GS2024-14

Bedrock mapping in the northwestern Burntwood Lake area, Kisseynew domain, west-central Manitoba (part of NTS 63N7)

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Summary

A mapping project in the northwestern arm of Burntwood Lake, accompanied by fieldwork for an honors thesis, was initiated in 2024 after the discovery of numerous carbonatite dikes within the Burntwood Lake syenite complex in 2023. Much of the area is underlain by migmatitic gneisses derived from Burntwood group wacke. The Burntwood group is intruded by quartz diorite and minor bodies of tonalite, which are locally orthopyroxene bearing. A heterogeneous clinopyroxene syenite pluton (the Burntwood Lake syenite complex) occurs in the centre of the mapping area. The syenite is intruded by a variety of carbonatite dikes, veins, and 'blows'. A variety of pegmatitic granite intrusions, ranging from centimetre-scale dikes to kilometre-scale bodies, occur throughout the study area and are likely derived from the partial melting of Burntwood group rocks. Two discrete, kilometre-scale bodies of porphyritic granite occur in the western and eastern portions of the map area. Sparse, centimetre- to metre-scale xenoliths and dikes of aplitic granite occur throughout the study area.

Burntwood group rocks are characterized by a northwest-striking S_1 gneissosity, which is moderately to steeply dipping to the northeast. Minor isoclinal folding of the gneissosity is accompanied by an axial planar, northwest-striking S_2 foliation, which is moderately to steeply dipping to the northeast. The S_2 fabric is well developed in all of the intrusive phases, except for some of the latest pegmatite and aplite dikes. The S_2 fabrics are cut by discrete, centimetre- to rarely metre-scale S_3 mylonitic shear zones, which are most abundant in the western portion of the study area. Peak metamorphic assemblages in the Burntwood group rocks consist of quartz–plagioclase–K-feldspar–garnet–cordierite–biotite±sillimanite±spinel, which is characteristic of the granulite facies for aluminous rocks.

Carbonatites from similar tectonic settings in California and China host several world-class rare-earth-element deposits, which suggests the Trans-Hudson alkaline-carbonatite igneous province could represent a new metallotect for rare-earth-element exploration in Manitoba. An apparent increase in the size and density of carbonatite intrusions proximal to an area of low ground in the northern part of the syenite complex suggests it could be underlain by relatively soft, carbonate-rich rocks. Although graphite was not found in any significant quantities, the high metamorphic grade of the area makes it ideally situated for the formation of high-value, large flake, or vein/lump graphite deposits.

In Brief:
- The northwestern Burntwood Lake area is largely underlain by migmatite derived from Burntwood group wacke
- The Burntwood group is intruded by locally-derived pegmatitic granite, quartz diorite, tonalite, porphyritic granite, and a syenite-carbonatite complex
- The area could have potential for rare-earth element and graphite mineralization

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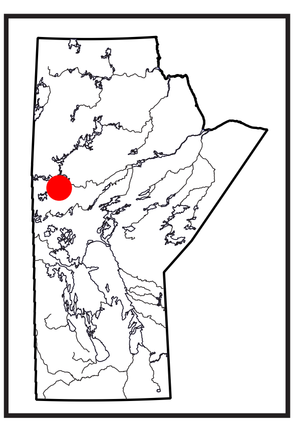
Introduction

A scoping study of the Burntwood Lake syenite complex was initiated in the summer of 2023 following a forest fire that burned the area in 2022. The fire resulted in much better exposure than the last time the complex was visited in 2011, with significantly reduced lichen and moss cover (Martins et al., 2011). The improved exposure enabled a better understanding of the structural relations of different rock types, particularly in recessed areas. This led to the discovery of numerous carbonatite dikes, both in situ, and in displaced, locally derived material. These discoveries, coupled with their scientific and potentially economic importance, prompted additional work in July 2024, which included shoreline mapping of the northwestern arm of Burntwood Lake at a scale of 1:10 000 and fieldwork for an honours thesis at the University of Manitoba. This report is a summary of the preliminary findings.



Background

The Burntwood Lake syenite complex is located in the central Kisseynew domain, approximately 70 km north-northwest of the town of Snow Lake. The Kisseynew domain forms part of the internal zone of the Trans-Hudson orogen in Manitoba and is flanked by the Lynn Lake domain to the north, Flin Flon domain to the south, and Superior boundary zone to the east (Figure GS2024-14-1). The central Kisseynew domain is underlain by Burntwood group metagreywacke that is intruded by large plutons, sheets, and lenses of felsic to ultramafic rocks (Zwanzig, 2008). The Burntwood group was

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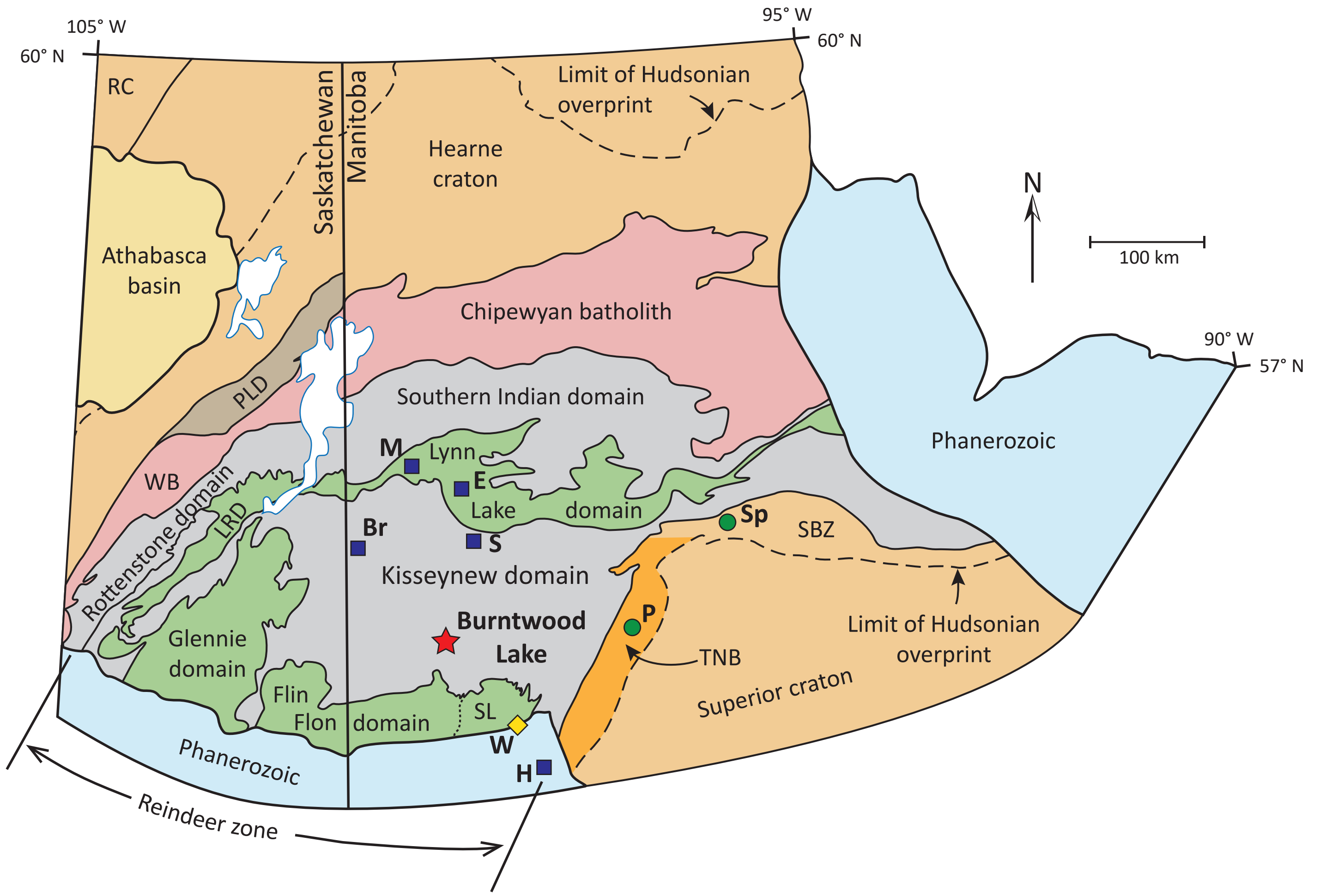

Figure GS2024-14-1: *Schematic map of major tectonic elements in the Manitoba–Saskatchewan segment of the Trans-Hudson orogen, west-central Manitoba (modified from Lewry et al., 1990; Maxeiner et al., 2021; Manitoba Geological Survey, 2022). The location of the Burntwood Lake syenite complex is indicated with a red star. Blue squares indicate the locations of high-potassium to shoshonitic syenite complexes in the Trans-Hudson orogen. Green circles indicate the locations of Paleoproterozoic, late-orogenic carbonatite magmatism in the Superior boundary zone. The yellow diamond indicates the location of anorogenic carbonatite magmatism. Abbreviations: Br, Brezden Lake; E, Eden Lake; H, Huzyk Creek; LRD, La Ronge domain; M, McVeigh Lake; P, Paint Lake; PLD, Peter Lake domain; RC, Rae craton; S, Suwannee River; SBZ, Superior boundary zone; SL, Snow Lake subdomain; Sp, Split Lake; TNB, Thompson nickel belt; W, Wekusko Lake; WB, Wathaman batholith.*

deposited between 1860 and 1840 Ma (Machado et al., 1999; Murphy and Zwanzig, 2021) into what has been variously interpreted as a back-arc, inter-arc or fore-arc basin (Ansdell et al., 1995; Zwanzig, 1997; Zwanzig and Bailes, 2010). The detritus was largely derived from the adjacent, juvenile magmatic arcs, as indicated by prominent, overlapping detrital zircon age peaks of 1870–1850 Ma in probability plots (Zwanzig and Bailes, 2010; Murphy and Zwanzig, 2021).

The Burntwood group is intruded by orthopyroxene-bearing, intermediate to mafic sheets and sills of the ca. 1825 Ma Touchbourne suite (Gordon et al., 1990; Zwanzig, 1990; Machado et al., 1999). This suite is postdated by coarsely inequigranular, garnetiferous tonalite to granodiorite, which are most abundant in the High Rock Lake area (Gordon et al., 1990; Zwanzig, 1990). Peraluminous granodiorite and granite are the most widespread igneous rocks in the central Kisseynew domain. They occur as segregations, sills, dikes, and irregular nebulitic bodies with inclusions of paragneiss (Gordon et al, 1990; Zwanzig, 1990). Other intrusions in the region include monzonite and syenite of the Trans-Hudson alkaline-carbonatite igneous province, melatonalite, and pegmatite (Baldwin et al., 1979; Gordon et al., 1990; Chakhmouradian et al., 2023).

The 'Trans-Hudson alkaline-carbonatite igneous province' consists of several syenite complexes of high-potassium calcalkaline to shoshonitic affinity, along with spatially associated carbonatite and lamprophyre dikes that occur within the Trans-Hudson orogen of Manitoba (Figure GS2024-14-1; Chakhmouradian et al., 2023). The Burntwood Lake (Martins et al., 2011; Chakhmouradian et al., 2023), Brezden Lake (Martins et al., 2012; Hnatiuk et al., 2022), Suwannee River (Martins and Couëslan, 2022), and Huzyk Creek (Couëslan, 2023) syenite plutons occur within the Kisseynew domain, whereas the Eden Lake (Mumin, 2002; Couëslan, 2005; Chakhmouradian et al., 2008) and McVeigh Lake (McRitchie, 1988) complexes occur within the Lynn Lake domain. Granitoid rocks within these complexes typically range in composition from alkali-feldspar syenite (referred to as monzonite in some reports) to clinopyroxene melasyenite and leucocratic quartz syenite. Spatially associated lamprophyres have been reported at Brezden (Hnatiuk et al., 2022) and McVeigh (A.R. Chakhmouradian, pers. comm., 2023) lakes, and carbonatite dikes crosscutting syenites have been reported at Burntwood (Chakhmouradian et al., 2023), Brezden (Hnatiuk et al., 2022) and Eden lakes (Mumin, 2002; Couëslan, 2005; Chakhmouradian et al., 2008). The Hudsonian syenite complexes have been the subject of exploration for zirconium (Zr), rare-earth elements (REEs), thorium (Th), and uranium (U), with the majority of activities centered on Eden Lake, which hosts REE-rich apatite (up to 8 wt. % REEs) and late, hydrothermal REE-mineralization (McRitchie, 1989; Chakhmouradian et al., 2008; Mumin, 2010).

Rocks of the central Kisseynew domain attained upper-amphibolite– to granulite–facies metamorphic conditions. The migmatitic Burntwood group rocks contain zones of coarse, garnet- and cordierite-rich diatexite (Zwanzig, 2008). Gordon (1989) estimated peak metamorphic conditions of 750 ±50 °C and 5.5 ±1.0 kbar at ca. 1815 Ma for the central Kisseynew domain. However, estimated peak metamorphic conditions as high as 900 °C and 12 kbar at ca. 1800 Ma were reported by Growdon (2010). Large-scale, recumbent isoclinal folds predated peak metamorphism in this part of the domain and were subsequently refolded during the regional metamorphism (Gordon, 1989; Zwanzig, 2008).

Geology of the Burntwood Lake area

The Burntwood Lake area was last mapped in 1971 and 1972 (McRitchie, 1971; Baldwin and McRitchie, 1972; McRitchie, 1972). The area is underlain by Burntwood group wacke intruded by various igneous phases including gabbro, diorite, monzonite, granodiorite, granite, and syenite. Western portions of the Burntwood Lake area are characterized by northwest-striking metamorphic fabrics that consistently dip to the northeast. Metamorphic assemblages in the Burntwood group rocks are interpreted to be middle- to upper-amphibolite facies (McRitchie, 1971). The syenite intrusion of northwestern Burntwood Lake was later mapped in detail by McRitchie (1987), and revisited by Martins et al. (2011) and Chakhmouradian et al. (2023). The reader is referred to those publications for greater detail on the Burntwood Lake syenite complex.

Results of 2024 mapping

Mapping of the Burntwood Lake area in 2024 was restricted to the northwestern arm, in the vicinity of the syenite complex (Figure GS2024-14-2). The goal was to determine if additional syenite or carbonatite intrusions were present outside of the main plutonic complex. All rocks, except for some of the latest pegmatitic and aplitic intrusions, were deformed and subjected to at least amphibolite-facies metamorphic conditions. To improve the readability of the text, the 'meta-' prefix has been omitted from rock names.

Burntwood group

Burntwood group rocks underlie much of the Burntwood Lake area (Figure GS2024-14-2) and occur as a metatexite to diatexite that is typically intercalated with 20–80% pegmatitic granite. The metatexite is typically derived from more psammitic layers, whereas the diatexite is derived from more pelitic layers (Figure GS2024-14-3a, b). The psammitic layers are typically <1 m thick, fine to medium grained, and quartzofeldspathic with <20% biotite and <3% garnet. The layers contain rare pods of calcsilicate <20 cm thick that likely represent concretions (Figure GS2024-14-3a). The concretions appear to be plagioclase and/or amphibole rich, and locally scapolite bearing, with accessory amounts of garnet and a black, opaque mineral. The concretions can be partially epidotized.

The more pelitic layers are typically <3 m thick, medium to coarse grained, strongly foliated, and quartzofeldspathic, with 20–30% biotite, 5–7% garnet, and accessory graphite. The most pelitic layers can contain up to 20% cordierite, 15% garnet, and trace amounts of sillimanite. The cordierite is commonly pinitized. Outcrops can be dominated by psammitic or pelitic beds, and the composition of individual beds can be a gradation between the psammitic and pelitic end-members described above. Pods and discontinuous layers of in situ and in-source leucosome are typically <30 cm across and contain minor amounts of possibly peritectic cordierite and garnet. Garnet and cordierite in the leucosome commonly have biotite selvages/rims. Rose quartz forms rare pods <20 cm across.

Quartz diorite

A single outcrop of grey-weathering quartz diorite occurs in the northwestern part of the map area; however, similar intrusions of much greater extent (kilometre-scale) are reported from the northeastern and southwestern portions of the map area (Figure GS2024-14-2; Baldwin et al., 1979). The quartz diorite is brown on fresh surfaces, medium grained, and biotite and orthopyroxene bearing. The unit is relatively homogeneous and equigranular (Figure GS2024-14-3c), and is intruded by the pegmatitic granite. Contacts between the quartz diorite and granite are marked by the presence of medium- to very coarse-grained garnet. The quartz diorite could be correlative with the ca. 1825 Ma Touchbourne suite (Gordon et al., 1990; Zwanzig, 1990; Machado et al., 1999).

Tonalite

Sparse outcrops and metre-scale occurrences of tonalite occur throughout the map area (Figure GS2024-14-2). It varies from light grey to dark grey and is medium to coarse grained. The mafic mineral content is variable, with 5–20% biotite and locally minor amounts of garnet or a brown-weathering min-

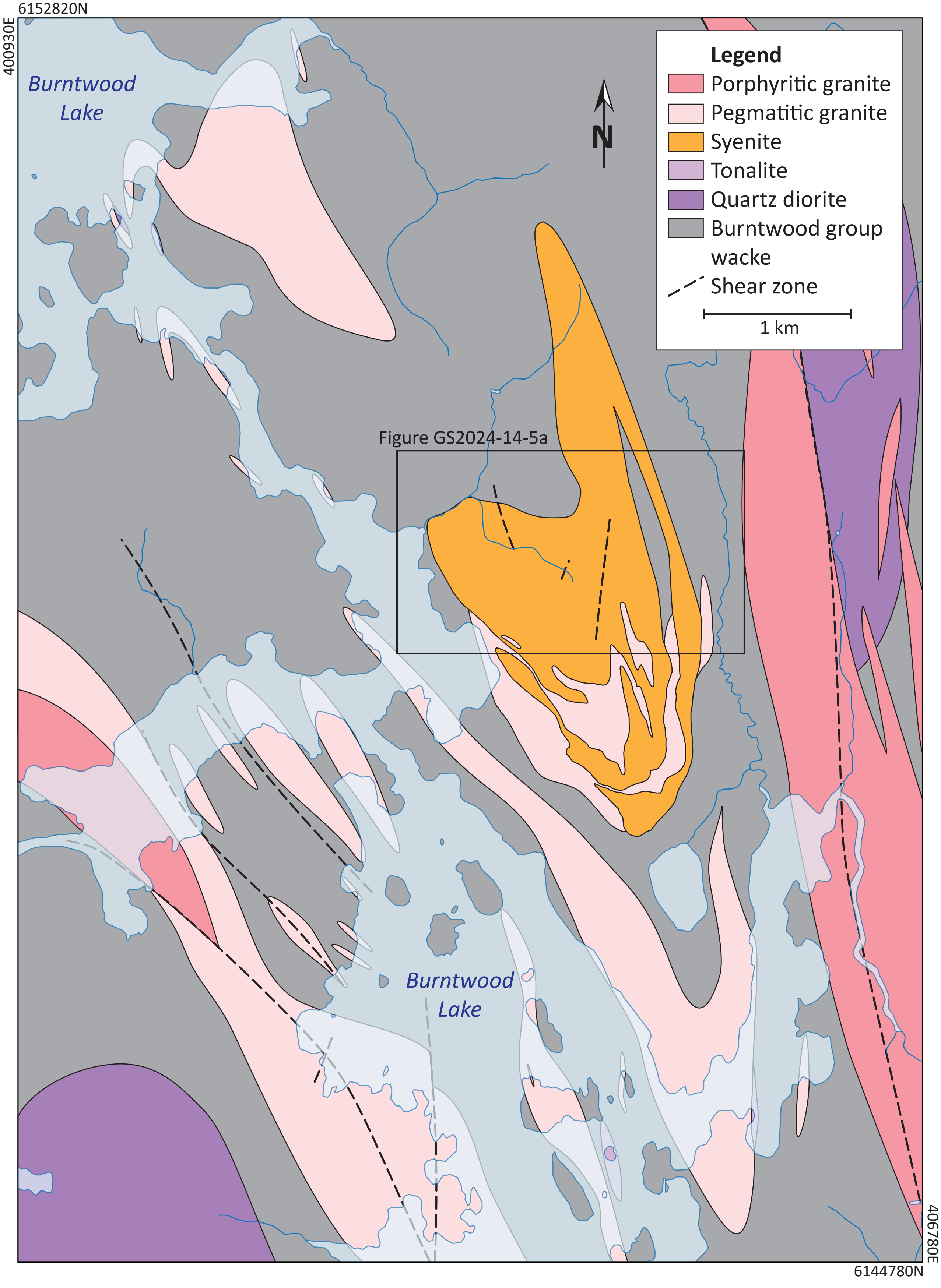

Figure GS2024-14-2: *Bedrock geology of the northwestern Burntwood Lake area, west-central Manitoba (simplified from Couëslan, 2024). Box outlined in black shows location of Figure GS2024-14-5a. Co-ordinates are in UTM Zone 14, NAD83.*

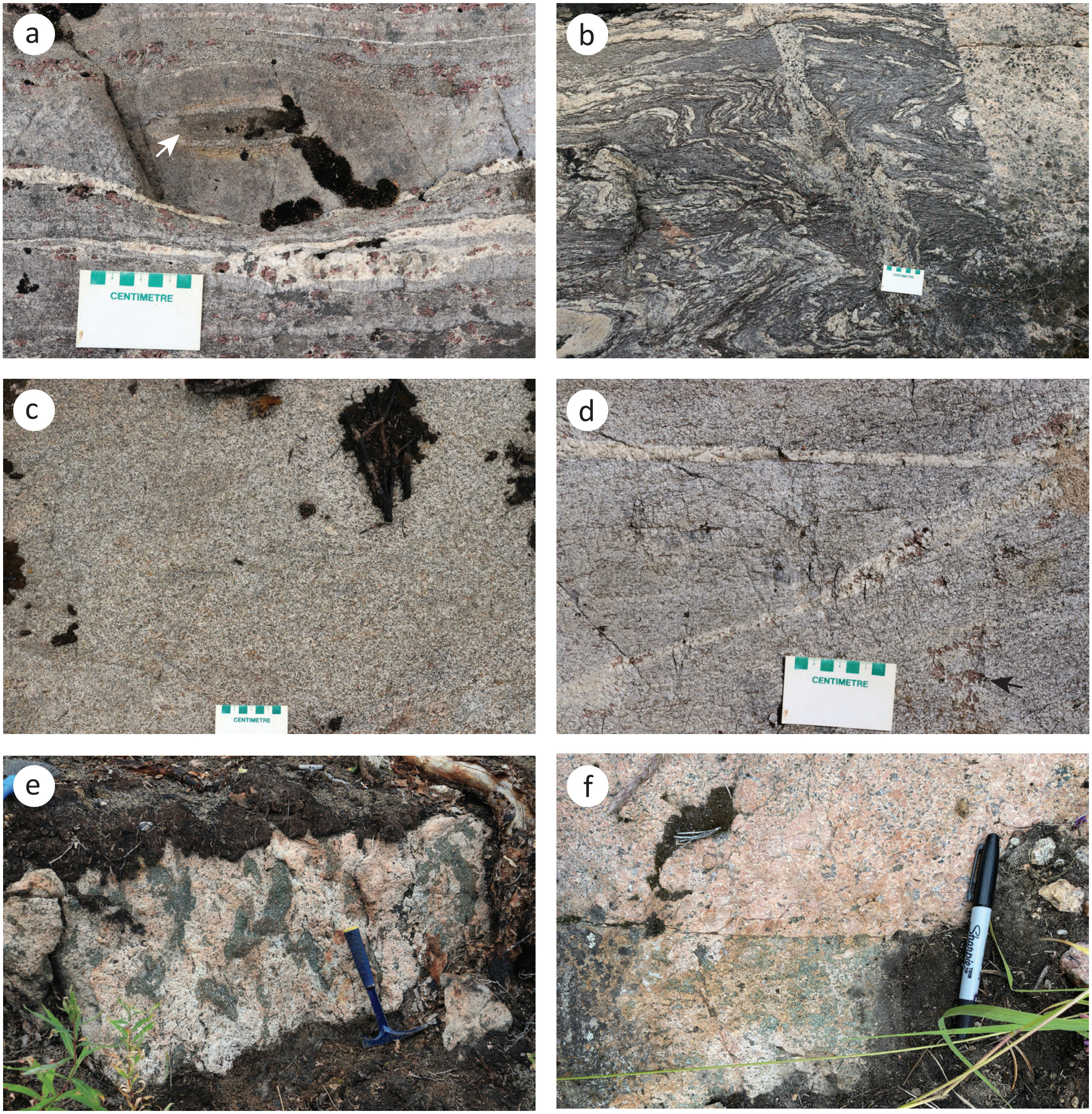

***Figure GS2024-14-3:** Outcrop images from the northwestern Burntwood Lake area: **a)** Burntwood group metatexite consisting of more psammitic wacke, along with a calcsilicate concretion (arrow); **b)** Burntwood group diatexite consisting of more pelitic wacke; **c)** quartz diorite; **d)** tonalite with garnet clots (arrow) and crosscutting dikes of pegmatitic granite; **e)** syenite with clinopyroxene-rich clots and local diffuse bleaching; **f)** contact between quartz syenite (top half of image) and more melanocratic syenite.*

eral that could be orthopyroxene. Biotite locally forms clots, which gives the tonalite a spotted appearance. When present, garnet is evenly distributed as coarse clots (Figure GS2024-14-3d) associated with leucosome or pegmatite injection. The tonalite is intruded by pink pegmatite dikes <2 m across. Some occurrences of the tonalite, especially those suspected of being orthopyroxene bearing, could be related to the Touchbourne intrusive suite.

Syenite

The Burntwood Lake syenite complex occurs in the central portion of the map area (Figure GS2024-14-2). It is relatively heterogeneous and comprises several intrusive phases. The dominant syenite phase is medium to coarse grained, beige to brick red, and appears relatively leucocratic on weathered surfaces and melanocratic on fresh surfaces. The beige syenite is interpreted to contain a higher proportion of albite than the red syenite. The dominant mafic mineral is clinopyroxene, which forms euhedral to subhedral 0.1–1 cm crystals. Minor amphibole and biotite can be present and typically form rims around the clinopyroxene. The clinopyroxene also forms lenses and pods that are largely aligned with the regional foliation (Figure GS2024-14-3e). These segregations can contain a large proportion of apatite as well as accessory titanite and/or allanite. These mafic-rich pods are interpreted as cognate xenoliths and appear to become more abundant in the northern portion of the pluton, where they can lend a leopard-skin–like appearance to the syenite. The leopard-skin syenite locally displays a crude magmatic layering that is crosscut by the regional foliation. Sparse occurrences of porphyritic melasyenite consist of nearly equal proportions of biotite, clinopyroxene, and feldspar. The feldspar occurs as medium-grained polycrystalline pseudomorphs of K-feldspar prisms up to 3 cm long.

The main syenite is intruded by a quartz syenite, which is interpreted to be a more evolved phase of the pluton (Figure GS2024-14-3f). The quartz syenite is relatively leucocratic and consists dominantly of microcline and interstitial quartz, and locally approaches a granite composition. Mafic minerals in the quartz syenite consist predominantly of biotite. Beige aplite was observed at a few localities and can occur as discrete dikes <5 cm wide or as more pervasive intrusions. The aplite consists of microcline and quartz; its relationship to the quartz syenite is uncertain. The syenite is crosscut by microcline-rich pegmatite dikes that contain minor biotite and locally quartz cores. The composition of the pegmatite can range from quartz syenite to granite. Local 'pegmatoid dikes' of nearly solid microcline are also present and could be interpreted as cumulate material emplaced as crystal mushes or as hydrothermal veins. Diffuse, bleached zones occur throughout the northern part of the pluton and appear to overprint all silicate rocks in the complex (Figure GS2024-14-3e). This bleaching is caused by the albitization of microcline and appears to overprint the regional foliation, which becomes locally obscured. Additional details regarding the Burntwood Lake syenite complex can be found in Chakhmouradian et al. (2023).

Carbonatite

Carbonatites from the Burntwood Lake syenite complex are mineralogically and visually diverse. They can be fine to coarse grained and massive to foliated. The carbonatite varieties are provisionally subdivided into grey-white carbonatite and blue-grey carbonatite, based solely on the colour of the main carbonate mineral, which is typically calcite. Weathered surfaces of both varieties are typically crumbly and appear a light brown-beige with well-expressed cleavage. The carbonatite can contain variable amounts of apatite, clinopyroxene, and biotite. Accessory titanite, allanite, amphibole, and magnetite can be present. Syenite-derived xenoliths and xenocrysts can be abundant and typically increase in proportion toward the margin of the carbonatite (Figure GS2024-14-4a). Both biotite and amphibole may form reaction rims around clinopyroxene as well as the syenite-derived fragments.

The carbonatite forms discrete, centimetre- to metre-scale dikes and 'blows' (cf. Wilson and Head, 2007), and zones of diffuse veinlets (Figure GS2024-14-4b). The carbonatite intrusions are typically structurally controlled and can be found along the contacts of silicate rocks and along planes of weakness (Figure GS2024-14-4c). Exocontacts can appear either bleached, as a result of albitization, or melanocratic, due to enrichment in clinopyroxene (Figure GS2024-14-4b). Although grey-white carbonatite appeared to be the most common variety encountered during fieldwork in 2023, the blue-grey variety was more commonly observed during the 2024 field season. Additional information regarding the carbonatite can be found in Chakhmouradian et al. (2023).

All carbonatite discovered to date occurs in the northern part of the Burntwood Lake syenite complex; however, a single carbonate vein of uncertain affinity was located approximately 650 m southeast of the pluton. The vein is emplaced in Burntwood group wacke and truncated by a pegmatite dike. In addition to carbonate, it contains minor diopside and amphibole, and trace sulphide. Further work is required to determine if the carbonate vein is magmatic or hydrothermal/metamorphic in origin.

Pegmatitic granite

The pegmatitic granite occurs throughout the map area (Figure GS2024-14-2) and varies from centimetre-scale dikes to kilometre-scale intrusions. It is pink to white and varies from medium grained to pegmatitic. Contacts between medium-grained and pegmatitic zones are typically diffuse. Local exposures can be more equigranular. The granite contains minor biotite, and trace amounts of cordierite and garnet. The latter two minerals commonly occur as garnet-quartz and cordierite-quartz aggregates or pods <20 cm across (Figure GS2024-14-4d). These pods commonly occur as trains up to several metres long. The garnet is locally rimmed by biotite. The granite can be intercalated with up to 80% Burntwood group rocks in outcrop, and metre-scale xenoliths of psammitic wacke and schlieren of pelite are common (Figure GS2024-14-4e). These intrusions are interpreted as anatectic melts derived largely from the Burntwood group. The pegmatitic granite is intruded by, and intrusive into, the porphyritic granite, which suggests multiple episodes of emplacement.

Porphyritic granite

The porphyritic granite forms two discrete bodies in the western and eastern portions of the map area (Figure GS2024-14-2). It is pink to grey, coarse grained, and characterized by prismatic, twinned K-feldspar phenocrysts <0.5 by 1.5 cm. The

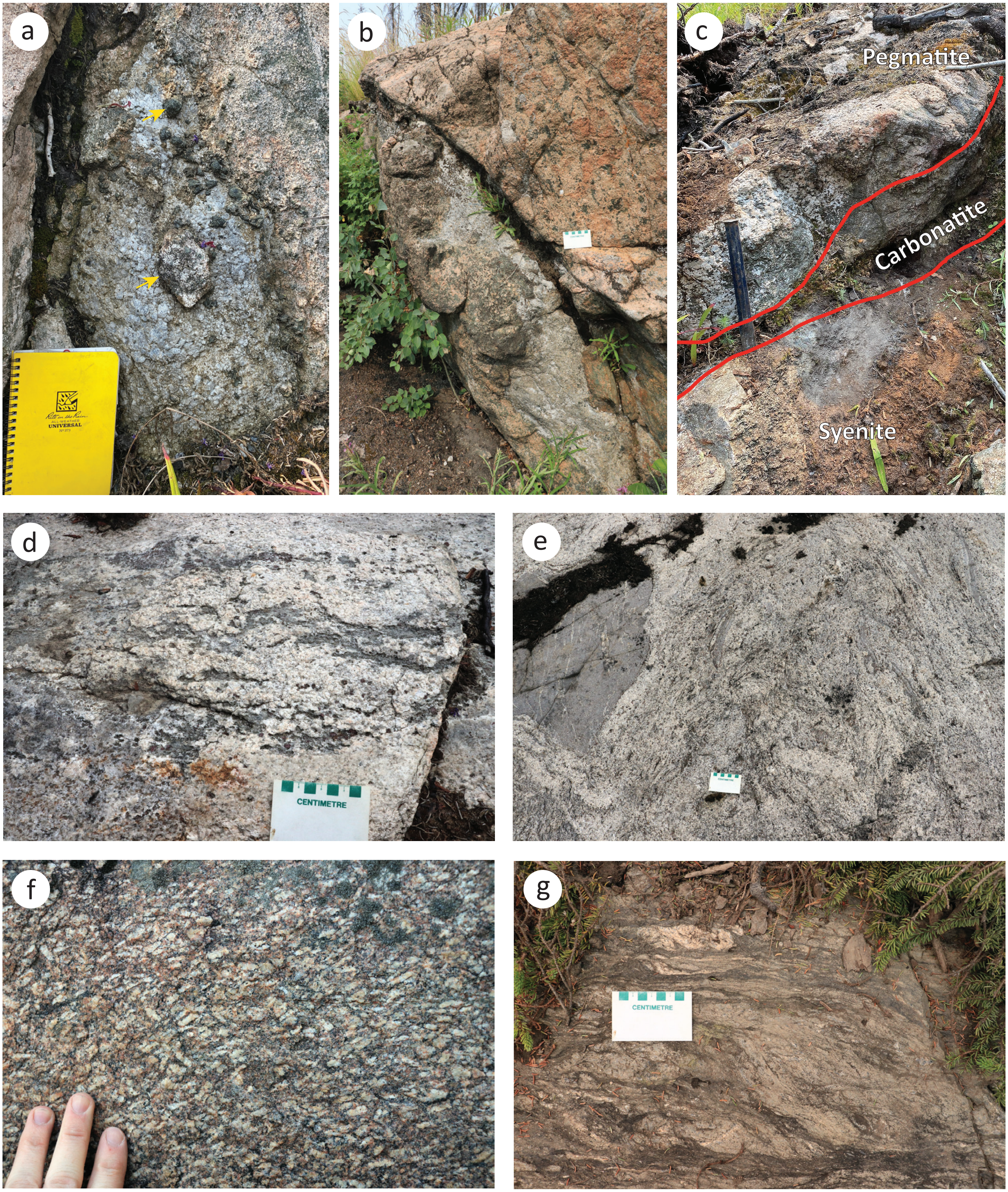

*Figure GS2024-14-4: Outcrop images from the northwestern Burntwood Lake area: **a)** blue-grey carbonatite with syenite-derived xenoliths and xenocrysts (arrows); **b)** carbonatite dike intruding syenite (note enrichment of clinopyroxene in the footwall exocontact and localized bleaching in the hangingwall); **c)** carbonatite dike that intruded along a syenite-pegmatite contact; **d)** trains of cordierite-quartz aggregates in pegmatitic granite; **e)** pegmatitic granite with xenoliths and schlieren derived from the Burntwood group; **f)** aligned K-feldspar phenocrysts in the porphyritic granite; **g)** mylonite derived from the Burntwood group, with entrained pegmatitic granite or leucosome.*

phenocrysts are aligned with the foliation, suggesting this could be a tectonic fabric (Figure GS2024-14-4f); this is supported by the local recrystallization of phenocrysts into augen. The granite locally has a seriate texture and can grade into zones of more equigranular granite; however, this could be the result of recrystallization during tectonic reworking. Minor biotite forms the dominant mafic mineral.

Aplitic granite

The aplitic granite is not an outcrop-forming unit, but occurs as sparse centimetre- to metre-scale xenoliths and dikes throughout the map area. It is pink to grey and contains trace to minor amounts of garnet and biotite. The garnet could be xenocrystic and commonly occurs as <1 cm clots that are rimmed by biotite. The aplite occurs as foliated, angular xenoliths in the pegmatitic granite and as rare massive dikes crosscutting the same unit, which suggests multiple episodes of emplacement.

Structural and metamorphic geology

Primary sedimentary layering (S_0) in the Burntwood group wacke has been transposed along a northwest-striking S_1 gneissosity that is moderately to steeply dipping to the northeast. Minor isoclinal folding of the gneissosity is accompanied by an axial planar northwest-striking S_2 foliation that is moderately to steeply dipping to the northeast. The S_2 foliation forms a regionally penetrative fabric that is well developed in all of the intrusive phases, except for some of the latest pegmatite and aplite dikes.

A primary S_0 igneous layering is locally developed within the syenite and is crosscut by the S_2 fabric. Diffuse zones of metasomatism (bleaching) within the syenite appear to overprint the S_2 foliation, suggesting it postdates the fabric development. The carbonatite varies from foliated to massive, which suggests that: 1) intrusions were emplaced before and after D_2, 2) some intrusions experienced static recrystallization after D_2, or 3) the fabric development is unrelated to the D_2 phase of deformation. Carbonatite dikes are locally emplaced along the S_2 foliation, suggesting that this plane of weakness was developing, or already developed, at the time of intrusion.

Discrete centimetre- to metre-scale, mylonitic D_3 shear zones are most abundant in the southwestern part of the map area (Figure GS2024-14-4g). The shear zones are dominantly sinistral and northwest-striking, and dip steeply to the northeast. Minor conjugate dextral shears are northeast-striking with steep dips. Regional S_2 fabrics wrap into these later D_3 structures.

Peak metamorphic assemblages observed in the Burntwood group wacke consist of quartz–plagioclase–K-feldspar–garnet–cordierite–biotite±sillimanite±spinel. The assemblage K-feldspar–garnet–cordierite is characteristic of granulite-facies metamorphism for aluminous rocks (Pattison et al., 2003). The majority of biotite grains appear to be part of the peak assemblage, which suggests that the incongruent melting reaction of this mineral was not surpassed. Granulite-facies peak metamorphic conditions could also be supported by the presence of orthopyroxene in the quartz diorite and locally in the tonalite. Orthopyroxene-bearing intrusions in this region have previously been interpreted as pre-peak metamorphic, which would imply a metamorphic, rather than magmatic, origin for the orthopyroxene (Gordon et al., 1990). Detailed petrographic studies will be required to corroborate this interpretation. Granulite-facies metamorphism is significantly higher than the middle- to upper-amphibolite–facies estimate of McRitchie (1971), and in broad agreement with the estimate of 750 ±50 °C and 5.5 ±1.0 kbar of Gordon (1989) for much of the central Kisseynew domain. Biotite is commonly observed as rims around garnet, and locally cordierite, in Burntwood group rocks and related granitoids, as well as rims around orthopyroxene in the quartz diorite and tonalite. This indicates some degree of retrogression, possibly under amphibolite-facies conditions.

Economic considerations

The Government of Canada has placed rare-earth elements (REEs) on its list of critical minerals (Natural Resources Canada, 2024). An increased demand for REEs, spurred on by the proliferation of low-carbon-footprint transportation, energy, and communication technologies, has created a need for new, economically viable REE deposits to sustain a reliable REE supply chain outside of the current producers, which are largely dependent on China (Cordier, 2024). Carbonatites are the most economically important source of light lanthanides (La-Eu) and host the largest known REE deposits, including Bayan Obo, Mianning-Dechang, and Weishan in China, and Mountain Pass in California, United States. The tectonic setting and geochemical characteristics of the rocks associated with these deposits are similar to those of the Trans-Hudson alkaline-carbonatite igneous province of Chakhmouradian et al. (2023), which includes the syenite-carbonatite complexes at Burntwood, Brezden, and Eden lakes (Figure GS2024-14-1). This represents a potential new metallotect for REE exploration.

There is an apparent increase in density and size of carbonatite intrusions around a low-lying area in the northern part of the Burntwood Lake syenite complex (Figure GS2024-14-5a, b). A ridge protruding into the southwestern end of the low ground contained a wide variety of carbonatite intrusions, with exposed areas of carbonate up to 10 m^2 that disappeared under cover in multiple directions. This could imply that the low ground, which encompasses an area of approximately 0.14 km^2, is underlain by more easily eroded, carbonate-rich rocks. It may be possible to test this hypothesis by using geophysical or soil/vegetation geochemical surveys.

Graphite is another mineral on the Government of Canada's critical minerals list (Natural Resources Canada, 2024). Some of its many uses include refractory applications, motor brushes, and steel making; however, higher valued coarse-grained graphite is used in high-temperature lubricants, and lithium battery and fuel

Figure GS2024-14-5: *Images of low ground in the northern part of the Burntwood Lake syenite complex:* ***a)*** *area outlined in Figure GS2024-14-2 with red stars indicating the locations of carbonatite intrusions and the extent of the syenite outlined in white;* ***b)*** *view looking east-northeast from the ridge protruding into the southwestern-end of the low ground and located between the two white arrows in (a).*

cell applications (Robinson et al., 2017). Several graphite deposits are hosted in Burntwood group rocks in the Kisseynew domain of Manitoba, including the Neuron claim (Callinex Mines Inc., 2014; Assessment File 63O15404, Manitoba Economic Development, Investment, Trade and Natural Resources, Winnipeg) and the Huzyk Creek graphite-vanadium property (Couëslan, 2020, 2022). The high metamorphic grade at Burntwood Lake makes it ideally situated for the formation of high-value, large-flake, or vein/lump graphite (Buseck and Beyssac, 2014). Although graphite was not found in any significant quantities during mapping, graphite-rich horizons are relatively soft and easy to erode, and are more likely to form negative relief than outcrops. The best way to explore for graphite mineralization would be using geophysical methods. Stratabound graphite-rich horizons should appear as relatively continuous, folded conductors, whereas vein or lump graphite could form more linear conductors coincident with shear zones. Graphite-rich mineralization is likely to have a relatively low magnetic response unless it is accompanied by significant pyrrhotite.

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