

Flin Flon Regional Geology

The Paleoproterozoic Flin Flon Belt is part of the Reindeer Zone of the Trans Hudson Orogen. The Flin Flon Belt consists of a series of tectonostratigraphic assemblages (juvenile arc, juvenile ocean-floor back arc, ocean plateau, ocean-island basalt and evolved plutonic arc) that range in age from 1.92 to 1.87 Ga. All of the VMS deposits mined to date in the Flin Flon area are associated with the juvenile Flin Flon arc assemblage (Syme et al., 1999).

The volcanic rocks of the Flin Flon area are part of the 1.9 Ga juvenile Flin Flon arc assemblage, which consists mainly of tholeiitic subaqueous pillowed basalt and basaltic andesite, with lesser amounts of heterolithic mafic breccia and mafic and felsic volcaniclastic rocks, and minor dacite to rhyolite flows (Bailes and Syme, 1989). The VMS deposits in the area occur in association with the felsic volcanic units in synvolcanic collapse structures and calderas, within the main mafic volcanic complex (Bailes and Syme, 1989; Syme and Bailes,

Recent detailed geological mapping and stratigraphic analysis of volcanic rocks of the Flin Flon mines area (Devine, 2003; Tardif, 2003; DeWolfe and Gibson, 2006; Gibson, unpublished data 2000-2006), have allowed the establishment of an informal stratigraphic subdivision of rocks hosting and occurring within the footwall and hangingwall to the Flin Flon-Callinan-Triple 7 massive sulphide deposits (Devine, 2003; DeWolfe and Gibson,

Rocks equivalent to the Flin Flon-Callinan-Triple 7 hangingwall strata have been recognized in the Schist Lake-Mandy mines area. They occur west of the Mandy Road Fault, around Carlisle Lake, and east of the Burley Lake Fault. More work is required before rocks east of the Mandy Road Fault and west of the Burley Lake Fault can be associated with any of the known stratigraphic units in the Flin Flon area.

TGI3 project

The Flin Flon area of the Paleoproterozoic Flin Flon belt is well known for its volcanogenic massive sulphide (VMS) deposits. Three active (Callinan, Triple 7 and Trout Lake) and three past-producing (Flin Flon, Mandy, and Schist Lake) VMS mines occur in the immediate vicinity of the town of Flin Flon, which makes this area one of the most productive base-metal regions in Canada. Despite its productive past, however, Flin Flon area's reserves are being rapidly depleted and new reserves/deposits are needed to maintain the economic viability of the Hudson Bay Mining and Smelting Co. Ltd. smelter at Flin Flon.

With the intent of stimulating private-sector resource exploration in areas of high base-metal potential in established mining communities, the Government of Canada launched a new five-year Targeted Geoscience Initiative (TGI-3) in 2005. As part of this initiative, the Manitoba Geological Survey, in collaboration with the Saskatchewan Geological Survey, the Geological Survey of Canada, and researchers from Laurentian University, is participating in production of a new 1:10 000 scale 'cross-border' geological map of the Flin Flon area.





Schematic stratigraphy of Flin Flon vs Schist Lake-Mandy mines areas

	Flin Flon a
Louis formation Mainly plagioclase- and pyroxene-phyric flows with locally aphyric to sparsely porphyritic flows and mafic tuff.	
Icehouse member Strongly plagioclase-pyroxene-phyric (>30% phenocrysts) flows with intercalated mafic tuff. Tower member	
Local rhyolitic flows and associated felsic breccia overlain by finely bedded mafic tuff, locally felsic- clasts-bearing.	
Hidden formation	
Stockwell memberMainly plagioclase-phyric (>15% phenocrysts) flowswith subordinated amount of aphyric flows.1920 unit	
Andesitic cryptoflows (icelandite).	
<u>Reservoir member</u> Aphyric mafic flows and synvolcanic sills with localized tuff interbeds.	
Flin Flon formation	
<u>Millrock member</u> Mainly aphyric to sparsely porphyritic mafic flows with associated mafic volcaniclastic rocks. Toward the top contains localized rhyolite flows and associated felsic breccias and massive sulphide lenses.	
<u>Blue Lagoon member</u> Aphyric and highly plagioclase-phyric (>15-25% phenocrysts) mafic flows with associated, abundant, plagioclase-crystal- rich mafic tuff.	
<u>Club member</u> Mainly aphyric mafic flows and associated mafic volcaniclastic rocks, with localized	

rhyolitic flows and associated felsic breccia.

Geology of the Schist Lake - Mandy Mines Area, Flin Flon, Manitoba by R-L. Simard

Schist Lake-Mandy mines area



Louis formation

Mainly plagioclase- and pyroxenephyric basalt flows with local aphyric to sparsley porphyritic basalt flows and mafic tuff. In places, rhyolite flows and associated felsic breccia define the base of this formation .

Hidden formation Aphyric to sparcely plagioclase-phyric basalt flows intercalated with minor mafic volcaniclastic material. Laterally the lithofacies change abruptly to heterolithic mafic volcanic breccia across synvolcanic faults associated with localized mafic and felsic magmatism/volcansim.

Aphyric to sparsely plagioclase-phyric mafic flows
Plagioclase-phyric mafic flows
Plagioclase-pyroxene-phyric mafic flows
Icelandite
Mafic volcaniclastic rocks
Heterolithic mafic breccia
Rhyolitic flows
Felsic breccia
VMS lenses

Hidden formation rocks

In the Schist Lake - Mandy mines area, rocks of the Hidden formation consist of aphyric to sparsely plagioclase-phyric basalt flows with minor mafic volcaniclastic rocks to the north, and abundant heterolithic mafic breccia intercalated with aphyric to sparsely plagioclase-phyric basaltic flows to the south. This transition from mainly flows in the north to mainly breccia in the south is abrupt and corresponds to an important mafic and felsic dike complex along a northwest-trending fault just southeast of Carlisle Lake. Up stratigraphy the dike complex ceases to be present and its termination is marked by a small quartz-plagioclase-phyric rhyolite lobe, associated with felsic breccia and agossan zone, is interpreted to be part of a small extrusive dome.

Heterolithic mafic volcanic breccia of the Hidden formation is mainly massive to crudely bedded, clast supported and very poorly sorted. Fragments are subangular to angular, all mafic in composition, but vary in texture. Few felsic-cored clasts with mafic scoriaceous envelopes have been observed. The high angularity of the contained fragments and local preservation of fragments with fragile structures, such as scoriaceous and cored clasts, suggest they underwent a minimum amount of transport and likely were derived from a local source.

The abrupt transition from mainly flows in the north to mainly breccia in the south along a series of northwest-trending faults associated with a dike complex suggests that these faults may be synvolcanic in origin. For this reason, the heterolithic breccia is interpreted to be the product of debris flows deposited in a fault-bounded subsidence structure from local sources to the north. The cored clasts, with scoriaceous envelopes, are typical of spatter deposit. Because they were only observed in proximity to the transition area, the fault structures may have localized some 'fountaining' volcanism. The mafic-felsic dike complex is interpreted to be a synvolcanic dike swarm emplaced along synvolcanic subsidence faults.







amygdaloidal aphyric basalt (upper left corner), aphyric nonamygdaloidal

basalt (middle left) and sparsely plagioclase-phyric basalt (lower centre) in

showing abundant scoriaceous pillow fragments (tabular and angular), Hidden

formation

plagioclase-crystal-rich matrix, Hidden formation

Louis formation rocks The Louis formation rocks and stratigraphy are very similar at Flin Flon and in the Schist Lake - Mandy mines area. In both places, the formation is composed mainly of plagioclase-pyroxene-phyric basaltic flows, with minor aphyric and plagioclase-phyric basaltic flows, mafic volcaniclastic rocks, and local rhyolite flows and associated felsic volcaniclastic rocks near the base. One small difference is that the basaltic flows in the Flin Flon camp are generally thinner (averaging 15 m and ranging up to 60 m; DeWolfe, pers. comm., 2006) than those in the Schist Lake and Mandy mines area (averaging 50 m and ranging up to 80 m).

The main difference between Louis formation rocks at Flin Flon and those in the Schist Lake and Mandy mines area is that the former are exposed in the core of the Burley Lake syncline, whereas the latter form a single, homoclinal, west-facing sequence. Further work is required to define the location of the Burley Lake syncline as it extends south into the Schist Lake and Mandy mines area.









flow (tops to the top of the photograph), Louis formation

Schist Lake - Mandy mines area rocks









contraction cracks, Hidden formation

Photo 4 - amoeboid pillow breccia composed of poorly sorted, subangular, highly vesicular to scoriaceous fragments of amoeboid pillows; note the darker chilled margin around the fragments, Hidden formation

Economic significance

Volcanogenic massive sulphide (VMS) deposits in the Flin Flon area occur in association with the felsic volcanic units in synvolcanic collapse structures and calderas, within the main mafic volcanic complex (Bailes and Syme, 1989; Syme and Bailes, 1993). The ability to recognize these structures is key to exploring for VMS deposits in and around the Flin Flon area, as well as in other greenstone belts in

This summer's 1:5000 scale bedrock mapping of the Schist Lake and Mandy mines area has identified a potential subsidence structure complete with associated synvolcanic faults and local fault-associated mafic and felsic magmatism. This structure, within the Hidden formation rocks just southeast of Carlisle Lake, also has a spatially associated and well-developed gossan. Other smaller gossans were observed in the area, often associated with mafic and felsic dikes.



Until recently, rocks of the Hidden formation occurring in the hangingwall to the Flin Flon-Callinan-Triple 7 VMS deposits were never considered as a serious exploration target. The recent mapping at both Flin Flon (DeWolfe and Gibson, 2006) and in the Schist Lake and Mandy mines area, however, clearly shows that the hangingwall stratigraphy possesses the very same volcanic structures that focused mineralization and ore formation in the underlying Flin Flon formation. Thus, these rocks should be and are being re-evaluated in terms of their exploration potential.

Other rocks

The rocks east of the Mandy Road Fault on the west shore of the Schist Lake are of considerable interest as they host the past-producing Schist and Mandy VMS mines. Only part of this area was remapped during the 2006 field season, as they are the focus of a new M.Sc. thesis by E. Cole at Laurentian University under the supervision of H. Gibson and S. Piercey.

Overall, the rocks east of the Mandy Road Fault consist of three or more faulted packages of vertical to subvertical, north-trending and west-facing volcanic rocks, which are composed mainly of heterolithic mafic and felsic volcanic breccia and minor intercalated mafic flows.









Preliminary map: PMAP2006 ____

Geology of the Schist Lake-Mandy mines area, Flin Flon, Manitoba (part of NTS 63K12)

Intrusiv	e rocks	
	B1	Boundary intrusions
		a) melagabbro, locally with various xenoliths
		b) hornblende-leucogabbro, pegmatitic in places
		c) fine to medium grained gabbro
	P	a) quartz feldspar porphyty
Mensi C	Follo	
WISSI G	roup	Madium to users as the strate conditions
_	IVIZ	Medium to very coarse peoply arkosic sandstone
	M1	Pebble to cobble conglomerate, with minor interbedded arkosic sandstone and pebbly arkosic sandston
FLIN FL	ON ARC	ASSEMBLAGE (>1.88 GA ROCKS)
Louis F	ormation	
	L7	Undivided mafic dvkes/intrusion and massive coarse grained mafic flows
	L6	Syn-volcanic mafic dykes/intrusions
	-	a) medium to coarse grained gabbro, locally plaglociase- and/or pyroxene-phyric
	L5	Rhyolite
		a) qualtz-plagiociase-phyric
	L4	Matic volcaniclastic rocks
	12	
	L3	Aphyric to sparcely plagioclase-phyric basaltic flows
		a) massive and philowed nows b) massive flows
-	12	Plagioclase-phyric basaltic flows
		a) massive and pillowed flows
		b) pillowed flows
	L1	Plagioclase-pyroxene-phyric basaltic flows
	-	a) thick coarse grained massive flows with thin pillowed and/or amoeboid breccia top
		b) massive and pillowed flows
		c) mainly pillowed flows
Hidden	Formatio	2n
	H5	Syn-volcanic felsic dykes/intrusions
_	-	a) quartz-phyric
	H4	Syn-volcanic mafic dykes/intrusions
		a) Dyke swarm with <10% screens of host rock(s)
	H3	Mafic volcaniclastic rocks
_		a) well-bedded mafic tuff, lapilli and breccia
	H2	Heterolithic mafic breccia
		a) with cored-clasts b) plagioclase-crystal-rich matrix
-	H1	Appyric to sparcely plagioclase-phyric basaltic flows
		a) mainly pillowed flows
		b) massive and pillowed flows
		c) massive and pillowed flows with abundant amoeboid pillow breccia
		d) monolithic flow top breccia
11		e) massive now showing columnar jointing
Unaivia		NIC ROCKS
	vo	
	V5	Mafic volcaniclastic rocks
		a) well-bedded mafic tuff
		b) plaglociase-crystal-rich tum
	V4	Heterolithic breccia composed of mafic and felsic volcanic clasts
	V3	Heterolithic mafic breccia
	V2	Plagioclase-phyric basaltic flows
_	_	a) massive to pillowed plagioclase-phyric fows, locally pyroxene-plagioclase-phyric or
_	-	aphyric, locally interbedded with thin well bedded matic tuff
	V1	Aphyric to sparcely plagioclase-phyric basaltic flows
		a) massive and pillowed flows b) massive flows and matic sills intercalated with thin well bedded matic tuff intervals
Undivid	ed Intrus	
Chaivia		Multiple matic dulor complex
	13	a) locally showing screens of the host rock/c)
	12	A) rocary showing screens of the host rock(s) Rhyolite dyles/intrucions
	12	a) quartz-plagioclase-phyric
		b) plagioclase-phyric
		c) aphyric
	11	Gabbro dykes/intrusions

- Planar structure Bedding: tops - unknown, known, overturned
- Pillow; top known
- Foliation; generation unknown, 1st, 2nd
- Flow contact, top unknown, known, overturned Crenulation cleavage; generation - unknown, sense - unknown
- Crenulation cleavage; 2nd generation, sense unknown, dextral, sinistra
- Shear zone; sense unknown, dextral, sinistral
- Shear band; generation unknown, 2nd: sinistral Fault; sense - unknown, dextral, sinistral
- Fold axial plane
- Mafic dike
- Felsic dike
- Lineations Fold axis; generation - unknown
- Fold axis; generation unknown, symmetric
- Fold axis; generation unknown, S symmetry Fold axis; generation unknown - Z symmetry L-fabric; generation unknown
- Slicken striae
- Geological contacts ----- Defined ----- Approximat
- ·· Assumed ----- Facies
- ------ Fault defined ----- Fault - approximate
- ----- Fault assumed

Limit of mapping ----- Road

- Bridge ----- Railway

- SUGGESTED REFERENCE
- 100 50 0 100 200 300 400 500 Metre

