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A preliminary stratigraphic and structural geology framework for the Archean Mary River Group, northern Baffin Island, Nunavut

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Abstract: New mapping (parts of NTS 37 G) has established a preliminary stratigraphic and structural framework for the supracrustal rocks of the Archean Mary River Group on northern Baffin Island. The supracrustal sequence consists of psammite, amphibolite, Algoma-type iron formation, quartzite, dacite, and komatiite. Four generations of structures are recognized. Strongly developed bedding-parallel S_1 foliations are transposed and folded by northwest-vergent, reclined F_2 folds. Moderately south-plunging L_2 lineations are coaxial with F_2 fold hinges. Superposition of east-trending, steeply north-dipping F_3 folds on F_2 in the southern map area results in 'mushroom' interference patterns, whereas in the west-central area, F_2 and F_3 are nearly coaxial, producing Type 3 interference patterns. Northwest- and northeast-trending conjugate kink and chevron-style folds are attributed to D_4. Newly identified economic mineral prospects include sulphidized (up to 30% pyrite+/chalcopyrite+/-arsenopyrite) iron formation, and disseminated and fracture-filling sulphides in ultramafic intrusions.

Résumé : De nouveaux travaux de cartographie (parties de SNRC 37 G) ont permis d'établir un cadre stratigraphique et structural préliminaire pour les roches supracrustales du Groupe de Mary River de l'Archéen dans le nord de l'île de Baffin. La séquence supracrustale consiste en psammite, en amphibolite, en formation de fer de type Algoma, en quartzite, en dacite et en komatiite. Quatre générations de structures y sont reconnues. Des foliations S_1 bien développées et parallèles à la stratification ont été transposées et plissées par des plis réclinés F_2 à vergence nord-ouest. Des linéations L_2 à plongement modéré vers le sud sont coaxiales aux charnières des plis F_2. Dans le sud de la région cartographique, la superposition aux plis F_2 de plis F_3 de direction est et plongeant fortement vers le nord engendre des configuration d'interférence en forme de «champignons»; par contre, dans la partie centrale ouest de la région, les plis F_2 et F_3 sont presque coaxiaux et engendrent alors des configurations d'interférence de type 3. Des plis conjugués en kink et en chevrons de direction nord-ouest et nord-est résulteraient d'une déformation D_4. Des prospects nouvellement identifiés englobent une formation de fer sulfurée (jusqu'à 30 % de pyroxène±chalcopyrite±arsénopyrite), ainsi que des sulfures disséminés et des sulfures de remplissage de fractures dans des intrusions ultramafiques.

INTRODUCTION

This report presents preliminary bedrock geology field results from the 2003 season, the first of the three-year North Baffin Project, a collaborative effort of the Canada–Nunavut Geoscience Office, Geological Survey of Canada, and the Polar Continental Shelf Project. The emphasis of the project is on surficial geology mapping of the NTS 37 E, F, G, and H map sheets, with complementary, detailed, bedrock mapping in selected, well exposed areas. Results for the regional Quaternary geology of NTS 37 G are reported in Little et al. (2004).

The bedrock geology mapping subcomponent of the North Baffin Project, undertaken by the primary author with visits in the field by other government geologists (coauthors), had three main objectives: 1) to identify new economic mineral prospects; 2) to collect samples for assay analysis to supplement and help guide the drift-prospecting survey, and 3) to provide an updated stratigraphic and structural geology framework for the Archean Mary River Group supracrustal rocks through detailed mapping in key localities. The new mapping and structural interpretations will be supplemented by follow-up U-Pb zircon geochronology as well as whole-rock and Nd-isotopic geochemistry.

This project builds upon recent regional mapping projects in the Committee Bay area to the southwest (e.g. Skulski et al., 2003), the Central Baffin area to the southeast (e.g. Scott et al., 2003), and the Eqe Bay area to the south (Bethune and Scammell, 2003a, b) (Fig. 1). The NTS 37 G map area (Fig. 2) is underlain by Archean supracrustal rocks of the Mary River Group and surrounding plutonic rocks, siliciclastic and carbonate sedimentary rocks of the Mesoproterozoic Bylot Supergroup, Neoproterozoic Franklin diabase gabbro dykes, and Paleozoic carbonate sedimentary rocks (Fig. 2). This study focuses on the under-explored Archean Mary River Group and associated plutonic rocks. Previous mapping in this area, summarized in Jackson (2000) and compiled in de Kemp and Scott (1998), provided a framework for the distribution of rock types of the Mary River Group and provided stratigraphic and structural data, but did not develop their detailed geometric relationships.

GEOLOGICAL SETTING

The North Baffin study area (Fig. 1) occurs near the northern extent of the postulated Committee fold belt (Jackson and Taylor, 1972), ascribed to the northern Rae domain of the western Churchill Province (Hoffman, 1989). On north-central Baffin Island, Archean rocks of the Rae domain are bounded to the southeast by the crustal-scale Isortoq fault zone (Fig. 1; Jackson, 2000; Bethune and Scammell, 2003a) and the Paleoproterozoic Foxe fold belt that forms the northern margin of the eastern segment of the ca. 1.8 Ga Trans-Hudson Orogen (e.g. St-Onge et al., 2002).

The Rae domain is a granite-greenstone terrane characterized by northeast- and north-trending linear greenstone belts with intervening gneissic and granitoid rocks. On Melville Peninsula and to the southwest (Fig. 1), supracrustal rocks of the Prince Albert and Woodburn Lake groups (Frisch, 1982; Zaleski et al., 2000; Skulski et al., 2003) consist of an association of basalt, komatiite, orthoquartzite, iron formation, and variable amounts of felsic volcanic rocks. On northern Baffin Island, comparable supracrustal rocks of the Mary River Group (Jackson, 1966) were correlated with the Prince Albert group on the basis of lithology and aligned trends (Jackson and Taylor, 1972). These supracrustal sequences were deposited between ca. 2.74 and 2.63 Ga, on rare vestiges of Mesoarchean plutonic crust (Jackson et al., 1990; Zaleski et al., 2000; Wodicka et al., 2002; Bethune and Scammell, 2003b).

In the Eqe Bay area on northern Baffin Island (Fig. 1), two greenstone belts of the Mary River Group comprising basalt, iron formation, and felsic volcanic rocks overlain by clastic sedimentary rocks, rest unconformably on Mesoarchean to early Neoarchean (ca. 2.84–2.77 Ga) gneissic basement (Bethune and Scammell, 2003b). Zaleski et al. (2000) and Skulski et al. (2003) interpreted komatiitic to basaltic units, interlayered with epicontinental sedimentary rocks, as representing the partial melt products of a mantle plume(s) in a rift setting. On the other hand, in the Eqe Bay area, the Neoarchean volcano-sedimentary sequence is dominated by arc-type volcanic rocks that were deposited on thinned, possibly rifted, continental crust (Bethune and Scammell, 2003b).

The Archean rocks of the Committee fold belt have been affected by polystage tectonometamorphic events including at least one, and possibly two, episodes of Archean to early

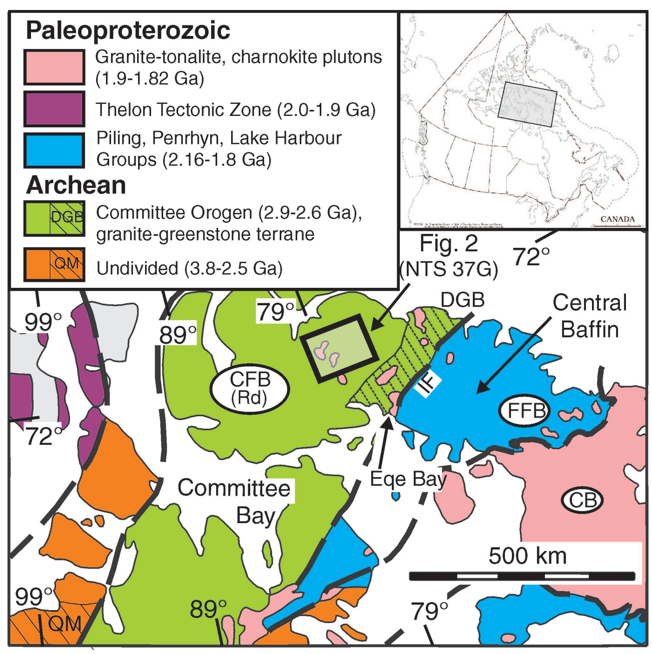

Figure 1. Location and lithotectonic setting of the North Baffin study area. Abbreviations: CFB - Committee Fold Belt; Rd - Rae domain; QM - Queen Maud block; FFB - Foxe Fold Belt; CB - Cumberland Batholith; IF - Isortoq fault zone; DGB - Dexterity Granulite Belt. Modified from *Jackson and Berman (2000).*

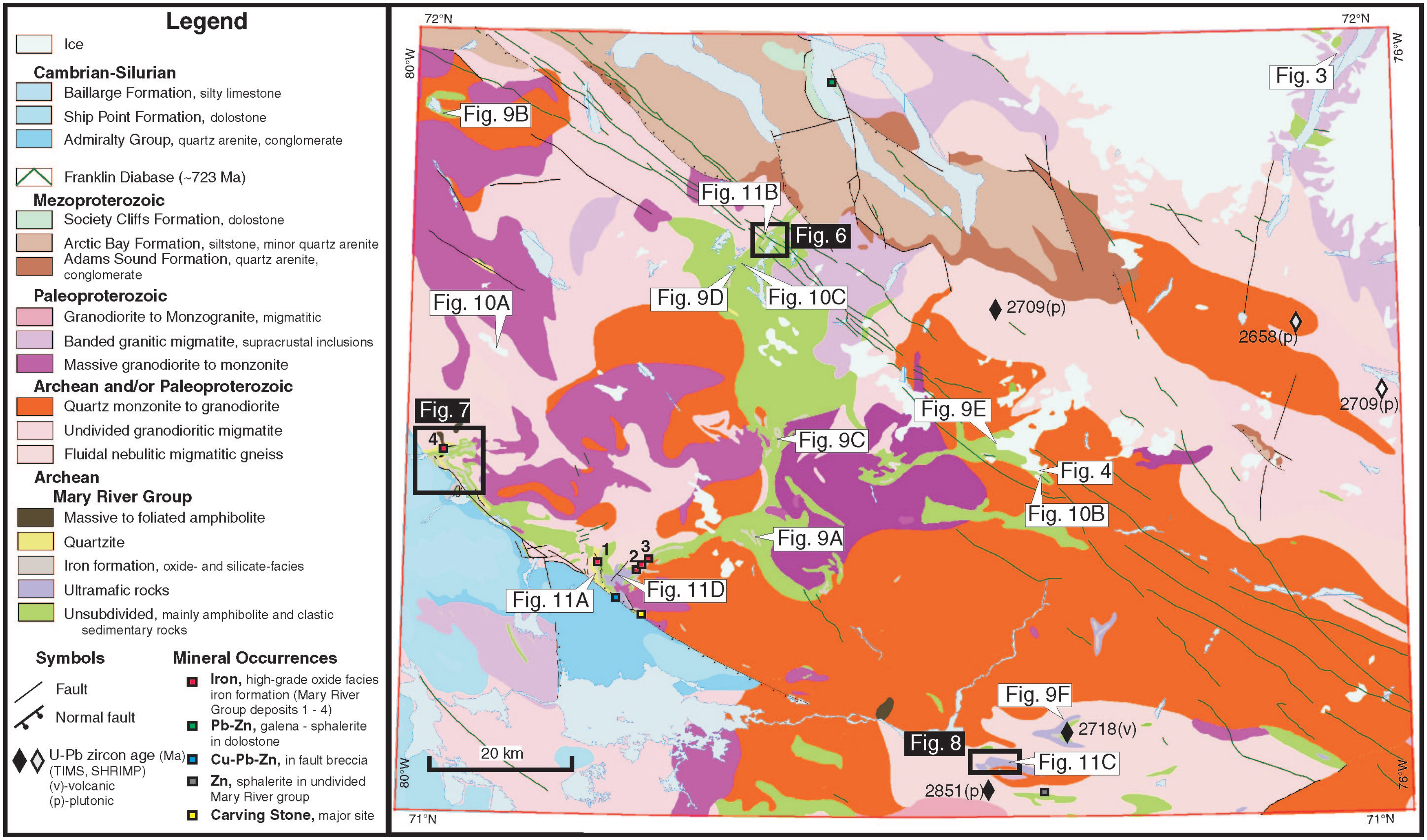

Figure 2. *Generalized bedrock geology of NTS 37 G. U-Pb zircon ages from Jackson et al. (1990) (thermal ionization mass spectrometry (TIMS)) and de Kemp and Scott (1998) (sensitive high-resolution ion microprobe (SHRIMP)). The locations of field photographs (Figs. 3, 4, 9–11) and larger scale maps (Figs. 6–8) are indicated. Map and mineral occurrences from compilation of de Kemp and Scott (1998).*

Paleoproterozoic deformation and greenschist- to amphibolite-facies metamorphism (Jackson and Berman, 2000; Bethune and Scammell, 2003a; Sanborn-Barrie et al., 2003; Scott et al., 2003). The characteristic northeast-trending structural grain throughout the Committee fold belt has been attributed to the Paleoproterozoic (ca. 1.8 Ga) Trans-Hudson Orogeny, which produced tight, kilometre-scale, northwest-vergent folds (F_2) in the Committee Bay greenstone belt (Sanborn-Barrie et al., 2003), and the prominent southeast-dipping Isortoq fault zone on Baffin Island (Jackson and Berman, 2000; Bethune and Scammell, 2003a). The Isortoq fault zone has a history of northwest-directed thrusting followed by southeast-directed extension resulting in the exhumation of the Dexterity granulite belt (Fig. 1). Northeast-trending folds (F_{2P}) related to the Trans-Hudson Orogeny on central Baffin Island are superimposed by orogen-perpendicular folds (F_{3P}) resulting in the dome-and-basin map pattern in the area (St. Onge et al., 2001a, b, c, d; 2002a, b, c, d; Scott et al., 2003). Similar northeast- to northwest-trending box-style folds (F_3) affect the northeastern part of the Committee Bay greenstone belt (Sanborn-Barrie et al., 2003).

BASEMENT(?) TO THE MARY RIVER GROUP

Previous mapping and topical studies in northern Baffin Island have identified extensive tracts of inferred (e.g. Jackson, 1966) and dated (Jackson et al., 1990) Mesoarchean banded orthogneiss thought to form the 'basement' to the Neoarchean Mary River Group (Jackson, 2000). The inference that much of the banded orthogneiss represents basement was based on the structurally complex nature of the gneissic rocks (Jackson, pers. comm., 2003; Fig. 3). During this investigation, unambiguous basement was not observed. Typically, granitoid rocks immediately adjacent to the supracrustal belts contain abundant, flattened xenoliths and rafts of supracrustal rocks, suggesting these rocks intruded the greenstone belt.

***Figure 3.** Near-horizontal compositional banding in biotite-hornblende tonalitic to granodioritic gneiss with inclusions of amphibolite and undeformed cross-cutting syenogranite pegmatite dykes. The visible cliff face is approximately 300 m high.*

Vestiges of Mesoarchean plutonic rocks do occur in the area, but may not be as widespread as previously thought. In the southern part of the study area, a tonalitic gneiss (nebulitic migmatite) yielded a U-Pb zircon age of 2851 +20/-17 Ma (Jackson et al., 1990), in the Eqe Bay area, a tonalitic cobble from an intraformational conglomerate yielded a U-Pb zircon age of 2843 ±2 Ma (Bethune and Scammell, 2003b), and biotite monzogranite in a domal inlier to the Piling Group yielded a U-Pb zircon age of 2827 +8/-7 Ma (Wodicka et al., 2002). These data support the presence of Mesoarchean crust in the Rae domain on Baffin Island, which we infer to occur mainly as isolated vestiges entrained in Neoarchean plutonic rocks, and may, locally, occur as basement to an unconformably overlying supracrustal sequence.

MARY RIVER GROUP

Mary River Group supracrustal rocks are best exposed and preserved in the northern, west-central, and southern parts of the map area, whereas the main, central corridor is covered by extensive, thick, glacial till deposits (Fig. 2). As a result of penetrative deformation and metamorphism, primary features in the supracrustal rocks are poorly preserved and no stratigraphic younging directions were determined; however, indirect evidence is used to propose a stratigraphic sequence. Such evidence includes an upward increase in silica in volcanic rocks, the presence of ultramafic sills and dykes below interbedded komatiite and felsic volcanic rocks, and lithologically correlative sequences in the Prince Albert (Skulski et al., 2003) and Woodburn Lake groups (Zaleski et al., 2000). Collectively, these observations have led to our proposed stratigraphic order of psammite, amphibolite, Algoma-type oxide- and silicate-facies iron formation, and quartzite, overlain by interbedded ultramafic and intermediate volcanic rocks (Fig. 4, 5). The interbedded volcanic rocks yielded a U-Pb zircon age of 2718 +5/-3 Ma (Jackson et al., 1990), which is time-correlative, within error, with the upper sections of the supracrustal sequences in Eqe Bay (Bethune and Scammell, 2003b), Committee Bay (Skulski et al., 2003), and Woodburn Lake area (Zaleski et al., 2000). The age correlation lends further support for the proposed stratigraphic order presented here.

Although the stacking order of amphibolite–iron formation–quartzite is consistent throughout much of the region, the thicknesses of individual units vary considerably across the map area, as do the lithofacies expressed in the upper part of the stratigraphic sequence (Fig. 5). These variations are further illustrated in the maps and cross-sections produced for areas mapped in detail in the northern (Fig. 6), west-central (Fig. 7), and southern (Fig. 8) parts of the map area and discussed below.

In the north at 'Long lake', the succession of amphibolite–iron formation–quartzite-dacite is folded into moderately southeast-dipping reclined folds attributed to D_2 deformation (*se*e 'Structural Geology' below; Fig. 6). In

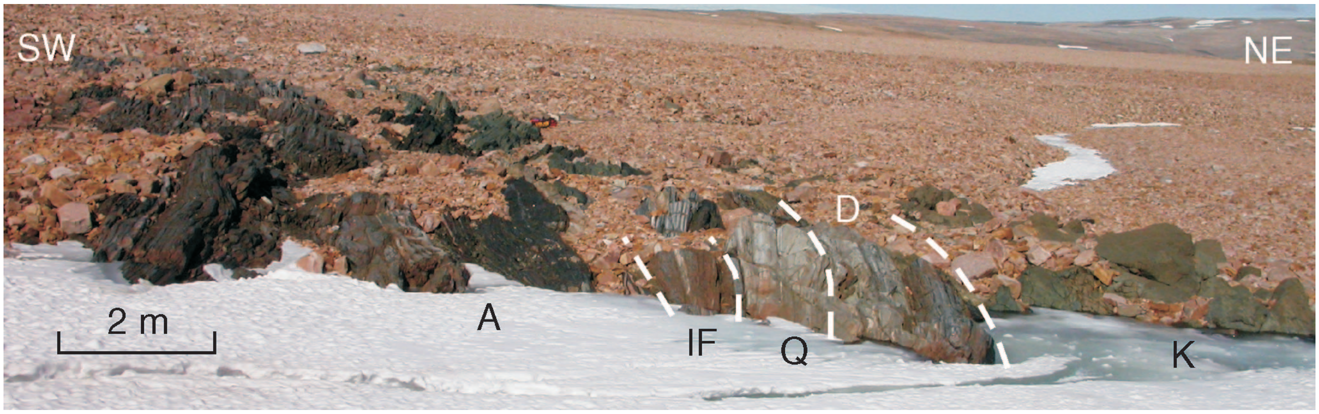

Figure 4. *Exposure of typical stratigraphic sequence throughout NTS 37 G including amphibolite (A) - iron formation (IF) - quartzite (Q) - dacite (D) - komatiite (K).*

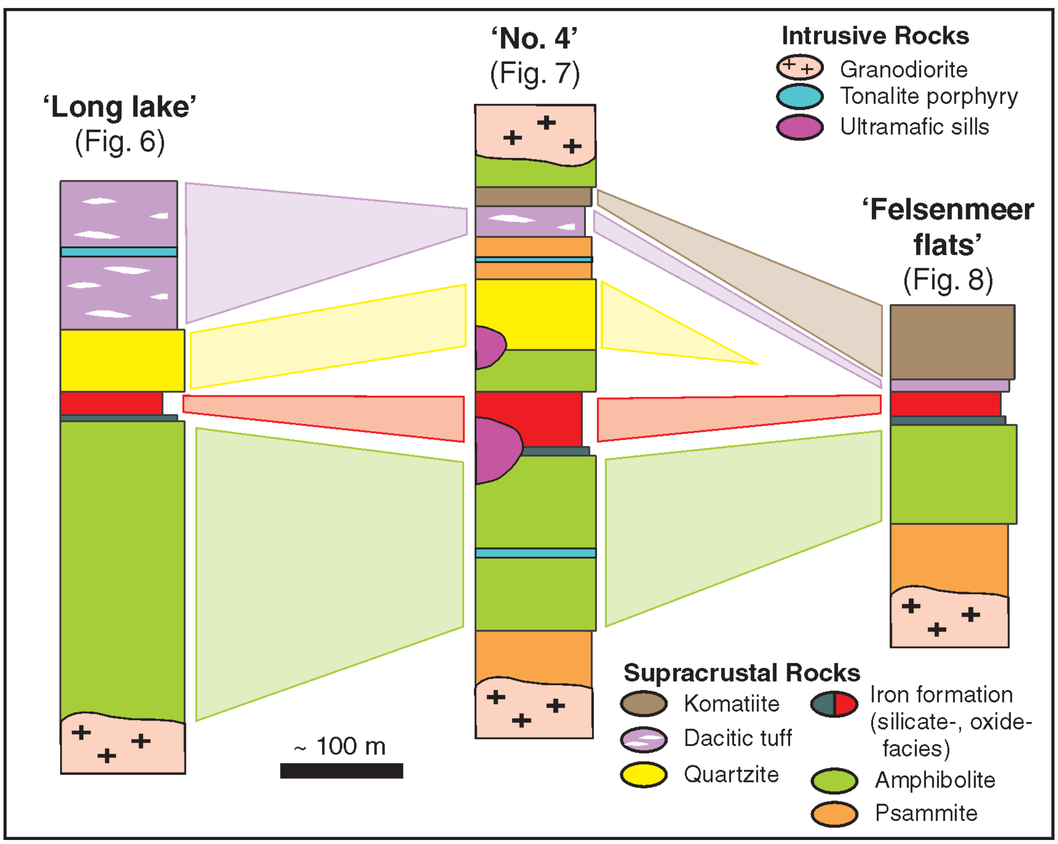

Figure 5. *Schematic stratigraphic correlation of the Mary River Group supracrustal rocks across NTS 37 G. The three stratigraphic columns correspond to the areas mapped in detail representing the northern (Long lake), west-central (No. 4), and southern (Felsenmeer flats) parts of the map area (refer to Fig. 2 for location).*

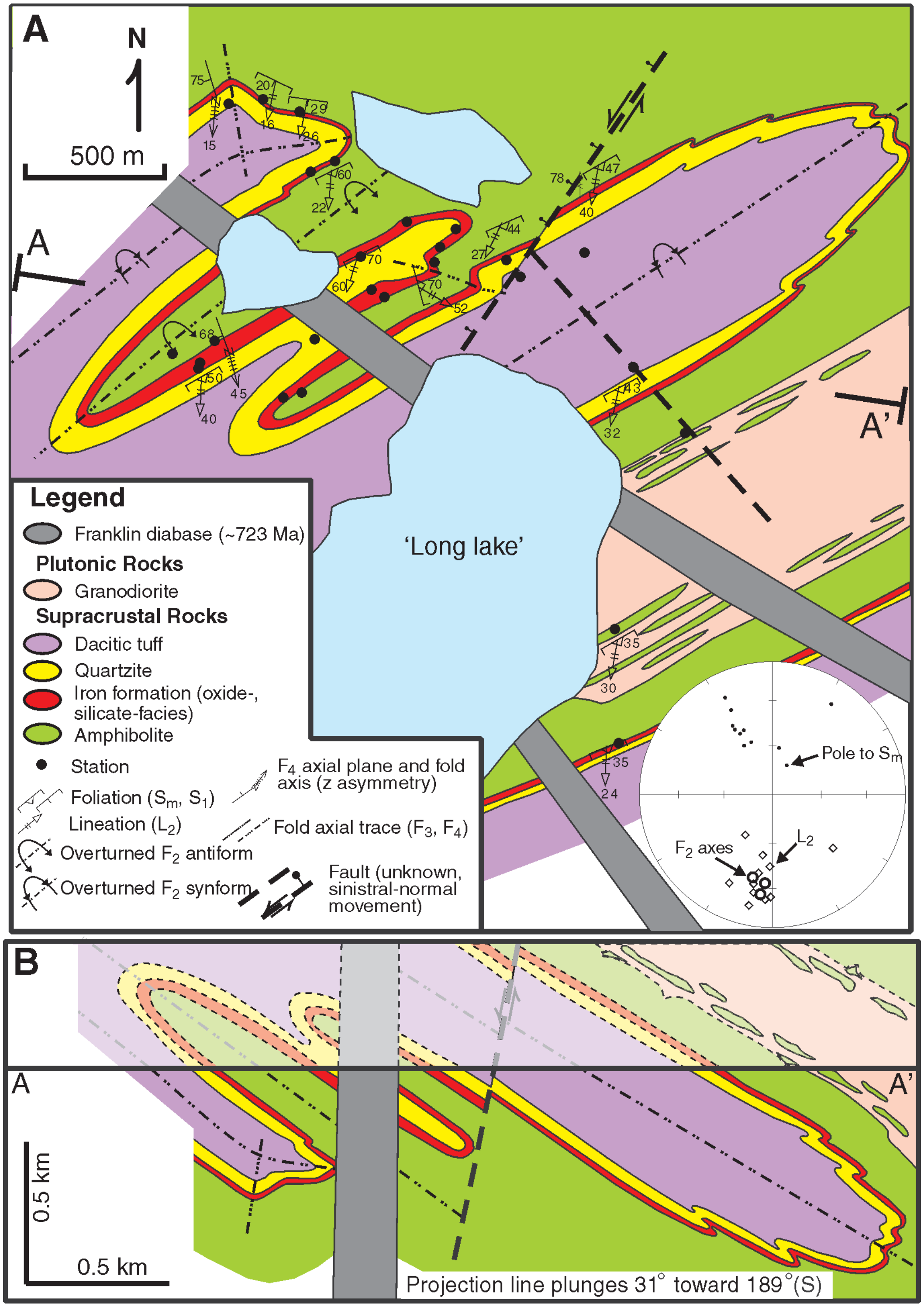

Figure 6. *Simplified geology map (**A**) and down-plunge cross-section (**B**) of the informally termed 'Long lake' area in the northern part of NTS 37 G (refer to Fig. 2 for location).*

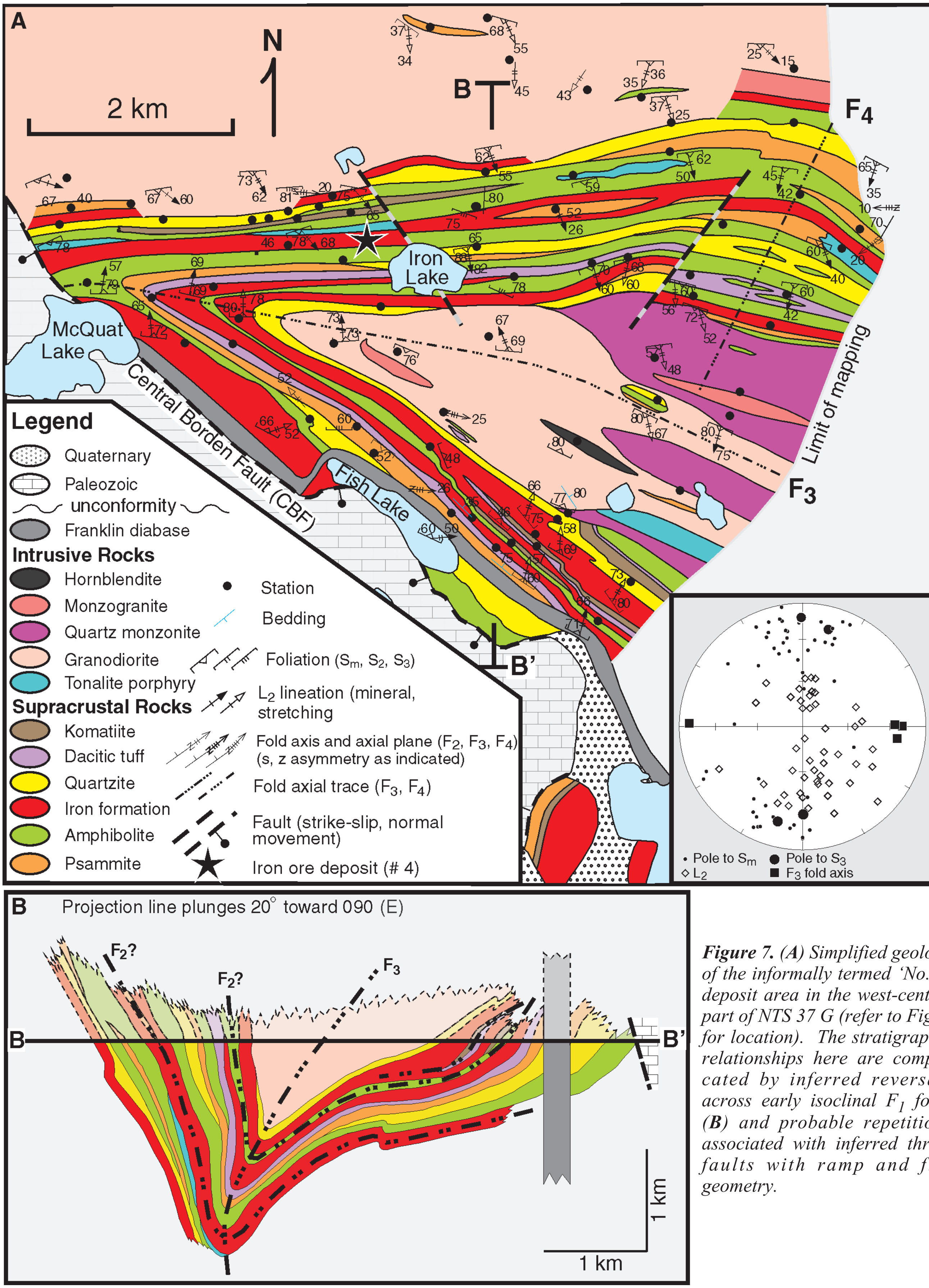

Figure 7. *(**A**) Simplified geology of the informally termed 'No. 4' deposit area in the west-central part of NTS 37 G (refer to Fig. 2 for location). The stratigraphic relationships here are complicated by inferred reversals across early isoclinal F_1 folds (**B**) and probable repetitions associated with inferred thrust faults with ramp and flat geometry.*

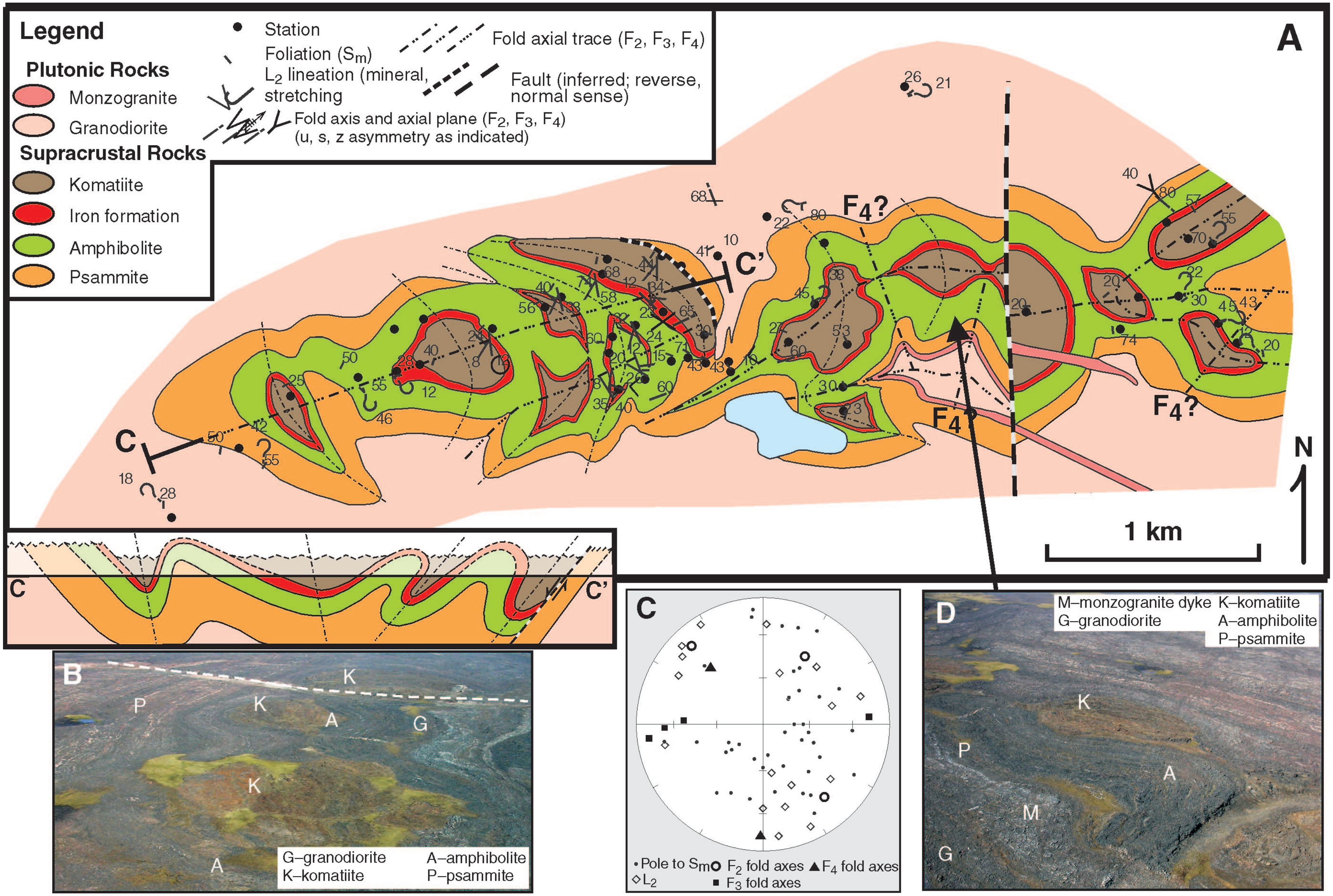

Figure 8. *Simplified geology and cross-section (**A**) of the informally termed "Felsenmeer flats" area in the southern part of NTS 37 G (refer to Fig. 2 for location). The aerial photograph in **B** was taken at about 500 m above the ground looking toward the eastern half of the map in A. The aerial photograph in **D** was taken about 200 m above the ground looking north, toward a structural basin preserving komatiite; komatiite is brown, amphibolite is dark grey, and intrusive rocks are paler.*

contrast to this relatively straightforward supracrustal sequence, at the 'No. 4' deposit in the west-central area (Fig. 7) and the 'Felsenmeer flats' area in the south (Fig. 8), stratigraphic relationships are more variable, and are complicated, in part, by lateral facies changes, as well as three episodes of penetrative deformation resulting in early isoclinal folding overprinted by east-west-trending folds. Regionally, in the upper part of the stratigraphic sequence, ultramafic volcanic rocks are more abundant in the south (Felsenmeer flats), whereas intermediate volcanic rocks are most abundant in the north (Long lake; Fig. 5).

Psammite

Psammite is the structurally lowest lithological unit at Felsenmeer flats (Fig. 8) and is inferred to be the lowest preserved stratigraphic unit. Psammite to semipelite occurs interbedded with amphibolite and quartzite in the No. 4 area. The psammite is characterized by brown-weathering, ubiquitous, coarse mica±sillimanite, imparting a strong schistosity, and locally developed 'knots' of quartz-muscovite-sillimanite± garnet (Fig. 9A). To the southeast, psammite is also the

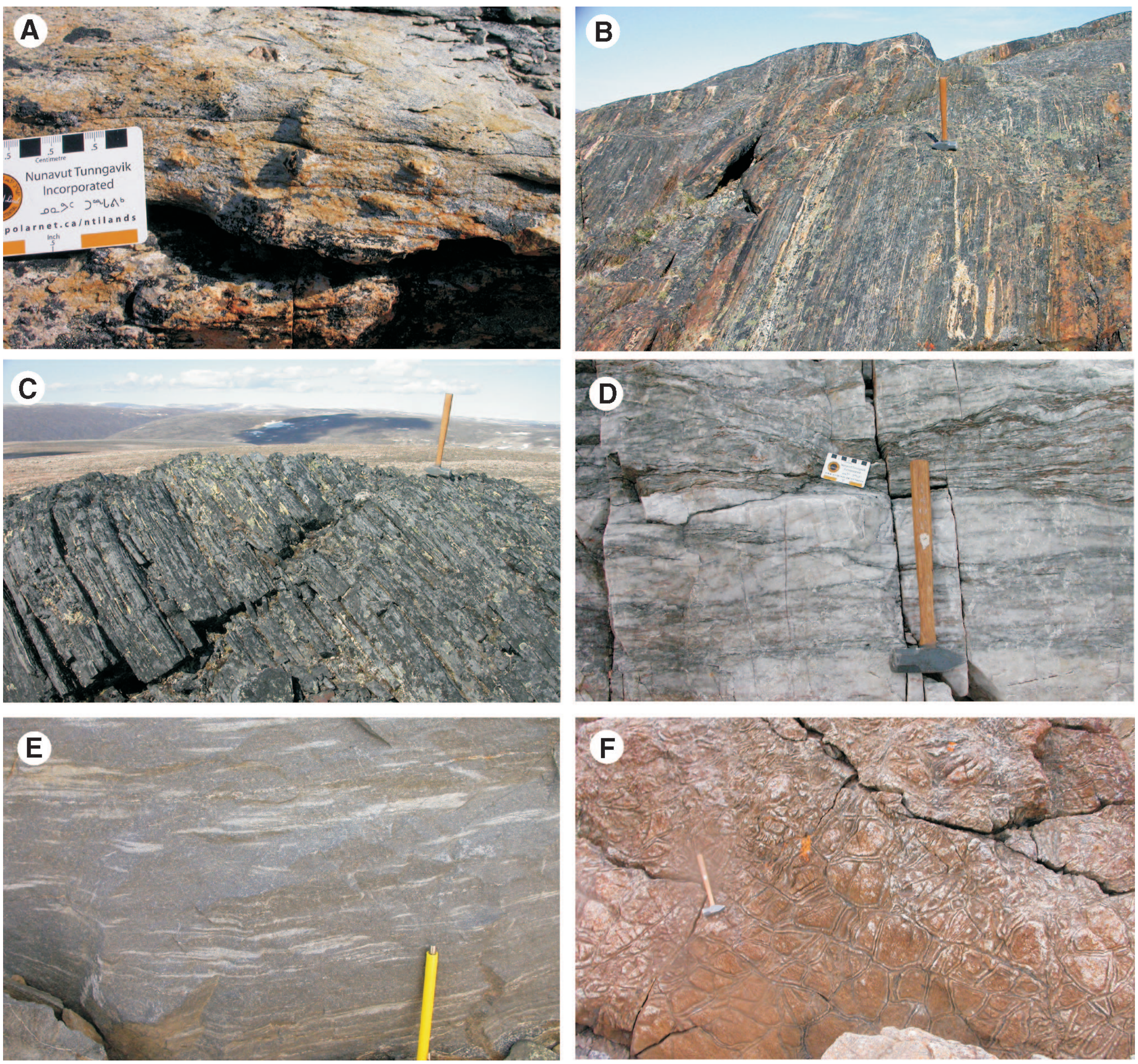

Figure 9. *Representative field photographs of the major rock types of the Mary River Group.* ***A)*** *psammite with 'knots' of quartz-sillimanite-muscovite;* ***B)*** *amphibolite with characteristic colour banding;* ***C)*** *oxide-facies iron formation interbedded with minor chert;* ***D)*** *thickly bedded quartzite with heavy mineral (dark) and muscovite-rich (red-brown) layers;* ***E)*** *lapilli to fragmental dacitic tuff characterized by bluish fresh surface and rare quartz eyes;* ***F)*** *bedding-plane view of polyhedral jointing in an ultramafic flow.*

stratigraphically lowest recognized unit of the Mary River Group in the Archean domal culminations of central Baffin Island (Scott et al., 2003).

Amphibolite

Mafic to intermediate amphibolite is the most common supracrustal rock type in the map area. The lower amphibolite unit is characterized by colour ‘banding’ (Fig. 9B) not present in the lower unit, distinguishing it as a regional stratigraphic marker. In places, the banding is defined by deformed epidote-albite pods and iron carbonate zones, the former perhaps representing transposed interpillow material and the latter likely a result of subsequent hydrothermal alteration. Massive, medium-grained, banded amphibolite was commonly observed in the Long lake area, as were slightly younger, cross-cutting irregular dykes and sills of strongly lineated, L>S tectonized plagioclase-phyric amphibolite.

Iron Formation

Iron formation occurs as a 3 to 40 m thick oxide- and silicate-facies unit, and serves as an excellent marker. In places, it exceeds 120 m as a result of tectonic thickening, possibly in the hinge zones of folds. Silicate-facies iron formation is generally thin (1–3 m) and commonly contains coarse garnet, anthophyllite, cummingtonite, and actinolite porphyroblasts. Oxide-facies iron formation includes laminated recrystallized chert, magnetite, and hematite. Locally, in the west-central map area, iron formation varies laterally from ore-grade iron deposits (No. 1-4 deposits, Fig. 2) consisting of approximately 99% hematite and/or magnetite (Jackson, 1966) to lean, chert-hematite-magnetite banded iron formation. Where exposed outside of this area, iron formation is commonly banded magnetite and chert layers of varying abundance, and generally has a strongly laminated appearance in outcrop (Fig. 9C).

Quartzite

Quartz arenite, orthoquartzite, and meta-chert constitute subfacies of the quartzite map unit, which ranges in thickness from less than 1 m in the south to approximately 20 to 40 m thick in the north (Fig. 5). Recognition of individual beds in quartzite is difficult, but in the Long lake area they may be defined by heavy mineral and mica-rich layers (Fig. 9D). The quartzite locally contains variable amounts of muscovite±sillimanite±fuchsite±magnetite. Where upper and lower contacts with adjacent units are observed, quartzite typically overlies iron formation with a gradational to sharp contact, and is in turn overlain by interbedded, intermediate and ultramafic volcanic rocks.

Two samples of quartzite, one from the Long lake area and another from the No. 4 area, have been collected for geochronology in order to assess the timing of sedimentation and the provenance of the detritus.

Intermediate and ultramafic volcanic rocks

In the west-central (Fig. 7) and central (Fig. 4) map areas, intermediate and ultramafic volcanic rocks are interbedded, and both rock types consistently overlie the quartzite. In the north, komatiitic rocks were not observed, whereas thick, dacitic, fragmental to lapilli tuff (Fig. 9E) overlies the quartzite (Fig. 5, 6). In contrast, only minor intermediate tuff occurs in the south, giving way to a thick komatiite sequence (Fig. 5, 8) which is characterized by a distinct brown weathering surface and, in places, exhibits polyhedral jointing along bedding planes (Fig. 9F).

Dacite in the Long lake area and the eastern supracrustal tongue (near the location of Fig. 4) has been sampled for geochronology to provide a direct age of volcanism.

PLUTONIC ROCKS

A large proportion of the map area is underlain by voluminous granodiorite, tonalite, and monzogranite, and by smaller amounts of quartz monzonite, quartz diorite, and diorite. Overall, contacts between the granitoids and the supracrustal rocks are typically not exposed, and where observed are commonly tectonized. Moreover, the apparent increase in strain as one progresses southward across the map area (*see* ‘Structural Geology’) complicates the interpretation of relative age relationships. Hence, relative ages may only be determined locally. Jackson et al. (1990) and de Kemp and Scott (1998) provided four reasonably precise U-Pb zircon ages for plutonic rocks of the region: two of these are roughly synvolcanic with the Mary River Group (ca. 2709 Ma), whereas the third determination is slightly younger (ca. 2658 Ma). The fourth determination of ca. 2851 Ma (Jackson et al., 1990) was inferred to represent basement to the supracrustal sequences.

North of the No. 4 deposit area (Fig. 7), what was termed ‘nebulitic orthogneiss’ by Jackson et al. (1978), was observed to comprise medium- to coarse-grained, moderately foliated and lineated, biotite tonalite to granodiorite containing sparse phenocrysts and megacrysts of potassium feldspar. The granitoid contains foliation-parallel screens and rafts of biotite± garnet psammite, flattened xenoliths of fine-grained amphibolite, and is locally cross-cut by nonfoliated, but lineated north-northwest-trending gabbroic dykes. Proximal to the supracrustal package, the intensity of the foliation and, in particular, the lineation, increases dramatically as does the abundance of supracrustal xenoliths and rafts. Similarly, the modal proportion of muscovite increases dramatically near the supracrustal-granitoid contact. In the core of the major F_2 fold at that locality is a generally coarse-grained, L>S biotite+ muscovite granodiorite that contains rare xenoliths of supracrustal rocks. This plutonic rock is similar in appearance to that exposed along the northern margin of the supracrustal belt. These observations suggest that the granitoids at the No. 4 deposit locality are younger than and intrude the supracrustal belt, but older than the F_3 synform which preserves the granitoids in the core of the fold. The contacts are commonly obscured or tectonized, however, and hence a U-Pb geochronological sample has been collected to determine the age of the northern plutonic unit.

Immediately north of the supracrustal rocks at the Felsenmeer flats locality (Fig. 8), and mapped by Jackson et al. (1978) as predominantly banded migmatite of possible Archean or Paleoproterozoic age, is a variably foliated, generally medium-grained, leucocratic biotite granodiorite. The foliation, defined by wispy biotitic schlieren and elongate rafts and xenoliths of amphibolitic supracrustal rocks, appears to increase in intensity in proximity to the supracrustal sliver. Taken as a whole, field observations suggest that the granodiorite intrudes the supracrustal rocks and likely predates D_3.

Contacts between the supracrustal rocks and engulfing granitoid rocks were not seen in the Long lake area owing to the extensive glacial till cover. The supracrustal sequence, however, contains foliation-parallel, laterally continuous bodies of fine- to medium-grained, leucocratic, locally plagioclase-phyric biotite granodiorite to monzogranite. These were observed to locally cross-cut the main foliation (S_m) but preserved a moderately developed L_2 lineation suggesting that these were intruded late in the D_2 deformation history.

Serpentinized peridotite sills occur in the central part of the belt, in contact with amphibolite, iron formation, and locally, quartzite (Fig. 5). Generally these bodies occur as a series of closely spaced sills and slightly discordant dykes inflating and cutting the supracrustal sequence. Commonly, these bodies display pale and dark green banding, 2 cm to 2 m thick, on the weathered surface. Some of them occur as large screens in granodiorite, and are interpreted to be late synvolcanic.

STRUCTURAL GEOLOGY

Rocks of the Mary River Group and the intervening plutonic rocks have been affected by at least three regionally penetrative episodes of deformation, and late-stage shortening reflected by locally developed kink bands and shearing. The character and orientation of structural fabrics attributed to each of these episodes of deformation correspond to similar generations of structures described in the Committee Bay greenstone belt to the southwest (Sanborn-Barrie et al., 2003 and references therein), in the Eqe Bay area to the south (Bethune and Scammell, 2003a), and in the central Baffin Island area to the southeast (Scott et al., 2003; Fig. 1).

D_1 deformation

The first recognized generation of structures is characterized by variably developed bedding-parallel foliations (S_1) and locally preserved intrafolial F_1 folds. Resolving the effects of D_1 and D_2 deformation is a common problem in the map area, and the main foliation in outcrop was often mapped as a generic S_m. These structures are either D_1 or transposed D_1/D_2 fabrics.

In hinge zones of some F_2 folds, S_1 is observed to continue around the nose of the fold, staying roughly parallel to bedding (e.g. northwest part of the Long lake map area, Fig. 6). In places, a strongly developed S_1 foliation in granitoid rocks is folded by northwest-striking, reclined F_2 folds (Fig. 10A). Distinguishing S_1 from a composite S_1/S_2 in the southern part of the map area becomes difficult because overprinting D_3 strain increases southward, obscuring the earlier cross-cutting relationships (e.g. Fig. 7, 8).

D_2 deformation

The main penetrative structures recognized throughout the map area are attributed to D_2 deformation. These include moderately southeast-dipping, shallowly to moderately south-plunging F_2 reclined folds that are best preserved in the northern part of the map area (Fig. 6). A moderately to strongly developed axial-planar S_m foliation (composite S_1/S_2) dips moderately to the southeast in the north (Fig. 6), and is best developed on the limbs of F_2 folds. South of this area, F_2 folds and associated fabric elements are reoriented by F_3 folding (discussed below).

The predominant mineral and stretching lineations are attributed to D_2 deformation because they are coaxial to F_2 fold hinges and, in places, amphibolitic to plagioclase-porphyritic dykes carry a strongly developed L_2 lineation, but lack an S_1 fabric (Fig. 10B). In plutonic rocks, accumulated strain is typically lower than in the intervening supracrustal strands, and is characterized by moderately developed L_2 lineations that plunge shallowly to the east-southeast, approximately perpendicular to L_2 in supracrustal rocks. Variation in the intensity of composite D_1/D_2 strain between these domains likely reflects strain partitioning into the relatively less competent and more anisotropic supracrustal rocks.

Plagioclase-porphyritic biotite granodiorite intrudes supracrustal rocks in the Long lake area and cuts S_1, but contains a moderately developed L_2 lineation. The porphyritic intrusive phase is interpreted to have intruded prior to or during D_2 deformation. A sample has been collected for geochronology and will provide a minimum age for D_2 deformation.

D_3 deformation

Variably developed east-northeast- to east-trending folds associated with a weakly developed axial-planar foliation are the principal structures attributed to D_3 deformation. Macroscopic F_3 folds are generally open, steeply north-dipping, and shallowly east- and west-plunging. Regional F_3 folds are recognized by the reorientation of D_1 and D_2 fabric elements, particularly the L_2 lineation (Fig. 7, 8). The complex map pattern at the Felsenmeer flats locality (Fig. 8) is inferred to represent noncoaxial F_1 and F_2 fold interference resulting in a 'mushroom'-style outcrop geometry. Strongly developed bedding-parallel S_m foliations and associated L_2 mineral-elongation lineations vary in orientation dramatically over a short distance as a result of superimposed F_3 folding (Fig. 8).

At the No. 4 deposit, strongly developed composite D_1/D_2 fabric elements are folded about a steeply dipping, west-striking F_3 synform associated with only locally developed S_3 axial planar foliations which are oriented clockwise with respect to S_m on the northern limb and counterclockwise on the southern limb (Fig. 7). The two generations of folds are nearly coaxial, producing a modified Type 3 interference pattern (Ramsay and Huber, 1987). At the Long lake locality, F_3 folds produce undulations of S_m surfaces at outcrop scale (Fig. 10C), but do not significantly affect the regional pre-existing structural elements (Fig. 6, stereonet inset).

D_4 deformation

Late-stage shortening, attributed to D_4 deformation, is manifested by outcrop-scale, conjugate kink- and chevron-style F_4 folds that commonly lack an associated cleavage (Fig. 10C). F_4 folds are best developed in relatively incompetent rocks such as pelite to psammite, as well as strongly flattened rocks (Fig. 10C). The orientations of F_4 folds range from northwest- to northeast-trending and typically plunge to the south, and less commonly to the north. The style of folding (kink and chevron) and the orientation of the pre-existing anisotropy (S_m surfaces) are the dominant controls on the geometry of F_4 folds. The southwest- and southeast-trending F_4 conjugate kink and chevron folds are interpreted to be the result of approximately east-west-directed shortening.

Timing and regional correlation considerations

In the Eqe Bay and Committee Bay areas, structures inferred to be correlative to northwest-vergent D_2 structures in northern Baffin Island have been dated at ca. 1.8 Ga (Bethune and Scammell, 2003a; Sanborn-Barrie et al., 2003 and references therein), and attributed to hinterland reworking during the Trans-Hudson Orogeny. It seems likely that correlative D_2 structures in north Baffin are a result of Trans-Hudson-related deformation.

In the Eqe Bay area (Bethune and Scammell, 2003a), locally developed, east-trending folds overprint ca. 1.8 Ga deformation fabrics and may be correlative to D_3 in north Baffin. In the intervening area between Eqe Bay and the north Baffin study area, and northwest of the Isortoq fault zone, the predominant structural grain is east-west and appears to be most intense adjacent to Steensby Inlet. In the Woodburn Lake group near the Meadowbank gold deposit, Hrabi et al. (2003) described a complex history of polyphase deformation involving strongly developed composite D_1/D_2 fabrics affected by locally developed east-northeast-trending, steeply northwest-dipping F_3 folds and northeast-trending, upright F_4 folds. The sequence and orientation of this polyphase history of deformation is similar to that recorded in north Baffin.

To the southeast in central Baffin Island, the final phase of deformation (D_{3P}) is represented by northwest- to northeast-trending cross folds, correlative to D_4 in north Baffin, that generate the overall dome-and-basin geometry of the map area (Scott et al., 2003 and references therein). Similarly, in the northeastern Committee Bay area, the dominant,

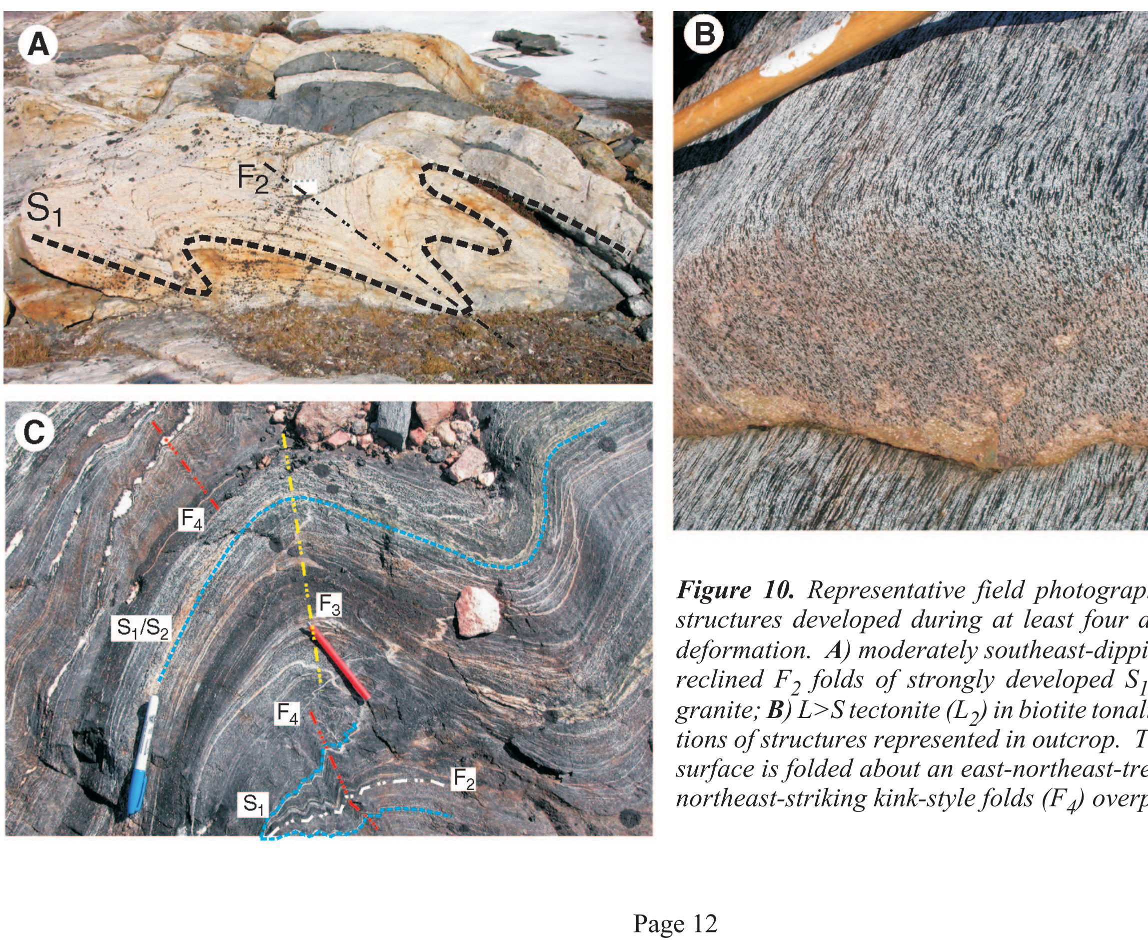

Figure 10. *Representative field photographs of macroscopic structures developed during at least four distinct episodes of deformation.* ***A)*** *moderately southeast-dipping, south-plunging reclined F_2 folds of strongly developed S_1 in biotite monzogranite;* ***B)*** *L>S tectonite (L_2) in biotite tonalite;* ***C)*** *four generations of structures represented in outcrop. The composite S_1/S_2 surface is folded about an east-northeast-trending F_3 axis, and northeast-striking kink-style folds (F_4) overprint all structures.*

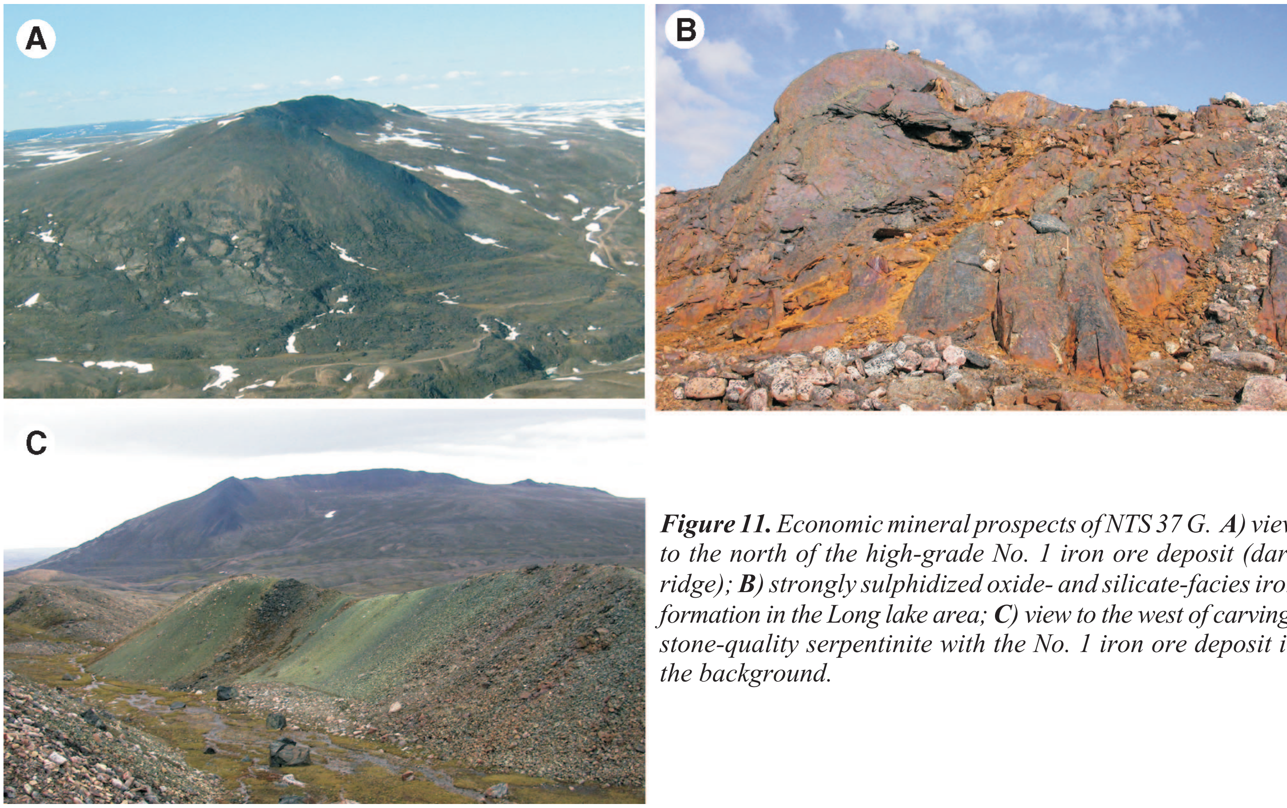

***Figure 11.** Economic mineral prospects of NTS 37 G. **A)** view to the north of the high-grade No. 1 iron ore deposit (dark ridge); **B)** strongly sulphidized oxide- and silicate-facies iron formation in the Long lake area; **C)** view to the west of carving-stone-quality serpentinite with the No. 1 iron ore deposit in the background.*

northeast-trending D_2 structures are reoriented by F_3 conjugate kink- and chevron-style folds interpreted to be the result of approximately northeast-directed layer-parallel shortening (Sanborn-Barrie et al., 2003).

ECONOMIC GEOLOGY

Mineral prospecting during the present study focused on the supracrustal rocks of the Archean Mary River Group in NTS 37 G. There is high potential for iron-formation-hosted gold deposits in the area, as well as potential for Ni-Cu-PGE magmatic sulphide deposits in the locally abundant ultramafic intrusions and Franklin dykes. Initial reconnaissance investigations included helicopter and foot traverses in order to identify prospective regions, followed by detailed mapping and assay sampling. A total of 89 assay samples were collected and results will be released in a GSC open file report in the spring of 2004.

Iron formations vary from lean, banded magnetite-chert to iron-ore-quality deposits consisting of approximately 99% magnetite and hematite (Jackson, 1966). Thick deposits of iron ore occur in the west-central area at Nos. 1–4 iron deposits (Fig. 2, 11A). Predominant ore mineralogy ranges from fine- to coarse-grained magnetite as well as specular hematite. Sulphide mineralization is also locally present.

Oxide- and silicate-facies iron formation occurs throughout the map area and is locally highly sulphidized. The Long lake area is most noteworthy, where northeast-striking centimetre-scale banded magnetite-chert iron formation is commonly sulphidized (Fig. 11B). A 20 m thick zone of iron formation with a strike length of approximately 700 to 800 m contains pods and veins with up to 30% pyrite+/-arsenopyrite+/-chalcopyrite.

Locally abundant ultramafic sills intrude the Mary River Group supracrustal rocks. These sills are most common at the 'No. 1' iron deposit area (Fig. 2) and locally these were observed to contain thin sulphide veinlets as well as disseminated sulphides, predominantly pyrite±chalcopyrite. No massive sulphide pods were observed, but locally, sulphide-bearing, coalesced veinlets were observed, presumably formed during subsequent deformation and metamorphism. The veinlets occupy fractures which are generally foliation-parallel, and may represent a fracture cleavage.

Carving-stone-quality serpentinized ultramafic rocks occur throughout the map area associated with the Mary River Group. Large deposits of carving stone are most abundant near the Nos. 1–3 iron deposits in association with thick ultramafic sills (Fig. 2, 11C).

In the northern part of the map area, dolostone of the Society Cliffs Formation of the Mesoproterozoic Bylot Supergroup is variably mineralized with coarse galena and sphalerite. Mineralization styles range from bedding-parallel and perpendicular veins of calcite and galena to disseminated and vug-filling calcite, galena, and sphalerite.

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