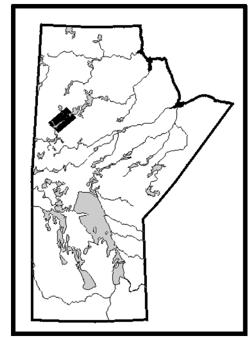
GS-18 CHURCHILL RIVER–SOUTHERN INDIAN LAKE TARGETED GEOSCIENCE INITIATIVE (NTS 64B, 64C, 64G, 64H), MANITOBA: UPDATE AND NEW FINDINGS

by D. Corrigan[1] and N. Rayner[1]



Corrigan, D. and Rayner, N. 2002: Churchill River–Southern Indian Lake Targeted Geoscience Initiative (NTS 64B, 64C, 64G, 64H), Manitoba: update and new findings; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 144–158.

SUMMARY

This paper provides a brief summary of the fieldwork performed during the 2002 field season as part of the Churchill River–Southern Indian Lake Targeted Geoscience Initiative. This was the second of two field seasons directed at upgrading our understanding of the lithological and tectonic framework of the northern flank of the Trans-Hudson Orogen, with a main objective of providing a regional geological context to potential ore deposits. During this past field season, the transect from the central part of the Rusty Lake belt was completed southwards to the northern flank of the Burntwood Group in the Kisseynew Domain. Detailed reports and maps are pending on upcoming geochronological and geochemical analyses, and will be published within the coming months as open files.

INTRODUCTION

The Lynn Lake Multidisciplinary Geoscience Project was initiated by the Manitoba Geological Survey (MGS) in 2000 to provide an integrated and updated view on the regional geology and economic mineral potential of the Lynn Lake belt and surrounding area. In 2001 and 2002, the Geological Survey of Canada joined the MGS through a new federal government Targeted Geoscience Initiative (TGI), with the specific intention of providing a regional tectono-stratigraphic context for the Lynn Lake belt, Rusty Lake belt and other volcanic, sedimentary and plutonic belts that occur along a transect spanning the entire northern flank of the Trans-Hudson Orogen (THO), from the north flank of the Kisseynew Domain to the Wathaman-Chipewyan Batholith (Fig. GS-18-1). This TGI project covers parts of four 1:250 000-scale NTS sheets (64A, 64B, 64G, 64H) and follows up on a similar, multidisciplinary, bedrock-mapping project that was recently completed along Reindeer Lake in Saskatchewan (Corrigan et al., 1997, 1998a, 1998b, 1999a, 1999b, 2000; Corrigan, 2000a, 2000b, 2001). One of the primary goals of this TGI is to complete a similar transect

[1] Geological Survey of Canada, 615 Booth Street, Ottawa, Ontario K1A 0E9

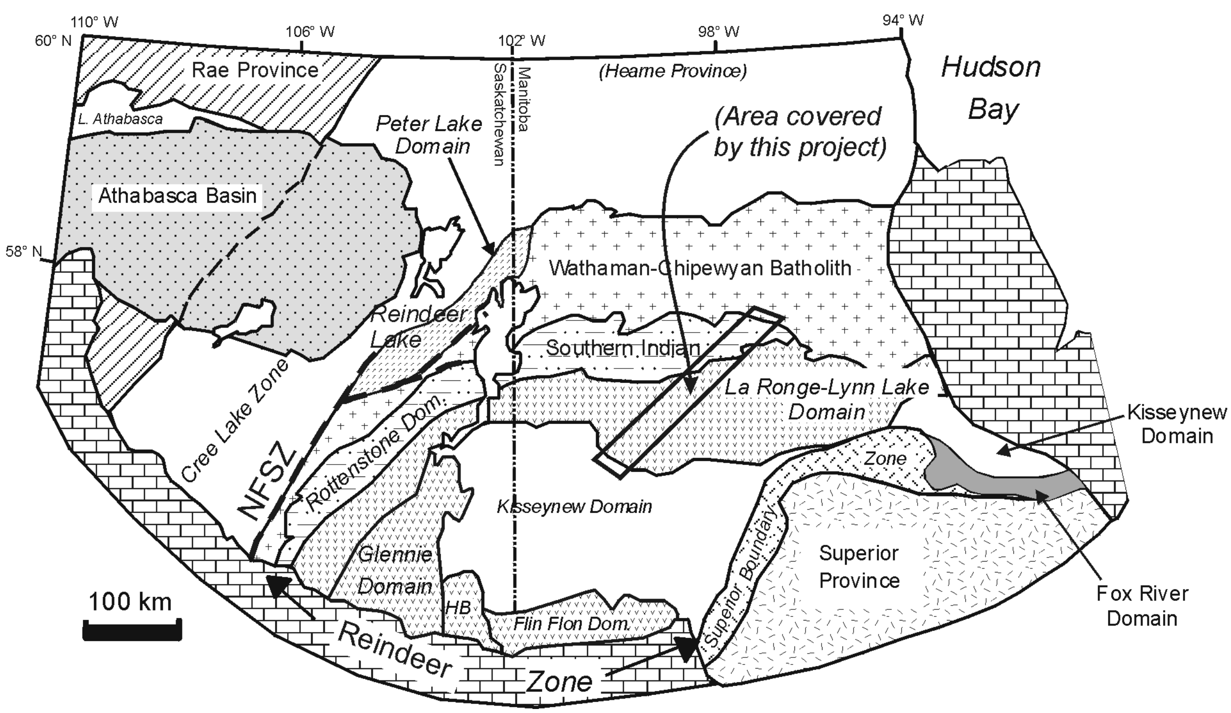


Figure GS-18-1: Simplified geology of the Trans-Hudson Orogen in Manitoba and Saskatchewan (after Lewry and Collerson, 1990). Abbreviation: NFSZ, Needle Falls Shear Zone.

from the northern flank of the Kisseynew Domain to the southern margin of the Wathaman-Chipewyan Batholith (Fig. GS-18-2). The new data will enable a better understand of the tectonostratigraphic framework and tectonic evolution of the Lynn Lake and associated belts in northern Manitoba. Integration of the results with those from the Reindeer Lake transect will further the understanding of the Trans-Hudson Orogen, provide a tectonic context for ore formation and mineralization, and permit comparisons with other known metallotects (e.g., the Flin Flon and Snow Lake belts).

Results presented herein highlight preliminary findings of the second of two field seasons. Emphasis during the 2002 field season was not directed at systematic bedrock remapping, since that had been previously done in relative detail, but at the re-evaluation of lithological assemblages in terms of protolith origin, geochemical signature, isotopic age, tectonic environment of emplacement/deposition, and provenance (in the case of major sedimentary units). The GSC-led regional synthesis 'dovetails' with detailed structural, geochronological and metallogenic studies of the Lynn Lake belt undertaken by the Manitoba Geological Survey (Beaumont-Smith and Böhm, GS-19, this volume) in collaboration with the Universities of Alberta and New Brunswick, and Laurentian University. In the first summer, the work covered, at various scales, an area of approximately 8000 km^2, extending from the Rusty Lake belt at the latitude of Leaf Rapids to the Partridge Breast Lake Belt on the lower Churchill River. Fieldwork consisted mainly of traverses by boat and on foot on the shoreline and islands of the better exposed Churchill River–Southern Indian Lake system, as well as a transect, mainly by road access, across the northwestern portion of the Rusty Lake belt. Preliminary results were summarized in Corrigan et al. (2001). This summer saw the completion of the southern half of the regional transect, from Leaf Rapids to Wheatcroft Lake, south of Granville Lake. The main points of this past field season are summarized below. A brief, partial summary of the preliminary radiogenic isotope data and their first-order implications is also provided.

REGIONAL GEOLOGY

The supracrustal and associated plutonic rocks on the northern flank of the THO in Manitoba have been previously assigned to three main lithological packages: the Kisseynew, Lynn Lake–Leaf Rapids and Southern Indian domains.

The Kisseynew Domain comprises mainly upper amphibolite to granulite facies metaturbidite of the Burntwood Group, flanked to the north by fluvial to shallow marine meta-arkosic and psammitic rocks of the Sickle Group.

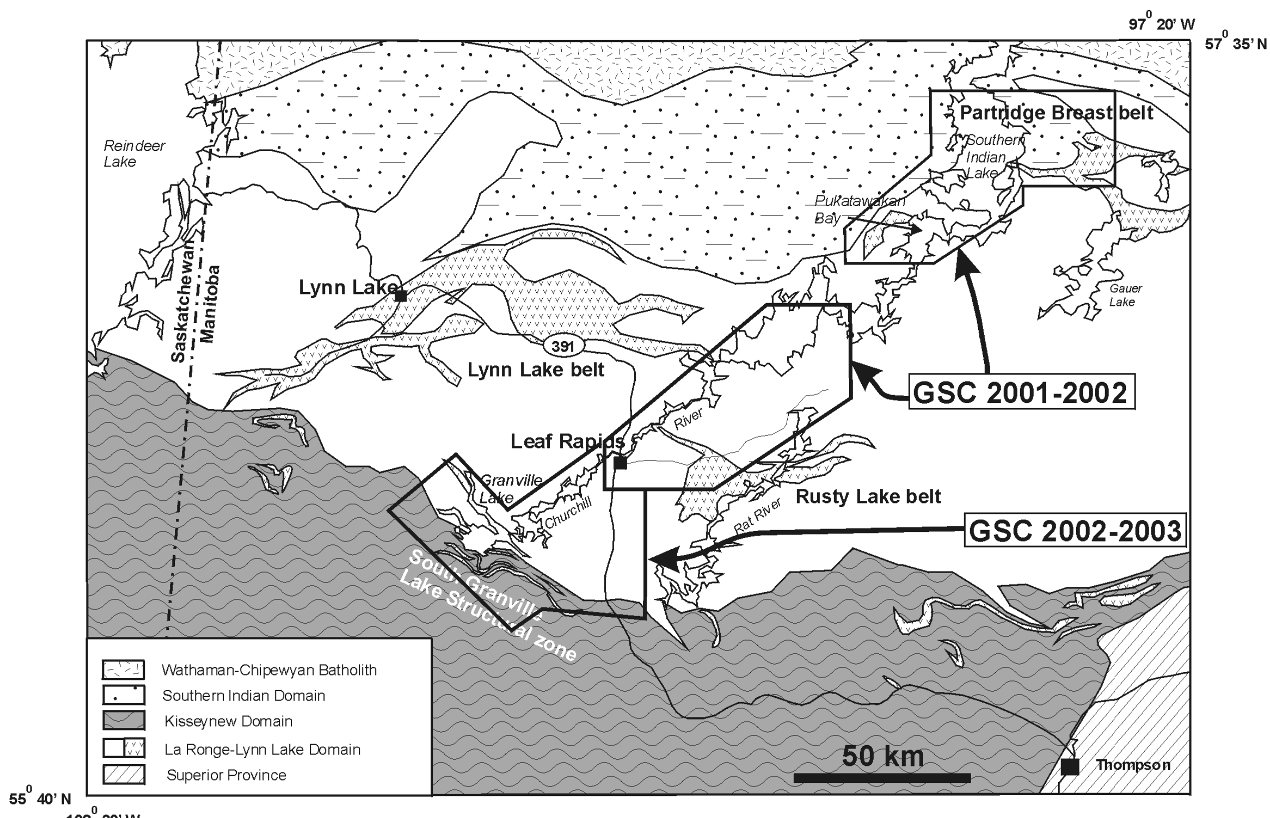


Figure GS-18-2: Major geological domains along the north flank of the Trans-Hudson Orogen in Manitoba, showing approximate areas covered by this project.

Geochronological data obtained mainly on the southern and western margins of the Kisseynew Domain constrain the ages of deposition during the interval 1.85–1.84 Ga for the Burntwood Group and 1.84–1.835 Ga for the Sickle Group (Ansdell and Yang, 1995). The structural boundary between the Burntwood and Sickle groups is also the site of a narrow but laterally continuous unit (over 400 km in strike length) that comprises folded and boudinaged mafic flows and sills of mid-ocean ridge basalt (MORB) affinity, interlayered with calcareous psammite, metapelite and minor quartzite. This package, named the Levesque Bay assemblage in Saskatchewan (Corrigan et al., 1998b, 1999b) is intruded by 1896 +18/–16 Ma leucogranite dikes, suggesting that it may be either contemporaneous with, or older than, the La Ronge and Lynn Lake arcs. The Levesque Bay assemblage stratigraphically correlates with the MacLean Lake belt in Saskatchewan (Thomas, 1993; Harper, 1998) and the Granville Lake structural zone in Manitoba (Zwanzig, 2000).

The Kisseynew Domain is flanked to the north by the Lynn Lake–Leaf Rapids Domain, which comprises a tectonic collage of ca. 1.90–1.88 Ga (Baldwin et al., 1987) volcanic and associated epiclastic and sedimentary rocks (*see*, however, Beaumont-Smith and Böhm, GS-19, this volume). Most of the tectonostratigraphic elements can be correlated with units in the La Ronge Domain in Saskatchewan (Maxeiner et al., 2001). Two major volcanic belts have been identified, the Lynn Lake and Rusty Lake belts, each of which has been further subdivided into separate litho-tectonic components and subcomponents based on geochemical signature and inferred plate-tectonic setting, which includes tholeiitic arc, calc-alkaline arc, MORB-like and oceanic island basalt (OIB)–like rocks (Syme, 1985; Ames and Taylor, 1996; Zwanzig et al., 1999). Field relationships suggest that the various volcano-sedimentary assemblages were aggregated into a tectonic collage before the emplacement of calc-alkaline plutons, which include ca. 1876 Ma gabbro stocks and tonalite (Baldwin et al., 1987).

The Southern Indian Domain flanks the Lynn Lake–Rusty Lake belt to the north and, for the most part, correlates with the Rottenstone Domain in Saskatchewan. It is dominated by foliated granitoid orthogneiss and clastic sedimentary rocks that include conglomerate, greywacke and metaturbidite, as well as subordinate rocks of volcanic origin. Recent work on Reindeer Lake in Saskatchewan has led to the recognition of at least two distinct sedimentary basins in the Rottenstone Domain. They consist of the Milton Island assemblage (Corrigan et al., 1997), interpreted as a fore-arc or accretionary complex formed north of the advancing La Ronge–Lynn Lake arc, and the Park Island assemblage (Corrigan et al., 1999b), interpreted as forming part of a foreland–molasse basin that was deposited on the Hearne continental margin and its autochthonous cover sequence as a result of tectonic loading of the La Ronge–Lynn Lake arc. Stratigraphic equivalents of the Park Island assemblage have also been interpreted to occur in the upper sequence of the Wollaston Domain (Janice Lake assemblage; Yeo, 1998).

The area north and south of the Southern Indian Domain is dominated by the voluminous Chipewyan Batholith and related Baldock and Livingston plutons. The Chipewyan Batholith is the Manitoba equivalent of the Wathaman Batholith and consists of a continental magmatic arc that was emplaced during the interval 1.86–1.85 Ga (Fumerton et al., 1984; Van Schmus and Schledewitz, 1986; Meyer et al., 1992). Compositions within the batholith range mainly from quartz diorite to syenogranite, with hornblende-biotite monzogranite forming the most abundant rock type. The ca. 1855 Ma Baldock granite (Van Schmus; U-Pb zircon age cited in Manitoba Energy and Mines, 1990) intrudes supracrustal rocks and orthogneiss of the Southern Indian Domain along its northern margin and appears to merge with the Wathaman-Chipewyan Batholith east of the Partridge Breast Lake belt. It intrudes supracrustal and plutonic rocks of the Rusty Lake belt on its southern flank. The Livingston granodiorite forms another east-trending elongate pluton that intrudes the Rusty Lake belt on its northern margin and the Sickle and Burntwood groups along its southern margin. Its emplacement age is presently unconstrained.

GRANVILLE LAKE–CHURCHILL RIVER AREA

Mapping during the 2002 field season was concentrated on the Granville Lake area of the Churchill River system (Fig. GS-18-3), completing the regional transect across the northern flank of the Trans-Hudson Orogen, from the northern flank of the Kisseynew Domain to the Wathaman-Chipewyan Batholith. The objective of this second and last season of field mapping was mainly to investigate the tectonostratigraphy of the northern Kisseynew Domain, in light of new constraints established from a similar transect in Saskatchewan (Corrigan et al., 1999a, 2000b), which suggested the presence of potentially older supracrustal rocks (the ca. 1.89 Ga Levesque Bay assemblage), tectonically imbricated between the ca. 1.85–1.84 Ga Burntwood and Sickle groups.

The Granville Lake area was mapped by Barry (1965), Barry and Gait (1966), Cranstone (1968), Campbell and Kendrick (1972) and Zwanzig (1981), with a reissued map by Zwanzig and Cameron (2002). Along Churchill River, Laurie River and Granville Lake, the Burntwood and Sickle groups are relatively well exposed, forming a predominantly south-dipping stack of variably strained, lower- to middle-amphibolite facies siliciclastic rocks with minor

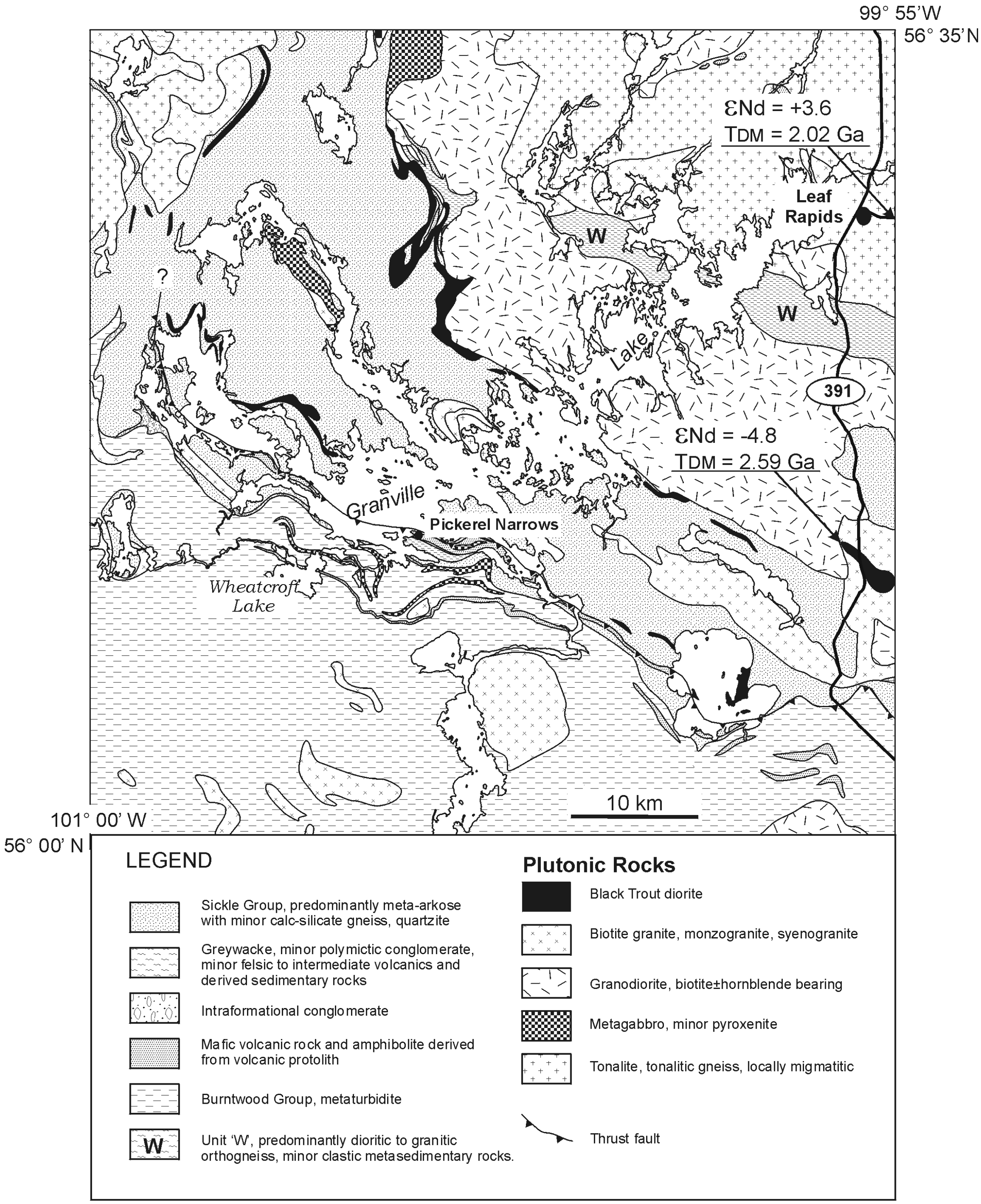


Figure GS-18-3: Simplified geology of the Granville Lake area (after Manitoba Energy and Mines, 1986a, b).

volcanic flows and sills. Mafic volcanic flows are concentrated in the upper stratigraphic levels of the Burntwood Group, as well as in an approximately 2 km wide band lying between the Burntwood and Sickle groups, informally named the ‘Granville Lake structural zone’ (Zwanzig, 1990). The Sickle Group forms an upright syncline with its southern limb in structural contact with the Burntwood Group and its northern limb in possible unconformable contact with underlying granitoid rocks (*see* below). The above are intruded by more than one suite of mafic to felsic plutons and sills, as is suggested from relationships with the various sedimentary sequences and structures. The following sections provide brief descriptions of the tectonostratigraphy of the Burntwood and Sickle groups.

Burntwood Group

In the Wheatcroft Lake area south of Granville Lake, the Burntwood Group is affected by a regional metamorphic low, with mineral assemblages suggesting middle to lower amphibolite facies. Sedimentary structures, although substantially shortened perpendicular to bedding, are well preserved and suggestive of deposition by turbidity currents in a deep basin. Bedding couplets, ranging from a few millimetres to a few tens of centimetres thick and grading from psammite to psammopelite and more rarely to pelite, form the dominant sedimentary facies (Fig. GS-18-4). Although massive to laminar beds account for most of the structures observed, crossbeds are present but less common. Oval-shaped, calc-silicate pods, up to one metre in long axis length, are common throughout the siliciclastic rocks. They likely represent metamorphosed calc-silicate nodules. Younging directions are common and suggest that the entire sequence is overturned to the north, with minor facing reversals on short limbs of asymmetric folds. The metamorphic assemblage in the pelitic layers is biotite-garnet-sillimanite±cordierite±staurolite.

The structurally lowest — and stratigraphically highest — part of the Burntwood Group contains concordant amphibolite layers, up to 250 m thick and continuous over a strike distance of tens of kilometres or more. Of those observed this summer, only two appeared to be unequivocally derived from a volcanic protolith, with an overall very fine grained texture, abundant calc-silicate alteration and preservation of pillow rinds. The majority are medium to coarse grained, more compositionally and texturally homogeneous, and contain chilled margins, suggesting that they were derived from a mafic intrusive protolith of apparently gabbroic to dioritic composition.

Granville Lake structural zone

This south-dipping supracrustal assemblage sits structurally beneath Burntwood Group metaturbidite. It contains numerous north-younging (overturned) top indicators with rare south-facing ones, suggesting that it stratigraphically overlies Burntwood Group turbidite and contains a similar style of folds. It is compositionally heterogeneous, containing coarse- to fine-grained siliciclastic rocks, calc-silicate gneiss and greywacke, as well as mafic to intermediate volcanic and associated volcaniclastic rocks. Its stratigraphic base consists of a finely laminated psammite that grades rapidly into a quasi-monolithic (intraformational), grey, clast-supported conglomerate (Fig. GS-18-5) with distinctive pebble- to cobble-sized clasts that strongly resemble the psammitic layers within the Burntwood turbidite. Most of the clasts are massive, but some contain laminar and crossbedded structures, as well as graded beds typical of some of the horizons found in the turbidite. The conglomerate also contains rare calc-silicate clasts, possibly derived from the carbonate concretions described above. This nearly monolithic, potentially locally derived clast composition is quite distinctive from the usually polymictic, granitoid-rich nature documented elsewhere for the base of the Sickle Group and its Saskatchewan equivalent (McLellan Group).

The conglomerate grades upwards into grey to pink, amphibole-bearing meta-arkose (Fig. GS-18-6), which grades into a pink to light grey, biotite- and muscovite-rich, magnetite-bearing, locally crossbedded arkose that is, in many aspects, indistinguishable from 'proper' Sickle arkose. This arkose-dominated layer, a few hundreds of metres wide, is in turn overlain by relatively thin and laterally discontinuous horizons of mafic tuff (or mafic wacke), greywacke and polymictic conglomerate, with thin, minor marble and impure quartzite horizons. The mafic tuff-wacke contains rounded

Figure GS-18-4: Burntwood Group turbidite showing graded psammite beds and calc-silicate concretions (arrow), south shore of Granville Lake. Pencil for scale.

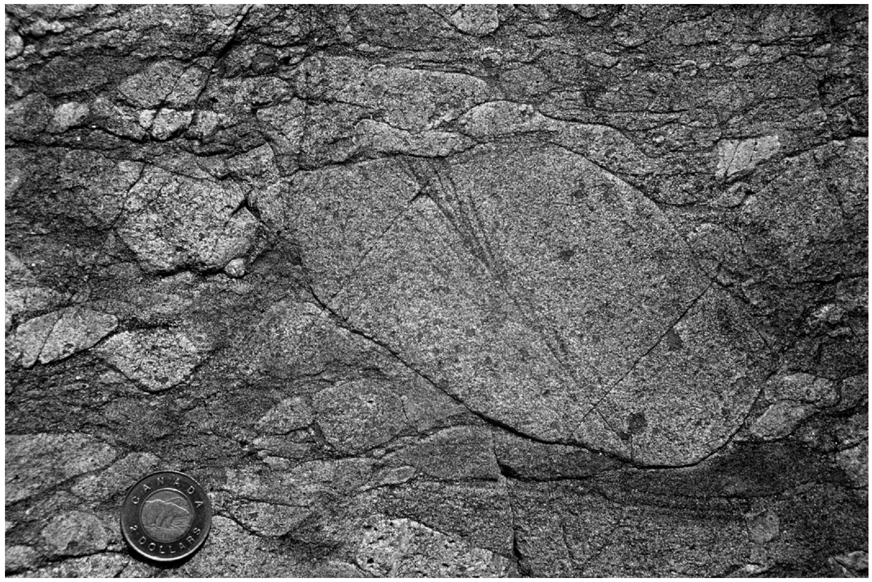


Figure GS-18-5: Intraformational, clast-supported conglomerate with psammite cobbles. Note crossbeds in the large clast in centre of photograph. Coin is 2.8 cm in diameter.

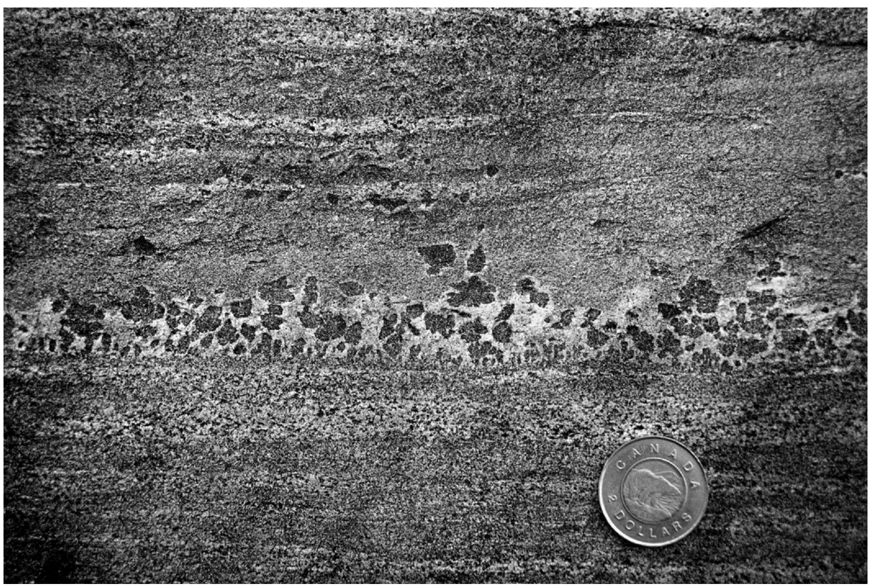


Figure GS-18-6: Bedded, hornblende- and biotite–bearing, 'Sickle-like' meta-arkose from the Granville Lake structural zone, southern shore of Granville Lake. Note large hornblende porphyroblasts in the layer in centre of photograph. A similar unit has been observed in the >1.86 Ga Park Island assemblage along Reindeer Lake in Saskatchewan. Coin is 2.8 cm in diameter.

to subangular mafic fragments set in a mafic to intermediate matrix (hornblende-biotite-plagioclase-quartz). It is massive to well banded and contains rare, grey, aphanitic quartzite layers that may represent recrystallized chert horizons. In the western Granville Lake area, the mafic tuff-wacke locally grades stratigraphically upwards into a well-banded greywacke a few tens of metres thick, which is in turn overlain by a thick mafic volcanic flow. In the Pickerel narrows[2] area, the transition from 'Sickle-like' meta-arkose to the upper mafic volcanic flow is more complex.

A section through the well-exposed shoreline near this locality shows a transition, moving stratigraphically upwards, from mainly biotite psammite to a felsic fragmental rock with a fine-grained, bone white matrix, interpreted as a rhyodacitic to dacitic tuff (Fig. GS-18-7), that in turn grades upwards into rhyolite. This layer is overlain by a hornblende- and biotite-bearing greywacke a few tens of metres thick, which grades stratigraphically upwards into psammopelite with abundant faserkiesel (Fig. GS-18-8). The psammopelite is overlain by polymictic conglomerate along a relatively sharp conformable contact (Fig. GS-18-9). Clasts are angular to rounded and are predominantly derived from mafic to felsic volcanic rocks, but include siliciclastic sedimentary rocks as well as fine-grained felsic granitoid bodies. The polymictic conglomerate grades stratigraphically upwards into grey psammite, which is itself overlain by calc-silicate rock and by a thick, highly altered mafic volcanic horizon. A third section along the upper Churchill River, east of Pickerel narrows, highlighted a more complex stratigraphy than the ones described above, with the presence of numerous, relatively thin layers of quartzite (?metachert), ultramafic flows or sills, and mafic wacke

[2] unofficial name

interlayers within the mafic volcanic flows. In contrast with the sections to the west, the mafic flows along this section rest directly on 'Sickle-like' meta-arkosic rocks.

An immediate question that comes to mind regarding the Granville Lake structural zone is whether the intraformational conglomerate located at the base of the sequence, as well as the 'Sickle-like' meta-arkose lying stratigraphically above, belong to the Sickle Group in the strict sense, or whether they form a distinct package integral to the Granville Lake structural zone. This distinction has important tectonic and stratigraphic implications and needs serious consideration. A similar conundrum resulted from mapping a detailed section through the Levesque Bay assemblage along Reindeer Lake, Saskatchewan, where meta-arkose previously assumed to belong to the McLennan (i.e., Sickle) Group were found to be intruded by 1867 ± 4 Ma tonalite, which provided a minimum age of deposition for that unit. This contrasts sharply with the presently established age of ca 1840–1835 Ma for deposition of the McLennan Group arkose (Ansdell and Yang, 1995) and the Missi Group in the Flin Flon area, which is believed to be a Sickle equivalent (Stauffer, 1990).

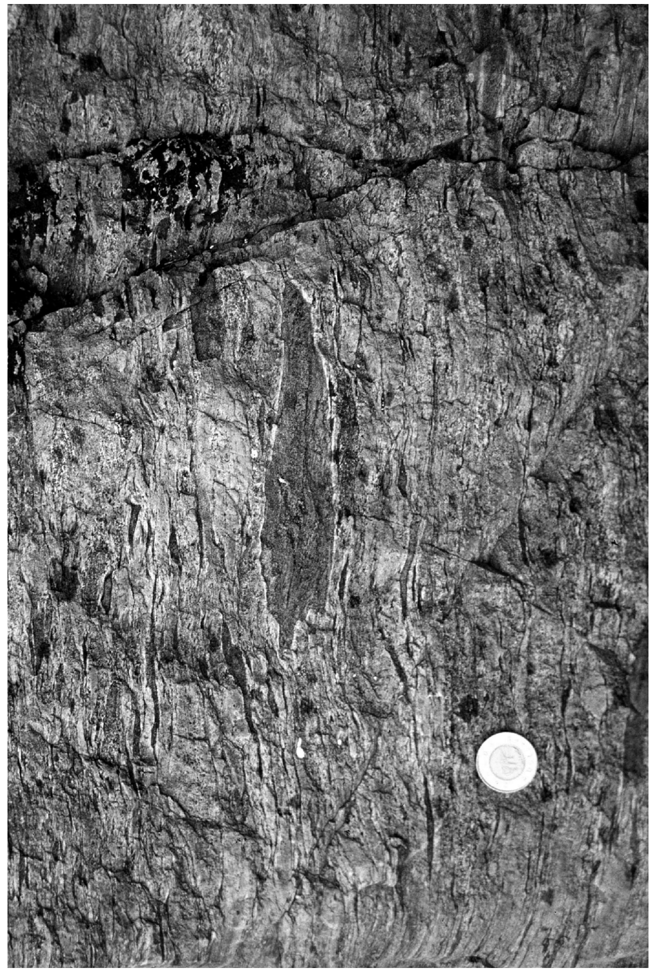


Figure GS-18-7: Felsic tuff-breccia with fragments of intermediate composition, shore of island west of the community of Pickerel narrows. Coin is 2.8 cm in diameter.

Sickle Group

A large proportion of the Sickle Group occurs in the Granville Lake area and forms large, kilometre-scale, gently plunging, upright folds. The basal unit, exposed along both southern and northern flanks of the fold structure, consists of a muscovite-bearing impure quartzite a few decimetres to a few tens of metres thick (Fig. GS-18-10). Along the southern flank, it is strongly mylonitized and forms the footwall of a north-verging thrust fault (Fig. GS-18-11), with mafic volcanic rocks of the Granville Lake assemblage forming the hanging wall. Along the northern flank of the fold structure, the basal quartzite is in contact with a large, variably foliated, biotite granite (Fig. GS-18-12) that shows a strain increase towards the contact with the quartzite.

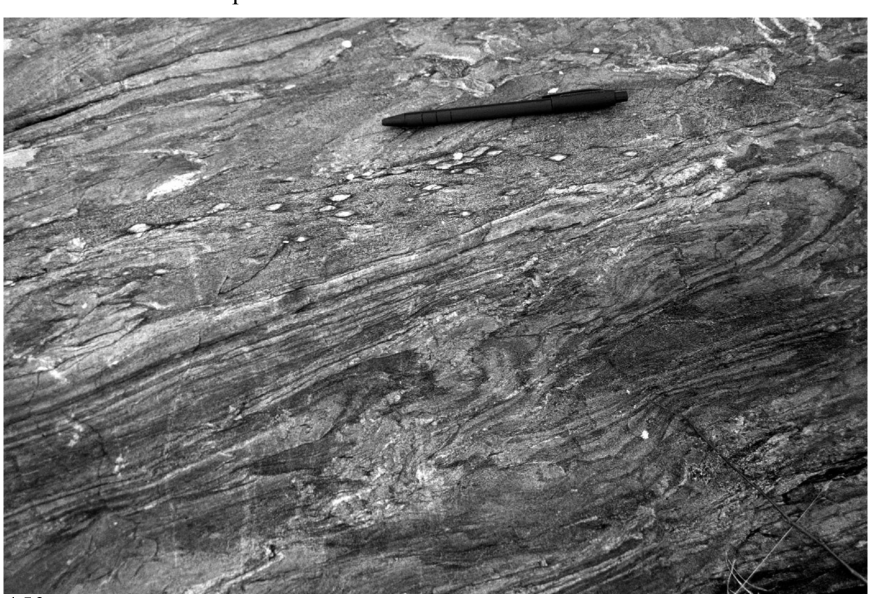


Figure GS-18-8: Metapelitic rock from the Granville Lake structural zone, southern shore of Granville Lake, showing faserkiesel (fibrolite knots) oriented at a slight anticlockwise angle to the transposed beds. Pen for scale.

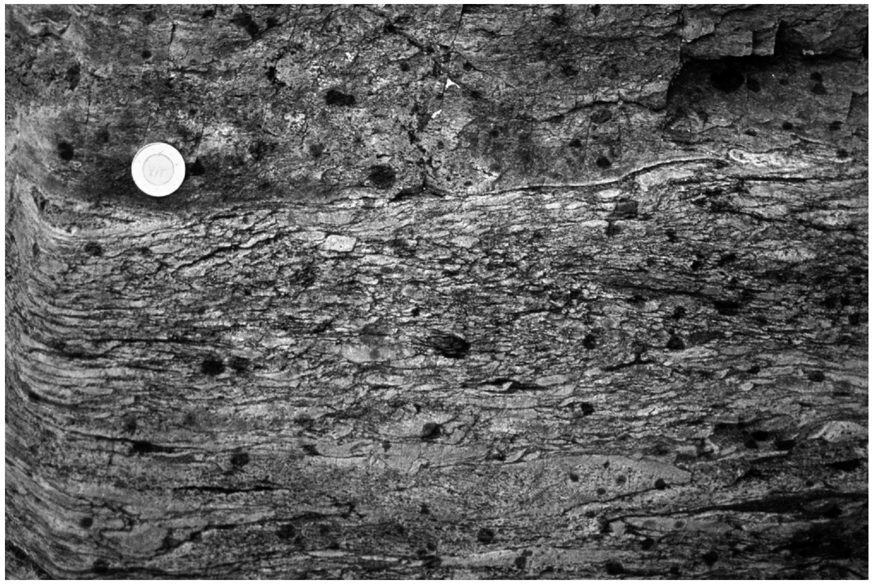


Figure GS-18-9: Polymictic conglomerate from the Granville Lake structural zone, southern shore of Granville Lake. Note the subangular to subrounded shape of the clasts, suggesting a relatively proximal source. Coin is 2.8 cm in diameter.

Figure GS-18-10: Steeply dipping quartzitic base of the Sickle Group, along its northern flank on Granville Lake. Dark grey bands are nearly pure quartzite; lighter coloured and narrower bands are muscovite rich.

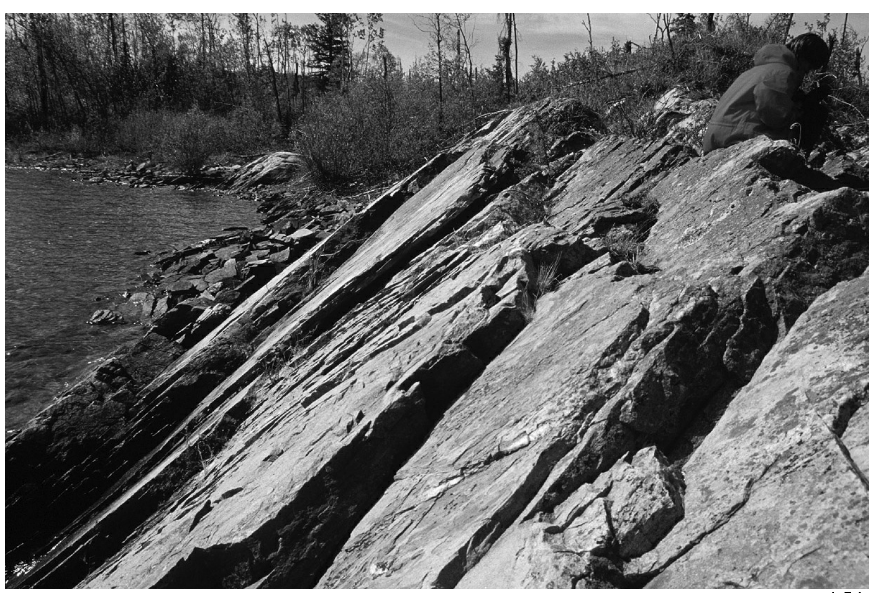


Figure GS-18-11: Highly strained and flaggy quartzite from the stratigraphic base of the Sickle Group on Granville Lake. View is to the west, and shows the moderate southerly dip surface. Mylonitic mafic volcanic rocks from the leading edge of the Granville Lake structural zone are to the left of the picture (not shown). Stretching lineation is nearly downdip (not shown). Person for scale.

Figure GS-18-12: Coarse-grained monzogranite flanking the Sickle Group to the north, along Granville Lake. The moderate foliation fabric (top to bottom on photograph) is parallel to the transposition plane in the adjacent quartzite. Fibrolite-muscovite–rich knots (arrow) are only present in the monzogranite near the contact with the quartzite. Coin is 2.8 cm in diameter.

The quartzite contains variable muscovite concentrations and locally includes rare, quartz pebble conglomerate lenses. The biotite granite contains an increasing abundance of muscovite towards the contact with the quartzite. Foliation is parallel in both units, and parallel to the contact. The presence (although rare) of pebble conglomerate in the quartzite, the absence of quartzite xenoliths in the granite, and the high concentration of muscovite in the granite margin all suggest that this may be a reworked unconformity. However, the possibility that it is a reworked intrusive contact cannot be ruled out. In order to address this question, a sample of the quartzite was taken for U-Pb sensitive high-resolution ion microprobe (SHRIMP) analysis, and a sample of the biotite granite was taken for U-Pb thermal ionization mass spectrometry (TIMS) analysis. If the biotite granite is indeed basement to the quartzite, its emplacement age should be older than the youngest detrital zircon grain in the quartzite. A granite intruding the Sickle Group was also sampled in order to provide constraints on the minimum age of the latter.

Supracrustal rocks north of the Sickle Group (unit 'W')

North of the Sickle Group in the Leaf Rapids Domain, a major linear belt had been previously interpreted as a predominantly supracrustal unit of unknown age (unit 'W' in Manitoba Energy and Mines, 1986a). This belt was revisited in order to determine its age and relationship relative to other supracrustal belts in the immediate region. A detailed transect through the well-exposed shoreline and islands along Granville Lake indicated that rocks of sedimentary or volcanic origin form only a very limited portion of this unit, with most of the belt being composed of banded gneiss of definite plutonic origin. The metasedimentary rocks, which form either transposed enclaves in the metaplutonic rocks or elongate subunits a few metres to a few hundred metres thick, are predominantly composed of biotite-muscovite-sillimanite–bearing psammite and psammopelite. One single unit of potential — but equivocal — volcanic origin was observed. It consists of a 3 m thick layer of banded mafic to ultramafic rock with carbonate alteration, and is associated with a rusty, mafic to intermediate gneiss of probable volcaniclastic origin. Overall, unit 'W' is mainly composed of moderately to highly strained banded orthogneiss of granitic to ultramafic composition. Within a few tens of metres, one can walk on continuously exposed bedrock from what is clearly an intrusive complex (Fig. GS-18-13), with multiple injections of variable composition, to an essentially 'straight' banded gneiss that strongly resembles a volcanic-derived sediment (Fig. GS-18-14, GS-18-15).

Plutons and sills in the Granville Lake area

Field relationships and preliminary Sm-Nd data suggest that there are at least three generations of plutonic rock suites in the north flank of Kisseynew Domain and southwestern Rusty Lake belt, within the Granville Lake area. The potentially oldest suite is located in the Rusty Lake belt, approximately 20 km south of Leaf Rapids, and consists of a migmatitic granitic gneiss (Fig. GS-18-16) intruded by a foliated diorite, which yielded a T_{dm} Nd model age of 2.83 Ga and an ε_{Nd} value of –7.1 (Ch.O. Böhm and R. Creaser, pers. comm., 2002), indicating either that it is an Archean to early Paleoproterozoic rock, or that it is Proterozoic but has incorporated a substantial amount of Archean crust during its generation and emplacement. However, this Nd model age is consistent with another, similar Nd model age obtained on a tonalite from the Southern Indian Domain, which yielded a U-Pb zircon age of ca. 2.45 Ga (N. Rayner,

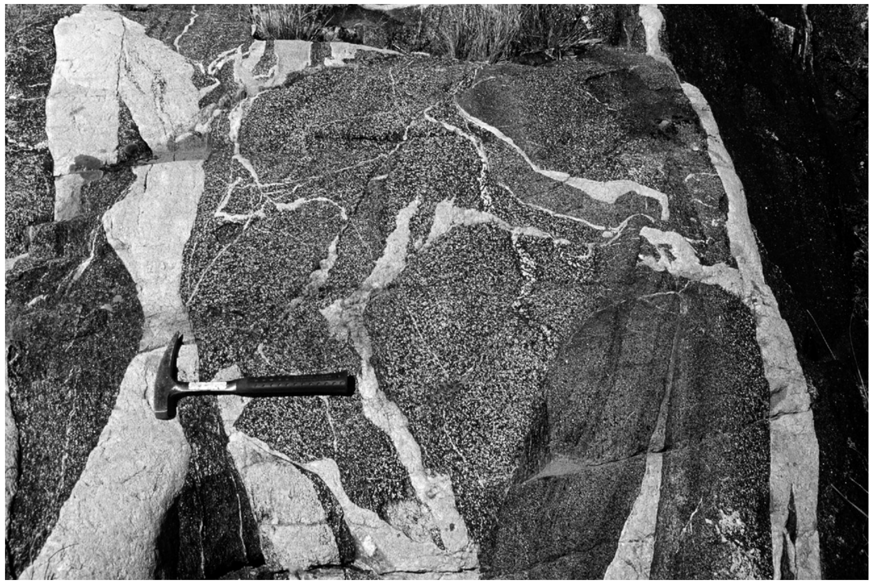


Figure GS-18-13: Banded tonalite (bottom right) intruded by diorite (black with white specks and syenogranite (light coloured dikes and veins).

unpublished preliminary data, 2002). A U-Pb SHRIMP study is currently underway to verify this preliminary model age. These new data suggest that there are likely crustal-scale slivers of Neoarchean to earliest Paleoproterozoic age tectonically imbricated with juvenile rocks of the Lynn Lake–Rusty Lake belt and Southern Indian Domain.

All plutonic rocks described in the previous paragraph are completely recrystallized and do not retain original igneous textures or minerals. However, potentially younger suite(s), including large gabbroic to granitic plutons, are intrusive into the supracrustal rocks of the northern margin of the Kisseynew Domain and the Rusty Lake belt. These are generally larger in size, more compositionally homogeneous and, in most cases (at least locally), preserve relict igneous textures and minerals (Fig. GS-18-17). They range in size from a few kilometres to a few tens of kilometres, and in composition from gabbroic to syenogranitic. In the Granville Lake area, they include the Black Trout diorite (Fig. GS-18-18) and elongate gabbroic to granitic sheets. During the course of the fieldwork, all plutonic rocks observed along a transect from Wheatcroft lake to Outlaw Bay were systematically sampled for geochemical analysis, and most of the representative suites were sampled for Sm-Nd tracer isotope analysis. Six were sampled for U-Pb isotopic dating, including the Black Trout diorite. Results will be published in a subsequent report.

Locally, the Black Trout diorite contains immiscible magmas of mafic (amphibolite) and felsic (granitic) composition; when transposed, these form a characteristic banded gneiss. An identical intrusion was observed in the Pukatawakan belt, approximately 100 km to the north (*see* Corrigan et al., 2001), and yielded a positive ε_{Nd} value and a Proterozoic (ca. 2.38 Ga) Nd model age (Ch.O. Böhm and R. Creaser, pers. comm., 2002).

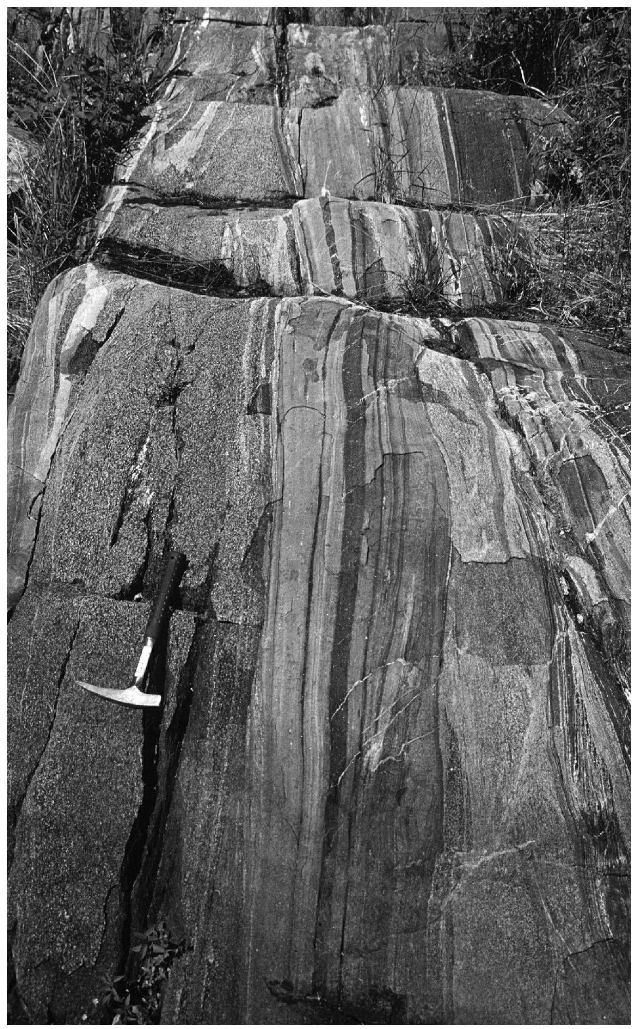


Figure GS-18-14: Same outcrop as Figure GS-18-12, showing moderate transposition of the intrusive layers into parallelism with the regional structural grain.

UPDATE ON U-PB, SM-ND AND GEOCHEMICAL WORK

During the 2001 field season, 12 samples were taken along a transect from the Rusty Lake belt to the Wathaman-Chipewyan Batholith, in order to constrain the emplacement age of plutonic and volcanic rocks, as well as the depositional age and source of sediments in the Rusty Lake belt and Southern Indian Domain. In addition, 24 rocks were analyzed for Sm-Nd systematics and over 100 rocks were analyzed for major element, trace element and rare earth element geochemistry. During the 2002 field season, a similar number of samples was taken from representative rock units extending from the north flank of the Kisseynew Domain to the Rusty Lake belt. The combined dataset will provide constraints on the lithological framework and tectonic evolution of the northern flank of the Trans-Hudson Orogen, from the Kisseynew Domain to the Wathaman-Chipewyan Batholith. In particular, it will provide a context for comparing and contrasting the nature, evolution and mineral potential of the Lynn Lake and Rusty Lake belts, as well as smaller, isolated supracrustal belts in the Kisseynew and Southern Indian domains. A thorough description of the results obtained to date is beyond the scope of this preliminary report of current activities, and will be presented in an open file report (D. Corrigan, work in progress, 2002). To date, the preliminary radiogenic isotope data indicate the following:

Figure GS-18-15: Same outcrop as Figure GS-18-14, showing a more complete stage of recrystallization and transposition of plutonic protoliths, into a well-banded orthogneiss.

- Sediments derived from erosion of Rusty Lake belt volcanic rocks contain zircons that range in age from ca. 1.92 to 1.88 Ga, reflecting the approximate age range of the source plutonic and volcanic rocks within the belt. These data are compatible with detritus ages from sedimentary rocks associated with the La Ronge belt in Saskatchewan (D. Corrigan, work in progress, 2002), indicating a similar age range for the two belts.
- A porphyry rhyolite from the upper stratigraphic levels of the western domain of the Rusty Lake belt yielded a ca. 1884 Ma age, constraining the minimum age of volcanism in the Ruttan mine sequence to approximately that age. The previous interpretation of ca. 1878 Ma for the Rusty Lake belt (Baldwin et al., 1987) hinged on a single U-Pb age from the Karsakuwigamak block and likely reflected late caldera formation.
- A significant portion of the Southern Indian Domain may be underlain by Archean crust intruded by ca. 2.45 Ga (Rayner et al., work in progress, 2002), mixed to layered plutons of ultramafic to intermediate composition, including the Turtle Island intrusive complex (Corrigan et al., 2001). Preliminary Sm-Nd data suggest that a small (?)tectonic sliver of Archean crust may also be present in the Rusty Lake belt, south of the Ruttan mine.
- Polymictic conglomerate and meta-arkose in the Southern Indian Domain, previously interpreted as 'Sickle-like' (Cranstone, 1972), yielded detrital zircons of ca. 1.88 Ga to Neoarchean age, suggesting a likely source from the Lynn Lake and Rusty Lake belts, including minor components of earliest Proterozoic to Neoarchean source rocks. A similar rock assemblage located at a similar tectonostratigraphic level was identified and dated in Saskatchewan (Park Island assemblage; Corrigan et al., 1999a) and tentatively interpreted as a foredeep or molasse basin deposited on the continent side of an early, accreted, oceanic-arc assemblage (La Ronge–Lynn Lake–Rusty Lake belts).
- Potassium feldspar megacrystic granite, similar in every aspect to the 1.86 to 1.85 Ga Wathaman-Chipewyan Batholith, yielded a ca. 1.83 Ga age, suggesting that either 1) the age range of the Wathaman-Chipewyan Batholith is broader than previously accepted, or 2) a separate event occurred at ca. 1.83 Ga and produced magmas similar in composition to the Wathaman-Chipewyan Batholith.

ECONOMIC POTENTIAL

Granville and Wheatcroft lakes sit on one of the largest Cu-Au and As lake-sediment anomalies in northern Manitoba (Kaszycki et al., 1988). Apart from minor sulphide mineralization associated with the mafic volcanic layer on Wheatcroft Lake, no major gossan zones or alteration zones were observed along the exposed bedrock. This suggests that, if a major mineralized zone exists in the region, it is likely buried under glacial drift. However, very minor Cu mineralization was observed in association with pegmatite bodies at the margin of a large gabbroic intrusion in the Sickle Group. There may also be potential for shear zone–hosted Au mineralization along the leading edge of the Granville Lake structural zone, at the interface between the hanging wall mafic volcanic rocks and the footwall quartzite. Tourmaline±garnet±beryl–bearing pegmatite bodies, injected in the Sickle Group in the aureole of granitic plutons, may also present potential targets for rare earth element mineralization.

In the 2001 field season, one grab sample of tourmaline-garnet pegmatite from the Partridge Breast Lake belt, from an outcrop on the shore of the lower Churchill River near Partridge Breast Lake, returned interesting Nb (57 ppm) and Ta (27 ppm) values. The analysis also revealed significant values of Be, indicating the likely presence of beryl in the sample. This type of pegmatite may be related to the fluorine-bearing Thorsteinson granite (T. Corkery, pers. comm., 2001), located approximately 15 km southeast of the sampled pegmatite.

Figure GS-18-16: Migmatitic monzogranite showing small-scale tight folds and leucosome injections.

In terms of gold exploration, the Rusty Lake belt remains relatively poorly explored, despite high potential indicated by the presence of late shear zones in volcanic rock (an environment similar to that of known gold occurrences in the Lynn Lake belt), as well as the presence of shear zones in plutonic rocks intruding the volcanic rocks (similar to known gold occurrences in the La Ronge Domain in Saskatchewan; e.g., Lafrance, 1999).

Figure GS-18-17: Coarse-grained biotite-hornblende monzogranite showing a weak foliation parallel to the knife. Note the nonmigmatitic texture and preservation of some of the coarser igneous feldspar crystals. Knife handle is 14 cm long.

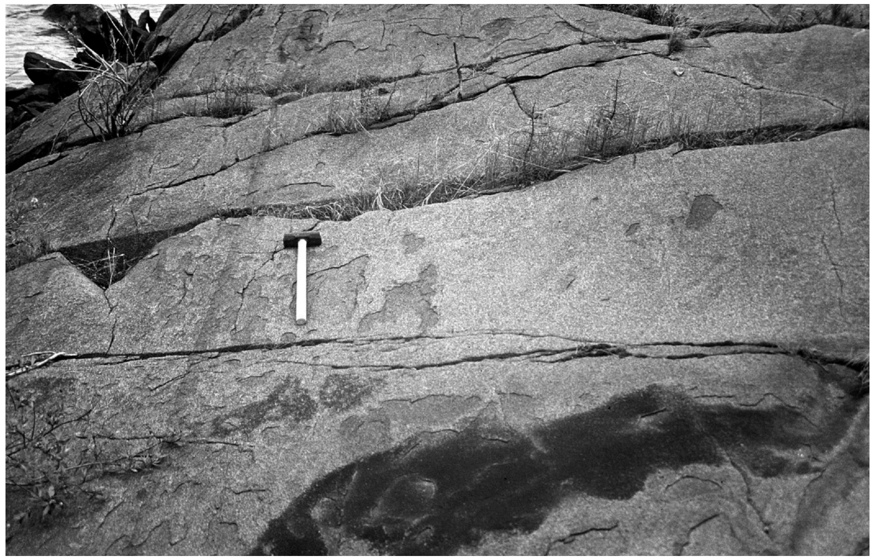


Figure GS-18-18: Elongate Black Trout diorite sill in Sickle Group, on an island in Granville lake. Note igneous layering (straight band to left of hammer). Dark band in foreground is black organic material. Igneous layering is parallel to the sill margins.

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REFERENCES

Ames, D.E. and Taylor, C. 1996: Geology of the West Anomaly orebody, Ruttan volcanic-hosted massive sulphide deposit, Proterozoic Rusty Lake Belt; *in* EXTECH I: A Multidisciplinary Approach to Massive Sulphide Research in the Rusty Lake–Snow Lake Greenstone Belts, Manitoba, G.F. Bonham-Carter, A.G. Galley and G.M. Hall (ed.), Geological Survey of Canada, Bulletin 426, p. 45–76.

Ansdell, K.M. and Yang, H. 1995: Detrital zircons in the McLennan Group meta-arkoses and MacLean Lake Belt, western Trans-Hudson Orogen; *in* Trans-Hudson Orogen Transect, Report of Fifth Transect Meeting, April 3-4, 1995, Regina, Z. Hajnal and J. Lewry (ed.), LITHOPROBE Secretariat, University of British Columba, LITHO-PROBE Report No. 48, p.190–197.

Baldwin, D.A., Syme, E.C., Zwanzig, H.V., Gordon, T.M., Hunt, P.A. and Stevens, R.P. 1987: U-Pb zircon ages from the Lynn Lake and Rusty Lake metavolcanic belts, Manitoba: two ages of Proterozoic magmatism; Canadian Journal of Earth Sciences, v. 24, p. 1053–1063.

Barry, G.S. 1965: Trophy Lake area (east half); Manitoba Mines and Natural Resources, Mines Branch, Publication 63-3, Map 63-3, scale 1:63 360.

Barry, G.S., and Gait, R.I. 1966: Suwannee Lake area; Manitoba Mines and Natural Resources, Mines Branch, Publication 64-2, Map 64-2, scale 1:63 360.

Campbell, F.H.A. and Kendrick, G. 1972: Turnbull Lake; Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Publications 71-2D and 71-2E, Map 71-2-5, scale 1:50 000.

Corrigan, D. 2000a: Geology, central Reindeer Lake, Saskatchewan; Geological Survey of Canada, Open File 3750, scale 1:100 000.

Corrigan, D. 2000b: Geology, Milton Island area, Reindeer Lake south, Saskatchewan; Geological Survey of Canada, Open File 3881, scale 1:50 000.

Corrigan, D. 2001: Geology, northern Reindeer Lake, Saskatchewan; Geological Survey of Canada, Open File 3881, scale 1:100 000.

Corrigan, D., Bashforth, A. and Lucas, S. 1997: Geology and structural evolution of the La Ronge–Lynn Lake Belt in the Butler Island area (parts of 64D-9 and -10), Reindeer Lake, Saskatchewan; *in* Summary of Investigations 1997, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 97-4, p. 18–30.

Corrigan, D., MacHattie, T.G. and Chakungal, J. 1999a: The Wathaman Batholith and its relation to the Peter Lake Domain: insights from recent mapping along the Reindeer Lake transect, Trans-Hudson Orogen; *in* Summary of Investigations, 1999, Volume 2, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 99-4.2, p. 132–142.

Corrigan, D., MacHattie, T.G. and Chakungal, J. 2000: The nature of the Wathaman Batholith and its relationship to the Archean Peter Lake Domain along the Reindeer Lake transect, Saskatchewan; Geological Survey of Canada, Current Research 2000-C13, 10 p.

Corrigan, D., MacHattie, T.G., Piper, L., Wright, D., Pehrsson, S., Lassen, B. and Chakungal, J. 1998b: La Ronge–Lynn Lake Bridge Project: new mapping results from Deep Bay (parts of 64D-06 and -07) to north Porcupine Point (64E-07 and -08), Reindeer Lake; *in* Summary of Investigations 1998, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 98-4, p. 111–122.

Corrigan D., Maxeiner, R., Bashforth, A. and Lucas, S. 1998a: Preliminary report on the geology and tectonic history of the Trans-Hudson Orogen in the northwestern Reindeer Zone, Saskatchewan; *in* Current Research, Part C, Geological Survey of Canada, Paper 98-1C, p. 95–106.

Corrigan, D., Pehrsson, S.J., MacHattie, T.G., Piper, L., Wright, D., Lassen, B. and Chakungal, J. 1999b: Lithotectonic framework of the Trans-Hudson Orogen in the northwestern Reindeer Zone, Saskatchewan: an update from recent mapping along the Reindeer Lake Transect; *in* Current Research, Part C, Geological Survey of Canada, Paper 99-C, p. 169–178.

Corrigan, D., Therriault, A. and Rayner, N.M. 2001: Preliminary results from the Churchill River–Southern Indian Lake Targeted Geoscience Initiative; *in* Report of Activities 2001, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 94–107.

Cranstone, J.R. 1968: Watt Lake area (east half); Manitoba Mines and Natural Resources, Mines Branch, Publication 61-5 , Map 61-5, scale 1:63 360.

Cranstone, J.R. 1972: Geology of the Southern Indian Lake area, northeastern portion; Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Publication 71-2J.

Fumerton, S.L., Stauffer, M.R. and Lewry, J.F. 1984: The Wathaman Batholith: largest known Precambrian pluton; Canadian Journal of Earth Sciences, v. 21, p. 1082–1097.

Harper, C.T. 1998: The La Ronge Domain–Glennie Domain transition: Street Lake area (parts of NTS 64D-3 and -6); *in* Summary of Investigations 1998, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 98-4, p. 66–80.

Kaszycki, C.A., Suttner, W. and DiLabio, R.N.W. 1988: Gold and arsenic in till, Wheatcroft Lake dispersal train, Manitoba; *in* Current Research, Part C, Geological Survey of Canada, Paper 88-1C, p. 341–351.

Lafrance, B. 1999: Gold studies in the Byers Fault–Waddy Lake area, La Ronge Domain; *in* Summary of Investigations 1999, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 99-4.2, p. 202–207.

Lewry, J.F. and Collerson, K.D. 1990: The trans-Hudson Orogen: extent, subdivision and problems; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 1–14.

Manitoba Energy and Mines 1986a: Granville Lake; Manitoba Energy and Mines, Minerals Division, Bedrock Geology Compilation Series, NTS 64C, scale 1:250 000.

Manitoba Energy and Mines 1986b: Uhlman Lake; Manitoba Energy and Mines, Minerals Division, Bedrock Geology Compilation Series, NTS 64B, scale 1:250 000.

Manitoba Energy and Mines 1990: Big Sand Lake; Manitoba Energy and Mines, Minerals Division, Bedrock Geology Compilation Series, NTS 64G, scale 1:250 000.

Maxeiner, R.O., Corrigan, D., Harper, C.T., MacDougall, D.G. and Ansdell, K.M. 2001: Lithogeochemistry, economic potential and plate tectonic evolution of the 'La Ronge–Lynn Lake Bridge', Trans-Hudson Orogen; *in* Summary of Investigations 2001, Volume 2, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 2001-4.2, p. 87–110.

Meyer, M.T., Bickford, M.E. and Lewry, J.F. 1992: The Wathaman Batholith: an early Proterozoic arc in the Trans-Hudson orogenic belt, Canada; Geological Society of America Bulletin, v. 104, p. 1073–1085.

Stauffer, M.R. 1990: The Missi Formation: an Aphebian molasse deposit in the Reindeer Lake Zone of the Trans-Hudson Orogen, Canada; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 121–141.

Syme, E.C. 1985: Geochemistry of metavolcanic rocks in the Lynn Lake Belt; Manitoba Energy and Mines, Geological Report GR85-1, 84 p.

Thomas, D.J. 1993: Geology of the Star Lake–Otter Lake portion of the Central Metavolcanic Belt, La Ronge Domain; Saskatchewan Energy and Mines, Report 236, 132 p.

Van Schmus, W.R. and Schledewitz, D.C.P. 1986: U-Pb zircon geochronology of the Big Sand Lake area, northern Manitoba; *in* Report of Field Activities 1986, Manitoba Energy and Mines, Minerals Division, p. 207–210.

Yeo, G. 1998: A systems tract approach to the stratigraphy of paragneisses in the southeastern Wollaston Domain; *in* Summary of Investigations 1998, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 98-4, p. 36–47.

Zwanzig, H.V. 1981: Watt Lake northeast; Manitoba Department of Energy and Mines, Mineral Resources Division, Preliminary Map 1980 L-1; scale 1:20 000.

Zwanzig, H.V. 1990: Kisseynew gneiss belt in Manitoba: stratigraphy, structure, and tectonic evolution; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 95–120.

Zwanzig, H.V. 2000: Geochemistry and tectonic framework of the Kisseynew Domain–Lynn Lake Belt boundary (part of NTS 63P/13); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 91–96.

Zwanzig, H.V. and Cameron, H.D.M. 2002: Geology of Suwannee Lake (northwest) and Trophy Lake (northeast); Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Preliminary Map PMAP2002-3; 1:20 000.

Zwanzig, H.V., Syme, E.C. and Gilbert, H.P. 1999: Updated trace element geochemistry of ca. 1.90 Ga metavolcanic rocks in the Paleoproterozoic Lynn Lake Belt; Manitoba Industry, Trade and Mines, Geological Services, Open File Report OF99-13, 46 p. and Map 99-13-1 at 1:100 000 scale.