GS-4 TRACE-ELEMENT SIGNATURES OF FLIN FLON VOLCANOGENIC MASSIVE SULPHIDE (VMS) DEPOSITS (NTS 63K, 63L), MANITOBA

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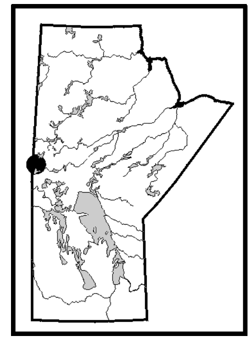

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SUMMARY

This aspect of the Flin Flon Targeted Geoscience Initiative deals with profiling the trace-element signatures of the Flin Flon deposits and major prospects through instrumental neutron-activation analysis (INAA), inductively coupled plasma–optical emission spectroscopy (ICP-OES) and inductively coupled plasma–mass spectrometry (ICP-MS) geochemical analysis. Major base metals, precious metals, trace and rare earth elements will be evaluated in order to investigate the relationship between deposit signatures and the geochemical profiles of their footwall rocks. The objective is to test whether exploration criteria can be based on comparisons of deposit trace-element signatures and those of their host strata.

INTRODUCTION

One of the interesting aspects of current metallogenic studies is the profiling of Canadian VMS deposits through the trace and rare earth element signatures of their host rocks and ores. These signatures are determined by the nature of the hydrothermal fluid, and by the chemistry of the footwall strata, which supply metals and other elements to the hydrothermal fluid. The chemistry of these footwall rocks can be unique to the particular tectonic environment in which the VMS deposits were formed.

The distinctive trace-element signatures of sulphide ores from VMS deposits may also be used as exploration vectors. Sulphides intercepted during drill programs or prospecting can be analyzed, and their signatures compared to the geochemical archive developed during the Flin Flon Targeted Geoscience Initiative. This can be particularly useful in determining whether a prospect lies along a known VMS-hosting stratigraphic succession, thereby allowing a more accurate assessment of the type of massive sulphide mineralization to be expected if drilling is continued.

PROGRESS REPORT

The study of some 150 ore samples from a total of 17 massive sulphide deposits (Fig. GS-4-1) and prospects in the Flin Flon camp was undertaken to provide

- *summary compositional data on ore samples for major metal components (Cu, Zn, Fe, Pb), precious metals (Au, Ag), trace metals (*see *list in Table GS-4-1) and rare earth elements:* Rock-forming elements that constitute the mainly altered, fragmental hostrock portion of the ore samples were also determined (by ICP-OES) to facilitate interpretation of the other analytical data.
- *mineralogical information on silicate and sulphide components of the ore samples:* To this end, 190 polished thin sections were prepared for petrography and electron microprobe analysis of sulphide minerals, work that is now underway.
- *analysis of sulphide and oxide mineral separates (329) derived from the ore samples:* Hand-picking and physical separation methods (superpanning, magnetic susceptibility) were employed to yield clean mineral separates of chalcopyrite, sphalerite, pyrite, pyrrhotite, magnetite and galena. These were routinely obtained, along with occasional rare components, such as tennantite and arsenopyrite. These were analyzed for the same suites of major ore-metal components, as well as trace metals, by ICP-OES, ICP-MS and wet chemical methods. Numbers of separates for individual minerals are presented, in summary form, for each deposit in Table GS-4-1. Small amounts of galena were recovered from a number of lead-bearing ores, but were not analyzed due to insufficient quantities. They were retained for possible future use in isotopic studies.
- *archive suites of sulphide ore slabs and reflected light photography of their polished surfaces:* These were prepared for distribution to the National Mineral Collection (held at GSC–Ottawa) and to the analogous collections held by the Province of Manitoba.

One of the most challenging aspects of this study is the fact that, in most cases, the VMS orebodies are hosted within

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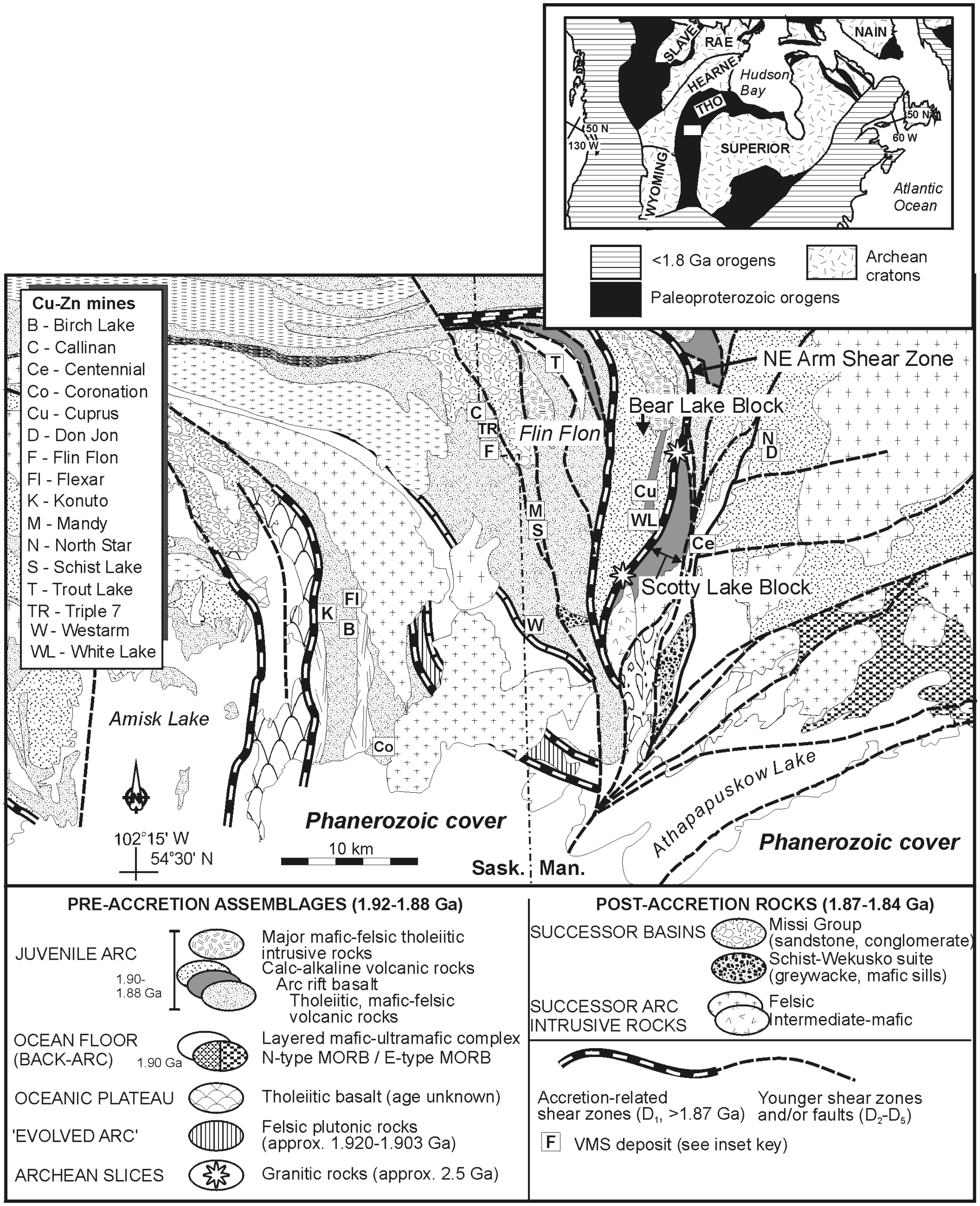

Figure GS-4-1: Tectonic-assemblage map of the central portion of the Flin Flon Belt (after Lucas et al., 1996), showing the locations of producing and past-producing base-metal VMS mines.

Table GS-4-1: Summary of work undertaken on samples of sulphide mineralization collected from VMS deposits in the Flin Flon area.

Domain	Tectonics	Age (Ga)	Ore Type	Cu/ (Cu+Zn)	Host rocks for ore samples	Ores analyzed	Polished thin sections / slabs	Minerals analyzed Cp	Sp	Gn	Py	Po	Mt	Asp
1) Flin Flon Assemblage	juvenile arc	1.91–1.88												
1a) Flin Flon Block	juvenile arc	ca. 1.903												
Flin Flon	arc rift, basin fill	1.903	Cu-Zn-(Pb)-(Au)	34	heterolithic fragmental and felsic flows	30	32	7	16	2	10	3	2	1
Callinan	arc rift, basin fill	1.903	Cu-Zn-(Pb)-(Au)	30	heterolithic fragmental and felsic flows	9	13	4	4	-	8	5	5	-
777	arc rift, basin fill	1.903	Cu-Zn-(Au)	36	heterolithic fragmental and felsic flows	8	12	6	1	-	3	7	3	-
Mandy	juvenile arc	1.903(inferred)	Cu-Zn-(Au)	42	heterolithic fragmental and felsic flows	12	39	13	6	-	7	2	-	-
Schist Lake	juvenile arc	1.903(inferred)	Cu-Zn-(Pb)-(Au)	38	felsic cataclastite	15	17	6	9	-	9	-	-	-
West Arm	arc rift or back arc?	<1.903?	Cu-Zn	69	cataclastite and argillite	6	7	4	-	-	3	-	-	1
1b) Bear Lake Block	juvenile arc-caldera fill	1.886			basalt and overlying cauldron infill succession									
White Lake	intra-arc rift	1.886	Cu-Zn-(Pb)	30	argillite-chert and andesitic turbidite	8	8	3	3	-	7	4	4	-
Cuprus	intra-arc rift	1.886	Cu-Zn-(Pb)	34	argillite-chert and andesitic turbidite	6	8	1	3	-	5	3	4	-
1c) Sourdough Bay Block	juvenile arc	not known												
Northstar			Cu	100	felsic cataclastics	7	8	4	-	-	7	1	-	-
Don Jon			Cu	100	felsic cataclastics	1	1	1	-	-	1	-	-	-
Pine Bay			Cu	100	augen schists, felsic (?)	7	7	6	-	-	7	2	7	-
Centennial			Cu-Zn-Pb	36	siliceous mylonites (recrystallized)	5	5	5	-	-	4	2	-	-
2) Birch Lake Assemblage	primitive juvenile arc	1.886												
Flexar			Cu-(Zn)	89	mafic flow/sill dominated	14	13	10	-	-	9	9	7	-
Birch Lake			Cu	100	mafic flow/sill dominated	3	4	3	-	-	1	-	3	-
Coronation			Cu-(Zn)	93	mafic flow/sill dominated	8	9	7	-	-	4	1	6	-
Konuto			Cu (Zn)	~90	tholeiitic basalt and associated sills	9	9	5	-	-	4	4	6	-
3) Successor Arc	succesor arc	1.875–1.84												
Trout Lake		1.869	Cu-Zn+/-Pb	31	Fault-bounded mafic-felsic volcanics and argillites	6								
4) Vamp Lake	setting unknown	?	Cu-Zn	~50	?	2	2	2	1	-	2	1	2	-

ICP-OES & ICP-MS (GSC Laboratories, Ottawa): SiO_2, TiO_2, Al_2O_3, Fe_2O_3(T), MnO, MgO, CaO, Na_2O, K_2O, CO_2(T), P_2O_5, S(T), Ba, LOI
Ag, Be, Bi, Cd, Co, Cr, Cs, Cu, Ga, Hf, In, Mo, Nb, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Te, Th, Tl, U, V, Zn, Zr, REE
INAA (Activation Laboratories, Ancaster, Ontario): Au, As, Hg, Se, Zn (major), S(T) %

fault systems localized along stratigraphic contacts. The result is that the ores have undergone mechanical, and occasionally chemical, synkinematic remobilization. This process has most likely caused significant remobilization of base and precious metals and trace elements, which results in a very different chemical profile than that of the original orebodies. For this reason, the authors expect the most significant results to come from analysis of sulphide separates rather than aggregate ores.

SAMPLE SOURCES

Ore samples for the study were obtained from several sources. An extensive suite of relatively well preserved material was collected from dumps at defunct mines, and underground at Callinan, 777 and Konuto. Rusty rinds were removed by saw prior to further treatment. Where mine dumps have become grassy meadows as a result of a burgeoning reclamation program in the Flin Flon camp, archival collections at GSC and Hudson Bay Exploration and Development Co. Ltd. (HBED) facilities in Flin Flon were accessed. Without the extensive slab collections of D.F. Sangster, R.V. Kirkham, R.I. Thorpe and A.G. Galley, there would have been large gaps in what is now a comprehensive set of analyzed ore samples. K. Gilmore (HBED) provided a suite of underground samples from Trout Lake, and supplemented GSC suites with material from another nine deposits and prospects.

It should be noted here that an equivalent range and number of ore samples were obtained from the same sources for the Snow Lake camp (as well as the Sherridon mine), with a view to a future study of that camp for comparative purposes.

One bonus feature from this study was the discovery of some historical suites of samples collected from two of the most famous deposits in the Flin Flon camp, namely the Mandy mine (mined by open pit 1919–1920), and the Flin Flon deposit lakeshore discovery site (1919–1920) and 600-foot level (1928). These were slabbed, prepared for analysis and polished for the archival suites noted above. The ores were collected by then GSC curator A.T. McKinnon and geologist J.F. Wright. The research value of these carefully preserved samples is gratefully acknowledged. The authors trust that new archival suites derived from the present study will be of similar value to future researchers.

Table GS-4-1 provides information on deposits sampled and details on the numbers of ores and separates analyzed and the number of sections prepared for each deposit. Deposits have been grouped and arranged in an order that relates to their likely stratigraphic positions within the tectonic assembly of the Paleoproterozoic Flin Flon Belt. Geochronological data for individual deposits are sparse; those that are available are discussed in Syme et al. (1999). Geographically, the deposits cluster within discrete tectonic domains or fault-bounded slivers (Table GS-4-1). This order of listing is subjective, and merely designed to facilitate eventual presentation of analytical and mineralogical datasets. A full paper and digital database file describing results of the study are in preparation.

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