THE ARCHEAN-PROTEROZOIC BOUNDARY IN THE SAGLEK FIORD AREA, LABRADOR: REPORT 1[1]

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Abstract

The Aphebian Ramah Group in northern Labrador occupies the boundary zone between gneisses of the Archean (Kenoran deformed) Nain Province and gneisses of the lower Proterozoic (Hudsonian deformed) Churchill Province. The Nain Province displays few effects of lower Proterozoic thermotectonism, and the major lithological components identified by previous workers in the eastern Archean block are recognized throughout the area. The Ramah Group unconformably overlies the Archean complex; eastward transgression of the Hudsonian orogenic front has resulted in increased deformation and metamorphism of the Ramah southward from Saglek Fiord, and major thrust interleaving of basement and cover has occurred. Gneisses of the Churchill Province west of the Ramah Group are granulite facies rocks with mylonitic fabrics. Magnetite iron formation, graphite and copper sulphides occur in the area.

Introduction

The 1982 field season was the first of a two year project funded by the Federal Mineral Program in Newfoundland to examine the Nain-Churchill boundary zone in northern Labrador. The program involves 1:50 000 and 1:100 000 scale mapping of NTS sheets 14 L/2, 3, 4, 5, 6 and 7 (Fig. 41.1). The region lies within the southern part of the Torngat Mountains, where topography and exposure are ideal for documenting the character of the structural province boundary.

Ryan and Martineau were responsible for regional mapping. Associated participants Bridgwater and Schiøtte concentrated on specific problems in the Archean block arising from earlier mapping; Lewry examined part of the Ramah Group and its contact with adjacent gneisses.

Geological Setting

The survey area (Fig. 41.1) straddles the contact between the Nain Province in the east, an Archean block containing 3.6 Ga to 2.5 Ga gneisses and last deformed during the Kenoran Orogeny, and the Churchill Province in the west, an Aphebian mobile belt incorporating reworked Archean rocks and lower Proterozoic supracrustals last deformed during the Hudsonian Orogeny (Taylor, 1971). The Ramah Group, a variably deformed and metamorphosed Aphebian supracrustal sequence, occupies the central part of the map area, and records the easternmost influence of major Hudsonian thermotectonism.

Previous Work

The earliest geological studies in the region were those of Bell (1884), Daly (1902), Delebarre (1902), Coleman (1921) and Odell (1938). Geological mapping along the coastal strip was carried out by Christie (1952) and Douglas (1953). Major geological elements were defined only after regional scale mapping in the late 1960s and early 1970s (Taylor, 1969, 1970, 1971, 1979; Morgan, 1972, 1973, 1975).

In 1974 and 1975, a joint Geological Survey of Canada – Memorial University of Newfoundland party carried out detailed investigations of the geology of the eastern Archean block in the Saglek area (Bridgwater et al., 1975). This study defined and informally named major rock units, and established a relative age sequence of rocks and events involved in development of the complex. A concurrent Rb-Sr isotope study (Hurst et al., 1975) identified pre- 3.6 Ga components. It was established that the geological evolution of the Saglek area was similar to that of the Godthaabsfjord area of West Greenland (McGregor, 1973). Collerson and coworkers, between 1976 and 1978, continued detailed work on several aspects of the Archean complex of eastern Saglek Fiord, and further refined the chronology (cf. Collerson et al., 1976; Bridgwater and Collerson, 1976; Bridgwater et al., 1978; Collerson and Bridgwater, 1979; Kerr, 1980; Collerson et al., 1982).

Present Study

The current project involves geological mapping and economic mineral evaluation of the area west of that investigated in detail during the earlier GSC-MUN program, with particular emphasis on establishing the effects of the Hudsonian Orogeny on the Aphebian Ramah Group and its Archean basement along the eastern orogenic front. This report focuses on the Proterozoic rocks, and only salient features of Archean rocks not affected by penetrative Hudsonian deformation are documented here.

Nain Province

The Archean complex of the Nain Province comprises predominantly quartzofeldspathic gneisses, derived from intrusive protoliths interlayered with subordinate belts of supracrustal rocks derived from sedimentary and volcanic successions. The detailed work of Bridgwater et al. (1975) and by Collerson and his colleagues showed that the Archean block could be divided across the Handy fault into a largely amphibolite facies terrane in the east, and a largely granulite

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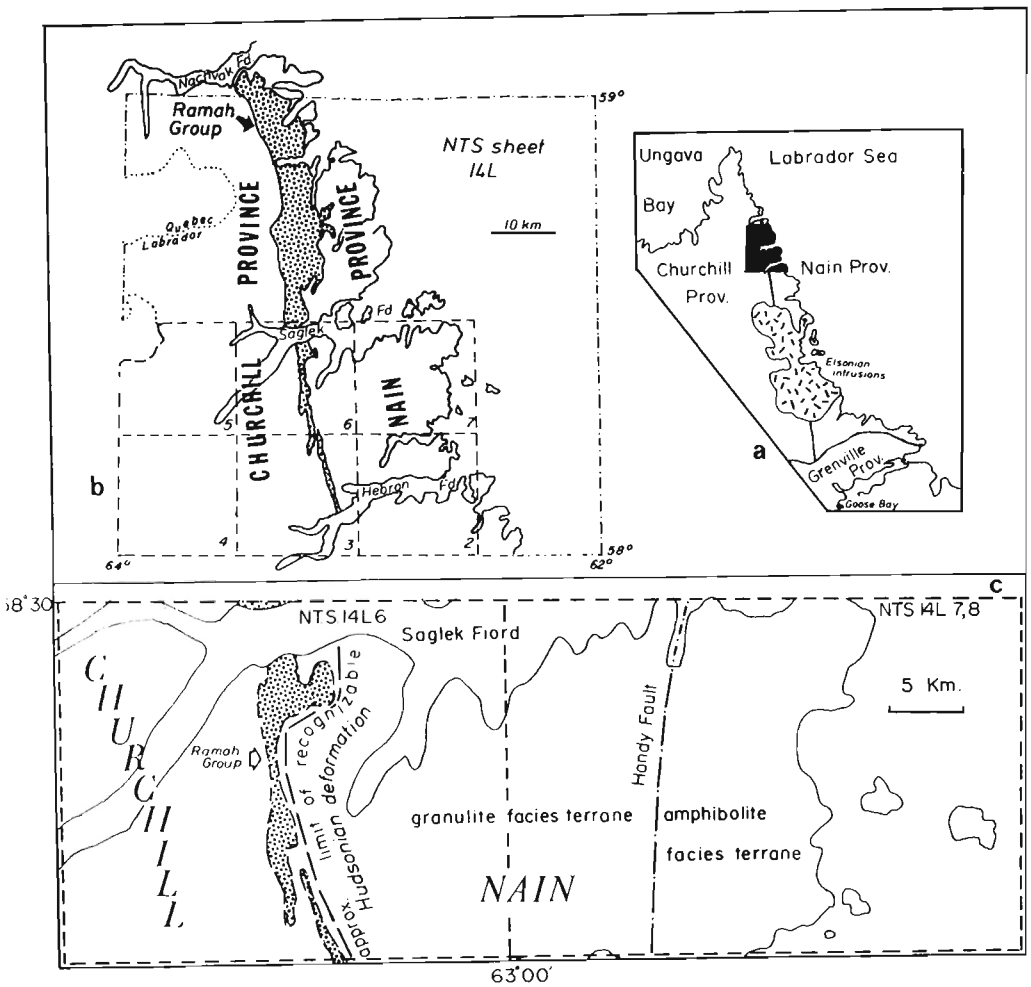


Figure 41.1

a. Sketch map showing the portion of Labrador covered by NTS sheet 14 L.

b. Outline of 14 L showing six 1:50 000 sheets to be covered during project.

c. Generalized subdivisions of regional geology in area of 1982 survey; in part after Bridgwater et al. (1975).

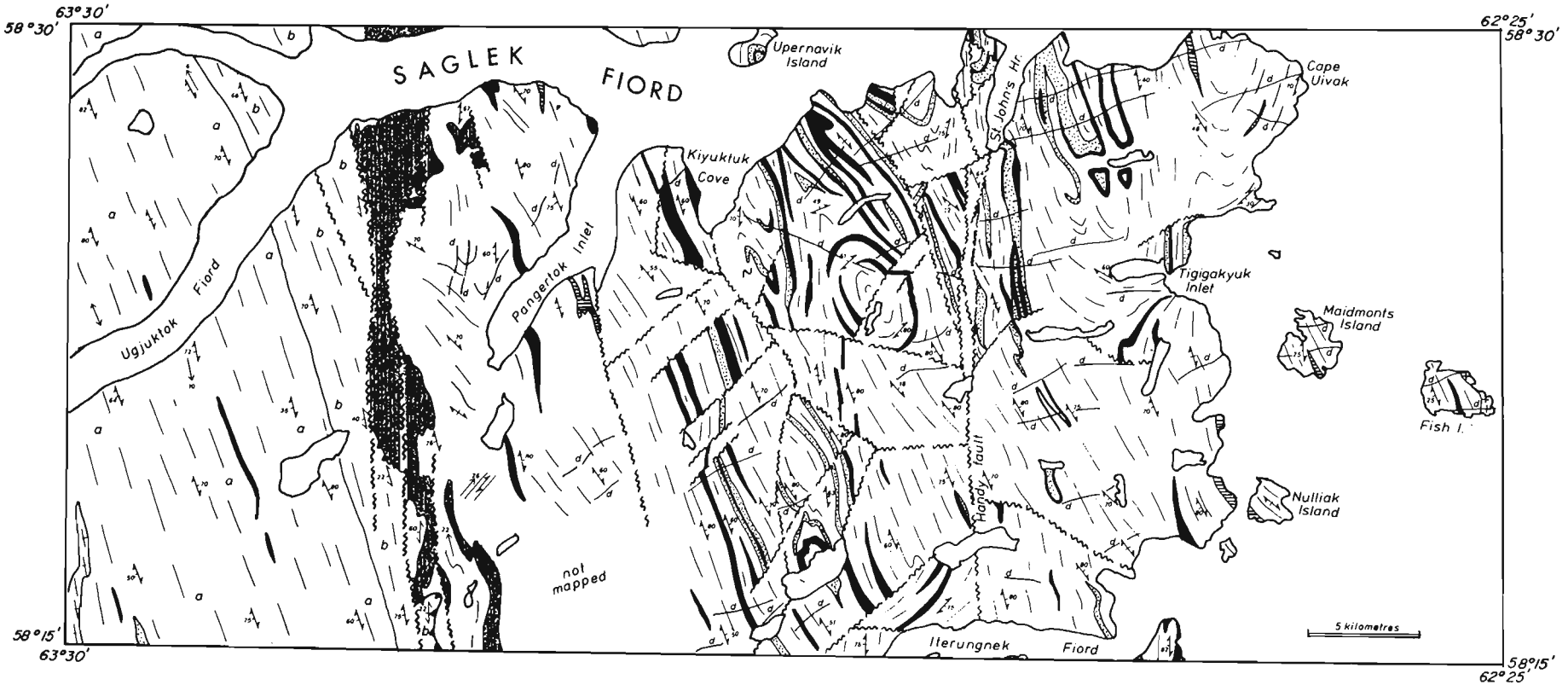
facies terrane in the west (Fig. 41.1, 41.2). Major rock units can be correlated on both sides of the fault, and the two terranes are interpreted to represent different structural levels of the same crustal components. Details of rock types are given by previous workers and only a generalized summary of chronology of the major stratigraphic units (Fig. 41.2) is presented here.

The earliest components are small (1-10 m^2 in area) rafts and belts (2 x 0.1 km) of basic intrusive and extrusive rocks, magnetite iron formation, calc-silicate rock and pelitic gneiss, known collectively as the Nulliak assemblage (Collerson and Bridgwater, 1979). These occur within a multiphase orthogneiss group (Uivak gneisses) comprising a grey migmatitic tonalitic to quartz monzonitic member (Uivak I) and a younger iron rich porphyritic (augen) granodioritic to dioritic member (Uivak II; Bridgwater et al., 1975). The Univak I suite was deformed and migmatized prior to the emplacment of the Uivak II augen gneiss. A major deformational and metamorphic/metasomatic event occurred circa 3.6 Ga which isotopically homogenized all rocks within the complex. This was followed by intrusion of a basic dyke swarm (Saglek dykes), and accumulation of a series of sedimentary, volcanic and basic intrusive rocks known as the Upernavik supracrustals (Bridgwater et al., 1975). Tectonic interleaving of the Uivak gneisses and Saglek dykes (Plate 41.1a) with the Upernavik supracrustals occurred circa 3.0 Ga giving rise to a regionally layered complex of paragneiss and orthogneiss. The complex was remobilized circa 2.8 Ga and the early orthogneisses were transformed into a heterogeneous suite ranging from Uivak gneiss with a local in situ irregular melt component, to lit-par-lit migmatites, to nebulites in which nearly all earlier features of the precursor are destroyed. The Upernavik supracrustal rocks were disrupted locally and injected by sheets of the mobilizate. Hurst et al. (1975) referred to these rocks as "undifferentiated gneisses". Recently Kerr (1980) and Collerson et al. (1982) have referred to this younger group of gneisses west of the Handy fault as the Kiyuktok gneisses. The reworking event appears to have been coeval with the granulite facies metamorphism, the effects of which have locally been nearly completely masked by later retrogression in the western block. Similar reworked gneisses in the southern part of the eastern (amphibolite facies) block, also showing evidence of having developed during a granulite grade event and having suffered subsequent retrogression, were earlier termed Iterungnek gneisses by Ryan (1977). These gneisses imply that rocks from deeper crustal levels are exposed to the south in the area east of the Handy fault.

In addition to the major lithostratigraphic units mentioned above, there are several types and generations of granitoid rocks.

The injection of regional diabase dyke swarms circa 2.3 Ga is the last major recognized event to affect the Archean complex prior to Aphebian erosion, uplift, and deposition of the Ramah Group. The dykes are conspicuous and abundant in the eastern half of the Nain Province in the study area, but become less abundant westward.

This year's mapping has shown that major rock units identified in the eastern Saglek Fiord area can be traced south and west within the Archean block (Fig. 41.2). Minor rafts and larger coherent belts of the Nulliak and Upernavik associations extend to the limits of the study area. One such belt of grey quartzite (interpreted as recrystallized chert),



LEGEND

CHURCHILL PROVINCE

Aphebian

Ramah Group: *Quartzite, dolostone/marble, black slate/pelitic schist.*

Archean and/or Aphebian

Quartz-feldspar-garnet-graphite gneiss; mafic and ultramafic granulite (black); garnet-sillimanite gneiss (dots); foliated granite (crosses).

Quartzofeldspathic and mafic granulite, mylonitized and retrogressed locally.

NAIN PROVINCE

Archean-Aphebian

Diabase dikes (many omitted for clarity).

Archean

Granite.

Upernavik Supracrustals: *Metasedimentary rocks (dots), metavolcanic and mafic/ultramafic intrusive rocks (black).*

Quartzofeldspathic Gneiss: *Uivak gneiss and its reworked and migmatized derivatives.*

Nulliak Assemblage: *Metasedimentary and mafic/ultramafic rocks.*

SYMBOLS

Geological boundary

Fault

Thrust

Trend of gneissic layering

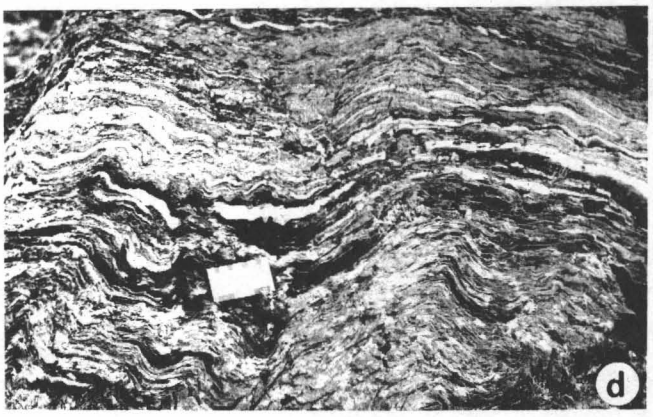
Gneissosity: inclined, vertical, dip unknown

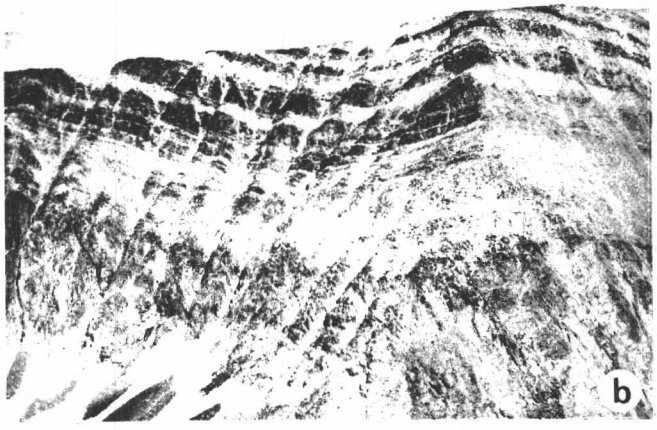
Mylonitic foliation: inclined

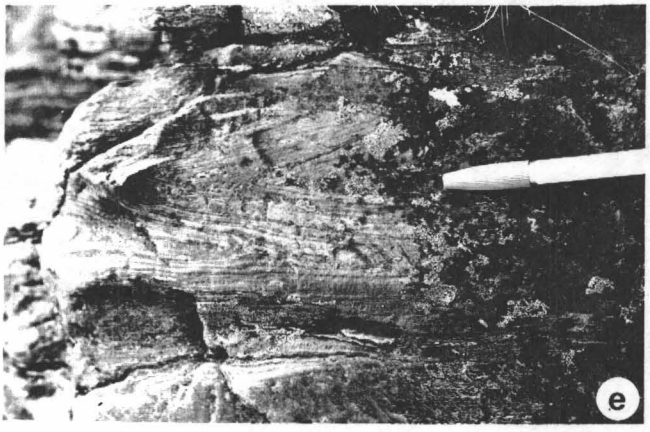
Lineation: inclined, horizontal

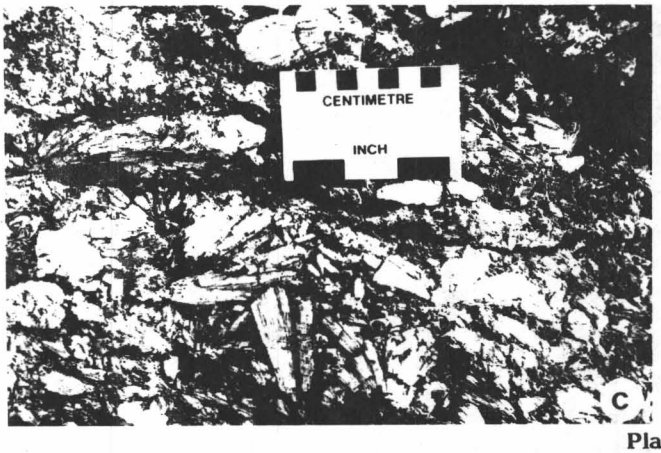
Figure 41.2. *Generalized lithological map for the area south of Saglek Fiord. The St. John's Harbour – Cape Uivak area and the coastal strip and off-shore islands between Tigigakyuk Inlet and Nulliak Island compiled from Collerson and Bridgwater (1979); area directly east of Kiyuktuk Cove after Kerr (1980).*

magnetite iron formation and calc-silicate rock of the Nulliak assemblage at Pangertok Inlet is one of the largest pre-Uivak supracrustal remnants found in this area. The belt of migmatites east of St. John's Harbour (not distinguished on Fig. 41.2), originally defined by Bridgwater et al. (1975), is more extensive to the south, and the granitic component forms discrete homogeneous masses and sheets in this area. In addition, we have found that the gneisses east of the Handy fault especially in the Iterungnek Fiord area show more widespread effects of the 2.8 Ma granulite facies event than previously recognized. Retrogression caused by intrusion of younger granites has destroyed nearly all vestiges of this high grade overprint. Much of the western granulite facies block comprises Kiyuktok gneisses, but zones of unreworked granulite facies Uivak gneisses also occur, particularly in the south. This granulite terrane is characterized by conspicuous, white weathering, late kinematic granite sheets (generally less than 0.5 km wide) parallel to the regional lithological layering.









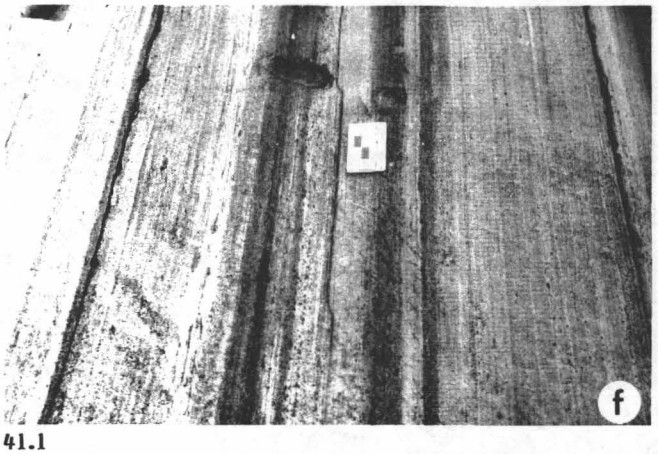


Plate 41.1

a. Migmatized Uivak gneiss and Saglek dykes, Maidmonts Island

b. Subhorizontal Ramah Group (Rowsell Harbour Formation) in unconformable contact with Archean gneiss, south shore of Saglek Fiord. Unconformity occurs at base of white quartzite unit in centre of photograph. Cliff face is approximately 300 m high

c. Radiating tremolite aggregates in marble, western margin of Ramah Group at Saglek Fiord

d. Refoliated gneiss adjacent to the Ramah Group, south of Pangertok Inlet

e. Isoclinal folds in Ramah Group quartzite, south of Pangertok Inlet

f. Quartz-feldspar-garnet-graphite gneiss, Ugjuktok Fiord.

Churchill Province

The Churchill Province is defined by the presence of rock types, isotopic ages, metamorphism, and structures resulting from the Hudsonian Orogeny. Its eastern boundary in northern Labrador was defined by Morgan (1975) as the eastern limit of the folded Aphebian Ramah Group. This definition is retained here, although present work indicates a Hudsonian thermotectonic overprint in the Archean foreland several kilometres east of the Ramah Group (Fig. 41.1c). Thus, in the study area, the Churchill Province comprises the Ramah Group, bounded to the west by granulite facies quartzofeldspathic gneiss and quartz-feldspar-garnet-graphite gneiss. The Ramah Group is affected by increasing deformation to the south and west; the western gneisses are typified by a north- to northwest-trending mylonitic fabric.

Hudsonian Effects in the Archean Foreland

Many faults and shear zones in the Archean block, including the Handy fault may in part be related to Hudsonian deformation (cf. Bridgwater et al., 1975). More obvious, however, are the effects which the Hudsonian tectonic overprint has had on the basement up to several kilometres east of the Ramah Group. The best markers of this are the late Archean diabase dykes which are converted into massive or foliated amphibolite near the more pronounced deformational front defined by the Ramah Group. In the vicinity of the latter south of Pangertok Inlet, both dykes and planar features in the basement gneisses are commonly rotated into parallelism with the sheared basement-cover contact. The extent of Hudsonian meta-morphic overprint on the structurally unreworked Archean gneisses where dykes are absent is ill-defined but much of the retrogression in the terrane immediately east of the Ramah Group may be of Proterozoic age.

Hudsonian effects on the Ramah Group

The Aphebian Ramah Group (Morgan, 1972, 1973, 1975; Knight, 1973) is best preserved north of Saglek Fiord, in a northerly-trending, doubly plunging synclinal belt up to 16 km wide, extending approximately 90 km from Saglek Fiord to Nachvak Fiord (Fig. 41.1b). Six formations are recognized in the Group (Knight and Morgan, 1977, 1981; Table 41.1). In this region the eastern boundary of the fold belt is little disturbed, and the group rests with profound unconformity on peneplaned Archean gneisses. The western boundary is faulted and overthrust, and metamorphic grade reaches amphibolite facies. Morgan (1975) recognized that the Ramah Group extended south of Saglek Fiord through the present study area as a narrower, increasingly tectonized and metamorphosed belt; he was able to trace it 35 km southward to Hebron.

In the north of the study area, along the south shore of Saglek Fiord (Fig. 41.3), the group comprises interbedded white and maroon quartzite, pelite and dolostone of the Rowsell Harbour and Reddick Bight formations, overlain by black slate of the Nullataktok Formation. Several diabase sills are present, one of which, in the Nullataktok Formation, is the highest stratigraphic unit preserved. The sequence is folded into open anticlines and tighter synclines. In the east it is autochthonous and lies unconformably on basement (Plate 41.1b). In the west it is fault-bounded and is in sheared contact with underlying Archean gneiss. Vertical and lateral changes in metamorphic grade are apparent along the fiord wall. Pelite of the Nullataktok Formation is represented by black slate at 600 m elevation, whereas pelite of the Rowsell Harbour Formation at sea level is muscovite-andalusite schist containing kyanite in quartz-feldspar segregations. Similarly, brown dolostone interbedded with quartzite at the top of the Reddick Bight Formation in the east is transformed to spectacular pale green tremolite marble in the west (Plate 41.1c).

Table 41.1

Summary of stratigraphy of the Ramah Group (from Knight and Morgan, 1981)

RAMAH GROUP Maximum measured thickness 1702 m	Cameron Brook Formation		200 m +	Greywacke – sandstones and mudstones.
	Typhoon Peak Formation		85-130 m	Slates; some sandstone and limestone.
	Warspite Formation		165 m	Dolomitic breccias and sandstones; dololutites; some limestone and calcareous mudstone; argillite, mudstone.
	Nullataktok Formation		595 m	Varicoloured mudstones and shales; graphitic pyritiferous; chert; pyrrhotite-pyrite unit; calcareous and dolomitic mudstones.
	Reddick Bight Formation		53-143 m	Black quartzite; grey muddy sandstone; sandstone-siltstone laminites; yellow weathering dolomite unit.
	Rowsell Harbour Formation 251-470 m	Upper White Quartzite Member	46-267 m	White quartzite; some conglomerate; interbedded shale and mudstone.
		Phyllite Member	15-44 m	Laminated purple mudstone and very fine grained sandstone.
		Purple Quartzite and Mudstone Member	75-157 m	Pink quartzite; alternating units of purple quartzite and purple mudstone; grey sandstone and shale.
		Volcanic Member	0-9 m	Altered tholeiitic basalt flow.
		Lower White Quartzite Member	31-97 m	Granitic wash; pebble conglomerate; white quartzite with heavy mineral laminae; white quartzite; pebbly, coarse grained sandstone.

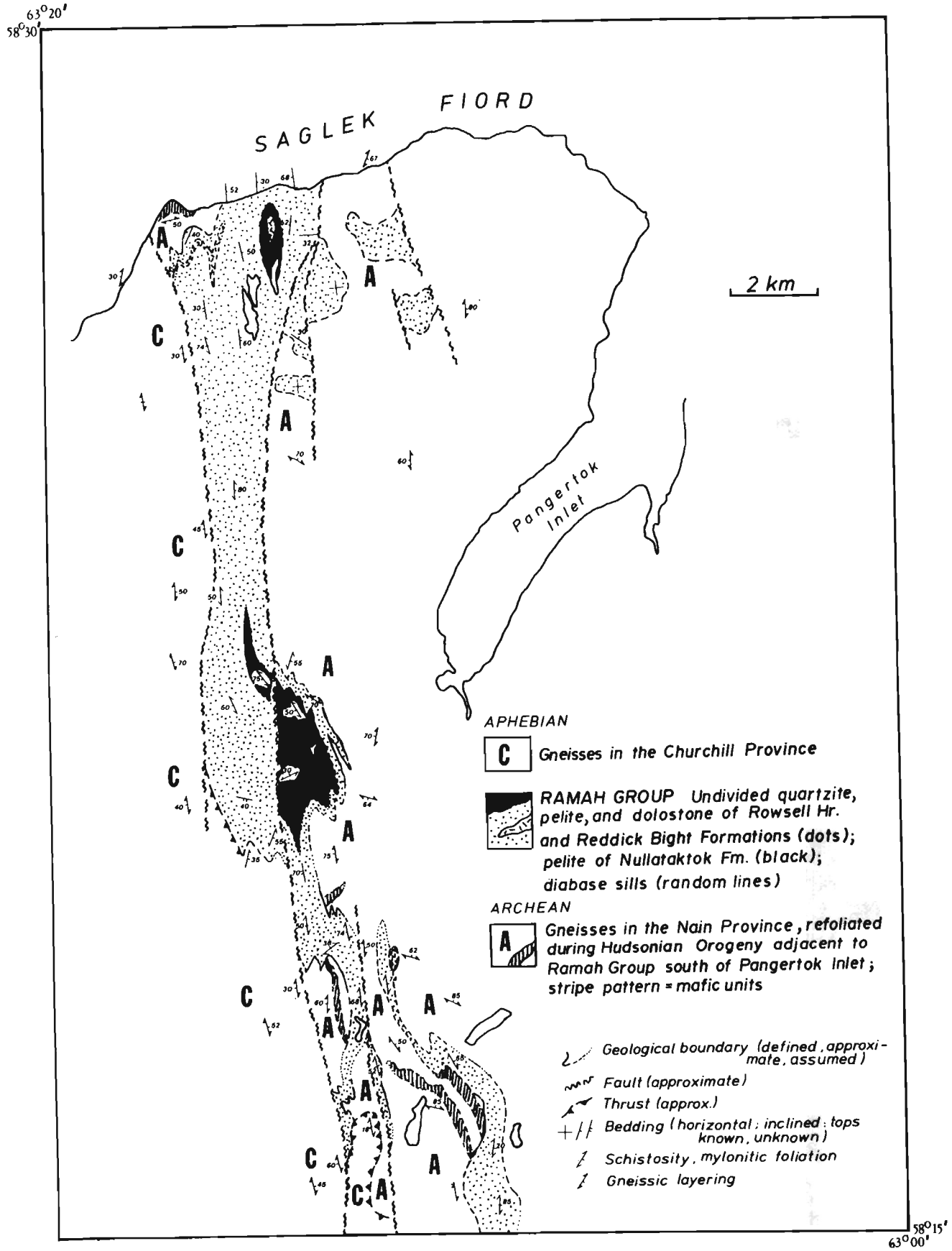


Figure 41.3. *Distribution of the Ramah Group in the map-area south of Saglek Fiord.*

Southward from Saglek Fiord, the Ramah Group narrows markedly in outcrop width, becomes entirely bounded by tectonic junctions, and is increasingly tightly folded and metamorphosed. Approximately 10 km south of the fiord it splits into two or more narrow belts, generally less than 1 km in width. Just north of this bifurcation, an extensive zone of black muscovite schist is thought to represent Nullataktok Formation; the quartzite sequence to the east is tectonically thinned, and the eastern contact is a décollement surface of basement-cover detachment. The western margin in this part of the belt varies from a steep reverse fault to a low angle westward-dipping thrust which has transported refoliated granulite facies gneisses over the Ramah Group.

Still farther south, the narrow belts of Ramah Group are entirely of white quartzite, muscovite schist and minor calc-silicate rocks (Rowsell Harbour Formation?). The configuration of the belts is a function both of thrust interleaving with basement and multiple folding. All contacts are tectonic; on both margins of the belts, recognizable Ramah Group is separated from basement gneisses by a zone of tectonic schist, phyllonite, and mylonite derived both from cover and basement (Plate 41.1d). Structural data indicate that early deformation involved thrust slice intercalation of mylonitically refoliated basement coeval with development of recumbent isoclinal folding and axial planar schistosity within the cover (Plate 41.1e). Both F_1 folds and basement slices are refolded by open to tight upright F_2 folds, and S_1 axial plane fabrics are crenulated. Further, post-F_2, thrusting is evident along the southern periphery of the area where a subhorizontal sheet of quartzofeldspathic and mafic gneiss overrides and truncates upright F_2 folds in the Ramah Group.

Gneisses of the Churchill Province

The zone immediately west of the Ramah Group comprises dark green to grey weathering, slightly retrogressed granulite facies quartzofeldspathic and subordinate mafic gneisses. These rocks commonly possess a mylonitic fabric, and pseudotachylyte vein networks related to later faulting occur locally. It is unclear at present whether the granulite facies parageneses are Archean or Proterozoic in age. Morgan (1975) interpreted numerous discordant amphibolites in this unit north of Saglek Fiord as metamorphic equivalents of the late Archean dykes east of the Ramah Group. If this is so, then the character of the gneisses probably results from an Archean granulite event, overprinted by a Hudsonian amphibolite facies metamorphism.

The westernmost part of the map area comprises a rather uniform, white weathering, quartz-feldspar-garnet-graphite gneiss (Plate 41.1f) of uncertain derivation. Mesoscopically the gneiss has an apparently medium grained granitoid texture, with local coarse pegmatoid zones; however, mineral subdomains are polycrystalline and the rock in fact has a blastomylonitic fabric. Locally, lenticular grey quartz subdomains parallelling this fabric are slightly oblique to the compositional layering. A pronounced mineral rodding plunging gently (2-10°) north and south is evident throughout the unit. Two phases of garnet growth, predating and postdating the main tectonic fabric, are evident.

The contact of the white granitoid gneiss with granulite gneisses to the east is largely modified by faulting, but locally the contact is marked by a zone in which thin (1 m or less) sheets of the quartz-feldspar-garnet-graphite gneiss occur within the granulites with an apparently intrusive relationship. Subordinate metasedimentary and mafic granulite rafts occurring locally within the granitoid gneiss also display small-scale intrusion by white granitoid neosome.

Morgan (1975) interpreted the western leucocratic granitoid gneiss as paragneiss. However, the inclusion of discrete paleosomal metasedimentary rafts, contact relations with the granulite gneisses to the east, rather uniform character over large areas, and apparent coarse grained premylonitic relict granitoid textures suggest that this unit is predominantly magmatic in origin. Mineralogically it resembles granitoid segregations and intrusive bodies found in granulite facies paragneisses in the Archean block to the east. It is, therefore, suggested that this unit is a diatexite representing an advanced stage of anatexis of metasediments under granulite facies conditions. However, the age of the metasedimentary paleosome and extent of migration of the mobile mass is unknown.

Economic Geology

The Archean layered quartzite-magnetite iron formation documented by exploration companies in the 1950s and 1960s (Brinex, 1960; Schlobohm, 1958) has a limited distribution. The best zones are found on the southeast shore of Pangertok Inlet on Saglek Fiord where a belt of calc-silicate rocks and grey quartzite (recrystallized chert?) of the Nulliak assemblage locally contains 1-3 m bands of quartzite with 70-80 per cent magnetite. Several other iron formations occur in this area, but none appear economically viable.

A graphite occurrence described from the white granitoid gneiss of inner Saglek Fiord by H.S. MacLean (in Douglas, 1953) could not be located. However, coarse graphite, with a similar mode of occurrence to that described from the prospect, has been observed by us in this part of the survey area.

A scintillometer ("total count" BGS-1L) survey proved unrewarding, with 4000 cps from gneisses at Pangertok Inlet being the highest reading recorded. This is only 8-10 times normal background for this area.

Minor sulphide mineralization occurs on the south wall of Saglek Fiord, where a gabbro sill has intruded black slate of the Nullataktok Formation of the Ramah Group. The slate locally contains 2-5 per cent disseminated pyrite, pyrrhotite and chalcopyrite. A scintillometer survey of the Ramah/basement contact did not reveal any anomalous radioactivity.

Summary

The major Archean rock units identified by earlier mapping in the Nain Province of the Saglek area have been traced southward and westward. The Hudsonian front swings eastward south of Saglek Fiord, transgressing the Ramah Group and giving rise to a complex zone of southward-increasing deformation and metamorphism, but the extent of Hudsonian overprint on the Archean terrane of the Nain Province has not been fully defined. The area has several small mineral occurrences.

Acknowledgments

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