FOXE FOLD BELT IN EASTERN BAFFIN ISLAND, DISTRICT OF FRANKLIN

Project 790024

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Abstract

Foxe Fold Belt, a late Aphebian (Hudsonian) mobile belt, contains polydeformed Archean and Aphebian rocks ranging from greenschist to granulite facies of metamorphism. Within the Home Bay map area (NTS 27 SE and SW) Aphebian Piling Group supracrustal rocks are divided into four lithostratigraphic units. A basal unit of mainly quartzite in the south part of the region is overlain by an interbedded marble and calcium-silicate gneiss unit towards the apparent north margin of the sedimentary basin. Locally in the interior of the basin in the southwest part of the Home Bay map area a stratiform complex of mafic and ultramafic metavolcanics overlies the quartzite. The upper unit, composing the major part of Piling Group, is made up of a succession of metaturbidites.

The first appearance of anatectic leucogranite occurs near the base of Piling Group in the southwest part of the Home Bay map area, and cuts higher into the metaturbidite succession farther east. In the south, east and north parts of the map area metamorphic conditions were highest; granulite grade rocks occur in the southeast part of the region.

Four fold sets deform Aphebian and older rocks in the region. The first two sets (F_1 and F_2) are recumbent isoclines: the largest single structure in the region appears to be a northeast-striking F_1 or F_2 anticlinal nappe. F_3 and F_4 folds are mainly horizontal normal folds developed on the recumbent fold limbs. The F_3 set strikes east-northeast and is dominant northwest of the apparent crest of the anticlinal nappe, whereas the F_4 set strikes west-northwest and is dominant southeast of the apparent crest of the nappe. Foxe Fold Belt undergoes an abrupt regional strike change across the zone where the fold sets interfere.

Anatexis apparently antedates F_4 folding in the region.

Introduction

Bedrock mapping in Home Bay map area (NTS 27SE, SW) was completed during 1979; this was the final field season devoted to studies of the stratigraphy, structure and metamorphism of rocks in Foxe Fold Belt in Baffin Island. Other studies done in relation to this project are described by Morgan et al. (1975, 1976), Tippett (1978, 1979), and Henderson et al. (1979).

Figure 23.1 outlines the Home Bay map area and indicates mapping reported upon previously. Contributions to the mapping in 1979 were made by Robert Anderson, Steven Aungst, Derek Brown, Mariette Henderson, Patrick McLellan, and Ginny Peterson, in addition to the writers. Traversing was done mainly on foot from daily excursions with a helicopter from base camps at Cape Hooper (FOX-4 DEW Line site), the head of Inugsuin Fiord, and Dewar Lakes (FOX-3 DEW Line site). Camp moves were facilitated by use of DC-3 and Twin Otter aircraft chartered from Frobisher Bay.

Much of eastern Baffin Island is nearly inaccessible except by helicopter. Local relief exceeds 1000 m in the fiords and most of the upland is covered by permanent ice and snow. In addition, prevailing easterly winds in the region produce abundant orographic cloud cover and precipitation. In this regard, we greatly appreciate the help of Alan Stacey, pilot of Aero Trades' Bell 206-A, who was constantly aware of the special difficulties presented to us in mapping the country.

Summary of Regional Relations in Foxe Fold Belt

Foxe Fold Belt is a 100-200 km wide zone of late Aphebian deformation characterized by generally gently plunging, east-west striking normal folds superposed on recumbently folded Aphebian supracrustal rocks and their Archean granitoid basement rocks. Jackson and Taylor (1972) drew the boundaries of the deformed zone from the Canada mainland southwest of Melville Peninsula to the east coast of central Baffin island. South of Barnes Ice Cap in central Baffin Island, Foxe Fold Belt changes strike from the east-northeast-west-southwest trend characteristic in western Baffin Island and Melville Peninsula to west-northwest-east-southeast in the short eastern segment that terminates in Home Bay.

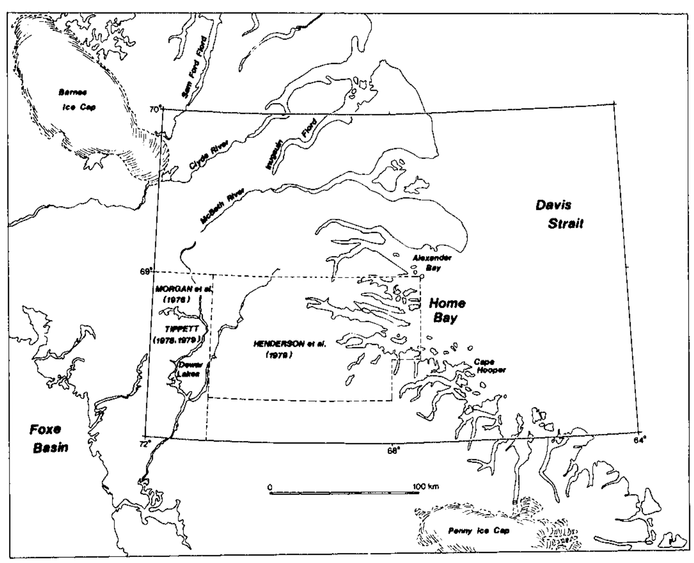

Figure 23.1. Index map of areas referred to in central Baffin Island. Home Bay map area (NTS 27 SE and SW) is outlined; parts of the area reported upon previously by Henderson et al. (1979), Morgan et al. (1976) and Tippett (1978, 1979) are indicated.

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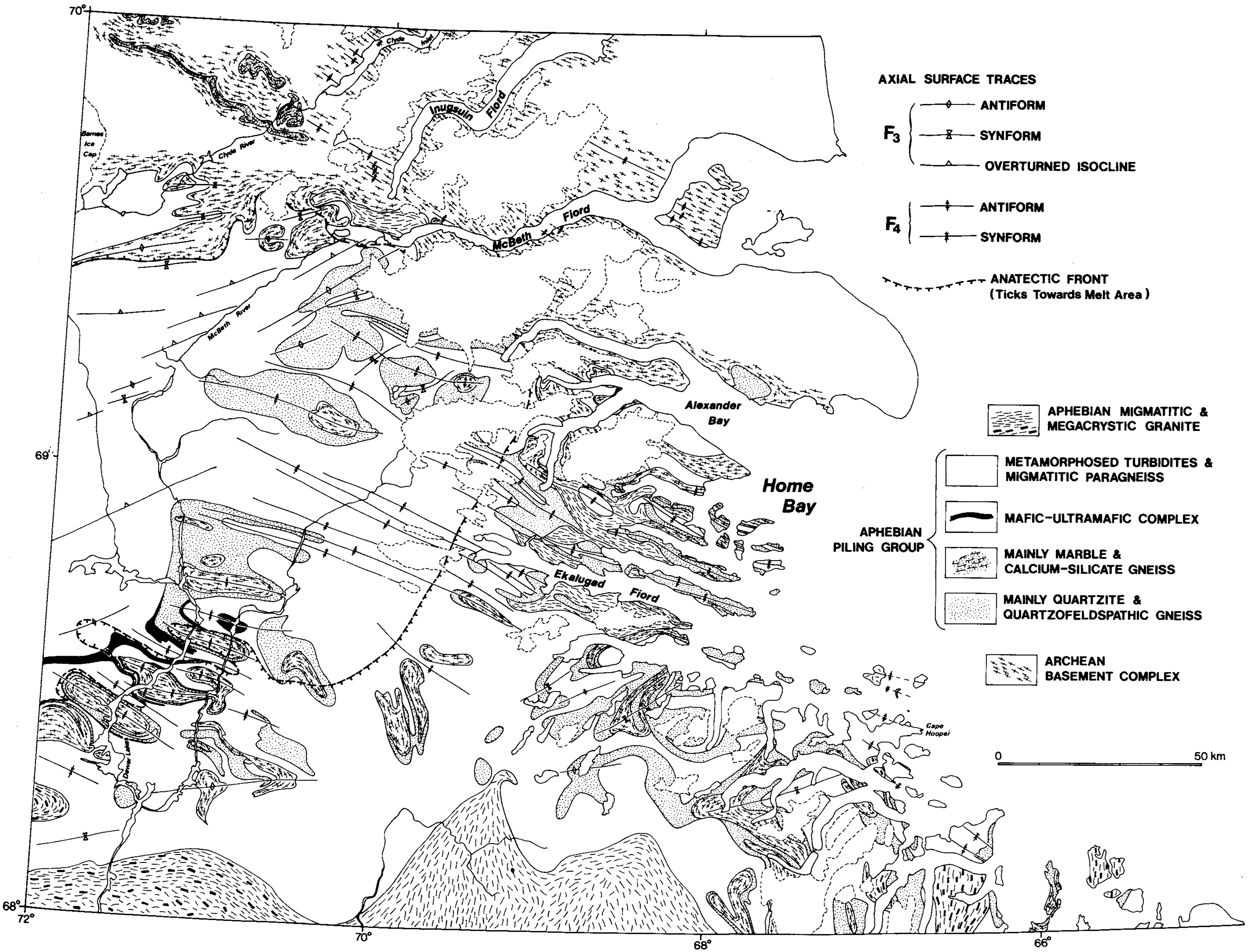

Figure 23.2. Geological sketch map of the Home Bay map area. Geology west of 70° and south of 69° by W.C. Morgan, A.V. Okulitch, P.H. Thompson, P. Chernis, 1976, and by C.R. Tippett, 1978-79. Compilation by J.R. Henderson and C.R. Tippett, 1979.

Metamorphism in the belt on Baffin Island increases outwards from greenschist grade in the central Piling Basin to granulite grade north and south of Foxe Fold Belt (Jackson and Morgan, 1978). In the high grade terranes extensive Hudsonian migmatization made it difficult to distinguish between Aphebian and Archean supracrustal and plutonic rocks. Final folding of the rocks in Foxe Fold Belt on Melville Peninsula took place before the metamorphic culmination about 1800 Ma ago (Henderson, in press); folding in the belt on Baffin Island outlasted the metamorphic climax which, according to Jackson and Morgan (1978), may have occurred about 1670 Ma ago.

Stratigraphy and Lithology

Rocks in the Home Bay map area (Fig. 23.2) may be divided on the basis of relative age and lithology into four major categories: (1) Archean (Kenoran) granitoid basement complex; (2) Piling Group supracrustal succession assumed to be Aphebian in age; (3) Late Aphebian (Hudsonian) granitoid rocks; and (4) post-Aphebian (Hadrynian) diabase dykes (not shown on Fig. 23.2).

Archean Basement Complex

A continuous expanse of granitoid basement gneiss occurs in the region northeast of a line from Alexander Bay to Barnes Ice Cap. South of this line basement rocks occur largely in west-northwest trending elliptical domes in the Dewar Lakes region, and in north trending isoclinal anticlines in the Cape Hooper region.

Basement rocks are mainly medium grained, pink-grey, layered granite-granodiorite with locally abundant folded amphibolite boudins. Layering is developed on a scale of 1-10 cm in the gneiss; mineral foliation and lineation (where developed) parallel layering in limbs and hinges of mesoscopic folds. Identification of basement rocks in the high grade terranes north and east of the anatectic front shown in Figure 23.2 commonly is based on negative mineralogical criteria, such as absence of graphite, iron oxide, garnet, sillimanite and cordierite, although presence of allanite may be a positive criterion for identification of basement rocks.

The pre-Piling relative age of the basement rocks was established by Morgan et al. (1975, 1976) and Tippett (1978, 1979) based on the regional occurrence of granitoid gneiss beneath Piling Group graded turbidites northwest of Dewar Lakes. Jackson (1978) obtained Rb-Sr "errorchron" ages of 2605 Ma and 1964 Ma from 12 samples of basement gneiss collected near the mouth of McBeth River (Fig. 23.2). The Rb-Sr values obtained from the suite according to Jackson (1978) show significant geological variation, but do, however, provide evidence for at least two periods of igneous-metamorphic activity, the earlier representing the Kenoran orogeny and the later possibly indicative of the time of metamorphism of the Piling Group.

Piling Group

In the Home Bay map area Piling Group is divided into four lithostratigraphic units. In ascending order the sequence of units is (1) micaceous quartzite or quartzofeldspathic gneiss, (2) marble and calcium silicate gneiss, (3) amphibolite and ultramafic rocks, and (4) turbidite or paragneiss. The brief descriptions of field aspects which follow emphasize regional variations within the map area. Tippett (1978, 1979) and Henderson et al. (1979) presented some additional data on the megascopic features of Piling Group rocks in the Home Bay map area. Morgan et al. (1976) described some aspects of Piling Group rocks in the west of the Home Bay map area. Piling Group is given an Aphebian age and probably is correlative with Penrhyn Group in Melville Peninsula.

Micaceous Quartzite or Quartzofeldspathic Gneiss The basal unit of Piling Group varies with increase in metamorphic grade from micaceous quartzite and schist to quartzofeldspathic gneiss. The anatectic front drawn on Figure 23.2 marks the approximate position of the transition. Pure quartzite is a minor but characteristic component of the unit throughout the region. The basal unit is most widespread in the region immediately south of McBeth River; north of the river the unit is not represented on the map, although in places northwest of Clyde River thin quartzite occurs between marble and basement gneiss. Thickness estimates are valueless, due to the imprecise knowledge of structural complexities in the region. However, the virtual disappearance of quartzite and the appearance of marble as a map unit north of McBeth River probably reflect a transition from dominantly clastic sedimentation in the interior of the basin to chemical sedimentation near the basin margin.

Marble and Calcium-Silicate Gneiss North of McBeth River, marble and calcium-silicate gneiss occurs in several narrow west-northwest striking bands in contact with basement gneiss. In places the unit overlies a thin quartzite or pelitic gneiss in contact with basement rocks. Elsewhere in the Home Bay map area the marble unit is absent or is too thin to map separately from the quartzite-quartzofeldspathic gneiss unit (e.g. north of Ekalugad Fiord).

Typically the unit is coarse grained calcite marble with scattered layers, lenses and pods of finer grained diopside-feldspar-quartz gneiss. Dispersed grains of graphite, forsterite, humite, diopside and scapolite occur in some marble outcrops. White pegmatitic granite commonly occurs with marble and may make up most of the exposure.

Marble seems to occur in Piling Group only near the north margin of the basin on Baffin Island. Morgan et al. (1975, 1976) mapped a marble-rich unit overlying quartzite in the keels of several northeast striking synclines along the north margin of the basin in the Lake Gillian map area (37 D) southwest of Barnes Ice Cap. In the region west of the Home Bay map area they noted that carbonate rocks occur in Piling Group only near the north margin of the basin.

Amphibolite and Ultramafic Rock A stratiform complex composed mainly of amphibolite and hornblendite layers occurs around several of the elliptical domes near Dewar Lakes. In this region the unit overlies the basal quartzite or occurs within the turbidite-paragneiss unit. The latter occurrence may be allochthonous if the complex forms a single conformable volcanogenic sequence overlying the quartzite unit. Amphibolite occurring east of the Dewar Lakes region is too thin and discontinuous to map separately from the quartzite unit. Tippett (1978) suggested that the amphibolite and ultramafic rock unit found around Dewar Lakes may be a lateral facies equivalent of extensive sulphide facies iron formation and rusty schists, which apparently occupy the same stratigraphic position in Piling Group to the north.

Turbidite or Paragneiss Unit The principal unit of Piling Group in the Home Bay map area is a flyschoid sequence that varies with increase in metamorphic grade from a succession of recognizably distal turbidites to migmatitic biotite-graphite paragneisses. Where they occur in their lowest grade condition (e.g. the upper McBeth River and upper Dewar Lakes drainage areas), the rocks composing the turbidite unit of the group are rusty shales, siltstones and greywackes; where their metamorphic grade is higher, they are mainly rusty graphitic schists and paragneisses. In the region inside the anatectic front drawn in Figure 23.2, granitic leucosome is a significant component of the paragneiss unit and in the highest grade terranes (e.g. south and southwest of Cape Hooper) the paragneiss unit is difficult to separate from Hudsonian plutonic rocks.

Granitic Rocks

Based on their relative age and mode of occurrence, three varieties of granitic rocks (sensu lato) were distinguished in the Home Bay map area. Pegmatitic leucogranite occurs most abundantly; it forms the leucosome in migmatitic paragneiss and is the principal component of the migmatitic granite mapped inside the anatectic front. Several foliated megacrystic quartz monzonite plutons occur south of Cape Hooper. These rocks were emplaced after some of the leucogranites formed. Postkinematic granite pegmatite dykes compose the third variety of granitic rock distinguished in the region; they indicate that some granitic magmatism outlasted the dynamothermal Hudsonian metamorphism.

Leucogranite Inside the anatectic front drawn on Figure 23.2, Piling Group paragneiss contains conformable leucocratic laminae produced in situ by anatexis of the turbidites. In addition, deformed sills and dykes of leucocratic granite intrude the migmatitic paragneiss. These discordant leucogranites are slightly more mobile products of local anatexis. Mainly along the south margin of the Home Bay map area leucogranite forms the major component of the migmatite and is distinguished on the map as migmatitic granite. The migmatitic granite contacts are located approximately where Piling Group rocks could no longer be distinguished from Archean basement rocks or Hudsonian granites.

Where leucogranite is intimately associated with Piling Group paragneiss, it commonly contains schistose biotite-fibrolite lenses, except in the region south of Ekalugad Fiord where sillimanite is absent and the leucogranite contains dispersed garnet and cordierite.

Charnockitic granite southwest of Cape Hooper gave a Rb-Sr isochron age of 1670 ± 30 Ma, probably recording the time of high grade Hudsonian metamorphism in the region (Jackson and Morgan, 1978).

Megacrystic Quartz Monzonite Several north-south trending plutons and many smaller sills and dykes of foliated biotite quartz monzonite with coarse feldspar augen occur south of Cape Hooper. The plutons are semiconformable but locally the dykes crosscut leucogranite in migmatitic paragneiss. Quartz monzonite contains a few xenoliths of apparent derivation from the Archean basement complex, suggesting the magmas may have been generated by fusion of basement rocks.

Megacrystic quartz monzonite probably is a member of the quartz monzonite-monzocharnockite suite (Jackson and Morgan, 1978) covering tens of thousands of kilometres of the granulite facies terrane south of Home Bay map area. Similar rocks near Pangnirtung gave a U-Pb zircon age of 1900 ± 20 Ma, interpreted as recording the pre-granulite facies igneous activity in the region (Pidgeon and Howie, 1975).

Pegmatite Dykes Postkinematic granite pegmatite dykes occur near and inside the anatectic front throughout the Home Bay map area. The dykes commonly intrude Archean basement rocks or the Piling Group quartzite unit. They have diverse trends and range up to 30 m wide and 1000 m long. These dykes are not shown on the geologic map (Fig. 23.2).

Diabase Dykes

Vertical northwest-southeast striking diabase dykes crosscut all other rocks in the region. The dykes are widespread but not common; they are generally less than 50 m wide but may be 50 km long. Their trend is parallel to the Hadrynian Franklin dykes of north Baffin Island (Fahrig et al., 1971), but the possibility exists that some of them may be related to Tertiary rifting in Davis Strait. They are not shown on the geologic map (Fig. 23.2).

Metamorphism

In the Home Bay map area metamorphic conditions ranged from greenschist to granulite facies. Greenschist facies is evident in rocks of the upper McBeth River and Dewar Lakes drainage areas where fine grained chlorite-biotite-quartz schist (metaturbidite) and muscovite quartzite occur. Because of the restricted composition of the rocks few indicator minerals occur in the Home Bay map area, signifying lower amphibolite facies metamorphism: andalusite and staurolite are very rare; one occurrence of andalusite-sillimanite was found in the Dewar Lakes region (Tippett, 1979).

The disappearance of muscovite and appearance of sillimanite in the presence of K feldspar is the first obvious indication that the rocks have reached upper amphibolite facies. Appearance of abundant sillimanite in quartz-rich rocks is closely followed in the field by a virtual "explosion" of anatectic leucosome in metaturbidites, transforming them into migmatitic paragneisses. The assemblage biotite-sillimanite-garnet is common in the schistose restite layers in the migmatite.

Note that the anatectic front drawn on Figure 23.2 signifying the appearance of migmatitic paragneiss occurs near the base of the Piling Group succession at Dewar Lakes, and rises stratigraphically in the sequence to the south and east. Careful mapping in the Dewar Lakes region shows that the anatectic front generally follows the trace of F_4 folds in the formational contacts. Farther east and north of Dewar Lakes the location of the front is less precisely drawn, but it does appear to swing northeast towards Alexander Bay and intersect the Piling basal quartzite unit. The front remains near the base of the Piling Group as it describes a broad arc north and west from Alexander Bay towards Barnes Ice Cap.

Granulite facies is achieved in at least some of the region of migmatitic granite along the south part of Home Bay map area. Especially south and east of Cape Hooper, the feldspars show the greasy lustre and grey-green colour typical of granulites. Here also, the leucogranitic layers in migmatitic paragneiss contain cordierite and garnet; and sillimanite appears to be absent from the rocks.

The sequence of metamorphic changes observed in the Home Bay map area seems to be typical of the Abukuma facies series, suggesting a high thermal gradient and relatively shallow depth of orogenic activity in Foxe Fold Belt.

Structure

Four sets of folds may be observed directly or may be inferred to be present from map patterns of Archean and Aphebian rocks in the Home Bay map area. Tippett (1978, 1979) and Morgan et al., 1976 reasoned that a pre-Piling deformation (Kenoran?) affected the Archean basement gneiss, but folds related to this (gneissosity-forming?) event were not recognized. The two earliest fold sets (F_1 and F_2) are isoclines that originally were recumbent, whereas the two latest sets (F_3 and F_4) are mainly horizontal normal folds with oppositely-dipping limbs.

F_1 and F_2 Folds

The earliest folds directly observed in the region are isoclines exhibiting axial-planar mineral foliation: these

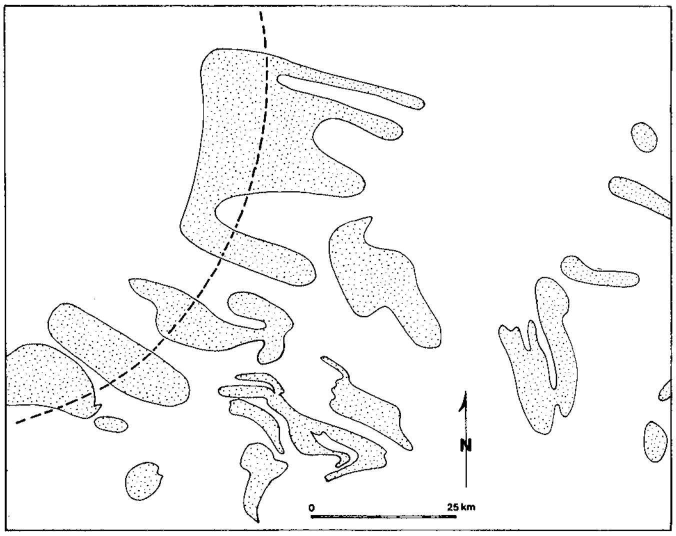

Figure 23.3. *Geological sketch map of the region around Dewar Lakes. Patterned areas are underlain by Piling basal quartzite and Archean basement gneiss. The heavy-dash line shows the apparent trace of an early (F_1 or F_2) anticlinal nappe hinge.*

F_1 folds occur mainly in basement-cover contact surfaces exposed near Dewar Lakes (D_2 folds of Tippett, 1978, 1979). The great majority of mesoscopic isoclines observed are classified as F_2 folds because both lithological layering and mineral foliation are folded isoclinally. Some very large recumbent folds drawn by Kranck (1955) from direct observations in McBeth, Clyde and Sam Ford fiords are F_2 structures.

Henderson et al. (1979) outlined some macroscopic isoclines in the region southwest of Ekalugad Fiord where overprinting relationships indicate that both F_1 and F_2 fold sets are present. Tippett (1978, 1979) correlated macroscopic imbrication of basement and cover rocks, as well as development of mineral foliation and lineation around Dewar Lakes with the F_1 set of folds. Because hinge zones of isoclines are seldom seen the distinction between macroscopic F_1 and F_2 folds is not apparent unless the two sets interfere.

F_3 and F_4 Folds

Both F_3 and F_4 folds typically are horizontal normal folds (i.e. folds with nonplunging axes and vertical axial surfaces) with oppositely-dipping limbs. They are set apart mainly by their different trends in regions of non-interference: F_4 folds strike northwest-southeast, and are developed best in the region between Dewar Lakes and Alexander Bay; F_3 folds strike northeast-southwest, and are developed best in the region between Barnes Ice Cap and McBeth Fiord. The dome-and-basin map pattern southeast of McBeth River resulted from type 1 interference (Ramsay, 1967) of nearly orthogonal macroscopic F_3 and F_4 folds. The order of the two-fold sets is rather arbitrarily defined because mesoscopic folds belonging to either set are rare, and no regionally consistent observations on their sequential development were made: perhaps they are coeval.

In previous reports (e.g. Tippett, 1978, 1979, and Henderson et al., 1979) no distinction between F_3 and F_4 folds was made. It is clear now that the change in regional strike of Foxe Fold Belt in Baffin Island from northeast-southwest to northwest-southeast resulted from different strikes of the two latest fold sets rather than a progressive change in strike of a single set of folds.

Geometric Significance of Fold Interference Patterns

The en échelon arrangement of F_4 domes northwest of Dewar Lakes may be controlled by their localization on the crest of an F_1 or F_2 basement-gneiss cored anticlinal nappe. Figure 23.3 shows the trace of the contact between lower and upper Piling Group lithologies. The dentate appearance of the aligned F_4 domal culminations terminating west of the heavy-dash line resembles outcrop patterns produced by superposition of late normal folds on an early recumbent fold nappe. The heavy-dash line parallels the apparent trend of the nappe hinge. An interference pattern of this sort was described by Reynolds and Holmes (1954) and classified as a type 2 interference pattern by Ramsay (1967). Farther north along the apparent nappe crest F_3 and F_4 folds interfere to produce the type 1 interference pattern previously mentioned.

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