Overview of bedrock mapping in the northern and western parts of the Tehery Lake–Wager Bay area, western Hudson Bay, Nunavut

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This work is part of the Tehery-Wager geoscience mapping activity of Natural Resources Canada's (NRCan) Geo-mapping for Energy and Minerals (GEM) program Rae activity, a multidisciplinary and collaborative effort being led by the Geological Survey of Canada and the Canada-Nunavut Geoscience Office (CNGO), with participants from Canadian universities (Dalhousie University, Université du Québec à Montréal, Université Laval and University of New Brunswick). The focus is on targeted bedrock and surficial geology mapping, stream-water and stream- sediment sampling, and other thematic studies, which collectively will increase the level of geological knowledge in this frontier area and allow evaluation of the potential for a variety of commodities, including diamonds and other gemstones, base and precious metals, industrial minerals, carving stone and aggregates. This activity also aims to assist northerners by providing geoscience training to college students, and by ensuring that the new geoscience information is accessible for making land-use decisions in the future.

Steenkamp, H.M., Wodicka, N., Weller, O.M. and Kendrick, J. 2016: Overview of bedrock mapping in the northern and western parts of the Tehery Lake–Wager Bay area, western Hudson Bay, Nunavut; *in* Summary of Activities 2016, Canada-Nunavut Geoscience Office, p. 27–40.

Abstract

Bedrock-geology mapping was conducted in the summer of 2016 in the Tehery Lake–Wager Bay area on the northwestern coast of Hudson Bay, Nunavut, as part of a multiyear, multidisciplinary mapping campaign led by the Geological Survey of Canada, through Phase 2 of the Geo-mapping for Energy and Minerals program (GEM-2), and the Canada-Nunavut Geoscience Office. Fieldwork resulted in the identification and spatial constraint of rock units in the northern and western parts of the study area, which were sampled for geochemical, geochronological and petrographic analysis, as well as to assess their economic potential. Mapping has revealed the presence of a large granulite-facies metamorphic domain in the southern part of the study area; the possibility of two different supracrustal rock sequences; the western continuations of the Chesterfield fault zone and Wager shear zone; and generally high, but locally variable, peak metamorphic conditions across the study area. Further analytical work is required to fully characterize rock units, compare and correlate them with other well-studied units, and determine the geological history and economic potential of the Tehery Lake–Wager Bay area.

Résumé

La cartographie géologique du substratum rocheux dans la région de Tehery Lake–Wager Bay sur la côte nord-ouest de la baie d'Hudson, au Nunavut, a été menée à l'été 2016 dans le cadre d'une campagne de cartographie pluriannuelle et pluridisciplinaire dirigée par la Commission géologique du Canada (programme de géocartographie de l'énergie et des minéraux) et le Bureau géoscientifique Canada-Nunavut. Les travaux de terrain dans les parties nord et ouest de la zone d'étude ont permis l'identification et la contrainte spatiale d'unités lithologiques qui ont été échantillonnées en vue d'analyses géochimiques, géochronologiques et pétrographiques, ainsi que pour évaluer leur potentiel économique. La cartographie a révélé la présence d'un domaine métamorphique au faciès des granulites dans la partie sud de la zone d'étude, la présence possible de deux séquences différentes de roches supracrustales, le prolongement vers le nord-est de la zone de faille de Chesterfield et vers l'ouest de la zone de cisaillement de Wager et des conditions de pic métamorphique généralement élevées mais localement variables dans la zone d'étude. Des travaux analytiques supplémentaires sont nécessaires pour mieux caractériser les unités lithologiques, les comparer et les corréler avec d'autres lithologies bien connues et déterminer l'histoire géologique et le potentiel économique de la région de Tehery Lake–Wager Bay.

Introduction

The Tehery Lake–Wager Bay area, located on the northwestern coast of Hudson Bay (Figure 1), is known to host kimberlite intrusions (Pell and Strickland, 2004), anomalous base- and precious-metal concentrations in till and stream sediments (Jefferson et al., 1991; Day et al., 2013; McMartin et al., 2013), major shear zones (Henderson and Broome, 1990; Panagapko et al., 2003) and significant belts of supracrustal rocks, and yet the region is characterized by limited and outdated geoscience information. A multiyear activity being conducted by the Canada-Nunavut Geoscience Office and the Geological Survey of Canada through the second phase of the Geo-mapping for Energy and Minerals (GEM) program aims to fill in these fundamental geoscience-knowledge gaps (e.g., Lawley et al., 2015; Steenkamp et al., 2015; Wodicka et al., 2015, 2016; this study). The new geoscience information gathered through this activity will specifically support 1) the creation of modern bedrock and surficial-geology maps (1:100 000 Canada Geoscience Maps) for all or parts of eight National Topographic System map areas (NTS 46E, D, 56A, B, C, F, G, H); 2) the establishment of the geological history for the area through identifying, characterizing and analyzing individual rock units and their spatial, temporal and structural relationships (see also Tschirhart et al., 2016); 3) the refinement of glacial and postglacial histories, and re-evaluations of the dispersal and weathering of surficial deposits in the area (see also Byatt et al., 2015; McMartin et al., 2015, 2016; Randour et al., 2016); and 4) the identification of locations and rock units that may have potential for economic materials, such as base and precious metals, gemstones, carving stone, industrial minerals and aggregates.

This paper summarizes the initial bedrock-geology findings from the 2016 field season. Presented here are a simplified bedrock-geology map of the entire study area (Figure 2); lithological, structural and metamorphic descriptions based on field observations of the dominant rock units mapped in the northern and western parts of the study area; and a discussion of the implications of this new mapping and the potential for economic resources in this area.

Regional geological background

Bedrock geology in the Tehery Lake–Wager Bay area was initially mapped at reconnaissance scale (1:1 000 000) by the Geological Survey of Canada (GSC) in the 1950s (Wright, 1955, 1967; Lord and Wright, 1967) and 1960s (Heywood, 1967a, b). The study area comprises Archean to Proterozoic orthogneiss, paragneiss and plutonic rocks belonging to the Rae Province. This region is located north of the Snowbird Tectonic Zone, a significant geophysical lineament that separates the composite Rae-Chesterfield and Hearne cratonic blocks, and records Neoarchean and Paleoproterozoic tectonic events (e.g., Hanmer et al., 1995; Berman, 2007; Martel et al., 2008), the latter of which being a component in the initial assembly of Laurentia at 2.0–1.7 Ga (Hoffman, 1988).

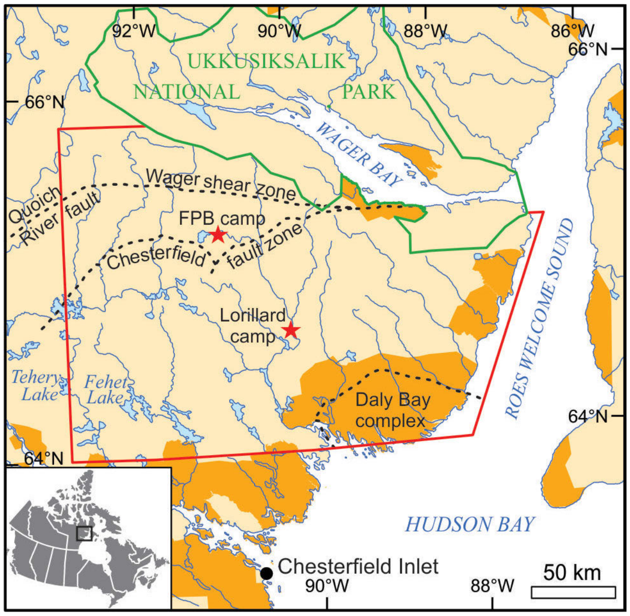

Figure 1: Tehery Lake–Wager Bay study area (outlined in red), northwestern Hudson Bay, in relation to Ukkusiksalik National Park (outlined in green) and Inuit-owned lands (orange polygons). Red stars indicate the locations of the 2016 FPB camp and 2015 Lorillard camp.

The northern part of the study area includes the Wager shear zone, a major, dominantly dextral, strike-slip fault that coincides with a prominent aeromagnetic anomaly extending westward from Wager Bay (Broome, 1990; Henderson and Broome, 1990). Parts of the shear zone were previously mapped along Wager Bay prior to establishment of the Ukkusiksalik National Park (Henderson et al., 1991; Jefferson et al., 1991), and the most recent deformation along the shear zone was dated at <1808 ±2 Ma (Henderson and Roddick, 1990). The Chesterfield fault zone is another significant structure in the northern part of the study area that was previously defined based on a cuspate, folded aeromagnetic anomaly (Panagapko et al., 2003). It is thought to separate amphibolite-facies rocks to the north from amphibolite- to granulite-facies rocks to the south (Schau, 1983).

Panels of supracrustal rocks exist north of the Chesterfield fault zone, and south of, within and north of the Wager shear zone (Henderson et al., 1991; Jefferson et al., 1991; Panagapko et al., 2003). The structural relationships of these panels with respect to the basement orthogneiss, their depositional age and their lithostratigraphic correlations with other known and described supracrustal rock packages in the Rae Province have yet to be determined. The northern part of the study area also hosts three kimberlite

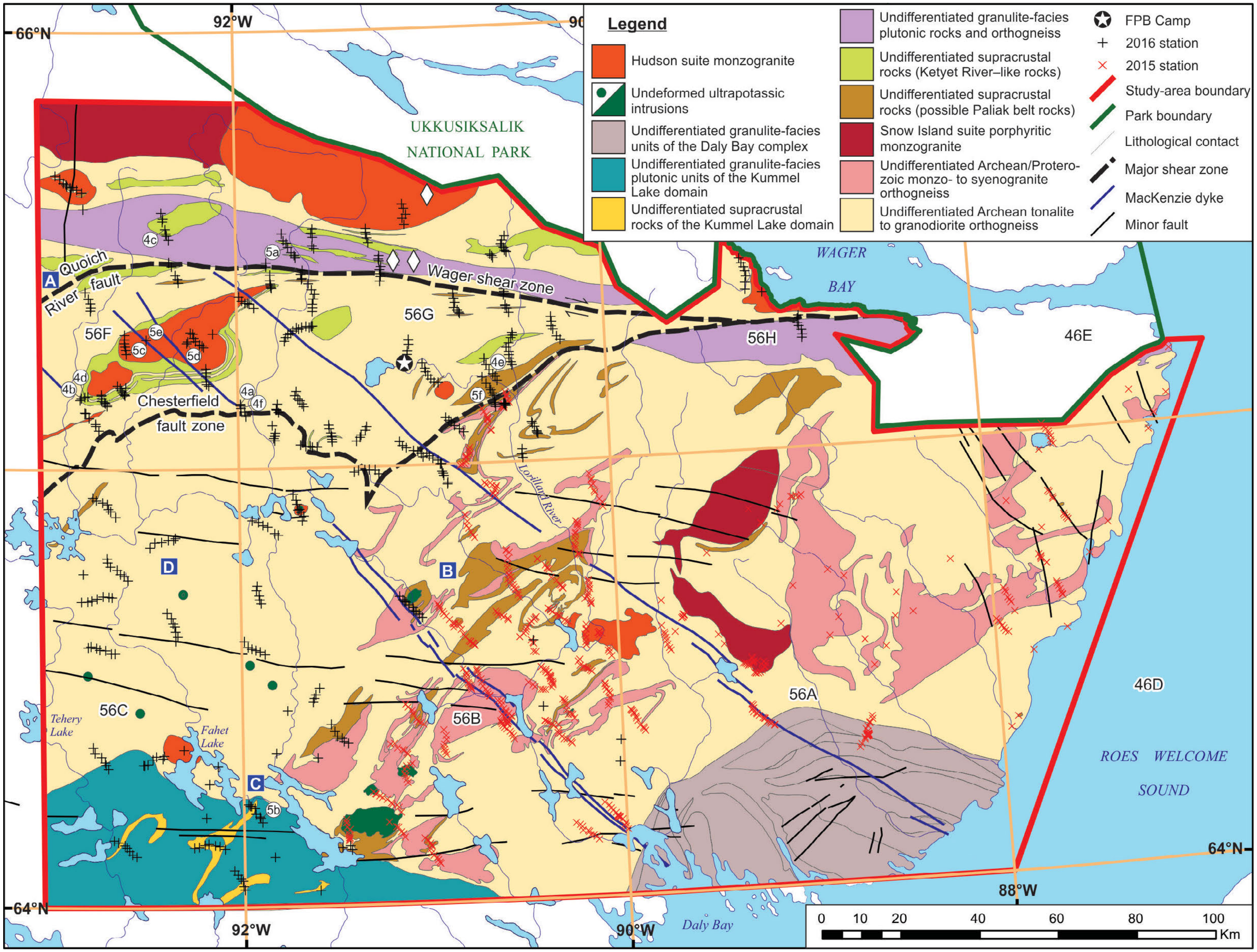

Figure 2: Preliminary bedrock geology of the Tehery Lake–Wager Bay area (after Wodicka et al., 2016), based on observations from the 2015 and 2016 field seasons and aeromagnetic-survey data (see Figure 3). White star in black circle is the location of FPB camp; white diamonds indicate known kimberlite localities; labels in white circles are the locations of photos in Figures 4 and 5; and blue squares are the locations of U-Pb zircon crystallization ages in van Breemen et al. (2007), where A is 2707 ±8 Ma, B is 2701 ±14 Ma, C is 2699 ±11 Ma and D is 2584 ±12 Ma.

occurrences (Figure 2, white diamonds) within the Nanuq property currently held by Peregrine Diamonds Ltd., which were discovered largely through till and stream-sediment sampling, and a high-resolution aeromagnetic survey over the property (Pell and Strickland, 2004).

The west-central part of the study area was previously mapped as mainly undifferentiated Archean orthogneiss (Heywood, 1967a, b; Lord and Wright, 1967). Several small, circular aeromagnetic anomalies in this area were targeted during reconnaissance mapping in 2012 as part of the Geomapping Frontiers' project, conducted within the first GEM program. Most anomalies were identified as ultramafic plugs (Figure 2), likely correlative with Proterozoic ultrapotassic rocks of the Christopher Island formation (Peterson et al., 2002).

The southwestern corner of the study area is just north of the Uvauk complex, which comprises granulite-facies anorthosite–gabbro intrusive rocks (Mills et al., 2007) similar to the Daly Bay complex to the east (Gordon and Heywood, 1987; Gordon, 1988; Hanmer and Williams, 2001) and the Kramanituar complex to the west (Sanborn-Barrie et al., 2001). These complexes, which occur along an east-west trend on the northern side of Chesterfield Inlet, record high-pressure granulite-facies metamorphism and deformation at ca. 1.9 Ga that is likely related to the collision of the Hearne and Rae cratons along the Snowbird Tectonic Zone, but they also contain evidence of Archean tectonic events (Sanborn-Barrie et al., 2001; Mills et al., 2007).

Field observations

Helicopter-supported fieldwork took place between June 27 and July 29, and was based out of FPB camp (Figure 2), a temporary camp built adjacent to the Nanuq property of Peregrine Diamonds Ltd. on the upper Lorillard River. Bedrock-geology mapping, which focused on the northern and western parts of the study area, consisted of daily set-outs of 3–4 teams that traversed 2–12 km routes. Targeted helicopter stops were also planned at sites with anomalous aeromagnetic signatures, with interesting rocks based on archival information, or where few bedrock outcrops are exposed amongst the surficial till. Bedrock samples, structural measurements, digital photographs, and textural and mineralogical observations were collected at a total of 463 stations. The main features of map units present in the northern and western parts of the study area are described in the following subsections.

Archean basement rocks

Much of the northern and western parts of the study area is underlain by biotite±hornblende±titanite±epidote granodiorite to tonalite gneiss (Figure 2, tan map unit) that includes pods, lenses or discontinuous layers of diorite, gabbro, pyroxenite and mafic rocks representing volcanic rocks and/or dykes (e.g., Lawley et al., 2015; Steenkamp et al., 2015). The gneiss is mostly medium grained and displays a moderately to strongly developed compositional layering. It typically contains millimetre- to centimetre-scale biotite±hornblende granitic veins that are transposed parallel to the gneissic fabric (Figure 4a). In general, these rocks resemble much of what exists in the eastern and central parts of the study area (Steenkamp et al., 2015; Wodicka et al., 2015), although more pervasive migmatitic textures are present south of the Chesterfield fault zone.

Rocks with compositions ranging closer to monzogranite or monzonite are also present in the northern and western parts of the study area. In the northwest corner of the area, although outcrop is limited owing to intense glacial weathering and frost heave associated with the Keewatin Ice Divide (e.g., McMartin et al., 2016), deformed K-feldspar–phyric monzogranite may correlate with ca. 2.6 Ga Snow Island suite plutonic rocks found in the east-central part of the area (Steenkamp et al., 2015; Wodicka et al., 2015). However, the poor exposure and complex aeromagnetic signatures (i.e., northern part of NTS 56C; Figure 3) over much of the area make it difficult to separate the monzogranite to monzonite rocks into map units distinct from the widely abundant granodiorite to tonalite gneiss.

Three samples of granodiorite to tonalite gneiss from within the study area were described and dated at ca. 2.7 Ga, and a foliated biotite monzonite at ca. 2.58 Ga (Figure 2), by van Breemen et al. (2007). However, the variability in composition and textures in the orthogneissic rocks suggest that there may be other older and/or younger plutonic phases in the study area than what has already been dated.

Supracrustal rocks

The majority of supracrustal rocks mapped during the 2016 field season are north of the Chesterfield fault zone. At least two different supracrustal sequences are proposed, based on differences in lithological assemblages, degree of partial melting and aeromagnetic signatures. One sequence is characterized by distinct, relative magnetic-low features between the Chesterfield fault zone and Wager shear zone, and north of the Wager shear zone (Figure 2, green map unit; Figure 3; see also Tschirhart et al., 2016), and contains thick units of siliceous metasedimentary rocks. The sequence includes sillimanite±muscovite quartzite interlayered with biotite±garnet±sillimanite psammite, semipelite and minor pelite, with discrete biotite±garnet mafic layers of probable volcanic origin, all of which are locally injected with 2–15 cm thick monzogranitic veins that are oblique or parallel to layering. The white-weathering quartzite (Figure 4b) is typically found at the base of the sequence and is up to 400 m thick, but also occurs as 1–15 m thick layers intercalated with the other metasedimentary rocks. Interlayered psammite, semipelite and pelite vary in thickness and abundance. Sillimanite mats define a mineral foliation, and

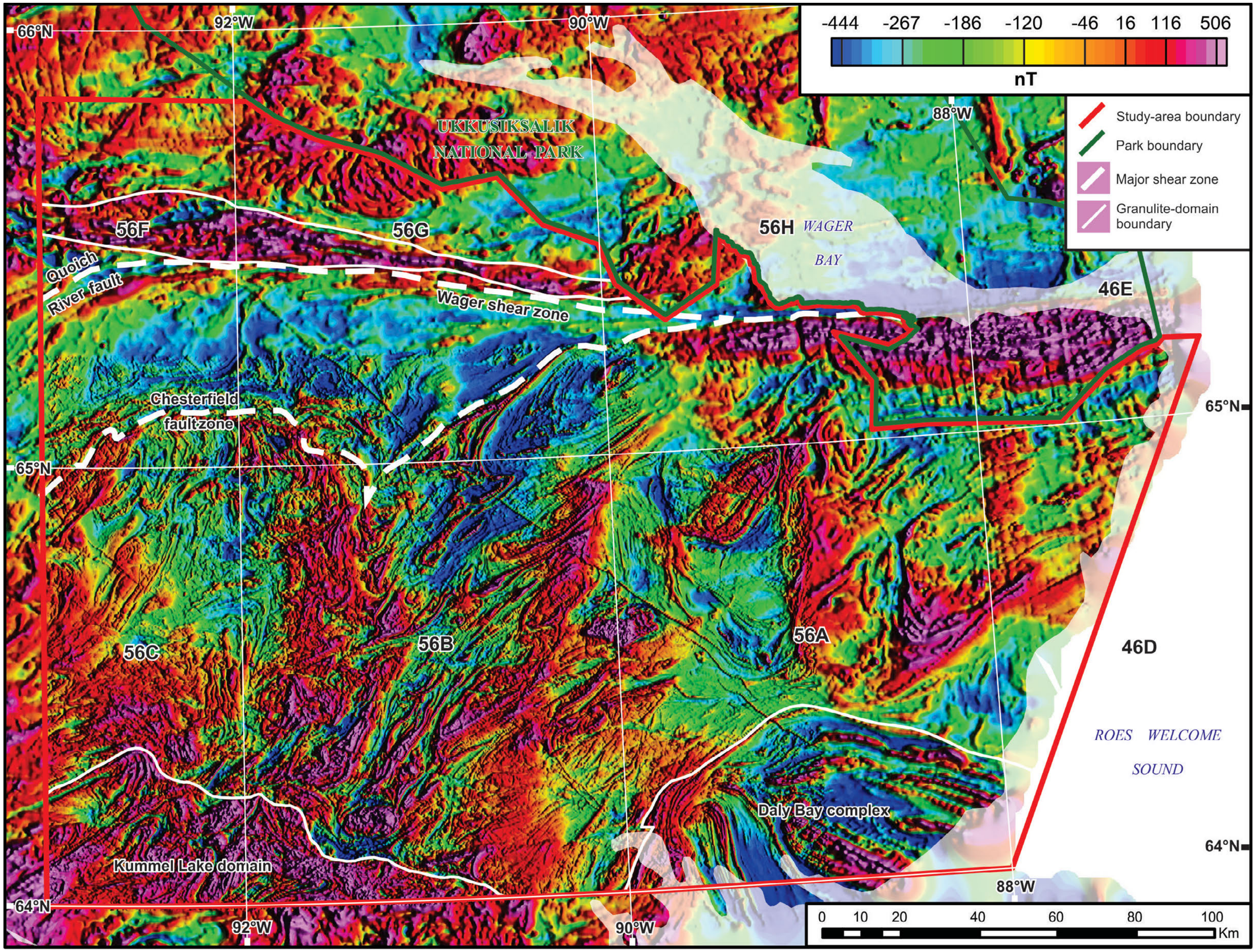

Figure 3: Total-field aeromagnetic anomaly map of the Tehery Lake–Wager Bay area (after Tschirhart et al., 2016), northwestern Hudson Bay, Nunavut, compiled from surveys flown at 800 and 400 m line spacings (Coyle and Kiss, 2012; Natural Resources Canada 2015).

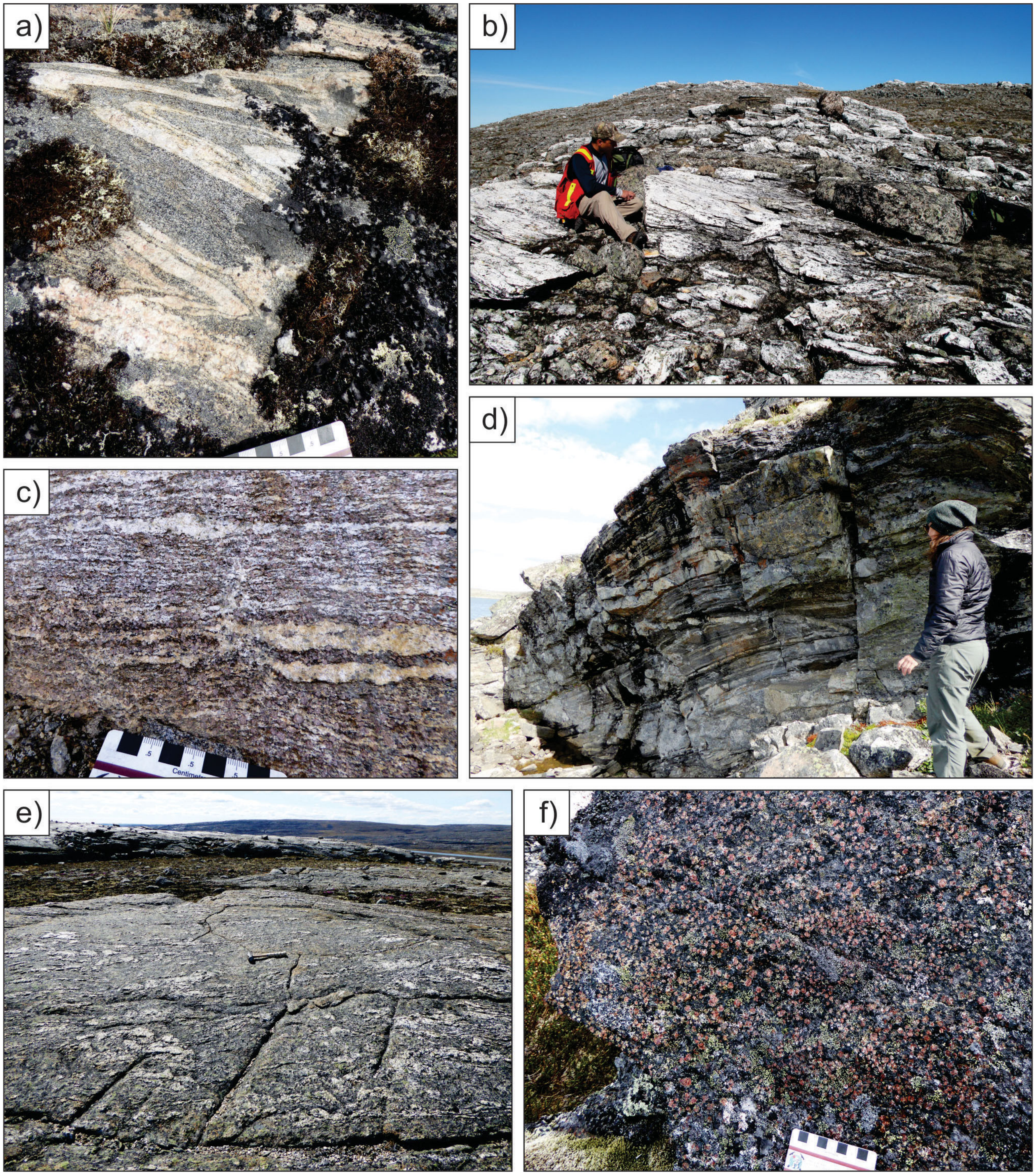

Figure 4: Field photographs of rocks in the Tehery Lake–Wager Bay area: **a)** grey, biotite-bearing granodiorite with injections of white monzogranite that have been transposed parallel to foliation and folded; **b)** thick section of white-weathering, sillimanite+muscovite quartzite in the southwestern nose of a large fold structure in the northwestern part of the study area (NTS area 56F); **c)** leucosome layers and biotite define a foliation in garnet+biotite+sillimanite pelite north of the Wager shear zone; **d)** well-layered mafic rocks of probable volcanic origin in the nose of the large fold structure in the northwestern part of the study area; **e)** migmatitic texture in biotite+sillimanite+leucosome±garnet semipelite mapped within one of the brown supracrustal panels north of the Chesterfield fault zone (hammer for scale is 40 cm long); **f)** red garnet porphyroblasts in a massive mafic rock that surrounds a large ultramafic body located just south of the Chesterfield fault zone.

individual crystals define a lineation parallel to the hinges of large-scale folds. Where present, garnet porphyroblasts are 2–10 mm in diameter and wrapped by biotite and sillimanite (also where present), which define the foliation in these rocks (Figure 4c). The mafic volcanic rocks, which appear to be limited to one or two discrete layers up to 25 m thick (Figure 4d), contain aligned biotite and hornblende, and thin (2–10 mm) quartz-rich layers that together define a well-developed foliation.

The other supracrustal sequence was mapped as discontinuous panels north of the Chesterfield fault (Figure 2, brown map unit). Rocks in this sequence have mostly low magnetic signatures with discrete high bands (Figure 3) and contain more varied rock types that resemble the majority of the supracrustal rocks in the central and eastern parts of the study area (Steenkamp et al., 2015; Wodicka et al., 2015, 2016). Rock types include biotite±garnet psammite–semipelite, garnet+biotite±sillimanite±cordierite pelite, iron formation, garnet-bearing mafic rocks and ultramafic rocks in pods and boudins. The psammite–semipelite is highly recrystallized, with granular, coarse plagioclase and quartz grains, aligned biotite that defines a mineral foliation, and garnet porphyroblasts that are typically <5 mm in diameter. It also contains up to 15 vol. % granitic leucosome present as lenses and discontinuous layers (Figure 4e). Minor pelite is typically associated with the more mafic rocks and contains abundant leucosome layers that define a foliation. The pelite contains garnet porphyroblasts up to 2 cm in diameter, aligned biotite and sillimanite that define a mineral foliation, and local idioblastic cordierite in leucosome layers. The iron formation layers are up to 2 m thick and made up of thinly laminated magnetite and quartz bands with rare coarse-grained garnet and grunerite. The mafic rocks are relatively massive, with garnet porphyroblasts up to 1 cm in diameter (Figure 4f) that are typically rimmed by plagioclase. The mafic rocks are generally associated with ultramafic rocks, including large pods and boudins of pyroxenite or peridotite. These rocks are relatively rare compared with the other units described in this sequence; however, they are very prominent, as they weather positively and have a dark brown to golden brown weathered surface. One peridotite locality north of the Chesterfield fault zone at the western edge of NTS area 56G contains orthopyroxene up to 4 cm long, clinopyroxene, olivine, magnetite and garnet.

Granulite-facies domains

Distinct domains containing granulite-facies plutonic, gneissic and minor supracrustal rocks were mapped in both the northernmost and southernmost parts of the study area, and are associated with strong magnetic-high signatures (Figure 3). In the northern domain, granulite-grade metamorphism is interpreted based on the local presence of orthopyroxene in granodioritic orthogneiss, as well as increased leucosome volumes and migmatitic textures in otherwise typical orthogneiss and supracrustal rocks. These rocks are cut by relatively undeformed, medium- to coarse-grained, monzodiorite to monzogranite plutonic rocks (Figure 2; purple map unit) that contain about 5% biotite, 1% magnetite and rare amphibole, and have distinctive grey, translucent plagioclase grains with white, opaque rims (Figure 5a).

In the southern granulite-facies domain, referred to as the Kummel Lake domain (Wodicka et al., 2016; Figure 2, teal and yellow map units), most orthogneiss and supracrustal rocks have a pervasive, waxy, greenish-brown hue, typical of granulite-facies rocks. Granodioritic to monzogranitic orthogneiss contains the assemblage biotite±hornblende±orthopyroxene±magnetite (Figure 5b). A few metagabbro localities were documented, including a coarse-grained cumulate gabbro and a leucogabbro. Supracrustal rocks (Figure 2; yellow map unit), including minor garnet+clinopyroxene mafic rocks and garnet+biotite pelite, are characterized by magnetic-low anomalies (Figure 3) and are lithologically similar to those present to the south of the Chesterfield fault zone (brown map unit described above; see also Steenkamp et al., 2015; Wodicka et al., 2015, 2016). An undeformed, biotite+magnetite±amphibole monzodiorite to monzogranite plutonic phase, similar to that observed in the northern granulite zone, has also been injected through much of this area, cutting the regional fabrics.

Paleoproterozoic monzogranite and ultrapotassic intrusions

Several large plutonic bodies of mostly undeformed, coarse-grained, biotite±magnetite monzogranite (Figure 2, orange map unit; Figure 5c) were mapped in the northern part of the study area, and one smaller body was identified north of the Kummel Lake granulite domain. The plutons generally have a weak foliation around their margins, defined by aligned biotite, and contain xenoliths of orthogneiss, K-feldspar–phyric monzogranite and quartzite. A large magnetic anomaly north of the Wager shear zone (Figures 2 and 3; NTS area 56G) is also associated with similar biotite+magnetite monzogranite. The core of the plutonic body is undeformed and contains K-feldspar megacrysts up to 3 cm in size. The edge of the pluton has a finer grain size and shows some foliation development defined by aligned biotite grains and deformed feldspar crystals.

Coarse-grained to pegmatitic syenogranite dykes and sill complexes intrude much of the study area, cutting most other rock units and deformational fabrics. These dykes and sills are associated with minor magnetic anomalies in areas dominated by Archean granodiorite to tonalite rocks, and form topographic highs owing to their competent nature. It is believed that these late dykes and sills, and the large plutonic bodies, belong to the 1845–1795 Ma Hudson

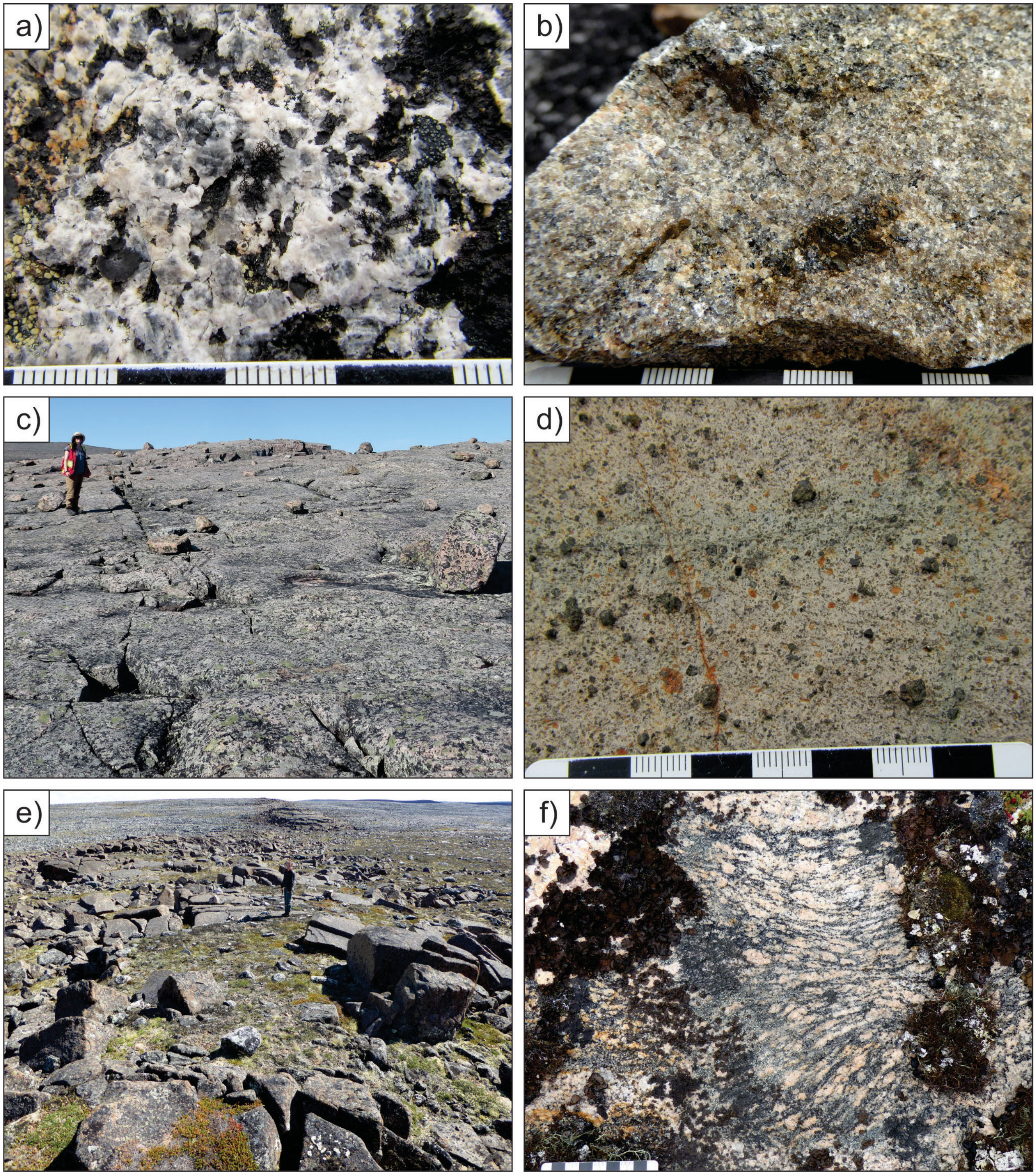

Figure 5: Field photographs of rocks in the Tehery Lake–Wager Bay area: **a)** white-weathering biotite±hornblende monzodiorite spatially associated with the Wager shear zone; plagioclase has grey cores and white rims; **b)** large, brown orthopyroxene grain in granodiorite gneiss found along the Wager shear zone near Wager Bay; **c)** homogeneous, undeformed biotite monzogranite north of the Chesterfield fault zone; **d)** weathered surface of lamprophyre, showing olivine and pyroxene phenocrysts; **e)** blocky, brown-weathering, southeast-trending diabasic dyke cutting through Archean basement orthogneiss in the northwestern corner of the study area (looking southeast); **f)** deformed K-feldspar porphyroclasts in monzogranite consistently found along the northern side of the Chesterfield fault zone.

plutonic suite (Peterson et al., 2002; van Breemen et al., 2005).

Scattered localities with ultrapotassic rocks (Figure 2, dark green unit), including biotite+clinopyroxene syenite, phlogopite clinopyroxenite and biotite+clinopyroxene+olivine lamprophyre (Figure 5d), were documented south of the Wager shear zone and Chesterfield fault zone. These rocks generally correspond to small, circular magnetic-high anomalies, appearing to be plug or stock intrusions. In some places, the ultrapotassic rocks are spatially associated with Hudson plutonic rocks and similarly cut through the older orthogneiss and supracrustal rocks, suggesting that they may be contemporaneous with the emplacement of the Hudson suite.

Mafic dyke swarms

A series of diabasic dykes (Figure 2, thick blue lines) is evident in the aeromagnetic-survey data as continuous, southeast-trending magnetic-high anomalies (Figure 3). They cut all rock types and structural elements, with the exception of relatively younger brittle faults. The dykes are up to 50 m wide, weather dark brown and fracture to form a distinctive blocky pattern (Figure 5e). They typically have a porphyritic texture, with medium-grained, white-weathering plagioclase phenocrysts set in a dark, fine-grained matrix. Based on their orientation, composition, textures and field relationships, these dykes are likely associated with the ca. 1267 Ma MacKenzie dyke swarm (LeCheminant and Heaman, 1989). In the west-central and southwestern parts of the study area, a second set of diabasic dykes trends roughly east-west. These dykes range in thickness from 10 cm to 1.5 m but do not have associated aeromagnetic anomalies, possibly because the aeromagnetic-survey lines were also oriented east-west, effectively hiding the dykes' signatures, or they are simply too thin to resolve, given the scale of the survey.

Regional structure, metamorphism and deformation

The state of strain, orientation of regional fabrics and grade of metamorphism vary considerably across the northern and western parts of the study area. In the west-central part of the area, south of the Chesterfield fault zone, the main foliation (S_m) in the Archean orthogneissic rocks strikes northeast or southwest and dips 25–65°, with mineral and stretching lineations that plunge primarily to the northeast at shallow angles. The foliation is axial planar to dominantly northeast-trending macroscopic folds and is defined mainly by the alignment of biotite±hornblende. The presence of migmatitic textures but continued stability of biotite and absence of orthopyroxene indicate that upper amphibolite–facies conditions prevailed during this deformation event. Evidence for an earlier deformation event comes from the local preservation (e.g., in the hinge zones of major folds) of a foliation oriented at a high angle to the dominant S_m foliation.

The S_m fabrics in the Kummel Lake domain strike northeast or southwest but generally dip more steeply (50–80°) to the southeast or northwest than in the orthogneissic rocks outside the domain. Also, macroscopic northeast-trending folds in the Kummel Lake domain are much better defined than in the neighbouring rocks to the north (Figure 3). As noted in the previous section, the Kummel Lake domain preserves the greatest evidence for granulite-facies peak metamorphism, where orthogneiss contains coarse-grained orthopyroxene, foggy blue quartz and plagioclase with a waxy greenish-brown hue. Pelitic to semipelitic supracrustal rocks, containing the assemblage garnet+biotite±sillimanite, also display a waxy greenish-brown hue and have 10–30 cm wide layers of granitic leucosome that were likely produced through biotite-dehydration reactions. Fine-grained biotite and garnet porphyroblasts up to 5 mm in diameter are concentrated in folded melanosome that defines the S_m fabric. These features suggest that the main deformation fabric and granulite-facies conditions in the Kummel Lake domain were concomitant. Locally, garnet and orthopyroxene porphyroblasts are individually rimmed by biotite, indicating minor retrogression.

The Chesterfield fault zone is characterized by strongly deformed to mylonitic rocks (Figure 5f) that preserve both dextral and sinistral shear-sense indicators. Foliations within and adjacent to the fault zone dip mainly at steep angles to the north-northwest; however, there is a zone approximately 1 km wide where fabrics dip moderately to steeply to the south-southeast. The highly strained rocks contain well-developed stretching lineations that plunge shallowly to the east-northeast or west. Fabrics in the gneissic rocks to the north and south appear to be reoriented close to the fault zone, but the fault zone itself is folded, as suggested by its curved form (Figures 2, 3). Supracrustal rocks along the fault zone generally preserve amphibolite-facies peak mineral assemblages, such as biotite+garnet+sillimanite±leucosome±muscovite in pelite and garnet+hornblende±clinopyroxene in mafic rocks. Evidence of retrogression includes biotite and plagioclase rims on garnet porphyroblasts in pelitic and mafic rocks, respectively, indicative of lower to moderate amphibolite–facies conditions. These retrograde textures are more abundant in rocks along the western part of the Chesterfield fault, while rocks along the eastern part of the fault typically show no or minimal retrogression.

Between the Chesterfield fault zone and Wager shear zone, the foliation fabrics in plutonic and supracrustal rocks vary widely due, in large part, to two phases of folding: an early phase of northeast-trending folds and a later phase of upright, northwest- and southeast-trending folds (Figures 2, 3). These macroscopic folds are broadly similar in orientation and scale to those documented in the southeastern part of the study area (Wodicka et al., 2015). However, as the Wager shear zone is approached from the south, all fabrics are reoriented parallel to this major structure (see also Henderson and Broome, 1990). Pelitic rocks between the two fault zones contain metamorphic mineral assemblages ranging from muscovite+sillimanite+biotite+garnet to biotite+garnet+sillimanite+leucosome. Similarly, mafic rocks within this area contain either biotite+hornblende or a higher grade peak assemblage of clinopyroxene+garnet+ hornblende. This could indicate that peak metamorphic conditions varied throughout this area from lower-amphibolite to upper-amphibolite facies, or that the two supracrustal packages preserve distinct mineral assemblages and thus metamorphic histories. In mafic rocks, garnet porphyroblasts are partially to fully pseudomorphed to plagioclase+biotite±hornblende, indicating decompression to lower amphibolite–facies conditions.

Most planar fabrics along the Wager shear zone strike easterly or westerly and have moderate to steep dips (55–85°), whereas linear features are primarily subhorizontal. Highly strained to mylonitized orthogneiss within the shear zone is locally deformed by broad to isoclinal folds, causing reorientation of lineations. Plutonic rocks within and adjacent to the Wager shear zone contain either biotite±hornblende± epidote assemblages or granulite-facies assemblages, as outlined in the previous section. Discontinuous panels of supracrustal rocks contain garnet+biotite+sillimanite+leucosome in pelite. Garnet porphyroblasts show some recrystallization of biotite and plagioclase at their rims that defines strain shadows. These features suggest a complex interplay between deformation and metamorphism along the shear zone.

Discussion and future work

Targeted bedrock mapping and thematic scientific research in the Tehery Lake–Wager Bay study area has led to redefinition and definition of previously known and unknown rock units, respectively. First, the southwestern part of the study area, characterized by the Kummel Lake granulite domain (Figure 2, teal and yellow map units), is thought to be only a part of a much larger, high-pressure, granulite-facies metamorphosed area that would include the Daly Bay, Uvauk and Kramanituar complexes (Gordon, 1988; Hanmer and Williams, 2001; Sanborn-Barrie et al., 2001; Mills et al., 2007). Geochronology and petrography are required to define the timing of protolith formation and the timing, duration and conditions of peak and retrograde metamorphism within the Kummel Lake domain, which in turn will be compared with interpreted histories from the better studied, high-pressure, granulite-grade mafic–anorthosite complexes.

Second, mapping suggests the presence of two distinct supracrustal sequences across the study area: the supracrustal packages either contain an assortment of rock types (pelite, psammite, quartzite, mafic and ultramafic rocks, iron formation, calcsilicate and/or carbonate rocks; Figure 2, brown map unit) or are dominated by siliceous rocks (quartzite, psammite, semipelite, pelite) with minor mafic rocks (Figure 2, green map unit). The latter, silica-dominated supracrustal sequence is tentatively interpreted as correlative with the lower succession of the Paleoproterozoic Ketyet River group documented north of Baker Lake, Nunavut (Rainbird et al., 2010), as previously suggested by Panagapko et al. (2003) and Ferderber et al. (2013). The former, more lithologically varied supracrustal package is similar to the description of the Paliak belt that was mapped near Wager Bay (Jefferson et al., 1991). In both cases, the supracrustal rock sequences in the Tehery Lake–Wager Bay area require detrital geochronology and geochemistry to fingerprint the rock units and enable their comparison with other, better studied sequences outside the study area.

Third, the Chesterfield fault zone, previously defined based on aeromagnetic-anomaly data and metamorphic contrasts, is now better delineated on the basis of the distribution of highly deformed to mylonitic rocks. While most fabrics measured near the Chesterfield fault zone dip to the north, a 1 km wide zone contains south-dipping fabrics. This provides field evidence that is consistent with Spratt et al. (2014), who interpreted a south-dipping fault based on magnetotelluric data, and recent geophysical data collected by Tschirhart et al. (2016). The deformed rocks record at least two major deformational events: one that created the porphyroclastic and lineated textures, and a second that folded and reoriented these fabrics. In-depth structural analysis, petrography and geochronology will be undertaken to fully understand the relative timing and structural relationships of the contrasting fabrics and porphyroclastic textures along and adjacent to the Chesterfield fault zone.

Fourth, mapping has established that the Wager shear zone continues far inland from Wager Bay, as suspected from aeromagnetic-survey data. Similar to the Chesterfield fault zone, rocks within the Wager shear zone appear to record at least two phases of deformation: a high-strain phase that created the mylonitic fabrics and strong lineations, and a second phase that broadly folded and reoriented those structures. It is unclear whether these phases of deformation are related to separate events or were created through progressive deformation during a single event. Additionally, the Wager shear zone has been intruded by younger, dominantly undeformed monzodiorite to diorite, which has obliterated large parts of the shear zone. In the westernmost part of the study area, the shear zone may continue to the southwest to become the Quoich River fault (Figures 2, 3; Schau, 1983; Panagapko et al., 2003), or extend to the northwest outside the study area toward the Amer mylonite zone (e.g., Broome, 1990). Many samples were collected for geochronology and petrography to constrain the timing, duration and kinematics of deformational events within the Wager shear zone.

Finally, peak metamorphic assemblages are variable across the study area. Detailed petrography and thermodynamic modelling of metamorphic mineral assemblages in pelitic and mafic supracrustal rocks are underway to 1) test whether the two proposed supracrustal sequences record different metamorphic histories, and 2) determine whether the major fault zones are responsible for the juxtaposition of rocks with distinct metamorphic grades.

Economic considerations

Supracrustal panels in the Tehery Lake–Wager Bay area contain rock types that have potential for economic mineralization. For example, gossanous layers were found associated with garnet amphibolite and semipelite in the Ketyet River–like supracrustal rocks, whereas iron formation and ultramafic rocks are concentrated in the supracrustal package that has more variable lithological assemblages. One particular panel of the latter supracrustal package is adjacent to where till and stream-sediment samples containing anomalous concentrations of Au, Cu, Bi and Ag were discovered in 2012 (Day et al., 2013; McMartin et al., 2013). Rock, till and stream-sediment samples were collected from all localities with economic potential to analyze for base and precious-metal concentrations (this study; McMartin et al., 2016).

The Archean basement has previously been explored for its kimberlite potential in the northern part of the study area (Pell and Strickland, 2004). Given the vast expanses of similar Archean crust elsewhere within the study area, there remains potential for existence of other kimberlite occurrences.

Acknowledgments

The authors wish to acknowledge the other field party members who worked tirelessly to complete this mapping project: É. Girard, S. Day, I. McMartin, V. Tschirhart, B. Garrison, L. Lebeau, A. Lion, R. Bayne, I. Randour and M. Roy. Thanks go to D. Guilfoyle for extraordinary meals, T. Evviuk and A. Alooq for monitoring wildlife and maintaining camp infrastructure, D. Willis of Peregrine Diamonds Ltd. for support and co-operation regarding camp logistics, and Discovery Mining Services for building and removing the camp infrastructure. The Polar Continental Shelf Project co-ordinated rotary- and fixed-wing aircraft support (Project 059-16). The authors gratefully acknowledge pilot and engineer E. Polzin and the rest of Prairie Helicopters for providing a safe and enjoyable daily commute in the field, as well as Ookpik Aviation, S.K. Construction and the Baker Lake Lodge for their professional logistics support, expediting and hospitality, respectively.

This project is funded by the Geological Survey of Canada's Geo-mapping for Energy and Minerals program and the Canadian Northern Economic Development Agency's Strategic Investments in Northern Economic Development program. D. Wright, D. Desnoyers, L. Ham, R. Khoun and R. Murphy are thanked for their management and administrative support. K. Clarke assisted with community engagement in Baker Lake, and R. Buenviaje provided pre-field GIS support. This paper benefited from a thorough and thoughtful review by C. Guilmette.

Natural Resources Canada, Earth Science Sector contribution 20160222

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