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Proterozoic reworking in a portion of the western Churchill Province, Akunak Bay area, Nunavut[1]

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Abstract: Neoarchean polydeformed lithologies in the study area comprise amphibolite-facies sedimentary and mafic volcanic supracrustal rocks, tonalitic orthogneiss, and variably deformed gabbro to granite plutons. Metamorphosed ca. 2.19 Ga mafic dykes, and relatively undeformed ca. 1.83 Ga granite and (?)co-magmatic lamprophyre dyke-swarms record Proterozoic igneous events. A mylonitized layered anorthosite-gabbro-mafic granulite suite, the Uvauk complex, structurally overlies part of the orthogneiss terrane.

At least four deformation events (D_1–D_4) are recognized. Associated structures include an isoclinal, doubly plunging, east-southeast-trending fold set (F_1) which is coaxially refolded by open to tight folds (F_2). They are modified by northeast-trending open F_3 and north-trending F_4 fold sets. Amphibolite-facies, east- and north-northeast-trending, high-strain zones, and east- and northwest-trending faults transect the region. The ca. 2.19 Ga mafic dykes cut the D_2 fabrics and the Akunak Bay shear zone and were affected by D_3 and D_4. The ca. 1.83 Ga magmatism, in part, postdates D_4.

Résumé : Les lithologies polydéformées néoarchéennes dans la région étudiée comprennent des roches sédimentaires et volcaniques mafiques supracrustales du faciès des amphibolites, des orthogneiss tonalitiques et des plutons gabbroïques à granitiques variablement déformés. Des dykes mafiques métamorphisés datant d'environ 2,19 Ga et des essaims de dykes de granite et de lamprophyre (?)co-magmatique (environ 1,83 Ga) relativement non déformés témoignent d'activité ignée au Protérozoïque. Le complexe d'Uvauk, une suite mylonitisée stratiforme de granulite mafique, de gabbro et d'anorthosite, recouvre stucturellement une partie du terrane d'orthogneiss.

On peut reconnaître au moins quatre épisodes de déformation (D_1 à D_4). Les structures associées comprennent un jeu de plis isoclinaux à double plongement et à orientation est-sud-est (F_1) qui a été replissé de façon coaxiale par des plis ouverts à serrés (F_2). Ces plis sont modifiés par des ensembles de plis ouverts à orientation nord-est (F_3) et de plis à orientation nord (F_4). Des zones de fortes contraintes à orientation est-nord-est et nord-nord-est, métamorphisées au faciès des amphibolites, et des failles à orientation est et nord-ouest recoupent la région. Les dykes mafiques d'environ 2,19 Ga recoupent les fabriques D_2 et la zone de cisaillement de la baie d'Akunak et ont été touchées par les déformations D_3 et D_4. Le magmatisme (environ 1,83 Ga) est en partie postérieur à la déformation D_4.

[1] Contribution to the Western Churchill NATMAP Project

INTRODUCTION

This report summarizes preliminary results of bedrock mapping completed at a scale of 1:50 000 during the 1999 field season in parts of Akunak Bay area (Fig. 1). The principal objectives are to upgrade the reconnaissance database and to evaluate the nature and tectonothermal reworking of Archean rocks during the Proterozoic. This work represents the third and final year of the Geological Survey of Canada's (GSC) field component for the western Churchill NATMAP project, initiated in 1997 as a collaborative program involving the GSC, the Government of the Northwest Territories (GNWT), and the Indian and Northern Affairs Canada (INAC). The Akunak Bay area (Fig. 1, 2) is part of a region previously mapped at 1:250 000 scale (Tella and Schau, 1994) or smaller (Wright, 1967; Reinhardt et al., 1980). The results of recent work in the adjoining portions to the west and east were reported by Hanmer et al. (1999a, b), Ryan et al. (1999), Tella and Annesley (1987, 1988), and Tella et al. (1993, 1997a, b; 1999; references therein).

LITHOLOGY

Geological overview

The Akunak Bay area (Fig. 2, 3) includes previously mapped eastern portions of the Archean MacQuoid–Gibson supracrustal belt, Big Lake shear zone, and the Cross Bay plutonic complex (Tella et al., 1997a, b, 1999; Hanmer et al., 1999a). The region is underlain by Neoarchean, amphibolite-facies, polydeformed sedimentary and mafic volcanic rocks (units 1, 2), tonalitic orthogneiss (unit 3), and tonalite plutons (unit 4). North of Akunak Bay, across the Chesterfield Inlet, a polydeformed and metamorphosed, layered gabbro-mafic granulite-anorthosite complex, the Uvauk complex (unit 5; Tella et al., 1993; Tella and Schau, 1994; Mills et al., 1999), structurally overlies part of the orthogneiss (unit 3) terrane. Several generations of relatively undeformed felsic and mafic intrusions (augen granite, diorite, gabbro; units 6–9) of Neoarchean and/or Paleoproterozoic age are exposed throughout the region. East- and north-northeast- trending, ductile high-strain zones (unit 10) are sporadically distributed. An east-trending, metamorphosed mafic dyke swarm (unit 11; correlative to ca. 2.19 Ga MacQuoid dykes; Tella et al., 1997a), several quartz-monzonite (unit 12) to granite (unit 13) intrusions, and ultrapotassic lamprophyre dykes (too small to be represented on Fig. 2, 3) record relatively younger Proterozoic magmatic activity. The mafic dyke swarm, which cuts two sets of Archean structural fabrics, is subsequently metamorphosed and affected by at least two deformation events, suggesting that significant Paleoproterozoic tectonothermal events affected older Archean rock units in the Akunak Bay region.

Metasedimentary and mafic volcanic supracrustal rocks (units 1, 2)

The tectonic setting, distribution, and field characteristics of these supracrustal rock units were previously described (Tella et al., 1993; Tella and Schau, 1994). The current study revises the map distribution of these units and provides a better structural framework. Between Akunak Bay and Butts Lake (Fig. 2), the polydeformed metasedimentary rocks (unit 1) and intercalated mafic volcanic rocks (unit 2) are exposed in a northwest-trending, polydeformed belt (Fig. 2, 3), which is truncated to the west by a north-northwest-trending fault that extends towards Little Big Island. West of this tectonic break, planar fabrics (Fig. 3, 4) trend northeast with moderate to steep dips (> 45°) both to the northwest and southeast. To the east and south, the metasedimentary rocks and associated mafic volcanic rocks were intruded by felsic plutons (unit 13). The metasedimentary rocks consist of biotite+garnet+plagioclase+quartz±sillimanite schist and biotite granofels with locally developed garnet layers, oxide iron-formation, and subordinate intercalated amphibolite. The garnet-rich layers contain small amounts of arsenopyrite (gossan zones, Fig. 2). Minor structures in supracrustal rock units (1, 2) include east-southeast-trending, coaxially

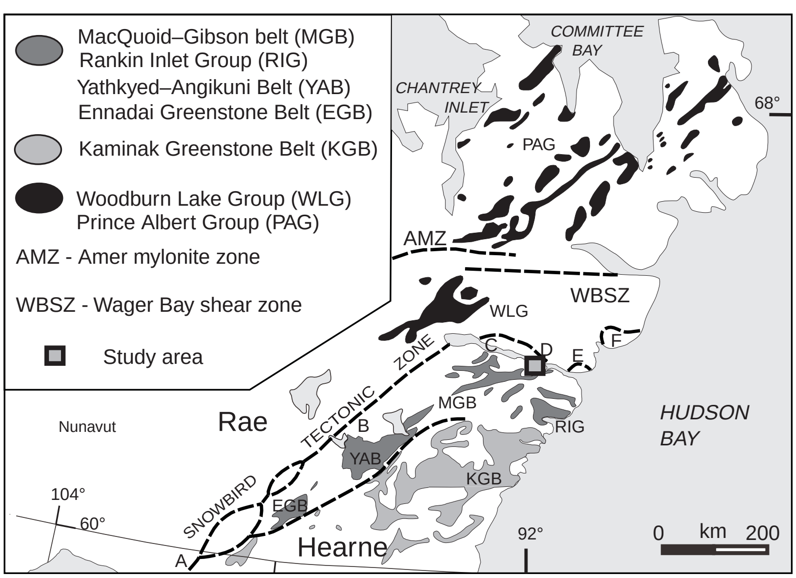

Figure 1.

Sketch map showing location of the study area, and the distribution of major supracrustal belts, and shear zones. A = Athabasca–Three Esker segment of the Snowbird tectonic zone (Hanmer, 1997); B = High P-T granulitic rocks, Kamilukuak Lake area (Tella and Eade, 1986), C = Kramanituar complex (Schau et al. 1982; Sanborn-Barrie, 1993), D = Uvauk complex; E = Hanbury Island shear zone (Tella and Annesley, 1988), F = Daly Bay complex (Gordon, 1988). Trace of Snowbird tectonic zone (after Hoffman, 1988).

refolded, tight isoclinal folds (Fig. 3, 5, 6). The mafic volcanic rocks, exposed southwest of Akunak Bay, contain rarely preserved primary structures (Fig. 7).

Southwest of Butts Lake and southeast of the Promise Point granite plutons, the metasedimentary paragneiss (unit 1) consists of biotite+garnet+plagioclase+quartz± sillimanite assemblages. They are fine- to medium-grained iron-rich pelite and psammite units that are compositionally well banded with quartz-, quartz+feldspar-, and garnet+ biotite±sillimanite-rich layers. For the most part, they wrap around and dip away from domal masses of younger felsic plutons (unit 13). The gneissosity in the paragneiss is concordant with that in the layered tonalitic orthogneiss (unit 3; Fig. 3) for the most part, but discordant relationships are locally preserved along some contact zones, suggesting that the orthogneiss is in part intrusive. Mafic volcanic rocks (unit 2, Fig. 7) are less abundant. These supracrustal rocks extend west and east into the adjoining region, where their lithological and structural relationships have been described previously (MacQuoid homocline of Tella et al., 1992, 1993, 1999; Tella, 1993; Hanmer et al., 1999a; Ryan et al., 1999).

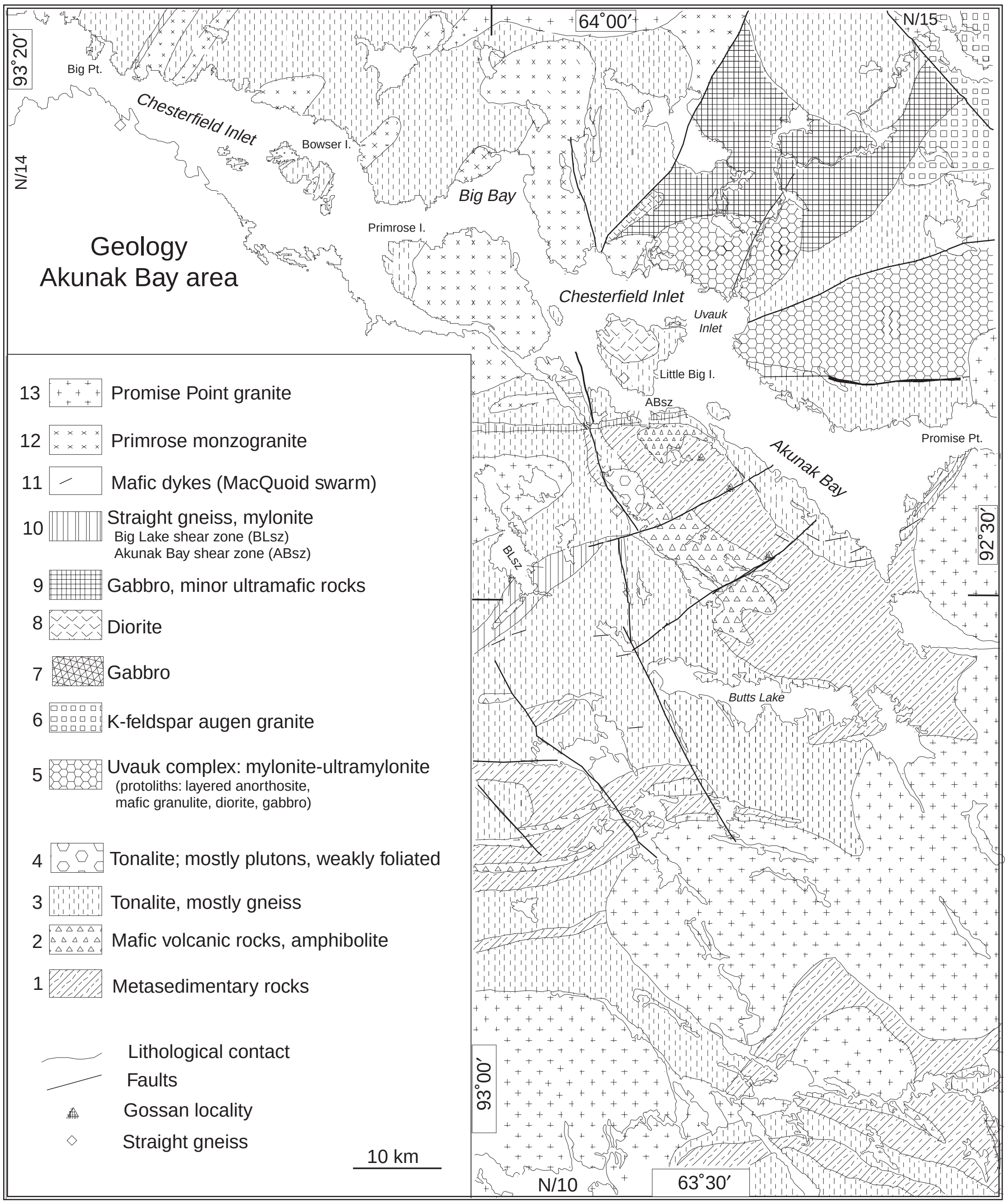

Figure 2. *Simplified geological sketch map of the Akunak Bay area (NTS 55 N).* See *Figure 1 for geological setting.*

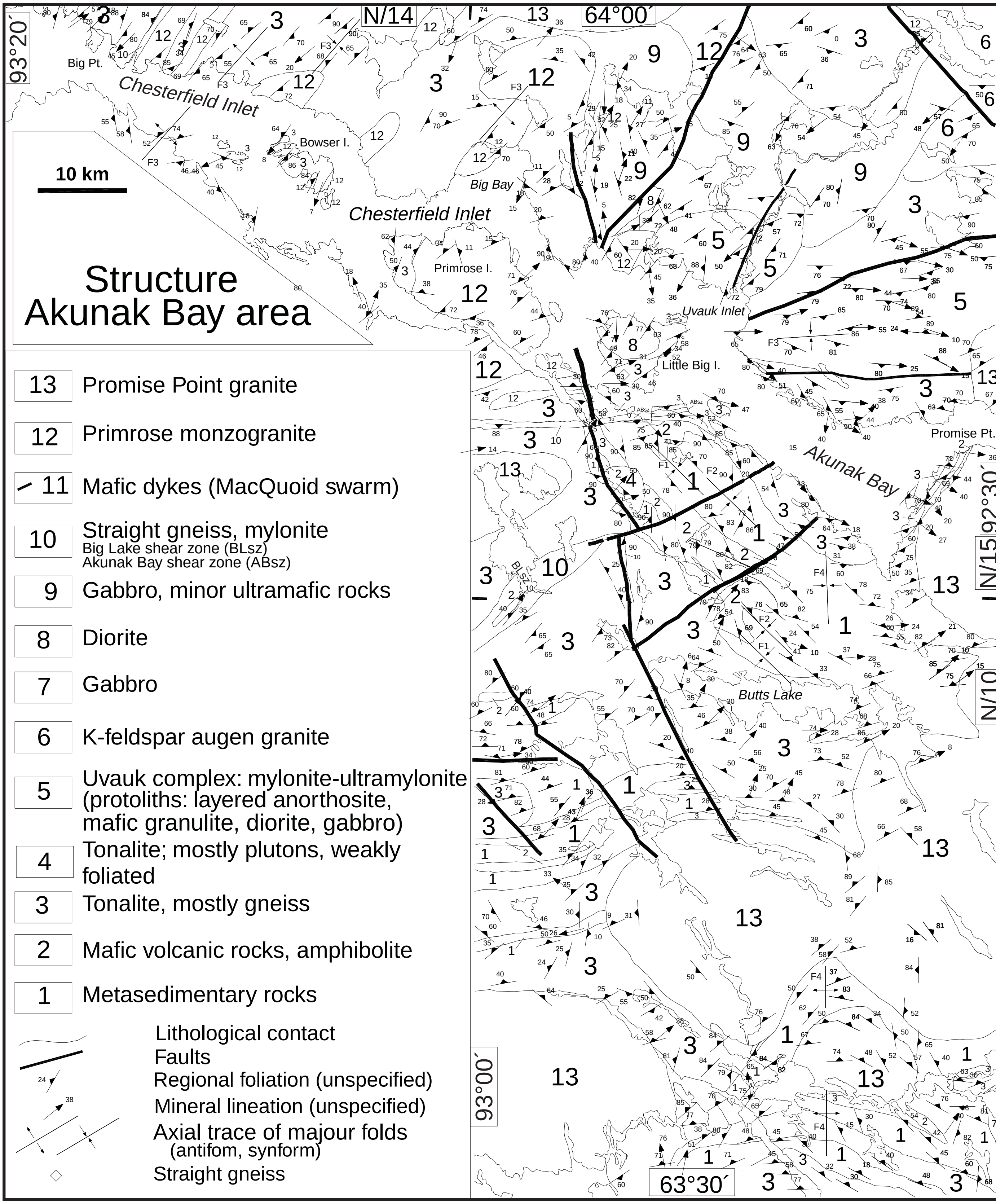

Figure 3. *Simplified structural map of the Akunak Bay area (NTS 55 N).*

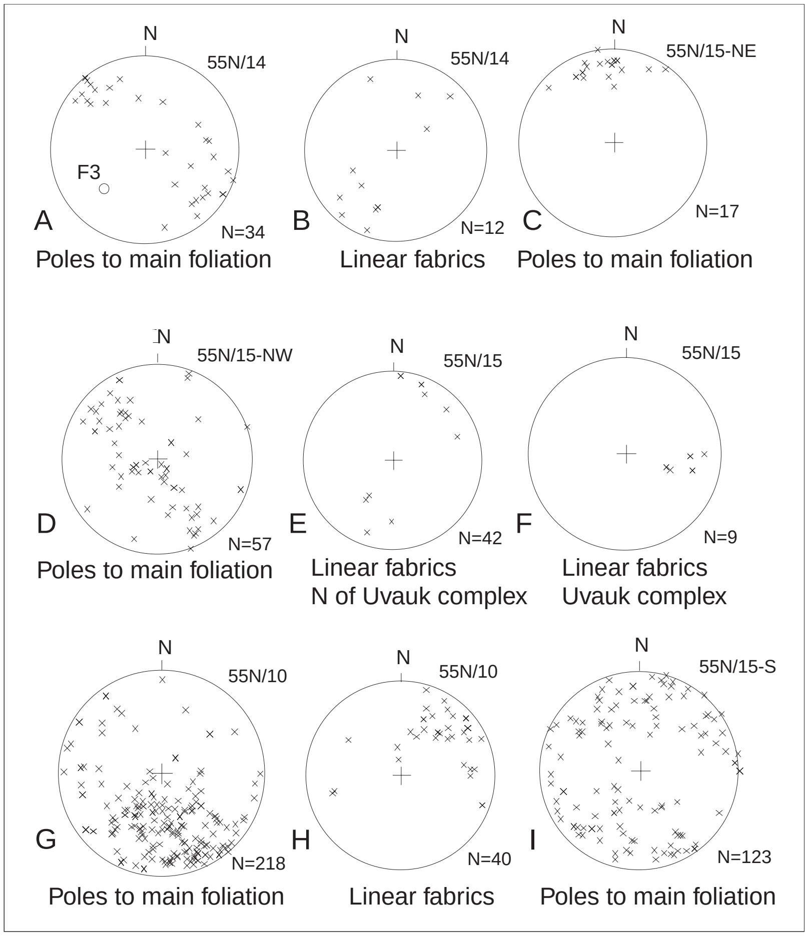

Figure 4.

Orientation of planar and linear fabric elements from the Akunak Bay area; ***A)*** *poles to main foliation define a great-circle girdle around map-scale F_3 fold axes;* ***B)*** *shallow, doubly plunging composite linear fabrics (mineral lineations and minor fold axes);* ***C), D)*** *poles to main foliation outside the Uvauk complex. They define a great-circle girdle around a northeast, shallow plunging, map-scale F_3 fold (D; 55 N/15 NW);* ***E), F)*** *orientation of composite mineral lineations outside and within the Uvauk complex;* ***G), H)*** *composite planar and linear fabrics southwest of Akunak Bay (55 N/10). Note the concentration of linear fabrics coincide with map-scale F_3 fold trends;* ***I)*** *composite planar fabrics centered around Akunak Bay (55 N/15; includes the Uvauk complex).*

Figure 5. *High-amplitude, steep-plunging, isoclinal F_1 folds of bedding in garnet-sillimanite metapelitic paragneiss (unit 1), south of Akunak Bay; hammer, 50 cm long for scale; view to the north.*

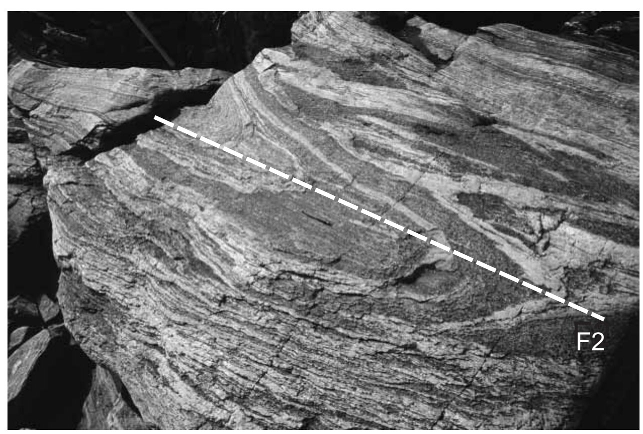

Figure 6. *Penetrative elongation lineation developed parallel to minor F_2 folds of layering in the mixed orthogneiss (unit 3) and paragneiss (unit 1) on the north limb of a regional F_2 fold; south side of Akunak Bay. The lineation appears to be related to the F_2 folds. Pencil for scale.*

Figure 7. Attenuated primary volcanic textures preserved in amphibolitic rafts in tonalite gneiss, south shore of Akunak Bay. Note hornblende-rimmed pillow selvages and plagioclase phenocrysts. Flattened epidote patches may represent interstitial hyaloclastite. Pencil for scale.

Tonalitic gneiss and plutons (units 3, 4)

The tonalitic gneiss and plutons (Fig. 2, 3) are the eastward extension of similar rock units described from the MacQuid–Gibson lakes region (*see* Tella et al., 1997a; Hanmer et al., 1999a for details). In the Akunak Bay area, the tonalite gneiss (unit 3) is fine- to medium-grained, light- to dark-grey to pink, well layered units consisting of distinct compositional phases that range from tonalite to granodiorite. Metamorphosed mafic xenoliths consisting of garnet-hornblende-clinopyroxene assemblages, and metasedimentary supracrustal inclusions are locally present. The gneiss units contain a regionally pervasive foliation (S_2). This planar fabric commonly trends northeast to east-northeast with moderate to steep dips both to the northwest and to the southeast (Fig. 3, 4). However, northeast of the Big lake shear zone (unit 10, Fig. 2, 3) and west of Akunak Bay, this trend is towards the northwest. A weakly deformed, poorly foliated, tonalite to granodiorite (unit 4) is intrusive in to the gnessic tonalite. Southeast of Big lake shear zone, smaller bodies of tonalite occur within the gneiss. Although the age of the tonalite pluton is uncertain, one lithologically similar pluton has been dated at ca. 2.68 Ga. (W. Davis, unpub. data, 1999) in the adjoining area to the west, where it is considered to be synkinematic with respect to D_2 deformation (Hanmer et al., 1999b; Tella et al., 1999). Coarse, pink pegmatite dykes, possibly related to large granite plutons (units 12, 13, Fig. 2, 3), cut the tonalite gneiss.

Uvauk complex (unit 5)

The lithological character, tectonic setting, and tectonothermal aspects of the Uvauk complex were previously outlined by Tella et al. (1993), Tella and Schau (1994), and Mills et al. (1999). The complex comprises a layered anorthosite-gabbroic anorthosite-gabbro-diorite suite that was deformed and metamorphosed under granulite-facies conditions. The complex forms an east-northeast-trending triangular segment, the boundaries of which are marked by well developed ultramylonite derived from anorthosite, gabbro, and diorite protoliths. The overall geometry of the complex is that of an east-northeast-trending synform which overlies an amphibolite-grade tonalite gneiss terrane (unit 3). The northern and southern margins converge and terminate to the west near Uvauk Inlet where the mylonitic fabric dips (70º–85º) towards the south. A shallow (10º–30º) east-northeast-trending mineral stretching lineation (Fig. 3, 4) is well developed throughout the complex.

Based on reconnaissance studies, Tella et al. (1993), and Tella and Schau (1994) interpreted the Uvauk complex to represent an Archean allochthonous remnant of a ductile high-strain zone developed under granulite-facies metamorphism that was subsequently affected by later tectonothermal events. Based on preliminary geochronology, the above authors suggested that the complex records two granulite-facies mylonite events — a ca. 2.59 Ga event juxtaposed by a ca. 1.94 Ga event. Ongoing detailed work around Uvauk Inlet by Mills et al. (1999), indicates that anorthosite within the complex is a synkinematic intrusion into the gneissic wall rocks, and that field relations do not unequivocally indicate that the wall rocks have undergone an Archean granulite-facies event. Based on shear-sense criteria, these authors also document an eastward transport of the anorthosite body with respect to its wall rocks.

Felsic and mafic intrusions (units 6–9)

A well foliated to locally massive, coarse-grained, pink to grey, K-feldspar augen granite (Fig. 8; unit 6) is exposed in the northeastern portions, north of the Uvauk complex (Fig. 2). Its boundaries with the adjoining rock units (3 and 9) are not exposed and hence the contact relationships can not be established with certainty. The granite contains less than 2% mafic minerals (biotite, trace magnetite), and apatite, zircon, monazite, and titanite as accessory phases. Locally, the granite displays well developed, northeast-trending, quartz-ribboned porphyroclastic (K-feldspar) mylonite fabrics in narrow (1 m wide), discontinuous bands (Tella et al., 1993). Preliminary U-Pb isotopic studies on zircon and monazite fractions from this unit yielded imprecise ages of ca. 2.73 Ga and ca. 2.74 Ga respectively (J.C. Roddick, unpub. data, 1993).

In the southeastern part of the map area (Fig. 2), a narrow (20–50 m wide), north-northwest-trending elongate body of gabbro (unit 7) cuts the metamorphosed supracrustal rocks (units 1, 2) and the tonalite orthogneiss (unit 3). Although its age is uncertain, the gabbro postdates D_1–D_2 fabrics in the country rock (units 1–3).

Adjacent to Little Big Island and northwest of Uvauk Inlet (Fig. 2, 3), small plugs of relatively undeformed, coarse-grained, hornblende-diorite (unit 8) cut the gneissic rocks (unit 3). Several generations of pink to white, monzogranite dykes, probably related to Primrose and Promise Point granitoid rocks (units 12, 13), intrude the diorite.

Large masses of relatively undeformed gabbro (unit 9), and subordinate pyroxenite and ultramafic rocks are exposed in the northwestern parts of the region northwest of the Uvauk complex (Fig. 2, 3), and to a lesser extent on Little Big Island (Tella et al., 1993). The gabbro is medium to coarse grained, homogeneous, commonly massive, and shows a well developed ophitic texture. It intrudes the layered tonalite gneiss (unit 3) and is cut by white and pink granite dykes. Adjacent to some of the major northeast-trending faults, the gabbro is intensely sheared and altered to a fine-grained rock mostly consisting of hornblende, chlorite, and serpentine.

Small plugs of pyroxenite and ultramafic rocks (?dunite) occur along the northern and southeastern shores of Little Big Island. They contain olivine phenocrysts set in a clinopyroxene matrix, and rafts of anorthosite and gabbro (correlative to the Uvauk complex) are sparsely distributed in the plugs. On the north side of Chesterfield Inlet similar ultramafic rocks cut the highly strained Uvauk complex (unit 5) and the tonalite gneiss (unit 3), and were emplaced late in the tectonic history of the region (Tella et al., 1993). These ultramafic rocks may be correlated with similar units noted on Bowell Island to the west (Schau et al., 1982), and other small ultramafic bodies described from the adjoining regions (Reinhardt et al., 1980; Hanmer et al., 1999a).

Straight gneiss, mylonite (unit 10)

Recrystallized straight gneiss and mylonite, predominantly derived from granitoid protoliths, form northeast- and east-trending linear belts (Fig. 2, 3). Several minor strands also occur within the tonalite gneiss (unit 3). On the southwestern portion of Little Big Island, a straight gneiss unit is cut by monzogranite sheets (Fig. 9), probably related to the Promise Point granite (unit 13). The regional tectonic significance of these straight gneiss and mylonite units remains to be evaluated.

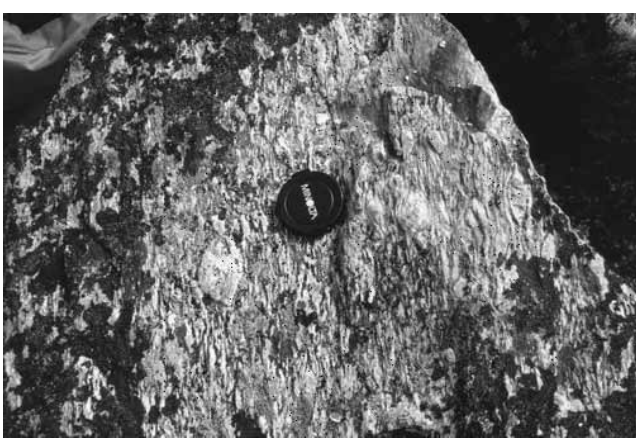

Figure 8. *K-feldspar megacrystic augen granite (unit 6, Fig. 1, 2) with a strong northeast-trending regional foliation; north-northeast of Uvauk complex*

Southeast of Uvauk Inlet, a narrow, east-trending wedge of straight gneiss and mylonite (Fig. 2) separates tonalite gneiss from the Uvauk complex. The southern contact is an inferred fault whereas the northern margin is gradational with the granulite-facies rocks of the Uvavuk complex. The straight gneiss exposed southeast of Big Point, extends south-southwesterly across the Chesterfield Inlet and appears to link with a north-northeast-trending straight gneiss unit (Fig. 2, 3).

The Akunak Bay shear zone (Fig. 10, 11) is an east-trending belt of straight gneiss and mylonite, anastomosing on a 5–10 m scale. South of Little Big Island and east of a north-northwest-trending fault, it separates the metasedimentary and mafic volcanic supracrustal rock units in the south from the predominantly granitoid gneiss terrane in the north (Fig. 2, 3). The belt is comprised of S>L, porphyroclastic, recrystallized straight gneiss and mylonite,

Figure 9. *A ca. 1.83 Ga monzogranite (unit 13) sheet cutting layered straight gneiss (recrystallized mylonite, unit 10), southwestern portion of Little Big Island, Chesterfield Inlet (Fig. 2). The age of mylonitization is not well constrained.*

Figure 10. *Rotated boudins of highly attenuated plagioclase phyric diabase dykes within the Akunak Bay shear zone.*

derived mainly from the granitoid and supracrustal protoliths. Foliation in the straight gneiss and mylonite is steeply (>70°) south dipping, and locally contains a poorly developed, shallow, east-northeast-plunging stretching lineation. Rarely preserved shear-sense indicators (rotated K-feldspar porphyroclasts) suggest an oblique, dextral shear sense locally, but overall shear sense has not been established. The eastern extension of the Akunak Bay shear zone swings southeasterly towards Akunak Bay along the south shore of Chesterfield Inlet and appears to die out. The straight gneiss units are not exposed on the east side of Akunak Bay. The western extension appears to link with a previously mapped straight gneiss unit in the Cross Bay plutonic complex (Hanmer et al., 1999a, b; Tella et al., 1999). The north- northwest-trending fault which separates the dominantly supracrustal region southwest of Akunak Bay from the adjoining tonalite gneiss region to the west, does not offset the Akunak Bay shear zone. The precise age of the Akunak Bay shear zone is unknown, but the mafic dykes (potentially ca. 2.19 Ga; Fig. 12) which cut the shear zone have not been affected by the shear strain associated with its development, suggesting that it predates dyke emplacement and postdates the north-northwest-trending fault.

The Big lake shear zone is a steeply dipping belt of porphyroclastic, amphibolite-facies straight gneiss and ribbon mylonite (S>L), up to 2 km thick, that marks the southern margin of the Cross Bay complex (Hanmer et al., 1999a, b). Its extent, lithological and structural aspects, and tectonic significance were outlined elsewhere (Hanmer et al., 1999a, b; Ryan et al., 1999, 2000; Tella et al., 1999). In the Akunak Bay area, the foliation in the straight gneiss and mylonite is steeply north dipping, and contains an east-trending, subhorizontal lineation. Shear-sense criteria from elsewhere in the zone suggest that the Big lake shear zone is a dextral, strike-slip structure (Hanmer et al., 1999b). The easterly extension of the Big lake shear zone branches into several splays of discrete high-strain zones which appear to die out and/or are truncated by a north-northwest-trending fault (Fig. 2, 3). Southeast of Big lake shear zone, at its eastern extremity, several discontinuous bands of ribbon mylonite occur along the western margin of the north-northwest-trending fault.

Figure 11. *Asymmetric isoclinal folds in a plagioclase-phyric diabase dyke (predates MacQuoid swarm) within the Akunak Bay shear zone (unit 10). The phenocrysts, preserved in a relatively low-strain domain within the Akunak Bay shear zone, are concentrated in the core of the dyke and show a flattened shape fabric in the fold hinge.*

Mafic dykes (MacQuoid swarm; unit 11)

Southwest and east of Akunak Bay, east-southeast- to east-northeast-trending gabbro and diabase dykes (up to 20 m wide; *see also* Fig. 12) are abundant, but occur preferentially in the vicinity of the south shore of Chesterfield Inlet (Fig. 2). They are considered to be the eastward extension of the ca. 2.19 Ga MacQuoid dyke swarm (Tella et al., 1997a, b; Hanmer et al., 1999a), although in the absence of definitive geochronology, it is possible that some dykes may belong to a different set of uncertain age. The mafic dykes are commonly

Figure 12. *Mafic dyke, probably correlative to the ca. 2.19 Ga MacQuoid swarm (Tella et al., 1997a, b; Hanmer et al., 1999a, b), cutting regional foliation in the Akunak Bay shear zone (ABsz, Fig. 2, 3). Such dykes cut across F_2 folds in the map area and apparently represent a younger suite than those observed within the Akunak Bay shear zone.*

plagioclase-phyric with locally preserved coronitic garnet, and show well preserved chilled margins. The dykes intrude the polydeformed rocks of units 1 to 3 (Fig. 12), and are overprinted by subsequent metamorphism and deformation.

Primrose monzogranite (unit 12)

Rocks in this unit are exposed as plutons in the northwestern portions of the map area on either side of Chesterfield Inlet (Fig. 2, 3). They consist of pale pink, well foliated to massive, in part fluorite-bearing, granodiorite to granite phases. They intrude the polydeformed, layered tonalitic gneiss of the Cross Bay complex (unit 3; Hanmer et al., 1999a), and show complex commingling textures which are well exposed on Bowser Island and along the south shore of Chesterfield Inlet (Sandeman et al., 2000). Parts of some plutons are undeformed. Preliminary geochronology yields U-Pb zircon magmatic ages in the range ca. 1.83–1.81 Ga. (W.J. Davis, unpub. data, 1999).

Promise Point granite (unit 13)

A number of relatively young, locally K-feldpar megacrystic, granite plutons (unit 13) are widely distributed in a northeast-trending belt south of Akunak Bay (Fig. 2, 3), and to a lesser extent on the north side of Chesterfield Inlet. They are in part magnetite and fluorite bearing and some have associated aeromagnetic anomalies. Although all plutons are grouped into one unit, they may not all be coeval. Individual plutons range in composition from granodiorite to granite. They are equigranular to massive, pink, and typically poor in mafic phases (<2% biotite). South of Butts Lake they exhibit weakly to well foliated margins. Gradational (?migmatitic) contacts with the orthogneiss (unit 3) are locally present, and country rock xenoliths are common. The abundance of inclusions increases towards the margins of some plutons. However, one pluton near Promise Point, has a well defined sharp intrusive contact with the orthogneiss (unit 3) and the Uvauk complex (unit 5). Uranium-lead geochronology on similar plutonic suites from the adjoining regions to the east and west, yielded magmatic zircon ages in the range ca.1.83–1.81 Ga. (Tella and Schau, 1994; Tella et al., 1997a, b; J.C. Roddick, unpub. data, 1999).

Figure 13. *Undeformed, north-northeast-trending lamprophyre dyke cutting the layered tonalite orthogneiss (unit 3) northeast of Akunak Bay.*

Lamprophyre dykes

Northeast- and southeast-trending, undeformed, ultrapotassic lamprophyre dykes (Fig. 13), up to 3 m wide and probably related to the ca. 1.85 Ga alkaline igneous suite in the central Keewatin (LeCheminant et al., 1987), occur throughout the region. They contain inclusions of country rock. They are dark grey to black, medium to fine grained, phlogopite±hornblende-phyric (*see also* Tella et al., 1993). The dykes exhibit mutually crosscutting relationships with the Primrose monzogranite (units 12) and Promise Point granite plutons (unit 13) and suggest diverse ca. 1.83 Ga magma commingling (Sandeman et al., 2000).

STRUCTURE AND METAMORPHISM

At least four deformation events (D_1–D_4) affected the supracrustal units and the tonalite orthogneiss. The fabric elements, shown in Figures 3 and 4, represent composite fabrics developed during these four events. Field observations in the Akunak Bay area together with fabric relations established in the adjoining MacQuoid–Gibson belt (Tella et al., 1997a, b; Hanmer et al., 1999b; Ryan et al., 1999), suggest that the regionally pervasive foliation in rock units 1 to 4 is a D_2 fabric element. In supracrustal units (1, 2), this fabric represents an S_2, developed from the transposition of an older S_0/S_1 fabric. Elsewhere in the region, the foliations (Fig. 3, 4) are of unspecified generation and represent main foliation trends within specified rock units. Unless otherwise indicated, the linear fabrics are composite.

Southwest of Akunak Bay, an early isoclinal, doubly plunging, east-southeast-trending fold set (F_1; Fig. 3, 5) is coaxially refolded by an open to tight fold set (F_2; Fig. 3, 6), which in turn, is modified by open, northeast-trending F_3 folds and north-northeast-trending F_4 folds (Fig. 3, 4, 14, 15). South of Little Big Island, a map-scale F_2 fold is truncated by the Akunak Bay shear zone suggesting that D_2 predates the Akunak Bay shear zone. Although definitive geochronology is pending, based on the synkinematic relationships of ca. 2.68 Ga tonalite with respect to D_2 fabric formation noted in the MacQuoid–Gibson lakes region, the D_1–D_2 are likely to be Archean events. D_3–D_4 are considered to be Proterozoic tectonothermal events because ca. 2.19 Ga mafic dykes, which cut the D_2 fabrics, were metamorphosed and deformed subsequent to their emplacement. These dykes provide a minimum age for S_2 fabric development and maximum age on the metamorphism which affected the dykes. If the correlation to the MacQuoid swarm is valid, these mafic dykes record Paleoproterozoic, younger than ca. 2.19 Ga deformation and metamorphism that affected all older rock units. The above structural observations are consistent with those reported from the adjoining area to the west (Hanmer et al., 1999a, b; Ryan et al., 1999; Tella et al., 1999). It should be noted,

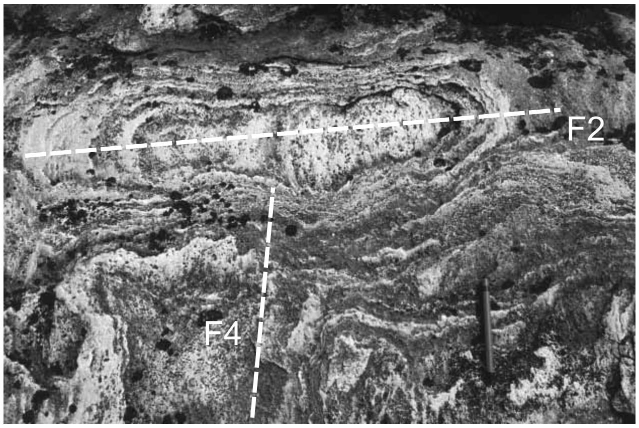

Figure 14. *Strong L-fabric preserved on the (?)S_1 gneissosity (unit 3) exposed as fold interference between a tight, shallow-plunging F_2 fold which trends 120°, and open buckling by F_4 folds which trend 045°; view to the north.*

Figure 15. *Mesoscopic fold interference pattern between a tight, shallow, 120° trending, doubly plunging F_2 fold (parallel to hammer handle), and open buckling by northeast-trending F_4 folds (unit 3). Such patterns are commonly developed on the map scale.*

however, that D_3–D_4 fold sets in the Akunak Bay area are not necessarily correllative to D_3–D_4 fold sets noted in the adjoining Cross Bay plutonic complex (Hanmer et al., 1999b; Ryan et al., 1999).

Although not all ca. 1.83 Ga plutons show postemplacement deformation, some were clearly affected by D_3–D_4 deformation events. Associated structures include northeast- and north-trending F_3–F_4 open folds (Fig. 4). Most Promise Point granite plutons in the Akunak Bay area are nonfoliated and do not appear to have been deformed.

West of Akunak Bay and south of Chesterfield Inlet, two contrasting structural domains are juxtaposed along a north-northwest-trending fault that extends from west of Butts Lake to the south shore of Chesterfield Inlet (Fig. 2, 3). In the eastern domain, dominated by supracrustal rock assemblages, the structural trends are predominantly north-west-southeast, where as they are commonly northeast-trending in the western tonalite-gneiss domain. The Akunak Bay shear zone, which cuts D_2 fabrics in the supracrustal rocks and in the tonalite gneiss, is not offset by this north-northwest-trending fault. These field relationships suggest that the juxtaposition of the two domains occurred prior to the development of the Akunak Bay shear zone.

The presence of garnet, biotite±aluminosilicates (andalusite, sillimanite) in sedimentary rocks, and of garnet+biotite+plagiclase±clinopyroxene assemblage in mafic volcanic rocks suggest amphibolite-facies conditions of regional metamorphism for the supracrustal units. The metasedimentary rocks contain rare, pre- to synkinematic andalusite as well as garnet porphyroblasts partially wrapped by S_2. Andalusite is partially replaced by sillimanite which shows 'faserkiesel' textures. Garnet porphyroblasts in mafic volcanic rocks commonly show plagioclase rims, textures typical of postkinematic decompression. The porphyroblast-fabric relations in the Akunak Bay area suggest that the regional metamorphism in the supracrustal rocks was syn- to post-D_1 with peak conditions attained during early D_2. Since the S_2 fabric wraps around some garnet porphyroblasts, D_2 deformation outlasted peak metamorphic conditions. Random growth of a second sillimanite across the D_2 fabrics in the supracrustal rocks suggest that a post-D_2 metamorphic event occurred at elevated temperatures.

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REFERENCES

Gordon, T.M.
1988: Precambrian geology of the Daly Bay area, District of Keewatin; Geological Survey of Canada, Memoir 422, 21 p.

Hanmer, S.
1997: Geology of the Striding-Athabasca mylonite zone, Northern Saskatchewan and southeastern District of Mackenzie, Northwest Territories; Geological Survey of Canada, Bulletin 501, 92 p.

Hanmer, S., Tella, S., Sandeman, H.A., Ryan, J.J., Hadlari, T., and Mills, A.
1999a: Proterozoic reworking in Western Churchill Province, Gibson Lake-Cross Bay area, Northwest territories (Kivalliq Region, Nunavut). Part 1: general geology; *in* Current Research 1999-C; Geological Survey of Canada, p. 55–64.
1999b: Proterozoic reworking in Western Churchill Province, Gibson Lake-Cross Bay area, Northwest Territories (Kivalliq Region, Nunavut). Part 2: regional structural geology; *in* Current Research 1999-C; Geological Survey of Canada, p. 65–75.

Hoffman, P.F.
1988: United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia; Annual Review of Earth and Planetary Sciences, v. 16, p. 543–603.

LeCheminant, A.N., Miller, A.R. and LeCheminant, G.M.
1987: Early Proterozoic alkaline igneous rocks, District of Keewatin, Canada: petrogenesis and mineralization; *in* Geochemistry and mineralization of Proterozoic Volcanic Suites; (ed) T.C. Pharaoh, R.D. Beckinsale, and D. Rickard; Geological Society of London, Special Publication No. 33, p. 219–240.

Mills, A., Berman, R., and Hanmer, S.
1999: Geology of the Uvuak complex, Northwest Territories (Kivalliq Region, Nunavut); *in* Current Research 1999-C; Geological Survey of Canada, p. 97–106.

Reinhardt, E.W., Chandler, F.W., and Skippen, G.B.
1980: Geological map of the MacQuoid Lake (NTS 55M, E1/2) and Gibson Lake (NTS 55N, W1/2) map area, District of Keewatin; Geological Survey of Canada, Open File 703, scale 1:125 000.

Ryan, J.J., Hanmer, S., Sandeman, H.A., and Tella, S.
2000: Archean and Paleoproterozoic fault history of the Big lake shear zone, MacQuoid–Gibson lakes area, Nunavut; Geological Survey of Canada, Current Research 2000-C6, 11 p. (online; http://www.nrcan.gc.ca/gsc/bookstore)

Ryan, J.J., Hanmer, S., Tella, S., and Sandeman, H.A.
1999: Detailed structural studies, Gibson Lake-Cross Bay-MacQuoid Lake area, Northwest Territories (Kivalliq Region, Nunavut); *in* Current Research 1999-C; Geological Survey of Canada, p. 87–96.

Sanborn-Barrie, M.
1993: A structural investigation of high-grade rocks of the Kramanituar complex, Baker Lake area, N.W.T.; *in* Current Research, Part C; Geological Survey of Canada, Paper 93-1C, p. 137–146.

Sandeman, H.A., Lepage, L., Ryan, J.J., and Tella, S.
2000: Field evidence for commingling between ca. 1825 Ma lamprophyric, monzonitic, and monzogranitic magmas, MacQuoid-Gibson lakes area, Nunavut; Geological Survey of Canada, Current Research 2000-C5, 10 p. (online; http://www.nrcan.gc.ca/gsc/bookstore)

Schau, M., Tremblay, F., and Christopher, A.
1982: Geology of Baker Lake map area, District of Keewatin: a progress report; *in* Current Research, Part A; Geological Survey of Canada, Paper 82-1A, p. 143–150.

Tella, S.
1993: Geology, Chesterfield Inlet, District of Keewatin, Northwest Territories; Geological Survey of Canada, Open File 2756, scale 1:250 000.

Tella, S. and Annesley, I.R.
1987: Precambrian geology of parts of the Chesterfield Inlet map area, District of Keewatin; *in* Current Research, Part A; Geological Survey of Canada, Paper 87-1A, p. 25–36.
1988: Hanbury Island Shear Zone, a deformed remnant of a ductile thrust, District of Keewatin, N.W.T.; *in* Current Research, Part C; Geological Survey of Canada, Paper 88-1C, p. 283–289.

Tella, S. and Eade, K.E.
1986: Occurrence and possible tectonic significance of high-pressure granulite fragments in the Tulemalu fault zone, District of Keewatin, N.W.T., Canada; Canadian Journal of Earth Sciences, v. 23, no.12, p. 1950–1962.

Tella, S. and Schau, M.
1994: Geology, Gibson Lake (east-half), District of Keewatin, Northwest Territories; Geological Survey of Canada, Open File 2737, scale 1:50 000.

Tella, S., Hanmer, S., Sandeman, H.A., Ryan, J.J., Hadlari, T., Mills, A., and Kerswill, J.A.
1999: Geology, Parts of MacQuoid-Gibson lakes area, Kivalliq Region, Nunavut; Geological Survey of Canada, Open File 3701, scale 1:50 000.

Tella, S., LeCheminant, A.N., Sanborn-Barrie, M., and Venance, K.E.
1997a: Geology and structure of parts of the MacQuoid Lake area, District of Keewatin, Northwest Territories; *in* Current Research, 1997-C; Geological Survey of Canada, p. 123–132.
1997b: Geology, parts of MacQuoid Lake, District of Keewatin, Northwest Territories; Geological Survey of Canada, Open File 3404, scale 1:50 000.

Tella, S., Schau, M., Armitage, A., and Loney, B.C.
1993: Precambrian geology and economic potential of the northeastern parts of Gibson Lake map area, District of Keewatin, Northwest Territories; *in* Current Research, Part C; Geological Survey of Canada, Paper 93-1C, p. 197–208.

Tella, S., Schau, M., Armitage, A.E., Seemayer, B.E., and Lemkow, D.
1992: Precambrian geology and economic potential of the Meliadine Lake - Barbour Bay region, District of Keewatin, Northwest Territories; *in* Current Research, Part C; Geological Survey of Canada, Paper 92-1C, p. 1–11.

Wright, G.M.
1967: Geology of the southeastern barren grounds, parts of the Districts of Mackenzie and Keewatin (Operations Keewatin, Baker, Thelon); Geological Survey of Canada, Memoir 350, 91 p.

Geological Survey of Canada Project 970006