70-61

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 70-61

GEOLOGY OF HENIK LAKES (EAST HALF) AND FERGUSON LAKE (EAST HALF) MAP-AREAS, DISTRICT OF KEEWATIN

(Report, 15 figures and Map 15-1970, Map 16-1970)

R. T. Bell
(with a contribution by J. L. Talbot)

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ABSTRACT

The general geology of Henik Lakes (east half) and Ferguson Lake (east half) map-areas is summarized. The map-areas transect a tract of moderately well preserved Archean volcanic, sedimentary and plutonic rocks that form a small subprovince within the Churchill (Structural) Province. This subprovince is bounded to the north and to the south by gneisses derived chiefly, if not entirely, from Archean rocks by moderate to intense metamorphism and migmatization during Hudsonian Orogeny.

A small synclinorium of Aphebian rocks is present near Padlei. These rocks comprise a lower unit of pyritic submature arenites and conglomerates, and an upper unit, the Hurwitz Group, typified by quartzites. The lower unit is favourable for exploration for uraniferous placer deposits.

RÉSUMÉ

L'auteur donne un aperçu général de la géologie des régions cartographiques des lacs Henik (moitié est) et du lac Ferguson (moitié est). Les régions traversent un secteur de roches volcaniques, plutoniques et sédimentaires assez bien conservées d'âge archéen, qui forment une petite sous-province de la province de Churchill (structurale). La sous-province est bordée au nord et au sud par des gneiss provenant principalement, sinon intégralement, des roches archéennes modérément à fortement métamorphisées et migmatisées durant l'orogenèse hudsonienne.

Il existe un petit synclinorium de roches aphébiennes non loin de Padlei. Les roches comprennent une unité inférieure d'arénites pyritiques et de conglomérats incomplètement évolués et une unité supérieure, le groupe d'Hurwitz, caractérisée par des quartzites. L'unité inférieure semble propice à la recherche de placers uranifères.

GEOLOGY OF HENIK LAKES (EAST HALF) AND FERGUSON LAKE (EAST HALF) MAP-AREAS, DISTRICT OF KEEWATIN

INTRODUCTION

The map-areas lie between latitudes 61°00N and 63°00N and longitudes 96°00W and 97°00W in the District of Keewatin with centre of the two areas about 250 miles north of Churchill, Manitoba and are within much larger regions mapped by Lord (1953) and Wright (1955, 1967) and are adjacent to those mapped by Eade (1964) and Davidson (1968, 1970 a, b, c). Progress reports on the bedrock geology of Henik Lakes (east half) and Ferguson Lake (east half) and portions thereof (Bell, 1969b, and 1970b) summarize the present work. The surficial geology has been discussed by Lee (1959) and Wright (1967).

Ninety per cent of the land is normally free of snow cover by mid-June and in exceptional years by the end of May. The larger lakes are ice covered until early to mid-July. Float-equipped aircraft may land in late June near Padlei where Maguse River causes early disappearance of ice. Access by float-plane is limited by the shallow and bouldery nature of most small lakes and considerable parts of the larges lakes.

For the most part relief is low and rolling, but quartzites of the Hurwitz Group produce some high ridges. Outcrop distribution is shown in Figures 1 and 2. Scattered groves of black spruce and tamarack occur in the southern sheet. A few low spruce shrubs (6 to 12 inches) were observed just north of Kogtok River. The remainder of the area is typical of the barren lands.

Supply bases for this area are Churchill, Manitoba where aircraft services are available, and Eskimo Point, Rankin Inlet, Whale Cove, and Baker Lake, in the District of Keewatin, where food may be purchased. It is possible but impracticable to gain access to the area by canoe from Hudson Bay via McConnell, Maguse, and Ferguson Rivers.

From late May to late August, 1968, the area was studied by foot and boat traverses with some air support. A Bell 47-G2A helicopter was utilized from mid-June to mid-July in outlining the main bedrock geology and in positioning traversing crews. From late July to late August a Cessna 185 was used occasionally to position traversing crews and to obtain mail and supplies. Traverse distribution is shown on Figures 3 and 4.

Most equipment and all fuel were positioned in March 1968 by a ski-equipped DC-3 aircraft. The crew and initial food supplies were positioned by De Havilland Otter on skis; the crew, samples and equipment were depositioned to Churchill, Manitoba by Otter on floats.

The writer was ably assisted by Professor J. L. Talbot of Lakehead University, Thunder Bay, Ontario whose report on aspects of the structure of the area and some of the implications of the present method of study forms

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part of this paper. Field assistants were R.K. Anderson, J.W.E. Lau, T.M. Robertson, and B.C. Wilson. The author gratefully acknowledges critical and constructive comments, information, and encouragement from A. Davidson, K.E. Eade, W.W. Heywood, and G.M. Wright of the Geological Survey of Canada.

The competent services of the aircrews and their companies (TransAir Ltd., Winnipeg, Manitoba; Lambair Ltd., The Pas, Manitoba; and Athabaska Airways, Prince Albert, Saskatchewan are gratefully acknowledged.

GENERAL GEOLOGY

The map-areas lie within the Churchill (Structural) Province (Stockwell, 1964) of the Canadian Shield and transect a portion of moderately well preserved Archean rocks (part of the Hudson protocontinent (Goodwin, 1968)). Undoubted early Proterozoic rocks of the Hurwitz Group occur near Padlei where metamorphic effects of the Hudsonian Orogeny are weak. The northern two thirds of the Ferguson Lakes map-area and the southern half of the Henik Lakes map-area have been moderately to severely altered during the Hudsonian Orogeny.

The area has tentatively been divided into four regions (A, B, C, and D; Fig. 5) on the bases of structural style, and lithologic and metamorphic features.

Region A, an area of very poor exposure in the south half of the Henik Lakes map-area is typified by leucocratic gneisses, greenstones, and biotite and amphibole schists and gneisses and by large dioritic and granitic plutons. All rocks save some granitic pultons have a moderate to strong foliation.

Region B lies north of A and appears to be separated from it by an east-striking shear zone across which the metamorphic grade drops sharply. Region B is underlain by a deformed assemblage of volcanic and sedimentary rocks that have been designated the Kaminak Group (Davidson,1970b). These rocks are intruded by plutons ranging from leucogabbro through diorites to adamellites of Archean age. These rocks are overlain by Aphebian sedimentary rocks in the Padlei belt (Fig. 5). Metamorphic grade is low and the dominant structural trend is northeasterly.

Region C lies northeasterly of B and the boundary is gradational; diorites and adamellites become foliate, greenstones become amphibolitic and quartzofeldspathic schists and greywackes become cordierite-andalusite-biotite schist and biotite-feldspar schists and gneisses. In the east the structural trend is northeasterly, but becomes more complex in the west. Small granite plutons of Archean and/or Aphebian age are scattered throughout region C. Region C, where migmatization has not been pervasive and where the stratigraphic framework is only moderately disrupted and can be considered an intermediate zone between B and D.

Region D is underlain by gneiss complexes apparently derived largely from rocks similar to the Archean rocks of regions B and C. New granitic material is restricted to sheets and dykes. In general the structural trend is northeasterly to easterly and very steeply dipping.

STRATIGRAPHY

The following discussion relates chiefly to units in regions B and C where the stratigraphic framework is relatively intact and the rocks are the least altered. Gneissic units characteristic of area D are discussed in the succeeding section on metamorphism.

Archean

Kaminak Group (Av, Af, Am, As, Avs, Amg, Av', Avn, Am', Amn, As', Asn)

Volcanic (Av, Af, Am) and sedimentary (As) rocks are the oldest units in the map-areas. Davidson (1970b) has proposed the name Kaminak Group for those rocks immediately east of the Ferguson Lake map-area. Eade (1964) mapped the volcanic and sedimentary correlatives of these as map-units 1 and 2 respectively in the area immediately west of the Henik Lake (east half) map-area.

Massive or pillowed, greenish grey, fine-grained andesitic flows are the most abundant rock type in map-unit Av (Fig. 6). Locally felsic and siliceous volcanic flows and tuffs and quartz and quartz-feldspar porphyries are mappable as distinct units (Af). In contrast, some volcanic terrains are characterized by metagabbro flows and/or sills and dark green massive to pillowed mafic volcanics (Am, Amg). Elsewhere the volcanic rocks are undivided (Av).

Where the greenstones grade into amphibolitic and biotitic schists and gneisses, commonly with preserved primary structures, the metavolcanics are designated Av' and Am'. In the higher grade regions A and D, layered mafic schist and gneiss and amphibolites are designated Avn and Avm. These latter have undergone severe recrystallization and rarely show relict primary structures. Minor structures such as pillows and vesicles are still evident, however, in the schists and gneisses (Avn) on McConnell River.

Weakly metamorphosed greywacke, conglomerate, phyllite, argillite, and minor iron-formation and tuff or tuffaceous greywacke characterize the sedimentary portion of the Kaminak Group. These rocks are best exposed southwest of Padlei where the northern (younger ?) portion is typified by fine-grained sediments and lean iron-formation and the southern portion grades southwards into coarse tuffaceous greywackes and tuffs and is intercalated with volcanic flows. Minor thin (5 feet to 200 feet) zones of greywacke occur within the volcanic terrain (Avs).

Biotite schist and fine-grained pink and grey leucogneiss and migmatite (As', Asn, 7) in the centre of the Ferguson Lake map-area (east half) can be traced eastward into the adjacent Kaminak Lake map-area where in turn they grade eastwards into relatively nonmetamorphosed sedimentary rocks of the Kaminak Group. The metamorphism of these rocks is largely Hudsonian.

Archean Intrusive Rocks (1, 2, 3, and 5 (?))

Plutons and plutonic complexes are widespread. Leucocratic metagabbro and diorite (1) are the oldest intrusive rocks in the area and cut the Kaminak Group. These are cut by grey and greensih grey tonalite and granodiorite (2). Both these units commonly have contact zones of agmatite with the volcanic rocks they intrude. The southern margin of the main diorite pluton just north of the Padlei belt best illustrates this; in contrast the northern and eastern margins are sharp.

Pink, commonly porphyritic adamellite and minor pink granodiorite (3) represent the third phase of Archean plutonism. Units in contact with the adamellites are commonly cut by pink, fine-grained dykes of similar composition. The adamellite batholith (Maguse Batholith, Fig. 5) north of Padlei has been tentatively dated as late Archean using zircons (Wanless, pers. comm.). This is consistent with the interpretation of similar plutons in adjacent areas (Davidson, 1970b; Wanless, pers. comm.).

In the east-central portion of the Henik Lakes map-area pink granodiorites (3b) typifies this unit. A more granitic phase (3a) of adamellite (K-feldspar/total feldspar = .45) that is nonporphyritic and remarkably uniform typifies the Corbett Batholith (Fig. 5). The northern contact of this batholith is marked by a zone of lit-par-lit gneisses (7) that grade northwards into biotite schists (As') apparently derived from sediments of the Kaminak Group. It was earlier suggested (Bell, 1969b) that the Corbett Batholith was Archean, but in the light of its relatively unaltered condition (i.e. massive, not recrystallized), its lit-par-lit contact relations with units derived from the Kaminak Groups and evidence farther east (NTS 55E, Bell, 1970a) suggesting metamorphism is chiefly Hudsonian, then it is possible that the Corbett Batholith is late Aphebian in age.

Massive, pink granite (5) locally grading into migmatite with metasediments (As', A'q) is common north of Kogtok River. These granites locally have been transformed into weakly foliated and weekly layered gneisses. In places the massive phase grades into the foliated phase. These granites may be late Archean and/or late Aphebian in age. Exposure in the detail of this survey does not permit an unequivocal distinction.

Late Archean and/or Aphebian Diabase (Ad , Ad')

Porphyritic diabase dykes and their metamorphosed equivalents (Fig. 7) identical to those described by Davidson (1968, 1970b) are present south of Kogtok River. These dykes are older than the Hurwitz Group and also may be older than the Montgomery Lake sediments (Am). They may be younger than the MacKenzie Lake metasediments (Bell, 1969b). Tentatively these dykes are dated as at least 2,300 million years (Davidson, pers. comm.).

Immediately north of Kogtok River, metadiabase and amphibolite dykes and sills are rare. However around Ferguson Lake they are abundant. Some of these dykes may be equivalent to those described above. Others such as the north-striking dyke on the island at the south end of Ferguson Lake may be late Aphebian or even early Helikian in age.

Aphebian(?)

MacKenzie Lake Metasediments (A'q, A'qn)

Porphyritic biotite-feldspar gneisses (A'q) containing intensely flattened metaconglomerates and biotite schist layers are present in the east-central part of the Ferguson Lake map-area. These can be traced directly into the metasedimentary complex near Victory and MacKenzie Lakes in the Kaminak Lake map-area which have been described previously (Davidson, 1968 and 1970b; Bell, 1968a and 1969a, b).

In the Ferguson Lake map-area minor metaquartzite and mica schist in places containing cordierite are present along the southern edge of this belt of metasediments. The metasedimentary packet is intruded by numerous pink granite sills and lenses; to the west this unit is strongly metamorphosed and gives way to pink granitic migmatites (A'qn). Locally xenoliths of metaquartzite and feldspar-quartz gneiss are observed in the migmatite terrain. It is also apparent that migmatization has occurred in two stages: an earlier lit-par-lit stage and a later stage in which the lit-par-lit gneisses have been intruded by a stockwork of pink granite. It is possible that the earlier phase is Kenoran; the later Hudsonian. On the other hand they may represent syntectonic and late tectonic phases respectively of th Hudsonian. Pink granites (5) surround the MacKenzie Lake metasediments and are similar to the igneous phase of the migmatites.

An amphibolite dyke cuts these metasediments at the eastern border of the area. If this dyke can be proven to be equivalent to the pre-Hurwitz porphyritic diabases then the MacKenzie Lake metasediments are clearly pre-Hurwitz and possibly Archean in age. Amphibolite and metadiabase dykes to the south and southeast of the metasediments are almost certainly all of this association. However dykes a few miles north and northwest of the belt are quite diverse in trend and petrographic character.

Aphebian

Montgomery Lake Sediments (Am)

The Montgomery Lake sediments have been described in detail by Bell (1969a, 1970b) and are mapped as possible correlatives of pre-Hurwitz sediments near Montgomery Lake (unit 7 of Eade, 1964).

These sediments comprise impure grey and green, pyritic, quartz arenites, grits, siltstones, and oligomictic conglomerates (Fig. 8). Minor buff and pink-mottled siltstones and impure quartz arenites, and orthoquartzites occur near the top of the succession in the Padlei belt. Minor basal polymictic conglomerate and greywacke occur at the base of the succession but are not well exposed, possibly being only of local distribution.

The Montgomery Lake sediments are restricted to the southeast flank of the Padlei belt and reach a maximum thickness of about 2,500 feet (excluding basal conglomerates) in the middle of the belt. These sediments are cut out completely in about 3 miles. The only location where undoubted Montgomery Lake sediments occur on the northern flank of the belt is west of Padlei. A slight angular unconformity with the Hurwitz Group is observable on the south flank of the belt due south of Padlei. This, and the restricted distribution with respect to the overlying Hurwitz Group, and the sharp cut-off, suggests that a gentle unconformity separates the groups. On the other hand, the close association of the two groups both in the present area and to the west near Henik Lakes suggests both are closely related and the older packet of sediments may represent filling of a locally restricted basin or basins with onlapping of the Hurtwitz Group. It is unlikely that a period of severe folding separates the two, but rather a period of local tilting and/or gentle folding and faulting, probably not unlike the event separating the Huronian Gowganda Formation from older Huronian sediments (Roscoe, 1969).

The age of the Montgomery Lake sediments with respect to the pre-Hurwitz diabase dykes (Ad) is unknown as no such dykes were observed where this relation could be determined. Because the Montgomery Lake sediments overlie the Archean volcanics and sediments with sharp angular unconformity, they are believed to be Aphebian rather than "possibly Archean" as Eade suggested (1964). The relationship with the MacKenzie Lake meta-sediments (A'q, A'qn) is unknown and probably not resolvable.

Hurwitz Group (Ap; Ak, Aa)

The name Hurwitz Group (Fig. 10) was proposed by Wright (1955, 1967) for the early Proterozoic sediments characterized by orthoquartzites in south and central Keewatin. The stratigraphy has been discussed by Eade (1964, 1966) and Bell (1968) who (1970b) described the succession in this map-area in detail with proposals for the several formational names used below. Detailed discussion of this group and a detailed (one inch to one mile) map of the Padlei belt are the topic of this latest report.

Padlei Formation (Ap)

The basal unit of the Hurwitz Group in this and other areas is defined by the Padlei Formation, a succession of grey paraconglomerates (Fig. 9) with minor rythmically layered (varved ?) mudstone near the top. This unit is present almost the entire length of the Padlei belt where it lies on the Montgomery Lake sediments on the southeastern flank and directly on the Archean basement on the northern flank.

Kinga Formation (Ak)

The Kinga Formation comprises impure, hematitic, quartz arenites and orthoquartzites and is the best exposed unit of the Hurwitz Group. The lower part of the Kinga Formation (Maguse Member; Bell, 1970b) is locally feldspathic and crossbedded, sparsely ripple-marked and is characterized by gritty, coarse-, and medium-grained arenites. Locally it contains oligomictic quartz- and jasper-pebble conglomerate. In contrast the upper member (Whiterock Lake Member; Bell 1970b is relatively pure, vitreous, fine-grained orthoquartzite, usually well ripple-marked and sparsely crossbedded. The Whiterock Lake Member is remarkably uniform in its distribution and thickness from Hudson Bay to Watterson Lake map-area and is the most wide-spread unit of the Hurwitz Group.

The Kinga Formation overlies the Padlei Formation, apparently conformably throughout the Padlei belt except on the northwest flank near the western border of Henik Lakes map-area (east half) where it apparently lies directly on the Archean basement.

Ameto Formation (Aa)

Grey, black, green, and varicoloured mudstone, siltstone, slate, argillite and fine-grained greywacke typify the Ameto Formation. This formation is exposed only at the southwestern end of the Padlei belt. Massive green, fine- to medium-grained volcanics occur a few tens of feet from the base of the Ameto Formation and form a thin member, the Happotiyik Member (Bell, 1970b) which is best developed in the Kaminak Lake map-area (Davidson, 1968; Bell, 1968, and 1970b). Some of the enclosing greywackes are in part tuffaceous.

A thick metagabbro sill cuts the Ameto Formation and appears to be similar to those in the Kaminak and Whiterock belts to the east (Bell, 1968, 1970b) which are believed to be coeval with the latter phase of the Happotiyik volcanics. This sill is not indicated on the accompanying maps but is illustrated on the more detailed map with an earlier report (Bell, 1970b).

HUDSONIAN METAMORPHIC TERRAINS (late Aphebian)

General Aspects and Framework

The map-areas have been divided into four regions (Fig. 5). The preceding discussion related largely to region B in which Hudsonian effects are at first glance largely structural rather than bulk mineralogical transformations. Region C has been severely metamorphosed (i.e. cordierite-sillimanite schists are present) in the Hudsonian but the stratigraphic framework is still relatively intact and may be traced southward and eastward into regions of much lower grade metamorphism. In contrast, the stratigraphic framework is severely disrupted in region D by migmatization.

Metamorphism in Region A

Region A is separated in the northwest corner from region B by a sharp structural and metamorphic break. Weakly metamorphosed greywackes in region B are in juxtaposition with biotite-feldspar schists (rarely garnetiferous) in region A. Plutonic rocks (except unit 3a) are recrystallized and weakly to moderately foliated in region A (2', 3' and 3a'). In the southeast corner of region A, a few scattered, thin, pink, fine-grained granitic and aplitic dykes cut all units, including presumed pre-Hurwitz porphyritic metadiabase.

Work by Davidson (1970a,c) and Bell (1970a) during the 1969 field season east of region A disclosed that Hurwitz strata near Wallace and McConnell Rivers have been severely involved in Hudsonian metamorphism and migmatization. Consequently the metamorphism in region A is probably largely Hudsonian.

Metamorphism in Regions of Intact Stratigraphic Framework

Region B

In region B, primary textures and other features of most units are well preserved and there is little obvious recrystallization. Very fine biotite and secondary chlorite are present in sediments of the Padlei and Ameto Formations. The post-Archean and pre-Hurwitz diabase dykes have a matrix of secondary amphibole and altered feldspar with few relict cores of the original pyroxenes, and mildly to severely sericitized to saussuritized plagioclase phenocrysts. Secondary biotite is present in most, but stilpnomelane (reported by Davidson 1970b) in similar diabase dykes in Kaminak Lake map-area) was not observed in the dykes in region B. It is considered that the grade of Hudsonian metamorphism in region B has not exceeded greenschist facies.

Porphyroblasts of andalusite were observed in the lower part of the Kinga Formation in the Padlei belt. Hence the grade of metamorphism in region B, in spite of the general fresh appearance of both Archean and Aphebian rocks may be as high as upper greenschist facies.

Region C

In contrast to regions A and B the obviously transformed and recrystallized rocks in region C are characterized by cordierite-biotite schists, and locally, such as along the south boundary and the northeast corner of region C, by cordierite-andalusite and cordierite-sillimanite schists, indicating subfacies of the cordierite-amphibolite facies of Abukuma type metamorphism.

About a quarter of region C comprises migmatites (Asn, A'qn) which can be traced into relatively intact stratigraphic units (As', A'q). Biotite schists and biotite leucogneiss together with pink granitic bodies similar to unit 5 are traceable into biotite schists and paragneiss derived from the Keminak Group. These migmatites are distinguished as Asn. Granitic content is variable but generally greater than 40 per cent with the structure commonly varying from a closed stockwork to disperse sharply defined angular blocks and nebulitic layered zones. The contacts with granites (5) and the metasediments (As') are generally gradational. Both granite and metasediments are cut by two or more generations of granitic dykes and sills.

Metamorphosed arkose, ortho-, and paraconglomerate, and minor quartzite and argillaceous rocks of the MacKenzie Lake metasediments (A'q) are progressively migmatized to the west. The terrain where 20 to 90 per cent of the rock appears to be granite or granitic orthogneiss is distinguished as A'qn.

The western boundary of region C is essentially the zone where all units become migmatized (Asn and A'qn can no longer be distinguished) and the stratigraphic framework is no longer intact.

Migmatite Complexes of Region D

Region D is divisible into migmatite terrains, differentiated mainly on the basis of gross mineralogy and weak stratigraphic correlation. Unit 6 defines layered migmatites largely made up of amphibole leucogneiss and schists with grey granitic to tonalitic gneiss. The amphibolitic migmatites on Kogtok River are traceable into amphibole gneisses and schists derived from the Kaminak Group. Locally flattened agmatites (Fig. 11), originally angular volcanic fragments in a tonalite matrix were observed. Unit 6 is cut by scattered pink and grey granitic dykes commonly oblique to the prevailing layering. Unit 6a comprises dark-hued amphibolites, hornblendites and metagabbros which may have been derived in part from pre-Hurwitz dykes and in part be equivalent to mafic Archean metavolcanics (Am'). Dioritic and tonalitic orthogneiss (2') and pink granitic orthogneiss (3') are locally distinguished in terrains typified by unit 6.

Map-unit 7 comprises pink and grey biotite leucogneiss, pink granitic gneiss, and minor biotite and biotite-cordierite schists derived largely from metamorphic equivalents of the sedimentary phase of the Kaminak Group (As') and the MacKenzie Lake metasediments (A'q), orthogneiss from Archean adamellites (3'), and pink granite (5). The granitic rocks occur as both elongate gneissic to massive plutons and as granitic dykes with lit-par-lit to stockwork structure.

Pink orthogneiss (7a and 7b) is locally distinguished largely on the basis of lack of layering. Unit 7a defines terrains of pink granitic gneiss which are only sparsely and weakly layered. These may be derived from Archean plutonic units 3 and 5. Unit 7b is a pink porphyroblastic granitic gneiss, in part blastomylonitic and in addition distinguished from 7a and adjacent units on aeromagnetic maps (Geol. Surv. Can., 1966b) by a distinctly stronger aeromagnetic expression.

In summary, region D may be divided into three basic migmatite terrains: unit 6 with metavolcanic and mafic to intermediate plutonic affinities; unit 7 with metasedimentary affinities; and units 7a and 7b with possible granitic plutonic affinities. Cordierite and sillimanite are locally present in gneisses of unit 7. Amphibole and locally garnet are present in gneisses of unit 6. Region D apparently belongs to the Abukuma-type cordierite amphibolite subfacies and differs from region C in having a more complex and disrupted framework, with a more homogeneous trend of the principle layering.

HELIKIAN IGNEOUS ROCKS

Martell Syenite (Py)

Massive, purplish pink, biotite-pyroxene-amphibole syenite is exposed east of Ferguson Lake. The largest body (Fig. 5) is massive and relatively uniform; locally there is a lineation defined by pyroxene and amphibole crystals. Three specimens from the large body have as much as 2 per cent sphene. This syenite is tentatively correlated with the Martell Syenite (Donaldson, 1965) on the basis of lithology.

Late undeformed andesitic and trachytic dykes with apparently no preferred trend cut rocks in the northern third of region D. These dykes (not distinguished on the map) are probably related to igneous rocks of the Dubawnt Group.

STRUCTURAL GEOLOGY

The contacts between the regions A, B, C, and D are based chiefly on lithology and homogeneity of structural style. The contacts between B, C, and D are gradational. In contrast the contact between A and B is marked on the west by an east-striking shear zone across which the metamorphic grade increases sharply; metamorphism on the south side represents higher temperature and pressure conditions and presumably there is considerable throw along this fault. Talbot (see appendix) enlarges in detail on the structural geometry of the regions.

A variety of northwest- and west-striking faults disrupt the synclinorium in the Padlei belt effectively breaking it up into two outliers of Aphebian rocks. Part of the northern flank of the Padlei belt is marked by a northeast-striking shear zone.

In the middle of the Ferguson Lake map-area (where ground traverses were the most closely spaced) numerous southeasterly trending lineaments were observed; some clearly marked by faulting suggesting a pervasive system of small faults with dominant right lateral movements. These are apparently the latest faults of the area and may be early Helikian in age. In area D there are numerous mylonite zones trending northeasterly, parallel with the dominant layering; these faults appear to be older than the southeasterly faults.

ECONOMIC GEOLOGY

Wright (1955, 1967) describes activities in the general region chiefly prior to 1955. Since that time Selco inspected claims at the southwest end of the Padlei belt for gold. Northgale Exploration (Limited) drilled an anomaly (Geol. Surv. Can., 1966a) northeast of Ray Lake and encountered some magnetite iron-formation. Inco still retains claims at Ferguson Lake (Wright, 1967).

Gossans are common in the area, particularly in region B and have been indicated on the accompanying maps. Chalcopyrite and secondary copper minerals are present in the metagabbro sill and volcanics in the Ameto Formation at the southwest end of the Padlei belt.

Earlier reports (Heywood and Roscoe, 1967; Bell, 1968, 1969a, 1970b) indicated higher than normal radioactivity associated with the Montgomery Lake sediments. In late 1968 and early 1969 a large number of claims were staked covering the Hurwitz Group and Montgomery Lake sediments in the Padlei belt. Dennison and Falconbridge are at present inspecting these properties for uranium.

The granitic and pegmatite dykes in the area are notably barren. Abundant sphene was observed in several specimens from the main body of Martell syenite.

Lean Archean iron-formation is present just south of the Padlei belt and continues westward to Henik Lakes but is probably of little interest because of its inaccessibility to markets and apparent lack of secondary enrichment zones.

APPENDIX

THE STRUCTURAL GEOMETRY OF PRECAMBRIAN ROCKS IN THE EASTERN PARTS OF FERGUSON LAKE AND HENIK LAKES MAP-AREAS

J. L. Talbot

Geological mapping in the Ferguson Lake and Henik Lakes map-areas showed rocks with a wide variety of metamorphic grade, structural style, structural history and igneous activity. The area is characterized by a complex of Archean metasediments and metavolcanics at a variety of metamorphic grades, overlain unconformably by folded Aphebian sediments. The rock units exposed in the area have been included in the main part of this report.

No detailed structural information is available for any of this part of the Northwest Territories although a prominent northeast grain to the structures in many parts of the southern Keewatin has been noted in several studies (Wright, 1967; Eade, 1964; and Davidson, 1968). In addition, the aeromagnetic maps of the Ferguson Lake and Henik Lakes map-areas (Geol. Surv. Can., 1966a, b) also show a pronounced northeasterly grain especially in the northern part of the Ferguson Lake map-area.

In this study the structural geometry and history is outlined. The data from general reconnaissance mapping has been analyzed to enhance the information given on the geological maps. The data were treated as though randomly distributed, but in fact the density of distribution of data varies widely throughout the area and is controlled by the requirements of the reconnaissance mapping. The traverse maps (Figs. 3, 4) give a good indication of the distribution of data. The average density of data, from the Ferguson Lake map-area, for layering and schistosity collected on foot traverses was about 6 readings per mile; on helicopter traverses the density was about 1 reading every 2 miles. In the Henik Lakes map-area the density of data is even lower owing to the scarcity of outcrop in the southern half. Furthermore, in both map-areas, the location of fly camps, with associated foot traverses, was determined in part by the apparent complexity of the geology. Areas of simple geometry were covered mainly by helicopter traverses, with landing sites determined by lithologic boundaries or structural breaks. The dominant trends therefore tend to be subdued in the statistical treatment.

The author concludes that a balance between economy of operation and desirability of statistically meaningful observations is difficult to achieve with a reconnaissance operation and a relatively small party. The accompanying contoured density diagrams are therefore only an indication of the structural geometry. In general they show a higher percentage of dispersed points than is truly representative of the area. For example, the diagrams for compositional layering and for schistosity from region D_1 show a girdle and partial girdle respectively. Visual impression from the air and ground traverses, however, suggest that a random sample would show a preponderance of steep dips. Statistical evaluation of the fold axis plunge indicated by individual layering measurements also shows a wide divergence from that seen by visual inspection of the diagrams. For example, the least squares best fit fold axis determined for compositional layering in region C has a trend of 270 degrees and a plunge of 71 degrees, whereas the visual estimate from the diagram is 275 and 30 degrees. This disparity is due to the wide dispersion of the preponderant near-vertical dips which weight the statistics towards a vertical fold axis. The relatively smaller number of readings from the hinge areas of folds, while outlining the main fold geometry, have less influence on the analysis.

Structural Elements

Structural elements recognized in the area are: 1) original bedding; 2) compositional layering, including structures which might be bedding in gneisses; 3) schistosity, including cleavage in lower grade rocks; 4) crenulation cleavage; 5) small scale fold axes; 6) lineations; and 7) joints.

These elements are shown on the accompanying maps (with the exceptions of the crenulation cleavage and joints) although map scale precludes plotting all observations in areas covered by foot traverses.

The dominance of the different structural elements varies from place to place owing to the wide variation in metamorphic grade and structural style which is present over the entire region. In the northern half of Henik Lakes map-area the grade of metamorphism is of the lower to middle greenschist facies and original structures such as bedding are readily recognized. However in the southern part of the Henik Lakes map-area and in most of the Ferguson Lake map-area the grade of metamorphism is considerably higher and original structures can be recognized only with difficulty.

For the purposes of description the mapped area has been divided into five regions, four in the Ferguson Lake map-area and one in the Henik Lakes map-area (see Fig. 5). Bell (1969b and this report) subdivided the Henik Lakes map-area into two regions on the basis of style and metamorphism. It is not practical to subdivide the Henik Lakes map-area for statistical analysis owing to paucity of outcrop and hence data in the southern half of the area.

Subdivision follows that made by Bell (1969b, also Fig. 5, this report) and is based on field characteristics rather than subdivision into homogeneous domains. In addition Bell's region D is subdivided into subareas D_1 and D_2. Clearly the subareas are not homogeneous but the nature of the survey did not allow a finer subdivision.

The boundaries between regions are marked in the field by clear changes in structural style, complexity and in some cases structural grain. In the case of the boundary between regions B and C and between B and D_2 it also represents a striking increase in metamorphic grade across the boundary from south to north. A similar boundary both in terms of time and style occurs north of Savard Lake in Henik Lakes map-area; there is an increase in metamorphism from north to south.

Structural Geometry

In the pre-Hurwitz rocks, original bedding can be unequivocally recognized only in the southern part of the Ferguson Lake map-area (region B, Fig. 5) and in the northern half of Henik Lakes map-area and only rarely in the south half of map-area. In these areas the low grade metasedimentary rocks commonly show good planar bedding planes and in some places, well preserved minor primary structures were observed. Foliation (cleavage), where observed, makes a finite angle with bedding.

Because of the rapid increase in metamorphism both to the south and north recognizable bedding is very rare and only a lithological layering of uncertain origin can be seen. Some of the gneisses show a marked planar type of layering which possibly represents original bedding. However, in most cases a schistosity parallel with the layering, suggests a high degree of transposition. In a few outcrops small scale isoclinal folds are observed with the schistosity parallel with the axial surface of the folds. In rare instances augen gneisses with good layering can be traced laterally into deformed conglomerates (A'q) with a marked plane of flattening parallel with bedding.

In most outcrops in the high grade metamorphic terrains, layering in the gneisses is very weak. Many of the rock units are granitoid and relatively homogeneous with a weak layering defined by small differences in quartz-feldspar-biotite ratios. Quartz commonly occurs as lensoid aggregates, and augen of feldspar are universal. These features are characteristic of massive rocks which have undergone a retrograde phase of metamorphism and may be blastomylonites.

The geometry of the structures is summarized in Figures 12 and 13. In Ferguson Lake map-area the effects of the Hudsonian Orogeny increase from south to north. Region B (Fig. 12) is dominated by pre-Hudsonian structures which are rather irregular. Some of the irregularities are the result of overprinting by Hudsonian structures but much is inherent and possibly related to the large number of late Archean igneous intrusions in the area. The same considerations apply to the northern half of the Henik Lakes map-area, although a northeast trend to the structures is more apparent.

In regions C and D_2 the influence of the Hudsonian Orogeny increases and the east-north-east Hudsonian trend for the structures becomes more apparent. The Hudsonian foliation, which is a weak and variable cleavage in the south, is in these regions a more regular schistosity. The earlier granitic rocks are also foliated.

Many of the present irregularities in the structural trends in regions C and D_2 are the result of a second stage of deformation. Broad folds visible in C and D2 show the first foliation folded along with the compositional layering (compare the contoured diagrams in Fig. 12). In rare cases refolded folds were observed (Fig. 14) with a weak crenulation clevage subparallel with the axial surface of second generation folds. However, the number of small scale second generation folds observed was very small.

The small first generation folds of region C show a close approach to a small circle distribution (Fig. 12 c) characteristic of refolded fold geometries.

The northernmost region D (D_1 + D_2) (Fig. 12 shows the greatest influence of the Hudsonian event. The rocks are high grade schists and gneisses and layered amphibolites thought to be equivalent to the greywacke-greenstone sequences (Kaminak Group) to the south. Structures appear simple and are dominated by east-northeast trending layering dipping steeply to the north and south. No clear distinction can be made between first and second generation structures in this region.

Joints

The joint patterns for all of the Ferguson Lake regions are so similar that only the collective diagram is shown here (Fig. 13). The joints are steep and show pronounced maxima with strikes of 40 and 145 degrees. These trends do not appear to be related to any other obvious structural trends. Very few joints were measured in the Henik Lakes map-area. The joints represented on the diagrams are all steep. However, there is in almost every outcrop a very pronounced subhorizontal jointing which is parallel with the local topography. This feature is apparently common in the barren lands (e.g. Wright, 1967, notes that this subhorizontal jointing gives the appearance of crossbedding in some units). Its tectonic significance is not clear but probably represents (glacial?) unloading phenomena. These subhorizontal joints have been omitted from the observations. Nevertheless, the virtual absence of moderately dipping joints is a notable feature of the area.

Structures of the Hurwitz Group Sediments

Hurwitz Group metasediments form a northeasterly trending belt of rocks in the northern part of Henik Lakes map-area (Padlei belt). The bedding attitudes give relatively well-defined girdles with low to moderate dips (Fig. 15a) predominating with fold axes generally horizontal and northeast trending. The belt is broken up somewhat into a series of *en echelon* structural basins with a northerly trend apparent in one of the basins. Data on the cleavage attitudes, although small in number, tend to mirror the other structural trends in some regions but are more northerly in others. This may suggest that the cleavage is somewhat later than the folding, and may be related to transverse faulting.

The Hurwitz Group cleavage (Fig. 15b) shows a similar spread of attitudes to the pre-Hurwitz cleavages, but is poorly developed even in favourable rock types. The cleavage in the underlying rocks is much better developed, although it tends to be irregular in the metavolcanics which dominate this part of Henik Lakes map-area. No evidence of the cleavage developed in the Hurwitz Group sediments could be found in the lower rocks but it would be difficult to recognize and differentiate in the metavolcanics.

SUMMARY

Pre-Hurwitz rocks in the highly metamorphosed areas show evidence of two major periods of deformation: an earlier, probably completely isoclinal phase which resulted in the layering parallel to schistosity relationships, and a later, more open type of folding which resulted in the overall structural patterns now visible. In the lower grade pre-Hurwitz rocks only one period of deformation, strong enough to impose structures on the rocks, is recognized, although the complexity of structural patterns is difficult to explain on the basis of a simple single period of deformation.

The folding of the Hurwitz Group sediments was only of a small scale and did not result in structures in the older rocks which could be differentiated from pre-existing structures.

There may have been a disengagement between the Aphebian sediments and the Archean basement permitting tighter structures in the Hurwitz sediments. Many contact zones in the Kaminak and Whitewater belts show shearing including in some localities strike-slip movements (Bell, pers. comm.).

On the scale of the mapping only a few faults could be directly inferred, but small scale fractures are common in lower grade rocks and some important breaks could be inferred from metamorphic and gross structural features.

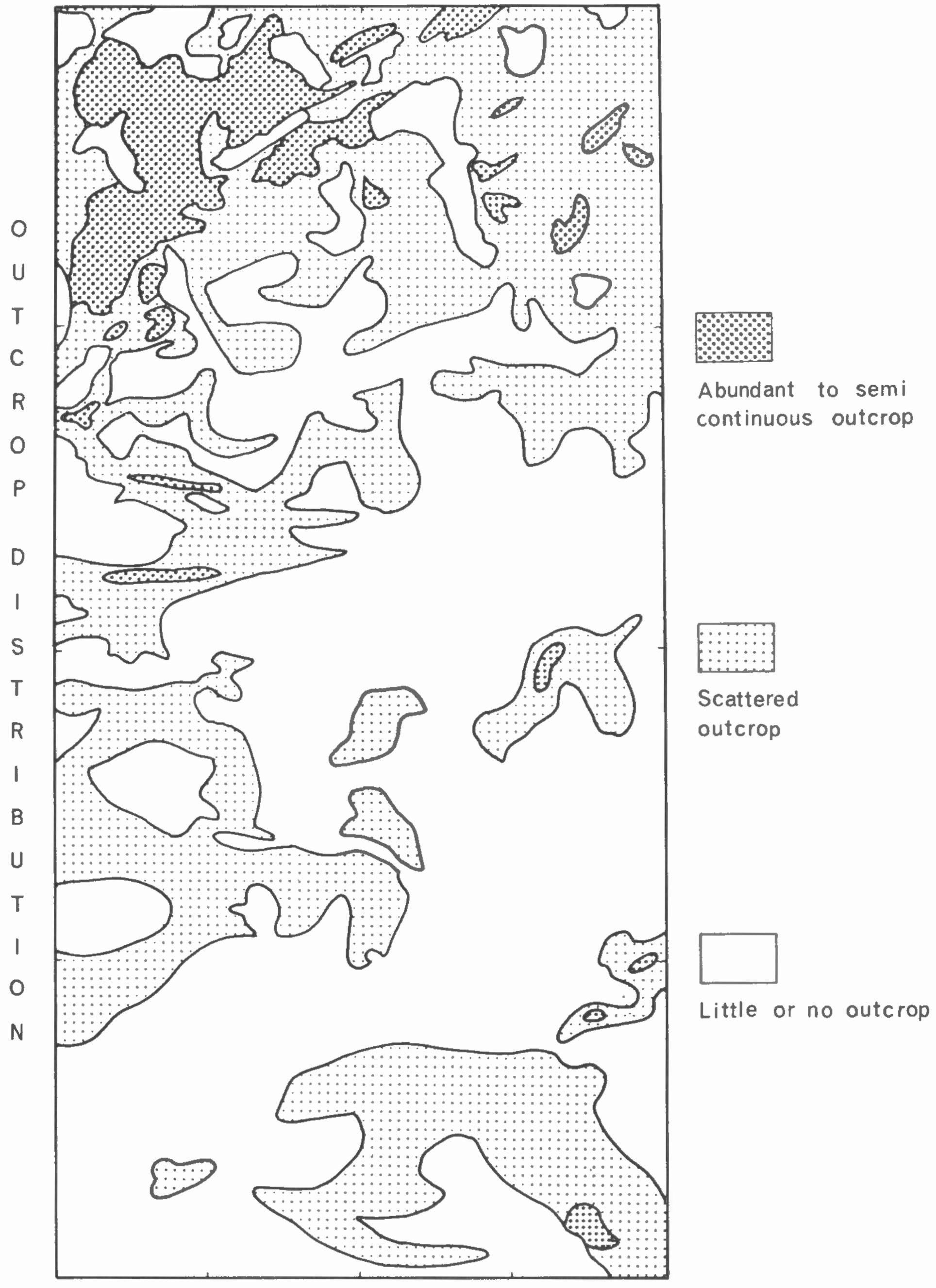


Figure 1. Outcrop distribution, Henik Lakes map-area.

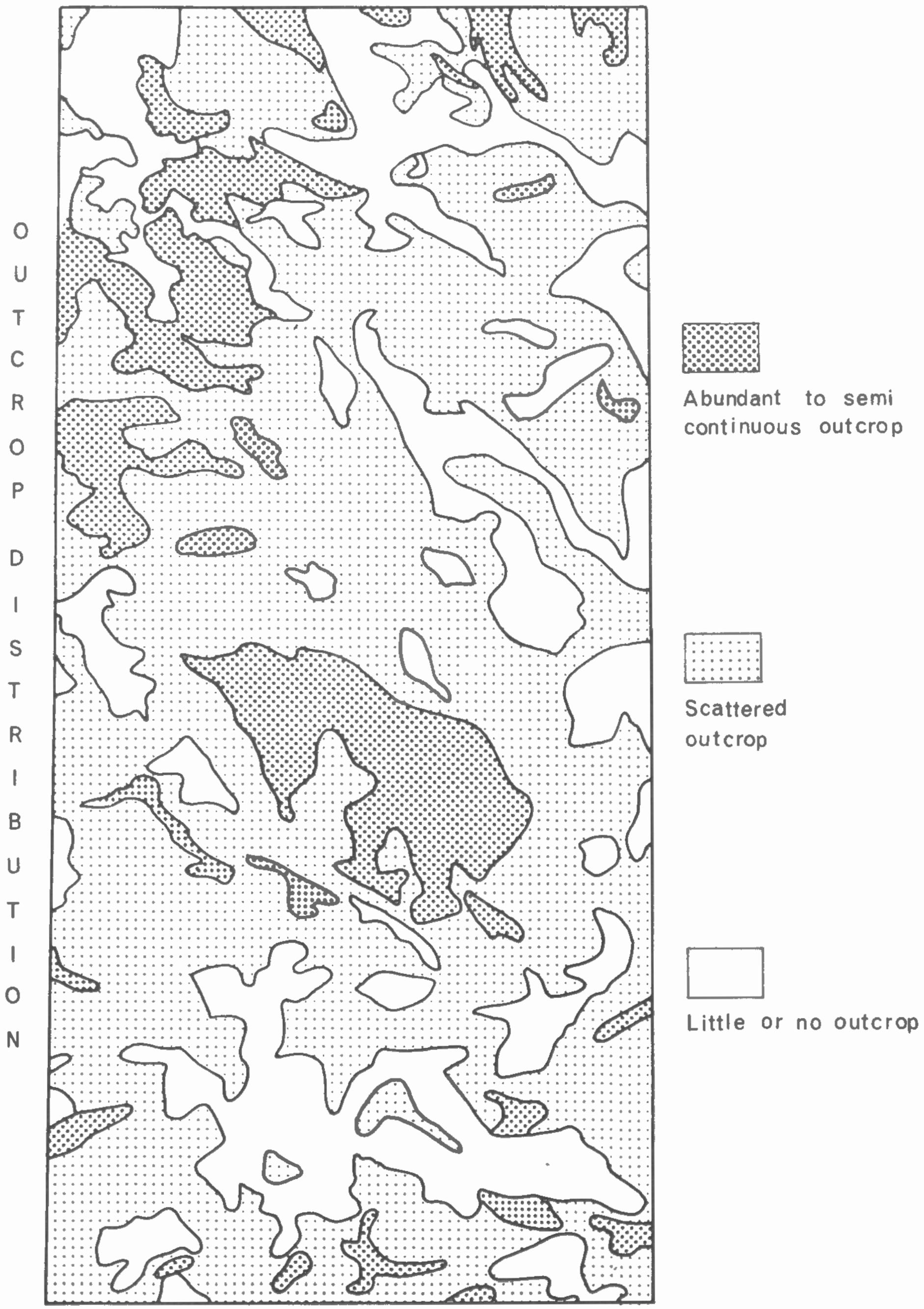


Figure 2. Outcrop distribution, Ferguson Lake map-area.

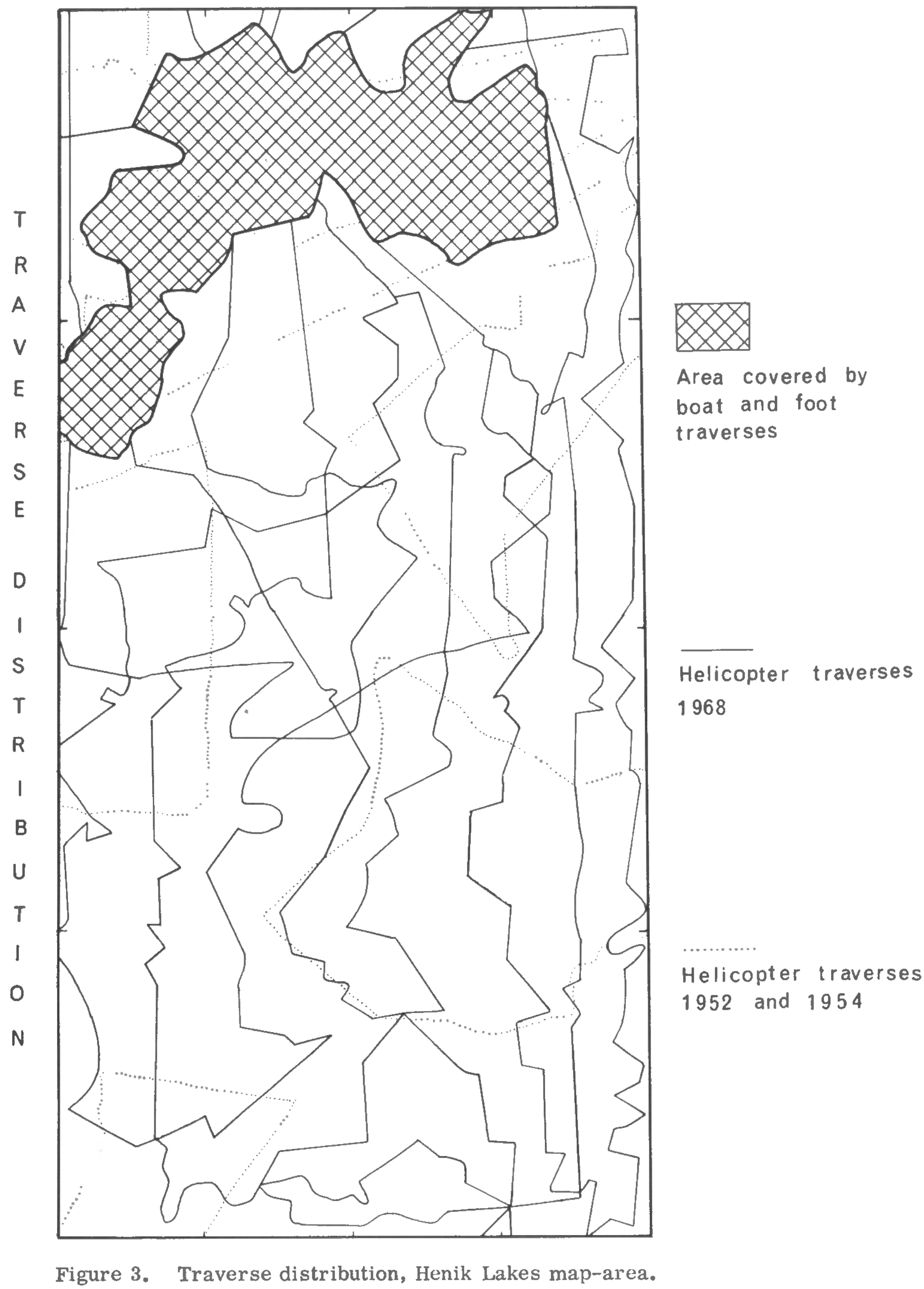


Figure 3. Traverse distribution, Henik Lakes map-area.

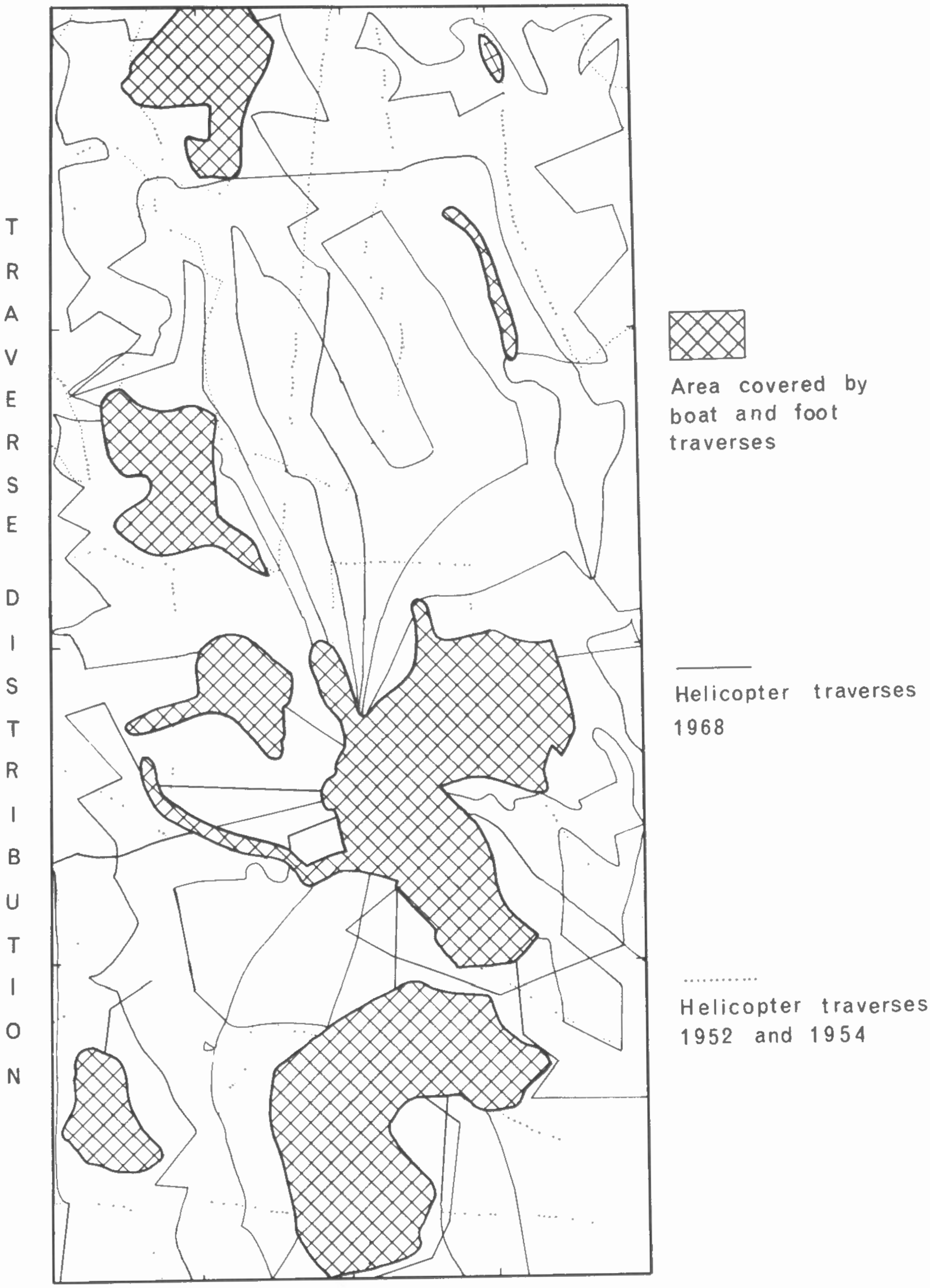


Figure 4. Traverse distribution, Ferguson Lake map-area.

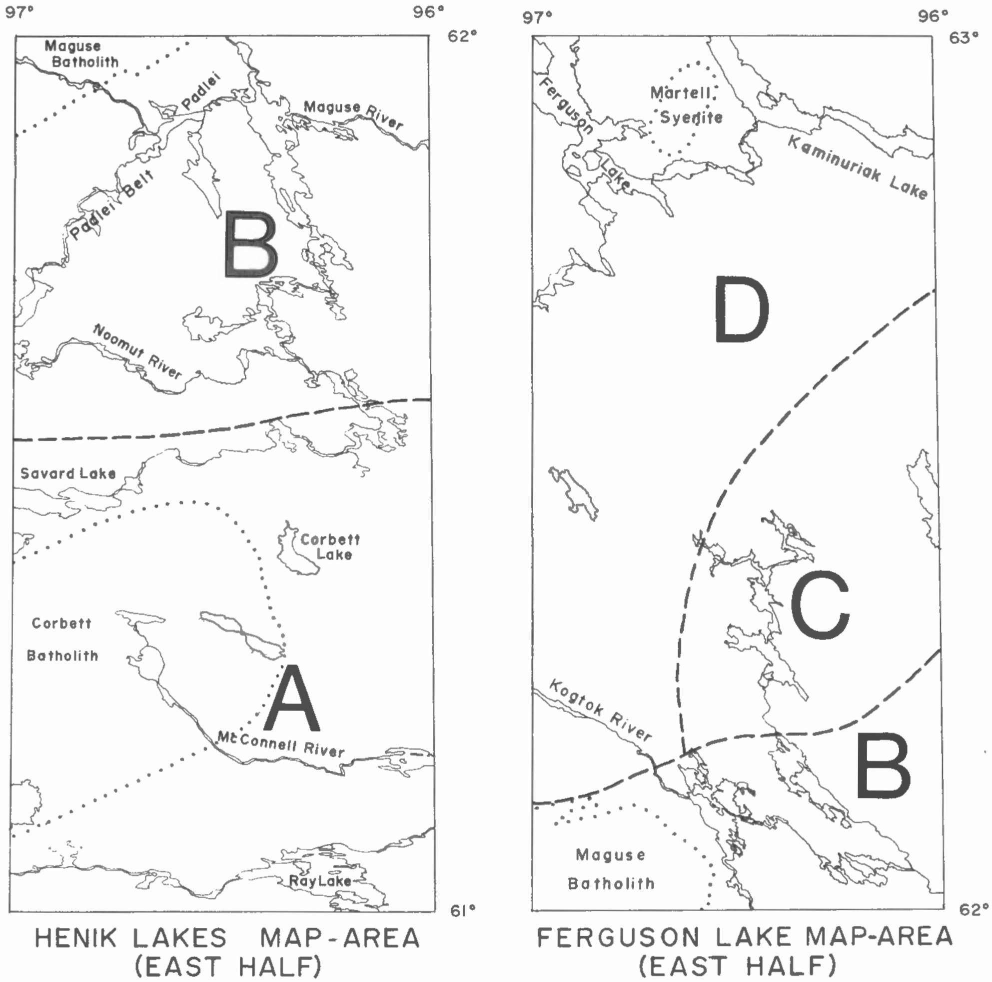


Figure 5. Sketch maps of areas illustrating structural regions and some plutonic complexes.

Figure 6. Kaminak Group: pillow volcanics east of Heninga Lake, tops to the right (east). GSC photo 201509

Figure 7. Porphyritic metadiabase dyke, near Ray Lake. Hammer handle about 2.5 feet long. GSC photo 201505

Figure 8. Montgomery Lake sediments: quartz-pebble conglomerate immediately beneath Padlei Formation on south side of Kinga Lake. GSC photo 201508

Figure 9. Hurwitz Group, Padlei Formation: open framework conglomerate typical of Padlei Formation with granitic phenoclast near pocket-watch, on island in Kinga Lake. GSC photo 201506

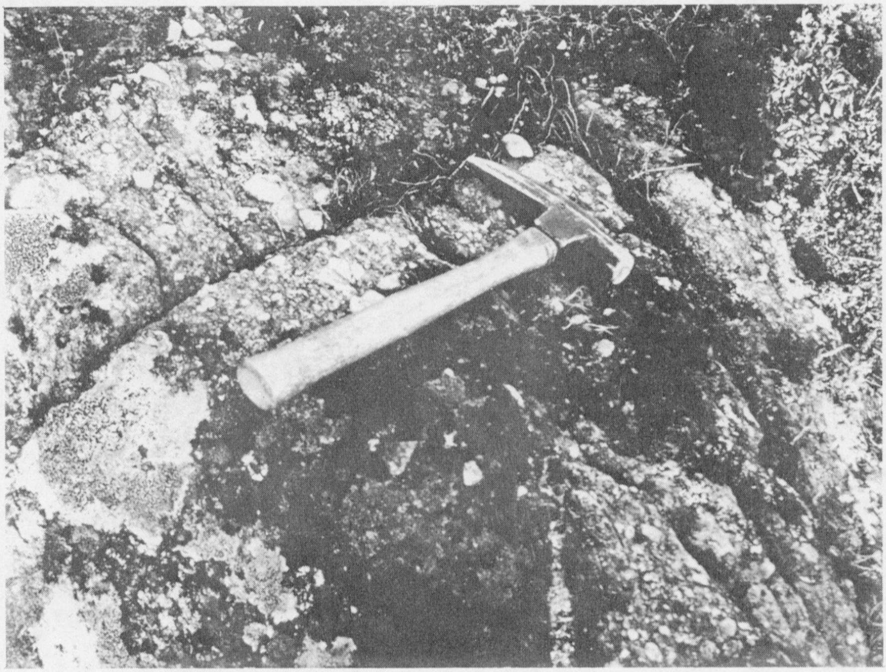
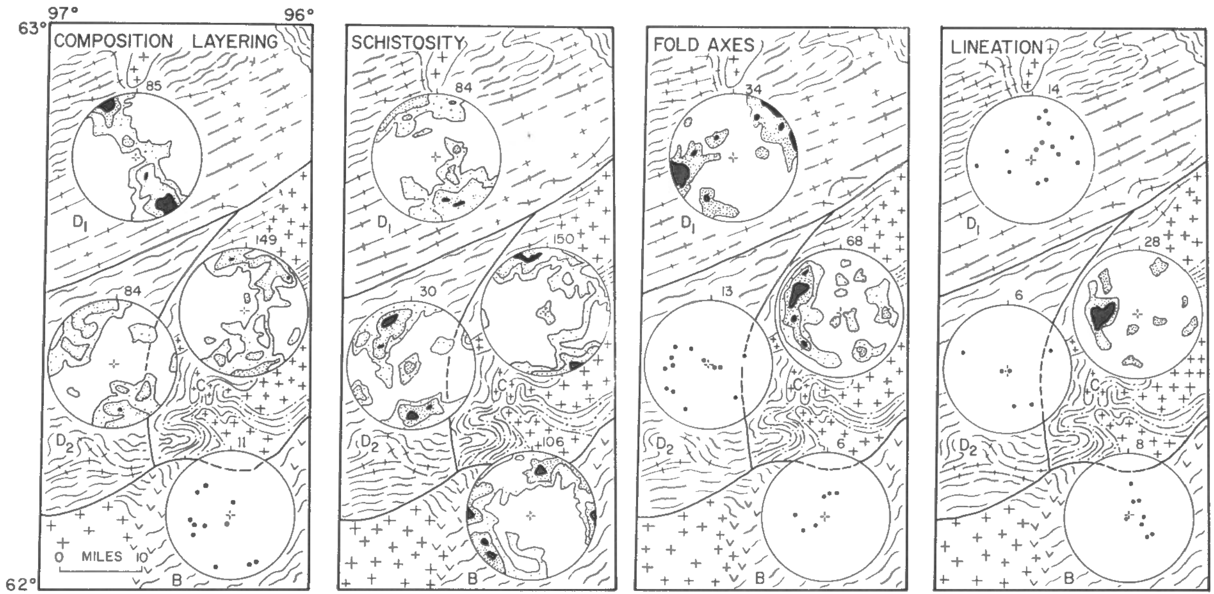


Figure 10. Hurwitz Group, Padlei Formation: conglomerates and mudstones of Padlei Formation dipping gently to left (south); in mid-ground the slope to the right is underlain by gently dipping, slightly pyritic quartzites of Montgomery Lake sediments; in background the hill to the left comprises steeply dipping orthoquartzites of the Kinga Formation. Picture taken just west of Padlei. GSC photo 201507

Figure 11. Map-unit 6: layered amphibolitic and tonalitic gneisses, possibly transformed agmatite. Picture taken in northeast section of Ferguson Lake map-area, looking southeasterly. GSC photo 201142



FERGUSON LAKE SHEET (EAST HALF) N65I (EAST)

Figure 12. Density distribution diagrams for data from the eastern half of the Ferguson Lake map-area. The number of points is given at the top of each projection. Contours 1, 2 and 5% per 1% area counted on a spherical projection. The projections are equal area, lower hemisphere.

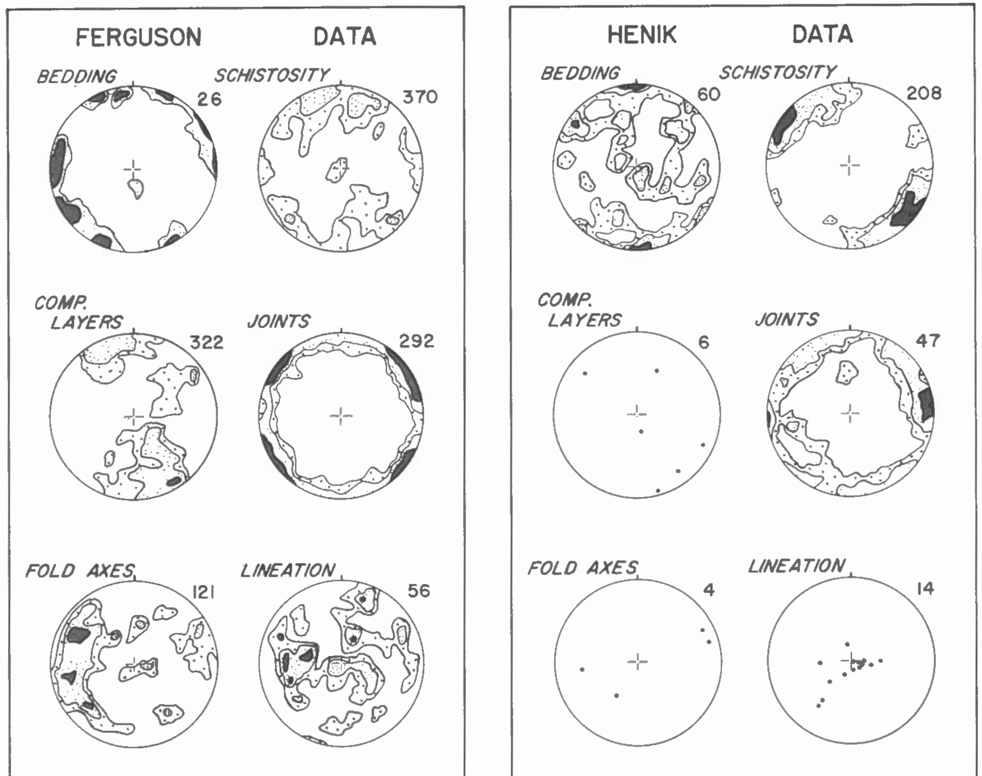


Figure 13. Collective plots of data from pre-Hurwitz rocks in the Ferguson Lake and Henik Lakes map-areas. The number of points is indicated for each diagram. Contours and projection are as Figure 12.

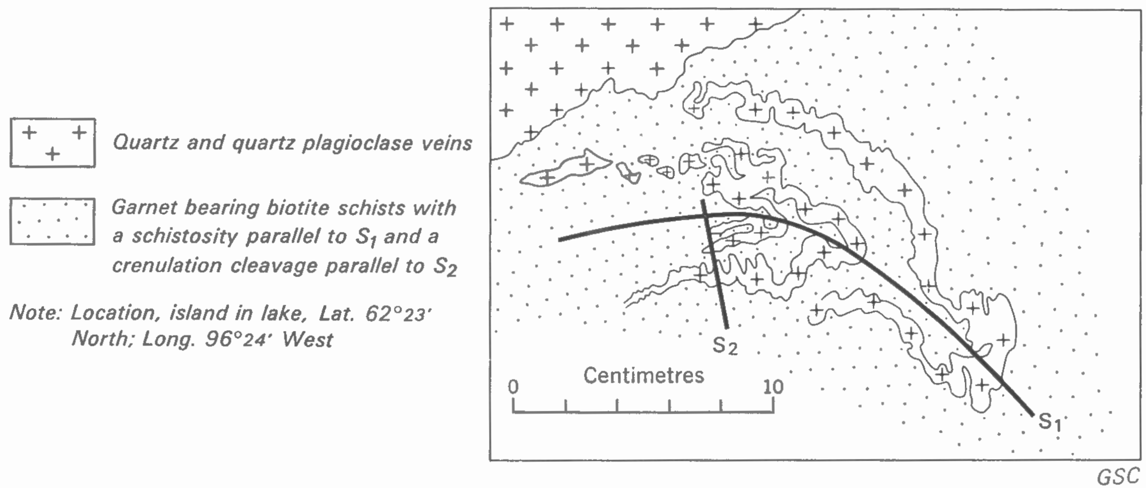


Figure 14. Folded quartz veins showing two episodes of deformation.

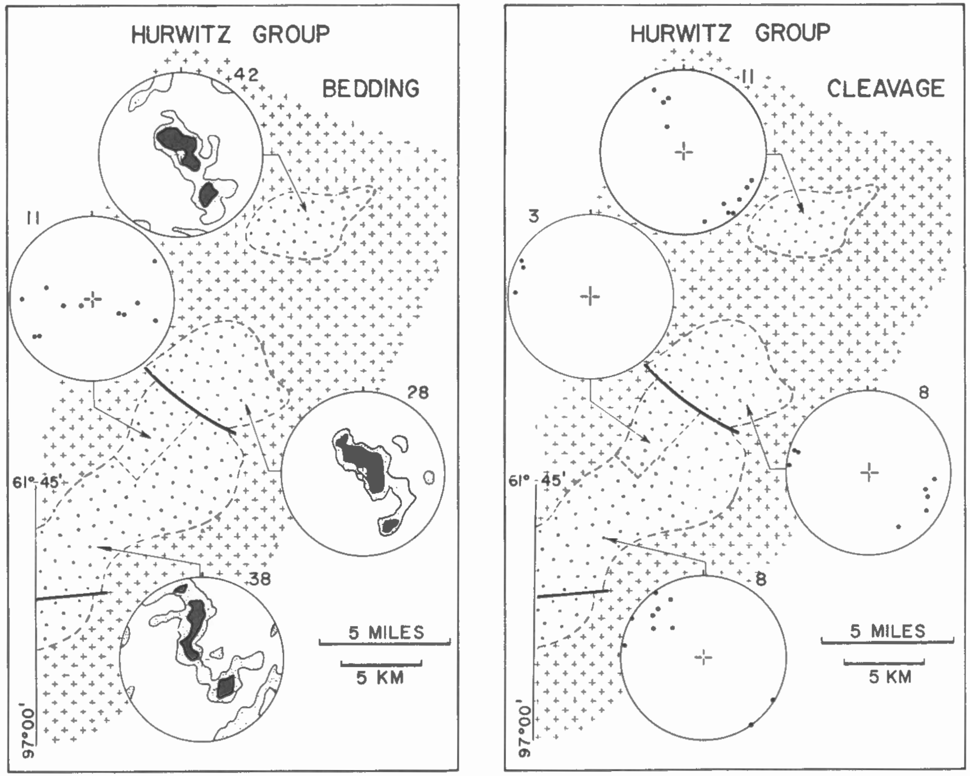


Figure 15. Bedding and cleavage data from Hurwitz Group sediments on the northern part of Henik Lakes map-area (east half).

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