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Bedrock geology and economic potential of the Archean Mary River group, northern Baffin Island, Nunavut

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Abstract: Bedrock mapping and prospecting in northern Baffin Island, including parts of NTS map areas 37 E, F, G, and H, has redefined interpretations of the stratigraphy and structure of the Archean Mary River group, surrounding gneiss, and intrusions. In the study area, the Mary River group includes psammite and sedimentary migmatite, amphibolite, ±psammite and sedimentary migmatite, Algoma-type silicate- and oxide-facies iron-formation, ±dacite, ±psammite, and quartzite, intruded by late ultramafic and gabbroic sills and dykes. Three episodes of penetrative deformation are recognized and Archean and Proterozoic rocks underwent amphibolite- to granulite-facies regional metamorphism during the ca. 1.8 Ga Hudsonian Orogeny. The youngest regional event, defined as D_3, folded metamorphic isograds and pre-D_3 fabrics. New economic mineral prospects include 20 m thick magnetite beds within iron-formation, and visible gold and molybdenum in quartz veins. The area also has potential for Ni-Cu-PGE magmatic sulphide mineralization in mafic and ultramafic sills.

Résumé : La cartographie du substratum rocheux et les travaux de prospection dans le nord de l'île de Baffin, notamment dans les régions couvertes par des parties des cartes 37 E, F, G et H du SNRC, ont permis d'élaborer de nouvelles interprétations de la stratigraphie et de la structure du groupe de Mary River de l'Archéen, ainsi que des gneiss et des intrusions avoisinants. Dans la région d'étude, le groupe de Mary River se présente comme suit : psammite et migmatite sédimentaire, amphibolite, ± psammite et migmatite sédimentaire, formation de fer de type Algoma à faciès silicaté et oxydé, ± dacite, ± psammite et quartzite. Toutes les unités précédentes sont recoupées par des filons-couches et des dykes ultramafiques et gabbroïques de formation tardive. Trois épisodes de déformation pénétrative sont distingués et les roches de l'Archéen et du Protérozoïque ont subi un métamorphisme régional allant du faciès des amphibolites au faciès des granulites pendant l'orogenèse hudsonienne, à 1,8 Ga environ. L'événement régional le plus récent, attribué à D_3, a plissé les isogrades du métamorphisme et les fabriques antérieures à D_3. De nouveaux prospects de minéralisations d'intérêt comprennent des lits de magnétite de 20 m d'épaisseur dans la formation de fer, ainsi que de l'or visible et du molybdène dans des filons de quartz. La région recèle en outre un certain potentiel quant aux minéralisations de sulfures magmatiques de Ni-Cu-ÉGP dans des filons-couches mafiques et ultramafiques.

INTRODUCTION

This report outlines preliminary field results from the 2005 season for the bedrock component of the three-year North Baffin Project, a collaborative effort of the Canada-Nunavut Geoscience Office and the Geological Survey of Canada. The primary objective of this project is surficial mapping and till sampling of NTS map areas 37 E, F, G, and H, northern Baffin Island, Nunavut (Fig. 1), with corresponding targeted bedrock mapping and prospecting of selected areas (Young et al., 2004). Surficial geology was discussed by Little et al. (2004) and Utting et al. (2006).

This project builds on previous regional bedrock mapping projects throughout the northern Rae Domain of the western Churchill Province: the Clyde-Cockburn Land area, north-central Baffin Island (Jackson, 2000, 1996; Jackson and Berman, 2000), the Eqe Bay area to the south (Bethune and Scammell, 1993, 2003a, b; Scammell and Bethune; 1995), and the Committee Bay region to the southwest (Frisch, 1982; Sanborn-Barrie et al., 2003; Skulski et al., 2003; Carson et al., 2004; Berman et al., 2005) (Fig. 1). The purposes of the bedrock component of the North Baffin Project are to discover prospective areas of economic mineral potential, collect rock samples for assay analysis supporting the drift prospecting component (Utting et al., 2006), and to update the stratigraphic, metamorphic, structural, geochemical, and geochronological knowledge for the Mary River group on northern Baffin Island.

GEOLOGICAL SETTING

The study area occurs in the ca. 3.0–2.5 Ga Committee belt of the western Churchill Province (Jackson and Berman, 2000). The Committee belt is part of the northern Rae Domain (Hoffman, 1988), and is characterized by felsic plutonism and greenschist- to upper-amphibolite-facies supracrustal (greenstone) belts (Jackson and Berman, 2000). These supracrustal belts are discontinuous, trend northeast (Jackson and Berman, 2000; Skulski et al., 2003), and extend from Baker Lake in southern Nunavut to northwest Greenland (Fig. 1). Correlative sequences include the Woodburn Lake, Prince Albert, and Mary River groups of the Rae domain, and the Inglefield Bredning–Melville Bugt region of northwestern Greenland (Fig. 1) (Frisch, 1982; Schau and Ashton, 1988; Zaleski et al., 1999, 2001; Jackson and Berman, 2000). These ca. 2.74–2.68 Ga Neoarchean supracrustal sequences were deposited on ca. 3.0–2.8 Ga Mesoarchean plutonic crust (Jackson et al., 1990; Jackson and Berman, 2000; Zaleski et al., 2000; Wodicka et al., 2002; Bethune and Scammell, 2003a; Pehrsson et al., 2005). The Mary River group is bordered to the southeast by the inferred crustal-scale Isortoq fault zone (Fig. 2) (Jackson, 2000; Bethune and Scammell, 2003b) and locally overlain by Paleoproterozoic supracrustal sequences, which extend from Melville Peninsula (Penrhyn Group) across Baffin Island (Piling Group) to west Greenland (Karrat Group) (Fig. 1) (Jackson and Taylor 1972; Henderson and Tippett, 1980; Hoffman, 1988, 1990; Henderson et al., 1989; Jackson and Berman 2000).

The Mary River group, exposed on northern Baffin Island, comprises two greenstone belts in the Eqe Bay area (Fig. 1), the Isortoq and Eqe Bay belts (Bethune and Scammell, 1993, 2003a, b; Scammell and Bethune, 1995). Primary stratigraphic relationships are well exposed within the predominantly greenschist-facies Eqe Bay belt. The stratigraphic sequence of the Eqe Bay belt, from base to top, is characterized by mafic to intermediate volcanic rocks, iron-formation, subordinate quartzite, intermediate to felsic volcanic rocks, and overlain by conglomerate and a greywacke-turbidite sequence (Bethune and Scammell, 2003a). This assemblage is interpreted to represent the formation of a volcanic arc on thinned continental crust with associated fumarolic activity forming iron-formation deposits (Bethune and Scammell, 2003a). In contrast, the mafic volcanic sequences and associated ultramafic volcanic rocks of the Woodburn Lake and Prince Albert groups are interpreted as melting products of one or more mantle plumes in a continental-rift setting (Zaleski et al., 1999, 2001; Skulski et al., 2003). Schau and Ashton (1988) suggested an additional interpretation for the Prince Albert Group, where the intermediate volcanic rocks formed within an ensialic basin or during crustal rifting above a linear mantle upwelling or plume, wherein the mafic volcanic rocks formed at the basin margins and the felsic volcanic rocks formed by partial melting of the lower crust.

The rocks of the Woodburn Lake, Prince Albert, and Mary River groups have been affected by several episodes of Archean and Proterozoic deformation and metamorphism. Evidence for three Archean metamorphic events is thought to be preserved in the Eqe Bay greenstone belt (Bethune and Scammell, 2003b). The first event is based on structural and metamorphic complexity observed in the gneiss complex which is absent from, and likely predates, the ca. 2780–2770 Ma orthogneiss and ca. less than 2770 Ma supracrustal Mary River group. The second event involved folding of volcanic rocks and iron-formation of the Mary River group, which is inferred to have occurred before the eruption of ca. 2740–2725 Ma intermediate to felsic volcanic rocks. The third is represented by low- to medium-pressure metamorphism of the entire Eqe Bay belt, which postdates turbidite sedimentation and is coeval with ca. 2700–2690 Ma peraluminous plutonism. Geochronology from the Committee Bay belt indicates that the northern Rae Domain experienced a metamorphic event at ca. 2.35 Ga (Carson et al., 2004; Berman et al., 2005). Structural studies of the Woodburn Lake Group also identified evidence for Archean deformation events (Pehrsson et al., 2004). Paleoproterozoic deformation within the northern Rae Domain was widespread during the Hudsonian Orogeny at ca. 1.8 Ga, and resulted in the development of a strong northeast-southwest structural grain in the

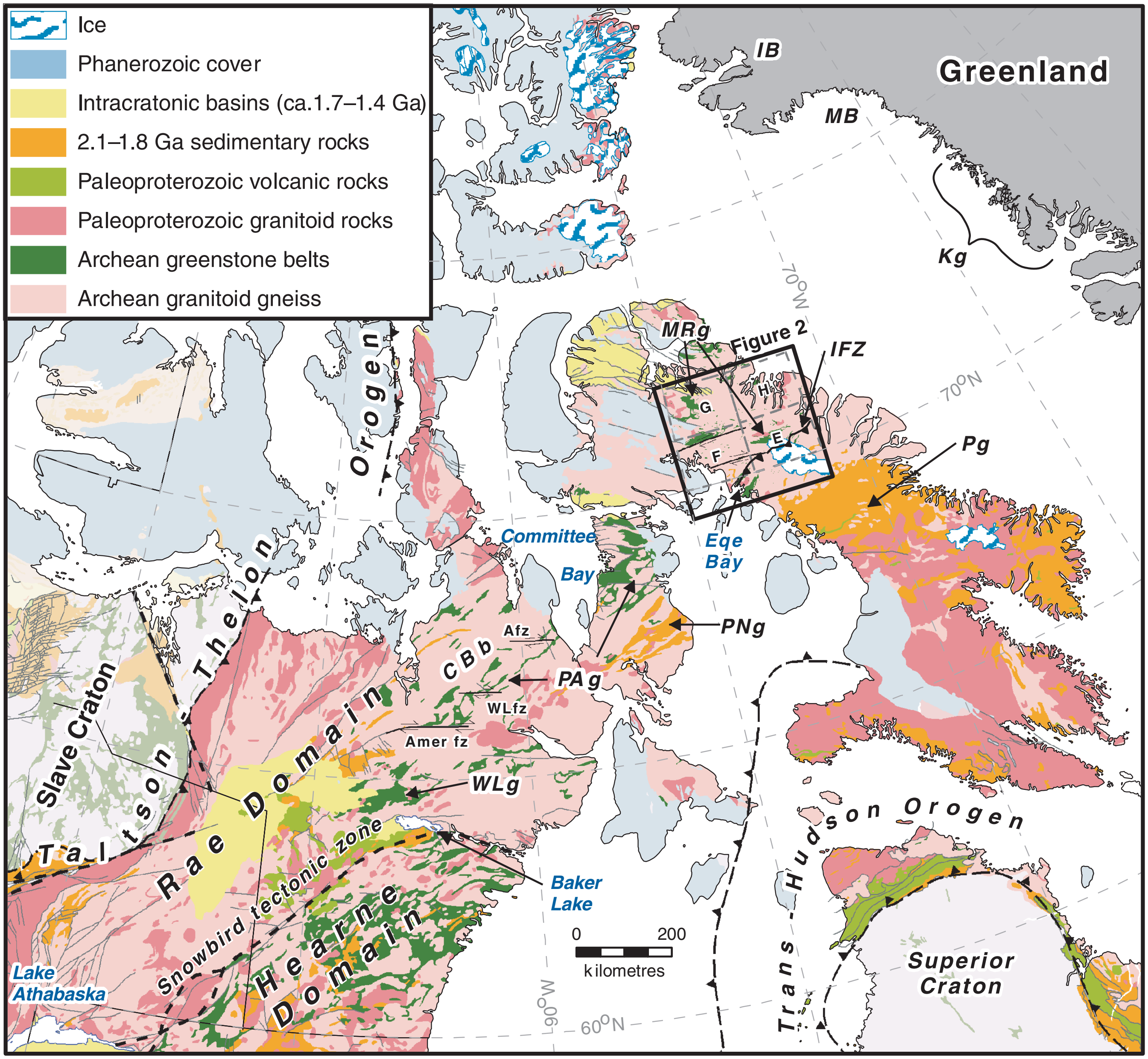

Figure 1. Regional geology of the Archean Rae Domain of the Western Churchill Province and environs. CBb = Committee Bay belt, IFZ = Isortoq Fault Zone, IB = Inglefield Bredning, Kg = Karrat Group, MRg = Mary River group, MB = Melville Bugt, PAg = Prince Albert Group, PNg = Penrhyn Group, Pg = Piling Group, WLg = Woodburn Lake Group. The east-trending dextral fault zones in the Committee Bay belt cut ca. 1.8 Ga northeast-striking fabrics; Amer fz = Amer fault zone, Afz = Atorquait fault zone, WLfz = Walker Lake fault zone. The letters within the area of Figure 2 represent NTS map areas; E = 37 E, F = 37 F, G = 37 G, H = 37 H.

northern Rae Domain, and produced large-scale, tight northwest-vergent folds and a fold-thrust belt in the Committee Bay and Woodburn Lake regions (Sanborn-Barrie et al., 2003; Carson et al., 2004; Pehrsson et al., 2004; Berman et al., 2005). The Hudsonian event also resulted in northwest directed thrusting and activation of the Isortoq fault zone on Baffin Island, culminating in granulite-grade metamorphism, anatexis, and local plutonism within the footwall of the fault zone. The region of granulite-facies rocks is known as the Dexterity granulite belt (Fig. 1, 2; Jackson (2000) Jackson and Berman (2000)). The granulite-facies metamorphism is dated at 1825 Ma (Bethune and Scammell, 2003b). Within the Mary River group, the northeast-trending folds have been refolded by east-trending, upright folds, producing a dome-and-basin geometry in the study area (Young et al., 2004). Local northeast- and northwest-trending crenulations also occur throughout the study area. The crenulation fabrics are inferred to be related to superposed folds which produce the dome-and-basin folding in Piling Group rocks (Scott et al., 2003).

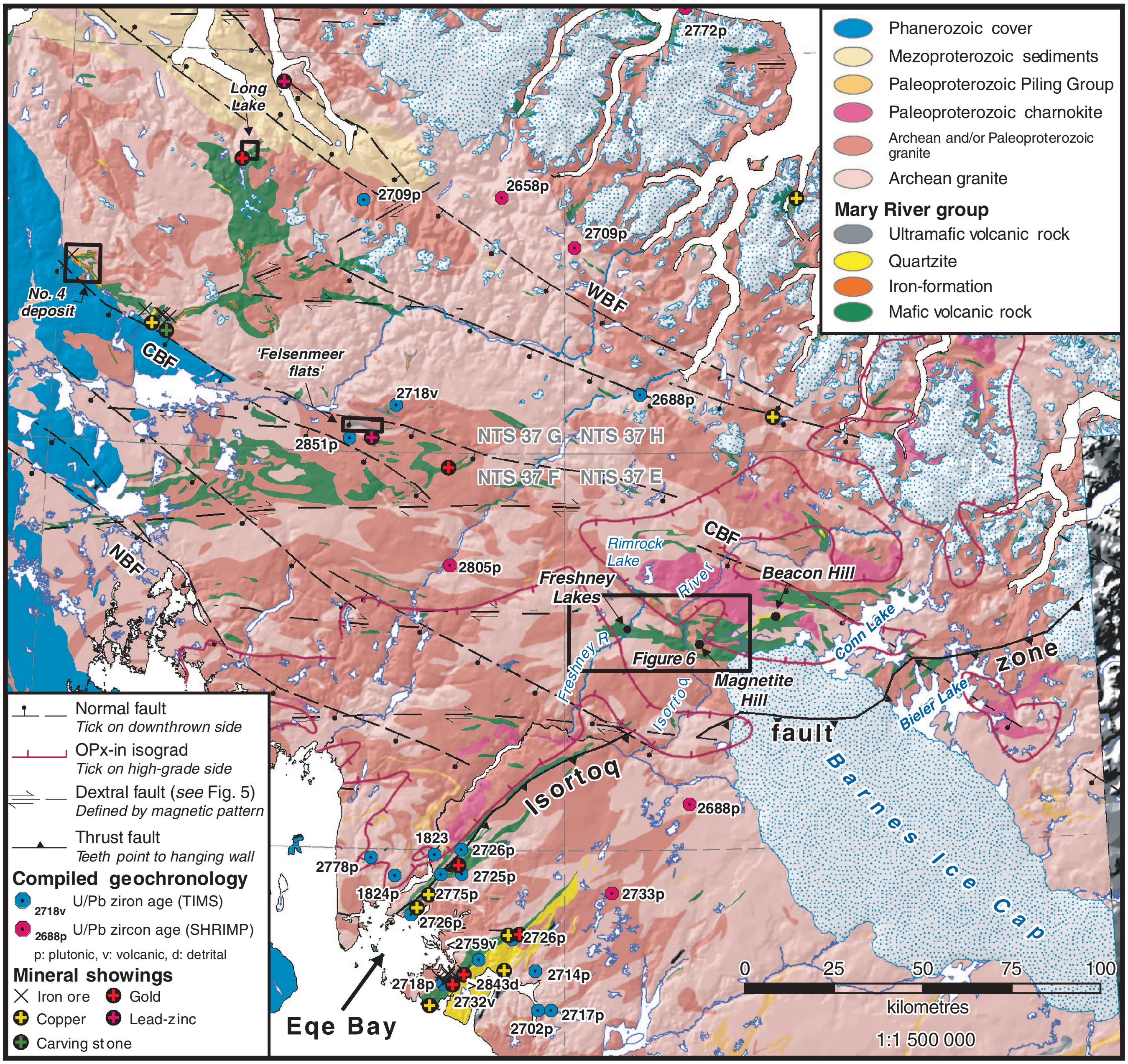

Figure 2. Generalized geology of northern Baffin Island focusing on NTS 37 E, F, G, and H. Map data *from* de Kemp and Scott (1998). Detailed maps of the areas indicated in NTS 37 G labelled as Long Lake, No. 4 deposit, and 'Felsenmeer flats' are published in Young et al. (2004). Detailed maps of the Freshney River and Magnetite Hill areas are shown in Figures 5 and 6. The SHRIMP U/Pb ages are unpublished data referred to in Scott and de Kemp (1999). The TIMS U/Pb ages in the Eqe Bay area are from Bethune and Scammell (2003a, b); all others are *from* Jackson et al. (1990). CBF = Central Borden Fault, NBF = Nina Bang Fault, WBF = White Bay Fault.

QUARTZOFELDSPATHIC GNEISS

Quartzofeldspathic gneiss, inferred to be derived from granitoid intrusions, forms irregular bodies and underlies most of NTS map areas 37 E and 37 H. Gneiss units are banded and predominantly represented by granodiorite compositions, with granodiorite-granite, granite-granodiorite, granodiorite-quartz monzonite, diorite-quartz diorite, and syenogranite subtypes. Biotite schlieren and amphibolite xenoliths occur locally. Several samples of gneiss were collected for geochronology to determine if some of these gneiss units represent basement to the Mary River group.

Previous studies on northern Baffin Island have identified the presence of extensive tracts of Mesoarchean banded orthogneiss, thought to form the basement to the Neoarchean Mary River group (Jackson et al., 1990; Wodicka et al., 2002; Bethune and Scammell, 2003a). In NTS map area 37 G, tonalitic gneiss yielded an igneous 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, 2003a). 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 age dates indicate the presence of Mesoarchean crust, which may occur as basement to an unconformably overlying supracrustal sequence, such as the Mary River group.

MARY RIVER GROUP

The Mary River group supracrustal rocks are gently dipping, and are best-exposed and -preserved in cliff sections and as tors in the central part of NTS map area 37 E, northwest of the Barnes Ice Cap along the Isortoq River, and northeast of the Barnes Ice Cap between Conn Lake and Bieler Lake (Fig. 2). The surrounding parts of NTS map areas 37 E and 37 H are covered by extensive, boulder-rich, glacial till deposits. In NTS map areas 37 G, the rocks are steeply dipping and are best exposed in the northern, west-central, and southern parts of the map area (Fig. 2; Young et al., 2004). Regional correlations and previous mapping in NTS map area 37 G during 2003 characterized the stratigraphy of the western part of the Mary River group (Fig. 3) (Young et al., 2004). The generalized stratigraphic order for 37 G, from base to top, is as follows: psammite, amphibolite, Algoma-type oxide- and silicate-facies iron-formation, quartzite, and interbedded ultramafic and intermediate volcanic rocks (Young et al., 2004).

The stratigraphic sequence in the northwest map area (NTS 37 G) comprises predominately mafic, ultramafic, and intermediate volcanic rocks and subordinate clastic metasedimentary rocks; whereas, towards the southeastern part of the map area (NTS 37 E and H), there is a gradation to a more metasedimentary-dominated sequence. Throughout the eastern map area, the supracrustal rocks are gently dipping, and best exposed in cliff sections, thus hindering representation on detailed plan maps. Although the entire stratigraphic section is rarely preserved in any one area and is cut by abundant late felsic intrusions, the stratigraphic order in the eastern map area (NTS 37 E and H) has been reconstructed and based on the authors' preliminary understanding, is as follows: psammite and sedimentary migmatite, amphibolite±psammite and sedimentary migmatite, Algoma-type silicate- and oxide-facies iron-formation±dacite±psammite, and quartzite, intruded by late ultramafic and gabbroic sills and dykes (Fig. 3). The thickness of each of the units varies considerably throughout the study area. Of note, the reconstructed stratigraphic successions of the Mary River group in the study area are comparable to the rocks described in the Woodburn Lake Group and the Prince Albert Group (Zaleski et al., 2000; Sanborn-Barrie et al., 2003; Skulski et al., 2003; Pehrsson et al., 2004). Figure 3 shows the relationship between these three groups, covering a distance of over 1000 km. This section describes the lithological units exposed in NTS map areas 37 E and H.

Psammite and sedimentary migmatite

Psammite and sedimentary migmatite represent the lowest preserved lithological unit of the Mary River group, although the basal contact is obscured by late felsic intrusions. The thickness of this unit is uncertain due to the obscured basal contact as noted. This unit displays schistosity defined by coarse-grained biotite and is commonly migmatized. The outcrops weather brown and are occasionally rust stained due to disseminated pyrite.

Amphibolite

Amphibolite is a common marker unit within the Mary River group and is present within the majority of exposed sections. It is generally in sharp contact with the basal psammite and sedimentary migmatite, but occasionally displays some gradation between units. Most exposures are massive and medium grained, although several show distinctive layering defined by more plagioclase-rich layers. The amphibolite unit ranges from approximately 1 m to at least 10 m in thickness, with the thickest units observed between Conn Lake and Bieler Lake (Fig. 2).

Iron-formation

Oxide-, silicate-, and silicate-oxide-facies banded iron-formation units occur above the amphibolite unit. Oxide-facies iron-formation varies from lean, banded magnetite-chert with millimetre- to centimetre-thick beds of magnetite, to massive magnetite with beds up to 20 m thick. The oxide-facies banded iron-formation is composed of fine-grained grey or bluish specular hematite and recrystallized quartz. Silicate-facies iron-formation is commonly found in association with the oxide facies and occurs in beds 20 m or less thick, but also occurs on its own as single beds 5 m or less thick. The silicate-facies exposures are rusty to gossanous, containing abundant garnet porphyroblasts. Biotite and sillimanite define the schistosity. Magnetite Hill (Fig. 2) represents an example of the association between silicate- and oxide-facies iron-formation (Fig. 4a, b). The combined silicate-oxide-facies iron-formation is typically rusty to gossanous with disseminated pyrite and thin, magnetite-rich layers. Exposures of the iron-formation are commonly 5 m or less thick. Psammite and sedimentary migmatite units are occasionally associated with the iron-formation, and are about 5–20 m thick.

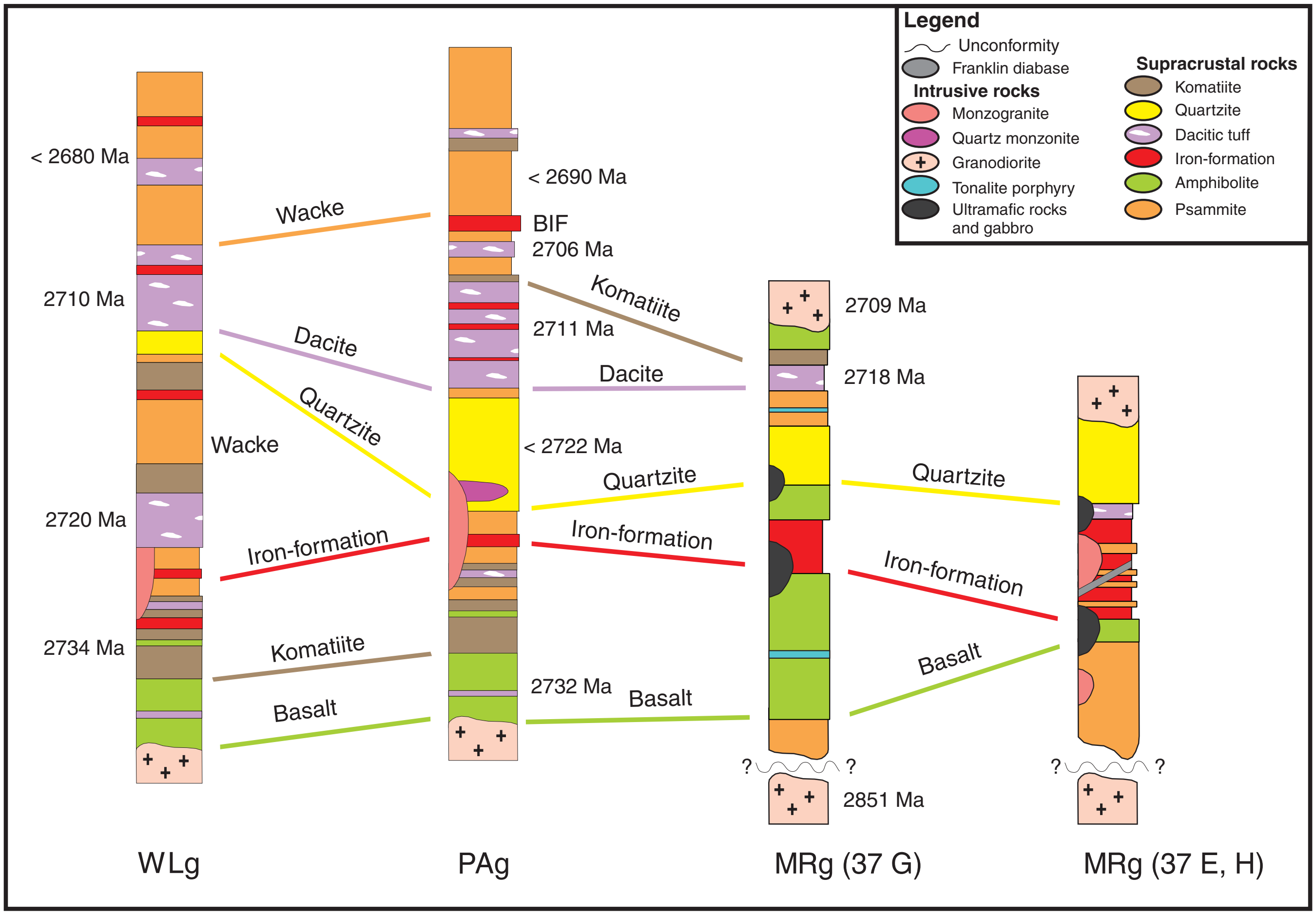

Figure 3. Schematic diagram comparing the stratigraphy of the Mary River group (MRg) in NTS 37 E, and H, to the Mary River group in NTS 37 G (*after* Young et al., 2004), to the Prince Albert Group (PAg) of the Committee Bay belt (*after* Sanborn-Barrie et al., 2003; Skulski et al., 2003), and the Woodburn Lake Group (WLg) (*after* Zaleski et al., 2000; Pehrsson et al., 2004). The Mary River group rock record from the Eqe Bay area is not included as the ages and geochemical compositions suggest distinct depositional and tectonic settings (Bethune and Scammell, 2003a). BIF = banded iron-formation.

Dacite

Dacite is rare within NTS map areas 37 E and H, and occurs in thin units 5 m or less above or below the silicate-facies iron-formation. These intermediate volcanic rocks are fine-grained and weather bluish-grey in outcrop. Dacite in the Magnetite Hill area has been sampled for U-Pb age dating to provide a direct age of volcanism.

Quartzite

Quartzite was observed at the eastern edge of NTS map area 37 G and in the centre of NTS map area 37 E near Beacon Hill and the Freshney River (Fig. 2). The thickness of this unit shows extreme variation ranging from several metres up to 500 m at Beacon Hill (Fig. 4c). Quartzitic monolithic conglomerate was also observed within the quartzite unit in the Freshney River area (Fig. 4d). Quartzite locally contains differing amounts of muscovite±biotite±sillimanite±fuchsite±magnetite±cordierite±orthopyroxene±garnet. Where contacts are observed, quartzite and occasionally psammite typically overlie iron-formation. Quartzite from Beacon Hill and from the Freshney River area has been sampled for geochronology in order to determine the provenance and maximum age of sedimentation.

(?)Archean carbonate and marble

Carbonate and marble was observed in close association with the Mary River group in outcrop near the Freshney River (Fig. 4e), and as in situ boulders near Beacon Hill. Zaleski et al. (2000) established that there are marble units interbedded with Archean quartzite units within the Woodburn Group; however, samples of adjacent Mary River group quartzite,

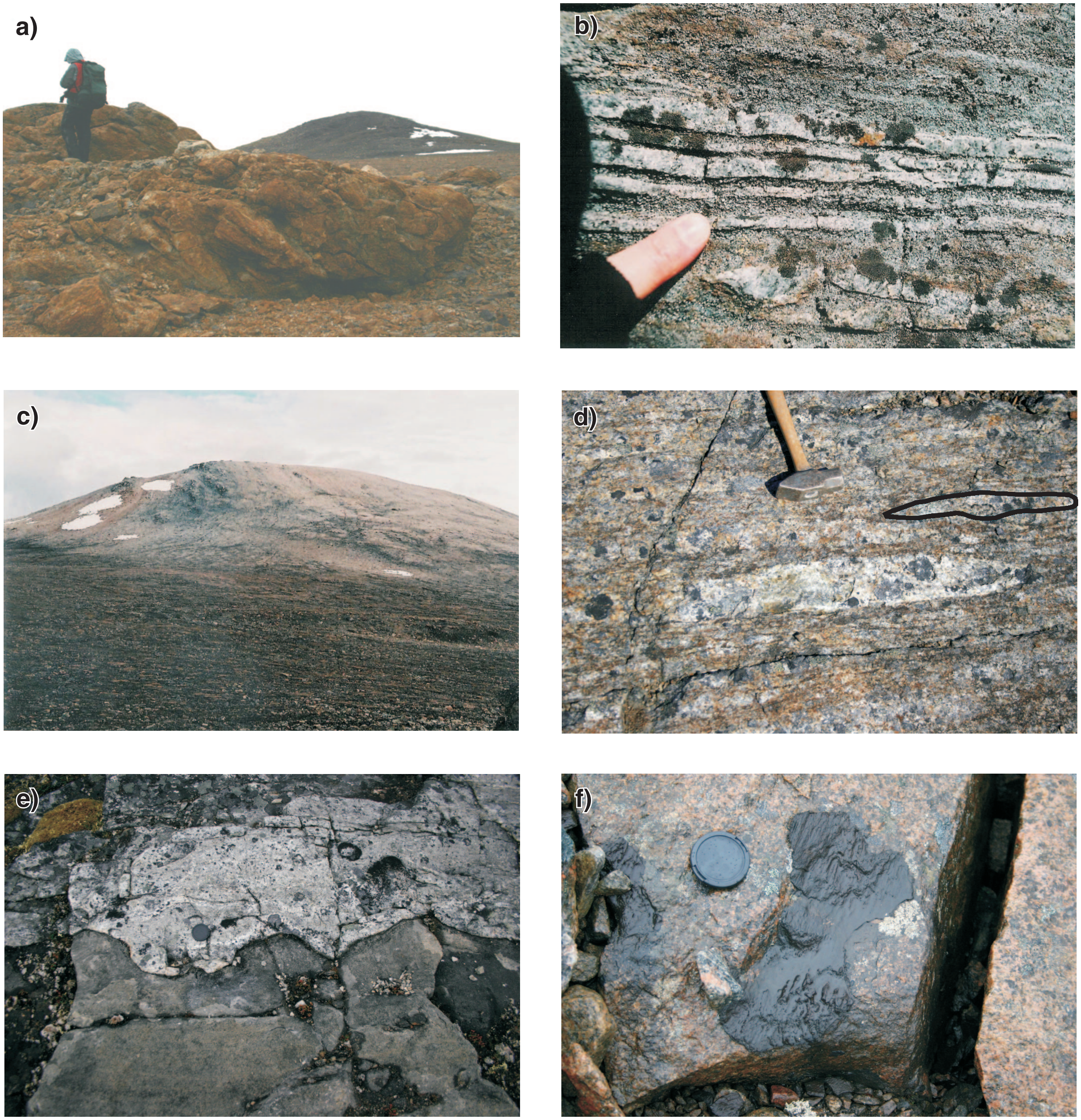

Figure 4. a) Silicate-facies iron-formation (foreground) and oxide-facies iron-formation (background), Magnetite Hill. View to the north; person is 1.7 m tall. **b)** Laminated magnetite-quartz beds, oxide-facies iron-formation, Magnetite Hill. Finger is 1.8 cm wide. **c)** Quartzite beds, Beacon Hill. Beacon Hill is about 750 m long and about 150 m high. **d)** Quartzitic monolithic conglomerate with minor fuchsite, Freshney River area. Black outline shows flattened clast. Hammer head is 14 cm long. **e)** Carbonate and marble (bottom) in contact with monzogranite (top), Freshney River area. Lens cap, centre of photograph, is 50 mm wide. **f)** Tertiary limestone conglomerate filling fractures in underlying gneiss approximately 5 km south of Rimrock Lake. Lens cap is 50 mm wide.

gneiss, and intrusive rocks from the Freshney River area were obtained for geochronology in order to determine if these marble units are part of the Mary River group stratigraphy.

Ultramafic intrusions

Ultramafic and gabbroic intrusions crosscut the sedimentary rocks, iron-formation, and amphibolite of the Mary River group throughout NTS map areas 37 E, H, and G. These intrusions weather dark green to brown and represent serpentinized peridotite, with large phenocrysts of pyroxene locally preserved. The intrusions form small sills and dykes up to a few tens of metres thick. Some of these intrusions may have inflated the supracrustal sequence (Young et al., 2004).

FELSIC INTRUSIONS

Felsic plutonic rocks are spatially associated with supracrustal rocks of the Mary River group in NTS map area 37 E, where foliated porphyritic monzogranite represents the most abundant type of felsic intrusion. Charnockite, tonalite, and tonalite-granodiorite intrusions containing biotite schlieren and amphibolite xenoliths also occur. The porphyritic monzogranitic intrusions are believed to be related to the ca. 2709 Ma porphyritic (K-feldspar phyric) monzogranite units of NTS map area 37 G, that were observed by Jackson (2000). Both types of intrusions in NTS map areas 37 E and 37 G are light pinkish-grey, medium grained, contain K-feldspar megacrysts, and are elongated parallel to local foliations. One felsic intrusion has been sampled for geochronology to constrain the age of the Mary River group.

FRANKLIN DYKES

Several north-trending vertical diabase dykes were observed in the study area. These undeformed and unmetamorphosed intrusions are about 10–20 m thick and are inferred to be part of the 723 +4/-2 Ma Franklin swarm (Heaman et al., 1992), based on rock type and dyke orientation.

TERTIARY CONGLOMERATE

A single outcrop of buff to dark-brown limestone conglomerate was observed in NTS map area 37 E on the top of a tor south of Rimrock Lake, about 26 km northwest of the Barnes Ice Cap (Fig. 2). The conglomerate fills fractures in the underlying gneiss units, representing a nonconformity (Fig. 4f). This exposure was previously observed by Andrews et al. (1972) and named “Rimrock Bed”. Palynology studies by Andrews et al. (1972) have determined that these sedimentary rocks are Paleocene (68–58 Ma) and were deposited during a warm climate in a fresh-water swamp or marginal marine marsh.

DEFORMATION

Rocks of the Mary River group and intervening plutonic rocks have been affected by at least three regionally penetrative episodes of deformation. The first episode (D_1) is not observed in the southeastern part of the map area (NTS 37 E and southern 37 H) as a result of strong overprinting of the two subsequent generations of structures. In the northern parts of NTS map area 37 G, D_1 is characterized by variably developed, bedding-parallel foliations (S_1), distinguished from S_2 only in the hinge zones of some F_2 folds (Young et al., 2004).

The second generation of structures, and earliest recognizable structures in the southeastern map area (all of map areas 37 E, F, and southern 37 H), comprise northwest-verging, south-plunging folds and axial-planar foliations. Well developed gneissic layering in all rock types is attributed to D_2. The metamorphic grade and intensity of gneissosity increases approaching the Isortoq fault zone which is interpreted to have formed during D_2 (Fig. 2). Discrete structures related to the Isortoq fault zone were not directly observed in the study area, although well developed shear zones and associated fabric elements are documented to the south in the Eqe Bay region (Fig. 1; Bethune and Scammell (2003b)). The Isortoq fault zone is well defined, however, by the extreme contrast in magnetic susceptibilities of the rocks in the hanging wall (greenschist facies) and footwall (granulite facies) (Fig. 5).

The predominant mappable structures in the southern portions of the study area (all of NTS map areas 37 E, F, and southern 37 H) are attributed to D_3 deformation. D_3 structures include steeply dipping, east-trending, strongly developed transposition fabrics and large- to small-scale folding of D_2 folds resulting in complex fold interference map patterns (Fig. 6). This generation of structures decreases in intensity to the north and to the south such that rocks in the Long Lake area (Fig. 2, 5) and in the Eqe Bay area only record weakly developed east-trending crenulation cleavage (Fig. 2, 5). This domain of D_3 deformation is associated with aeromagnetically defined, east-trending dextral transverse faults (Fig. 5). In the Committee Bay belt, widely spaced, east-trending dextral fault zones are younger than 1.8 Ga (Fig. 2; Sanborn-Barrie et al. (2003)); however, no associated ductile fabric elements outside the fault zones are documented. Whether this episode of deformation on northern Baffin Island reflects pure contraction or transpression is uncertain, but the deformation must have occurred after ca. 1825 Ma, the youngest age of metamorphism associated with D_2 in the

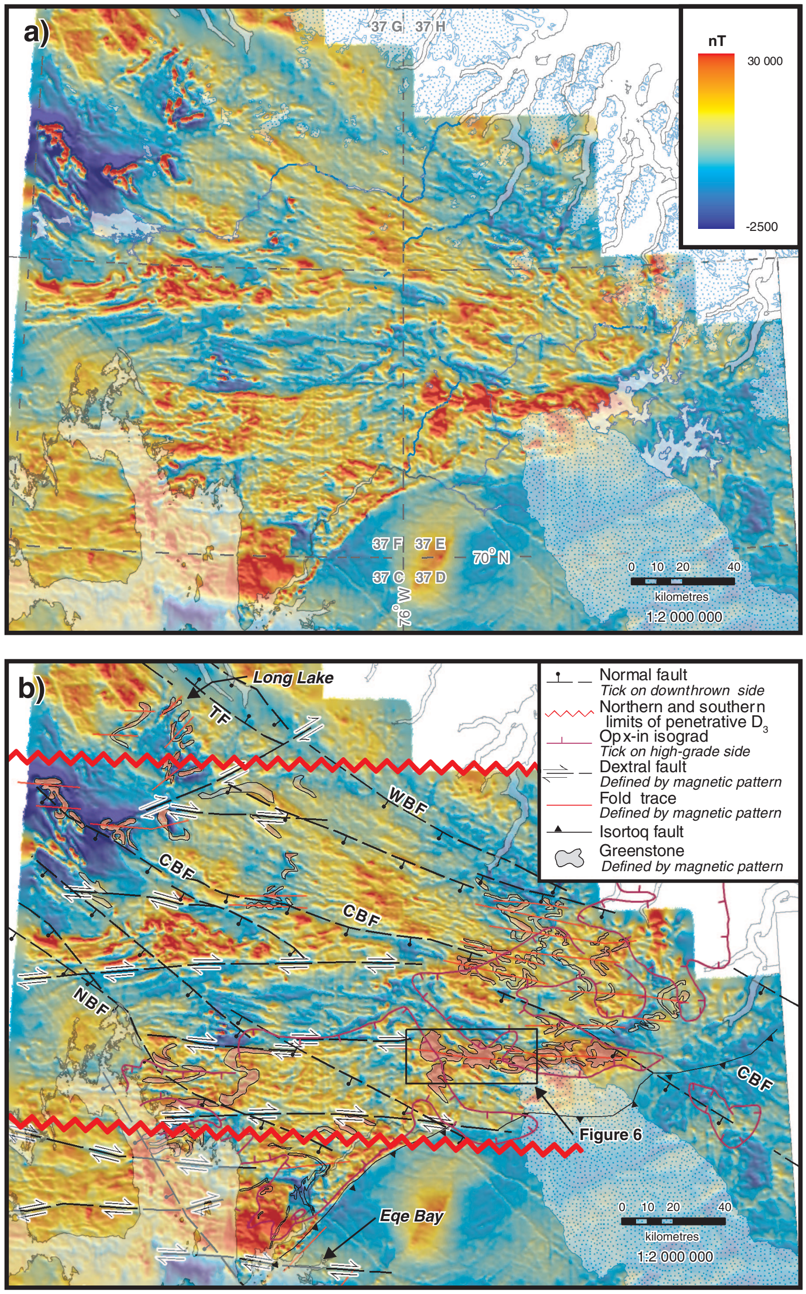

Figure 5. a) Aeromagnetic map (800 m resolution) of the study area. **b)** Aeromagnetic map with pertinent structural elements superposed. The outlines of linear units with high magnetic susceptibility (inferred to be greenstone) are shown to illustrate the complex fold interference patterns at the scale of 1 km to 10 km in the domain of penetrative D_3 deformation. The pattern of the opx-in isograd appears to have a similar folded map pattern. Numerous east-trending aeromagnetic lineaments are evident, and in at least three localities dextral offset of 5 km to 20 km can be observed along these structures, including the Isortoq fault zone. The red jagged lines indicate the approximate northern and southern boundaries of penetrative D_3 deformation. North and south of these boundaries, regional northeast-trending D_2 structures are not affected by penetrative D_3 except for local crenulations (e.g. Long Lake area in NTS 37 G (Young et al., 2004) and in the Eqe Bay area (Bethune and Scammell, 2003b). Numerous southeast-trending, brittle normal faults transect the map area, but have little to no transverse displacement. CBF = Central Borden Fault, NBF = Nina Bang Fault, TF = Tikerakdjauk Fault, WBF = White Bay Fault.

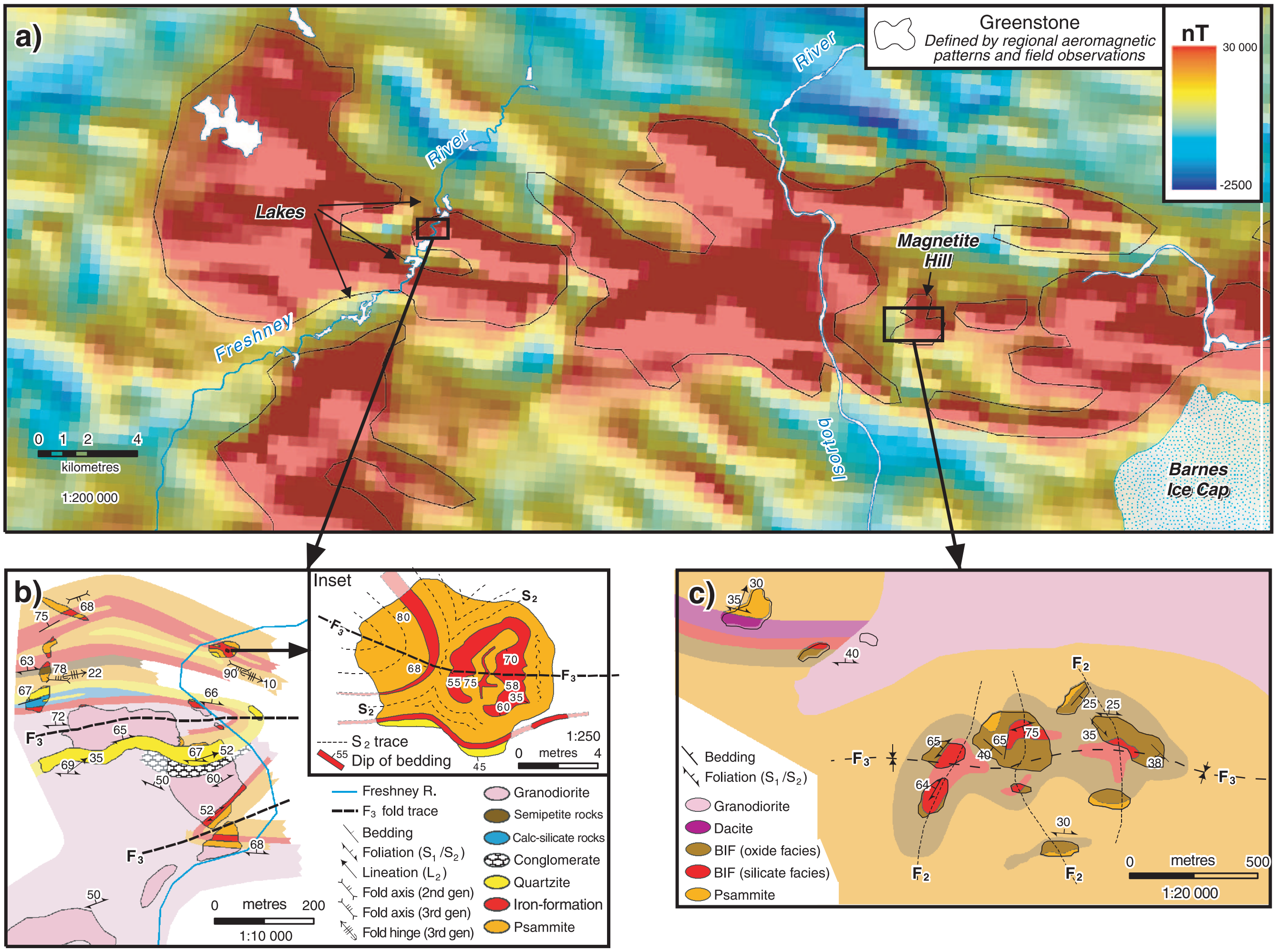

Figure 6. a) Aeromagnetic map of the Magnetite Hill and Freshney River areas with interpreted greenstone boundaries superposed. **b)** Map of part of the Freshney River area showing inferred fold interference at the macroscopic scale and type II interference patterns at the outcrop scale (inset); gen = generation. **c)** Map of Magnetite Hill illustrating modified dome-and-basin interference patterns. BIF = banded iron-formation.

footwall (northwest side) of the Isortoq fault zone, and most likely prior to regional exhumation in response to ca. 1.8 Ga tectonism (Bethune and Scammell, 2003b).

METAMORPHISM

Rocks of the Mary River group in NTS map areas 37 E and H underwent high-temperature, amphibolite- to granulite-facies regional metamorphism during the Hudsonian Orogeny. Quartzite and psammite and sedimentary migmatite of the amphibolite-facies contain the assemblage: sillimanite+garnet±cordierite±muscovite; and those of the granulite facies contain the assemblage: cordierite+garnet+K-feldspar+sillimanite. Several charnockite felsic intrusions, interpreted to represent granulite-facies granitic rocks, contain the mineral assemblage: orthopyroxene+hornblende+magnetite.

The northeast-trending Isortoq fault zone is a prominent aeromagnetic feature (Fig. 5) within the map area and was previously delineated by a 100 km wide belt of granulite-facies rocks, known as the Dexterity granulite belt (Fig. 1; Jackson (2000); Jackson and Berman (2000); Bethune and Scammell (2003b)). Several traverses were conducted across the Isortoq fault zone and the Dexterity granulite belt in NTS map area 37 E; however, there is no sharp surface expression of the fault, likely a result of overprinting D_3 deformation. The Dexterity granulite belt is discontinuous and folded in its northern reaches as shown by the map pattern of the orthopyroxene-in isograd (Fig. 2). In addition, a zone with metamorphic orthopyroxene occurs far to the east of the aeromagnetically defined Isortoq fault and may reflect large-scale F_3 fold interference (Fig. 5). In contrast, in the Eqe Bay area to the south, a prominent metamorphic grade change is documented across the southwest extent of the Isortoq fault zone, which passes between the greenschist-amphibolite facies Eqe Bay belt and the amphibolite-granulite facies Isortoq belt (Bethune and Scammell, 2003a). These belts are south of the southern limit of the overprinting D_3 deformation and therefore unaffected by the fold interference that complicates the map pattern to the north.

ECONOMIC GEOLOGY

Mineral prospecting during the 2005 field season focused on the supracrustal Mary River group in NTS map areas 37 E, H, and the eastern side of 37 G, as it is considered to hold elevated potential for a variety of mineralization types including iron ore, iron-formation-hosted gold, and Ni-Cu-PGE magmatic sulphide mineralization. Prospective areas were identified by traverses, detailed mapping, and assay sampling. Forty-five assay samples were collected, seven of these samples will be analyzed for FeO by titration to determine prospectivity for iron ore. Eighty-four samples were collected for lithogeochemistry, including analyses for base and precious metals. Lithogeochemistry samples include 50 plutonic rocks, 13 sedimentary rocks, and 21 volcanic rocks.

Algoma-type iron-formation is common within Mary River group exposures throughout NTS map area 37 E and the eastern edge of NTS map area 37 G, and includes oxide-, silicate- and silicate-oxide-facies iron-formation. The oxide-facies iron-formation typically is composed of lean, banded magnetite-chert or specular hematite-recrystallized quartz layers (Fig. 7a). The most striking occurrence of oxide-facies iron-formation is in the Magnetite Hill area (70.523ºN, 74.980ºW) (Fig. 2), where magnetite beds are up to 20 m thick and remobilized iron forms magnetite veins (Fig. 7b). Other prominent examples of oxide-facies iron-formation exposures are located at 70.565ºN, 74.782ºW and 70.957ºN, 77.024ºW. Silicate-facies iron-formation exposures are rusty to gossanous (Fig. 7c), and may contain disseminated pyrite layers. Significant examples of silicate-facies iron-formation occur in the Magnetite Hill area, at 70.442ºN, 73.483ºW; 70.559ºN, 75.507ºW; and 70.930ºN, 76.233ºW. Silicate-oxide-facies iron-formation is also rusty to gossanous, but contains thin magnetite-rich layers (Fig. 7d). A good example

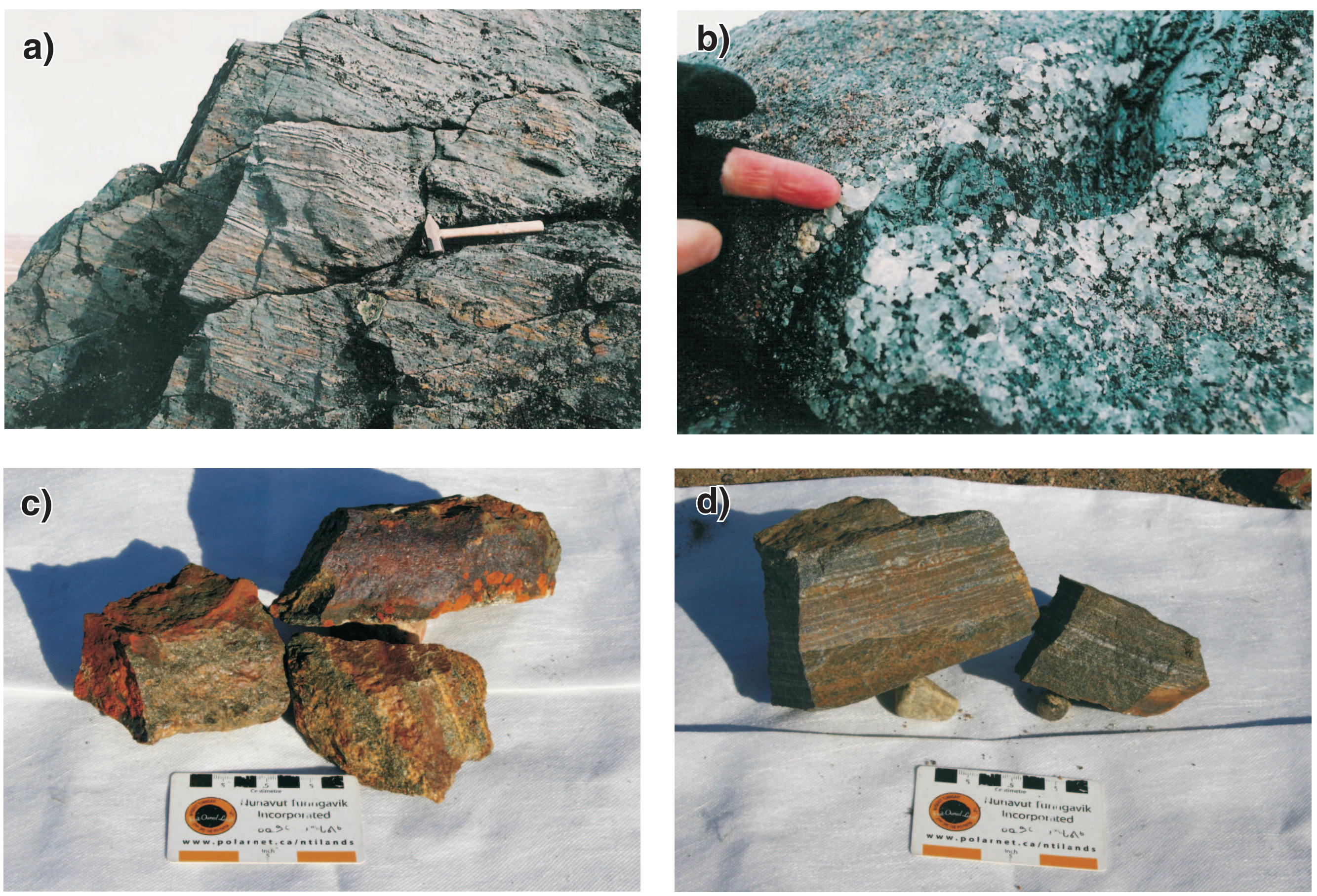

Figure 7. a) Lean banded oxide-facies iron-formation, Magnetite Hill. Hammer is 37 cm long. **b)** Magnetite veins, Magnetite Hill. Finger is 1.8 cm wide. **c)** Rusty to gossanous silicate-facies iron-formation, sample 05-LUA-4308A (70.559ºN, 75.507ºW). Scale card is 8.5 cm long. **d)** Rusty silicate-oxide-facies iron-formation with thin, magnetite-rich layers, sample 05-LUA-5170 (70.564ºN, 74.774ºW). Scale card is 8.5 cm long.

of silicate-oxide-facies iron-formation occurs at Magnetite Hill; others are located at 70.547ºN, 75.542ºW and 70.482ºN, 73.349ºW. Visible gold and molybdenum were discovered in quartz veins associated with gossanous iron-formation along the eastern edge of NTS map area 37 G (70.920ºN, 77.405ºW).

Ultramafic and gabbroic sills commonly intrude the Mary River group and locally contain the disseminated sulphide minerals pyrite±chalcopyrite. Several large gabbroic intrusions and dykes, located approximately 15 km south--southwest from the head of Royal Society Fiord (71.083ºN, 74.383ºW), contain a copper showing (malachite). Ultramafic and gabbroic intrusions can be host to magmatic sulphide deposits containing nickel–copper–platinum-group-element (Ni-Cu-PGE) mineralization. The presence of a copper showing in gabbroic intrusions of the Mary River group suggests potential for elevated Ni and PGE concentrations and Ni-Cu-PGE magmatic sulphide mineralization. Several samples of these intrusions were collected for assay.

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