# GS-5 Granitoid rocks in the Lynn Lake region, northwestern Manitoba: preliminary results of reconnaissance mapping and sampling

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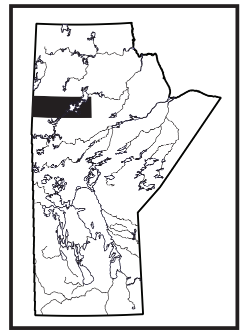

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## Summary

In 2015, the Manitoba Geological Survey continued its project to investigate the petrogenesis and metallogeny of granitoid rocks throughout Manitoba. Initiated the spring of 2014, the main objectives of this project are to identify the various petrogenetic types of granitoid rocks in Manitoba and to investigate their geodynamic settings and mineralization potential. This report presents the preliminary results of fieldwork conducted in the Lynn Lake region. Granitoid rocks were examined and sampled to document field relationships, textures (fabrics), mineral assemblages, magnetic susceptibilities (MS), and presence of mineralization and/or alteration.

This study indicates that muscovite- and/or garnet-bearing granitic rocks characterized by low MS values ($<0.1 \times 10^{-3}$ SI units; i.e., strongly peraluminous S type, or ilmenite series) were intruded mainly into domain boundaries, which may thus serve as a useful criterion for recognizing major tectonic or domain boundaries. These peraluminous granitic rocks may have formed in crust thickened as a result of terrane assembly and/or continental collision, and may have potential to host rare-metal and (or) Sn-W mineralization. In contrast, plutons consisting of quartz diorite, tonalite, granodiorite and granite are characterized by higher MS values ($>0.1 \times 10^{-3}$ SI units) and mineral assemblages typical of I-type granitoid rocks (e.g., amphibole±biotite or biotite±amphibole). Such plutons are abundant across the region, suggesting that this magmatism contributed significantly to crustal growth in the Trans-Hudson orogen, and may have been related to subduction tectonics.

It is worth noting that I-type or magnetite-series granitoid intrusions may have potential to host porphyry Cu, Au and Mo mineralization. In addition, subordinate A-type granitoid plutons in the region, characterized by relatively oxidized features (e.g., MS $>0.5 \times 10^{-3}$ SI units) and by the presence of sodic amphibole (±sodic pyroxene), likely emplaced in extensional settings, have potential for rare-metal (e.g., Nb, Ta) mineralization.

## Introduction

Granitoid rocks are the most abundant rock type in the Precambrian Canadian Shield, including the Lynn Lake region (Manitoba Energy and Mines, 1986; Baldwin et al., 1987; Hollings and Ansdell, 2002; Beaumont-Smith and Böhm, 2004). These rocks often preserve primary geochemical signatures that can be used in studies of their petrogenesis, sources, tectonic settings and mineral potential. I-type granite, originating from igneous sources, (Chappell and White, 1974, 1992, 2001) usually displays oxidized features with high MS values, consistent with magnetite-series granite (Ishihara, 1977, 1981, 2004), and potential for Cu-Mo-(Au) mineralization (Blevin and Chappell, 1995; Blevin, 2004). In contrast, S-type granite, sourced from sedimentary rocks (Chappell and White, 1974, 1992, 2001), commonly exhibits reduced features and low MS values, consistent with ilmenite-series granite (Ishihara, 1977, 1981, 2004), and is commonly related to Sn-W and rare-metal (e.g., Nb, Ta, rare earths, Y) mineralization (Blevin, 2004). Furthermore, alkaline A-type granite, formed in anorogenic tectonic settings, is usually characterized by relatively oxidized features and may have potential for generating rare-metal minerals (e.g., Whalen et al., 1987; Winter, 2009). Such generalizations can be useful in mineral exploration. There are some exceptions to these generalizations, however, such as reduced I-type ilmenite-series granitic rocks that are potentially related to intrusion-related Au mineralization (Lang and Baker, 2001; Blevin, 2004; Yang et al., 2008).

This report presents the preliminary results of reconnaissance mapping and sampling of granitoid rocks in the Lynn Lake greenstone belt (LLGB) and adjacent domains in northwestern Manitoba. Petrographic examination and whole-rock geochemical analysis of 46 samples collected in 2015 are ongoing and will be reported in future publications.

## Methods

Granitoid rocks were examined and sampled in the field to document field relationships, textures (fabrics), mineral assemblages, MS and presence of mineralization and/or alteration. A Terraplus Inc. KT-10 magnetic-susceptibility meter[1] was used with a pin to measure MS values of glaciated outcrops and fresh exposures in roadcuts; each rock type was measured in at least five locations and the average of the measurements was recorded to represent the MS value. Outcrops were sampled using

[1] The measurement range of magnetic susceptibility (MS) is $0.001 \times 10^{-3}$ to $1999.99 \times 10^{-3}$ SI units. The values of MS readings in Yang (2014) should therefore be read as ‘number $\times 10^{-3}$ SI’; for example, ‘$0.050 \times 10^{3}$ SI’ should be ‘$0.050 \times 10^{-3}$ SI’.

a rock saw or sledgehammer for laboratory study. The MS values were used to distinguish relatively oxidized and reduced granitoid rocks and, together with mineral assemblages, to classify the petrogenetic types of granitoid rock. A compilation of the main characteristics of I- and S-type granitoid rocks, including magnetite and ilmenite series, for the granitoid rocks in southeastern Manitoba can be found in Yang (2014).

## Geological setting

The LLGB in northwestern Manitoba is well known for its endowment in orogenic Au, magmatic Ni-Cu and volcanogenic Cu-Zn deposits, and it is an important tectonic element of the Lynn Lake–Leaf Rapids domain in the Reindeer zone of the Trans-Hudson orogen (Stauffer, 1984; Hoffman, 1988; Lewry and Collerson, 1990; Zwanzig and Bailes, 2010). The LLGB is bounded to the north by the Southern Indian domain (a mixed metasedimentary and metaplutonic domain) and the Chipewyan domain (a continental-arc granitoid batholith); to the south, it is bounded by the metasedimentary Kisseynew domain (Figure GS-5-1; Gilbert et al., 1980; Syme, 1980; Zwanzig et al., 1999; Beaumont-Smith and Böhm, 2004; Corrigan et al., 2007, 2009; Zwanzig and Bailes, 2010).

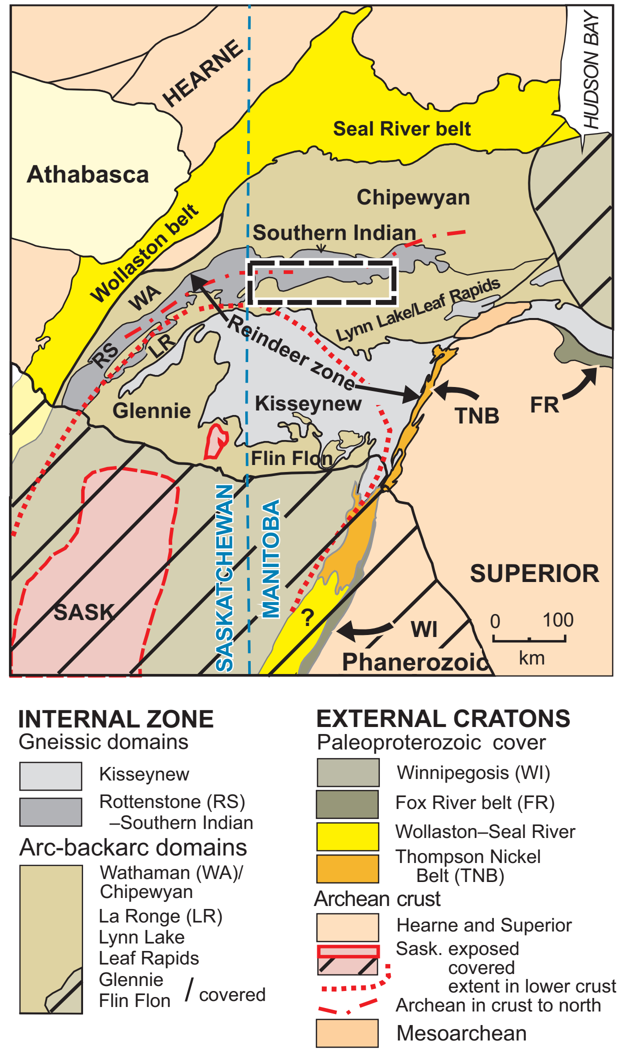


***Figure GS-5-1**: Simplified geology of the Trans-Hudson orogen in Manitoba and northeastern Saskatchewan, showing the major lithotectonic domains of the internal (Reindeer) zone of the Trans-Hudson orogen, Archean cratons and their Paleoproterozoic cover (external zones; after Zwanzig and Bailes, 2010). Dashed box indicates location of Figure GS-5-2.*

## Field descriptions of granitoid rocks

The locations of granitoid plutons described in this report are shown in Figure GS-5-2. In this report, the main features of these granitoid plutons are summarized, progressing in general from west to east, with a summary provided in Table GS-5-1.

### *Granitoid rocks in the Southern Indian domain*

Granitoid rocks examined and sampled in the Southern Indian domain (SID) include gneissic granodiorite of the Vandekerckhove Lake pluton (locality 1); quartz diorite, granodiorite and leucogranite of the Zed Lake pluton (locality 2); and pegmatitic granite and pegmatite of the Little Brightsand Lake pluton (locality 3; Figure GS-5-2; Table GS-5-1).

The Vandekerckhove Lake pluton is composed dominantly of gneissic granite to granodiorite, locally cut by late pegmatite and aplite dikes. The gneissic granite (Figure GS-5-3a) is medium grained and equigranular, and consists of 30–35% quartz, 30–35% Kfeldspar, 20–25% plagioclase, 1–5% biotite (locally up to 10% in mafic-rich bands) and minor amphibole. This granite generally exhibits consistent MS values of 1.52–3.27 × $10^{-3}$ SI, comparable to magnetite-series granite (Ishihara, 1977, 1981, 2004) in terms of MS values and to I-type granitoid rocks (Chappell and White, 1974, 1992) on the basis of mineral assemblages (i.e., biotite±amphibole).

The Zed Lake pluton is a composite pluton comprising quartz diorite, tonalite, granodiorite, and leucogranite, cut by muscovite (±garnet)–bearing pegmatite dikes. Quartz diorite is grey on fresh surfaces and weathers beige to pale grey. It is medium to coarse grained, massive, equigranular and locally porphyritic, and consists of 10–15% quartz, 15–20% biotite (pseudomorphic after hornblende) and amphibole, and 60–70% plagioclase (Figure GS-5-3b); disseminated pyrite is locally present. The tonalite phase contains more quartz than the quartz diorite, but the modal percentages of the other mineral phases are similar. Granodiorite is widespread along the shore of Zed Lake and consists of 25–28% quartz, 35–45% plagioclase, 15–25% K-feldspar and 5–10% biotite. Very coarse grained to pegmatitic leucogranite (Figure GS-5-3c), which occurs locally, consists dominantly of quartz and feldspar, with minor muscovite (±garnet) and rare biotite. Pegmatite

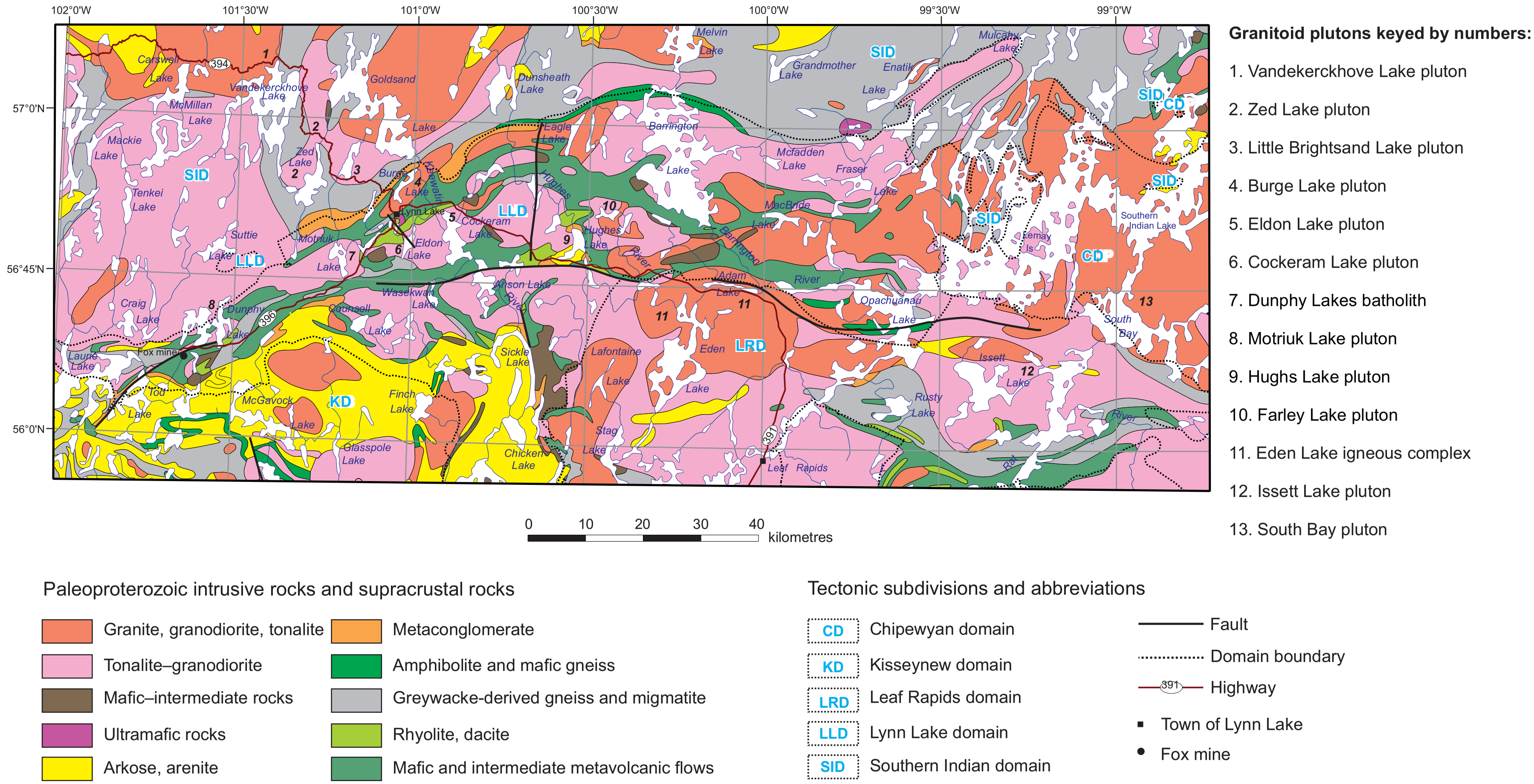


***Figure GS-5-2:*** *Simplified geology of the Lynn Lake greenstone belt and adjacent domains, showing the dominance of granitoid rocks in the region. Numbered granitoid plutons or batholiths are referred to in the text. Nomenclature of tectonic entities or domains modified from Manitoba Energy and Mines (1986) and Zwanzig and Bailes (2010).*

**Table GS-5-1:** Main features of granitoid rocks in the Lynn Lake region, northwestern Manitoba.

| Tectonic unit | Pluton | | MS (x $10^{-3}$ SI) | Index minerals | Petrogenetic types |
|---|---|---|---|---|---|
| | Name | No.[1] | | | |
| Southern Indian domain (SID) | Vandekerckhove Lake pluton | 1 | 1.51–3.27 | Biotite, ±amphibole | Magnetite series, I type |
| | Zed Lake pluton | 2 | 0.30–14.1 | Amphibole, biotite | Magnetite series, I type; |
| | | 2 | 0.021–0.033 | Biotite, ±muscovite, and ±garnet | part of the Zed Lake pluton belonging to ilmenite series, S type |
| | Little Brightsand Lake pluton | 3 | 0.018–0.029 | Muscovite, garnet, ±biotite | Ilmenite series, S type |
| Lynn Lake domain (LLD) | Burge Lake pluton | 4 | 0.272–18.0 | Biotite, amphibole | Magnetite series, I type |
| | Corkeram Lake pluton | 5 | 0.318–32.9 | Biotite, amphibole | Magnetite series, I type |
| | Eldon Lake pluton | 6 | 0.357–12.9 | Biotite, amphibole | Magnetite series, I type |
| | Motriuk Lake pluton | 7 | 0.294–7.60 | Biotite, amphibole | Magnetite series, I type |
| | Dunphy Lakes batholith | 8 | 0.136–2.90 | Amphibole, biotite | Magnetite series, I type |
| | Hughes Lake pluton | 9 | 2.49–17.2 | Amphibole, biotite | Magnetite series, I type |
| | Farley Lake pluton | 10 | 0.098–0.154 | Amphibole, biotite | Ilmenite series, reduced to normal I type |
| Leaf Rapids domain (LRD) | Eden Lake pluton | 11 | 0.605–19.9 | Amphibole, biotite | Magnetite series, I type |
| | Issett Lake pluton | 12 | 0.046–0.085 | Muscovite, garnet, ±biotite | Ilmenite series, S type |
| | | 12 | 0.215–1.25 | Amphibole, biotite | Magnetite series, I type |
| Chipewyan domain (CD) | South Bay intrusion | 13 | 55.0–72.9 | Amphibole, biotite | Magnetite series, I type |

[1] See Figure GS-5-2.

dikes and sheets are common in the Zed Lake pluton. Rafts of recrystallized fine-grained greywacke (consisting of quartz, feldspar and biotite) up to 2 m in length commonly occur within the pegmatite, similar to the Little Brightsand Lake pluton that comprises pegmatitic granite (Figure GS-5-3d) and pegmatite-bearing muscovite and/or garnet. Interestingly, the major granitoid phases of the Zed Lake pluton display a range of MS values from 0.30 to 14.1 × $10^{-3}$ SI (Table GS-5-1), consistent with typical magnetite-series or normal I-type granite elsewhere. The leucogranite, however, has much lower MS values of 0.021–0.033 × $10^{-3}$ SI, which are compatible with those of ilmenite-series and S-type granites.

A sample of two-mica tonalite from the Zed Lake pluton was dated at 1785 ±1.5 Ma[2] (Beaumont-Smith and Böhm, 2002), much younger than the pre-Sickle (or Pool Lake) intrusive suite stitches the northern and southern belts of LLGB (Milligan, 1960; Gilbert et al., 1980; Baldwin et al., 1987; Zwanzig et al., 1999). This two-mica tonalite could be related to the S-type or ilmenite-series phases of the Zed Lake pluton, as indicated by the presence of muscovite. A garnet-bearing tonalite–monzogranite at Southern Indian Lake was dated at 1846 ±3 Ma by Rayner and Corrigan (2004), suggesting an age range of ca. 1846–1785 Ma for the emplacement of strongly peraluminous S-type granite in the SID.

## *Granitoid rocks in the Lynn Lake domain*

Granitoid rocks from the LLGB, a major component of the Lynn Lake domain (LLD; Figure GS-5-2), have been partly mapped and described by the MGS (Gilbert et al., 1980; Yang and Beaumont-Smith, GS-4, this volume). The plutons that are the focus of this report are the Burge Lake, Cockeram Lake, Eldon Lake and Motriuk Lake plutons; the Dunphy Lakes batholith; and the Hughes Lake and Farley Lake plutons (localities 4–10, respectively, in Table GS-5-1 and Figure GS-5-2). These rocks are divided into pre-Sickle (or Pool Lake) and post-Sickle intrusive suites based on their temporal relationships to the syntectonic molasse–type sedimentary rocks of the Sickle group (Milligan, 1960; Gilbert et al., 1980; Baldwin et al., 1987; Zwanzig et al., 1999; Beaumont-Smith and Böhm, 2004).

### Burge Lake pluton (locality 4)

The Burge Lake pluton (Figure GS-5-2) consists mainly of granodiorite and intrudes the Wasekwan group in the west and the Ralph Lake conglomerate. This pluton was dated at 1857 ±2 Ma (Beaumont-Smith et al., 2006) and is thus assigned to the post-Sickle intrusive suite (Yang and Beaumont-Smith, GS-4, this volume). The granodiorite is foliated, medium to coarse grained, equigranular and locally porphyritic (Figure GS-5-4a). It is typically

[2] Ages mentioned in this report were all determined by zircon U-Pb geochronology.

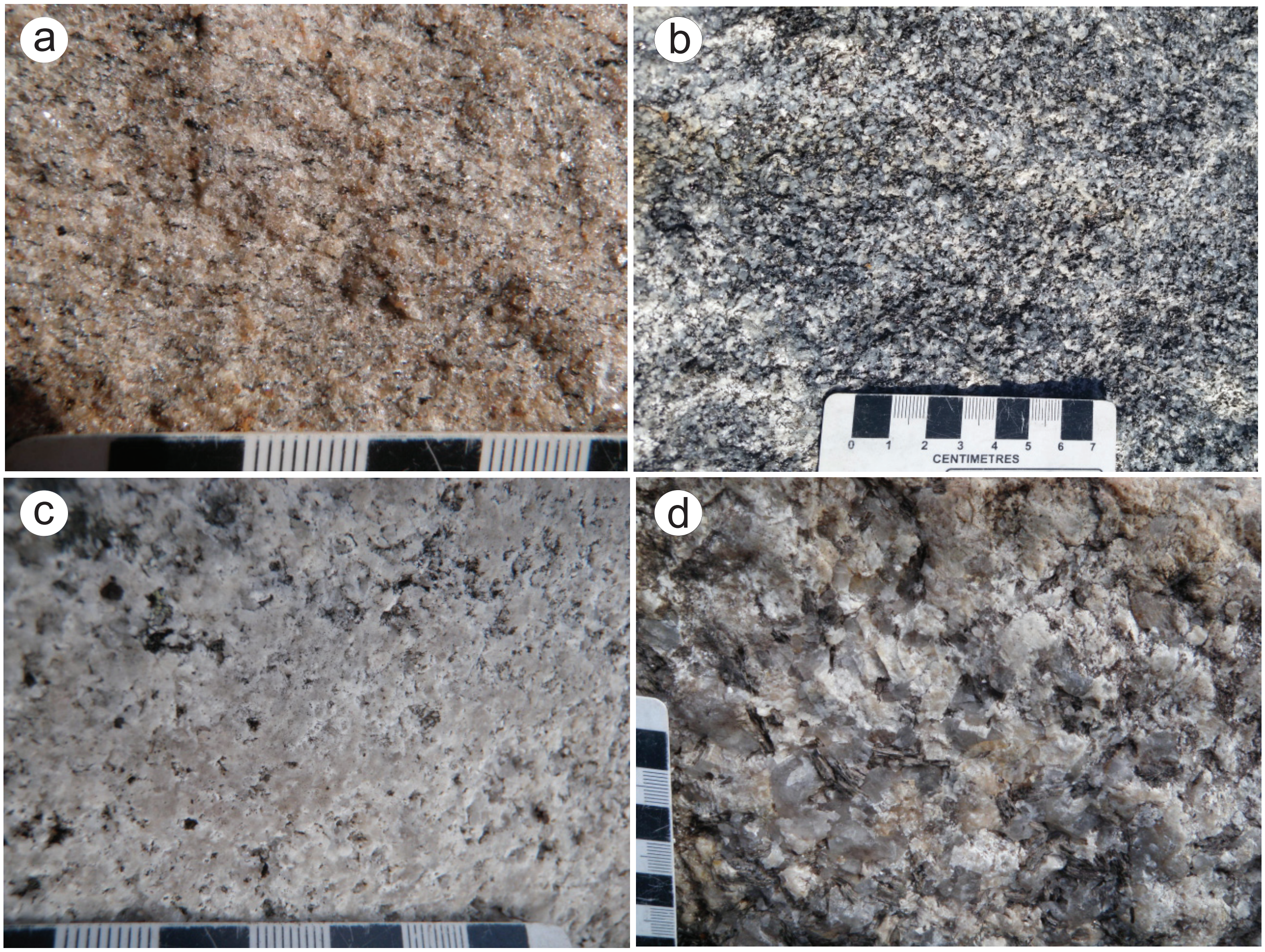


***Figure GS-5-3**: Field photographs of granitoid rocks from the Southern Indian domain: **a)** medium-grained granite with weak gneissic fabric, Vandekerckhove Lake pluton (UTM Zone 14, 353570E, 6329018N, NAD 83); **b)** medium-grained quartz diorite, Zed Lake pluton (UTM 363749E, 6314690N); **c)** coarse-grained leucogranite, Zed Lake pluton (UTM 361293E, 6315643N); and **d)** pegmatitic muscovite granite, Little Brightsand Lake pluton (UTM 367736E, 6312308N)*

composed of 10–15% biotite (3–5 mm), 35–45% subhedral to euhedral plagioclase laths (3–8 mm), 10–15% pinkish K-feldspar, 25–30% anhedral or subrounded quartz (2–5 mm) and accessory minerals, including magnetite, zircon, apatite and titanite. Hornblende is mostly replaced by biotite. Sericitic and chloritic alteration of feldspar and biotite, respectively, is common. The granodiorite at Burge Lake displays a range of MS values ranging from 0.272 to 12.6 × $10^{-3}$ SI, and locally up to 18.0 × $10^{-3}$ SI (Table GS-5-1), suggesting that it is a normal I-type (Chappell and White, 1974, 1992) or magnetite-series (Ishihara, 1981; Yang and Beaumont-Smith, GS-4, this volume) granite.

### Cockeram Lake composite granitoid pluton (locality 5)

The Cockeram Lake composite granitoid pluton (Figure GS-5-2), intruding the Wasekwan group, is attributed to the pre-Sickle intrusive suite, which was dated at 1876 +8/–6 Ma by Baldwin et al. (1987) and stitches the northern and southern belts of the LLGB. This pluton contains a range of rock types, including quartz diorite, tonalite, granodiorite and granite. In places, the granodiorite intrudes quartz diorite (Figure GS-5-4b) and tonalite, and is intruded by more evolved granite. The granodiorite is pinkish grey, medium to coarse grained, equigranular to locally porphyritic and foliated. Xenoliths of mafic to intermediate volcanic rocks are commonly present. The granodiorite consists of 20–25% anhedral quartz (0.5–0.8 mm), 25–35% subhedral plagioclase laths (5–12 mm), 20–25% K-feldspar (10–12 mm) and 10–15% hornblende (0.5–1 mm; mostly altered to biotite), along with accessory Fe-oxide minerals. It has MS values of up to 17.5 × $10^{-3}$ SI, which are lower than quartz diorite (up to 32.9 × $10^{-3}$ SI) and typical of the I-type granite of Chappell and White (1974) or magnetite-series granite of Ishihara (1981). The granodiorite is cut by a fine- to medium-grained granite that contains up to 35% quartz but less than 10% biotite, and has much lower MS values (near 0.63 × $10^{-3}$ SI), also typical of I-type or magnetite-series granite (Yang and Beaumont-Smith, GS-4, this volume).

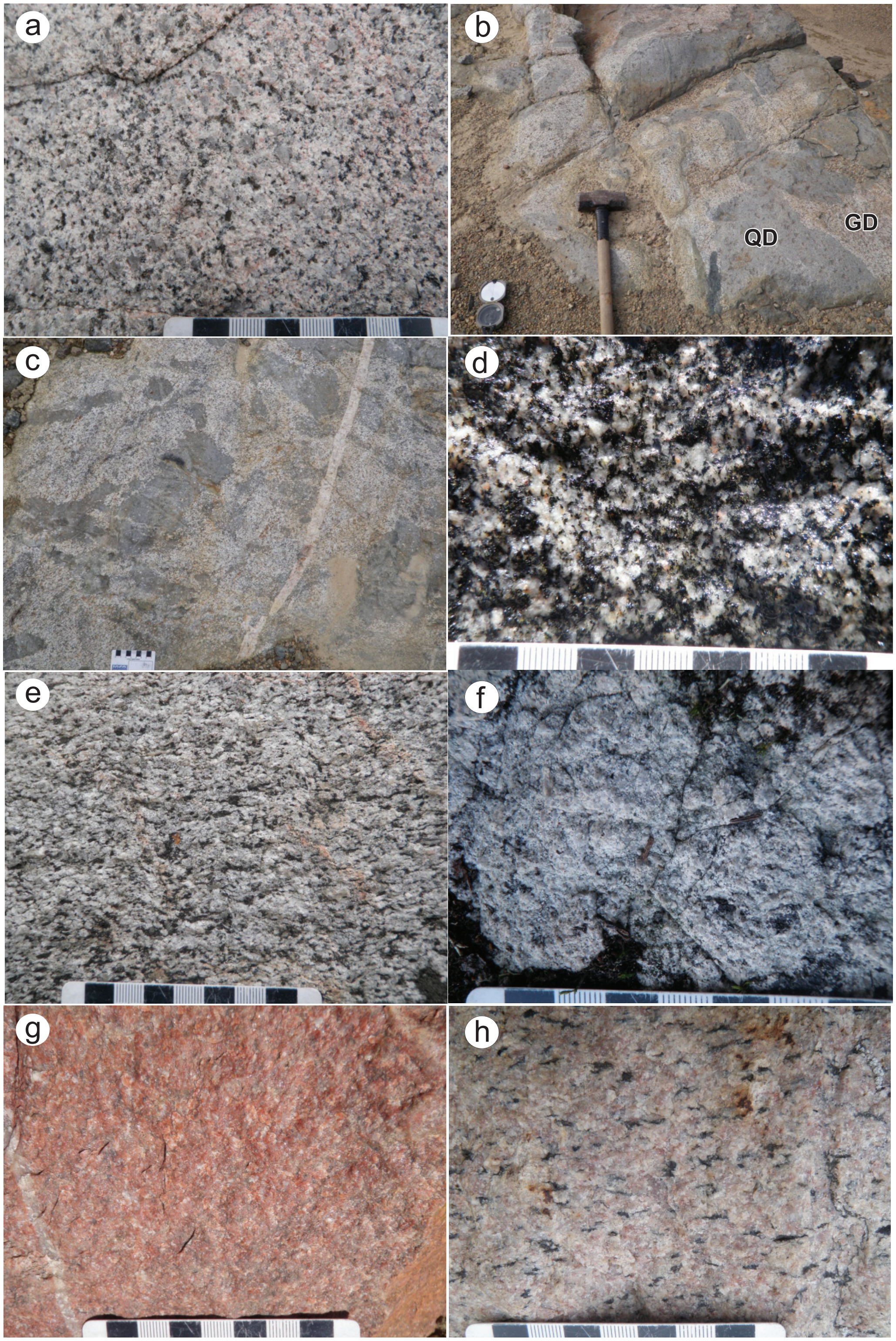


***Figure GS-5-4****: Field photographs of granitoid rocks from the Lynn Lake domain:* ***a****) medium- to coarse-grained granodiorite, Burge Lake pluton (UTM Zone 14, 375947E, 6307963N, NAD 83);* ***b****) intrusion breccia, consisting of granodiorite (GD) intruding quartz diorite (QD), Cockeram Lake pluton (UTM 386832E, 6303025N);* ***c)*** *medium-grained tonalite with irregular xenoliths of plagioclase-phyric basalt cut by a late, thin pegmatite dike, Eldon Lake pluton (UTM 3757761E, 6298253N);* ***d****) medium-grained tonalite, Motriuk Lake pluton (UTM 365499E, 6295322N);* ***e)*** *foliated medium-grained granodiorite, Dunphy Lake batholith (UTM 345251E, 6288790N);* ***f****) porphyritic granite, Hughes Lake pluton (UTM 406205E, 6298477N);* ***g****) fine- to medium-grained quartz syenite, Hughes Lake pluton (UTM 408236E, 6294050N); and* ***h****) foliated coarse-grained granodiorite, Farley Lake pluton (UTM 411174E, 6301508N).*

#### Eldon Lake pluton (locality 6)

The Eldon Lake pluton (Figure GS-5-2) is a component of the pre-Sickle intrusive suite. This pluton contains tonalite, quartz diorite and minor quartz monzonite. The tonalite weathers pale grey to beige and is grey on fresh surfaces. It is medium to coarse grained, equigranular and locally porphyritic, and consists of 10–15% amphibole that is replaced mostly by biotite, 20–25% quartz (5–7 mm, locally up to 10 mm), 60–65% plagioclase and minor K-feldspar (<5%). In places, many irregular xenoliths of fine-grained plagioclase-phyric basalt are present in the tonalite (Figure GS-5-4c). These xenoliths are texturally similar to plagioclase-phyric basalt in the LLGB (Yang and Beaumont-Smith, GS-4, this volume). The Eldon Lake pluton displays MS values of 0.357–12.9 × $10^{-3}$ SI, consistent with relatively oxidized I-type (Chappell and White, 1974, 1992) and magnetite-series (Ishihara, 1977, 1981) granite.

#### Motriuk Lake pluton (locality 7)

The Motriuk Lake pluton (Figure GS-5-2) is composed dominantly of medium- to coarse-grained tonalite (Figure GS-5-4d) that is locally cut by fine-grained granite dikes. The tonalite consists of 20–25% biotite (pseudomorph after hornblende) and minor amphibole relicts, 20–25% quartz (3–5 mm), 50–55% plagioclase and minor K-feldspar (<10%). It is noted that some biotite is altered to chlorite and magnetite, and some plagioclase crystals in fractures are stained to a reddish colour. The fine-grained granite contains 5–10% biotite, 30–35% quartz, 40–45% K-feldspar and 10–20% plagioclase. The MS measurements indicate that both tonalite and granite in the Motriuk Lake pluton are relatively oxidized, with MS values of 0.94–7.60 × $10^{-3}$ SI, typical of I-type and magnetite-series granites (Table GS-5-1).

#### Dunphy Lakes batholith (locality 8)

The Dunphy Lakes batholith (Figure GS-5-2) consists mainly of granodiorite and tonalite, which intruded the boundary of the LLD and SID. Two tonalite samples taken from the eastern portion of Dunphy Lakes yielded ages of 1847 ±2 Ma and 1829 ±2 Ma (Beaumont-Smith and Böhm, 2003), suggesting that this batholith is a post-Sickle intrusion emplaced over a time interval of ca. 18 m.y. The granodiorite is medium grained, foliated and equigranular (locally porphyritic), and consists of 20–25% quartz (3–4 mm), 45–55% plagioclase, 10–15% K-feldspar and 10–15% biotite (Figure GS-5-4e). The tonalite, however, contains notable amphibole relicts (up to 5%) in the ferromagnesian minerals (15–20%; dominated by biotite and hornblende). This rock also contains 20–25% quartz, 50–60% plagioclase and minor K-feldspar (<10%). The granodiorite and tonalite at Dunphy Lakes display MS values of 0.136–2.90 × $10^{-3}$ SI, consistent with I-type or magnetite-series granite (Table GS-5-1).

#### Hughes Lake pluton (locality 9)

The Hughes Lake pluton (Figure GS-5-2) comprises mainly granite and quartz diorite, and is locally intruded by quartz syenite dikes. This pluton intrudes dark green aphyric basalt with disseminated pyrrhotite in the northern belt of LLGB, and is unconformably overlain by polymictic conglomerate and arkosic sandstone of the Sickle group. A quartz diorite sample from the Hughes Lake pluton yielded an age of 1876 +8/–7 Ma (Baldwin et al., 1987), identical to that of the Cockeram Lake pluton, which has been assigned to the pre-Sickle intrusive suite. The granite at Hughes Lake is medium grained and equigranular to porphyritic (Figure GS-5-4f). It is pinkish on fresh surfaces and consists of 2–3% biotite, 30–35% quartz, 55–60% K-feldspar and 5–10% plagioclase. Locally, chlorite veinlets occur along cleavage planes in the granite. It is noted that late-stage reddish quartz syenite dikes locally intrude the pluton and the volcanic country rocks. The quartz syenite (Figure GS-5-4g) is fine to medium grained and consists of 10–15% quartz (0.1–1 mm, locally up to 4 mm), 80–85% K-feldspar and 1–2% magnetite (0.2–0.3 mm). Locally, narrow veinlets (<1 mm wide) of quartz, pyrite, ±magnetite±biotite occur in the quartz syenite dikes, which have MS values of up to 17.2 × $10^{-3}$ SI. The Hughes Lake granite displays consistent MS values of 2.49–3.00 × $10^{-3}$ SI, typical of I-type and magnetite-series granite.

#### Farley Lake pluton (locality 10)

The Farley Lake pluton (Figure GS-5-2) consists dominantly of granodiorite and intrudes volcanic rocks in the northern belt of LLGB. The granodiorite is pinkish on fresh surfaces and weathers beige to tan. It is medium to coarse grained, foliated and equigranular to locally porphyritic. The Farley Lake granodiorite consists of 5–8% hornblende (partly altered to biotite), 25–27% quartz, 30–40% plagioclase and 25–30% K-feldspar (Figure GS-5-4h). The feldspar laths are as phenocrysts, locally up to 20 mm, with diffuse grain edges due to sericitic alteration. Trace sulphide minerals are locally present. This granodiorite exhibits a relatively low MS value of 0.098 × $10^{-3}$ SI, consistent with reduced I-type and ilmenite-series granites elsewhere (cf. Yang et al., 2008). However, the MS values of granodiorite increase to 0.154 × $10^{-3}$ SI near the contact with the volcanic rocks, which is more consistent with I-type and magnetite-series granites.

### *Granitoid rocks in the Leaf Rapids domain*

Two granitoid plutons in the Leaf Rapids domain (LRD) that are thought comparable to the LLD in terms of lithostratigraphic correlation and ages (Rayner and Corrigan, 2004; Corrigan et al., 2007, 2009; Zwanzig and Bailes, 2010; Figure GS-5-1) were examined and sampled in the 2015 field season: the Eden Lake pluton (locality

11; Halden and Fryer, 1999) and the Issett Lake pluton (locality 12; Table GS-5-1 and Figure GS-5-2).

Various phases of granitoid rocks in the Eden Lake pluton were dated at 1871–1818 ±1.2 Ma (Turek et al., 2000; Manitoba Geological Survey, 2006). These phases include foliated tonalite, granodiorite, monzogranite, quartz diorite and aegirine-bearing monzonite, as well as pegmatite and aplite (Halden and Fryer, 1999; Mumin, 2002). In this report, the focus is on two granodiorite phases (one porphyritic, the other equigranular); carbonatite and associated rare-earth element mineralization within the Eden Lake complex are not discussed (see Mumin [2002] and Chakhmouradian et al. [2008] for more information on this topic). Porphyritic granodiorite containing K-feldspar megacrysts displays strong foliation and consists of 40–45% K-feldspar (15–26 mm), 15–25% plagioclase, 20–25% quartz, 15–20% biotite (pseudomorph after hornblende) and 1–2% magnetite (Figure GS-5-5a). The K-feldspar–megacrystic granodiorite has high MS values of up to $19.9 \times 10^{-3}$ SI. Foliated equigranular granodiorite is commonly observed on Highway 391 north of Eden Lake and cuts foliated tonalite, both of which are cut by pegmatite and aplite (Figure GS-5-5b). This granodiorite displays MS values of 0.605–$6.73 \times 10^{-3}$ SI. Overall, the majority of granitoids in this area are comparable to oxidized I-type and magnetite-series granites on the basis of mineral assemblage and MS values (Table GS-5-1), although the aegirine-bearing monzonite described by Halden and Fryer (1999) may be of A-type affinity (cf. Whalen et al., 1987).

The Issett Lake pluton in the LRD contains garnet-muscovite granite that intrudes strongly foliated tonalite (Figure GS-5-5c). The garnet-muscovite granite is creamy-white on fresh surface and weathers to pale white. It is medium grained, massive and equigranular. This granite typically contains euhedral, red to dark red garnet crystals (2–3 mm, locally up to 5 mm; Figure GS-5-5d) and minor muscovite flakes (~1%); it also contains 3–5% biotite (2–3 mm), 30–35% quartz, 50–55% whitish-cream K-feldspar laths (3–4 mm) and 10–15% subhedral to

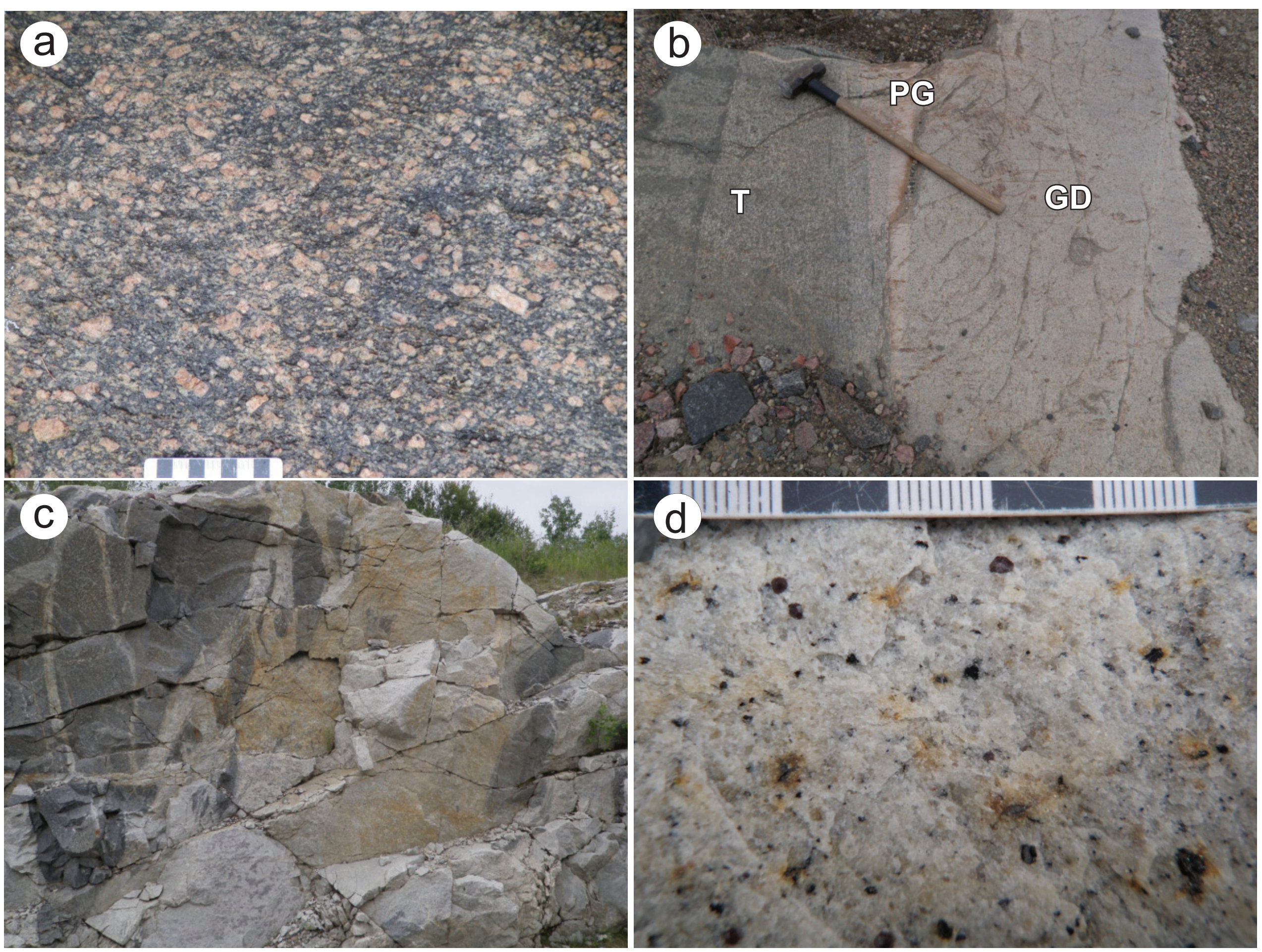


***Figure GS-5-5**: Field photographs of granitoid rocks from the Leaf Rapids domain, northwestern Manitoba: **a)** K-feldspar megacrysts in porphyritic granodiorite, Eden Lake igneous complex (UTM Zone 14, 423687E, 6291480N, NAD 83); **b)** foliated, medium-grained tonalite (T) cut by foliated granodiorite (GD) and pegmatite/aplite (PG), Eden Lake igneous complex (UTM 425753E, 6290886N); **c)** medium-grained garnet-muscovite granite intruded into foliated tonalite, Issett Lake pluton (UTM 4867914E, 6276099N); height of roadcut face is ~8 m; and **d)** medium-grained garnet-muscovite granite, Issett Lake pluton, same location as (c).*

euhedral plagioclase (3–4 mm). Locally, it contains trace disseminated pyrite. This granite has very low MS values of 0.046–0.085 × $10^{-3}$ SI, typical of S-type and ilmenite-series granites.

Tonalite from the Issett Lake pluton is strongly foliated and medium to coarse grained, and consists of 15–17% biotite (pseudomorph after hornblende; minor relict amphibole), 20–25% quartz (3–5 mm), 50–55% subhedral to anhedral plagioclase (3–6 mm in length) with diffuse grain boundaries and 5–10% K-feldspar. Compared to the garnet-muscovite granite described above, the tonalite shows higher MS values, ranging from 0.215 to 1.2 × $10^{-3}$ SI, consistent with normal I-type and magnetite-series granites (Table GS-5-1).

### *Granitoid rocks in the Chipewyan domain*

The South Bay intrusion (locality 13 in Figure GS-5-2) is dominated by strongly foliated porphyritic granite with distinctive K-feldspar megacrysts (Figure GS-5-6a). This granite phase is cut by late-stage, foliated, medium-grained and equigranular granite and pegmatite dikes (Figure GS-5-6b). The porphyritic granite typically contains 20–25% euhedral to subhedral K-feldspar megacrysts (20–40 mm in length) and up to 5% subhedral quartz phenocrysts (~20 mm) embedded in a medium- to coarse-grained groundmass comprising quartz, biotite, hornblende, K-feldspar, ±plagioclase, and magnetite. The groundmass consists of 20–25% biotite, 5–10% prismatic hornblende (3–5 mm), 15–25% quartz and 10–15% feldspar. This megacrystic K-feldspar granite displays very high MS values of 55.0–72.9 × $10^{-3}$ SI, indicating that it is a highly oxidized I-type or magnetite-series granite.

The K-feldspar megacrystic granite observed in this study is petrographically similar to that of the Chipewyan/Wathaman batholith, as well as other granitoid phases mapped elsewhere in the Southern Indian Lake area (e.g., Kremer, 2008; Martins, GS-6, this volume) and at Northern Indian Lake (Kremer and Martins, 2014). A sample of undeformed, K-feldspar megacrystic monzogranite (mesoscopically indistinguishable from the Chipewyan/Wathaman batholith and containing rafts of folded metasedimentary rocks described in Lenton and Corkery [1981]) at Pukatawakan Bay of Southern Indian Lake was recently dated at 1829 ±1 Ma by Rayner and Corrigan (2004). This age is much younger than those for the Chipewyan/Wathaman batholith (1.87–1.85 Ga; MacHattie, 2001; Corrigan et al., 2009), which prompted Rayner and Corrigan (2004) to suggest that the ca. 1.83 Ga intrusions may represent either a later pulse of the Chipewyan/Wathaman batholith or part of the ca. 1.83 Ga Nueltin suite described by Peterson et al. (2002). Further work will help determine if the granitoid sampled during this study is part of the Chipewyan/Wathaman batholith.

## Economic considerations

Several types of granitoid rocks have been identified in the Lynn Lake region. Critical petrographic information has been acquired during this reconnaissance mapping and sampling project by focusing on field relationships, textures (fabrics), mineral assemblages, magnetic susceptibilities, and mineralization and/or alteration at outcrop scale. However, systematic laboratory-based petrographic, lithogeochemical and petrological studies are needed to provide additional constraints on the sources, geotectonic settings, magmatic processes and metallogeny of these granitoid rocks.

The preliminary results reveal that muscovite- and/or garnet-bearing granitic rocks (i.e., strongly peraluminous granitoids or S-type) with commonly low MS values (<0.1 × $10^{-3}$ SI) are intruded mainly into terrane boundaries, constituting a macro-recognizable geological criterion to assist in the subdivision of tectonic units in the region. Peraluminous granitoid rocks typically form in

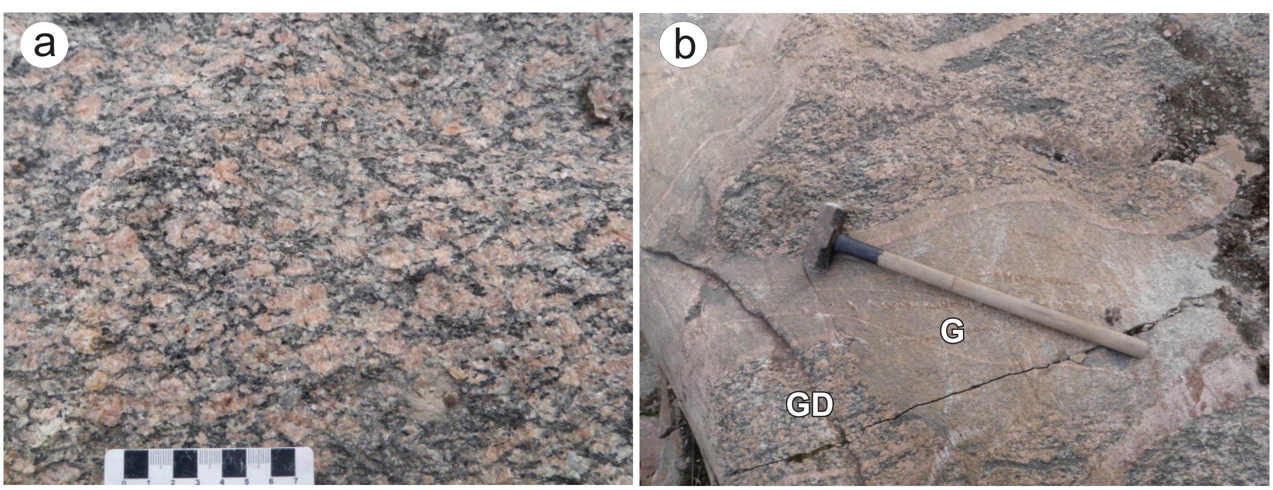


***Figure GS-5-6**: Field photographs of granitoid rocks from the Chipewyan domain: **a)** megacrystic K-feldspar in foliated porphyritic granite, South Bay intrusion (UTM Zone 14, 504604E, 6296357N, NAD 83); **b)** medium-grained granite (G) intruded into foliated megacrystic granite (GD), South Bay intrusion, same location as (a).*

tectonically thickened crust due to continental collision, are often associated with pegmatite intrusions enriched in rare metals and may have potential to host Sn-W mineralization. I-type granitoid plutons, consisting of quartz diorite, tonalite, granodiorite and granite, contribute to continental crustal growth at subduction margins. These types of granitoid plutons and batholiths host important deposits of Cu, Au and Mo in many orogenic belts. In contrast, A-type granitoids are commonly associated with extensional settings and may host important deposits of rare metals. Future work under this project will assist in identifying the chemical affinity of major granitoid intrusions throughout Manitoba, and will thus lead to a better understanding of their mineral potential.

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