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MONTAGNAIS GABBRO OF WESTERN LABRADOR: PRELIMINARY GEOLOGICAL AND PETROGRAPHIC DATA AND IMPLICATIONS FOR Ni–Cu–PGE MINERALIZATION

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ABSTRACT

The Ni–Cu–PGE potential of the Montagnais Gabbro in western Labrador was investigated as part of a multi-year field program investigating the metallogeny of the eastern Labrador Trough. Fieldwork in 2017 focussed on gabbro sills in the Howse Lake (NTS map area 23O/01) and the Moss Lake (NTS map area 23I/08) areas, from where samples were collected for detailed petrographic, geochemical and isotopic analysis. This report presents preliminary data on the type of sulphide mineralization in these sills.

Based on their host lithology and locations within a specific stratigraphic zone, the Montagnais Gabbro have been subdivided into three distinct intrusion suites; the Le Fer, the Menihek, and the Doublet gabbros. Sulphide mineralization is common in the Menihek and Doublet gabbros, which intrude sulphur-rich sedimentary rocks of the Menihek and Thompson Lake formations. Trace to minor sulphides (pyrrhotite, chalcopyrite and rare pentlandite) are common and some samples contain up to 20% sulphides. Mineralization predominantly occurs as finely disseminated sulphides, with net-textured pyrrhotite and chalcopyrite in samples containing higher sulphide contents. Samples from the Moss Lake area also show evidence of late-stage remobilization of sulphides.

This research is part of an ongoing B. Sc. (Hons.) project by A. Smith at Memorial University of Newfoundland. It will combine detailed petrography (Scanning Electron Microscope–Mineral Liberation Analyzer), whole-rock geochemical data, and sulphur-isotope data from both mineralized gabbros and sulphide-rich shales proximal to the gabbro sills. This project aims to determine the sulphur source within the mineralized gabbro, classify the deposit types, and create a genetic model for exploration.

INTRODUCTION

The Labrador Trough, located in western Labrador and northeastern Québec, is composed of Paleoproterozoic sedimentary and volcanic rocks deposited on the eastern continental margin of the Superior Province. From a mineral deposit perspective, it is primarily known for its extensive iron-ore deposits, including those currently mined in the Labrador City and Schefferville areas. However, the base-metal potential of the Labrador Trough has also long been recognized, and numerous base-metal occurrences are recorded in the MODS database, particularly from the eastern Labrador Trough. These include base- and precious-metal showings in graphitic mudstones (*e.g.*, Martin Lake Prospect; Swinden and Santaguida, 1993), late-stage Cu–Au mineralization of possible orogenic origin (*e.g.*, Montgomery Lake Showing; Swinden and Santaguida, 1995), and magmatic Ni–Cu–PGE showings hosted in gabbro sills (Swinden *et al.*, 1991).

Fieldwork in 2017 focussed on gabbro sills in the Howse Lake area (NTS map area 23O/01) and the Moss Lake area (NTS map area 23I/08), on the eastern margin of the Labrador Trough (Figure 1). Montagnais Gabbro are widespread in the eastern Labrador Trough and are possible hosts for magmatic Ni–Cu–PGE deposits (Clark, 2001; Clark and Wares, 2005). Recent exploration in Québec has identified significant mineralization at the Huckleberry Prospect (Figure 1), with grab samples containing up to 14% Cu, 1.2% Ni and 17g/t PGE + Au (Vaillancourt *et al.*, 2016).

The objectives here are to document the type of any Ni–Cu–PGE mineralization and to address the economic

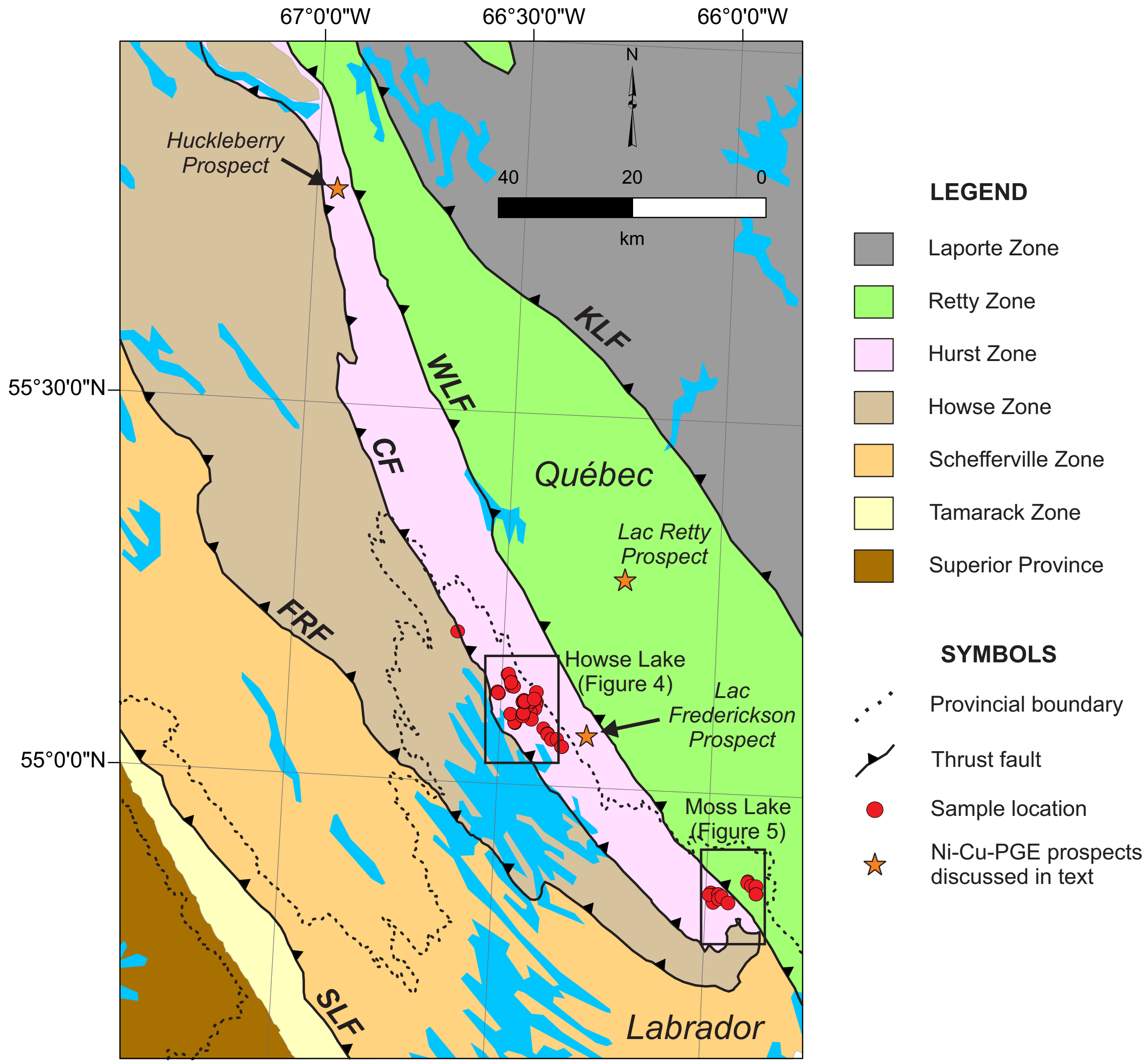

Figure 1. *Lithotectonic zones of the Labrador Trough in western Labrador and northeastern Québec (adapted from Clark and Wares, 2005), showing location of samples collected during 2017 fieldwork. CF – Chassin Fault, FRF – Ferrum River Fault, KLF – Keato Lake Fault, SLF – Stakit Lake Fault, WLF – Walsh Lake Fault.*

potential of the Montagnais Gabbro in western Labrador. This report presents preliminary field and petrographic observations from a number of known occurrences and new showings surveyed in 2017. It will form part of a larger research project on the metallogeny of the eastern Labrador Trough, which aims to create a metallogenic framework to aid future exploration in the region.

PREVIOUS WORK AND HISTORY OF EXPLORATION

The geology of the eastern Labrador Trough has previously been mapped as part of regional mapping projects (Donaldson, 1966; Frarey, 1967; Wardle, 1982) and the Howse Lake area was mapped, in detail, by Findlay *et al.* (1990).

The first geological exploration in the Labrador Trough was conducted in the 1890s by A.P. Low who noted the potential for large iron deposits (Low, 1896). After the discovery of high-grade iron ore by W.F. James and J.E. Gill in the Knob Lake area near the Québec–Labrador border in 1929, iron ore became the primary focus of exploration in the Labrador Trough. To date, iron-ore deposits remain the only metallic mineral deposit type to have been mined in the Labrador Trough (Clark and Wares, 2005).

Despite this, the potential for the Labrador Trough to host other mineral resources has long been recognized. Early exploration by Labrador Mining and Exploration (LM&E) in the 1930s and 1940s suggested the potential for Cu–Ni mineralization, with a belt of prospective rocks referred to as the "gossan belt" (Retty, 1943). Detailed mapping and prospecting was carried out along this belt by LM&E between the 1940s and 1960s (Moss, 1942; Auger, 1949; Bloomer, 1955; Wagner, 1955; Love, 1967), leading to the discovery of a number of base-metal occurrences, including the Martin Lake and Montgomery Lake showing, as well as numerous shale-hosted sulphide occurrences (Swinden and Santaguida, 1993, 1994). Drilling in the 1970s and 1980s targeted these occurrences, but no significant Cu, Zn, Ni or Pb values were returned (Grant, 1977; Avison *et al.*, 1984). Following the expiration of LM&E's licences in the 1980s, a number of companies continued exploration for sediment-hosted base-metal occurrences in the eastern Labrador Trough. Noranda Exploration Co. Ltd. carried out work around the Martin Lake showing, including prospecting, till sampling and ground VLF-EM and magnetic surveys (Banville, 1993), as well as diamond drilling to test zinc targets and the SEDEX potential of the Menihek Formation shales (Dessureault, 1999). Work in the 2000s, by Altius Resources and Cornerstone Resources in the Howse Lake and Moss Lake areas, also focussed on base-metal potential of the sedimentary rocks, and resulted in the discovery of a number of occurrences in the Moss Lake area (Butler and Churchill, 2004; Labonté *et al.*, 2009; Labonté and Kieley, 2009).

MONTAGNAIS GABBRO

The Montagnais Gabbro in the Howse Lake and Moss Lake areas have been the subject of numerous detailed petrographic and geochemical studies, including Baragar (1960, 1967); Fahrig (1962); Fraley (1967); Dimroth *et al.* (1970); Findlay *et al.* (1990); Rohan *et al.* (1993); Skulski *et al.* (1993) and Findlay (1996). Findlay *et al.* (1995) published a U–Pb zircon age of 1884 ± 1.6 Ma from a glomeroporphyritic gabbro sill in the Howse Lake area.

Although the potential of the Montagnais Gabbro to host Ni–PGE mineralization was noted by Bloomer (1955), subsequent exploration by LM&E focused on shale-hosted sulphide occurrences. In 1989, Cliff Resources Corp. and Canaustra Gold Exploration Ltd. investigated the Montagnais Gabbro in the Howse Lake area for base-metal, PGE, and Au deposits (Findlay and Fowler, 1989). Although zones with elevated sulphide contents were described, the potential for economic deposits of precious-metal mineralization was considered to be poor based on the low Ni, Cu and PGE values in assay data (Findlay and Fowler, 1989; Findlay *et al.*, 1990). The Moss Lake area was explored by Falconbridge Ltd. in 1992. Prospecting and lithogeochemical surveys were conducted to investigate the Montagnais Gabbro for Ni–Cu occurrences, and anomalous results included assay values of up to 0.98% Cu in coarse-grained gabbro (Butler and McLean, 1992).

A number of Ni–Cu–PGE occurrences are reported in Montagnais Gabbro in Québec (Clark and Wares, 2005). Although most of these occurrences are considered to be minor, significant base-metal and PGE values are recorded from a number of showings, including the Lac Frederickson and Huckleberry showings in the Hurst Zone, and the Lac Retty showings in the Retty Zone.

The Lac Frederickson showing, located ~12 km southeast of the Howse Lake area, was described in detail by Gerbert (1988), who conducted a detailed geochemical and isotopic study of the gabbro. Prospecting activity at Lac Frederickson by Groupe Platine de Fosse Inc. in 1988 reported grades of up to 3.99% Cu, 1.03% Ni and 0.69 g/t Pt + Pd from grab samples (Scott *et al.*, 1988). The Huckleberry Prospect, located ~80 km to the north-northwest of Howse Lake (Figure 1), has been the focus of recent exploration by Northern Shield Resources, including prospecting and diamond drilling. This occurrence, discovered in 2014 during regional reconnaissance prospecting, highlights the potential for new discoveries in the eastern Labrador Trough. Ninety-eight grab samples of mineralized glomeroporphyritic and olivine-bearing gabbros returned average grades of 1.0% Cu, 0.2% Ni and 0.72 g/t PGE, with highs of 14% Cu, 1.2% Ni and 17g/t PGE + Au from individual grab samples (Vaillancourt *et al.*, 2016).

The Lac Retty Prospect, located ~20 km northeast of the Howse Lake area, was the subject of detailed exploration from the 1950s to 1980s, outlining a non NI-43-101 compliant probable reserve of 1.03 Mt at 0.88% Cu, 0.44% Ni and 0.90 g/t Pt + Pd (Clark and Wares, 2005). The mineralization consists of massive to semi-massive sulphide lenses in differentiated mafic–ultramafic sills of the Montagnais Gabbro and Retty Peridotite (Clark and Wares, 2005; Fortin, 2016). Recent exploration by Rockland Minerals Corp. confirmed previous exploration results as well as identifying the potential for new discoveries (Fortin, 2016).

REGIONAL GEOLOGICAL SETTING

The Labrador Trough extends from the Grenville Front in the south to Ungava Bay in the north, and represents the foreland thrust-and-fold belt of the New Québec Orogen along the margin of the Superior Province (Wardle and Bailey, 1981; Le Gallais and Lavoie, 1982; Clark and Wares, 2005). It is composed of three cycles of Paleoproterozoic (2.17 to 1.87 Ga; Rohon *et al.*, 1993; Findlay *et al.*, 1995;

Machado *et al.*, 1997) sedimentary and volcanic rocks, which collectively form the Kaniapiskau Supergroup (Frarey and Duffell, 1964; Zajac, 1974; Wardle and Bailey, 1981; Le Gallais and Lavoie, 1982).

Cycle 1 was deposited during rifting on the eastern margin of the Superior Craton at least 2.17 billion years ago (Rohon *et al.*, 1993), and is composed of an intercratonic rift-basin sequence (immature sandstones and siltstones of the Seaward Formation) that is overlain by a passive margin sequence of the Attikamagen Group. It includes the Le Fer Formation siltstone, shale and basalt, Denault Formation dolomite, Fleming Formation chert breccia, and Dolly Formation shale and siltstone (Clark and Wares, 2005).

Cycle 2 is locally separated from Cycle 1 by an erosional unconformity, attributed to uplift associated with two major basement structures that created basin arches that both restricted sedimentation, and contributed to the local erosion (Wardle and Bailey, 1981). However, the recognition of conformable contacts between cycles 1 and 2 (Harrison, 1952; Baragar, 1967; Zajac, 1974; Clark *et al.*, 2006) suggests almost continuous sedimentation from >2142 Ma to <1880 Ma. In western Labrador, Cycle 2 is composed of a volcano-sedimentary sequence divided into two groups, the Ferriman Group in the west and the Doublet Group in the east. The Ferriman Group is a transgressive sequence that progresses from shelf-type rocks of the Wishart Formation (sandstone and siltstones) and the Sokoman Formation (iron formation) at the base, to deeper water turbidites (and minor basalts) of the Menihek Formation at the top. The intermediate to mafic volcanic rocks of the Nimish Formation are interbedded with the Sokoman Formation in the Dyke Lake area (Evans, 1978). The Doublet Group is interpreted to represent deeper water equivalents of the upper Ferriman Group (Clark and Wares, 2005), and consists of pyroclastic rocks of the Murdoch Formation at the base, overlain by siltstones and black shales of the Thompson Lake Formation and basalts of the Willbob Formation. In places, Cycle 2 is unconformably overlain by the Tamarak River Formation arkose rocks (Cycle 3), attributed to a synorogenic foredeep molasse.

Throughout the central regions of the trough, cycles 1 and 2 lithological units are intruded by thoeliitic, mafic to ultramafic sills, which together with the basalts and pyroclastic rocks of the Le Fer, Nimish, Menihek, Murdoch and Willbob formations, constitute part of a major magmatic province termed the Labrador Trough Basaltic Suite (Findlay, 1996).

LITHOTECTONIC ZONES

The Labrador Trough has been separated into eleven lithotectonic zones, each defined by a characteristic stratigraphy and bound by major thrust faults (Clark and Wares, 2005). They make up an imbricated thrust stack, formed from thrusting during the final accretional stages of the New Québec Orogen (Clarke and Wares, 2005).

In western Labrador, the Labrador Trough contains five lithotectonic zones; represented from west to east by the Tamarack, Schefferville, Howse, Hurst and Retty zones (Figure 1). The areas of this study lie within the Howse, Hurst and Retty lithotectonic zones (Figure 1). Descriptions of the stratigraphy of Tamarack and Schefferville zones are given in Clark and Wares (2005).

The Howse Zone is composed of the Seaward Group and a thick sequence of Le Fer Formation shales, siltstones and basalts, intruded by gabbro sills (Figure 2). It is a shallow-dipping thrust nappe, disrupted by numerous postdepositional folds and faults (Clarke and Wares, 2005), that was thrust over the Schefferville Zone along the Ferrum River Fault (Figure 1).

The Hurst Zone is located between the Howse and Retty zones. Wardle and Bailey (1981) and Wardle *et al.* (1990) included the Hurst Zone as part of the Howse Zone. However, Clark and Wares (2005) defined the Hurst Zone as a separate lithotectonic zone based both on its distinctive stratigraphy, and because it is separated from the Howse Zone by a major thrust fault (Chassin Fault; Figure 1). The stratigraphy of the Hurst Zone is composed of a thin sequence of Attikamagen Group sedimentary rocks overlain by the Ferriman Group. The Menihek Formation is relatively thick in the Hurst Zone; characterized by relatively enriched metal contents compared to the Menihek Formation in the Schefferville Zone, exemplified by numerous shale-hosted sulphide occurrences (Swinden and Santaguida, 1993). It is also intruded by numerous aphyric and glomeroporphyritic gabbro sills (Figure 2). A sample of a glomeroporphyritic gabbro sill in the Hurst Zone yielded a U–Pb zircon age of 1884 ± 1.6 Ma (Findlay *et al.*, 1995), which is interpreted as a minimum depositional age for the Menihek Formation in the Hurst Zone.

The Retty Zone is bounded by the Walsh Lake Fault to the west, and is thrust over the Hurst Zone in the study area, and farther south, it is thrust over the Schefferville Zone (Figure 1). The Retty Zone is composed of the Willbob, Thompson Lake and Murdoch formations of the Doublet Group, with rocks in the zone being intruded by mafic–ultramafic sills (Figure 2; Clark and Wares, 2005). Shales and siltstone of the Thompson Lake Formation have been correlated with the middle part of the Menihek Formation (Findlay *et al.*, 1995; Clark and Wares, 2005). There are numerous shale-hosted sulphide occurrences throughout the Thompson Lake Formation.

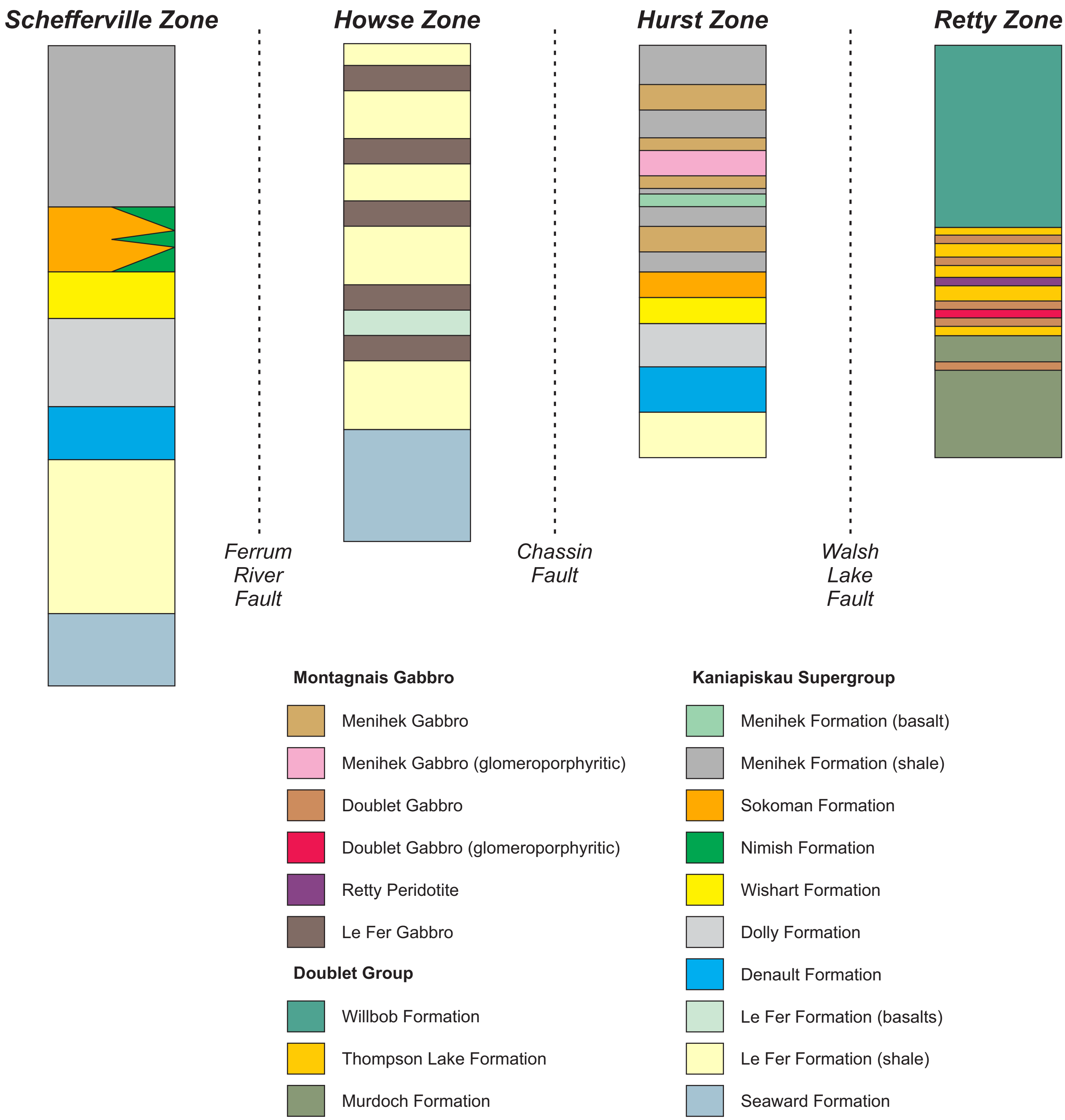

Figure 2. *Generalized stratigraphy of the Schefferville, Howse, Hurst and Retty lithotectonic zones in the Labrador Trough.*

MONTAGNAIS GABBRO

The Montagnais Gabbro is part of the Labrador Trough Basaltic Suite (LTBS; Findlay, 1996). Based on geochronological constraints (Rohan *et al.*, 1993; Findlay *et al.*, 1995), the Montagnais Gabbro is interpreted to represent at least two distinct magmatic episodes. A felsic differentiate from a gabbro sill intruding the Seward Group yielded a U–Pb zircon age of 2196 ± 4 Ma (Rohon *et al.*, 1993), whereas a U–Pb zircon age of 1884 ± 1.6 Ma was obtained from a gabbro sill intruding Menihek Formation shales (Findlay *et al.*, 1995), representing two distinct cycles of basaltic intrusive activity. However, despite the differences in age, the gabbros are commonly indistinguishable in the field and typically display similar geochemical signatures (Findlay, 1996). The earlier pulse of igneous activity is interpreted to be associated with the initial rift phase in the Labrador Trough (Wardle and Bailey, 1981), and the later phase of igneous activity may represent magmatism in pull-apart basins that reflect pre-collisional dextral transtension along the Superior margin (Skulski *et al.*, 1993). Based on their host lithology and location within specific stratigraphic zones, Findlay (1996) subdivided the Montagnais Gabbro into three distinct intrusive suites termed the Le Fer, the Menihek, and the Doublet gabbros.

LE FER GABBRO

Le Fer Gabbro sills intrude both the Seaward Group and the Le Fer Formation in the Howse Zone, being more common in the Le Fer Formation where they locally comprise up to 70% of the stratigraphy in the northern Howse Zone (Findlay, 1996). The sills are 50 to 600 m thick and are generally lithologically homogeneous with chilled margins (Findlay, 1996). The gabbros are subophitic to ophitic, medium-grained rocks, with common, but volumetrically minor, quartz gabbro, quartz monzogabbro and rare granitic veins (Findlay, 1996).

Currently, there are no known sulphide occurrences in the Le Fer Gabbro in western Labrador.

MENIHEK GABBRO

Menihek Gabbro sills occur within the Hurst Zone, where they intrude Menihek Formation shales. They have been studied in detail in the Howse Lake area (Findlay, 1996), where a 6- to 8-km-thick stratigraphic sequence is preserved, of which up to 80% consists of Menihek Gabbro. They form sills ranging in thickness from 100 m to >500 m and have common chilled margins. Menihek Gabbro sills typically show some degree of differentiation, exhibited as rhythmic layering, cumulate oxide horizons, or variations within glomeroporphyritic contents (Findlay, 1996). The presence of large aggregates of plagioclase crystals (glomerocrysts) is a characteristic feature of the Menihek Gabbro. Findlay (1996) showed that up to 60% of the gabbro in the Howse Lake area is glomeroporphyritic, and subdivided the gabbros into three main phases (Figure 3). The gabbroic phase is volumetrically the most common, and is generally aphyric to sparsely glomeroporphyritic (Plate 1A). The anorthositic phase occurs in the centre of some sills, and have glomerocrysts constituting 20–50% of the rock (Plate 1B). The third phase is termed the core phase due to its restriction to the centre of some sills, enclosed by the anorthositic phase. The core phase consists of large (up to 50 cm) spherical glomerocrysts in a gabbroic matrix. Other minor rock types include lenses and pods of felsic rocks, oxide-rich horizons and crosscutting leucocratic veins (Findlay, 1996). Although no ultramafic units have been described from the Howse Lake area (Findlay, 1996), exploration at the Huckleberry Prospect has recorded a poorly exposed olivine gabbro and peridotite unit within the Menihek Gabbro (Vaillancourt *et al.*, 2016).

Disseminated sulphides, composed predominantly of pyrrhotite and lesser chalcopyrite and pentlandite, are ubiquitous accessory phases in the Menihek Gabbro. Local sulphide concentrations of up to 25% per volume occur in irregular zones, lenses and stratiform horizons (up to 1 m thick), and are best developed in the gabbroic phase of the Menihek Gabbro (Findlay *et al.*, 1990).

DOUBLET GABBRO

Doublet Gabbro sills intrude all the formations in the Retty Zone, but are most voluminous in the Thompson Lake Formation, where they constitute up to 50% of the total stratigraphic thickness (Findlay, 1996). The Doublet Gabbro is commonly associated with Retty peridotite (Findlay, 1996). Sills in the Retty Lake area have gabbro at the tops and bottoms, and ultramafic units in the centres (Rohan *et al.*, 1993), but at the eastern margin of the Retty Zone the

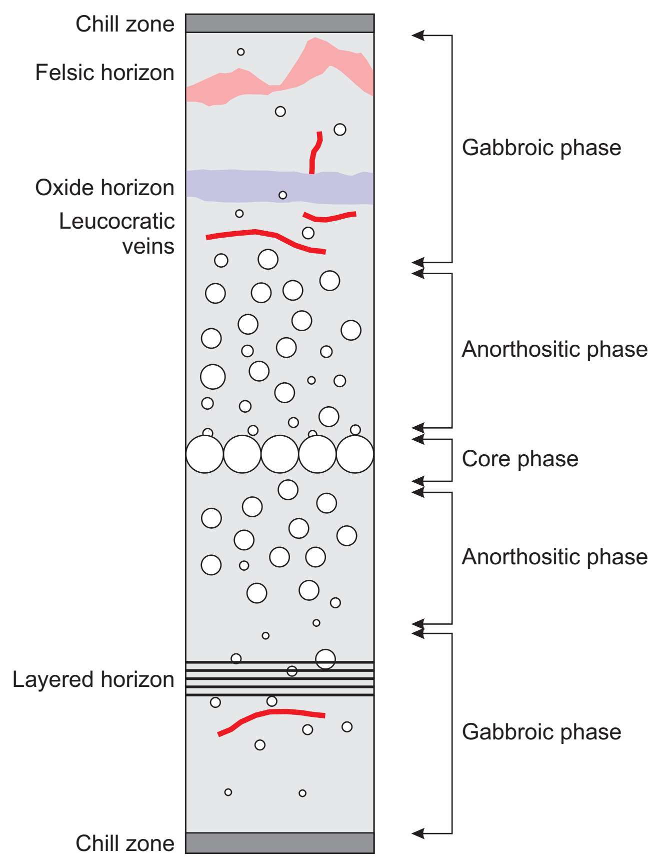

Figure 3. *Schematic illustration of lithological variations in an idealized Menihek Gabbro sill from the Howse Lake area (from Findlay, 1996). Circles represent glomerocrysts (size exaggerated). Sill thickness is arbitrary.*

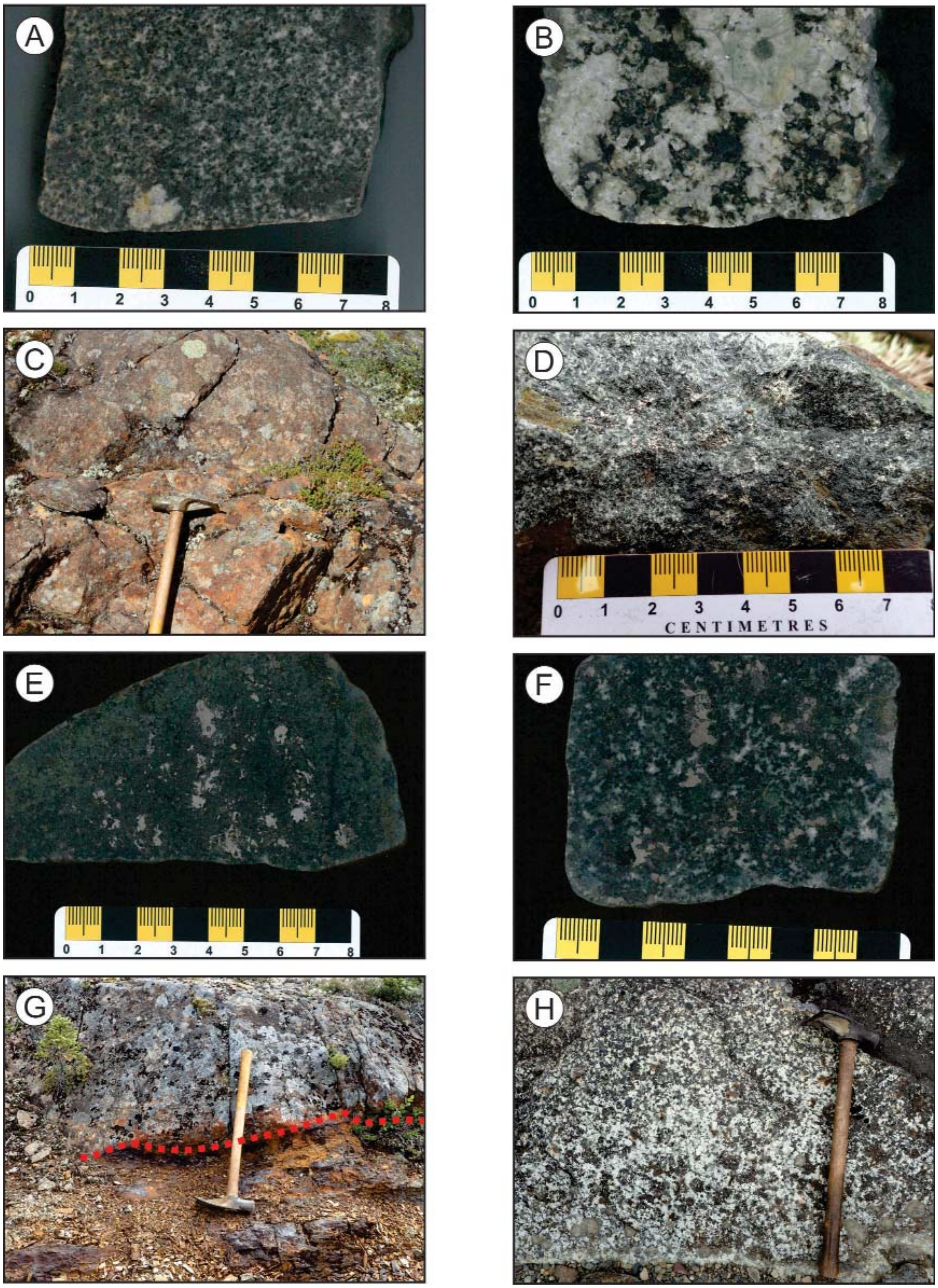

Plate 1. *Selected photographs from 2017 fieldwork. A) Weakly glomeroporphyritic gabbro sill from the Howse Lake area; B) Anorthositic phase of the Menihek Gabbro in the Howse Lake area, with abundant glomerocrysts; C) Rusty outcrop of mineralized gabbro in the Howse Lake area; D) Aphyric gabbro in the Howse Lake area, with abundant disseminated sulphides; E) Mineralized aphyric gabbro from the Howse Lake area, with blebby sulphides (dominantly pyrrhotite); F) Mineralized weakly glomeroporphyritic gabbro from the Howse Lake area, with blebby sulphides (dominantly pyrrhotite); G) Contact between sulphide-rich Menihek Formation sediments (bottom) and chilled margin of gabbro sill, from the Howse Lake area; H) Glomeroporphyritic Doublet Gabbro from the Moss Lake area, with ~3% interstitial sulphides (rusty patches).*

proportion of ultramafic cumulates are relatively minor. Findlay (1996) described two sills of Doublet Gabbro, consisting fine- to medium-grained gabbro that lack features attributable to *in-situ* differentiation, however, reconnaissance mapping of the Doublet Gabbro in the Moss Lake area have recorded thick sequences of glomeroporphyritic gabbro. The Doublet Gabbro in this area is indistinguishable from the Menihek Gabbro of the Hurst Zone.

Disseminated sulphides (<2% pyrrhotite and minor chalcopyrite) are common in the Doublet Gabbro, and massive sulphide mineralization has been reported from mafic–ultramafic sills in the Retty Lake area (Scott *et al.*, 1988).

SULPHIDE MINERALIZATION

Sulphide occurrences are widespread throughout the Hurst and Retty zones in western Labrador. Fieldwork focussed on sulphide occurrences in the Howse Lake and Moss Lake areas (Figures 1, 4 and 5). Samples were collected from both sulphide- and non-sulphide-bearing Montagnais Gabbro from both zones, as well as from shale-hosted sulphide occurrences in the Menihek and Thompson Lake formations.

HOWSE LAKE AREA

Outcrops examined in the Howse Lake area were all located in the Hurst Zone, consisting of a thick sequence of Menihek Gabbro that intrude sulphide-rich sediments assigned to the Menihek Formation (Figure 4). All samples of gabbro collected during this study contain trace to moderate sulphide contents, and local samples contain up to 20% coarse-grained pyrrhotite and chalcopyrite (Plate 1C–F). Sulphide mineralization is observed in both aphyric and glomeroporphyritic gabbro rocks. Mineralization within

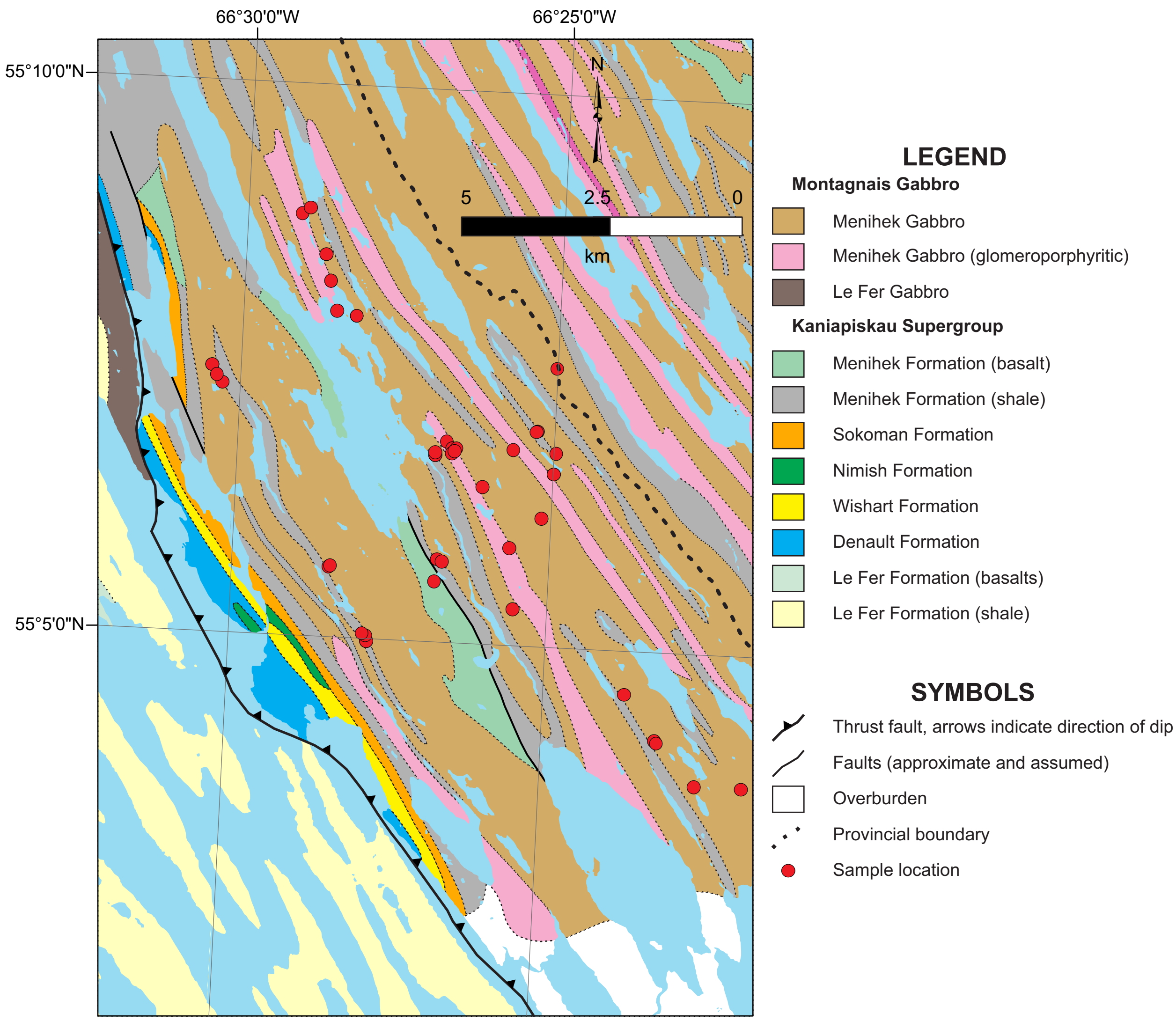

Figure 4. *Geological map of the Howse Lake area, showing sample locations (adapted from Wardle, 1982).*

aphyric gabbro sills is predominantly composed of finely disseminated pyrrhotite (± chalcopyrite and pentlandite), and blebby and rare net-textured pyrrhotite and chalcopyrite are observed in samples with higher sulphide contents. Samples from near the chilled margins of the sills display globular droplets up to 5 mm in diameter. Glomeroporphyritic gabbros contain sulphide mineralization within the hornblende and pyroxene groundmass between the plagioclase glomerocrysts.

Shale-hosted sulphide occurrences in the Howse Lake area have been described in detail by Swinden and Santaguida (1994). These occurrences are hosted in black argillite of the Menihek Formation, and mineralized beds can be traced along strike for up to 5 km. Mineralization is predominantly composed of pyrite and pyrrhotite, and minor to trace amounts of chalcopyrite and bornite, the latter identified by the peacock bloom observed after cutting the samples. The mineralized intervals contain up to 70% sulphides, occurring as stratabound sulphide horizons, finely disseminated sulphides, and millimetre-thick veinlets of pyrite and pyrrhotite that crosscut shale layers. The contact between sulphide-rich shales and the Menihek Gabbro can be locally observed (Plate 1G).

MOSS LAKE AREA

The Moss Lake area straddles the Hurst and Retty zones, which are separated by the Walsh Lake Fault (Figures 1 and 5). Although gabbro sills in the Hurst Zone are assigned to the Menihek Gabbro, and those in the Retty Zone to the Doublet Gabbro, they are virtually indistinguishable in the field. The gabbro sills are predominantly aphyric relative to gabbros in the Howse Lake area, and generally contain <5% glomerocrysts. Glomeroporphyritic gabbro, containing >50% glomerocrysts, was only observed at

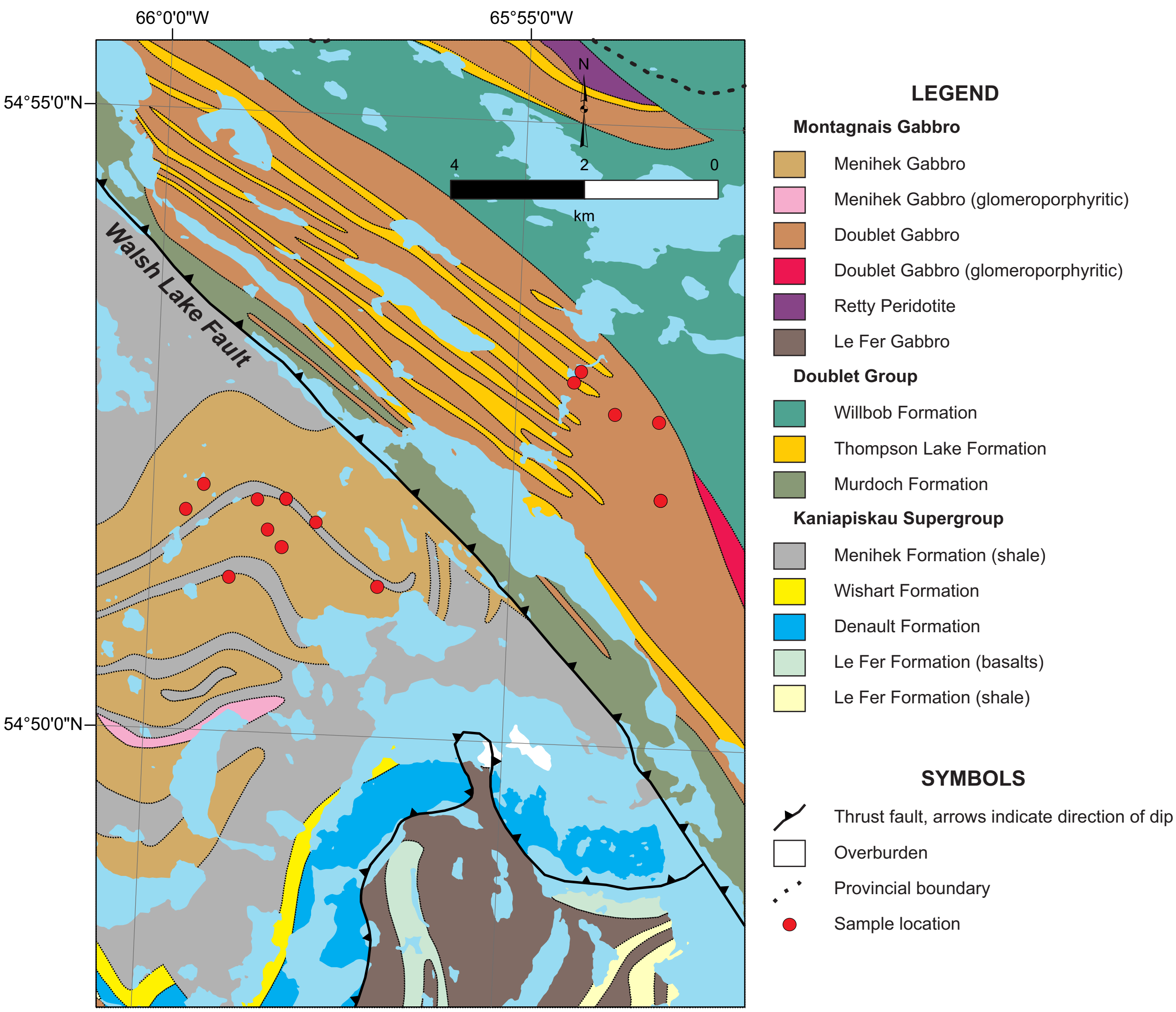

Figure 5. *Geological map of the Moss Lake area, showing sample locations (adapted from Wardle, 1982).*

one location in the Retty Zone. The aphyric gabbro sills only contain trace amounts of sulphide mineralization, and rare samples contain up to 3% finely disseminated sulphides (pyrrhotite and minor chalcopyrite). One location of glomeroporphyritic gabbro contains more sulphide mineralization (3–5%, Plate 1H) than aphyric gabbro, and locally composed of equal parts pyrrhotite and chalcopyrite. Locally, the sills are also moderately altered, and the altered gabbro samples contain more sulphides than unaltered aphyric samples. More altered gabbros are commonly crosscut by thin (<5 mm) calcite and quartz veinlets with trace sulphides.

Shale-hosted sulphide occurrences have been reported from both the Menihek Formation shales of the Hurst Zone and the Thompson Lake Formation shales of the Retty Zone. These occurrences are similar to shale-hosted sulphide occurrences of the Howse Lake area, and can be traced along strike for a number of kilometres.

PETROLOGY

Thirty-three representative samples were selected for petrographic analysis; represented by twenty-three gabbro and two sediment samples from the Howse Lake area and six gabbro and two sediment samples from the Moss Lake area. These samples represent the main rock types, and are both sulphide-rich and sulphide-poor. Polished thin sections were produced by Memorial University of Newfoundland's lapidary services, and analysed using a Nikon Eclipse 50iPOL, located in the Department of Earth Sciences at Memorial University. The following is a short petrographic description of gabbro samples from the Howse Lake and Moss Lake areas.

HOWSE LAKE

The mineral assemblage in Menihek Gabbro from the Howse Lake area is dominated by medium-grained, subhedral to euhedral plagioclase and clinopyroxene, and lesser amounts of hornblende, olivine, and oxide and sulphide minerals. Plagioclase glomerocrysts composed of subhedral to euhedral aggregates of plagioclase crystals, comprise up to 50% of some samples, and these samples also contain significant amounts of interstitial hornblende. Olivine is interstitial to plagioclase glomerocrysts in some mineralized samples (Plate 2A). Oxide minerals are generally minor, but some samples contain up to 30% magnetite and ilmenite. The gabbroic rocks commonly display poikilitic textures, with euhedral plagioclase in clinopyroxene oikocrysts (Plate 2B).

Sulphide mineralization is predominantly composed of pyrrhotite and chalcopyrite (Plate 2C), and lesser amounts of pentlandite. Sulphides generally occur as finely disseminated crystals in the silicates, or as interstitial, blebby and locally net-textured sulphides. Euhedral plagioclase crystals containing minor chalcopyrite were also recorded in the groundmass of some glomeroporphyritic gabbro samples, which may represent xenocrysts from a previously crystallized sill.

MOSS LAKE

Menihek and Doublet gabbros from the Moss Lake area are commonly altered. Aphyric, to weakly glomeroporphyritic samples are dominated by plagioclase, hornblende, and epidote, with minor to trace amounts of chlorite and crosscutting veinlets of hornblende and epidote. Minor oxide minerals (magnetite having minor to trace amounts of ilmenite) were also recorded in some samples. Glomeroporphyritic gabbro is less altered, with plagioclase glomerocrysts and a groundmass of hornblende with minor plagioclase and clinopyroxene.

Altered aphyric to weakly glomeroporphyritic samples contain minor amounts of sulphide mineralization, predominantly pyrrhotite containing minor amounts of chalcopyrite. Pyrrhotite occurs as fine disseminations throughout, whereas coarser grained pyrrhotite and chalcopyrite are associated with the altered glomerocrysts, or are hosted in crosscutting veinlets. Sulphide mineralization within unaltered glomeroporphyritic gabbro consists of chalcopyrite and pyrrhotite with minor amounts pentlandite as exsolutions from pyrrhotite (Plate 2D).

CONCLUSIONS AND FUTURE RESEARCH

The Ni–Cu–PGE potential of Montagnais Gabbro in the Hurst and Retty zones of the Labrador Trough has been recognized since the 1950s, and recent exploration results from the Huckleberry Prospect in Québec (Vaillancourt *et al.*, 2016) have highlighted the potential for new discoveries in this underexplored region. Fieldwork in 2017 has identified sulphide mineralization in aphyric and glomeroporphyritic gabbro sills from the Howse Lake and Moss Lake areas, with local samples containing up to 20% coarse-grained pyrrhotite and chalcopyrite and minor pentlandite.

This research on sulphide mineralization in the Montagnais Gabbro forms part of an ongoing B.Sc. (Hons.) project by the senior author at Memorial University of Newfoundland. Whole-rock geochemistry, including Pt, Pd and Au assay data, will be used to quantify any enrichment in Ni–Cu–PGE in sulphide-rich gabbro samples. In addition, this data will be used to assess the potential of these gabbro sills to host economically significant base-metal occurrences. Mineralized gabbro samples from the Howse Lake

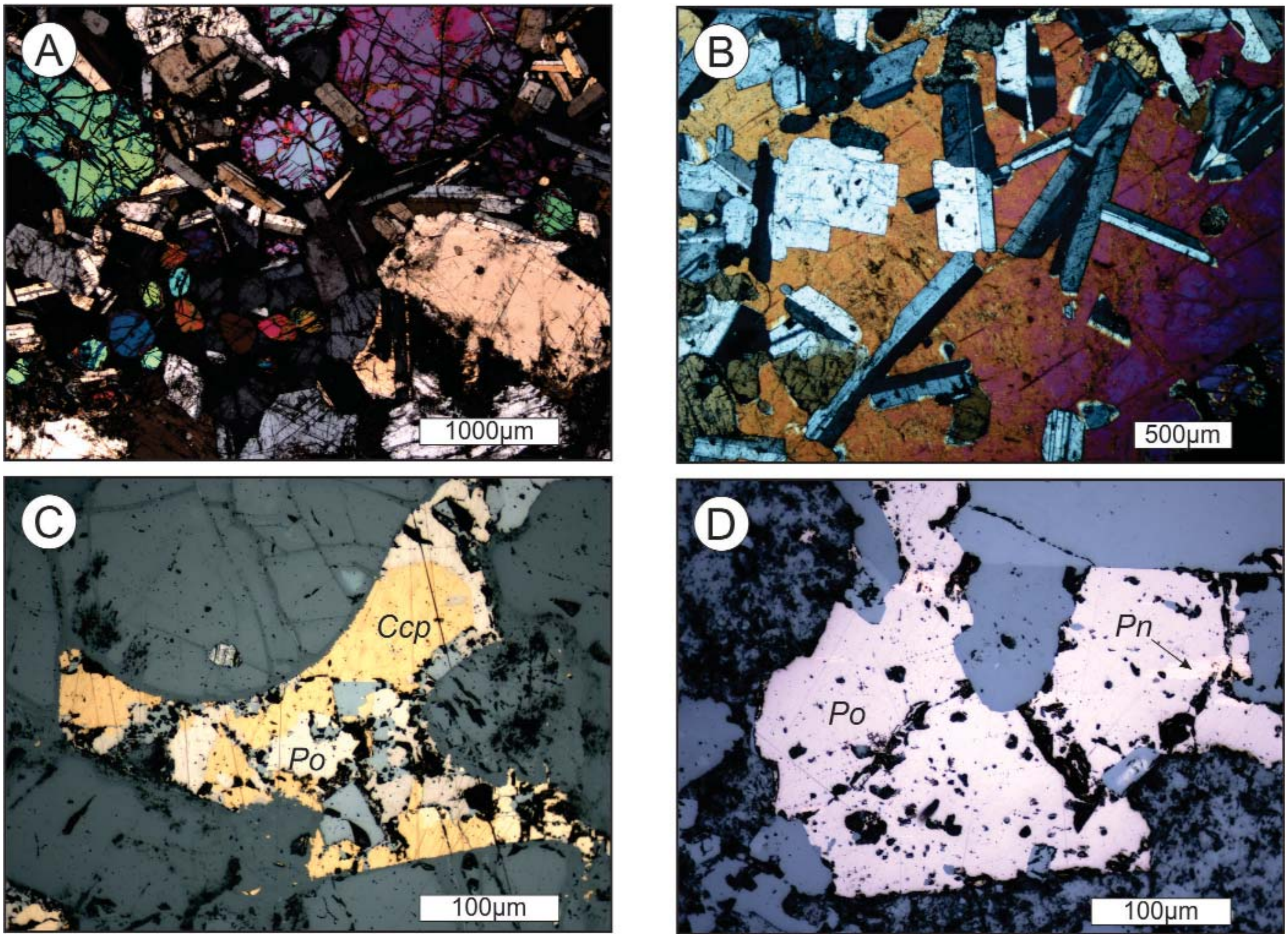

Plate 2. *Photomicrographs of gabbro samples from the Howse Lake and Moss Lake areas. A) Silicate mineral assemblage from weakly glomeroporphyritic gabbro in the Howse Lake area, with subhedral to euhedral plagioclase, clinopyroxene and olivine; B) Poikilitic texture in gabbro from the Howse Lake area, with euhedral plagioclase in clinopyroxene oikocryst; C) Interstitial pyrrhotite (Po) and chalcopyrite (Ccp) in mineralized gabbro from the Howse Lake area; D) Interstitial pyrrhotite (Po) with minor pentlandite (Pn) from groundmass of glomeroporphyritic gabbro in the Moss Lake area.*

and Moss Lake areas have been selected for analysis by Scanning Electron Microscope–Mineral Liberation Analyzer (SEM–MLA). This will provide detailed petrographic information on sulphide minerals, and will assist in locating and identifying platinum-group minerals (PGM's) and determining their relationship with sulphide and silicate minerals. Secondary Ion Mass Spectrometry (SIMS) will be used to determine the sulphur isotope ($\delta^{34}S$) values of sulphide minerals in mineralized gabbros and sulphide-rich shales proximal to the gabbro sills, which will provide insight into the source of sulphur and the amount of contamination related to the melting of the host shales. The petrography, geochemistry and sulphur isotope data from mineralized gabbros in the Howse Lake and Moss Lake areas will also be compared with data from Ni–Cu–PGE-enriched samples from samples collected during 2017 fieldwork from the Huckleberry Prospect in Québec.

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