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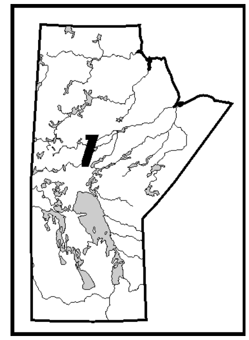
GS-18 Mineral modes of gneiss along the Thompson Nickel Belt–Kisseynew Domain boundary, Manitoba (parts of NTS 63J, 63O, 63P, 64A and 64B)



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Summary

Modal analyses confirm and quantify the observation, made during mapping and core logging, that the presence of certain minerals is highly diagnostic of different groups of rocks that occur along the margins of the Thompson Nickel Belt and the Kisseynew Domain. For example, magnetite in amounts from traces to 6% characterizes the Grass River and Sickle groups, whereas graphite helps to identify the Ospwagan and Burntwood groups. The Burntwood Group is further distinguished by its low content of quartz and abundance of plagioclase. A sillimanite-forming metamorphic reaction accounts for high modal counts of potassium feldspar in the Ospwagan Group; however, accurate and easy point counting of potassium feldspar may require stained thin sections. Moreover, modal analysis is labour intensive and serves best as a tool for checking field estimates of mineral contents and improving future estimates.

Introduction

At the margin of the Thompson Nickel Belt (TNB), Paleoproterozoic gneissic units of the Kisseynew Domain are structurally interleaved with the Archean basement and its Paleoproterozoic cover rocks, the Ospwagan Group. Identifying the Ospwagan Group is important because it hosts ultramafic bodies with associated nickel deposits. The complex geology at the margin of the TNB has been elucidated by structural mapping (Zwanzig, 1998), compilation mapping (Thompson Nickel Belt Geology Working Group, 2001) and Sm-Nd isotope work on samples from outcrops and drillcore (Zwanzig and Böhm, 2002); however, rock identification based on petrography remains the simplest tool to map the regional structure and stratigraphy. This report is a summary of modal thin-section analyses carried out on representative samples from various units of Paleoproterozoic siliciclastic rocks and Archean basement migmatite. The aim of the work is to provide petrographic criteria to help distinguish the various units of upper amphibolite grade gneiss that occur near the Kisseynew boundary from Setting Lake northeast to Rock Lake and northwest to Leftrook Lake (Fig. GS-18-1).

Petrographic results

The results are derived from modal analysis, wherein 200 points were counted with even spacing across each of 46 thin sections. Duplicate counts of an additional 100 points carried out on test sections did not substantially change the result from the first 200 points. Significant errors are expected mainly for untwinned potassium feldspar, which was identified using low relief relative to quartz. This may have increased the potassium-feldspar count and lowered the plagioclase count where untwinned oligoclase is present. (Albite, which has lower relief than quartz, is absent in these gneissic units, but oligoclase can also have a slightly lower relief). Counts with less than 0.5% were recorded as trace amounts. The data were reduced to a simplified format that gives average amounts where the variation of counts from the same unit is moderate or a range where the variation is greater than 2x (highest to lowest count). Results are given in a stratigraphic table form (Table GS-18-1), and highlights to distinguish the units are given below.

Archean gneiss

The orthogneiss and granitoid migmatite (unit Ag) of the Archean basement are best identified in drillcore by a banded structure. The gneiss ranges in composition from granite to granodiorite and is generally moderately foliated. Average apparent grain size in thin section is 0.1 to 0.3 mm. Potassium feldspar varies continuously throughout the suite from 16 to 26% for granite gneiss and from 5 to 11% for granodiorite gneiss. Samples vary between felsic and intermediate in composition, with a biotite content of 5 to 15% and hornblende content of 0 to 24%.

Archean paragneiss (unit Aw) is locally interlayered with the orthogneiss but needed to be distinguished from similar-looking Paleoproterozoic paragneiss using Nd model ages (Zwanzig and Böhm, 2002). The unit is a

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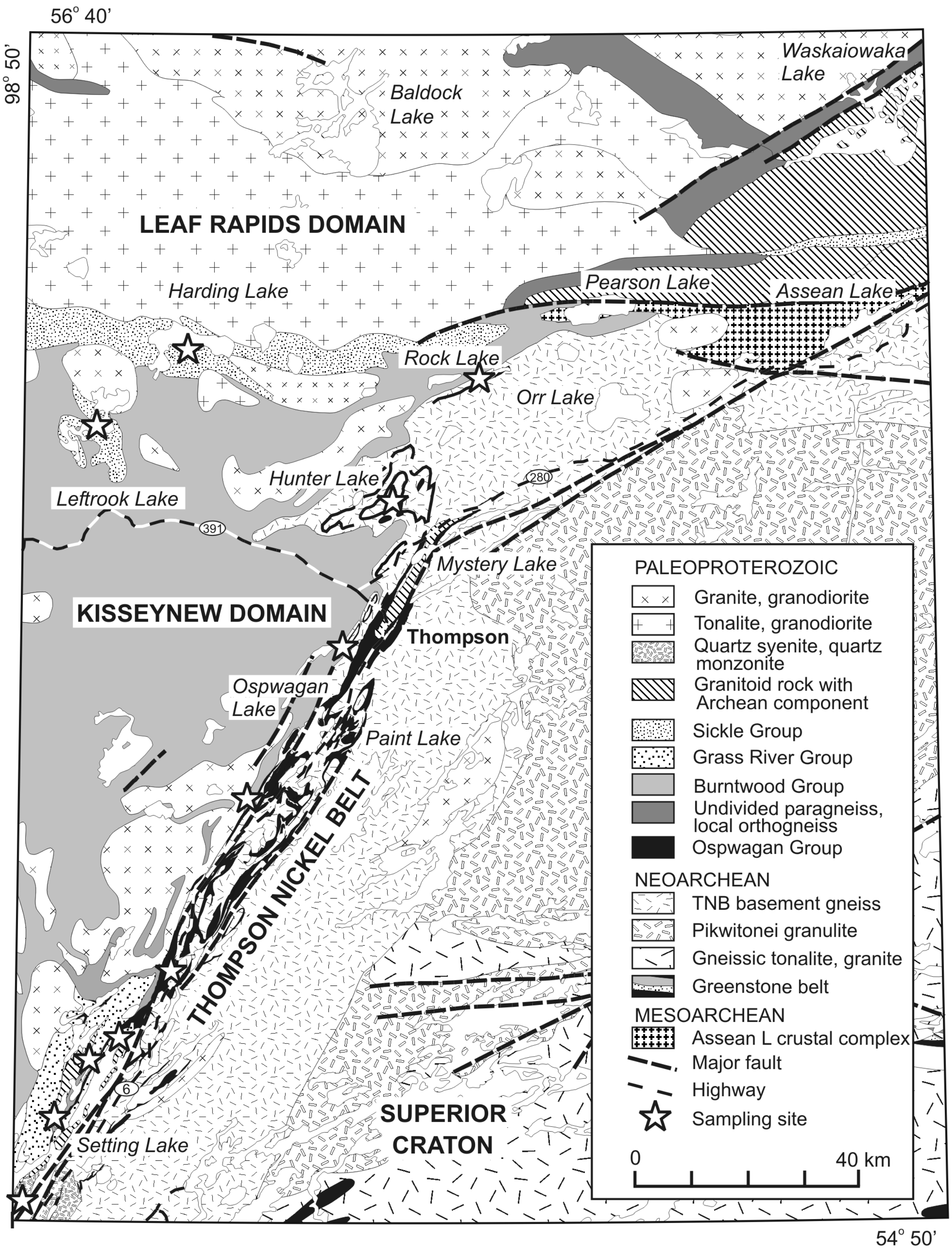

Figure GS-18-1: Sample locations and simplified geology of the Thompson Nickel Belt, part of the Kisseynew Domain and the margin of the Leaf Rapids Domain (after Zwanzig and Böhm, 2002).

Table GS-18-1: Mineral modes – single counts, averages or ranges.
Unit designation is from unpublished CAMIRO Project Report 97E-02, modified from Zwanzig (1999).

Unit	Rock type	Mineral modes (%, average % or range)											Other	n
		QZ	PG	KF*	AM	BO	CL	GR	MV	SM	TI	MT	minerals	
Pk	**Alkaline/calc-alkaline**			**SYNKINEMATIC INTRUSIONS**										
Pk1	Monzonite	1	28	33	25	6					4	2	AP	1
Gs	**Arkosic sandstone**			**GRASS RIVER GROUP**										
Ga1	Meta-arkose	52	21	14		**4**			8	**x**		**1**	AP, TM	1
	Muscovite schist	40	14	2		**8**			20	**10**		**6**	AP, TM	1
Gb	**Biotite-bearing sandstone**													
Gb1	Pebbly sandstone	40	18	9		**11**	x		10	7	x	**3**	AP, TM, ZR	1
Gb2	Felsice gneiss (?volc.)	30	26	**33**		**13**	x	x	x		x	**x**	AP, ZR	2
Gh	**Metasandstone ± hornblende**													
Gh2	Conglom., sandstone	37	40			17						**6**	AP	1
Ss	**Arkosic sandstone**			**SICKLE GROUP**										
Ss1	Sillimanite arkose	23	28	25		**15**			2	**7**	x	**2**	AP, TM, ZR	1
Sh	Hornblende arkose	17	27	28	**8-20**	**11**					x	**4**	AP, TM, ZR	2
B	**Greywacke-gneiss**			**BURNTWOOD GROUP**										
B	Garnet-biotite gneiss	**19**	**41**	7		25	x	8		x			**GP**, AP, ZR	3
B	Amphib.-biotite gneiss	**19**	**38**	0-5	10-26	16		0-9					**GP**, AP, ZR	2
Pi	**Calc-alkaline**			**EARLY INTRUSIONS**										
Pi3	Granodiorite gneiss	30	38	18	x	8		2	4				EP	1
Os	**Setting Formation**			**OSPWAGAN GROUP**										
Os2	Greywacke-mudstone	**34**	23	22		14		±	6	**0-8**	x		**GP**, AP, ZR	5
Os1a	Protoquartzite	**55**	18	13	5				6		1		**GP**, AP, PO	1
Os1b	Semipelite	**31**	18	25		12			3	**7**			**GP**, AP, ZR	1
Os1c	Pelite	7	8	48		20			8	**10**			**GP**, AP, ZR	1
Op	**Pipe Formation**													
Op2	Pelite-semipelite	22	14	24		**17**	x	**9**		**13**	x		**GP**, PO, ZR	4
Om	**Manasan Formation**													
Om2	Pelite	25	6	33	±	21		±		**x**	x		**GP**, PO, ZR	2
Om1	Quartzite-semipelite	40	13	23		17	x	8	x		x		AP, PO, ZR	1
Ag	**Mixed gneiss**			**ARCHEAN GNEISS (REWORKED)**										
Ag6a	Granite migmatite	24	35	21	0-24	7					x	x	AP, PO, ZR	3
Ag6b	Granodiorite migmat.	26	48	8	7-10	12	x	±	±		x	±	AP, PO, ZR	3
Aw	**Greywacke gneiss**	29	24-45	**1-22**		8-25	x	0-5			±	±	**GP**, PO, ZR	3

Abbreviations:

AM - amphibole (hornblende and ?cummingtonite) AP - apatite BO - biotite CL - chlorite
EP - epidote GP - graphite GR - garnet MT - magnetite MV - muscovite PG - plagiocase
PO - pyrrhotite KF* - K-feldspar (± oligoclase where untwinned) QZ - quartz SM - sillimanite
TI - titanite TM - tourmaline ZR - zircon
n - number of thin sections in estimated mode (1 - single, >1 - average or range)
x - present in small amounts ± - present in some samples
bold numbers - minerals used to help distinguish units

greywacke-migmatite that generally contains garnet and small amounts of graphite (<1%). Samples generally contain more potassium feldspar and less plagioclase than Paleoproterozoic greywacke of the Burntwood Group but can be similar to semipelite in the Setting Formation (Table GS-18-1). The highly variable modes of the paragneiss do not allow a positive petrographic identification of the Archean paragneiss.

Ospwagan Group

The upper-amphibolite–grade siliciclastic rocks in the Ospwagan Group (unit O) are characterized by their relatively high contents of biotite and potassium feldspar in the presence of small amounts of graphite and, commonly, pyrrhotite. The high sillimanite content (<19%) and common absence of muscovite indicate that this represents a higher temperature mineral assemblage than mica schist, such as at the Pipe 2 pit in the type section. The average apparent metamorphic grain size of these originally fine-grained sedimentary rocks is about 0.1 mm.

The Manasan Formation (unit Om) is subdivided into quartzite to semipelite (Om1 member) and pelite (Om2 member) on the basis of differing quartz and biotite contents (Table GS-18-1). The pelite in the Pipe Formation Op2 member is distinguished by conspicuous 4 to 8 mm porphyroblasts of garnet (7–13%) and sillimanite (9–19%) in quartz-sillimanite knots (faserkiesel). Samples of Setting Formation (unit Os) are weakly to strongly cataclastic or strongly foliated, and feldspar is partly altered to white mica. Setting Formation greywacke (Os2 member) is characterized by more quartz (generally 29–49%), less biotite (9–19%) and sillimanite (trace–8 %), and an absence of garnet relative to the Pipe Formation pelite.

Burntwood Group

This group of greywacke-gneiss is characterized by low contents of quartz (13–22%), potassium feldspar (0–15%) and sillimanite (trace). Garnet porphyroblasts (generally 7–9%), graphite (<1%) and abundant plagioclase (39–43%) are diagnostic of this unit. Amphibole, tentatively identified as cummingtonite, may represent an alteration product.

Grass River and Sickle groups

The Grass River Group, at Setting Lake, and the probably equivalent Sickle Group, at Leftrook and Harding lakes, which are interpreted as having been derived from nonmarine lithic arenite (redbeds), are distinguished by their high magnetite content (<6%) and generally low biotite content (4–15%). Their average apparent metamorphic grain size is highly variable (0.1–1.0 mm), a possible remnant of primary texture. A hornblende-bearing unit (unit Sh; analyzed only from the Sickle Group), is quartz poor (17%) like the Burntwood Group but clearly distinguished from the latter by its high magnetite content (3–4%) and the presence of platy green amphibole. A unit of felsic gneiss (unit Gb2) in the Grass River Group is interpreted as a possible rhyolite tuff or reworked tuff based on gradational contacts with overlying arenite. This unit contains abundant potassium feldspar (31–34%), similar to possibly equivalent high-potassium rhyolite in the Missi Group in the Snow Lake region. Both the Grass River and Sickle groups have stratigraphically uppermost sillimanite-bearing units (units Gs, Ss), but these are clearly distinguished from the Ospwagan Group by the presence of magnetite and tourmaline rather than graphite±pyrrhotite, and show the importance of these minor phases in unit identification.

Discussion

Modal analysis confirms and quantifies the observation, made during mapping and core logging, that the presence of certain minerals is highly diagnostic of different groups of rocks that occur along the margins of the Thompson Nickel Belt and the Kisseynew Domain. Small subhedral porphyroblasts of magnetite, occurring in amounts from trace to 6%, characterize the Grass River and Sickle groups, whereas graphite helps to identify the Ospwagan and Burntwood groups. The Burntwood Group is further distinguished by its low content of quartz and abundance of plagioclase.

Modal counts of potassium feldspar may include untwinned oligoclase; stained thin sections are required for easier, accurate point counting. Nevertheless, the high abundance of microcline in the Ospwagan Group at the uppermost amphibolite grade is confirmed and helps to distinguish these economically important rocks from biotite-rich paragneiss infolded from the Kisseynew Domain. The absence of muscovite and general abundance of sillimanite in the Ospwagan Group pelite indicate that the reaction

muscovite + quartz → sillimanite + potassium feldspar

has gone to completion in the sampling areas shown in Figure GS-18-1. A high content of potassium feldspar is also typical of part of the Archean basement gneiss, such that this orthogneiss may resemble the Ospwagan Group. Modal analysis may help the identification because counts suggest that the orthogneiss contains <15% biotite and the Ospwagan Group contains more biotite (e.g. Pipe Formation) or more quartz (e.g. Setting Formation).

Economic considerations

Identifying the Ospwagan Group and its formations in surface outcrops and drillcore is important, as this group hosts ultramafic bodies with associated nickel deposits. Because of the high metamorphic grade and strong deformation fabrics in much of the TNB, primary rock types are not always immediately apparent but must be inferred qualitatively from the mineral content of the various types of paragneiss. Similarly, the Ospwagan Group, the interleaved basement orthogneiss and the younger groups of paragneiss at the margin of the Kisseynew Domain must be clearly distinguished. The quantitative (modal) data presented here may aid mapping and core logging during mineral exploration. Modal analysis, however, is labour intensive and serves best as a tool for checking field estimates of mineral contents and improving future estimates.

Acknowledgments

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