Current Research (1993) Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 93-1, pages 401-418

ARGILLITE-HOSTED SULPHIDE OCCURRENCES IN THE EASTERN PART OF THE LABRADOR TROUGH

H.S. Swinden and F. Santaguida[1]
Mineral Deposits Section

ABSTRACT

The preliminary results of a project designed to evaluate the economic potential of shale-hosted sulphide occurrences in the eastern part of the Labrador Trough are presented. More than fifty known occurrences of pyrite and pyrrhotite, locally with base-metal enrichments, are found within the Howse Zone. The sulphides are hosted by carbonaceous argillites that are preserved as screens within and between gabbroic sills.

A reconnaissance survey of several of these showings in the Howse Lake, Martin Lake, Katey Lake and André Lake areas shows that most are conformable, base-metal-poor, probably syngenetic accumulations. The geological environment appears to record euxinic basins within an evolving continental-margin rift. Showings are composed variously of fine-grained laminated pyrrhotite, coarser grained disseminated conformable and crosscutting pyrite, and very coarse-grained pyrite associated with calcareous beds. Local base-metal enrichments may reflect proximity to sites of metalliferous hydrothermal discharge.

Besshi-type metallogenic models (i.e., cupriferous, shale-hosted massive sulphides in rift environments) are considered to be appropriate for these occurrences. Geochemical studies in progress will focus on along-strike variations of metals in an attempt to pinpoint areas of hydrothermal discharge and stable isotope studies to help further document the environment and mineralizing processes.

INTRODUCTION

Sulphide occurrences with and without associated base metals are widespread in the Labrador Trough east and northeast of Schefferville (Figures 1 and 2). In 1991, a project was initiated to evaluate the nature and genesis of these occurrences. The objectives were to identify the processes responsible for the concentration of the sulphides, apply deposit models in an effort to evaluate the economic potential of this mineralization, and suggest where further exploration might be focussed in the search for deposits of economic significance.

The project began with a helicopter-supported reconnaissance survey in 1991 of representative occurrences between Howse and André lakes (Swinden, 1991). Geochemical analysis of samples collected from this reconnaissance survey was carried out in the winter of 1992.

Follow-up work in the 1992 field season was focussed in the area immediately north of Martin Lake (Figures 2 and 3) where there are several documented sulphide occurrences, some of which have previously been reported to contain significant concentrations of base metals (Bloomer, 1954; Hoag, 1971). The objectives of this work were to document the nature of the mineral occurrences and to develop and test deposit models for the mineralization by: 1) observation of the field relationships of mineral occurrences in the area; 2) systematic sampling of sulphides and host rocks for assay and geochemical studies to document the base-metal contents and/or anomalies in tracer-element concentrations that could shed further light on the economic potential of the mineralization; and 3) collection of samples for petrographic and stable-isotope studies, which could further contribute to deposit models for this part of the Labrador Trough.

The 1992 field program was carried out in mid August from a camp on Martin Lake. Old trenches at the Martin Lake North #1 showing were cleaned out and further excavated in an attempt to expose the contact relationships of the mineralized zone. Foot traverses were made to a number of showings in the Martin Lake North, Jimmick Lake and Chicago Lake areas (Figure 3) with the objective of carrying out detailed mapping and sampling of the mineralized outcrops.

This project is funded by the Canada—Newfoundland Cooperation Agreement on Mineral Development (1990-1994); project jointly carried by Geological Survey Branch, Department of Mines and Energy, Government of Newfoundland and Labrador, and Geological Survey of Canada.

[1] University of Waterloo, Department of Earth Sciences, Waterloo, Ontario

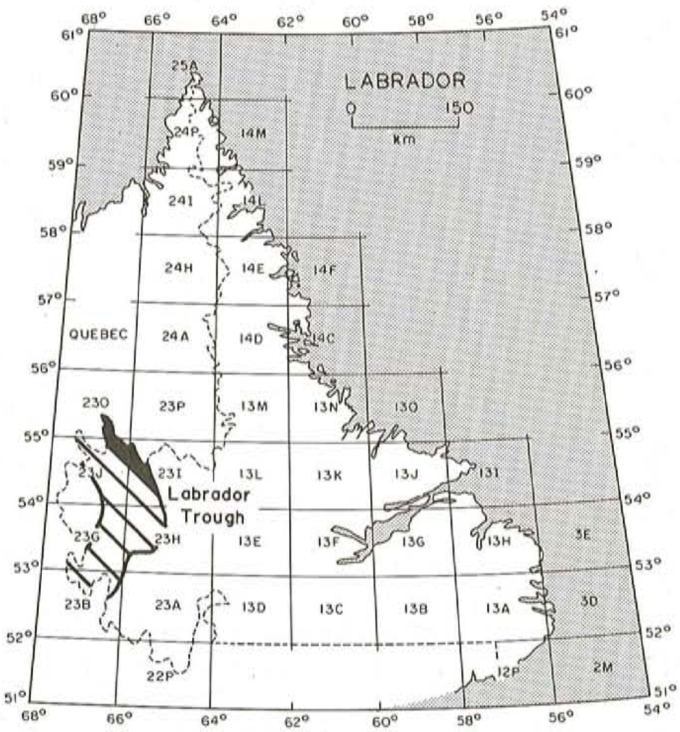

Figure 1. *Location of the Labrador Trough (cross-hatch) and area underlain by the Howse Zone (black) as illustrated on Figure 2.*

This report contains a preliminary summary of field observations and assay results from both the 1991 reconnaissance and the 1992 detailed studies at Martin Lake. Laboratory analyses, petrographic studies and modeling of mineralizing processes will form the basis of future reports.

REGIONAL GEOLOGY

The Labrador Trough, which forms the western division of the Churchill Structural Province in Labrador (Wardle *et al.*, 1990), comprises the largest Early Proterozoic sedimentary basin in the eastern Canadian Shield. It is underlain dominantly by low-grade sedimentary and volcanic rocks of the Knob Lake Group that were deposited between approximately 2.1 and at least 1.88 Ga (Wardle *et al.*, 1990). The rocks are presently disposed in a west-verging fold-and-thrust belt resulting from Hudsonian deformation ca. 1.8 Ga.

In the study area, two components to the basin have been recognized (Figure 2). The western division, the Schefferville Zone, consists dominantly of shallow-water sedimentary rocks whereas the eastern division, the Howse Zone, consists mainly of deep-water turbidites, shales, basalt flows and massive volumes of gabbroic sills. The two zones are separated by the Ferrum River thrust (Figure 2).

Stratigraphy in the Schefferville Zone consists of basal (rift-related) arkoses (Seward Subgroup) that unconformably overlie Archean metamorphic rocks of the Superior Craton. These are overlain by a shallowing-upward sequence of shale, dolomite and chert breccia of the Attikamagen Subgroup. This is disconformably overlain by the deepening-upward succession of quartzite, ironstone, shale and turbidite of the Ferriman Subgroup which is, in turn, overlain by the terrestrial arkoses of the Tamarack River Formation.

The Howse Zone also contains a basal continental arkose that is assigned to the Seward Subgroup. This is overlain by a thick pile of interbedded turbidite, carbonaceous, sulphidic argillite, siltstone and basalt intruded by voluminous gabbroic sills, which has been previously assigned to the Attikamagen Subgroup. The gabbros have yielded a U–Pb (zircon) age of 1.88 Ga (Findlay *et al.*, 1990). The carbonaceous argillites in the eastern part of the Howse Zone are highly sulphidic associated with numerous pyritic and pyrrhotitic sulphide occurrences, some of which contain base metals. In many areas, the sedimentary rocks are only sporadically preserved as screens between the gabbro bodies. The Attikamagen Subgroup in the Howse Zone passes upward into a sequence of quartzite and ironstone like that in the Schefferville Zone, supporting the paleogeographic linkage between the two zones (Wardle *et al.*, 1991).

The rocks of the Schefferville and Howse zones have been interpreted to represent an eastward-deepening prism formed during rifting of the Superior Craton (Wardle and Bailey, 1981). This is consistent with the relatively shallow-water depositional environments of the Attikamagen Subgroup in the Schefferville Zone relative to the Howse Zone and the abundance of deep-water sedimentary rocks and volcanic and intrusive rocks of oceanic tholeiite character in the Howse Zone. The gabbro sill swarm in the Howse Zone is interpreted in this scenario to be part of the continent–ocean transition and to represent attempted ocean-crust formation in a sediment-dominated environment. However, although the age of the gabbros is relatively well known, the age of the sedimentary rocks is not closely constrained and verification of the model awaits definitive evidence for the ages of the sedimentary and intrusive rocks.

SHALE-HOSTED SULPHIDES IN THE HOWSE ZONE

The study area was part of a mineral concession granted to Labrador Mining and Exploration Company (LM&E) in 1936 by the Newfoundland Commission of Government. The company initiated a long-term program of geological mapping and prospecting in 1937 to evaluate the mineral potential of this concession. Although efforts were principally focussed on iron and manganese deposits, attention was also turned to sulphidic gossans in what is now termed the Howse Zone. Although these gossans had probably been recognized as early as 1929 in adjacent New Quebec, they had not been examined in detail, nor evaluated for their base-metal potential. Retty (1942) described a 1936 discussion with a geologist, who reported seeing gossans in the headwaters of the George River, and described a subsequent visit (1937), in the company of a native prospector, to an area called 'MacNeill Lake' in New Quebec, where four gossans were encountered. In the same year, rust-coated pyrite–carbonate zones were discovered at

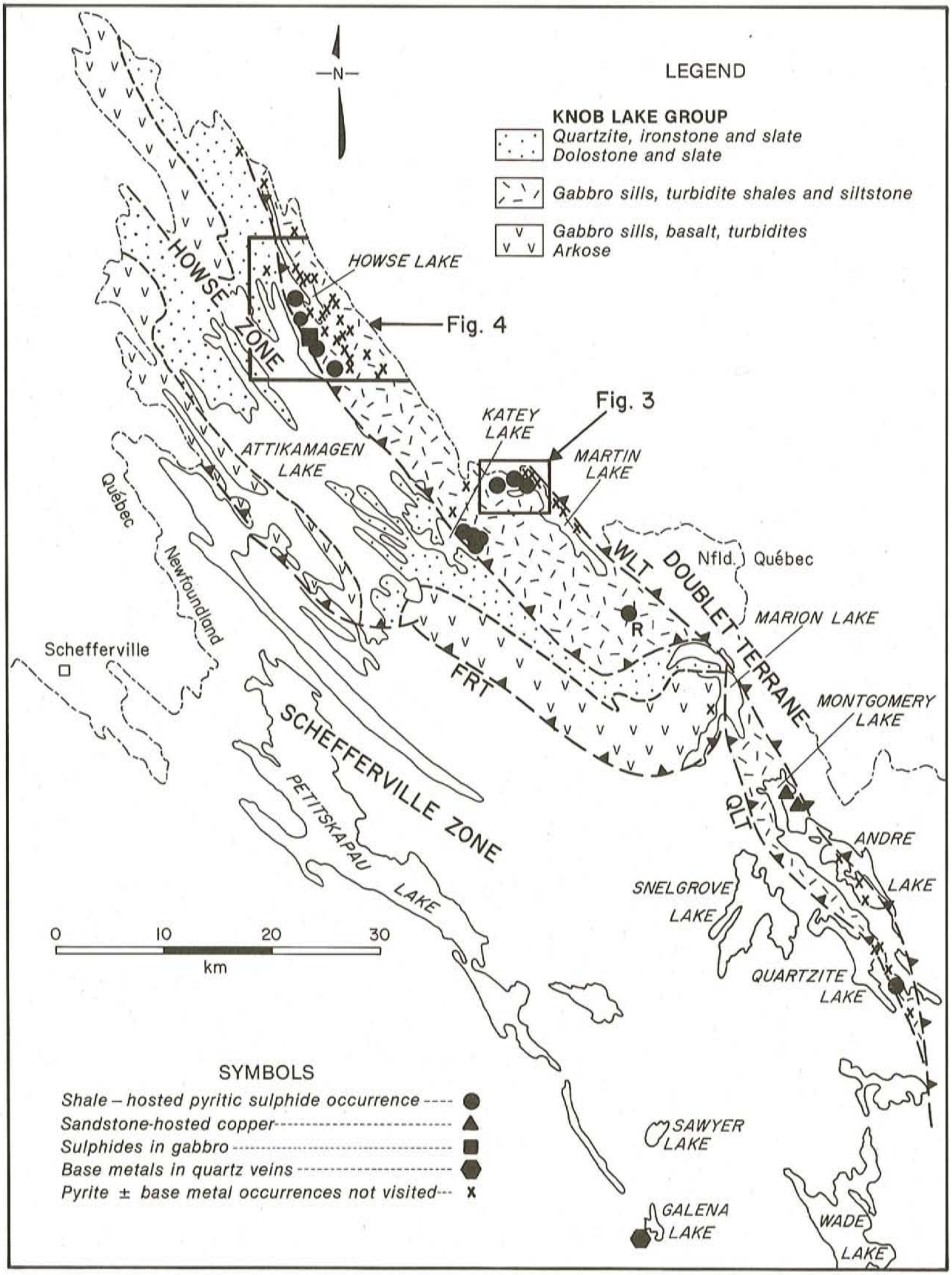

Figure 2. *General geology (after Wardle* et al., *1990) and base-metal sulphide occurrences of the Howse Zone, Labrador Trough. FRT–Ferrum River thrust; QLT–Quartzite Lake thrust; WLT–Walsh Lake thrust. Shale-hosted pyritic occurrences visited during the course of this study shown by solid dots; occurrences reported but not yet visited shown by 'x'. Area of Figures 3 and 4 are indicated. R–Rusty Lake showing.*

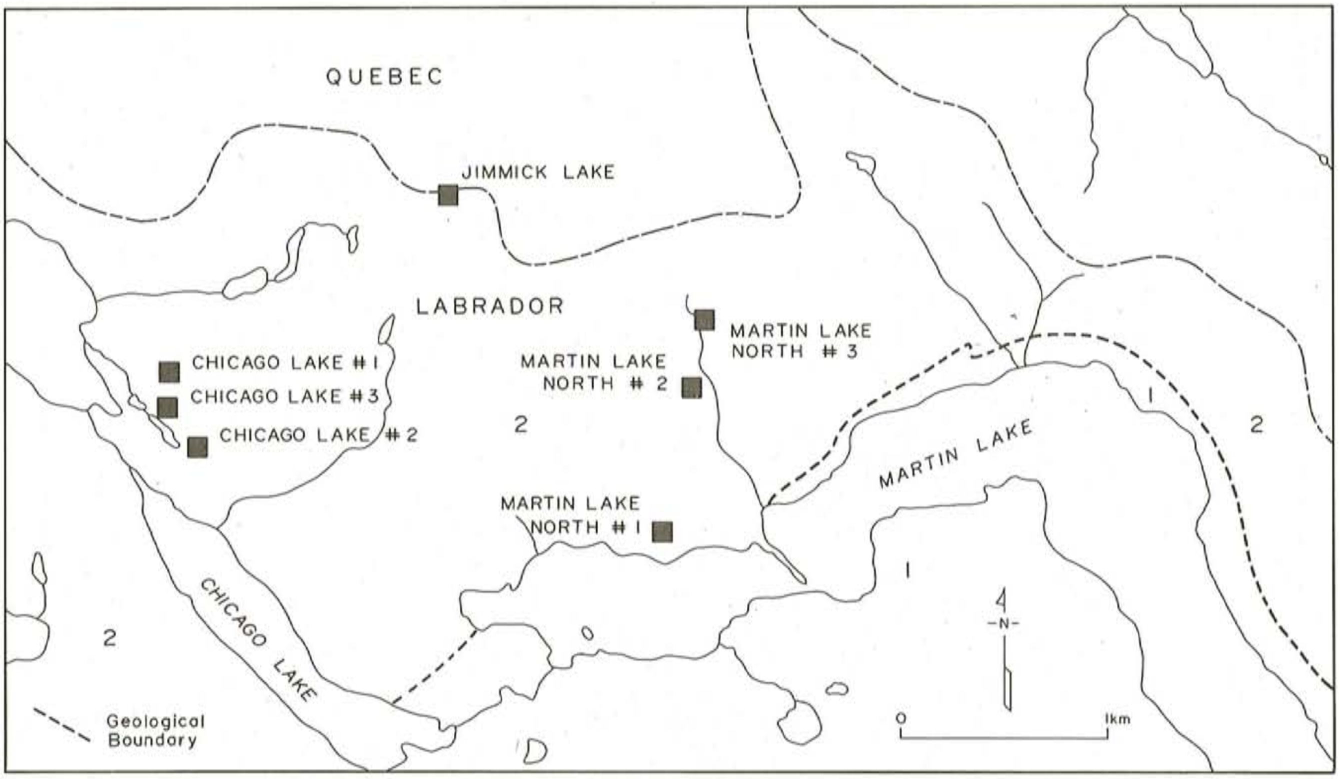

Figure 3. *Location of argillite-hosted sulphide occurrences in the Martin Lake area. 1—dominantly argillite and associated clastic sedimentary rocks; 2—dominantly medium- and coarse-grained gabbro and diabase with screens of carbonaceous argillite.*

Rusty Lake near Marion Lake, and this appears to be the first report of sulphide mineralization in the Labrador part of the Howse Zone (Retty, 1942, pages 117 and 118).

In the course of aircraft flights over the area, numerous other gossans were noted and this spurred LM&E to put several prospecting parties in the area in 1942. It soon became apparent that there was a belt of sulphide occurrences, termed the 'gossan belt' by Retty (1942), that extended from the area of André Lake in the south at least as far northeast as Retty Lake in Quebec, and possibly farther. Retty (1942) did not describe any new showings in detail but noted that most occurrences consisted of pyrrhotite associated with minor chalcopyrite hosted by carbonaceous tuffs. It is not clear whether any showings in Labrador, other than the one at Rusty Lake, were included in the study.

Mapping and prospecting in a large area between André Lake and Attikamagen Lake in 1942 and 1943 were described by Moss (1944), who reported finding more than 50 gossans. Although some of these appear to have been bog iron, he described massive sulphide bodies ranging from a few inches to several tens of feet wide and up to half a mile long that consisted variously of fine-grained pyrite and/or pyrrhotite along with associated chalcopyrite, nickeliferous pyrrhotite and sphalerite. Moss (1944) noted that gossans were particularly abundant in the vicinity of Marten, Gauthier and Moss lakes.

Regional investigation of the gossan belt was resumed by LM&E in 1949. Auger (1949) mapped the area between Frederickson Lake (Quebec) and the southern part of Martin Lake. Although working mostly in Quebec, Auger (*op. cit.*) did note the presence of several mineralized shale outcrops in the brook flowing into the south end of Katey Lake and reported blocks of mineralized shale in the area northeast of Gross Lake.

Detailed prospecting was carried out in the Martin Lake area during 1954 and the results reported by Bloomer (1954). During the course of that work, the area was mapped in detail, the showings in the Martin Lake North and Chicago Lake areas were discovered, and some trenching and stripping was carried out. Bloomer (1954) reported that massive pyritic sulphides in a showing immediately north of Martin Lake (now termed Martin Lake North #1) contained up to 5.85 percent Zn and 0.66 percent Cu. Subsequent descriptions of these showings can be found in Hoag (1971).

In the next year, Bloomer's attention was focussed in the Howse Lake area (Bloomer, 1955). He described the nature of the sediment-hosted mineralization and concluded that most of the sulphides were sedimentary in origin.

Base-metal occurrences between André and Howse lakes were the target of sporadic exploration by LM&E through the 1960's, 1970's and early 1980's. The work included regional-geochemical studies of surficial and bedrock materials (e.g., Grant, 1971), regional ground and airborne geophysical surveys (e.g., Bergmann, 1978; Grant, 1980, 1981; Labrador Mining and Exploration Co. Ltd., 1980) and several generations of diamond drilling. Of particular relevance to the present study was a regional study of the geology and mineralization between Martin and Marion lakes by Gall (1984), who substantially remapped this area, described the mineral occurrences, and assayed a large number of samples. Some of these assays were carried out on showings that were investigated during the present study and are reproduced here (see Table 2).

None of the LM&E exploration programs during the 1970's and 1980's resulted in discovery of economic proportions of base metal. Summary accounts of this exploration not specifically mentioned above can be found in the assessment files of the Geological Survey Branch and in the files of the Mineral Occurrence Data System (MODS). Core from several of the diamond-drill holes is preserved in the Department of Mines and Energy core library in Goose Bay.

Regional geological mapping has been carried out in the area at various scales. Baragar (1967) included the northern part of the area in his 1:250 000 mapping of the Wakuach Lake area. More detailed mapping of the area between Lac Faute and Howse Lake can be found in Frarey (1967). The geology between Marion and André lakes was described by Wardle (1979) and all of this information coupled with company geological information was compiled on regional geological maps of the northern part of the Trough in Labrador at a scale of 1:100 000 (Wardle, 1982a, b).

Regional lake-sediment geochemical data were collected on approximately 17 km centres during the National Uranium Reconnaissance Program (Geological Survey of Canada, 1982) and later analyzed for a suite of elements including gold and its tracers (Hornbrooke and Friske, 1989). A geochemical follow up of some base-metal anomalies in the lake sediments included further geochemical work in the Martin and Cunningham lakes area in the central part of the Howse Zone (McConnell, 1984).

Mineral deposit information has been researched and compiled for the whole area under the auspices of the Mineral Occurrence Data System (MODS) project. The data reside in digital and manual files; the locations of known deposits are displayed on mineral occurrence maps compiled by the Department of Mines and Energy (Smith, 1987a, b).

RECONNAISSANCE EXAMINATION OF HOWSE ZONE SHOWINGS

During July 1991, helicopter-supported reconnaissance of showings throughout the Howse Zone was carried out from a base in Schefferville. Field observations are reported below along with analyses of samples collected. Data collected from showings in the Martin Lake–Jimmick Lake–Chicago Lake area are not included in this section, but are incorporated in the more detailed descriptions of these showings arising from the 1992 field program.

HOWSE LAKE AREA

There are more than 35 documented sulphide occurrences in the immediate area of Howse Lake (Figure 4). Work in this area consisted of a ground traverse from the Howse Lake Southwest #2 showing southeastward to the Two Island Lake West showing, with visits to five intervening showings. These showings are, in fact, several specific localities along a more-or-less continuous and variably sulphidic argillite horizon that can be traced on the ground for more than 7.5 km (Wardle, 1982a).

The most northerly showing visited, the Howse Lake S.W. #2 [23O/1 (Cu005)], comprises mainly rubble crop of rusty black carbonaceous and locally siliceous argillite, which can be traced for more than 70 m along strike. Pyrite is ubiquitous and is present as disseminations and patches and locally as stratiform layers up to 6 cm wide. A single sample from a sulphide-rich bed returned no anomalous base- or precious-metal values (Table 1).

The Howse Lake Southwest #1 showing [23O/1(Pyr005)] comprises a series of outcrops of grey to black argillite associated with bands and crosscutting veinlets of pyrite. The mineralization can be traced for about 70 m along strike and is exposed across approximately 11 m at the surface. It goes around the nose of a northeast-trending fold at its north end and the enclosing gabbro appears to be folded with it. A single grab sample returned slightly less than 1 percent Zn and slightly elevated Au and Pt values (Table 1).

The Howse Lake Southwest #3 showing [23O/1(Pyr006)] appears to be within the gabbro, and comprises mainly late pyritic alteration and veinlets.

The Howse Lake Southwest #5 and #6 showings [23O/1(Pyr008)], [23O/1(Pyr009)], respectively are, in fact, part of a more-or-less continuous outcrop of sulphidic argillite that can be traced on the ground for more than 1.3 km. The argillite is consistently sulphidic, with pyrite occurring as fine laminations, small concretions, disseminations and veinlets. There are local beds of massive pyrite up to 30 mm wide and these are commonly associated with vuggy siliceous units within the argillite. Some of these siliceous units seem to be cherty and conformable, although it is not clear whether they are the result of siliceous sedimentation or later alteration. Four samples taken from the most heavily mineralized parts of the mineralized horizon returned no anomalous base- or precious-metal values (Table 1).

South of the end of continuous outcrop associated with the above showings, the sulphidic argillite can be traced in sporadic outcrop and rubble crop. Mineralized cherty units are common in this area, and represented by sample 2141236 (Table 1) which, like samples in the showings to the north, returned no anomalous base-metal values.

The southernmost showing in this traverse, the Two Island Lake West showing [23O/1(Pyr011)], comprises a poorly exposed black argillite unit containing sparse

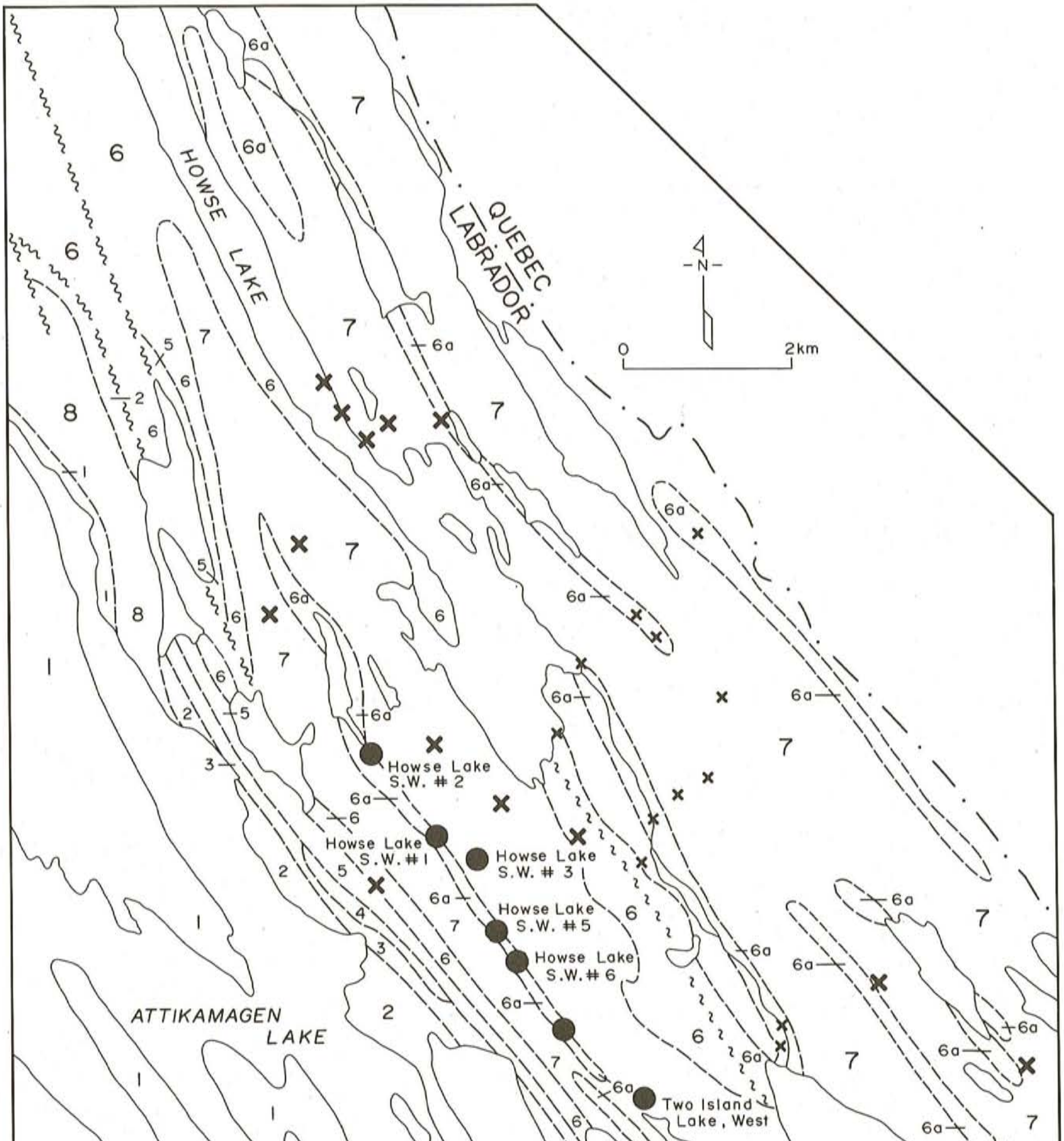

Figure 4. *General geology and location of sulphide showings in the Howse Lake area. Geology and showings after Wardle (1982a) and Smith (1987a). Showings visited during the present study are shown by solid dots; other showings by 'x'. Named occurrences are specifically referred to in text. 1—Le Fer Formation, dominantly fine-grained clastic sedimentary rocks; 2—Denault Formation, dolomite; 3—Wishart Formation, quartzite; 4—Nimish Formation, basalt; 5—Sokoman Formation, iron formation; 6—dominantly fine grained clastic sedimentary rocks, includes rocks assigned to the Menihek Formation; 6a—pyritic argillite; 7—dominantly gabbro with screens of fine-grained clastic sedimentary rocks.*

Table 1. Assays of samples collected during reconnaissance investigations in the Howse Lake, Katey Lake, and André Lake areas

sample #	%Cu	%Zn	%Pb	%Co	%Ni	Ba ppm	Au ppb	Ag ppm	Pt ppb
				Howse Lake area					
Howse Lake West #2									
2141228	0.047	0.12	nd	0.005	0.012	608	<4	0.3	<10
Howse Lake Southwest #2									
2141229	0.033	0.818	0.005	0.004	0.035	76	28	0.6	10
Howse Lake Southwest #5,6									
2141232	0.41	0.019	0.003	0.002	0.008	71	28	0.2	5
2141233	0.003	0.002	0.001	0.003	0.000	17	10	0.1	5
2141234	0.012	0.010	0.003	0.003	0.019	88	10	0.3	10
2141235	0.003	0.004	0.001	0.000	0.000	17	12	0.1	<10
Undocumented showing									
2141236	0.008	0.002	0.001	0.001	0.002	15	16	0.1	5
Two Island Lake West									
2141237	0.006	0.013	0.001	0.001	0.015	165	<24	0.1	<60
				Katey lake Northeast					
2141213	0.011	0.006	0.003	0.005	0.009	84	40	0.5	5
2141214	0.014	0.006	0.005	0.006	0.009	29	34	0.8	5
2141215	0.004	0.008	0.001	0.001	0.005	69	40	0.3	5
2141216	0.010	0.012	0.003	0.005	0.013	14	4	0.3	<5
				André Lake area					
2141222	0.025	0.014	0.016	0.004	0.019	661	12	0.3	10
2141223	0.028	0.011	0.003	0.005	0.022	114	34	0.4	15

sulphides. The exposure is about 35 m long and about 10 m wide. A grab sample returned no base-metal values (Table 1).

KATEY LAKE AREA

Several pyritic showings are exposed in a section of rapids and small cliffs in a northwest-flowing stream immediately northeast of Katey Lake ([23J/16(Pyr004 to 007)] inclusive, Figure 2). These showings were first reported by Auger (1949) and have received little attention since.

The mineralization is hosted by steeply dipping black argillites, which outcrop in the river bottom and adjacent small cliff faces. The black argillite is underlain by a blocky-bedded, slightly rusty limestone, which does not appear to be mineralized. Sulphides in the area are dominated by pyrite that occurs as disseminations, crosscutting veinlets and massive pyrite nodules up to 30 cm in diameter. Although the shales are ubiquitously, and locally impressively, pyritic, base metals do not seem to be present in anomalous amounts (Table 1). There is no appreciable difference between metal contents of pyrite nodules (samples 2141213 and 2141215) and black argillite with pyritic disseminations and veinlets (samples 2141214 and 1241216).

ANDRÉ LAKE AREA

Although sulphide mineralization in the André Lake area was described as early as 1944 (Moss, 1944), the only detailed descriptions are by Kozela (1960). Mineralized material examined during the present study consists principally of black carbonaceous argillite having widely variable sulphide contents ranging from less than 10 percent to more than 50 percent. Although the individual outcrops are small, the area underlain by mineralized argillite may be substantial. Grab sample assays reported by Kozela (1960) returned generally low base-metal and gold values with a maximum of 0.28 percent Cu. Grab samples collected during the present study from two outcrops approximately 130 m apart also returned generally low base-metal values (Table 1).

DETAILED EXAMINATION OF SHOWINGS IN THE MARTIN LAKE AREA

The MODS lists five sulphide occurrences in the area immediately north of Martin Lake. These showings were visited during the 1991 reconnaissance survey, briefly examined, and a number of grab samples taken (samples 2141205 to 2141212 inclusive, Table 2). Because of the

Table 2. Assays of samples collected from showings in the Martin Lake North area. Assays from the same showings reported by Gall (1984) are shown for comparison. (na–not analysed; nd–not detected)

sample #	Description	%Cu	%Zn	%Pb	%Co	%Ni	Ba ppm	Au ppb	Ag ppm	Pt ppb
				Martin Lake North #1 (present study) new Trench #1						
2141207	Grab; mass. sulph.	0.383	0.009	0.004	0.015	0.003	6	6	0.1	<5
2141288	2.3 m chip; mass. sulph.	0.274	0.008	nd	0.013	0.002	na	2	0.2	<5
2141289	0.65m chip; sulph. arg.	0.155	0.029	nd	0.011	0.006	na	na	0.3	na
2141291	0.65m chip; sulph. arg.	0.037	0.016	nd	0.003	0.006	na	2	0.4	<5
2141292	4 m chip; mass. sulph.	0.343	0.004	nd	0.021	0.002	na	2	0.3	<5
2141293	2 m chip; sulph. arg.	0.276	0.006	nd	0.014	0.002	na	na	0.2	na
				new trench #2						
2141294	1.6 m chip; mass. sulph.	0.216	0.013	nd	0.005	0.002	na	na	0.3	na
2141295	1.3 m chip; mass. sulph.	0.241	0.004	nd	0.012	0.003	na	na	0.4	na
2141296	grab; mass. sulph. boulder	0.341	0.019	nd	0.014	0.002	na	na	0.3	na
				south trench						
2141205	grab; sulphidic argillite	0.086	0.017	nd	0.002	0.003	495	8	0.1	<5
2141206	grab; gossan	0.549	0.033	0.004	0.001	nd	7	1450	0.3	<5
2141297	grab; sulphidic argillite	0.025	0.022	nd	nd	0.007	na	18	0.2	30
2141298	grab; unmineralized arg.	0.095	0.018	nd	0.002	0.008	na	4	0.1	<5
				Martin Lake North #1 (Gall, 1984)						
214	grab; 'mudstone'	0.418	0.002	0.002	na	0.003	na	103*	1.4	na
238	grab; 'mudstone'	0.274	0.002	0.003	na	0.001	na	69*	1.2	na
239	grab; 'mudstone'	0.308	0.003	0.002	na	0.002	na	69*	1.2	na
240	grab; 'mudstone'	0.276	0.003	0.003	na	0.001	na	<69*	1.6	na
241	grab; 'mudstone'	0.279	0.002	0.002	na	0.001	na	69*	2.0	na
				Jimmick Lake (present study)						
2141209	grab; outcrop in pit	0.080	2.224	0.036	0.003	0.004	55	460	10.5	15
2141211	grab; strongly pyrrhotitic boulder	0.313	0.006	0.004	0.020	0.013	15	12	4.6	5
2141285	grab; strongly pyrrhotitic boulder	0.233	0.004	0.003	0.016	0.011	na	8	4.7	<5
2141286	grab; strongly pyrrhotitic boulder	0.422	0.010	0.012	0.016	0.011	na	12	5.2	<5
2141287	grab; pyritic boulder	0.117	0.078	0.010	nd	0.001	na	78	5.3	<5
				Jimmick Lake (Gall, 1984)						
2025		0.033	0.176	0.069	na	0.008	na	<69*	2.0	na
245	grab; 'mudstone'	0.010	0.003	0.004	na	0.005	na	69*	2.2	na
250	grab; 'mudstone'	0.046	0.004	0.010	na	0.006	na	<69*	1.4	na
251	grab; 'mudstone'	0.056	0.005	0.002	na	0.004	na	69*	2.2	na
252	grab; 'mudstone'	0.010	0.006	0.002	na	0.003	na	103*	1.6	na
				Chicago Lake #2 (present study)						
2141273	grab; sulphidic arg.	0.018	0.004	0.001	0.003	0.009	na	12	0.7	10
2141274	chip; lightly min'd arg.	0.019	0.005	nd	0.004	0.009	na	34	0.5	5
2141275	2 m chip; sulphidic arg.	0.017	0.009	nd	0.003	0.009	na	4	0.4	10
2141276	1.5 m chip; sulphidic arg.	0.021	0.006	nd	0.004	0.009	na	28	0.5	5
				Chicago Lake #3 (present study)						
2141277	60 cm chip; Cu-rich sulph. arg.	0.144	0.004	nd	0.012	0.01	na	10	0.7	<5
2141278	grab; sulphidic arg.	0.234	0.003	nd	0.021	0.005	na	4	0.8	<10
2141279	rep. grab; sulphidic arg.	0.055	0.003	nd	0.003	0.007	na	2	0.6	<5
2141281	1 m chip; sulph. arg.	0.129	0.004	nd	0.028	0.008	na	4	0.6	<5

Table 2. *Continued*

sample #	Description	%Cu	%Zn	%Pb	%Co	%Ni	Ba ppm	Au ppb	Ag ppm	Pt ppb
				Chicago Lake #1 (present study)						
2141212	grab; sulphidic arg.	0.017	0.004	0.002	0.003	0.014	249	6	0.7	5
2141282	grab; sulphidic arg.	0.010	0.004	nd	0.002	0.007	na	<2	1.1	<5
2141283	grab; sulphidic arg.	0.015	0.004	nd	0.006	0.012	na	10	0.8	<5
1241284	grab; sulphidic arg.	0.014	0.009	nd	0.003	0.011	na	4	0.6	<5
				Chicago Lake area (Gall, 1984)						
247	grab; 'mudstone'	0.016	0.005	0.004	na	0.007	na	<69*	1.8	na
248	grab; 'mudstone'	0.017	0.004	0.003	na	0.008	na	<69*	1.4	na
249	grab; 'mudstone'	0.016	0.085	0.065	na	0.006	na	69*	1.0	na
253	grab; 'mudstone'	0.010	0.025	0.001	na	0.003	na	103*	1.0	na
255	grab; 'mudstone'	0.009	0.003	0.002	na	0.003	na	103*	1.4	na
256	grab; 'mudstone'	0.157	0.003	0.001	na	0.003	na	69*	1.0	na
				Martin Lake North #2 (present study)						
2141299	1 m chip; sulphidic arg.	0.005	0.006	nd	nd	0.003	na	2	0.4	<5
2141301	1.8 m chip; slightly sulph. arg.	0.005	0.005	nd	nd	0.003	na	<2	0.4	<5
2141302	2.0 m chip; slightly sulph. arg.	0.002	0.006	nd	nd	0.002	na	≥2	0.2	5
2141303	2.0 m chip; slightly sulph. arg.	0.012	0.005	nd	nd	0.002	na	4	0.2	<5
				Martin Lake North #2 (Gall, 1984)						
215	grab; 'mudstone'	0.043	0.009	0.001	nd	0.012	na	137	1.0	na
242	grab; 'mudstone'	0.009	0.007	0.003	nd	0.003	na	69	1.4	na
243	grab; 'mudstone'	0.006	0.005	0.001	nd	0.002	na	137	1.6	na
244	grab; 'mudstone'	0.021	0.004	0.001	nd	0.002	na	103	0.8	na
				Martin Lake North #3 (present study)						
2141304	grab; unmineralized arg.	0.001	0.003	0.009	nd	0.002	na	10	1.0	5
2141305	grab; slightly pyritic arg.	0.004	0.005	nd	nd	0.002	na	<2	0.4	<5
2141306	grab; pyritic arg.	0.008	0.006	nd	nd	0.004	na	2	0.4	<5

*—imprecise gold assays originally reported in oz/T

concentration of showings within a relatively small area and the presence of a significant sulphide occurrence with reported base-metal values (Martin Lake North #1), it was decided to devote the time available during the 1992 field season to examining these showings in some detail. All showings in the area were visited and mapped in detail. Some additional outcrop stripping was carried out and, at the Martin Lake North #1 showing, some time was spent cleaning out and extending the old trenches. Samples were collected for petrographic, geochemical and stable isotopic studies. The geological base in Figure 3 shows the principal rock types, but not their detailed distribution, nor their structural disposition.

MARTIN LAKE NORTH #1 SHOWING

The Martin Lake North #1 showing, discovered by LM&E during detailed mapping and prospecting (Bloomer, 1954), is located on the edge of a swamp approximately 150 m north of Martin Lake (Figure 3). Bloomer's original description was of a vein-like mass at least 9 m wide and at least 45 m long conformable with the enclosing rocks. Host rock to the mineralization was described as 'impure marble' in a sequence of shale and basalt. He described the mineralization as a 'vein (which), is essentially a solid mass of pyrite with sphalerite and chalcopyrite included in irregularly distributed zones' and containing rare crystals of galena. Assays of grab samples from the massive sulphide taken at that time yielded up to 5.85 percent Zn and 0.66 percent Cu (Bloomer, 1954).

The showing is presently exposed in two old trenches (Figure 5). The northern trench is approximately 17 m long and 6 m wide and almost completely filled with water. It contains several large (up to 60 cm in diameter) boulders of massive pyrite with very minor chalcopyrite and sphalerite and small outcrops of similar material occur at edges of the trench (these were further excavated during the present study, see below). The southern trench is approximately 29 m long and ranges from 3 to 12 m wide. There is a small exposure of unmineralized black argillite and siltstone in rubble crop at its southern end. In the bottom of the central part of the trench, there is an area of highly fractured and deeply weathered gossan composed of shale and some pyrite. The long direction of the old trenches is approximately parallel to the strike of the bedding.

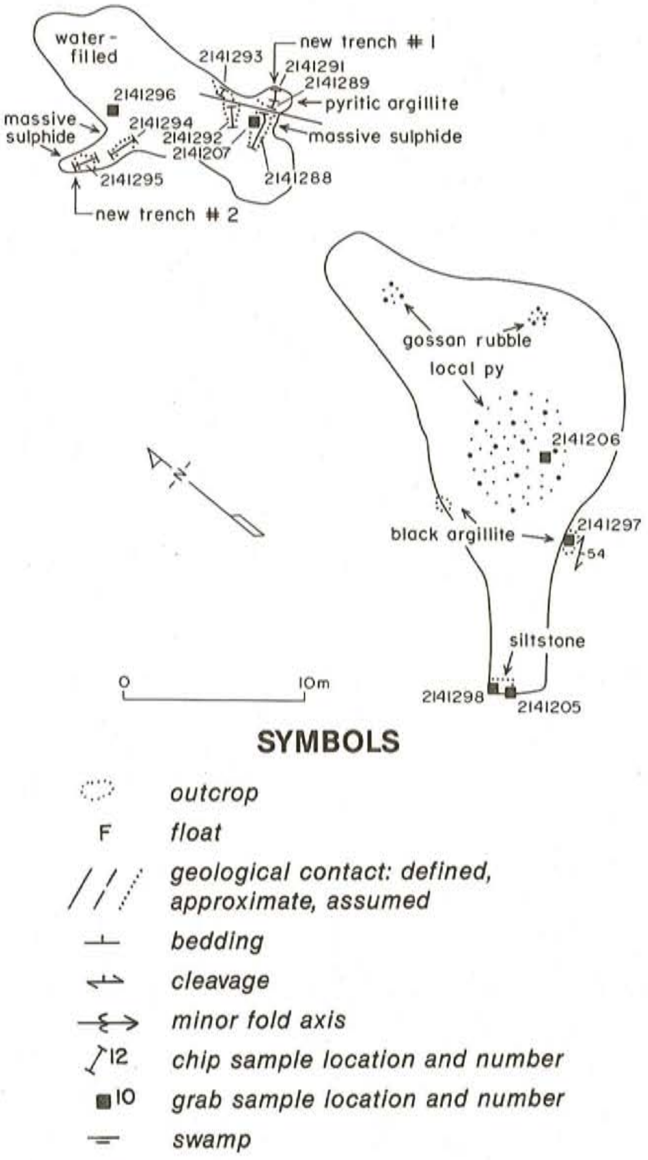

Figure 5. *Sketch map of trenches at the Martin Lake North #1 showing. Sample numbers keyed to Table 2.*

Most of the present study was carried out in the northern trench. The axis of the old trench is approximately parallel to bedding (and the long axis of the massive sulphide) but the contacts of the massive sulphide were not exposed. Two new trenches were excavated perpendicular to the axis of the old trench (Figure 5) to uncover the contacts and observe the relationship of the massive sulphide to the surrounding rocks. The new excavations are herein referred to as 'new trench #1' and 'new trench #2' on the eastern and western sides of the old trench, respectively (Figure 5; Table 2).

New trench #1 was cut back 1.3 m from the edge of the old trench. It exposed additional outcrop of the massive sulphide and the eastern contact between massive sulphide and a strongly cleaved black argillite containing 10 to 20 percent pyrite as disseminations, veinlets and small concretions. The argillite is most intensely pyritic near the contact with massive sulphide and pyrite content seems to decrease away from this contact. The contact is conformable and unfaulted and appears to be sedimentary in origin. Observations in this trench support the interpretation that the sulphides form a lens of essentially massive, coarse-grained pyrite associated with variable amounts of chalcopyrite and sphalerite. The country rock to the massive sulphide appears to be a calcareous argillite or siltstone, which probably explains previous descriptions of this deposit as being hosted by 'impure marble' (Bloomer, 1954).

One grab sample was collected at this locality in 1991 (sample 2141207, Table 2) and several chip samples were collected from both massive sulphide and nearby sulphidic argillite in 1992. Copper values are consistently anomalous (0.2 to 0.4 percent) in the massive sulphide (approximately 0.3 to 0.4 percent) and are generally anomalous in the argillite immediately adjacent to the massive sulphide as well. No anomalous Zn, Pb or precious-metal values were detected; Co and Ni are uniformly at background values.

New trench #2 was cut perpendicular to and on the west side of the old trench for a distance of approximately 3 m in an effort to observe the western contact of the massive sulphide. Although sulphides are present in this trench, there is a persistent hard pan above the outcrop in this area and good exposures were not easily obtained. The massive sulphide exposed in outcrop at the side of the old trench appears to strike into the new trench and to be pinching out along its length. In hand specimen, the massive sulphide comprises coarse pyrite with local chalcopyrite in a black argillite matrix. No carbonate rocks were noted in this trench. Massive sulphide samples from this trench returned anomalous Cu concentrations similar to new trench #1 but no other metal values (Table 2).

Attempts to reach bedrock in the south trench were largely unsuccessful although sparsely mineralized black argillite was recovered from rubble crop at the south end of the trench and from probable outcrop in a shallow pit on the east side of the trench (Figure 5). These samples were not anomalous in base or precious metals but a single grab sample of gossan material collected in 1991 returned 0.56 percent Cu and 1450 ppb Au (Table 2). This is the highest gold assay returned from anywhere in the Howse Zone during this study and should be treated with caution until it is confirmed by repeat sampling and assay.

MARTIN LAKE NORTH #2 SHOWING

The Martin Lake #2 showing comprises an outcrop of sulphidic, locally calcareous, black argillite and siltstone, which has been stripped over an area of approximately 6 by 20 m (Figure 6). The outcrops are generally quite rusty but overall are not rich in sulphides. The rocks are tightly folded.

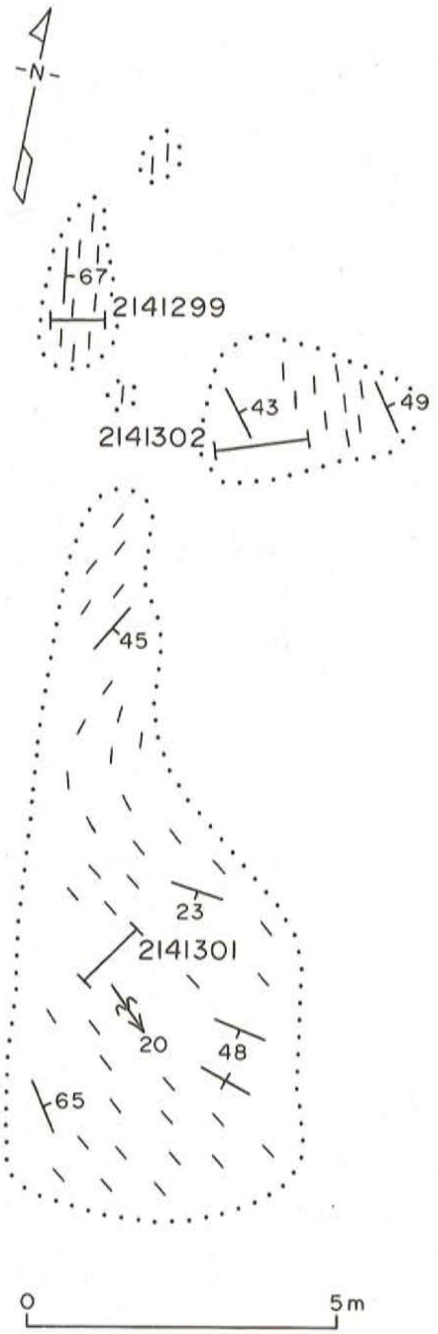

Figure 6. *Sketch map of stripped outcrops at the Martin Lake North #2 showing. Sample numbers keyed to Table 2. Symbols as for Figure 5.*

Pyrite is ubiquitous, but sporadically distributed, throughout the outcrop, locally reaching concentrations of 5 to 25 percent over widths of 1 to 2 m. It occurs as disseminations, veinlets and as concretions up to 70 cm in diameter. The most intense sulphide concentrations are found at the north end of the showing where approximately 25 percent pyrite occurs in roughly conformable patches and veins (sample 2141299, Table 2). Three chip samples taken from the showing did not return anomalous base- or precious-metal values (Table 2); neither did a fourth chip sample taken from similar, lightly mineralized argillite approximately 150 m north of the showing (sample 2141303).

Overall, this showing is a fairly representative, although comparatively lean, sulphidic argillite of typical Howse Zone aspect. It is probably on strike with the Martin Lake North #1 showing and may be its distal equivalent, although given the paucity of outcrop, this is difficult to demonstrate in the absence of geophysical evidence.

MARTIN LAKE NORTH #3 SHOWING

This showing is represented by a number of rusty black and grey argillite outcrops along a strike length of more than 300 m. Most of the outcrop here is gabbro, locally with small screens of pyritic argillite. The main band of argillite outcrops sporadically on the east side of a small pond, stream and bog near the height of land and apparently continues across the height of land into Quebec. Minor pyrite is present in most areas but no significant concentrations were observed. Three grab samples did not return anomalous base- or precious-metal values (Table 2).

JIMMICK LAKE SHOWING

This occurrence, very close to the Quebec border, is presently held by Hollinger North Shore Mines Ltd. The mineralization is poorly exposed and represented mainly by float and an outcrop in one small pit. The most intense mineralization is found in boulders near the pit and consists mainly of pyrrhotite, which is disseminated and forms massive lenses and bands within the carbonaceous argillite. Many of the boulders at the showing are highly pyrrhotitic and contain bands up to 10 cm wide of almost massive, very fine-grained pyrrhotite separated by intervals of similar width of black argillite with 20 to 30 percent pyrrhotite. Chalcopyrite is ubiquitous although not abundant, and when seen in hand specimen, commonly occurs as coarse patches and crosscutting veinlets within the fine-grained pyrrhotite. Pyrite is present, commonly as disseminations, small framboids and veinlets in somewhat silicic (cherty) black argillite.

The only outcrop in the vicinity of the showing is in the approximately 4-m-wide by 1-m-deep pit and consists of black argillite associated with disseminated pyrite.

Samples were collected from this showing in both 1991 (samples 2141209 and 2141211) and 1992 (samples 2141285 to 2141287). Interestingly, samples in which the main iron sulphide is pyrite carry anomalous Zn and Au values (samples 2141209 and 2141287) whereas the pyrrhotitic samples are anomalous in Cu (Table 2).

CHICAGO LAKE AREA

Mineralization in the Chicago Lake area was first reported by Bloomer (1954), who described pyrite, pyrrhotite and minor chalcopyrite in black argillites and reported assays of up to 0.1 percent Cu and 0.2 percent Zn from grab samples. Our examination of the area northeast of Chicago Lake shows that mineralized argillite is widespread in the area, occurring as screens between gabbro sills. Three principal areas of mineralized argillite were examined. The occurrence described in the MODS file as the Chicago Lake showing (2J/16/Cu002) is herein termed the Chicago Lake #1 showing (Figure 3). The Chicago Lake #2 and #3 showings have not been previously described.

The Chicago Lake #1 showing includes a large number of exposures over an area of more than 150 by 40 m. The mineralized rocks comprise complexly folded sulphidic, carbonaceous argillite intruded by diabase and gabbro, which make up more than 70 percent of the exposures within the area of the showing. Pyrrhotite and, to a lesser extent, pyrite are ubiquitous and locally abundant but no massive sulphides were noted. Screens of argillite range from 30 cm to several tens of metres thick and intrusive relationships with the gabbro are exposed at many locations. There is no evidence of concentration of sulphides at the argillite–gabbro contacts, nor is there any evidence of mineralization within the gabbros in the area of the showings. Three grab samples collected from some of the more intensely mineralized outcrops did not return anomalous values of base or precious metals (Table 2).

The Chicago Lake #2 and #3 showings are actually on-strike equivalents of the same sulphidic argillite band, separated by about 400 m of gabbro, which has excised the argillite between the two showings. The two showings are very similar in their geological characteristics, setting, and style of mineralization.

At the Chicago Lake #2 showing (Figure 7), a mineralized argillite band occurs as screens within the dominant gabbro and is exposed for lengths of up to 150 m and widths of 30 to 40 m. Layers of almost massive, very fine-grained pyrrhotite are the principal style of sulphide mineralization and appear to represent bands of sulphidic mud. Chalcopyrite is common and usually occurs in crosscutting, relatively coarse-grained veinlets. The mineralization is very similar in appearance to that at the Jimmick Lake showing.

The contacts with the surrounding gabbro are irregular and where observed, are not particularly sulphide rich. Samples of typical, moderately sulphidic, argillite (sample 2141273, Table 2, which was taken from an isolated outcrop about 150 m north of the showing proper), as well as representatives of the more heavily mineralized sections of the showing (samples 2141274, 21412775, 2141276; Figure 7) did not return anomalous base-metal values although slightly elevated Au was detected in two samples (28 and 34 ppb respectively).

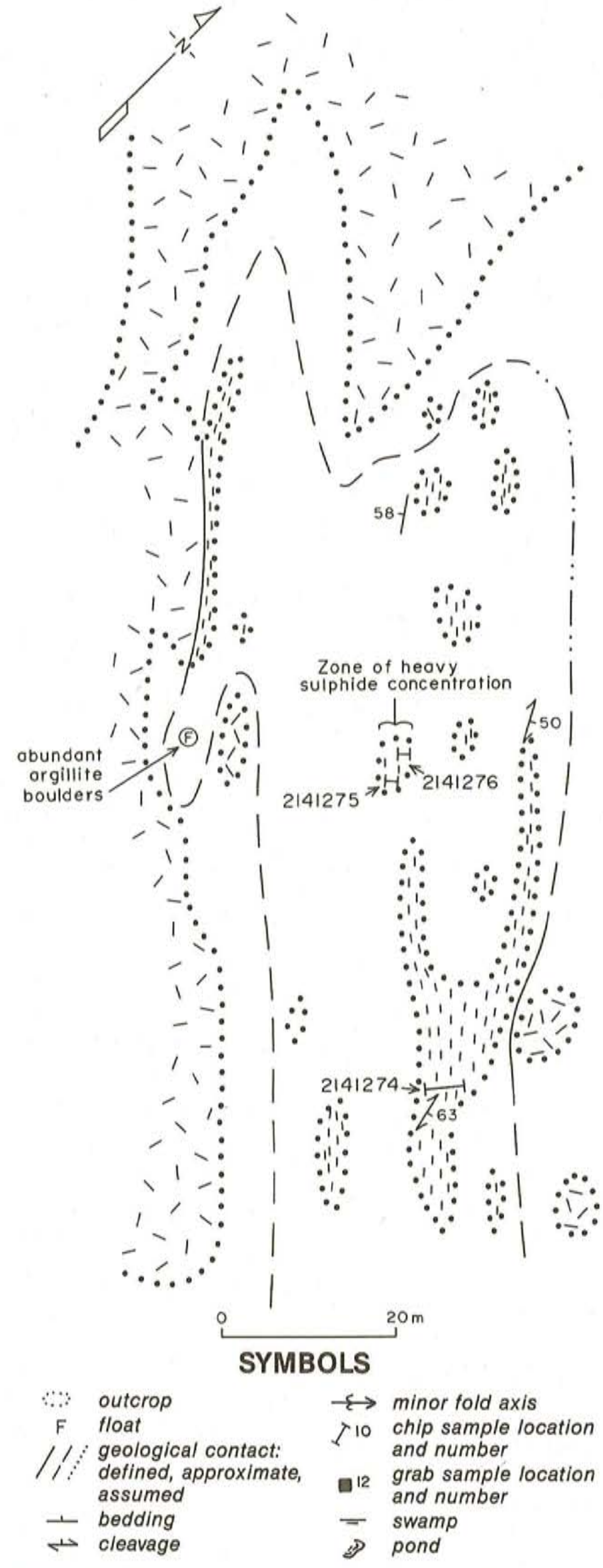

Figure 7. *Sketch map of the Chicago Lake #2 showing. Sample numbers keyed to Table 2.*

The Chicago Lake #3 Showing is also exposed over a strike length of about 130 m. It comprises two parallel argillite bands separated by a thin apophysis of gabbro (Figure 8). As at the #2 showing, the dominant sulphide mineral here is fine-grained pyrrhotite, disseminated and forming massive laminations. Pyrite is common, as is chalcopyrite (less so) in coarser grained veinlets. Samples from this showing are generally elevated in Cu relative to the other Chicago Lake area showings, although not quite to the extent of the Martin Lake North #1 and Jimmick Lake showings (Table 2).

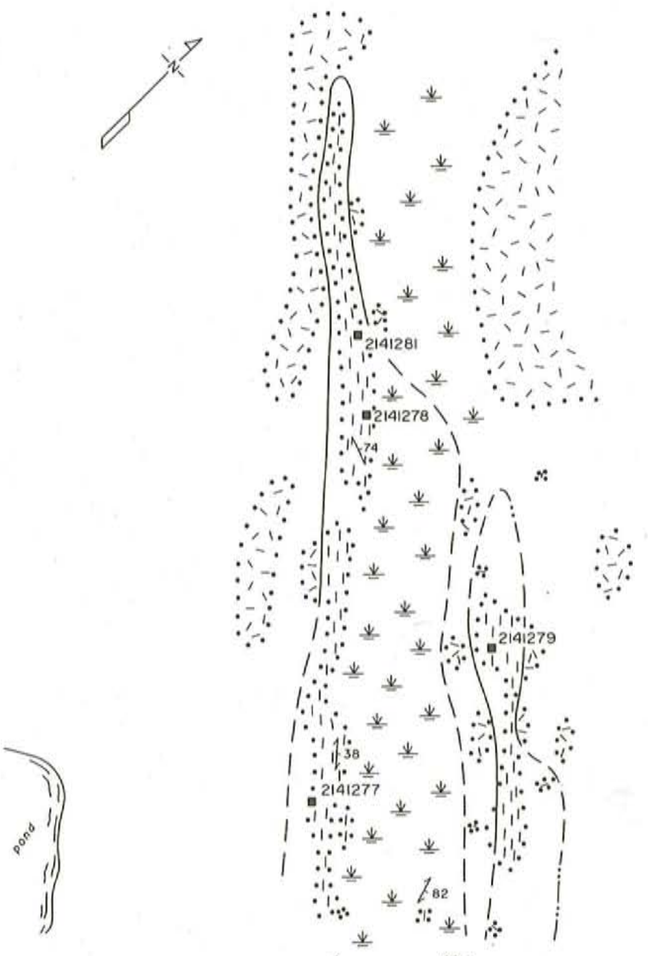

Figure 8. *Sketch map of the Chicago Lake #3 showing. Sample numbers keyed to Table 2. Symbols as for Figure 7.*

DISCUSSION

REGIONAL CHARACTERISTICS OF SHALE-HOSTED SULPHIDES IN THE HOWSE ZONE

Stratabound and stratiform sulphides are widespread in black argillites of the Howse Zone in the Labrador Trough. Although the argillites are mainly preserved as screens within a gabbro sill complex, they are not highly metamorphosed and primary textures and structures are commonly preserved. The argillites are folded and cleaved, and the gabbros seem to have been folded with them.

On the basis of field observations, three broad types of sulphide mineralization can be recognized. This classification is preliminary and may be further refined according to the results of laboratory studies in progress and further field work planned for 1993.

Fine-Grained Pyrrhotitic Mineralization

This appears to be the most widespread type of sulphide mineralization. The fine-grained pyrrhotite forms massive to semi-massive beds, up to several centimetres thick, separated by argillitic intervals with variably disseminated fine-grained pyrrhotite. This type of mineralization is locally cut by veinlets of coarser grained pyrite and chalcopyrite. In hand specimen and in drill core, it appears to represent more or less primary sulphidic mud interbedded with varying amounts of fine-grained clayey sediment. The depositional environment would appear to be best interpreted as a restricted anoxic setting. This type of mineralization is particularly characteristic of the Jimmick Lake and Chicago Lake areas, as well as the Lac Faute showings just across the border in Quebec, 6 km northeast of Martin Lake.

Pyritic Argillite

Pyritic mineralization is characteristically coarser grained than the pyrrhotitic type, in which individual cubes are typically, in the 0.5 to 3 mm range. Pyrite cubes are disseminated throughout the argillite, and coarse pyrite occurs within and as replacements along the margins of bedding-parallel and sinuous, crosscutting veinlets. In addition, pyrite framboids are locally common and some showings are characterized by pyrite concretions. This style of mineralization is particularly typical of the Katey Lake showings but is also present in association with fine-grained pyrrhotitic mineralization at Jimmick Lake and Lac Faute and forms the footwall to the massive sulphides in calcareous rocks at Martin Lake North #1. Although the pyrite does not appear to be syngenetic, the sinuous nature of the veins, the bedding-parallel nature, the framboidal textures and the common presence of concretions suggest that it was deposited in unconsolidated sediments and may be diagenetic.

Very Coarse-Grained Pyrite in Calcareous Rocks

This type of mineralization is only recognized at the Martin Lake North #1 showing. Very coarse pyrite, typically 10 mm in diameter, occurs in the massive sulphide lens in a very calcareous silty gangue. The pyrite is much coarser grained than in the adjacent black argillite. Although field observations strongly suggest that this deposit is a conformable lens within the argillite sequence, the form of the sulphides and the calcareous nature of the host rocks point to differences with the typical argillite-hosted mineralization in the area. The timing and nature of the mineralization poses questions that will be addressed separately by petrographic, geochemical and stable isotopic studies.

REGIONAL ASPECTS OF METAL CONCENTRATIONS

More than 50 sulphide occurrences have been documented in the Howse Zone. They occur in sulphidic argillite horizons that are locally continuous, in outcrop, for several kilometres, but in other cases are only intermittently preserved as local screens within gabbro sills and are not continuous between mineralized outcrops. In some instances, several showings may, in fact, represent along-strike exposures of the same sulphidic argillite band.

All of the showings examined in the Howse Lake area belong to the same argillite horizon. In the Martin Lake North area, it is possible that most of the sulphide occurrences occur at two horizons—one including the Martin Lake North #1, #2 and #3 showings and the other including the Jimmick–Chicago lakes occurrences. Preliminary data suggest that these horizons vary in metal content along strike.

On a regional scale, chalcopyrite is the only common base-metal sulphide. It occurs both as disseminations associated with pyrite and as crosscutting veinlets. All chalcopyrite observed in hand specimen seems to have been remobilized, although petrographic studies are required to determine whether primary chalcopyrite can be recognized. As a rule, metal contents are variable but generally low. Although all sulphidic argillites are of similar aspect, some have local enrichments in base metals and, locally, precious metals. Copper is the principal metal of value in most metal-enriched argillites but local enrichments in zinc have been encountered, for example, at the Jimmick Lake and Martin Lake North #1 showings.

Although geochemical analyses of mineralized samples are still preliminary (i.e., assays have been completed but more detailed geochemical studies are still in progress), some conclusions can be drawn regarding the distribution of metals in the mineralized argillites. In particular, correlations between metals in the showings help to suggest which metals were participating together in the mineralizing process.

Overall, Cu and Zn show a diffuse positive correlation (Figure 9a) and Cu and Pb (Figure 9b) a more pronounced correlation (although Pb is typically at very low concentrations). Cobalt is generally not highly enriched in any of the mineralized horizons but does show a good positive correlation with Cu (Figure 9c). This is the strongest metal correlation that has been recognized in these showings. Although there is not a general positive correlation between Au or Ag and the base metals, the samples with the highest concentrations of precious metals also are enriched in Cu (Figure 9d, e).

Barium concentrations are generally variable but low. There is no overall correlation of Ba with the base metals, and concentration spikes do not correlate with anomalous base metals (Figure 9f). There is no correlation at all between Cu and Ni (Figure 9g), suggesting that these two metals were not co-participants in the mineralizing process.

METALLOGENIC MODELS

Most previous workers have interpreted the argillite-hosted iron sulphides in the Howse Zone to be syngenetic, and the present observations support this view. In particular, the following lines of argument suggest that base-metal concentrations are not related to the intrusion of the nearby gabbros:

i) Within individual showings sulphides are distributed without regard to proximity to the enclosing gabbros. Sulphides are not concentrated near the gabbro–argillite contact, which was observed in several locations at Chicago Lake and the Martin Lake #3 area. The most sulphide-rich areas are commonly within the argillite well away from the nearest gabbro contact;

ii) Nickel contents are invariably negligible in all occurrences and Ni does not correlate with Cu in mineralized samples.

Therefore, the alternative that the base metals along with the iron sulphides represent primary enrichments in the carbonaceous argillites, which result from hydrothermal activity on the seafloor during deposition of the sediments, is preferred. Base-metal enrichments would seem, on the basis of present evidence, to be localized at specific localities along these sedimentary horizons. This is particularly evident in the area north of Martin Lake where significant enrichments in the argillites are present at Martin Lake North #1, Jimmick Lake and Chicago Lake #2, but only background values are present elsewhere in the argillites interpreted to be along strike. Our preliminary interpretation is that these metal enrichments reflect nearby metalliferous hydrothermal discharge during sedimentation. Although metal values do not reach economic proportions at the locations sampled to date, their presence is indicative of the mineralizing process and detailed exploration might reveal more substantial accumulations.

In general terms, two metallogenic models would seem to be appropriate for this environment, sedimentary exhalative (SEDEX) models (Large, 1980; Goodfellow and Lydon, 1990) and Besshi-type models (Mitchell and Bell, 1973; Fox, 1984). Both are stratiform, shale-hosted massive sulphide deposit types that typically form on the sea floor in sedimented rift environments in response to anomalous heat flow and associated hydrothermal activity. SEDEX deposits (e.g., the Sullivan deposit in southern British Columbia) although forming in an area of enhanced heat flow, generally are not associated with voluminous magmatic activity. Their base metals are dominated by Zn–Pb and are typically enriched in Ag and in Ba. In contrast, Besshi-type deposits, such as the Anyox Windy Craggy deposits in northern British Columbia, are typically associated with coeval tholeiitic and/or mildly alkalic volcanic or high-level intrusive activity. They are characteristically cupriferous with associated Zn but little Pb, and commonly contain anomalous amounts of Co.

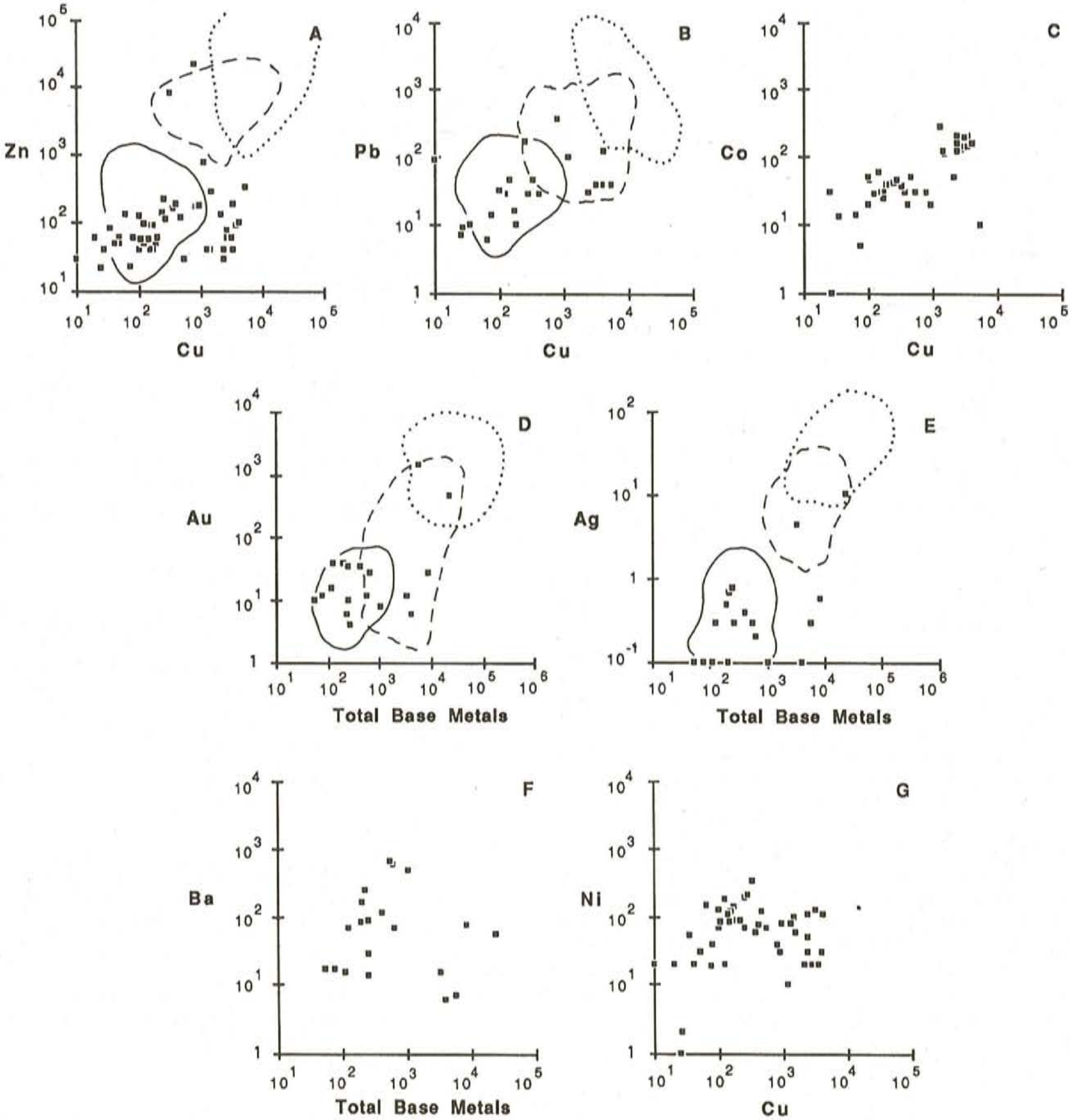

Figure 9. *Inter-element correlations for all Howse Zone samples analyzed during the present study. All elements in ppm except gold in ppb. Fields illustrate metal contents of different sulphide facies at the Soucy #1 deposit after Barrett* et al. *(1988): Solid line–Distal laminated sulphides; broken line–proximal laminated massive sulphides; dotted line–polymetallic massive sulphides. See text for discussion.*

In the Howse Zone, the presence of voluminous mafic sills of oceanic tholeiitic character suggests that Besshi-type models might be more appropriate for the associated shale-hosted mineralization. This conclusion is supported by the Cu-rich (relative to other base metals) nature of the occurrences and by the paucity of Pb and Ba. Although Co is not significantly enriched in absolute terms, the positive correlation between Cu and Co (Figure 9c) suggests that the two metals were moving sympathetically in the mineralizing system and is further suggestive of Besshi-type mineralization.

A more substantial analogue for the Howse Zone deposits in Labrador may be offered by the Soucy No.1 deposit in the northern part of the Labrador Trough in Quebec. This deposit, which contains drill-indicated reserves estimated at 5.4 million tonnes grading 1.49 percent Cu, 1.80 percent Zn, 13.7 g/t Ag and 1.61 g/t Au (Barrett *et al.*, 1988), is hosted by turbidites intruded by voluminous gabbro sills. Although stratigraphic correlation with the Howse Zone in Labrador cannot be demonstrated with confidence, the sedimentary and tectonic environment and geological setting of the mineralization shows many similarities. Barrett *et al.* (1988) have interpreted this deposit as comprising syn-sedimentary sulphides of Besshi-type in a rifted passive margin environment.

The massive sulphide at the Soucy No. 1 deposit is overlain by laminated pyrite–pyrrhotite sulphides both proximal and distal to the metal-rich massive sulphides. There is a more-or-less regular increase in metal contents from distal to proximal laminated sulphides and thence to massive sulphides (Barrett *et al.*, 1988). The fields for these sulphide types are plotted for reference on Figure 9a, b, d and e). Samples from the Howse Zone, which are not obviously enriched in base metals, have metal contents similar to the distal laminated sulphides at Soucy No. 1. Howse Zone samples having significant metal enrichments have Cu contents (although not Zn or Ag contents) similar to the proximal laminated sulphides at Soucy No. 1.

The metal enrichment in the proximal sulphides at Soucy No. 1 is interpreted by Barrett *et al.* (1988) to be related to proximity to the sites of hydrothermal discharge. A similar interpretation may be applicable in the Howse Zone, although considerably more work is needed before such an interpretation can be advanced with confidence. If metal contents in the argillites do provide an indicator of proximity to metalliferous hydrothermal activity, then the foci of such activity in the two horizons north of Martin Lake might have been in the area of the Martin Lake North ##, Jimmick Lake and Chicago Lake #3 showings, respectively. Alternatively, it may be that the primary metalliferous depocentres in the Howse Zone were not at the presently identified showings. Detailed exploration in the area of presently identified metal anomalies might result in the discovery of more proximal sites of metal deposition. Further regional exploration might focus on the regional metal contents of the metalliferous argillites in an effort to identify significant variations in metal contents that could signal proximity to a zone of metalliferous discharge.

CONCLUSIONS

Widespread syngenetic pyrite in carbonaceous argillite in the Howse Zone of the Labrador Trough, coupled with the local presence of copper in these showings and the abundant evidence for synchronous magmatism, suggest a significant potential for shale-hosted massive sulphides. The magmatic association (i.e., abundance of basalts and approximately coeval mafic intrusions), the copper-rich metal association (rather than Zn, Pb, and barite), and the suggestion of a covariation between Cu and Co suggest that deposit models for Besshi-type, rather than classic sedimentary exhalative (SEDEX) deposits might be appropriate. Similarities between Besshi-type deposits and shale-hosted sulphide deposits in the adjacent Quebec portion of the Labrador Trough have previously been pointed out by Fox (1984) and Barrett *et al.* (1988). Wardle and Bailey (1981) have previously suggested that the Gulf of California provides a good modern analogue for these rocks. Massive sulphide deposits presently forming in the Gulf of California are widely cited as examples of modern Besshi-type deposits (e.g., Fox, 1984; Slack and Shanks, 1990).

Most Howse Zone occurrences of this type are metal-poor. However, local (subeconomic) enrichments of base (and locally precious) metals may signal proximity to sites of hydrothermal discharge. If this interpretation is correct, it may provide evidence of the operation of a mineralizing process that has the potential to produce base-metal accumulations of economically interesting proportions.

The only showing that seems to have the potential for significant tonnages of economically interesting material is the Martin Lake #1 showing, where a conformable, pyritic massive sulphide body is locally Cu-enriched and appears to have some size potential. Further work is clearly warranted to evaluate the size and extent of the massive sulphide body here.

ACKNOWLEDGMENTS

We would like to thank Dave Liverman and the Labrador West Quaternary crew for many courtesies and much appreciated logistical help during the course of our work in Labrador West. This project would not have been possible without their help and support. The manuscript was critically reviewed by Dick Wardle and Jan Pasava.

REFERENCES

Auger, P.E.
1949: Report on detailed geological mapping in the Frederickson–Faute–Martin Lake area; base metal zone. Unpublished report for the Labrador Mining and Exploration Company Limited, 20 pages. [Lab (503)]

Baragar, W.R.A.
1967: Wakuach Lake map-area, Quebec-Labrador (230). Geological Survey of Canada, Memoir 344, 174 pages.

Barrett T.J., Wares, R.P. and Fox, J.S.
1988: Two-stage hydrothermal formation of a Lower Proterozoic sediment-hosted massive sulfide deposit, Northern Labrador Trough, Quebec. Canadian Mineralogist, Volume 26, pages 871-888.

Bergmann, H.J. (Prospecting Geophysics Ltd.)
1978: Report on geophysical surveys for Labrador Mining and Exploration Company Limited, Block No. 135, Andre Lake Area, Labrador. Unpublished report for The Labrador Mining and Exploration Company Limited. [23J (180)]

Bloomer, R.O.
1954: Geology of the Martin Lake area, Labrador. Unpublished report for the Labrador Mining and Exportation Company Limited, 33 pages. [23J/16(71)]

1955: The geology of the Howse Lake area, Ungava. Unpublished report for the Labrador Mining and Exploration Company Limited. [23O (5)]

Findlay, J.M., Fowler, T.D. and Birkett, T.C.
1990: Geology of the Howse Lake area, western Labrador. Geological Survey of Canada, Open File 2204, 70 pages.

Fox, J.S.
1984: Besshi-type volcanogenic sulphide deposits—a review. Canadian Institute of Mining Bulletin, Volume 77, Number 864, pages 57-68.

Frarey, M.J.
1967: Willbob Lake and Thompson Lake map-areas, Quebec and Newfoundland (23O/1 and 23O/8). Geological Survey of Canada, Memoir 348, 71 pages.

Gall, Q.
1984: Report on geological mapping, Licence Block 135, western Labrador, 1984 field season, 23I/13, 23J/16. Unpublished report for Labrador Mining and Exploration Company Limited, 35 pages.

Geological Survey of Canada
1982: Regional lake sediment and water geochemistry reconnaissance data, NTS 23J, Labrador. Geological Survey of Canada, Open File 904.

Grant, J.M.
1971: Trace element study in the Jimmick Lake, Moss Lake, Lac La Touche area. Unpublished report for Labrador Mining and Exploration Company Limited. [Lab. (230)]

1980: Report on Airborne Geophysical Survey Block No. 135. Unpublished report for Labrador Mining and Exploration Company Limited. [23I (54)]

1981: Block No. 135 Mag.—E.M. survey and drill report; Labrador Mining and Exploration Company Limited. Unpublished report for Labrador Mining and Exploration Company Limited. [Lab. (600)]

Goodfellow, W.D. and Lydon, J.W.
1990: Current concepts on the origin of SEDEX deposits: part 1—geological and geochemical constraints. 8th IAGOD Symposium, Ottawa, Canada, Program with Abstracts, page A189.

Hoag, R.B.
1971: Report on the Martin Lake area. Unpublished report to The Labrador Mining and Exploration Company Limited, 5 pages. [23J/16 (74)]

Hornbrooke, E.H.W. and Friske, P.W.B.
1989: National geochemical reconnaissance lake sediment and water geochemical data, west-central Labrador (parts of 23I, 23J and 23O). Geological Survey of Canada, Open File 2037.

Kozela, F.J.
1960: The geology of the Andre Lake area. Unpublished report to Labrador Mining and Exploration Company Limited, 12 pages. [23I(9)]

Labrador Mining and Exploration Company Limited
1980: Airborne geophysical survey, Schefferville–Ashuanipi River area, Labrador. Unpublished report for Labrador Mining and Exploration Company Limited. [23J/2 (230)]

Large, D.E.
1980: Geological parameters associated with sediment-hosted, submarine exhalative Pb-Zn deposits: an empirical model for mineral exploration. Geologisch Jahrbusch, Volume 40, pages 59-129.

McConnell, J.
1984: Reconnaissance and detailed geochemical surveys for base metals in Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 84-2, 114 pages.

Mitchell, A.H.G. and Bell, J.D.
1973: Island evaluation and related mineral deposits. Journal of Geology, Volume 81, pages 381-405.

Moss, A.E.
1944: The geology of the Attikamagen—André Lakes area, Newfoundland-Labrador. Unpublished report to the Labrador Mining and Exploration Company Limited, 74 pages. [Lab (491)]

Retty, J.A.
1942: Geological Report for 1942. Unpublished report to the Labrador Mining and Exploration Company Limited, 127 pages. [Lab (489)]

Slack, J.F. and Shanks, W.C. III
1990: Geologic and isotopic characteristics of modern and ancient Besshi-type massive sulfide deposits. 28th International Geological Congress, Washington, D.C., Abstracts, Volume 3, page 3-132.

Smith, J.L.
1987a: Mineral occurrence map of the south-central Labrador Trough, Map A. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 87-10.

1987b: Mineral occurrence map of the south-central Labrador Trough, Map B. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 87-11

Swinden, H.S.
1991: Metallogeny of base metal sulphide occurrences in the Labrador Trough east of Schefferville. *In* Report of Activities. Newfoundland Department of Mines and Energy, Geological Survey Branch, pages 103-106.

Wardle, R.J.
1979: Geology of the eastern margin of the Labrador Trough. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-9, 22 pages.

Wardle, R.J. (compiler)
1982a: Geology of the south-central Labrador Trough, Map 1. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 82-5.

1982b: Geology of the south-central Labrador Trough, Map 2. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 82-6.

Wardle, R.J. and Bailey, D.G.
1981: Early Proterozoic sequences in Labrador. *In* Proterozoic Basins of Canada, supplement. *Edited by* F.H.A. Campbell. Geological Survey of Canada, Paper 81-10, pages 331-358.

Wardle, R.J., Ryan, B., Nunn, G.A.G. and Mengel, F.
1990: Labrador segment of the Trans-Hudson Orogen: crustal development through oblique convergence and collision. *In* The Trans-Hudson Orogen of North America: Lithotectonic Correlations and Evolution. *Edited by* J. Lewry and M. Stauffer. Geological Association of Canada, Special Paper 37, pages 353-369.

Note: Geological Survey Branch file numbers are included in square brackets.