie *et al.*, 1978). East and west of the Red Wine Mountains, the typical mineral assemblages in quartzofeldspathic gneisses are sillimanite + quartz + plagioclase + biotite ± garnet and kyanite + quartz + plagioclase + biotite ± garnet. In mafic rocks, the assemblage is hornblende + plagioclase ± garnet ± biotite. These assemblages indicate a metamorphic grade for these rocks of at least middle to upper amphibilite.

The granitoid rocks west and north of the Red Wine Mountains do not have compositions conducive to the development of complete diagnostic metamorphic mineral assemblages but, based on the partial assemblage of secondary biotite + muscovite + epidote, their indicated grade is middle to upper greenschist. The metamorphic grade of rocks belonging to the Red Wine Alkaline Intrusive Suite has been estimated by Curtis and Currie (in press) to be middle to upper amphibolite.

The presence of primary sedimentary textures and structures as well as a quartz + albite + chlorite + epidote + muscovite mineral assemblage shows that rocks belonging to the Seal Lake Group which outcrop along the northwest margin of the map area are metamorphosed to lower greenschist grade.

Metamorphism in all rocks except the Hope Lake and Disappointment Lake gneisses is of Grenvillian age. In addition to being metamorphosed during the Grenville Orogeny, it is thought that these two units were also affected by the Hudsonian Orogeny.

MINERALIZATION

Quartzofeldspathic rocks of the Disappointment Lake (Unit 2) and Hope Lake (Unit 1) gneisses contain disseminated magnetite concentrated within thin biotite-sillimanite rich mafic layers. Amphibolitic rocks belonging to the Beaver gneiss (Unit 4) and the gabbroic rocks (Unit 10) contain local concentrations of disseminated magnetite resulting in moderate to strong aeromagnetic anomalies. These units also contain rusty zones due to minor concentrations of disseminated pyrite and pyrrhotite.

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