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GNEISS-ANORTHOSITE-GRANITE RELATIONSHIPS IN THE ANAKTALIK BROOK-KOGALUK RIVER AREA (NTS 14D/1, 8), LABRADOR

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ABSTRACT

Granulite and amphibolite facies gneisses of the Archean Nain Province and the Early Proterozoic Churchill Province are intruded by Middle Proterozoic plutons of gabbroid, intermediate and granitoid compositions. Contact aureoles are variably developed, the most widely recognized transformation being a pyroxene hornfels assemblage developed in a Churchill Province, granulite facies, garnetiferous gneiss south and east of Makhavinekh Lake. Gabbroic rocks occur as isolated rafts in younger rocks in the Kogaluk River area, but constitute a large coherent body in the northern half of the project area. Intermediate plutons form irregular intrusive bodies in anorthosite north of Trout Pond, but constitute a flat-lying sheet south of Makhavinekh Lake. Rapakivi granite forms an ovoidal, steep-walled, flat-topped pluton between Makhavinekh Lake and Anaktalik Brook. Field relationships suggest co-existence of gabbroid, intermediate and granitoid compositions. Minerals of economic importance are limited to isolated small occurrences of labradorite in the gabbroids, and graphitic and pyritic gossan zones in the metasedimentary rocks.

INTRODUCTION

The discovery in 1979 along the Quebec-Labrador border, approximately 100 km west of Nain, of a small 1.26 Ga pluton of peralkaline granite (Lac Brisson or Strange Lake pluton) unusually enriched in REE, zirconium and beryllium (Currie, 1985, Miller, 1985) has opened up the possibility that similar felsic rocks may occur within parts of the plutonic complexes of the Nain area, currently assigned to the 1.45 Ga Elsonian event. With the potential for such a discovery, a five-year project has been initiated to survey a corridor between coastal Labrador near Nain and the Quebec-Labrador boundary near the Strange Lake pluton (Figure 1). This project corridor is adjacent to a similar east-west transect of the plutonic complexes of central Labrador conducted by J. Hill between 1977-81 (Hill, 1982) in which the Flowers River peralkaline complex was discovered in 1973 (Collerson *et al.*, 1974).

Previous Work

The northern and southeastern parts of the 1985 project area were ground traversed by the late E.P. Wheeler during his pioneering investigations of the 'anorthosite-adamellite' suite of the Nain area, which began in 1926 (cf. Wheeler, 1955; 1974). The only other mapping in the project area is included in the 1:250,000 reconnaissance map of Taylor (1977).

Present Study

The current program aims at re-evaluating the plutonic rocks that occupy the southern half of NTS sheet 14D and the eastern fringe of 24A (Figure 1). The project corridor is well exposed in the east, but heavily covered by glacial overburden in the west. Mapping is being carried out with the aim of producing a final compilation sheet at 1:100,000 scale at the end of the project, and preliminary 1:50,000 maps in the spring following each field season. A preliminary 1:100,000 scale compilation map for the 1985 study area (Ryan and Lee, 1985) is presently available.

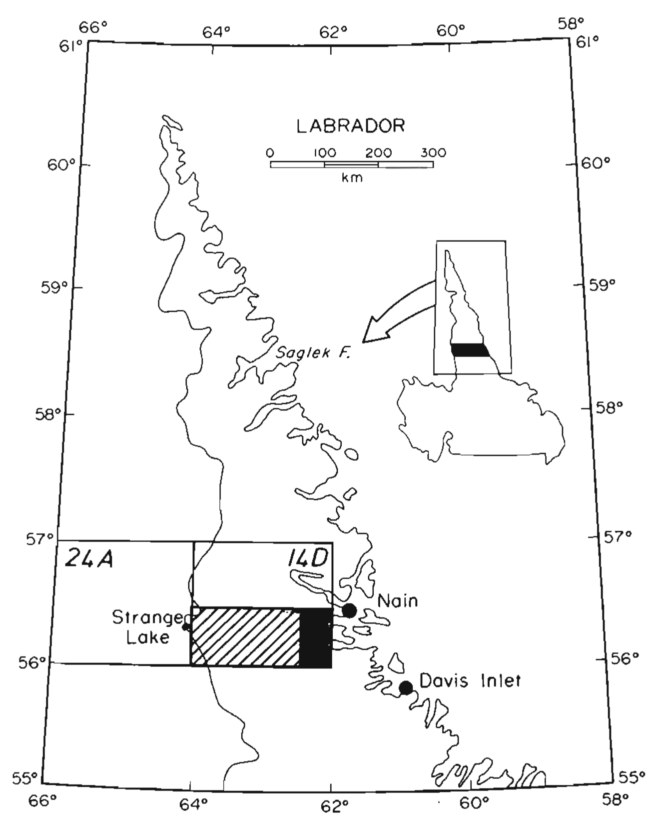

Figure 1: *Location of Nain-Strange Lake project corridor. Area outlined in black is shown in Figure 2.*

This project is a contribution to the Canada-Newfoundland Mineral Development Agreement, 1984-1989

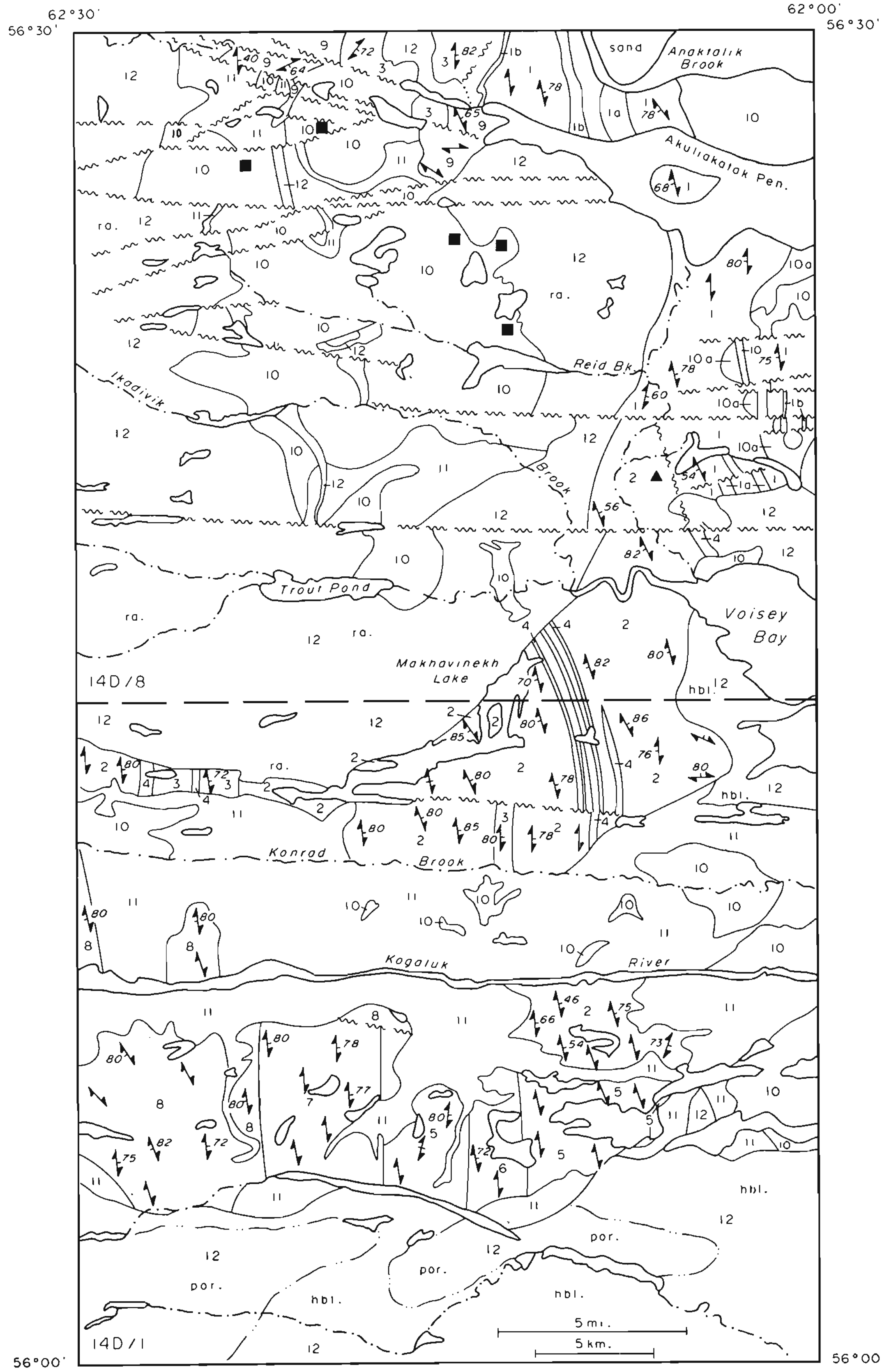

Figure 2: *Geological map of the Anaktalik Brook - Kogaluk River area (NTS 14D/1, 8), Labrador.*

LEGEND AND KEY

PROTEROZOIC

Intrusive Rocks

12 Granitic rocks; hbl. = hornblende+clinopyroxene+olivine quartz monzonite and related porphyry (por.); ra. = rapakivi granite.

11 Gabbro, monzogabbro, quartz monzonite.

10 Anorthosite-gabbro-troctolite; 10a, border zone ultramafic rocks.

ARCHEAN AND/OR PROTEROZOIC

Churchill Province

8 Undivided gneisses including augen gneiss and pink granitic gneiss.

6 White granitic gneiss.

4 Metasedimentary gneiss.

2 Garnet-quartz-feldspar gneiss (mylonitic).

9 Cordierite-rich granulite (paragranulite).

7 White, silicious, augen gneiss, locally garnet bearing.

5 Gray biotite gneiss.

3 Hypersthene tonalite gneiss.

ARCHEAN

Nain Province

1 Undivided, banded, gray gneiss and amphibolite, 1a, meta-anorthosite and metaleucogabbro; 1b, paragneiss and amphibolite.

Geological boundary : defined, assumed
Gneissic foliation : inclined, vertical

Faults:

Labradorite occurrence ■

Pyritic gossan ▲

An account of initial field investigations of the eastern part (14D/1, 8) of the project corridor is presented below. The map area comprises a variety of Archean and Lower Proterozoic gneisses that are intruded by middle Proterozoic plutons; the plutonic rocks range in composition from ultramafic to silicic. Narrow dikes of diabase post-date the plutons; these are rare and are not described here.

GENERAL GEOLOGY

Gneisses

Regionally metamorphosed rocks crop out along the northern and eastern fringes of 14D/8 and in the northern and central parts of 14D/1 (Figure 2). Following Taylor (1977), some of these gneisses are assigned as Archaean (Nain Province) and others as Lower Proterozoic (Churchill Province). These subdivisions are believed valid, based on comparison of the gneisses here with those of the Nain and Churchill provinces of northern Labrador, where age relationships are more clearly understood (Ryan *et al.*, 1983; 1984). The contact between the two provinces in the study area is obscured by expanses of glacial drift except along the northern fringe of the area (Ryan and Lee, 1985). There (west of Akuliakatak Peninsula) the contact corresponds with a small valley, assumed to be the trace of a fault, and separates a highland area of homogeneous enderbitic gneiss from a topographically lower area of amphibolite facies migmatite. The apparently sharp and narrow character of the junction in this region, however, is in strong contrast to that in northern Labrador where it is expressed as a broad zone marked by a major fault or series of faults containing fault gouge and breccia, and mylonite and pseudotachylite.

Nain Province (Archean) Gneisses. Metamorphic rocks considered to be Archean in age outcrop in an arcuate band stretching from Akuliakatak Peninsula southward to Voisey Bay (Figure 2). In many respects they resemble the early Archean rocks of northern Labrador (cf. Bridgwater *et al.*, 1975; Collerson and Bridgwater, 1979) but it is too early to make direct comparisons at this stage of investigation. They comprise a variety of quartzofeldspathic (granitic) gneisses containing mafic gneiss schlieren and pods, metasedimentary and mafic gneiss belts of supracrustal origin, and foliated meta-anorthosite and metagabbro.

By far the most abundant rocks of the Nain Province are gray to pink weathering, tonalitic to granitic, well banded gneisses believed to be of igneous parentage (Unit 1). In outcrop, these locally contain isolated inclusions of ultramafic, mafic and metasedimentary rocks, and more continuous (although also podiform) mafic layers (Plate 1). Previous investigations of similar gneiss terranes (Ryan *et al.*, 1983, 1984) suggest that these various inclusions and rectilinear mafic units have been derived from original rafts and dikes respectively in the igneous precursor to the gneisses. However, nowhere has any discordance been observed between the rectilinear units and a gneissic layering, which would substantiate the suggestion of the mafic units being originally dikes. Deformation has imparted a fabric to the gneisses which varies from a coarse banding to a finely laminated schistosity in straight belts; a good example of the latter is present on the eastern tip of the island south of the Akuliakatak Peninsula. The whole complex is migmatized by a network of granitic stringers and dikes, some of which are folded and synkinematic with the regional deformation, whereas others are planar and posttectonic.

Plate 1: *Nain Province gneisses. Gray, biotite gneiss (Unit 1), containing amphibolite layers probably derived from basic dikes; at least two generations of granitic veining is present. Coastal exposure north of Reid Brook.*

Interlayered with the quartzofeldspathic gneisses are supracrustal belts (subunit 1b) of layered mafic gneiss, metasedimentary gneiss, and meta-anorthosite (subunit 1a). Mafic gneisses (amphibolites and mafic granulites) are layered on a 1 cm to 10 cm scale, and are migmatized in a manner analogous to the surrounding gneisses. Layering is locally disrupted and rotated to varying degrees along discrete shear belts, which serve as avenues for the younger granitoid network. Metasedimentary rocks comprise rusty biotite-muscovite gneisses containing quartz-feldspar knots in the southernmost belts east of Reid Brook, and gray and pink magnetite-bearing quartzite, sillimanite-bearing psammite, and marble/calc-silicate rock in the northernmost belts on Akuliakatak Peninsula. White weathering metaleucogabbro and meta-anorthosite occur on Akuliakatak Peninsula and north of Voisey Bay. These form quite distinct units within the gneiss complex and, although strongly foliated and recrystallized, post-date all but the latest penetrative foliation in the gneisses. They contain rafts of the banded gneiss, rusty metasedimentary rocks and mafic gneisses. The fabric in the anorthositic rocks is simply a streaky discontinuous foliation defined by oriented hornblende (and orthopyroxene?); any layering present may reflect primary compositional variations, although no unequivocal primary structures were observed.

Metamorphic grade within rocks assigned to the Archean terrane varies from amphibolite to granulite facies. Observation of probable orthopyroxene cores in hornblende from some mafic units in the amphibolite facies areas, and similar cores in hornblende from metaleucogabbro on the Akuliakatak Peninsula, suggest that the whole complex is a variably retrogressed granulite terrane. Granulite facies rocks are best developed in a straight belt on the eastern tip of the island south of Akuliakatak Peninsula, where orthopyroxene is drawn out into parallelism with an intense, laminar, $S > L$ fabric.

Churchill Province (Lower Proterozoic) gneisses. Metamorphic rocks assigned to the Lower Proterozoic form a distinct assemblage, characterized in the southernmost block by a mylonitic fabric. The northern part of the Churchill Province comprises rusty 'paragranulites' which have no counterparts in the south.

There are gneisses east and west of Makhavinekh Lake (Figure 2) that represent the direct southern continuation of the eastern margin of the Churchill Province in the Nachvak-Hebron area of northernmost Labrador (Wardle, 1983; Ryan *et al.*, 1983, 1984). They comprise a distinctive, white weathering, garnetiferous, quartzofeldspathic gneiss (Unit 2) with rusty paragneiss belts (Unit 4), and a foliated hypersthene tonalite (enderbite) to enderbitic gneiss (Unit 3). The white garnetiferous gneiss unit (equivalent to the Tasiuyak gneiss of Wardle, 1983) is 20 km wide at Makhavinekh Lake; it is absent in the northern and southern parts of the area, apparently having been removed by a series of sinistral strike-slip faults prior to intrusion of the younger plutons. As in northern exposures, it is here characterized by lilac to dark-red garnets (replaced by cordierite + hypersthene in the contact aureole of younger plutons), and an anastomosing quartz + feldspar foliation of mylonitic character. It is locally characterized by a sillimanite-biotite assemblage (sillimanite is replaced by spinel and cordierite in thermal aureoles) in which garnet forms augen. The linear fabric so characteristic of the unit in the Nachvak-Hebron area is generally absent here (presumably due to recrystallization) but can be detected in a few areas. The eastern part of the unit contains abundant screens and schlieren of rusty, graphitic, metasedimentary gneiss. Several discrete, graphitic, garnetiferous, sillimanite-biotite-sulfide paragneiss units (Unit 4, Plate 2), up to 0.4 km wide, are outlined in Figure 2. In the western part of the unit, there is a paucity of rusty schlieren and the rock is chiefly a garnetiferous quartzofeldspathic rock with no aluminosilicate phase identifiable in the field. The unit locally contains non-garnetiferous, white weathering, siliceous granitic layers (impure metaquartzite?), and garnetiferous, allanite-bearing, white pegmatites.

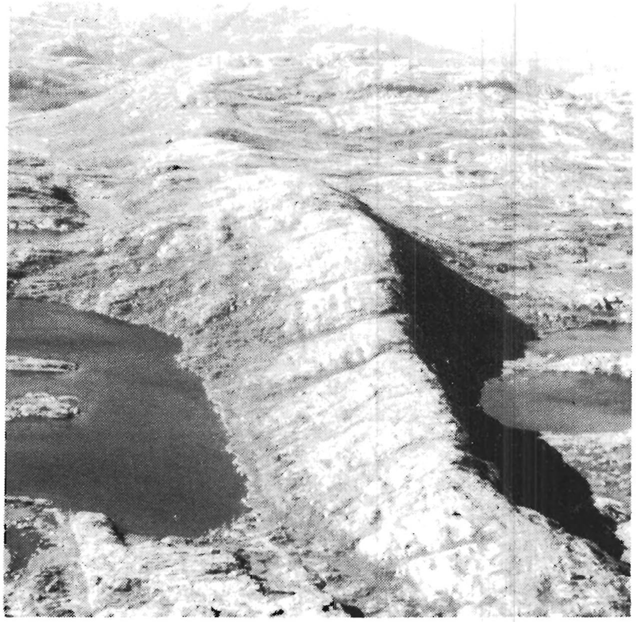

Plate 2: *Churchill Province gneisses. Spine of rusty, garnet-graphite paragneiss (Unit 4) rising above white garnet-quartz-feldspar gneiss (Unit 2), east of Makhavinekh Lake.*

Foliated enderbite (hypersthene tonalite) to enderbitic gneiss (Unit 3) forms several belts within the white, garnetiferous gneiss. These are characterized by fabrics that are defined by elongate, dark-brown orthopyroxenes and, to a lesser degree, a compositional banding.

An assemblage of gneissic rocks south of Konrad Brook appears for the most part, to be metamorphosed in the amphibolite facies and exhibits pervasive mylonitic foliations including localized ultramylonite zones. This assemblage is divided into several units (Figure 2) comprising, from west to east, a unit of mixed character, including pink granitic gneiss and augen gneiss (Unit 8), a white augen gneiss (Unit 7), and a gray biotite gneiss (Unit 5) containing rusty schlieren. Unit 5 is intruded by a white, siliceous, granitic gneiss (Unit 6).

The westernmost unit of mixed gneisses (Unit 8) is a variable package of rocks. It comprises well layered, migmatitic, gray gneiss and amphibolite, two varieties of granitic augen gneiss, and a pink granitic gneiss. The banded gneisses are gray, biotite-granodioritic gneisses and interbanded amphibolite, 4 m to 30 m wide, extensively injected by a white, granitic neosome that occurs as *lit-par-lit* masses and discordant vein networks. Within this migmatitic, gray gneiss/amphibolite association, there are isolated lenses of ultramafic rock and rusty garnetiferous biotite-rich gneiss of probable sedimentary parentage. The two varieties of augen gneiss are a gray, biotite-rich variety and a white, biotite-poor, garnetiferous variety, both derived from densely porphyritic granitic rocks. The gray unit is intrusive into the earlier banded-gneiss complex, and both are intruded by the white variety. The relationship of the pink granitic gneiss to the other members of this unit is unclear. This siliceous, pink weathering, mafic-poor granitoid is very homogeneous, and locally contains amphibolite inclusions.

A unit of white weathering, garnetiferous, granitic augen gneiss (Unit 7), probably representing a more extensive development of the white augen gneiss of the mixed unit, occupies a 5 km wide band south of the Kogaluk River (Figure 2). It locally contains numerous screens and schlieren of older, banded, biotite gneiss, rusty metasedimentary rock, and amphibolite. The fabric of this augen gneiss is an anastomosing, mylonitic type, culminating locally into narrow zones of ultramylonite.

Gray, migmatitic, biotite-rich gneiss containing rusty, sulfide-rich zones of probable metasedimentary origin, and minor amphibolite, constitute about one-third of the gneisses south of the Kogaluk River. This gneiss (Unit 5) is well layered, in places finely laminated, and commonly has white weathering granitic stringers parallel to the foliation. Garnet is locally replaced by cordierite + hypersthene. A white granitic gneiss (Unit 6) divides the biotite gneiss unit, and is a fairly homogeneous quartz-rich rock. It has discontinuous biotite foliae and scattered dark blebs, which appear to be biotite pseudomorphs of garnet.

Rusty weathering, granulite facies, cordierite-rich gneisses (Unit 9) form a distinctive unit along the northern fringe of the map area. These are different from the other Churchill Province gneisses, being rocks in which dark-blue, cordierite-bearing layers (2 to 10 cm wide) alternate with more massive hypersthene+quartz+feldspar layers. They also exhibit open folding and shallowly dipping layering. Berg and Wheeler (1976) reported the occurrence of the rare silicate osumilite from this unit, apparently a contact metamorphic mineral related to emplacement of the adjacent plutonic rocks.

Nain Igneous Suite

Anorogenic intrusive rocks of the study area are divided into three components, termed here the gabbroid plutons, the intermediate plutons, and the granitoid plutons.

Gabbroid plutons. The gabbroid plutons (Unit 10) encompass a wide variety of rocks which vary from olivine gabbronorites to anorthosite; gabbros are the most voluminous type. The gabbroids have three modes of occurrence in the map area, viz. as a core to an annular body of rapakivi granite north of Makhavinekh Lake, as part of a layered intrusion east of Reid Brook, and as inclusions of variable size in intermediate rocks south of the Kogulak River (Figure 2). Except for the layered intrusion, all the gabbroids seem to be correlative with the 'cumulate zone' as defined by Hill (1982) for plutons to the south. Textures vary from massive to diffusely layered, and from medium to very coarse grained (pegmatoidal), the latter grain size occurs especially in the anorthositic members. Labradorite schiller was noted in some of the anorthosites of this area, particularly in the northern pluton. Black olivine gabbro is widely developed east of Reid Brook, and forms a large inclusion in the granite east of Trout Pond. A similar dark-gray to black olivine gabbro, which occurs as part of the layered intrusion east of Reid Brook, is characterized by a radiating stellate growth of slender plagioclase crystals reminiscent of 'quench' textures (Plate 3). The other part of the intrusion is a well layered, orange-red weathering, troctolite and olivine norite (subunit 10a). The layered intrusion has a gently east-dipping (approximately 25°) contact against gneisses on its western margin, but is steeply dipping where the eastern contact was observed. The southern lobe has an antiformal shape; the olivine gabbro overlies the layered part. This intrusion may be younger than the other anorthositic rocks, and is probably equivalent to the Kiglapait intrusion and similar plutons in the area around and north of Nain.

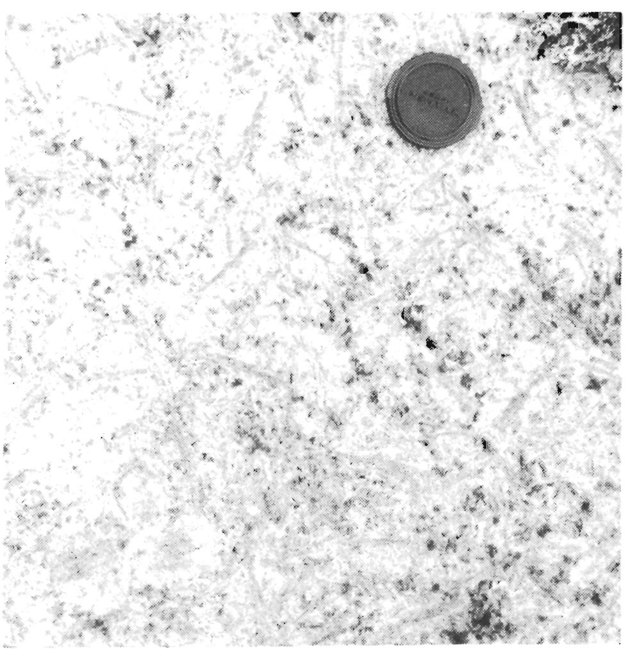

Plate 3: *Olivine gabbro. Stellate plagioclase growth in gabbro of layered intrusion (Unit 10) east of Reid Brook.*

Intermediate plutons. The intermediate plutons (Unit 11) comprise rocks which have a compositional range from hornblende-olivine-biotite gabbro to hornblende-clinopyroxene quartz monzonite. These rocks are best exposed and most widely developed in the region of Konrad Brook and the Kogaluk River; lesser amounts are present north of Trout Pond. They also temporally come between the gabbroid and the granitoid rocks (see below), but gradations with both the younger and older intrusions occur.

Rocks of intermediate composition are very conspicuous south of the Kogaluk River. They occur as chocolate-brown, crumbly weathering biotite gabbros and monzonites, which occupy a gently rolling plateau. Anorthosite inclusions stand out as rounded resistant knolls in contrast to the less resistant intermediate host rocks. Rare igneous layering indicates that the pluton forms an undulating, subhorizontal sheet, which consistently separates gabbroic anorthosite and Churchill Province gneisses. It is characterized by rafts of gabbroid, 1 m to 1 km long, in its interior portion (Plate 4). Texturally, the unit varies from massive subophitic with oikocrysts of clinopyroxene, to porphyritic with plagioclase and skeletal hornblende phenocrysts. Some of the 'porphyries' contain conspicuous dark-gray plagioclase 'phenocrysts'; these are in fact pseudoporphyries since the 'phenocrysts' are actually xenocrysts derived from fragmented anorthosite and leucogabbro, remnants of which are locally present in outcrop.

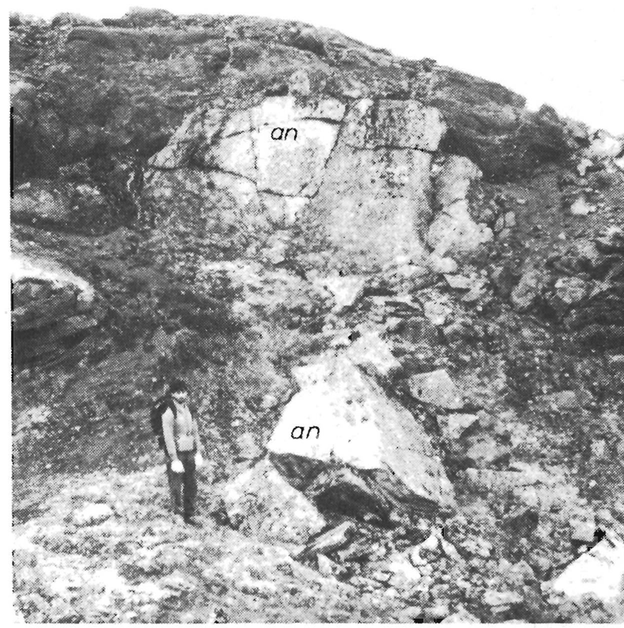

Plate 4: *Raft of anorthosite (Unit 10) in rusty gabbro (Unit 11), south of Konrad Brook.*

Several larger dikes emanate from the southern (lower) contact of the pluton into the gneisses (Figure 2). These dikes comprise an inner zone of medium to fine grained, quartz-bearing gabbro or diorite, and an outer zone of quartz-feldspar porphyry that exhibits an aphanitic chilled contact against the country rock. The dikes contain exotic inclusions of gabbroic anorthosite, and the adjacent gneiss.

The intermediate plutons north of Trout Pond have more restricted distribution than those to the south, and occur mostly as sheets within anorthosite. They do not exhibit to the same extent the crumbly weathering so characteristic of the southern exposures, and they also tend to be more porphyritic, in places containing 65 to 70 percent densely packed, subrounded, (alkali ?) feldspar phenocrysts in an opaque oxide, pyroxene (+ olivine?)-rich groundmass.

Granitoid plutons. The granitoid plutons (Unit 12) crop out in three separate areas: along the southern quarter of the study area, around Voisey Bay, and north of Makhavinekh Lake (Figure 2).

The southern belt of granitic rocks is the northward extension of a very large pluton outlined by Hill (1982), which extends a farther 50 km southward. The plutonic rocks of this area are predominantly medium grained, hypidiomorphic, fayalite-clinopyroxene-hornblende quartz monzonite and granite, including areas of quartz-feldspar porphyry and finer grained monzonite. The porphyry and fine grained monzonite appear to represent upper chilled phases that have been engulfed by the coarse grained granite.

Granitoid rocks around Voisey Bay are a similar, hypidiomorphic, pyroxene- and olivine-bearing quartz monzonite to granite. They are locally characterized by opalescent quartz, and are more biotite- and hornblende-rich than similar rocks to the south. Scattered ovoidal alkali-feldspar phenocrysts are present in some parts of this body.

The large elliptical pluton north of Makhavinekh Lake comprises predominently rapakivi granite containing ovoidal feldspar, granodiorite and quartz monzonite. Ovoidal alkali-feldspar phenocrysts, up to 5 cm in diameter, with zonally arranged mafic mineral inclusions and a plagioclase rim (Plate 5), occur throughout the pluton, but are more abundant in some areas than in others. Two phases can be identified in the field—a white to pink weathering phase resistant to weathering, and a brown crumbly phase that weathers very easily to a coarse grained grus in which the ovoidal feldspars remain as 'eggs'. Although not yet confirmed by petrography, the crumbly weathering rock appears to be an olivine-bearing phase. Locally, along the inner margins of the pluton where it forms a subhorizontal cap on anorthosite, there is a feldspar-rich phase in which abundant rounded feldspars are set in a dark, pyroxene-opaque oxide-rich groundmass. This densely porphyritic phase is mesoscopically identical to that associated with the intermediate sheets in this area.

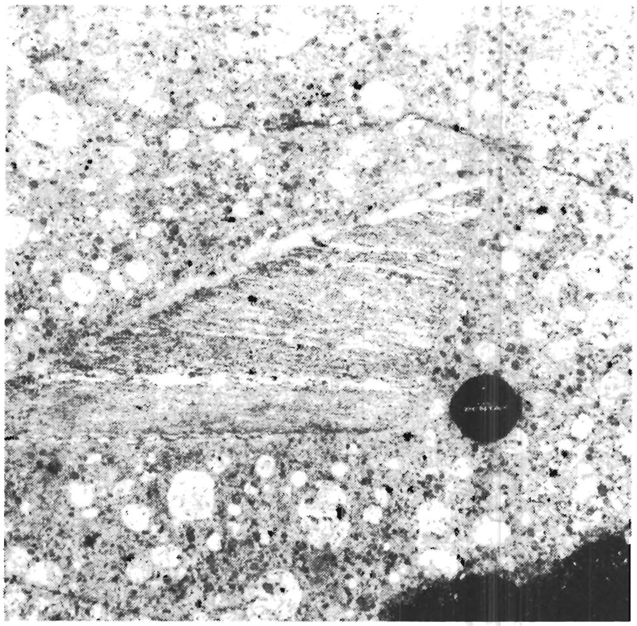

Plate 5: *Ovoidal feldspar in rapakivi granite (Unit 12) which contains gneiss inclusion, on north shore of Makhavinekh Lake.*

Contact Relationships of the Intrusive Rocks

An intrusive contact between the gabbroid plutons and Churchill Province gneisses south of Makhavinekh Lake has not been observed. In this area, the anorthositic and gabbroic rocks are separated from the surrounding gneisses by younger biotite gabbro and monzonite. The gabbroid pluton north of Trout Pond is separated from its Churchill Province country rock by rapakivi granite along most of its perimeter. However, in the north, there are several places where anorthositic gabbro is in close proximity to cordierite-rich granulite facies gneisses, and Wheeler (1974) indicates intrusive relationships between the two. Where observations have been made, there is a narrow fringe of brown gabbroic rock, like that in the intermediate plutons, separating the gneisses from the anorthositic pluton (see also Berg, 1980). These gabbros are characterized by fragments of anorthosite and variably digested cordierite-rich gneisses. Berg and Wheeler (1976) reported that these cordierite-rich granulites contain osumilite, a rather rare silicate which they concluded was generated by the contact effects resulting from the emplacement of the gabbroid pluton.

The layered intrusion east of Reid Brook has had no apparent effect on its Archean Nain Province country rock gneisses. Contacts are sharp and planar, and the olivine gabbro is chilled to a fine diabase adjacent to the gneisses.

The contact between the gabbro to monzonite pluton and the older rocks south of Makhavinekh Lake is exposed at several localities. Map pattern and topographic considerations (cf. Ryan and Lee, 1985) indicate that it is a subhorizontal sheet, the northern contact of which is the roof and the southern contact is the floor. The northern contact with the gneisses is usually sharp, with minor dike off-shoots. The pluton in this area varies from exhibiting little or no grain size reduction as the contact is approached to having a distinct chilled margin of diabase. The southern contact (floor) of the sheet, however, is characterized by a dark-gray quartz-feldspar porphyry, especially well developed in the western half of the body where large dikes of similar composition extend several kilometres from the sheet into the gneisses. Both the dikes and the main body have narrow, black, aphanitic, chilled rinds, which were partially peeled off and incorporated into the coarser grained gabbro-monzonite as magma intrusion progressed.

Observations from this area suggest that the intermediate sheet is the chief cause of contact metamorphism. It was noted that the white garnet-quartz-feldspar gneiss (Unit 2) displays well the contact effects, e.g., there is a progressive transformation of garnet to a cordierite + hypersthene symplectite, and of sillimanite to cordierite + spinel toward the sheet (Plate 6). Although the full extent of the contact aureole is not yet documented, field observations suggest that garnet is unstable at least 2 km away from the contact. This however may be an 'apparent thickness' due to the gently dipping nature of the sheet. As noted previously, the southern gabbro-monzonite pluton is intrusive into, and contains rafts of leucogabbro and anorthosite. Contact effects on these anorthositic rocks appear restricted to the transformation of original igneous pyroxene to a bright-green actinolitic amphibole.

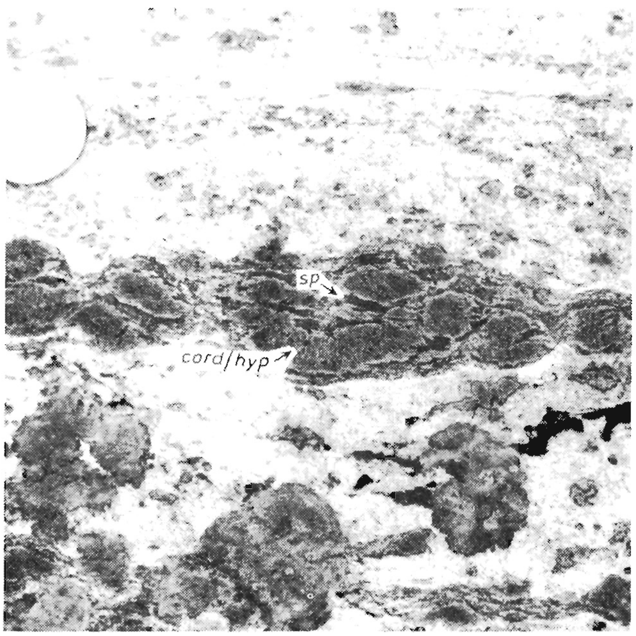

Plate 6: *Contact metamorphism of garnet-quartz-feldspar gneiss (Unit 2). Hypersthene + cordierite symplectic pseudomorphs of garnet, surrounded by darker spinel + cordierite pseudomorphs of sillimanite, south of Makhavinekh Lake.*

North of Trout Pond, the contact between the intermediate rocks and the Churchill Province gneisses is somewhat diffuse because the older rock is a rusty, schlieric, granoblastic, quartzofeldspathic granulite that superficially resembles the adjacent gabbros. The gneiss is cordierite bearing, and where digested by the gabbros, a cordierite restite is commonly preserved, giving rise to a cordierite-bearing igneous rock. Contact effects on the gneisses are not as easily defined here as they are to the south, but Berg and Wheeler (1976) and Berg (1980) document hypersthene+quartz+osumilite intergrowths in these gneisses adjacent to the gabbros, minerals which they attribute to thermal metamorphism.

The contact between the gabbro-monzonite (intermediate) plutons and the gabbroid rocks in the northern part of the map area exhibits somewhat ambiguous relationships. At their far northern exposures, the gabbros of the intermediate plutons are intrusive along the margins of the leucogabbroic and anorthositic rocks. However, some of the large dike-like bodies within the interior of the anorthosite pluton apparently have transitional contacts with gabbroic anorthosite over several metres and no discrete intrusive relationship can be demonstrated.

The granitoid plutons are the youngest major intrusive rocks in the area. They show few contact effects with the older rocks; the contact zone is usually an angular agmatite of older rocks pervaded by granite dikes. In several such zones, e.g., between rapakivi granite and gabbro in the north, and between rapakivi granite and black olivine gabbro east of Trout Pond, the dikes of granite are coarse grained and lack chilled margins, suggesting that the ambient temperature of the older rocks was similar to that of the granitoid magma at time of intrusion. It was observed, however, that 'bleached' zones occur in anorthosite in which plagioclase appears to be sericitized and the pyroxene is altered to amphibole adjacent to the rapakivi granite. Also, preliminary petrography suggests that the hypersthene+cordierite symplectites of the white garnet-quartz-feldspar gneiss are recrystallized to a biotite-garnet assemblage in the contact aureole of the granite in the southern part of the area.

The topographic distribution of the rapakivi granite-anorthosite contact north of Trout Pond (cf. Ryan and Lee, 1985), and observations of a gently dipping interface between the two, indicate that the granite forms a subhorizontal cap on the gabbroid pluton. The outer contact of the granite pluton was directly observed only west of Makhavinekh Lake, where the granite dips approximately 30° southward beneath the gneisses. Elsewhere there is a steep escarpment separating rapakivi granite on the highland from gneisses in the lowlands. A generally steeply dipping margin is suggested by the gently curved outline of the granite's outer contact, which contrasts sharply with the more irregular inner contact.

The contact between the intermediate plutons and the granites is usually an intrusive one. However, in some places in the north it appears gradational, exemplified by an increase in quartz and ovoid feldspar in the gabbroic to monzonitic rocks, which pass into rapakivi granite. This relationship is best displayed by some of the larger rapakivi granite dikes, which locally have border zones of either monzonite or hornblende gabbro.

In summary then, the field relationships between plutonic rocks indicate that the gabbroid plutons are intruded by the intermediate plutons, and both are intruded by the granitoid plutons. However, locally, there seems to be a gradation from anorthositic gabbros into the monzogabbros of the intermediate plutons, and a gradation from the intermediate plutons into rapikivi granite. These relationships suggest that three different magma batches co-existed, but underwent ordered crystallization to produce a temporal sequence, from oldest to youngest, of gabbroid plutons, intermediate plutons, and granitoid plutons.

The most profound contact effects resulting from emplacement of these magmas seems to be related to the intermediate plutons south of Makhavinekh Lake, marginal to which there is widespread transformation of country-rock mineralogy. Along the northern fringe of the area, however, it appears that the earlier gabbroid plutons were responsible for the contact metamorphism of a cordierite-rich gneiss unit.

MINERALIZATION

Gneissic rocks of the study area are locally characterized by rusty, sulfide-rich, lenses and discrete paragneiss belts several kilometers in length. These commonly contain 5 to 15 percent disseminated graphite and pyrite. Locally the gneisses contain discordant pegmatites and granite sheets of unknown affinity, which register up to 1300 cps on a GIS-4 scintillometer.

Anorthosite north of Trout Pond locally contains chatoyant plagioclase. The amounts noted to date are restricted to small (10 to 15 m^2) areas, and comprise randomly distributed crystals or crystal clusters in medium grained anorthosite or anorthositic gabbro. The color of individual crystals is a green or blue-green, including a zonation to a bronze variety. A black olivine gabbro dike in gneisses just east of Reid Brook displays a deeply weathered, orange-brown, sulfide gossan, a feature peculiar to this one area.

Granitic rocks lack any visible mineralization of economic interest, and show no anomalous radioactivity in regional scintillometer surveys. The only economically interesting mineral occurrence in these plutons is within a monzonite inclusion in rapakivi granite north of Reid Brook Pond. The inclusion contains globular concentrations of graphite up to 5 cm in diameter. This unusual feature seems to be a result of digestion of graphitic paragneiss by the monzonitic magma at depth, and the concentration of the graphitic restite into globlules before crystallization of the host.

SUMMARY

Field work during 1985 in the eastern part of the Nain-Strange Lake project corridor has outlined the distribution of gneisses of the Nain and Churchill provinces, defined the probable contact between the Nain and Churchill provinces, and subdivided the plutonic rocks of the Nain Igneous Suite into three regional-scale units. It has been demonstrated that a gabbro to monzonite pluton south of Makhavinekh Lake intrudes the earlier gneisses and anorthositic rocks as a subhorizontal sheet, and that rapakivi granite north of the lake forms a flat cap on a partially unroofed gabbroic pluton. Most of the contact metamorphic effects seen in the gneisses is attributed to emplacement of the intermediate plutons. Contact relationships indicate a temporal sequence of crystallization from gabbroic/anorthositic rocks to monzonitic/gabbroic rocks, and finally to granitic rocks. These relationships also suggest that all three magma associations may have co-existed at some point during their emplacement history. None of the granites are peralkaline, and potential for Strange Lake-type mineralization appears limited. The chief mineral of economic interest in the study area is labradorite, but the quantities outlined to date are not significant.

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