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Geology of the Henik, Montgomery, and Hurwitz groups, Sealhole and Fitzpatrick lakes area, Nunavut[1]

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Abstract: Bimodal mafic-felsic volcanic rocks, consistent with rift and back-arc tectonic settings, form lenses in the lower Henik Group (Neoarchean). Emplacement of granitic bodies within the Henik Group was syn- to post-tectonic. Montgomery Group (age uncertain) conglomerate beds unconformably overlie Archean basement and are voluminous, suggesting fault-generated relief during sedimentation. Lower Hurwitz Group continental strata record Paleoproterozoic intracratonic basin expansion; locally preserved dolostone beds near the base of the predominantly fluvial Maguse Member (Kinga Formation) reflect a short-lived marine incursion. Pebbly arkose units between mature arenite beds of the Maguse and Whiterock members signify slope failure from basement monadnocks. Unusual feldspar megacryst-bearing gabbro sills in the Hurwitz Group were likely fed by hitherto unreported dykes which cut basement. Well foliated basement clasts in Montgomery and Hurwitz group conglomerate units imply deformation (likely Archean) before Paleoproterozoic dome-and-basin basement-cover infolding. Variably oriented folds and faults, including a duplex-like structure, accommodated constrictions arising from Paleoproterozoic concentric infolding.

Résumé : Des roches volcaniques bimodales mafiques-felsiques, compatibles avec des milieux tectoniques de rift et d'arrière-arc, forment des lentilles dans la partie inférieure du Groupe d'Henik (Néoarchéen). La mise en place des massifs granitiques dans le Groupe d'Henik a été syntectonique à post-tectonique. Les lits conglomératiques du Groupe de Montgomery (d'âge incertain) reposent en discordance sur le socle archéen et sont volumineux, ce qui suggère un relief produit par des failles lors de la sédimentation. Les strates continentales de la partie inférieure du Groupe d'Hurwitz témoignent d'une expansion paléoprotérozoïque du bassin intracratonique; des lits dolomitiques, préservés localement à la base du Membre de Maguse (Formation de Kinga) d'origine principalement fluviale, font état d'une brève transgression marine. Des unités d'arkose caillouteux interlitées avec des lits d'arénite mature des membres de Maguse et de Whiterock sont interprétées comme résultant de ruptures de pente sur des monadnocks du socle. Des filons-couches inhabituels de gabbro à mégacristaux de feldspath présents dans le Groupe d'Hurwitz auraient été alimentés par des dykes, jusqu'à maintenant non reconnus, qui recoupent le socle. Des clastes de socle bien foliés dans les unités conglomératiques des groupes de Montgomery et de Hurwitz attestent une déformation (probablement à l'Archéen) avant le replissement en dômes et bassins du socle et de la couverture au Protérozoïque. Des plis et failles d'orientations variées, y compris une structure du type duplex, ont accommodé les contrictions dues au plissement concentrique au Paléoprotérozoïque.

[1] Contribution to the Western Churchill NATMAP Project

INTRODUCTION

As part of the Western Churchill NATMAP Project, we herein present results of fieldwork that extends 1:50 000 scale mapping of Archean and Paleoproterozoic rocks southward from Hawk Hill Lake (Aspler and Bursey, 1990) to the Sealhole and Fitzpatrick lakes area (Fig. 1, 2). This work updates reconnaissance mapping by Eade (1973, 1974), and focuses on the paleogeographic and structural evolution of the Henik Group (Neoarchean), the Montgomery Group (age uncertain), and the Hurwitz Group (Paleoproterozoic).

Several rock bodies of particular significance are exposed in the Sealhole–Fitzpatrick lakes area. First, a bimodal mafic-felsic volcanic sequence was found in the lower part of the Henik Group. The bimodal character of this sequence is consistent with rift or back-arc models that have been proposed for other parts of the Henik Group. Second, a thick, coarse conglomerate-arkose unit, apparently separated from the Henik and Hurwitz groups by unconformities, was identified. This unit is likely equivalent to the Montgomery Group and provides evidence, lacking in the Montgomery Lake type area, of high relief generated by faulting. In addition, conglomerate in this subunit contain abundant well foliated, basement-derived clasts, implying that the Henik Group and related granitic rocks experienced significant deformation (likely Archean) before Paleoproterozoic overprinting. Third, bedded dolostone units were recognized in an unusually thick siliciclastic subunit near the base of the Maguse Member (Kinga Formation, Hurwitz Group). These carbonate rocks may signify a short-lived marine incursion that punctuated predominantly continental sedimentation of the Maguse Member. Fourth, an unusual pebbly arkose and conglomerate unit locally outcrops between mature arenite of the Maguse and Whiterock members of the Kinga Formation. This unit, previously documented only in the Padlei area, may represent gravity sliding of immature debris formed by the weathering of basement monadnocks that stood above a relatively low-relief alluvial plain, and subsequent reworking of this debris by fluvial processes. Finally, feldspar megacrysts, not previously identified in the regional swarm of gabbro sills that intrude the Hurwitz Group, are prominent in Hurwitz sills at Sealhole

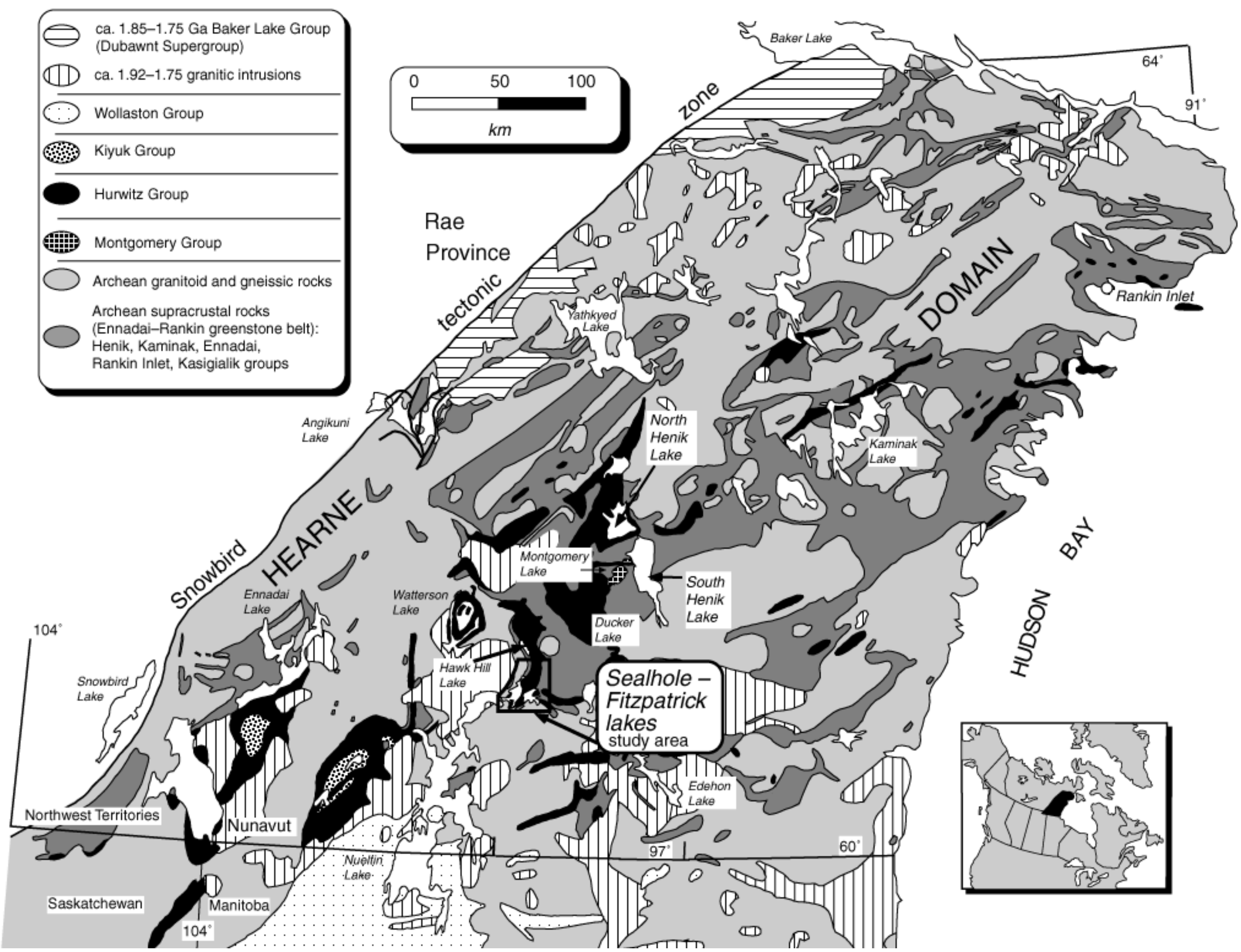

__Figure 1.__ Simplified geology of the Hearne Province, Nunavut (after Aspler and Chiarenzelli, 1996a), showing location of study area.

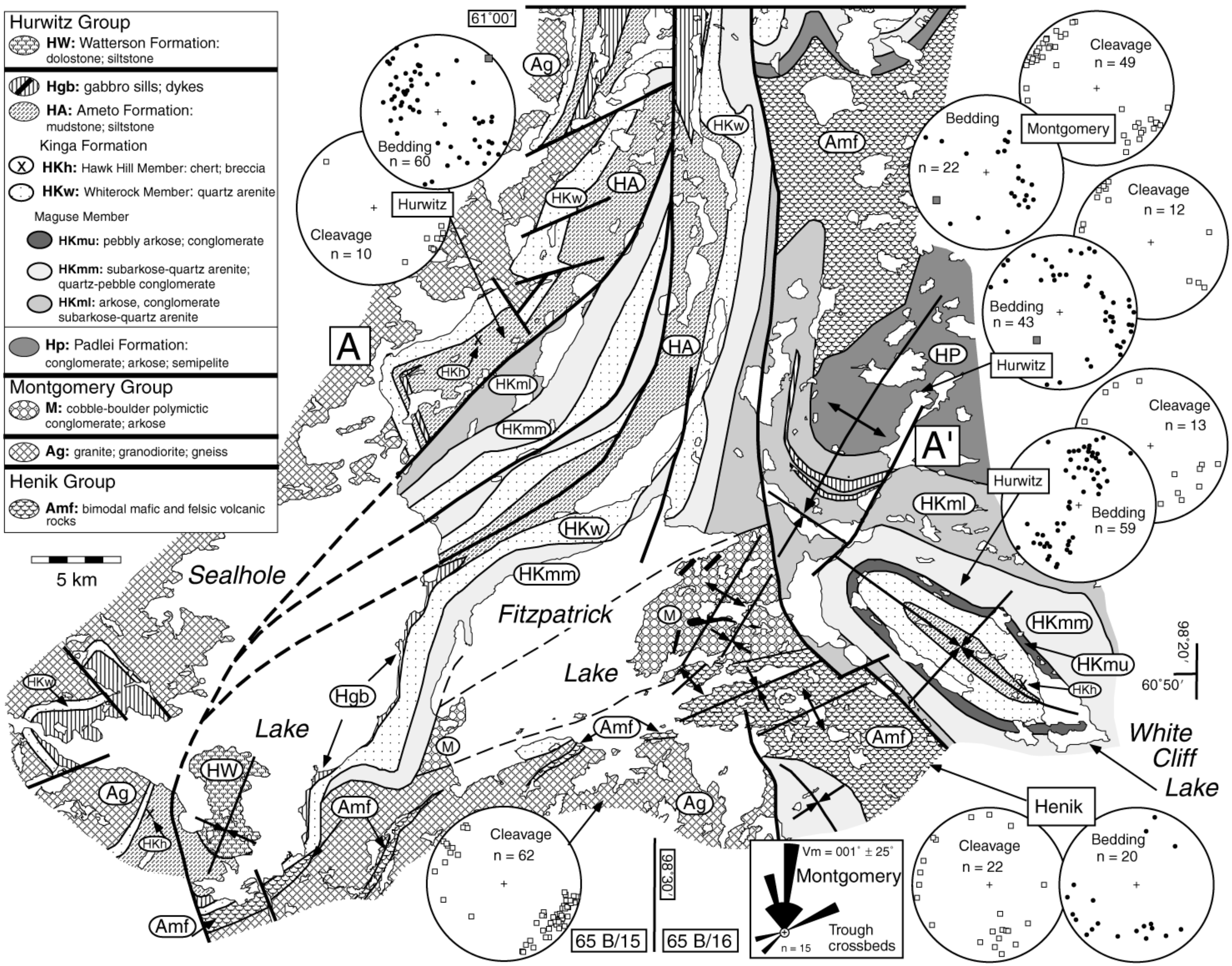

Figure 2A. *Simplified geological map, Sealhole and Fitzpatrick lakes area (NTS 65 B/15 and 65 B/16).*

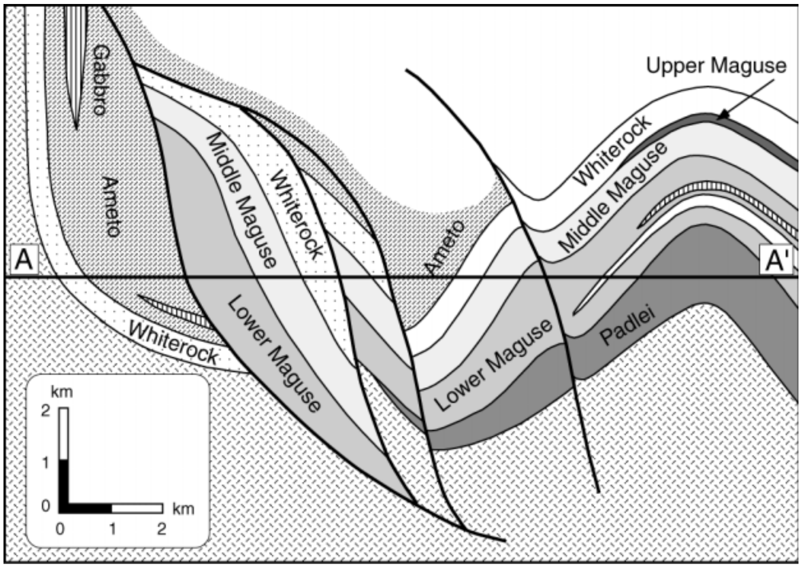

Figure 2B.

*Structural cross-section through the Hurwitz Group (*see *Fig. 2A for line of section).*

and Fitzpatrick lakes; in some outcrops the megacrysts define magmatic layering. In addition, hitherto unreported feeder dykes (also feldspar megacryst-bearing) to the Hurwitz gabbro sills were recognized.

HENIK GROUP AND ALLIED GRANITIC ROCKS (ARCHEAN)

North and east of Fitzpatrick Lake, the Henik Group is represented by a lower greenschist-facies bimodal mafic-felsic succession (Fig. 2). Mafic volcanic flows are predominant (about 90%), and consist of thickly bedded, fine-grained flows (±gabbro sills). Many of these flows display exceptionally well preserved pillow structures which locally contain variolites. Felsic flows form massive interlayers 1–10 m thick separating mafic flows several tens of metres thick. Interflow siliciclastic rocks (turbiditic sandstone and mudstone) and thin (<1 m) dolostone lenses are locally preserved.

This volcanic succession is near the base of, and likely forms a tongue within, a predominantly sedimentary subunit of the Henik Group exposed north of the map area near Hawk Hill Lake (Aspler and Bursey, 1990) and near Otter Lake (Aspler et al., 1994b) and informally referred to as 'unit A1' (Aspler and Chiarenzelli, 1996a). Subject to testing by geochemical and geochronological data, the bimodal character of the volcanic sequence is consistent with rift and back-arc basin models that have been proposed for the Henik Group (e.g. Aspler and Chiarenzelli, 1996a; Aspler et al, 1999b).

South of Sealhole and Fitzpatrick lakes, highly strained mafic volcanic rocks define dismembered lozenges within well foliated biotite-hornblende granitic rocks (Fig. 2). Contacts are faulted, but the volcanic rocks are inferred to be older because they are cut by granitic dykes and occur as enclaves in the granite at all scales. Granitic gneiss units are exposed beneath the Hurwitz Group on the western side of Sealhole Lake. The relationship of these gneiss units to the granitic rocks that cut the Henik Group is unknown.

MONTGOMERY GROUP (AGE UNCERTAIN)

A unit of polymictic conglomerate and arkose, up to 2000 m thick, overlies Henik Group strata east of, and extending across, Fitzpatrick Lake (Fig. 2). Although not exposed, the lower contact of this unit is inferred to be an angular unconformity because its map trace appears to truncate folds and fabrics in the Henik Group (Fig. 2), and because the conglomerate contains foliated clasts that are indistinguishable from subjacent basement.

Near the base of the unit, massive, thickly bedded, framework-intact cobble-boulder conglomerate units containing a coarse arkose matrix are predominant, and arkose units define local decimetre- to metre-scale lenses (Fig. 3). The conglomerate units contain clasts that are representative of subjacent basement sources and consist mainly of granitic fragments (up to 90%) with variable amounts of mafic volcanic, gabbro, and felsic volcanic debris. The clasts are subangular to well rounded; maximum sizes are up to 1 m. Significantly, many contain an internal penetrative foliation (*see* below). The relative abundance of conglomerate decreases gradually upsection such that near the top of the unit, arkose is predominant. The arkose units form decimetre- to metre-scale parallel-stratified and trough cross-stratified sheets (Fig. 3D) containing local single pebble-cobble layers and metre-scale lenses of conglomerate. Sparse (n = 15) data from trough crossbeds indicate mainly northward paleoflow (Fig. 2A).

Syndepositional faulting likely generated the relief necessary for the accumulation of these thick, coarse conglomerate-bearing strata, and we interpret this sequence to have been deposited on alluvial fans that drained northward from east-trending fault scarps cut into Archean basement. The lower part of the section is considered to reflect a proximal fan setting in which repeated low-viscosity flash floods produced amalgamated stacks of framework-intact, coarse sand matrix-bearing cobble-boulder conglomerate, as entrenched channel, bar, and diffuse sheet deposits. Local arkose lenses likely represent incompletely preserved channel- and bar-top

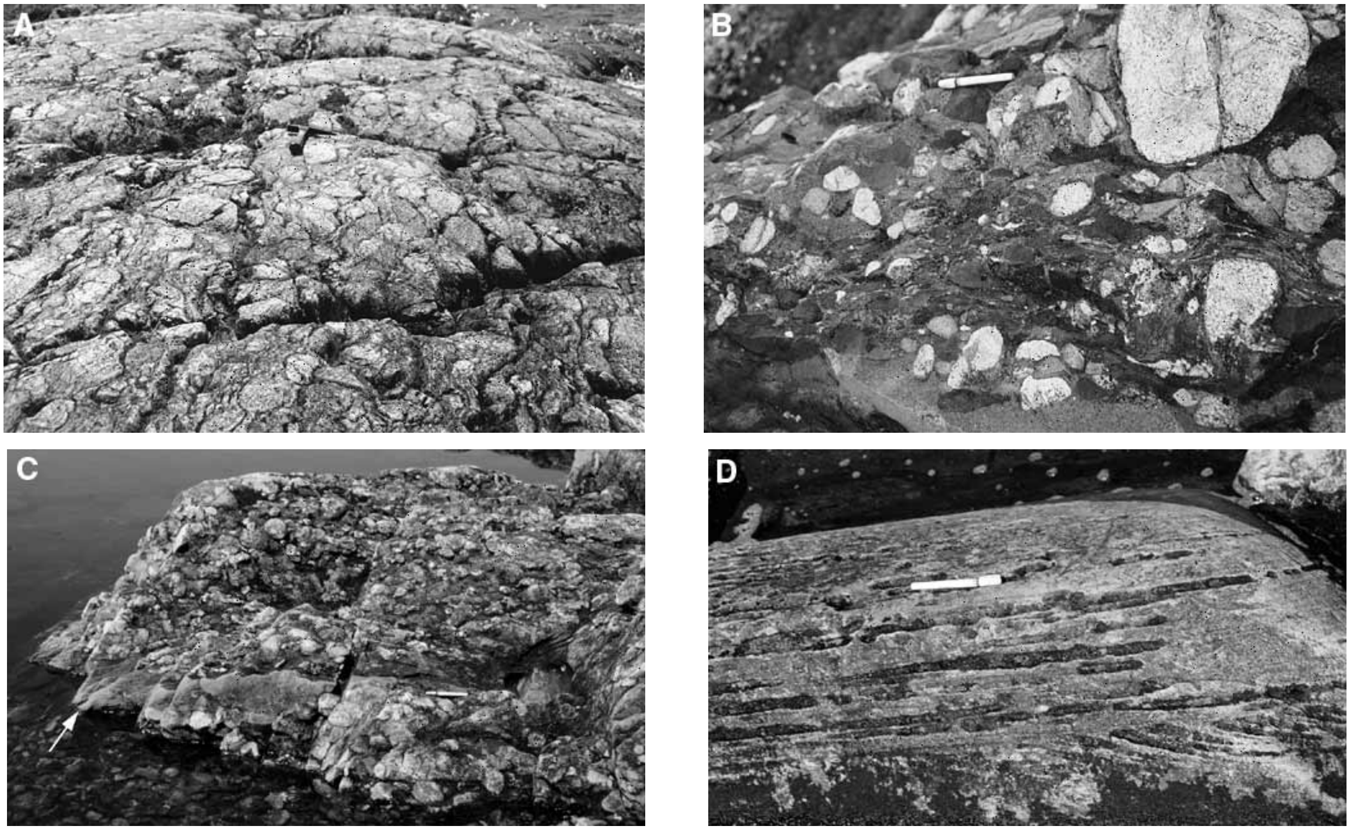

***Figure 3.** Montgomery Group. **A**) Massive, thickly bedded, framework-intact, predominantly granitic cobble-boulder conglomerate. **B**) Polymictic conglomerate with granitic, mafic volcanic, felsic volcanic, and gabbroic clasts. **C**) Amalgamated conglomerate channels with thin remnant sand wedge (arrow). **D**) Parallel-stratified and trough cross-stratified arkose.*

(waning flood) wedges. An overall fining-upward trend probably reflects scarp retreat; arkose (±conglomerate) units in the upper part of the section are considered to be medial to distal fan deposits formed by flash floods.

The relationship of this unit to the Hurwitz Group is uncertain because of faulted contacts and covered intervals. However, an unconformity is inferred because the unit is lithologically distinct from basal Hurwitz Group units in the area, and because it forms an isolated wedge that appears to be discordant with respect to lower Hurwitz Group strata. Hence the unit is interpreted to constitute an outlier of the Montgomery Group which, in its type area at Montgomery Lake (Fig. 1), is separated from the overlying Hurwitz Group by an angular unconformity (Aspler and Chiarenzelli, 1996b). At Montgomery Lake, the Montgomery Group consists of lithic arenite and lithic wacke (principal fluvial facies), local basal breccia (talus around paleohills), discontinuous lenses of polymictic conglomerate (basal channel-fill), and lenses of interbedded litharenite and siltstone (lacustrine facies; *see* Aspler et al., 1992). These rocks define a fluvial system that lacked significant fault-generated relief (Aspler and Chiarenzelli, 1996b), in marked contrast to the voluminous coarse conglomerate and arkose units at Fitzpatrick Lake, which indicate surface faulting. Whether the Montgomery Group represents a late Neoarchean molassic sequence or a Paleoproterozoic precursor to the Hurwitz Group remains unclear.

HURWITZ GROUP (PALEOPROTEROZOIC)

Unconformably overlying the Henik and Montgomery groups, the Hurwitz Group is an assemblage of siliciclastic and carbonate rocks that were deposited in a continental to shallow-marine intracratonic basin that once blanketed a large part of the Hearne domain (Fig. 1). The maximum age of Hurwitz Basin is defined by ca. 2.45 Ga baddeleyite (Heaman, 1994) from the Kaminak dykes that cut basement rocks but not the Hurwitz Group (Davidson, 1970). Previously (e.g. Aspler and Chiarenzelli, 1997a), sedimentation was thought to have entirely predated emplacement of a regionally extensive set of gabbro sills within the Hurwitz Group, dated at 2111 ± 1 Ma (baddeleyite; Heaman and LeCheminant, 1993). However, ongoing SHRIMP studies of detrital zircons indicate that upper parts of the Hurwitz Group (above Ameto Formation, Table 1) are significantly younger than 2.1 Ga (W. Davis, R. Rainbird, J. Chiarenzelli, and L. Aspler, unpub. data, 1999). To be presented in forthcoming papers, the SHRIMP data have dramatic implications for the

Table 1. Description and environmental interpretation of Hurwitz Group strata exposed in the Sealhole–Fitzpatrick lakes area.

GROUP	UNIT	DESCRIPTION	COMMENT/INTERPRETATION
HURWITZ GROUP	WATTERSON FORMATION	Mixed siliciclastic-carbonate facies comprising millimetre- and centimetre-scale massive dololutite and stratified calcisiltite that is rhythmically interlayered with siliciclastic siltstone and mudstone, and occurs at the tops of very fine, parallel-stratified (± ripple drift cross-stratified) sandstone-siltstone-mudstone fining-upward sequences. Local gutter casts at base of fining-upward sequences filled with intraclastic calcirudite breccia. Abundant soft-sediment deformation: load casts and flame structures; calcisiltite dykes with wall-parallel internal layering.	Below wave-base carbonate and siliciclastic mass flows
HURWITZ GROUP	GABBRO	Discontinuous coarse-grained gabbro sills. Unique occurrences of feldspar megacrysts, commonly in layers concordant with bedding in adjacent units. Layers locally display normal grading (Fig. 7). Feldspar-megacryst gabbro dykes In Montgomery Group are likely feeders to sills.	2111 ± 0.6 Ma (Heaman and LeCheminant 1993). Postdates lithification of Ameto Formation; predates deposition of Watterson Formation. Folded with Hurwitz Group.
HURWITZ GROUP	AMETO FORMATION	Frost-heaved mudrocks in Sealhole–Fitzpatrick lakes area, but immediately north at Hawk Hill Lake, varicoloured siltstone, mudstone, calcisiltite in fining-upward sequences.	Below fair-weather wave-base mass flow deposits.
HURWITZ GROUP	KINGA FORMATION: Hawk Hill Member	Discontinuous unit of bedded white chert, maroon chert, and chert breccia conformably between the Whiterock Member and Ameto Formation. Discordant hematitic breccia at top of Whiterock Member.	Sinters formed by surface discharge of hot springs (Aspler and Chiarenzelli, 1997a).
HURWITZ GROUP	KINGA FORMATION: Whiterock Member	Supermature quartz arenite. Lower part of section commonly massive, upper 200 m with ubiquitous wave ripples. Paleodepth calculations based on symmetric, vortex orbital ripples indicates depths of 2 cm to 2 m for the entire sequence (Aspler et al., 1994a).	Vast, hydrographically open, tide-free, fresh-water series of lakes.
HURWITZ GROUP	KINGA FORMATION: Maguse Member, Upper	Massive polymictic pebbly sandstone with angular to subrounded basement granules and pebbles (10–50%) dispersed in arkose matrix (Fig. 6) . Local parallel-stratified arkose and framework-intact pebble-cobble conglomerate with well rounded clasts and arkose matrix.	Abrupt appearance and limited extent suggest variably reworked immature detritus derived from slope failure within regolith over basement monadnocks isolated above fluvial plain.
HURWITZ GROUP	KINGA FORMATION: Maguse Member, Middle	Maroon, pink, grey subarkose to quartz arenite; interbeds of white quartz arenite at top. Local black parallel and cross-stratified heavy mineral bands. Quartz-pebble conglomerate with clasts of well rounded spherical white quartz, jasper, and blue and grey chert.	High-energy unchanneled sheet floods draining low-relief paleotopography. Textural and compositional maturity from repeated reworking and long residence times at sites of temporary storage: intense mechanical abrasion — chemical weathering before final deposition.
HURWITZ GROUP	KINGA FORMATION: Maguse Member, Lower	Parallel-stratified metre-scale sheets of arkose, subarkose, and quartz arenite. Polymictic framework-intact and framework-disrupted pebble-cobble conglomerate (coarse sandstone matrix). Local graded channels. Quartz-pebble conglomerate. Fifty metre interval near base: decimetre- to metre-scale beds of subarkose alternate with carbonate-rich beds comprising centimetre- to decimetre-scale layers of massive and microbial laminated dololutite (± chert laminae) and centimetre-scale siliciclastic sand lenses (Fig. 5).	High-energy unchanneled sheet floods; mixture of relatively immature and mature sediment due to variation in degree of reworking on fluvial plain. Carbonate-rich interval: remnant of mixed siliciclastic-carbonate sequence marking marine incursion that punctuated continental sedimentation.
HURWITZ GROUP	PADLEI FORMATION	Stratified polymictic conglomerate; arkose; millimetre- to centimetre-scale sandstone-siltstone rhythmites.	Cold climate (?proglacial) fluvial deposits (*see* Aspler and Chiarenzelli, 1997a).
MONTGOMERY GROUP		At base: massive, thickly-bedded, framework-intact cobble-boulder conglomerate with local arkose lenses. Clasts (to 1 m) representative of subjacent basement; many with predepositional tectonic fabric. At top : mainly parallel and cross-stratified arkose with local conglomerate. Northward paleocurrents.	Proximal to distal alluvial fan sedimentation leading northward from syndepositional fault scarps.
Granite; granodiorite; granitic gneiss		Well-foliated biotite-hornblende granite granodiorite; locally gneissic. With mafic volcanic enclaves at all scales. Satellite dykes crosscut volcanic rocks; some contain same penetrative fabric as volcanic rocks, others are discordant.	Undated; likely Archean. Syn- to post-tectonic emplacement.
HENIK GROUP	A1	Bimodal mafic-felsic volcanic rocks. Predominantly fine-grained flows, commonly pillowed, variolitic. Interlayered with felsic flows 1–10 m thick. Local interflow sedimentary rocks.	Tongue near base of predominantly sedimentary "A1" subunit (*see* Aspler and Chiarenzelli, 1996a).

evolution of Hurwitz Basin in relation to processes in bounding orogens, and for regional correlations of Paleoproterozoic units within the Churchill Province. Although previous suggestions regarding basin initiation (Noomut, Padlei, Kinga, and Ameto formations) by lithospheric stretching related to breakup of a possible Neoarchean supercontinent (Kenorland; Aspler and Chiarenzelli, 1997a, 1998) remain tenable, it now appears that the uppermost units (Watterson and Tavani formations) were deposited during assembly of Laurentia. Descriptions and environmental interpretations of Hurwitz Group strata exposed in the Sealhole–Fitzpatrick lakes area are summarized in Table 1. Below we focus on stratigraphic relationships and unusual units of limited regional extent.

Similar to relationships in the Hawk Hill Lake area (Aspler and Bursey, 1990), changes in Hurwitz Group stratigraphy coincide with changes in basement rock type. In the eastern and northern parts of the area, where the Archean basement consists of supracrustal rocks, units underlying Whiterock Member are up to 3000 m thick (Fig. 2, 4). These units thin abruptly to the south and west where granitic rocks are the predominant substrate, and in southern Fitzpatrick Lake and southern and western Sealhole Lake, the Whiterock Member directly onlaps basement (Fig. 2, 4). This suggests that the substrate strongly influenced paleotopography, with paleohighs sited above granitic rocks and paleolows above supracrustal rocks.

The thick section in the eastern and northern parts of the area is partly a consequence of extensive Padlei Formation conglomerate, arkose, and sandstone-siltstone rhythmite deposits. In addition, restricted subunits appear at both the base and top of the Maguse Member (Fig. 2, 4). The lower subunit (about 1200 m thick) contains arkose and polymictic pebble conglomerate sheets as well as the subarkose to quartz arenite and quartz-pebble conglomerate beds typical of the Maguse Member (Table 1). Mixing of relatively immature and mature arenite units in this subunit likely reflects variation in degree of reworking and residence time at sites of temporary storage on the Maguse Member fluvial plain. Near the base of this subunit is a 50 m thick interval in which decimetre- to metre-scale sheets of subarkose separate beds of dololutite (±microbial laminite) containing centimetre-scale sandstone lenses (Fig. 5, Table 1). With the exception of similar beds near Rankin Inlet (Ryan et al., 1999), and calc-silicate rocks west of Edehon Lake (Eade, 1973), carbonate rocks have not been reported from elsewhere in the Kinga Formation. The carbonate-bearing beds are inferred to represent the remnants of a mixed siliciclastic-carbonate sequence that was deposited during a short-lived marine incursion of the Maguse Member fluvial plain. This incursion was likely regional, but because of reworking by subaerial processes, evidence of its former extent is only locally preserved. At the top of the Maguse Member near White Cliff Lake (Fig. 2) is an approximately 175 m thick subunit, previously recognized only in the Padlei map area (Aspler and Chiarenzelli, 1997a), that consists of polymictic pebbly arkose and conglomerate containing primarily granitic and mafic volcanic clasts (Fig. 6, Table 1). The abrupt but local appearance of compositionally and texturally immature rocks above a thick

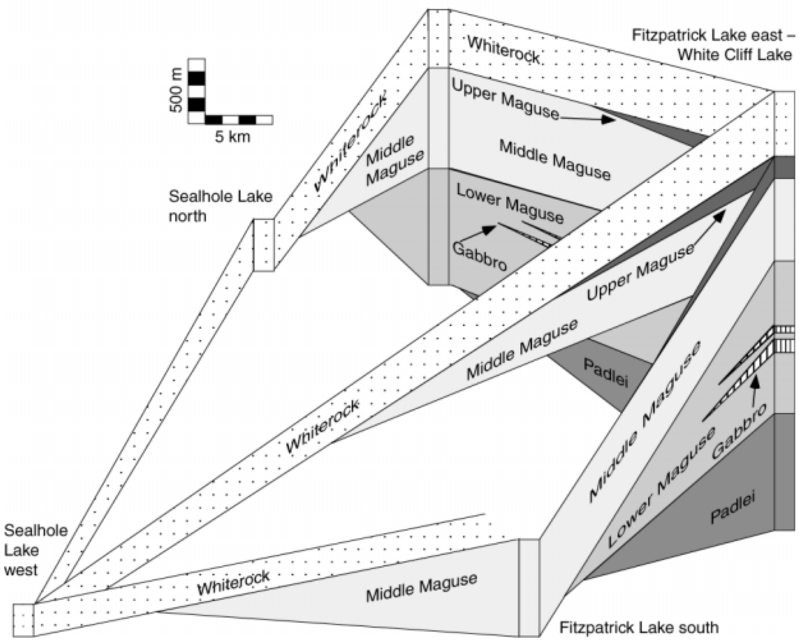

Figure 4.

Fence diagram illustrating stratigraphic variation of the Hurwitz Group underlying the Ameto Formation, Sealhole–Fitzpatrick lakes area. Thicknesses are best estimates based on map data; plotted on nonpalinspastic base.

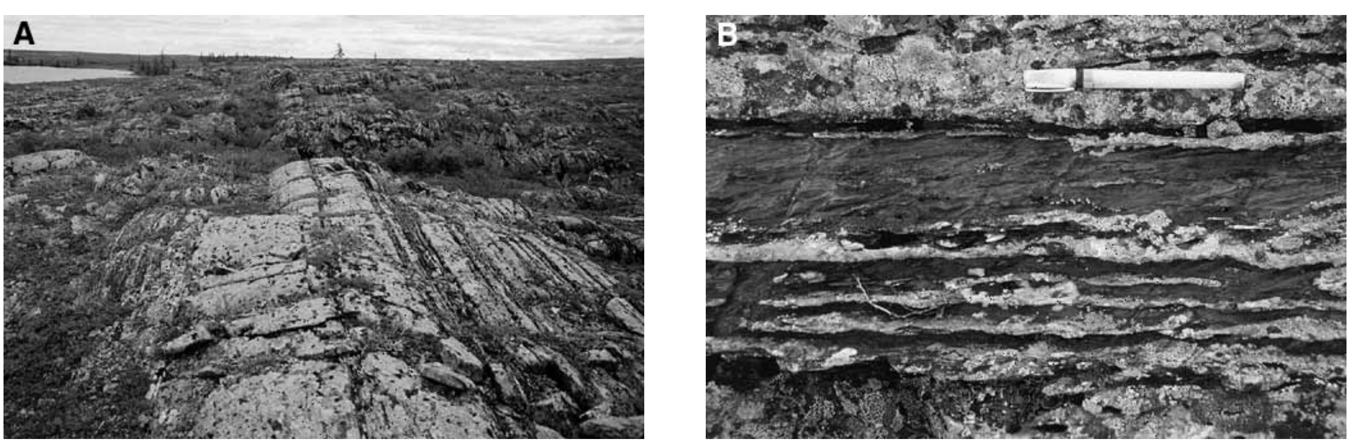

Figure 5. *Carbonate-bearing beds in lower Maguse Member, Hurwitz Group.* ***A****) Laterally continuous sheets of subarkose alternating with dolostone-rich intervals (dark-toned, recessive weathering).* ***B****) Close-up of dolostone-rich interval in A) in which sand-free dololutite alternates with discontinuous sandstone layers; note starved ripples, lower right.*

section of relatively mature subarkose and quartz arenite is unusual. We suggest that the abrupt and local influx of immature debris was due to slope failure of an immature regolith developed on basement monadnocks isolated above the Maguse Member fluvial plain, and that this subunit represents variably reworked debris introduced by gravity slides, as described from elsewhere by Bürgisser (1984). An origin by syndepositional faulting is considered unlikely because of the local nature of these deposits and because the conglomeratic component contains relatively small clasts.

Gabbro sills extend as discontinuous pods within the Hurwitz Group for a strike length of about 450 km, from the Rankin Inlet area southwest to Watterson Lake (Fig. 1). Typically within the Ameto Formation, the sills also occur in the lower part of the Maguse Member east of Fitzpatrick Lake, and directly above the Whiterock Member at Sealhole Lake (Fig. 2). In many of these outcrops, the gabbro units display centimetre-scale feldspar megacrysts, a feature not previously recognized elsewhere in the Hurwitz gabbro units (Fig. 7). On the eastern shore of Sealhole Lake, such megacrysts are distributed in layers concordant to bedding in

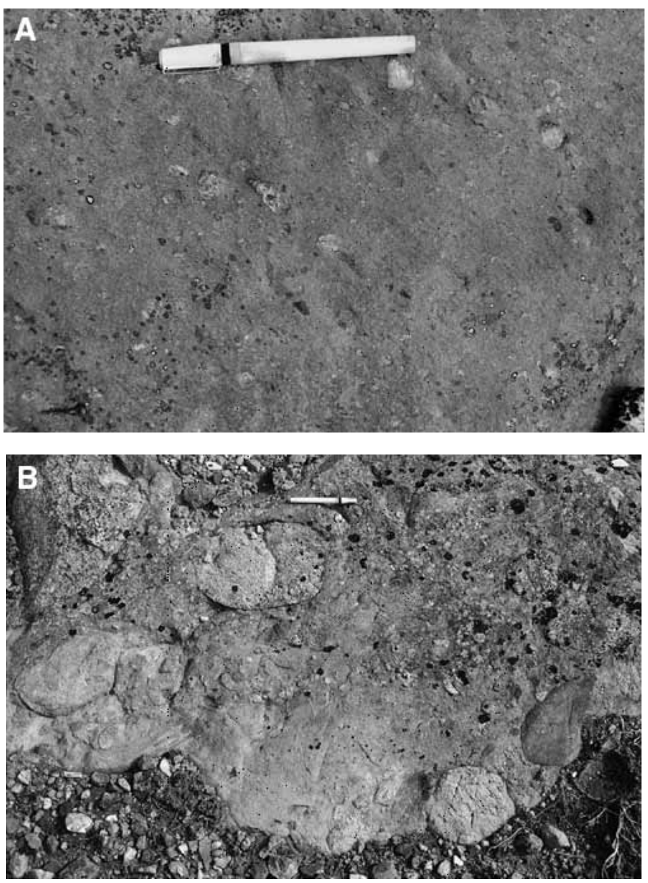

Figure 6. *Unusual conglomeratic unit between Maguse and Whiterock members, east of Fitzpatrick Lake.* ***A****) Angular to subrounded granitic and mafic volcanic granules and pebbles dispersed in arkose matrix.* ***B****) Well rounded granitic and mafic volcanic pebbles and cobbles dispersed in arkose matrix.*

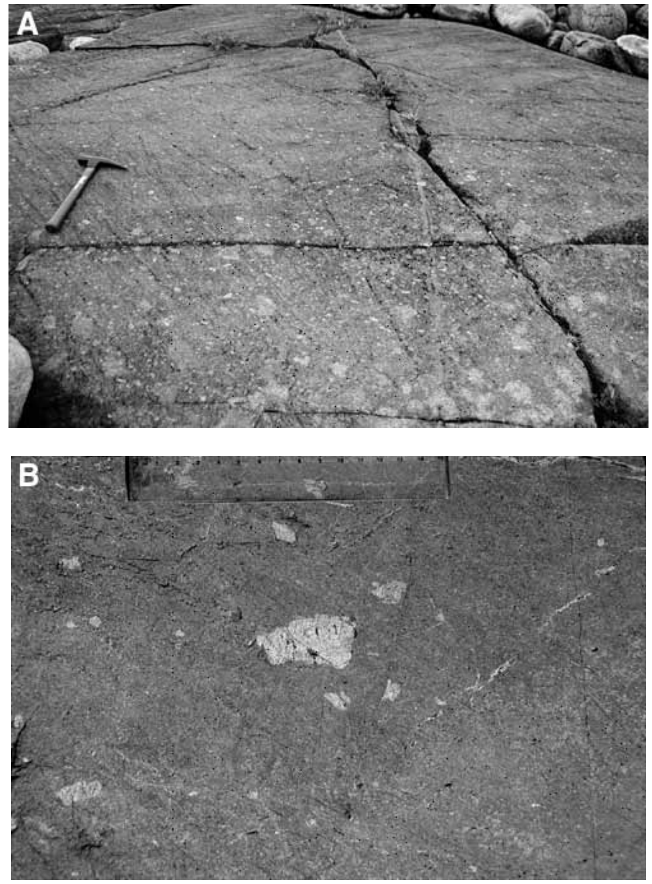

Figure 7. *Megacryst-bearing Hurwitz gabbro.* ***A****) Gabbro sill with feldspar megacrysts distributed in layers. Note apparent grading defined by decrease in size and concentration of megacrysts to top.* ***B****) Feldspar megacrysts in a gabbro dyke presumed to be a feeder to the lithologically similar sills.*

subjacent strata; some of these layers define graded beds (Fig. 7A). Feeder dykes to the gabbro sills have not hitherto been reported, but megacryst-bearing, north- and northeast-trending dykes that are indistinguishable from the gabbro sills outcrop east of Fitzpatrick Lake (Fig. 2), and we suggest that these are rare examples of feeder dykes.

STRUCTURE

Evidence for Archean deformation, and at least one episode of Paleoproterozoic deformation, is preserved in the Sealhole–Fitzpatrick lakes area.

Archean deformation: Henik Group and allied granitic rocks

Three lines of evidence suggest pre-Paleoproterozic deformation of Archean rocks. First, Montgomery Group and lower Hurwitz Group conglomerate units contain abundant well foliated basement-derived granitic and volcanic clasts. Second, east of Fitzpatrick Lake, east-northeast-trending folds and fabrics in the Henik Group are deflected and truncated by northwest-trending structures in the Hurwitz Group. Third, adjacent to the large granitic body south of Sealhole and Fitzpatrick lakes, granitic dykes cut mafic volcanic rocks. Some granitic dykes are folded with, and contain the same northeast-trending penetrative fabric as, the volcanic rocks, whereas other such dykes crosscut the penetrative fabric. Hence, deformation and granite emplacement appear to have overlapped in time. Although the granitic rocks are undated, they are unconformably beneath the Hurwitz Group and are interpreted to be Archean, and thus deformation was probably Archean. Northeast-trending fabrics in Archean rocks south of Sealhole and Fitzpatrick lakes (Fig. 2) are subparallel to some structures in the Hurwitz Group, indicating that Archean and Paleoproterozoic deformation was, in part, coaxial.

(?)Paleoproterozoic deformation: Montgomery Group

Rocks of the Montgomery Group are deformed by northeast-trending folds and related fabrics that are subparallel to structures in the Hurwitz Group (Fig. 2). We cannot specify with certainty that these structures postdate the Hurwitz Group because they may represent an earlier event such as recorded in the Montgomery Group type area. However, the Hurwitz gabbro dykes that cut the Montgomery Group contain cleavage parallel to cleavage in host strata, and hence we infer that the deformation recorded in the Montgomery Group is Paleoproterozic.

Paleoproterozoic deformation: Hurwitz Group

Detailed mapping in the Watterson (Aspler et al., 1993b), Hawk Hill (Aspler and Bursey, 1990), Otter (Aspler et al., 1994b), Henik (Aspler and Chiarenzelli ,1997b; Aspler et al., 1999a), Padlei (Aspler et al., 1993a), and Kaminak (Hanmer et al., 1998) areas (Fig. 1) has shown that many Hurwitz Group outliers constitute the synformal keels of doubly plunging basement-cover infolds and that, with the exception of local out-of-syncline slip, the Hurwitz Group is welded to its basement. At a simplified level, structures postdating the Hurwitz Group in the Sealhole–Fitzpatrick lakes area define a northerly trending basement-cover synclinorium (Fig. 2). At a detailed level however, the structure is more complex, and variably oriented folds and faults reflect heterogeneous strain from shortening of a lithologically anisotropic assemblage of nonuniform thickness.

The structural grain of the area is controlled by northeast- and north-trending folds, high-angle faults and cleavage (Fig. 2). Folds are open, concentric, and locally display a box-like morphology. Axial surfaces are steep, and hinge lines plunge gently to the north and south. Plunge reversals about northwest trends produce dome-and-basin (type 1) interference structures, but a northwest-trending cleavage has not been observed, and the near-vertical, northeast-trending cleavage surfaces are undeflected about northwest trends. This interference style, best exemplified by a northwest-elongate canoe-shaped syncline northwest of White Cliff Lake (Fig. 2), probably represents culmination and depression growth during progressive folding rather than discrete ‘D_1’ and ‘D_2’ events. Near the core of the synclinorium, high-angle north- and northeast-trending faults display both reverse and normal offsets (Fig. 2). Approximately 10 km north of Fitzpatrick Lake, one fault branches into three splays that rejoin along strike farther south in Sealhole Lake (Fig. 2). Together the faults define a duplex-like structure in which individual splays separate repeated lower Hurwitz Group panels (Fig. 2). This duplex-like structure probably formed to accommodate constrictions in the core of the main synclinorium. Similarly, variably oriented high-angle oblique-slip cross faults, particularly common where the section underlying Whiterock Member is thin or nonexistent (e.g. southwestern Sealhole Lake; Fig. 2), typically fan around fold-hinge zones and likely were formed to accommodate fold tightening during concentric folding.

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