WABUSH LAKE - SAWBILL LAKE MAP AREA, WESTERN LABRADOR

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INTRODUCTION

Mapping of the Gagnon Group and associated rocks was carried out in the Wabush Lake (23G/2) and Sawbill Lake (23G/7) map areas, directly north of the area mapped in 1977. Within these two map areas, rocks assigned to the Superior, Churchill and Grenville tectonic provinces occur, with the Grenville Front passing diagonally across the area. The complete sequence of the Gagnon Group occurs within the area in contact with the underlying Archean gneisses.

The objectives of the mapping in 1978 were: (1) to continue reevaluation of the mineral potential of the area, including known iron deposits, principally through interpretation of the structural and metamorphic geology of the Gagnon Group; and (2) to investigate the nature of the contact between the Gagnon Group and the gneisses of the Superior Province (locally known as the Ashuanipi Complex). As part of a separate project, samples for radiometric dating were collected to elucidate the timing of metamorphism within the Gagnon Group. Samples from units 2, 4 and 7 were collected for analysis by Rb/Sr and $^{40}Ar/^{39}Ar$ methods.

Previous work

Previous work in the area includes 1 inch to 1/2 mile mapping by Labrador Mining and Exploration Company (L.M. & E., Neale, 1951) with follow-up 1 inch to 1000 foot mapping together with drilling and geophysical work during the remainder of the decade by L.M. & E. and Iron Ore Company of Canada (Beemer, 1952; Almond, 1953; Eckstrand, 1956; Love, 1959 and others). Part of the area was mapped at 1 inch to 1 mile by Newfoundland and Labrador Corporation (Boyko, 1953) and the whole area is included in the 1 inch to 4 mile Geological Survey of Canada map by Fahrig (1967).

GENERAL GEOLOGY

Rocks of the Aphebian Knob Lake Group of the Labrador Trough (Churchill Province) continue south of the Grenville Front into the Grenville Province, where they are known as the Gagnon Group. The simple style of deformation and low or negligible grade of metamorphism characteristic of the Knob Lake Group are replaced by more complex structural patterns and higher grades of metamorphism within the Gagnon Group. The unconformity between the Ashuanipi Complex and the Knob Lake Group which marks the border between the Superior and Churchill Provinces, is reworked to the south, so that the contact between the Superior and Grenville Provinces, known as the Grenville Front, is a tectonic rather than a sedimentary feature. The Grenville Front therefore marks the northerly limit of structures developed during the Grenvillian Orogeny - it is a tectonic feature unrelated to the age or metamorphic grade of the rocks included within the Grenville Province.

K-Ar radiometric data on the Ashuanipi Complex give an age of 2425 Ma, and several K-Ar analyses of gneisses of the Gagnon Group yield ages between 900-1125 Ma (Fahrig, 1967). A single whole rock Rb-Sr analysis on metagabbro of unit 7 has been interpreted to yield an age of intrusion of 1600 Ma (Zodrow, 1971), but the data are incomplete, and the interpretation should be regarded as inconclusive pending further results. Field relations indicate that the Shabogamo Gabbro (Unit 7) was intruded, at least in part, prior to the metamorphism of the Gagnon Group (Rivers, 1978a). Thus, while the age of the low grade metamorphism of the Knob Lake Group is known to be Hudsonian, the age of metamorphism of the Gagnon Group is not yet definitely established, as the possibility exists that the K-Ar ages represent a late cooling age unrelated to the main metamorphic event.

Ashuanipi Complex (Unit 1)

Gneisses of the Archean Ashuanipi Complex outcrop in the northwestern part of the map as a large body, and reappear within the Gagnon Group to the southeast as a series of domes. The northern area comprises an extensive, well exposed, but rather monotonous terrain, which has only been cursorily examined on helicopter traverses. The unit is typically composed of banded migmatites, with fine to medium grained dioritic gneisses separated and commonly completely enclosed by coarse grained leucocratic granite with an igneous texture. Most contacts between the two rock types are parallel to banding in the gneisses, with a minority being markedly discordant. Biotite is the predominant mafic mineral in the unit, but hypersthene is common and may reach dimensions up to 2 cm in the coarse grained fraction, giving the rock a characteristic spotty appearance. The presence of orthopyroxene in the granitoid rocks indicates that metamorphism attained granulite grade during the Kenoran Orogeny, presumably resulting in mobilization of the coarse grained granitic fraction of the migmatite.

Gneisses near the margins of the Ashuanipi Complex, as well as those composing several of the smaller bodies, display a coarse cataclastic foliation which crosscuts the gneissic banding. Locally, along the contacts, the gneiss is altered to a fine grained mafic schist with occasional feldspar augen up to 5 cm in length. These features evidently postdate the formation of the gneissic banding, and were apparently developed during the D_1 deformation of the Gagnon Group. The cataclastic foliation is equivalent to S_1 in the Gagnon Group, with the fine grained mafic schists being mylonites developed along thrust faults during D_1.

Katsao Formation (Unit 2)

The Katsao Formation outcrops in the southeast corner and in a northeast trending belt across the middle of the map. It consists essentially of a biotite bearing quartz-plagioclase schist, with or without garnet, K-feldspar, hornblende and muscovite. Textural and mineralogical differences render its appearance quite variable. In the southeastern part of the area, it is a medium to coarse grained rock, frequently pinkish in color due to its high K-feldspar content. The rock is migmatitic in some outcrops with a gneissic banding parallel to the pervasive foliation defined by mica. The gneissic banding is expressed by different mineral proportions in adjacent layers; and is probably due to original compositional differences locally enhanced by segregation of anatectic sweats. In the more northerly belt the rock assumes a darker color as the proportion of biotite increases, and the grain size is generally finer. Furthermore, feldspar crystals form augen up to 2 cm in length in the schist, rendering it difficult to distinguish from sheared portions of unit 1. The unit is apparently sedimentary in origin, as indicated by Rivers (1978a).

Duley Formation (Unit 3)

The Duley Formation overlies unit 2 in two locations in the southern part of the map area. It is a buff colored, sugary, dolomitic marble, frequently possessing many quartz rich lenses and stringers which define a foliation ($S_0//S_1$) in this otherwise massive unit. Tremolite is common in the southerly body.

Wapussakatoo (or Carol) Formation (Unit 4)

Coarsely crystalline white quartzite comprises the Wapussakatoo Formation, which outcrops on the west and north sides of Wabush and Julienne Lakes. The unit is generally massive, but it thins laterally to a quartz-muscovite schist in some localities. The Wapussakatoo Formation directly overlies unit 2 throughout most of the map area, indicating that the Wapussakatoo and Duley Formations are in part lateral equivalents.

Wabush Formation (Unit 5)

Unit 5 is composed of both silicate-carbonate and oxide iron formation; it outcrops in a broad band across the middle of the area. Though the unit is not subdivided on the accompanying sketch map, the silicate-carbonate variety is dominant, especially in the northern and eastern parts of the area. Oxide iron formation occurs on the west side of Wabush Lake in an extensive unit, but elsewhere it is too thin or discontinuous to be mapped at the 1:50,000 scale. As a result the tripartite division of the Wabush Formation mapped around the mines on the west side of Wabush Lake (Rivers, 1978a,b) was not applicable to the present map area.

Carbonate iron formation is composed predominantly of siderite and quartz, with grunerite and other iron silicates common locally. Ellipsoidal pods of siderite in a banded quartzite are a common type near the borders with unit 1. Oxide iron formation consists of medium to fine grained quartz and specular hematite, generally with magnetite present in low proportions. North of Julienne Lake, iron formation has been extensively leached and enriched in secondary iron, rendering recognition of the original iron formation type difficult.

Nault Formation (Unit 6)

The Nault Formation, which outcrops near the southeastern border of the Ashuanipi Complex and on the west side of Shabogamo Lake, is composed of a dark gray to black graphite-biotite schist. Graphite frequently composes a large proportion of the rock, with graphite porphyroblasts rendering the unit particularly distinctive. However, in parts of the area, biotite replaces graphite as the predominant dark colored mineral, and the unit becomes difficult to distinguish from unit 2.

Shabogamo Gabbro (Unit 7)

The Shabogamo Gabbro is composed of metagabbro and associated mafic rocks, including amphibolite, biotite schist and serpentinite. Metaleucogabbro and pyroxenite also occur as gradational phases within gabbroic parts of the unit. Metamorphic corona textures are commonly developed between mafic and felsic mineral phases, as described by Rivers (1978b), and these give the unit a distinctive appearance. While the centres of large bodies do not possess a foliation, the margins frequently are retrograded to amphibolite or a mafic biotite schist (the latter is especially common where the gabbro is intruded into the Katsao Formation).

Inclusion of the serpentinite bodies in the Shabogamo Gabbro is tentative only, pending further information on the nature and distribution of this rock type and on the age of intrusion of the Shabogamo Gabbro. Dimroth *et al.* (1970) note that small ultramafic bodies are common throughout the southern Labrador Trough, and that they were probably emplaced prior to the Hudsonian Orogeny.

STRUCTURAL GEOLOGY

Archean gneisses of the Ashuanipi Complex show the effects of at least two phases of deformation. The earlier of these is indicated by the presence of a pervasive gneissic banding in the dioritic portions, and this has been folded into open folds during a subsequent episode. Additionally, mobilization of a granitoid phase occurred during the second deformation episode, resulting in the formation of lit-par-lit migmatites in much of the area. The age of deformation and migmatism is Kenoran.

Rocks of the Gagnon Group show effects of three phases of post-Archean deformation. During the first of these, large asymmetric, recumbent, northeast trending folds were formed with axial surfaces overturned towards the northwest and with antiforms probably having considerably greater amplitude than synforms. As D_1 progressed, thrust faults (slides) developed in the synforms, separating the rocks into distinct tectonic slices. At least three of these major faults have been mapped out on the basis of stratigraphy and structural features, and a fourth appears likely. The most northerly fault, located within the Ashuanipi Complex, may represent the Grenville Front locally. In each of the tectonic slices, rocks of the Ashuanipi Complex have been brought up in the cores of antiforms, so that they outcrop as large elongate arches or chains of smaller, more equidimensional domes surrounded by the younger rocks of the Gagnon Group. It appears likely on structural grounds that these isolated bodies have become detached from the main mass of Archean gneisses by sole thrusts, and have then been deformed with the cover sequence, while the main mass of gneisses to the northwest remained as a relatively rigid body during deformation and metamorphism, and deformed inhomogeneously by localized shearing.

A penetrative foliation, S_1, axial planar to the F_1 folds was developed in most rocks of the Gagnon Group, and also in adjacent portions of the Ashuanipi Complex. This is the only penetrative foliation developed in Gagnon Group lithologies, and it is defined by the preferred orientation of biotite, muscovite and graphite in the schist units, hornblende in amphibolites, grunerite and specular hematite in iron formation, and tremolite in marble.

The second deformation is characterized by northeast trending, gently plunging folds with axial planes overturned towards the northwest. Folds of this orientation are commonly encountered in the field, and larger ones can also be mapped out in many locations. The S_1 foliation is folded around the F_2 folds, with no axial planar S_2 foliation developed. However, near contacts with the Ashuanipi Complex, an S_2 crenulation or strain slip cleavage is occasionally seen in schistose lithologies. Slides are developed locally parallel to axial surfaces of mesoscopic F_2 folds.

F_3 folds are upright, northwest trending structures which are rarely recognized in the field. They are, however, apparent from the map pattern, where they cause large changes in strike of lithological contacts, for instance, the Katsao/Wabush Formation contact around Wabush, Julienne and Shabogamo Lakes.

Lineations are encountered in most outcrops in the field. Throughout the map area their orientation is quite variable, but domains of consistent orientation can be visually delimited. Most of lineations are due to the intersection of S-planes or to mineral alignment, and it is likely that most were developed during the D_1 deformation.

CONTACT RELATIONSHIPS BETWEEN THE ASHUANIPI COMPLEX AND GAGNON GROUP

Several contacts between the Gagnon Group (Wabush and Nault Formations) and the Ashuanipi Complex have been observed in the field. In all cases where the Nault Formation was found in contact with the Archean rocks, evidence of mylonitization was seen and the contact is considered to be tectonic. Two types of contacts were observed between the Wabush Formation and the Ashuanipi Complex. Most are tectonic, with D_1 mylonite fabrics preserved as in the Nault Formation; the remainder, however, apparently reflect the original unconformable sedimentary contact. Typically though, rocks of both the Ashuanipi Complex and the Wabush Formation possess a well developed S_1 fabric, so that the contact cannot be said to be completely undisturbed.

METAMORPHISM

The presence of orthopyroxene in granitoid rocks of the Ashuanipi Complex indicates that metamorphism attained granulite grade during the Kenoran Orogeny

In the Gagnon Group metamorphic grade is variable, being in greenschist facies near the contact with the Ashuanipi Complex and rising to amphibolite facies in a southeasterly direction. Mapping the location of the greenschist/amphibolite facies boundary is hampered by lack of suitable lithologies bearing index assemblages.

Metamorphic textures indicate that the metamorphic peak was synchronous with D_1 deformation in the Gagnon Group, but it is not known if this event was part of the Hudsonian or Grenvillian Orogeny.

AGE OF THE SHABOGAMO GABBRO

The timing of intrusion of the gabbros and associated rocks is not well established. Fahrig (1967) suggested that they form part of the Elsonian event (*i.e.* approximately 1350 Ma, or Neohelikian), on the basis of a body that intrudes the Sims Formation to the northeast of the map area (see Ware, this volume). The Sims Formation lies unconformably on deformed rocks of the Labrador Trough, and the southerly outlier has been deformed into northeast trending folds during the Grenvillian Orogeny. The age of intrusion of the gabbro, and of the deposition of the Sims Formation for that matter, is thus bracketed by a maximum age of about 1735 Ma (the Hudsonian Orogeny) and a minimum age of about 1100 Ma (the Grenvillian Orogeny). Rivers (1978a, b) noted that certain bodies of Shabogamo Gabbro were emplaced prior to D_1 deformation, whereas for other emplacement post D_1 appeared likely. Thus, post-Hudsonian pre-Grenvillian emplacement is very likely and syn-Hudsonian emplacement is a possibility. It is hoped that the radiometric age dating programme presently in progress will shed some light on this problem.

ECONOMIC GEOLOGY

Iron deposits in the area are generally smaller than around Wabush Lake where mining is currently in progress. However, a large body at the northwest end of Wabush Lake may warrant further investigation. North of Julienne Lake, iron formation is extensively leached, resulting in "soft ore" textures, but there has been no subsequent secondary hematite enrichment.

Several small sulphide showings occur in the west of the map area. They are associated with quartz veins which have been fractured and subsequently mineralized by late hydrothermal solutions. Chlorite, pyrrhotite, pyrite and minor chalcopyrite are the predominant minerals in the altered zones. Several units, including the Katsao, Wabush and Nault Formations, host these showings, and their location near D_1 thrust faults suggests that the faults rather than lithology may have been a controlling factor in their formation.

Scintillometer readings were low along the contact between the Ashuanipi Complex and the Gagnon Group, as they were generally elsewhere in the region.

Acknowledgements: *We would like to thank Nath Noel, Kevin Goodyear and Steve Lavigueur for enthusiastic and competent assistance in the field. Expediting was efficiently organized by Wayne Tuttle in Goose Bay. Ashuanipi Aviation, Viking Helicopters and Laurentian Air Services provided dependable flying services. Discussions with Dick Wardle at various stages during the project have been of great benefit.*

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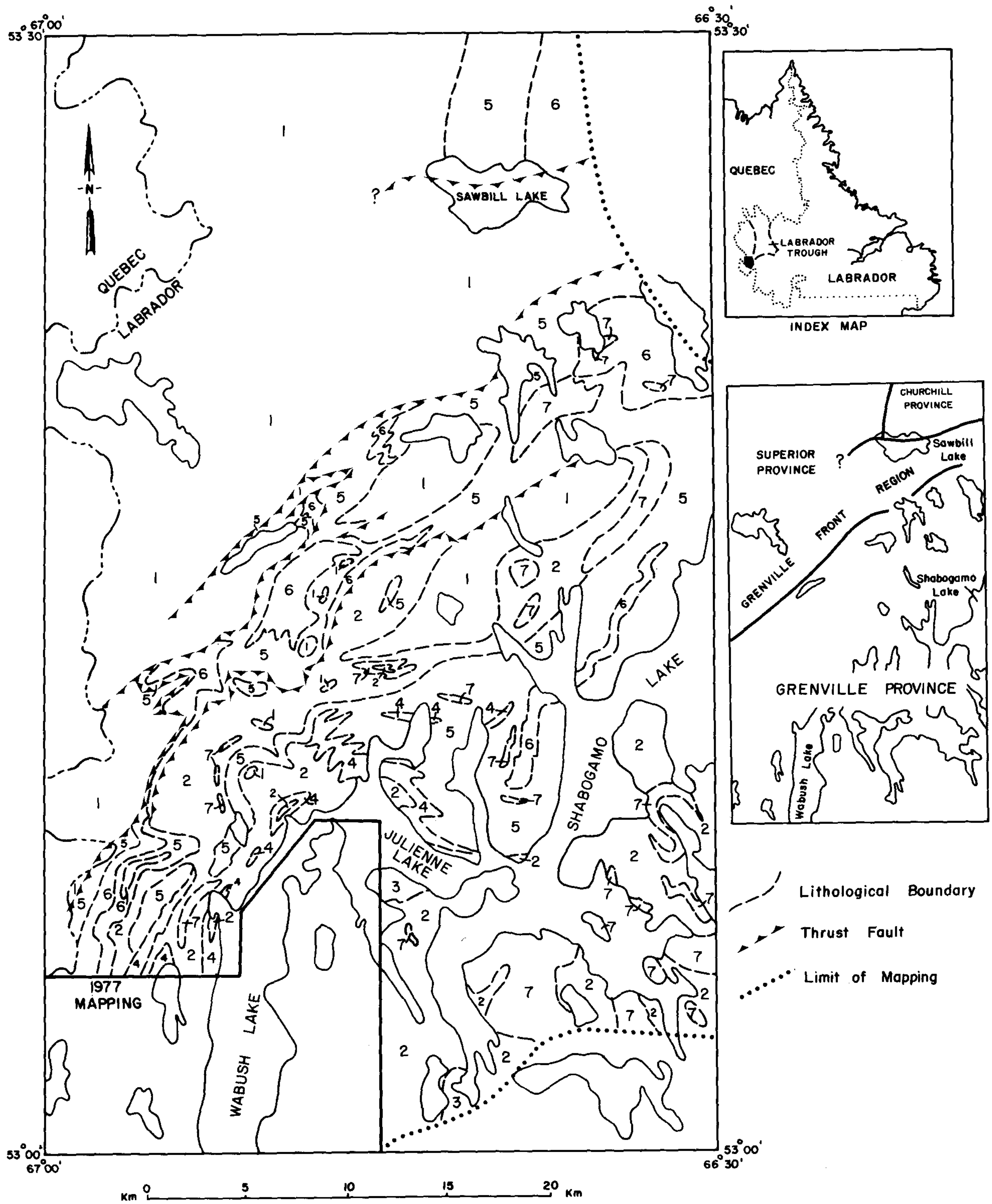

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LEGEND

APHEBIAN-HELIKIAN?

7	**Shabogamo Gabbro:** *Gabbro and associated rocks.*

Gagnon Group

6	**Nault Formation:** *Graphitic schist.*
5	**Wabush Formation:** *Iron formation, including silicate-carbonate and oxide varieties.*
4	**Wapussakatoo Formation:** *Quartzite.*

APHEBIAN

3	**Duley Formation:** *Dolomitic marble.*
2	**Katsao Formation:** *Quartzofeldspathic schists.*

ARCHEAN

1	**Ashuanipi Complex:** *Migmatite, including hypersthene bearing granite and diorite.*

Note: Units 5 and 6 north of Sawbill Lake are situated in the Churchill Province, where they are known as the Sokoman and Menihek Formations respectively and are part of the Knob Lake Group.