GS-1 Far North Geomapping Initiative: bedrock geology of the Snyder Lake area, northwestern Manitoba (part of NTS 64N5)

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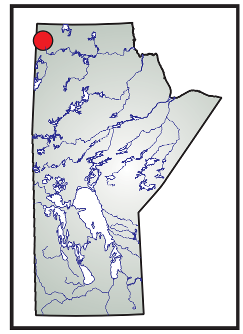

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Summary

The Manitoba Geological Survey's Far North Geomapping Initiative continued in the summer of 2011 with bedrock and surficial geological mapping in the Snyder Lake area, in the northwestern corner of the province. The Snyder Lake area is largely underlain by medium- to upper-amphibolite–grade metasedimentary rocks of the Wollaston Supergroup, including psammitic, semipelitic, pelitic, and lesser amounts of calcsilicate gneiss and marble. Southeast and northwest of Snyder Lake, the sedimentary succession is flanked by intrusive rocks of potential Archean age that were metamorphosed at upper amphibolite- to granulite-facies conditions. Calcium-rich horizons (calcsilicate gneiss and marble) within the Snyder Lake area locally host uranium and/or rare earth element enrichments of economic interest (main occurrences are Pitchblende Ridge and Snyder Island). Mineralization occurs both in outcrop and glacial deposits (e.g., boulders), with dispersal of the latter being small. Uranium and rare earth element mineralization appears to be focused on highly altered (silicified, albitized, hematized) zones in calcareous horizons of the sedimentary sequence, which presents a different mineralization environment and process compared to the unconformity-type uranium deposits at or near the top of the Wollaston Supergroup rocks in Saskatchewan.

The Wollaston Domain, which forms part of the basement sequence to the Proterozoic Athabasca Basin in northeastern Saskatchewan, locally contains basement-hosted unconformity-related world-class uranium deposits (e.g., Millennium deposit). A number of uranium occurrences in Saskatchewan are associated with particular strata of the Wollaston Supergroup (e.g., graphitic pelite of the Daly Lake Group, calcsilicate and calcareous arkose of the Geikie River Group, Yeo and Delaney, 2007). As a result, the Wollaston Domain in northwestern Manitoba has seen a recent increase in exploration activity. Regional mapping in the Snyder Lake area will provide data allowing for comparison and correlation between metasedimentary rocks of the Wollaston Domain in Manitoba with those in Saskatchewan, including known uranium-hosting strata.

Introduction

This report summarizes results from four weeks of geological mapping conducted in the Snyder Lake area of northwestern Manitoba in July of 2011. The Snyder Lake area was previously mapped by the Manitoba Geological Survey (MGS) in the mid-1970s (Weber et al., 1975). The current study is the final year of MGS's Far North Geomapping Initiative, which was initiated in 2008 in collaboration with the Geological Survey of Canada. The purpose of the project is to examine the mineral potential of, and contribute to, the geological mapping and geoscientific knowledge base of Manitoba's far north. The northwestern component of the Far North Geomapping Initiative expands on work carried out in 2005 and 2006 (Anderson and Böhm, 2005; Anderson and Böhm, 2006; Böhm and Anderson, 2006a, b; Matile, 2006) and in 2010 (Kremer et al., 2010a, b).

Regional setting

The Snyder Lake project area lies in the Wollaston Domain of the western Churchill Province in northwestern Manitoba, approximately 280 km north of Lynn Lake and just east of the provincial border between Manitoba and Saskatchewan. The Wollaston Domain comprises Paleoproterozoic rift, passive margin and foreland sedimentary sequences (collectively termed the Wollaston Supergroup), which overlie and are infolded with Neoarchean basement rocks of the southeastern Hearne craton margin (Tran, 2001; Tran et al., 2003; Yeo and Delaney, 2007) (Figure GS-1-1).

In Saskatchewan, inliers of the Hearne craton within the Wollaston Domain are composed of various suites of plutonic rocks including charnockite, monzonite-granite-granodiorite, granodiorite-tonalite, amphibolite, and mixed intrusive and sedimentary rocks (Tran, 2001; Yeo and Delaney, 2007). The majority of ages reported for the southeastern Hearne craton range from 2650 to 2500 Ma (Ray and Wanless, 1980; Annesley et al., 1993; Hamilton and Delaney, 2000; Bickford et al., 2001; Maxeiner et al., 2004; Rayner et al., 2005); however, older ages are documented in the transitional zone between the Wollaston Domain and the adjacent Mudjatik Domain to the northwest (Annesley et al., 1993).

In Saskatchewan, the Wollaston Supergroup has been subdivided into four groups separated by regional

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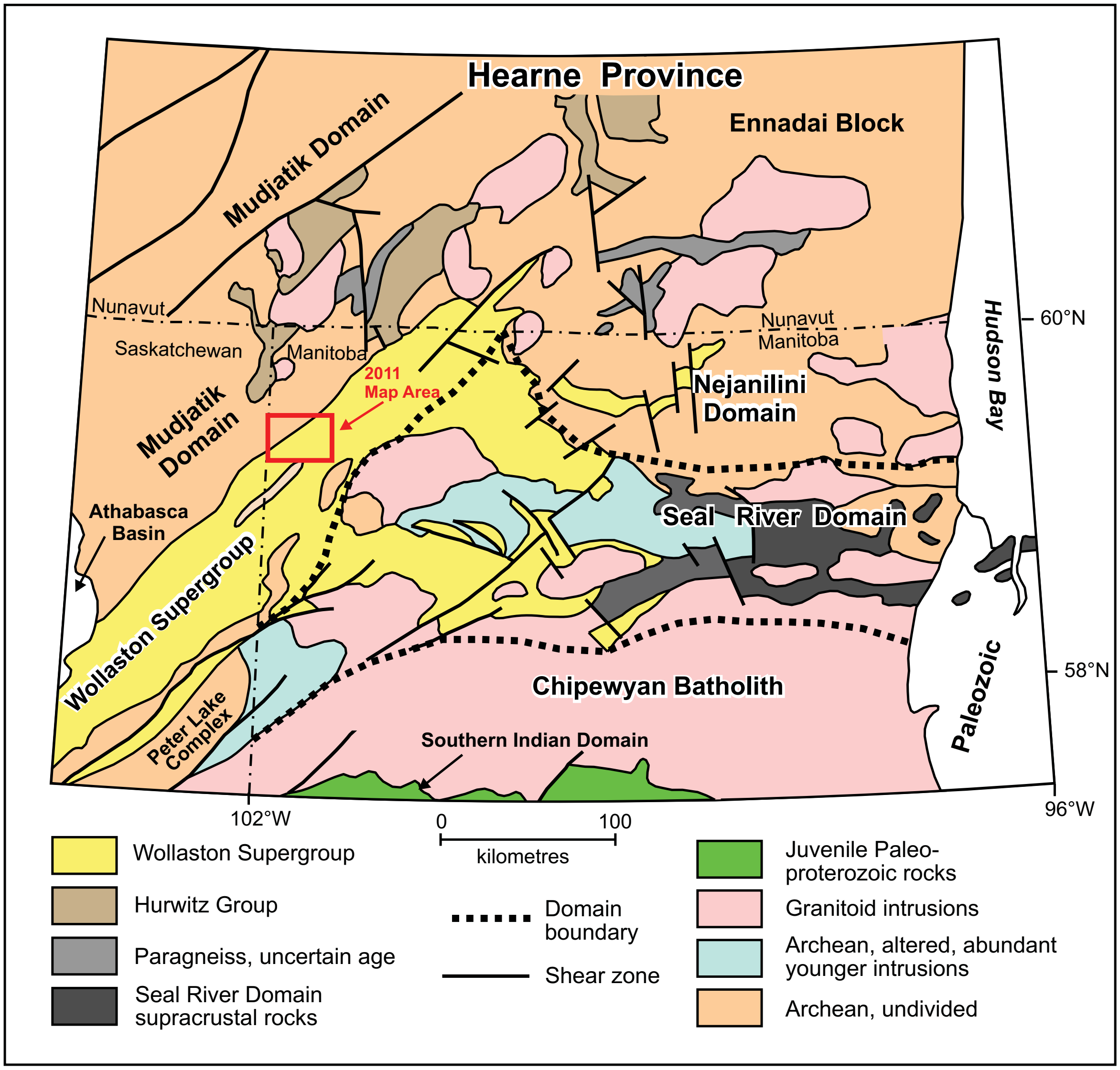

Figure GS-1-1: *General geology of the southeastern Hearne margin, showing the location of the Snyder Lake project area.*

unconformities (Yeo and Delaney, 2007), each of which represents a distinct stage in the tectonic and sedimentary evolution of the basin. 1) The Courtenay Lake Group, equivalent to the Needles Falls Group of Ray (1979) and Tran (2001), comprises conglomerate and arkosic rocks intercalated with bimodal volcanic rocks. Based on these oldest supracrustal rocks, the stratigraphically lowest group of the Wollaston Supergroup is interpreted as a synrift succession. An age of ca. 2.1 Ga for felsic volcanic rocks of the Courtenay Lake Group constrains the age of rifting (Ray, 1979; Ansdell et al., 2000). 2) The Souter Lake Group overlies the Courtenay Lake Group and consists dominantly of quartzitic and psammitic siliciclastic rocks, inferred to form part of a stable platform or passive margin sequence (Yeo and Delaney, 2007). This is in turn overlain by 3) the Daly Lake Group, which consists of various successions of pelite and psammopelite with minor quartzite, calcsilicate rocks and marble, and arkosic to quartzitic rocks that define an upward-coarsening succession. The Daly Lake Group is interpreted to record early stage foreland-basin sedimentation atop the southeastern Hearne margin. 4) Conglomerate, arkose, calcsilicate and marble of the Geikie River Group form the upper succession of the Wollaston Supergroup, which is thought to represent a later stage of foreland-basin infilling.

In Manitoba, the metasedimentary rocks in the Misty Lake area south of Snyder Lake (Kremer et al., 2010a, b) appear to be most similar to the early foreland-basin stage (Daly Lake Group) as described by Yeo and Delaney (2007). Similar correlations were made for metasedimentary rocks of the Wollaston Supergroup in the Kasmere and Putahow lakes area northeast of Snyder Lake (Böhm and Anderson, 2006b).

Four distinct populations of zircons have been identified from geochronological analyses on various metasedimentary rocks within the Wollaston Domain in Saskatchewan: 1) >2450 Ma, representing detritus eroded from Archean basement rocks of the Hearne craton; 2) ca. 2.1 Ma, thought to correspond to reworking of the underlying Courtenay Lake/Needles Falls Group; 3) 1920–1880 Ma, interpreted as detritus shed from the advancing volcanic terranes of the western Churchill Province (Rottenstone and Southern Indian domains); and 4) 1840–1790 Ma, interpreted as metamorphic zircon growth during peak Hudsonian tectonometamorphism (Ansdell et al., 2000; Hamilton and Delaney, 2000; Tran, 2001; Yeo and Delaney, 2007; Tran et al., 2008). Rocks in the lower successions of the Wollaston Supergroup (Courtenay Lake and Souter Lake groups), contain exclusively Archean to early Paleoproterozoic zircons, whereas younger Paleoproterozoic zircon ages increase in abundance moving up stratigraphy.

The Wollaston Domain experienced significant tectonothermal reworking during the Trans-Hudson orogeny. Metasedimentary rocks of the Wollaston Supergroup were intensely deformed and interfolded with basement granitic rocks during four episodes of ductile deformation (Lewry and Sibbald, 1980; Yeo and Delaney, 2007). Structural features corresponding to D_1 and D_3 are predominant and correspond to two generations of metamorphism and anatexis (Yeo and Delaney, 2007).

Paleoproterozoic felsic intrusive rocks in the western Churchill Province range from small plugs and sills to large batholiths. The ca. 1.86 Ga Chipewyan (Wathaman) Batholith, which intrudes the Wollaston Domain, represents continental-arc magmatism along the southern Hearne margin (Corrigan et al., 2000). The Hudson granite suite was emplaced during terminal collision of the Trans-Hudson orogeny. The granitic suite ranges in age from 1.84 to 1.79 Ga, with a main plutonic phase ca. 1.83 Ga (van Breemen et al., 2005).

Geology of the Snyder Lake area

The following section provides preliminary field descriptions, an overview of contact relationships between rock types and interpretations of the overall geology, based on four weeks of mapping, conducted in the Snyder Lake area during the summer of 2011 (Kremer and Böhm, 2011). Geochemical and geochronological laboratory analyses are pending.

Archean basement rocks

In the Snyder Lake area, the northeast-trending Wollaston Supergroup metasedimentary rocks are bound on both flanks by gneissic felsic intrusive rocks interpreted as Archean basement of the Hearne craton. The western portion of the map area (Figure GS-1-2), along the northwestern shore of Grevstad Lake, consists of multiphase tonalite to granite orthogneiss, with rare amphibolite gneiss. Fine-grained amphibolite gneiss is dark grey to black, occurs as rafts and boudins within the surrounding granitic gneiss, and is the oldest phase recognized within the gneisses. Tonalite and granite gneiss is leucocratic with locally abundant mafic schlieren composed of biotite and hornblende (Figure GS-1-3a). It is fine- to medium-grained, weathers light grey to pink and is strongly foliated and folded. Magnetite occurs regularly as an accessory mineral. The contacts between the basement rocks and the overlying Wollaston Supergroup are not exposed but marked by a zone of voluminous granitic intrusions that contain inclusions of both orthogneiss and metasedimentary rocks. On southern Grevstad Lake, the contact is marked by a zone of high strain, suggesting strong tectonic reworking of the original unconformity.

South and southeast of Snyder Lake, inliers of granitic gneiss occupy the cores of structural domes within the Wollaston metasedimentary succession. The intrusive cores are dominated by medium-grained, strongly foliated to gneissic granodiorite and tonalite containing up to 20% black amphibole and/or biotite. Honey-brown plagioclase and smoky-grey vitreous quartz give the gneisses honey-beige or greenish-grey fresh and reddish-brown weathering surfaces (Figure GS-1-3b) characteristic of granitic rocks in granulite terranes. Toward the margin with the metasedimentary rocks, the orthogneiss appears to be more heterogeneous and is composed of layered granite, granodiorite to diorite with biotite±garnet separated from quartzofeldspathic layers (Figure GS-1-3c).

Metasedimentary rocks of the Wollaston Supergroup

Psammitic to pelitic paragneiss

Psammitic, semipelitic and pelitic gneiss forms an interlayered and continuous package that extends from southeast of Snyder Lake to the eastern shore of Grevstad Lake, and forms the dominant rock type in the map area (Figure GS-1-2). Layering of paragneiss units, visible in outcrop as centimetre- to metre-scale compositional banding, is interpreted to reflect primary sedimentary bedding.

Psammitic gneiss weathers white to grey and is composed dominantly of quartz (50–70%), with lesser feldspar (10–30%) and minor biotite (<20%) ±garnet (Figure GS-1-4a). Psammitic gneiss is massive to crudely layered, and is locally interlayered with calcareous psammite ranging from 10 to 50 cm thick. Calcareous psammite weathers medium to dark greenish-grey and is grey-green on fresh surfaces. Semipelitic and pelitic paragneiss weather medium to dark grey, contain <60–80% quartz–feldspar and from 20 to >40% biotite±garnet±cordierite±sillimanite, and are often interlayered at outcrop scale (Figure GS-1-4b). They contain a well-developed, layer parallel foliation

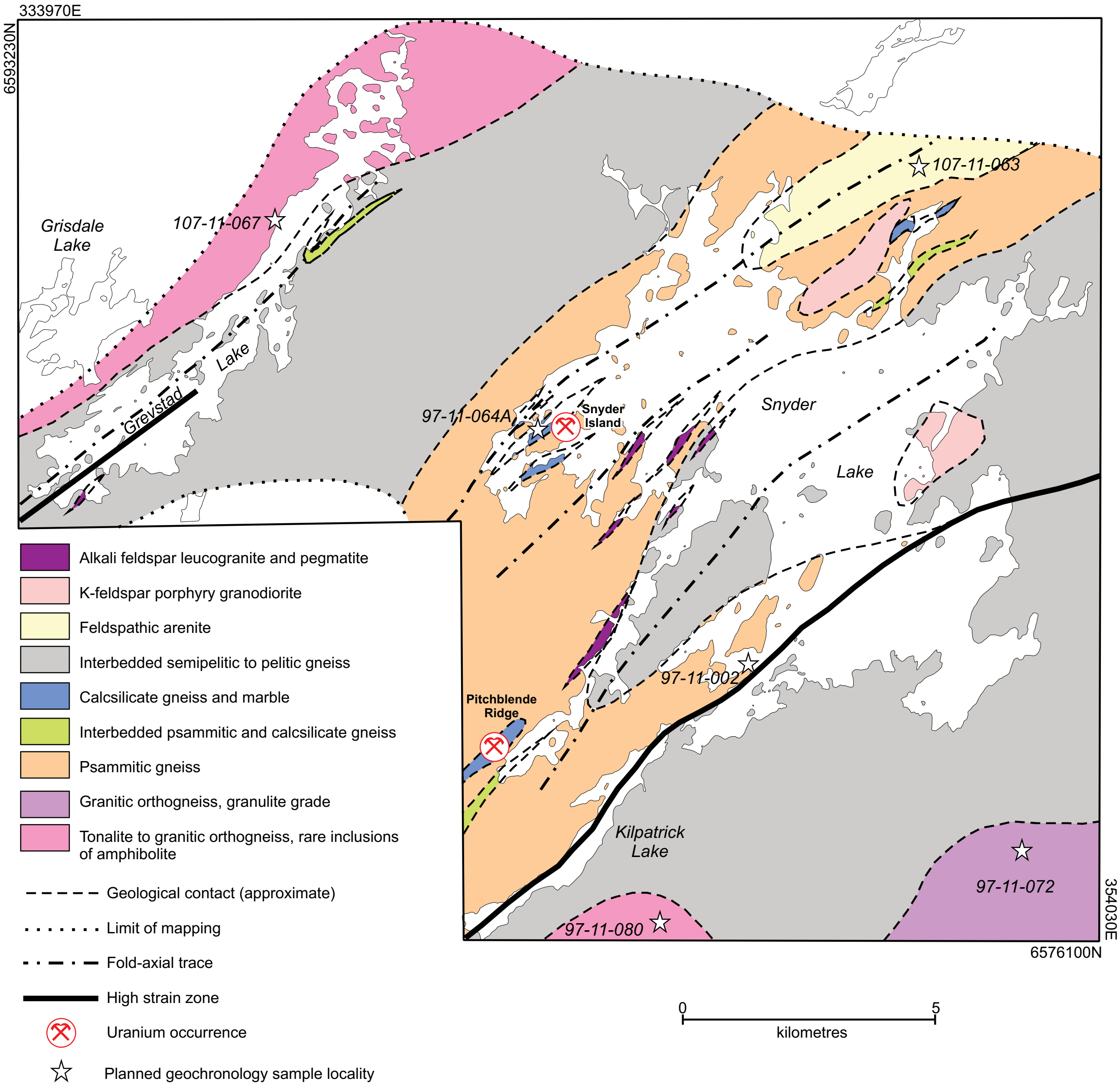

Figure GS-1-2: *Simplified bedrock geology of the Snyder Lake area.*

defined by alignment of biotite that ranges from planar to slightly anastomose.

Leucocratic alkali feldspar granite and granitic pegmatite injection is ubiquitous throughout the psammitic to pelitic paragneiss. Granitic dikes and sills are straight and continuous to boudinaged, have sharp contacts that parallel, or are oriented slightly oblique to, the dominant layer-parallel foliation in the metasedimentary rocks, or form small, irregular <10 cm sized granite pods within metasedimentary rocks (Figure GS-1-4c). These pods are mineralogically identical to the larger injection dikes and intrusive bodies, suggesting that this magmatic phase may be derived from melting of the metasedimentary host rocks.

Primary sedimentary features in psammitic to pelitic gneiss are absent. The high, upper amphibolite– to possibly lower granulite–facies metamorphic grade of the sequence hinders the identification of stratigraphic facing and therefore makes it difficult to define a stratigraphy. Reverse metamorphic grading can be inferred at rare locations, where porphyroblastic garnet–cordierite–sillimanite appear to be concentrated at the top of certain layers. Stratigraphic interpretation is further complicated by the absence of outcrop exposures across large portions of the

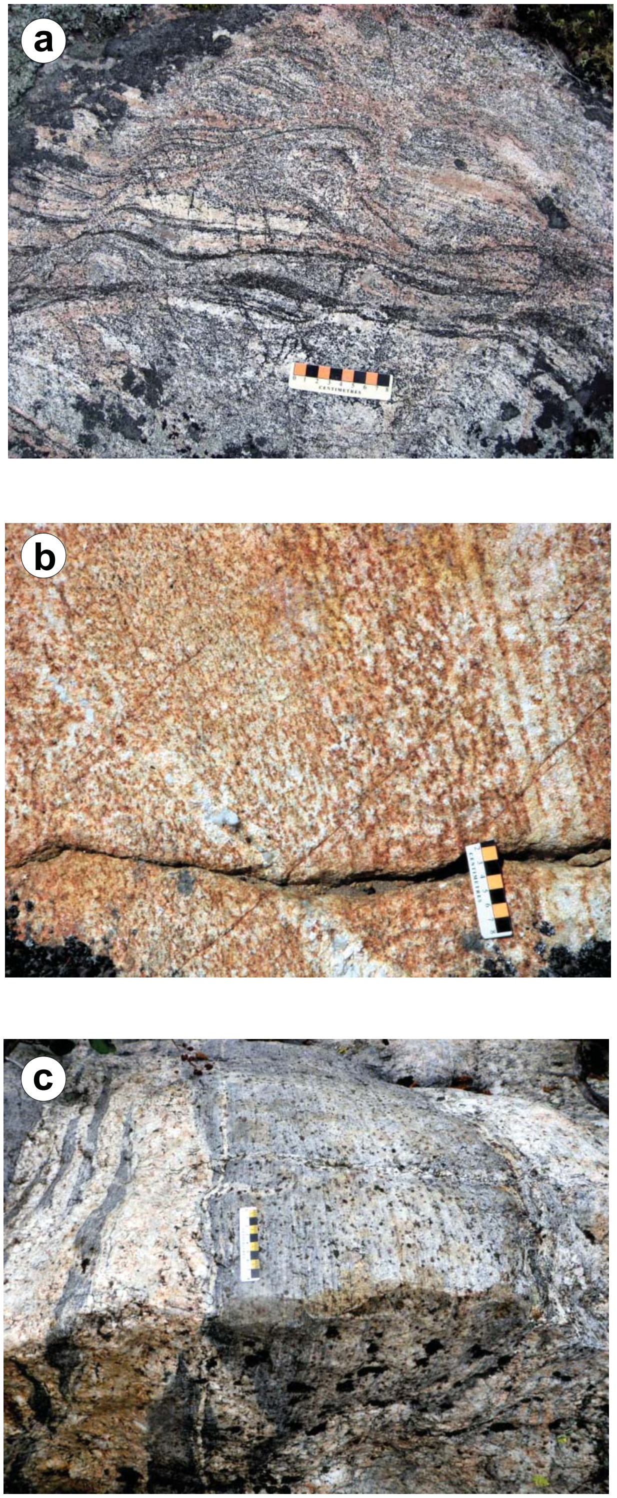

***Figure GS-1-3:** Outcrop photographs of Archean basement rocks exposed in the Snyder Lake area: **a)** granitic gniess, Grevstad Lake; **b)** light reddish-brown weathered granulite-facies foliated granodiorite, southeast of Snyder Lake; **c)** granodiorite gneiss with quartzofeldspathic pegmatitic injection layering, south of Kilpatrick Lake.*

map area (e.g., northeastern Snyder Lake). Nevertheless, the monotonous psammite-semipelite-pelite sequence at Snyder Lake is similar to psammitic to pelitic paragneiss mapped in the Misty Lake area to the south (Kremer et al., 2010a, b).

Calcsilicate rocks and marble

Calcareous rocks and marble occur in the western portion of Snyder Lake, where white to beige, relatively pure marble consisting of up to 90% coarse-grained, euhedral calcite and ~10% scapolite outcrops in small exposures in the area near the Snyder Island occurrence (Figure GS-1-2). Crystals of hornblende (5%), light green epidote (5%) and accessory titanite impart a speckled or layered texture on the rock (Figure GS-1-4d).

An approximately 10 m thick succession of interbedded marble and calcsilicate occurs in north central Snyder Lake, where grey to pink marble forms typically recessive exposures owing to weathered carbonate. Relatively resistant calcsilicate, composed of plagioclase with varying amounts of clinopyroxene and hornblende, weathers dark grey and is pale green on fresh surfaces.

Feldspathic arenite

Feldspathic arenite occurs north of Snyder Lake and correlates to a magnetic high on aeromagnetic maps. Feldspathic arenite is fine- to medium-grained, light pink, and massive to crudely bedded. It is composed of quartz (50%), feldspar (40%), biotite (5%) and accessory magnetite. Locally up to 10% green amphibole averaging 0.5 cm in size is present and its occurrence appears to be a function of variations in primary compositional layering.

Results of U-Pb geochronological analyses from the Misty Lake area

The Misty Lake area, mapped in the summer of 2010 (Kremer et al., 2010a, b), is located approximately 50 km south of Snyder Lake. The bedrock geological framework of the Misty Lake area is similar to that of Snyder Lake described here, in that it consists largely of metasedimentary rocks of the Wollaston Supergroup infolded with underlying Archean basement rocks (Figure GS-1-5). The results of geochronological analyses from three samples collected in the Misty Lake area are presented here and provide a framework against which upcoming geochronological analyses of similar units from the Snyder Lake area can be compared.

Analytical procedures

Uranium-lead geochronology was carried out using the sensitive high-resolution ion microprobe (SHRIMP) at the Geological Survey of Canada in Ottawa. The SHRIMP analytical procedures followed those described by Stern (1997), with standards and U-Pb calibration

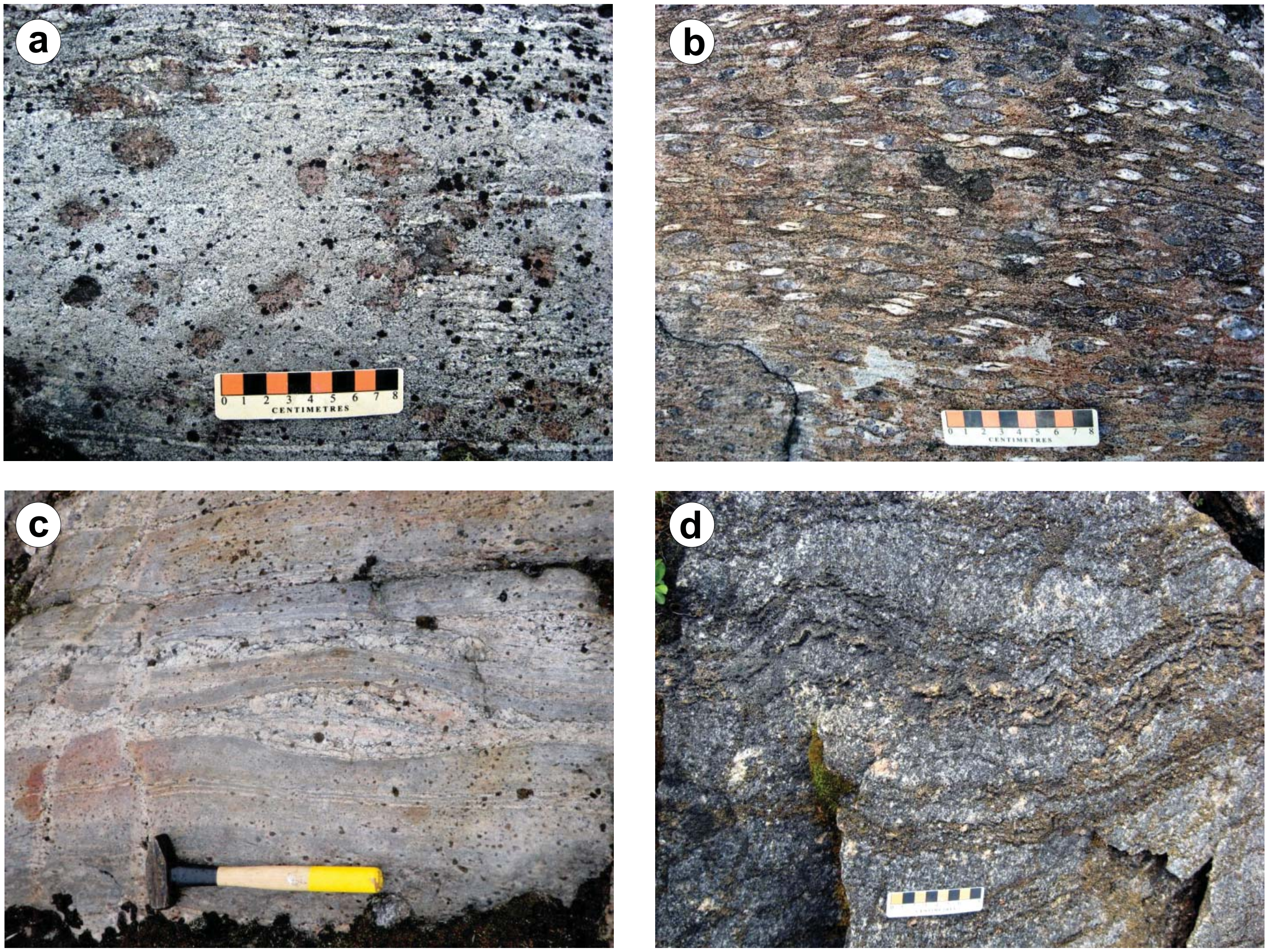

***Figure GS-1-4:** Outcrop photographs of metasedimentary rocks of the Wollaston Supergroup in the Snyder Lake area: **a)** garnetiferous psammitic gneiss, southeastern Snyder Lake;* b) *garnet–cordierite–sillimanite porphyroblastic semipelitic to pelitic gneiss, southeastern Snyder Lake; **c)** alkali feldspar granite intruding pelitic gneiss, southern Snyder Lake; **d)** openly folded marble, northwest of Halstead Island (unofficially known as Snyder Island).*

methods following Stern and Amelin (2003). The internal features of the zircons (such as zoning, structures, alteration, etc.) were characterized in back-scattered electron mode (BSE) utilizing a Zeiss EvoÒ 50 scanning electron microscope. Analyses of secondary standard z1242 were interspersed through the analytical sessions and the measured $^{207}Pb/^{206}Pb$ ages compared with the accepted age determined by thermal ionization mass spectrometry (2679.7 Ma, B. Davis, pers. comm., 2010). The Isoplot version 3.00 application of (Ludwig, 2003) was used to generate concordia plots and calculate weighted means. All errors reported in the text are given at the 2σ uncertainty level. Results for each sample are given in Data Repository Item DRI2011008[2].

Leucogranodiorite sample 107-10-014B

A sample of moderately to well-foliated leucotonalite to granodiorite was collected from the core of a structural dome in central Misty Lake (Kremer et al., 2010a, b; Figure GS-1-5). The nature of the contact relationship between leucotonalite and the flanking metasedimentary rocks of the Wollaston Supergroup is unclear, mainly due to structural and recrystallization overprint. Weber et al. (1975) interpreted the leucotonalite and granodiorite to be Archean, based on the apparent absence of tonalite or granodiorite dikes in the flanking metasedimentary rocks, or metasedimentary xenoliths in the leucotonalite and granodiorite. Together, these observations suggest that the intrusive suite could represent a basement inlier to the metasedimentary rocks. A sample of this unit was collected for U-Pb geochronological analysis to test this interpretation.

Zircons recovered from the sample are pale brown to colourless prisms, with oscillatory zoning visible in the outer portions of some grains. The zircons have numerous clear inclusions and are moderately fractured. In

[2] MGS Data Repository Item DRI2011008, containing data or other information sources used to compile this report, is available for download free of charge at http://www2.gov.mb.ca/itm-cat/web/freedownloads.html, or on request from minesinfo@gov.mb.ca or Mineral Resources Library, Manitoba Innovation, Energy and Mines, 360-1395 Ellice Ave., Winnipeg, Manitoba R3G 3P2, Canada.

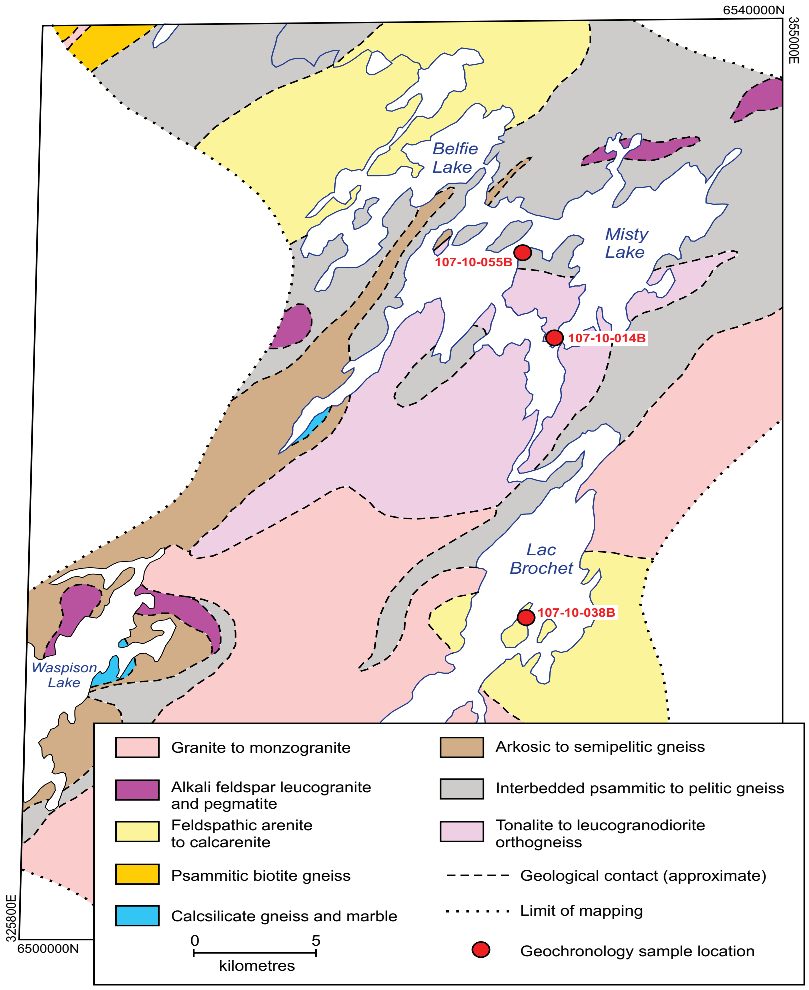

Figure GS-1-5: *Simplified geological map of the Misty Lake area showing the location of geochronolgical samples.*

BSE images the zircons are composed of low U ‘cores’, (medium grey in BSE) with broad concentric zoning, that are mantled by higher U ‘rims’ (lighter grey in BSE) with fine-scale zoning. The oscillatory zoning in both the core and rim are broadly parallel. Crosscutting zoning features that clearly indicate a second, distinct episode of zircon growth are rare; therefore, the observed zoning may reflect a change in the melt composition from which the zircon grew.

Forty-one analyses were conducted on thirty separate zircon grains (Figure GS-1-6a). They yielded ages between 2251 and 2654 Ma. There is a dominant population at ca. 2580, composed largely of analyses of the internal regions of low U zircons. Duplicate analyses of these same domains occasionally give variably concordant, younger ages indicative of Pb-loss. The weighted mean of 14 of the oldest grains (excluding any nonreproducible replicates) is 2584±7 Ma (mean square of weighted deviates [MSWD] = 1.9 Ma), which is interpreted as the crystallization age of the leucogranodiorite. Analysis of eight of the high U rims does not yield distinctly younger ages; they span the same age range as the low U cores. The metamorphic/recrystallization event that affected this sample is interpreted to be responsible for inducing Pb-loss and younger ages in both the low U cores and high U rims; however, the timing of this event cannot be precisely determined. The only constraint is that this event must have occurred later than the $^{207}Pb/^{206}Pb$ age of the youngest analysis, in this case 2251 Ma.

Psammitic gneiss sample 107-10-055B

Psammitic to pelitic gneiss form a sequence that extends from the Cochrane River, northwest of Misty Lake, to the northwestern corner of Lac Brochet (Kremer et al., 2010a, b; Figure GS-1-5). In map pattern, it defines a macroscopic fold cored by foliated leucotonalite to granodiorite. All exposures of paragneiss contain a well-developed layer-parallel foliation that varies from planar to slightly anastomose. Paragneiss is variably migmatitic across the map area, containing in situ anatectic melt pods with irregular boundaries and/or abundant anatectic dike injections. A sample of psammitic gneiss from a succession of psammitic to pelitic gneiss was collected for detrital zircon geochronology near Misty Lake.

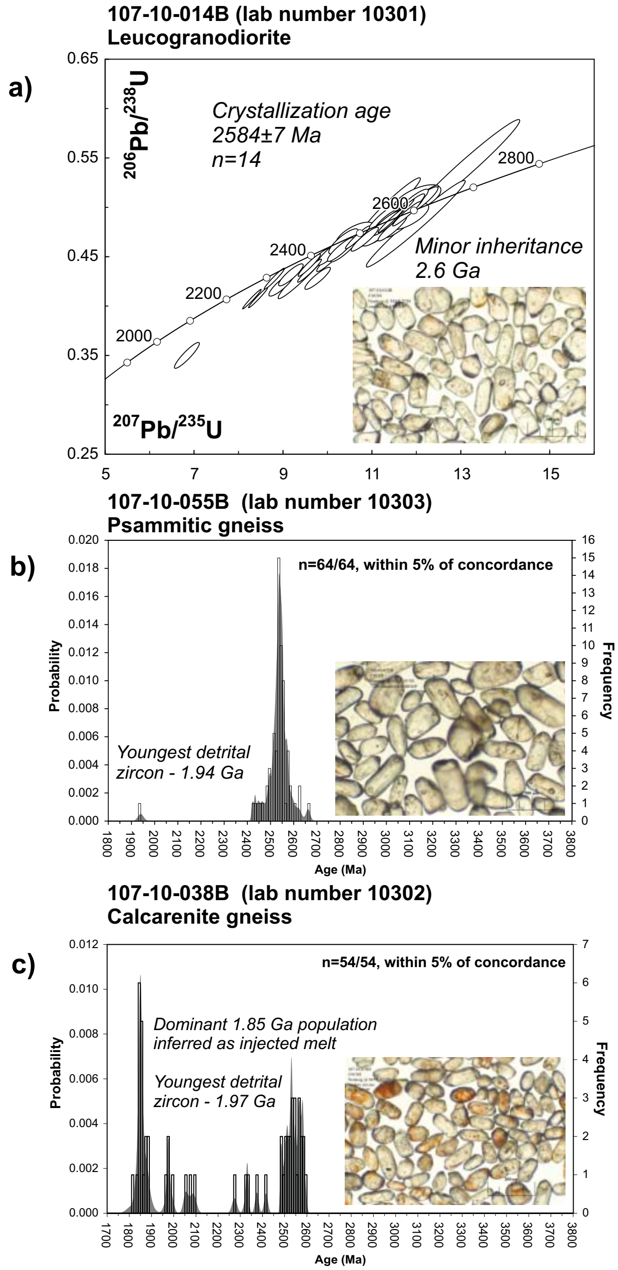

***Figure GS-1-6:** Results from U-Pb geochronological analyses in the Misty Lake area. Ellipses on concordia diagrams are plotted at the 2σ uncertainty level: **a)** concordia diagram showing results from leucogranodiorite sample 107-10-014B; **b)** probability density diagram showing detrital zircon results from paragneiss sample 107-10-055B; **c)** probability density diagram showing detrital zircon results from calcareous arenite sample 107-10-038B.*

The zircons recovered from the paragneiss are large (up to 100 µm wide), prismatic, clear to pale brown, with few inclusions or fractures. In BSE images they typically exhibit faint concentric zoning. The dominant detrital zircon age is centred at 2.54 Ga, with few older (ca. 2.62 Ga) and younger (ca. 2.45 Ga) grains (Figure GS-1-6b). A single younger grain yielded three results between 1900 and 1940 Ma. Since these three results do not yield a statistically significant mean age (MSWD of 2.9) the oldest $^{207}Pb/^{206}Pb$ age is interpreted to be the best estimate of the age of the zircon and the maximum age of deposition of the sediment. It is a large, oscillatory-zoned grain and therefore gives no indication that it represents an episode of in situ metamorphism.

Calcarenite gneiss sample 107-10-038B

A sample of calcarenite gneiss was collected from northwestern Lac Brochet from a suite of well-bedded, medium-grained arenite to calcarenite with minor calc-silicate (Figure GS-1-5). Bedding ranges from 2 to 30 cm in thickness and alternates between white and light pink layers. White layers are composed of quartz and feldspar with minor biotite and magnetite, whereas light pink layers are composed dominantly of quartz and K-feldspar. Fine to coarse grains of diopside and hornblende occur locally and impart a spotted appearance to some of the beds. Arenite is interlayered with calcsilicate rocks composed of diopside, plagioclase and minor quartz. As with the other sedimentary rocks in this area these units attained metamorphic conditions approaching granulite facies and are highly recrystallized.

Zircons recovered from the calcarenite are euhedral prisms, with variably rounded/resorbed outer surfaces. Approximately half of the zircon grains exhibit orange iron-oxide staining and contain few inclusions or fractures. Oscillatory zoning is exhibited in BSE images with high U zircon showing sharp fine-scale zoning and low U zircon with broader, fainter zones. The modal age of zircons (18 of 54 zircons) in this sample is centred at 1850 Ma (Figure GS-1-6c). The remaining zircons yield ages between 1.97 and 2.6 Ga. Age does not correlate with any of the differences in morphology, iron staining or style of zoning described above. A maximum depositional age of 1.85 Ga is inconsistent with other constraints in the Wollaston Domain (Tran, 2001; Tran et al., 2008; Yeo and Delaney, 2007). The oscillatory zoning and relatively high Th/U ratios (0.3–1.2) are not consistent with growth during in situ metamorphism and may instead represent injected melt into the calcarenite. Due to the extensive recrystallization and local hydrothermal alteration of these rocks, clear evidence for injection is not observed at the hand-sample scale, but is inferred here. Therefore, the next youngest population of zircons (four grains at ca. 1.97 Ga) are interpreted as the youngest detrital population and are representative of the maximum age of deposition for the calcarenite sequence.

Economic considerations

Metasedimentary rocks of the Wollaston Supergroup form part of the basement sequence to the Athabasca Basin, and locally are host to unconformity-type basement-hosted uranium deposits in Saskatchewan. Recent exploration in the Snyder Lake area by CanAlaska Uranium Ltd. has identified a number of uranium and/or rare earth element (REE) occurrences (CanAlaska Uranium Ltd., 2009). The mineralization reported by CanAlaska is not limited to a single rock type but has been found to occur in various units throughout the Snyder Lake area, where it is presumed to be associated with regional structural features (CanAlaska Uranium Ltd., 2009). Many of the anomalous values occur in boulders or boulder trains, however some have been traced to outcrop. Two mineralized sites (Pitchblende Ridge and Snyder Island) were visited during the course of the 2011 mapping.

Pitchblende Ridge occurrence

The Pitchblende Ridge uranium showing is located on a large crag southwest of Snyder Lake. CanAlaska Uranium Ltd. reported average values of 1.1% U_3O_8 (including 9.08% and 17%) from boulders in the area and 1.91% and 3.72% U_3O_8 from outcrop. The outcrop is composed of highly metasomatized calcsilicate rocks, which, although mineralogically similar, exhibit a variety of grain sizes and textures. For the most part, calcsilicate rocks consist of varying amounts of calcic and sodic amphibole and clinopyroxene, with small amounts of scapolite, calcite, titanite, graphite, garnet and rare uraninite. Clinopyroxene occurs either dispersed evenly as single crystals (ranging from <1 cm up to 50 cm in size), or in zones and bands of medium-grained aggregates several metres in size. A sharp contact on the western side of the Pitchblende Ridge exposure separates medium- to coarse-grained calcsilicate from very coarse grained to pegmatoid calcsilicate rock (Figure GS-1-7a). Pegmatoid calcsilicate contains white to grey amphibole crystals up to 15 cm in length, locally in radiating crystal aggregates, with clinopyroxene distributed as described above. Pegmatoid calcsilicate yielded the highest spectrometer readings, with values up to 5600 cps. Late fracture and alteration veins crosscut calcsilicate units. Veins

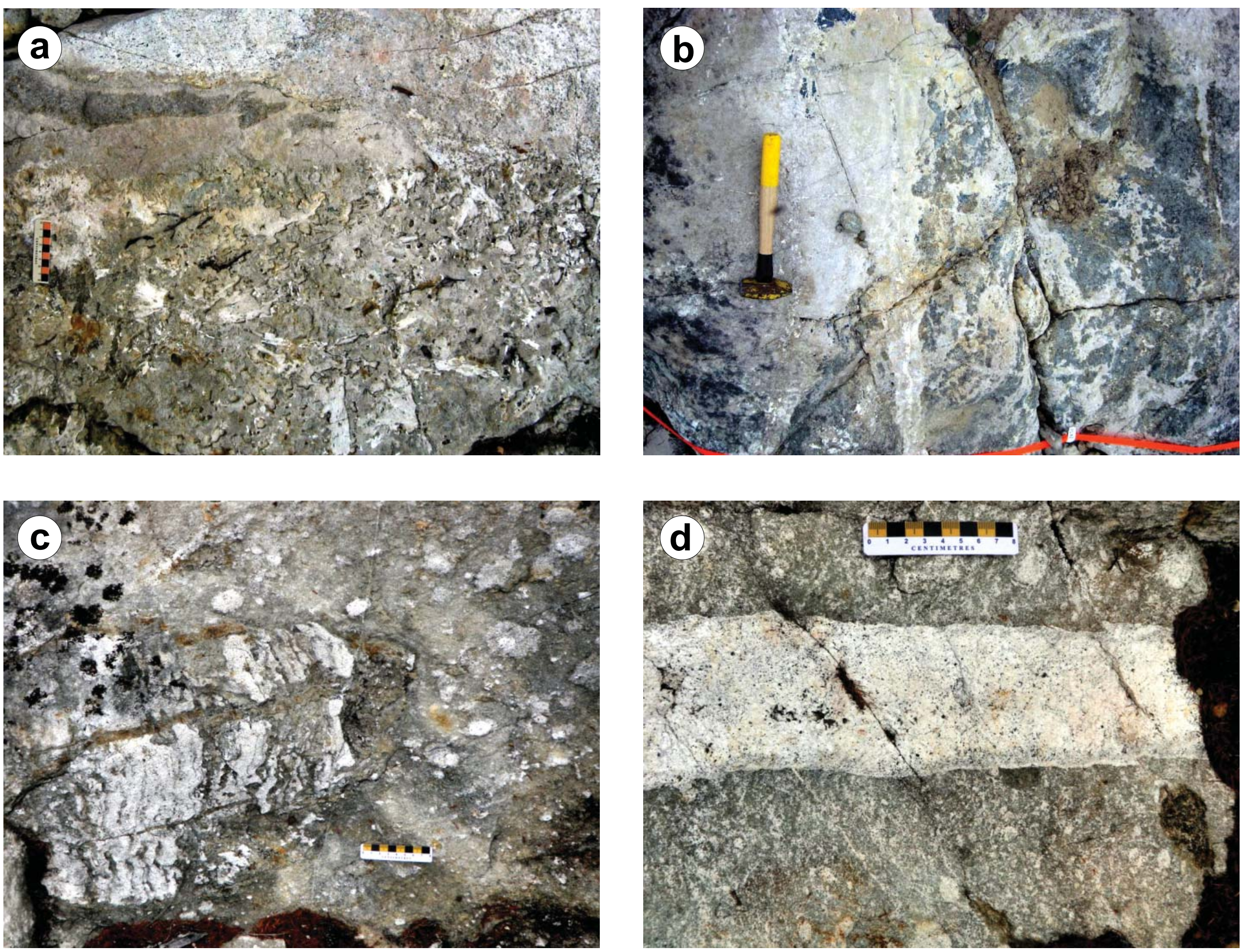

***Figure GS-1-7:** Outcrop photographs of uranium and rare earth element (REE) showings at Pitchblende Ridge and Snyder Island: **a)** sharp contact between pegmatitic and medium-grained calcsilicate at the Pitchblende Ridge occurrence; **b)** crosscutting veins with associated alteration haloes, Pitchblende Ridge occurrence; **c)** subangular arenite and calcsilicate clasts in calcsilicate matrix, Snyder Island occurrence; **d)** alteration zones, Snyder Island occurrence.*

are variably hematized and composed of feldspar, diopside and/or minor calcite, and have fine-grained, albitized alteration haloes up to 20 cm wide (Figure GS-1-7b).

A boulder dispersal train, extending roughly south-southwest, forms a ridge adjacent to the Pitchblende crag. Boulders within this train are predominately of calcsilicate rock types unique to the Pitchblende crag. A detailed till survey was conducted around the Pitchblende Ridge occurrence in an attempt to constrain the direction and distance of the dispersion pattern (Trommelen, GS-2, this volume).

Snyder Island occurrence

The Snyder Island uranium occurrence is located on Halstead Island near the western shore of Snyder Lake. The area was investigated by United Siscoe Mines Ltd. during the 1970s through geological mapping, rock and lake sediment sampling, and limited diamond drilling. Between 2005 and 2007, CanAlaska Uranium Ltd. carried out prospecting, mapping, outcrop washing and soil, drift and outcrop sampling on Halstead Island as part of their northwest Manitoba project (CanAlaska Uranium Ltd., 2010). Significant results from their prospecting indicate assays of up to 11.07% U_3O_8 from uraninite pebbles in sandy overburden and up to 0.79% U_3O_8 in outcrop. Results of their soil sampling showed that elements closely correlated to uranium include light and heavy REEs, Y and some base metals.

The local geology of the Snyder Island occurrence consists of a suite of intensely metasomatized and altered calcsilicate rocks within calcareous semipelitic and psammitic gneiss intruded by leucocratic K-feldspar granite. The main rock type observed on outcrops at north-central Halstead Island is a light greenish-white to pale grey calcsilicate, with locally abundant subangular to round clasts and fragments, suggesting a conglomeratic or brecciated origin. The clasts are typically 1–5 cm in size and are dominantly fine-grained recrystallized, light grey to greenish calcsilicate. Rare larger, subangular clasts up to 30 cm in size are composed of interlayered siliciclastic and calcsilicate lithofragments (Figure GS-1-7c). Based on the presence of abundant sodic scapolite, the calcsilicate is interpreted as a highly metamorphosed evaporate. Veins in the calcsilicate host rock are weakly layered and folded, and the clasts tend to be aligned along the main foliation. Silicification, argillization, bleaching (albitization) and hematization are pervasive and formed diffuse zones and veins of coarse-recrystallized scapolite and/or feldspar, diopside, biotite/phlogopite, sphene, epidote, carbonate and opaque minerals (Figure GS-1-7d). Leucocratic albite-rich granite forms dikes up to 1 m wide that trend ~010° and cut all calcsilicate rocks except a latest phase of coarse-grained calcsilicate fracture veins related to late brittle faults.

Pervasive calcic and/or alkalic metasomatism similar to that observed in the Snyder and Misty lakes areas has been described in association with a variety of mineral deposit types, including intrusion-hosted or metasomatic U, REE and rare-element deposits (U, skarn, carbonatite-related REE-Nb-F, LCT-type pegmatites [Černy, 1991] and peralkaline granitoid-related Zr-Nb-Y-REE-F). Rather than sharing similarities with unconformity-related uranium deposits of the Athabasca Basin to the west, the alteration/mineralizing systems observed in the Snyder and Misty lakes areas more resemble intrusion-related and metasomatic U and REE deposits (e.g., Valhalla deposit in Australia). The abundance of pervasively altered and deformed calcsilicate rocks together with the common presence of intense metasomatic veining and faulting warrant detailed follow-up work at Snyder and Misty lakes to better delineate the extent and understand the nature of uranium and REE enrichment.

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