GM 59678

REPORT ON A SOIL GEOCHEMICAL SURVEY, SARAH LAKE PROJECT

REPORT ON
A SOIL GEOCHEMICAL SURVEY

SARAH LAKE PROJECT
PEM 0001498
NTS 23B/05

REÇU AU MRN
1 5 OCT. 2002
BUREAU DU REGISTRAIRE

PREPARED FOR

LOUVICOURT GOLD MINES INC.

Graeme Scott

June 2002

TABLE OF CONTENTS

TABLES

FIGURES

APPENDIX

Introduction

This report has been prepared at the request and on behalf of Louvicourt Gold Mines Inc. The report summarizes past work on the Sarah Lake Project and presents the results of a soil geochemical survey completed on the Exploration Permit, PEM 0001498, between the dates of September 19 to September 29, 2001 . The work program was conducted by; Graeme Scott of Toronto, Ontario, Randon Ferderber of Val d'Or Quebec and Daniel Headricks of Malbaie, Quebec.

The objective of the 2001 field program was to further evaluate a Cu-Ni-PGE occurrence within ultramafic rocks located northeast of Sarah Lake. The mineral occurrence was first discovered by Quebec government geologists in the early 1970's. Subsequent to this the mineral occurrence has been explored by various operators, most recently by the Beaver Prospecting Syndicate and Diadem Resources in 1996.

The 2001 exploration program consisted of a soil geochemical survey, rock sampling of exposed mineralization and sampling of drill core from previous work. A total of 18 rock samples 12 Samples of drill core, 163 Mobil Metal Ion (MMI) samples and 155 B horizon soil samples were taken during the project. All samples were sent to XRAL Laboratories of Toronto, Ontario.

The program was completed for a total cost of $ 26,237.00. This includes $ 1,500.00 for the preparation of this report.

The report also recommends further work at an estimated cost of $ 369,800.00

Claim Status and Ownership

The Sarah Lake Project comprises a single exploration permit, PEM 0001498 covering 50 square kilometres in Desportes County, Quebec. The permit is in good standing until December 2004. In November 2001 the permit was reduced to 11 square kilometres (see figure 2).

The Fonteneau2001 Prospecting Syndicate is is currently the beneficial owner of the Project.

Louvicourt Gold Mines Inc exercised an option to earn an interest on the permit in June 2001. Under the terms of the option, Louvicourt can earn a 90% interest in the project by making an initial payment of $ 15,000 representing the syndicates expenditures on the property and to issue 500,000 common shares to Fonteneau over 3 years. The original claim owner retains a 10% carried interest and Fonteneau retains a 3% NSR from any production or proceeds from any sale to a third party of all or part of the Project and subsequent production. Louvicourt will also

LOUVICOURT GOLD MINES

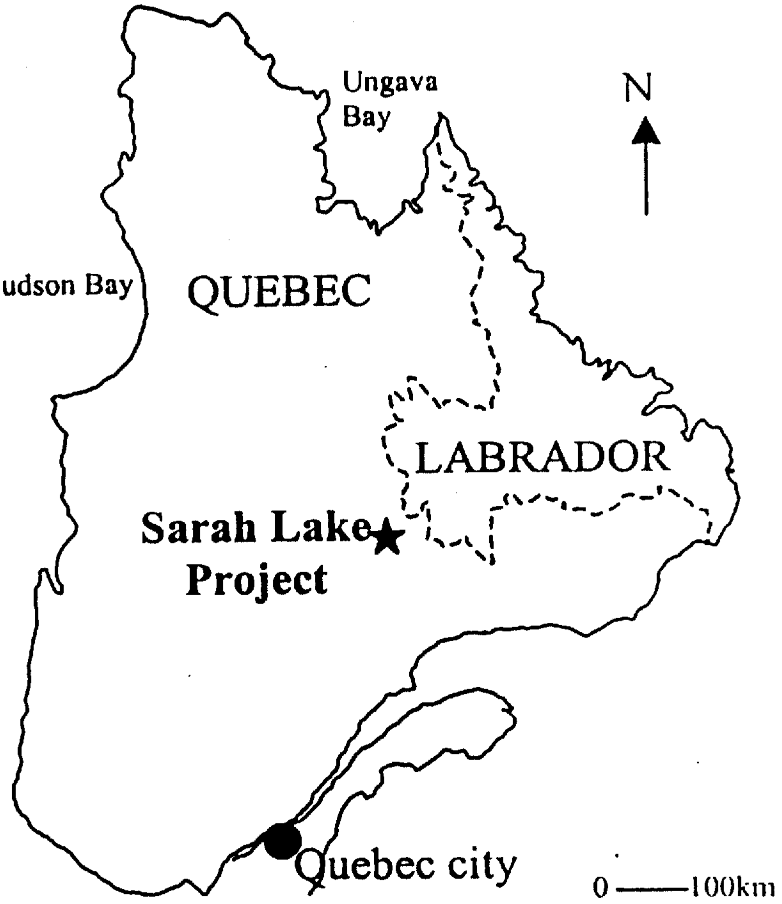


FIGURE 1-PROJECT LOCATION MAP

contract with Fonteneau to conduct the 2001 exploration program at cost. As of January 2001, the Company assumed all land rental and statutory work obligations on the Project.

Location and Access

The Sarah Lake Project is located 200 kilometres north of the city of Sept Iles in eastern Quebec, and is situated 90 kilometres southwest of the Quebec-Labrador border. Access to the Project is by means of float plane to Sarah and Edgar Lakes from the town of Wabush, located 85 kilometres to the north. The nearest road access is to Highway 389, 55 kilometres to the northwest at the community of Fire Lake. Rail access is available 60 kilometres to the east. Power can be provided by a Hydro Quebec transmission line located 15 kilometres northeast of Sarah Lake. The access road for the transmission line provides the best land access to the Project, however, some sections of the road currently require reconstruction. No infrastructure exists at the Sarah Lake Project or in the vicinity.

Physiography and Vegetation

The claim area is moderately hilly with two prominent northeast trending hills located between the north ends of Sarah and Edgar lakes. These hills are the topographic expression of the underlying ultramafic unit. Elevations in the Project area range from 550 to 730 metres above sea level. Vegetation is predominantly black spruce, reflecting the subarctic climate of the region. Bedrock exposure is less than 10%.

Geology and Mineralization

Granite gneiss rocks underlie most of the Sarah Lake Project. A large northwest trending sill consisting of both gabbro and ultramafic rocks intrudes the gneissic unit. Centrally located in the Project is a prominent hill, 2 kilometres wide and 4 kilometres long, consisting of an ultramafic sill.

All of the mineralization identified to date occurs within this ultramafic unit. Examination of outcrops and old drill core shows the sill to be of highly variable composition. Layers and or phases of gabbro, olivine gabbro, peridotite to pyroxenite have been identified. All units are partially altered to amphibolite. Sulphide mineralization, consisting primarily of chalcopyrite and pyrrhotite, has been identified in all the mafic and ultramafic rock.

The north 1.5 kilometres of the Sarah Lake sill has returned widespread copper, nickel and PGM mineralization (Virginia Mines 1983) . This mineralization has been divided into two zones, the East and West Zones

The dominant ultramafic rock is clinopyroxenite containing minor amounts of orthopyroxene and olivine. Along the eastern border of the sill, a dark coloured gabbro cut by quartz and carbonate veins has been identified.

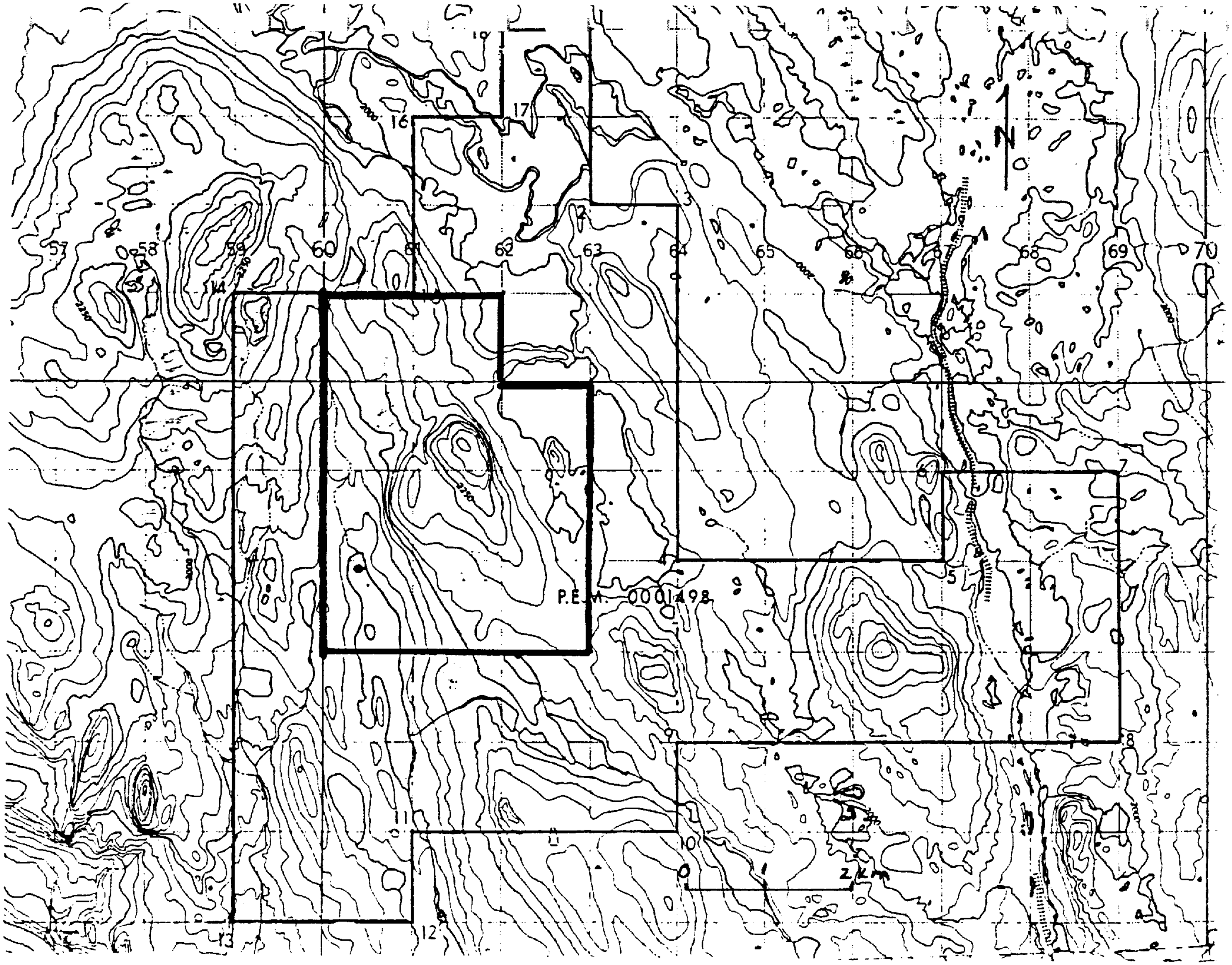


FIGURE 2-CLAIM MAP

Previous Work

No mineralization had been identified on the Sarah Lake Project until exploration work conducted by the Quebec Department of Natural Resources geologists in the early 1970s identified copper and nickel mineralization in the area. These occurrences were next evaluated in 1990 when the Quebec Department of Mines conducted an extensive examination of the Project including sampling and petrographic studies. All samples returned low gold, copper, nickel, platinum, palladium and rhodium values. Assay results included up to 2.15% copper, 376 ppm nickel, 113 ppb palladium, 125 ppb platinum and 18 ppb rhodium.

The mining rights were subsequently acquired by Explorograhics, Inc. and optioned to Virginia Gold Mines ("Virginia"). Between 1990 and 1992, Virginia conducted an extensive exploration program on the Project that included geological mapping, line cutting, geophysical surveying, geochemical sampling and stripping and sampling 14 trenches and limited diamond drilling. The principal findings from Virginia's program were as follows:

The ultramafic intrusion is multiphase comprised of amphibolized peridotite, pyroxenite and gabbro, the unit intrud biotite- amphibole gneisses. The geophysical surveys and outcrops suggest that these intrusions are much large in size than indicated by the geological mapping. Copper mineralization occurs throughout the outcropping area of the intrusives. Sulphide mineralization is generally disseminated and ranges in content from trace amounts to several percent. This mineralization is composed primarily of chalcopyrite, pyrrhotite and pyrite. The magnetic survey indicated areas of distinct igneous stratification on the Project. The trenching confirmed the presence of magnetite enriched horizons, several metres thick. A VLF-EM survey also showed several conductive zones on the Project, with the conductor axes often situated on the shoulders of or in the troughs of magnetic anomalies.

Sampling from outcrops and erratic blocks returned assay values of 0.61% copper, 25 ppb gold, 93 ppb platinum and 71 ppb palladium. Soquem joined Virginia in 1992 and the joint venture drilled six short diamond drill holes, ranging in depth from 30 to 60 metres, in the western area of the copper mineralization. The results of this drill program were not published but some of the core remains on site at the Sarah Lake Camp.

Subsequent work conducted by Fonteneau Resources on behalf of Diadem Resource Ltd. ("Diadem") in 1995 included core logging of these six drill holes and the collection of 10 representative samples of the remaining drill core. Each sample represented three metres of mineralization. The average grade of these samples was 0.35% copper.

The East Zone was sampled by Diadem in some detail including 32 rock samples mainly taken from previous trenching locations. The 32 samples yielded an arithmetic average of 0.43% copper. The four random rock trenches returned a composite weighted average of 0.37% copper.

Diadem drilled 12 diamond drill holes over the entire Project area. The purpose of the program was to test the lower contact of the ultramafic sill for potential sulphide concentrations in "embayments". Such zones have proven to be prolific copper, nickel and platinum producing areas in other parts of the world.

A summary of the drill program is provided in the table below:

Drill hole #	Description
1East Zone	Passed through 162 metres of peridotite before intersecting the underlying gneiss. Encountered 1 metre of copper mineralization, which also contained measurable gold,platinum and palladium values. Results included 200 metres grading 0.25% copper.
2East Zone	Drilled 200 metres west of drill hole #1. Cut the peridotite gneiss contact 200 metres. No sulphide minerals of interest were encountered.
3West Zone	Drilled at the westerly end of the Project, Encountered gneiss at 171 metres. Results included 17.2 metres grading 0.21% cooper.
5 East Zone	Drilled 200 metres north of drill hole #1. Stopped at 70 meters, after passing through peridotite at 49 metres. Bottomed in a breccia zone with no sulphide mineralization.
6 East Zone	Drilled 200 metres south of drill hole #1. Cut 60 meters of peridotite, without intersecting gneiss. No significant mineralization
7 East Zone	Drilled 50 metres east of drill hole #1. Peridotite/ gneiss encountered at 69.9 metres. No mineralization encountered
8 West Zone	Located 59 metres east of the most westerly zone of outcropping mineralization. Mineralized from the collar at 11.5 metres to the peridotite gneiss contact at 67.7 metres. Best interval was 0.58% copper over 16.8 metres
9 East Zone	Located 50 metres south of drill hole # 8. Continuous mineralization identified from the base of overburden at 12.3 metres to the gneiss contact at 78.9 metres. Best interval in this section was 12.0 metres of 0.49% copper and 8.5 metres grading 0.61% copper,.
11 East Zone	Drilled 50 metres west of drill hole #8. Peridotite encountered at 74 metres, with no gneiss contact. Several quartz veins and magnetite were reported cutting the peridotite.
12 East Zone	Drilled 100 metres southeast of drill hole #8. Gneiss contact at 186 metres, 150 metres deeper than in drill hole #8. Suggests that there is a drastic change in the base of the sill, or that faulting exists between drill holes #8 and #9 on one side and #12 on the other.

Work Program

The purpose of the field program was to evaluate a Cu-Ni- PGE- bearing ultramafic body located north east of Sarah Lake. Previous work had identified two mineralized zones; The "East Zone" and "West Zone" located on the east and west flanks of the ultramafic body. A three man field party based at the north end of Sarah Lake conducted a ten day program completed between September 20 to 29, 2001. The field program consisted of a soil geochemical survey and also rock sampling of exposed mineralization and drill core from previous work. Rock sample results are presented in table 2 below for reference but an interpretation will be presented in a separate report. The geochemical technique used for the survey is called Mobil Metal Ion geochemical survey. The author has found this technique to be effective in areas of both shallow and deep overburden. A detailed description of the Mobil Metal Ion technique is presented in Appendix II. For comparison "B" horizon soils were also taken . Lines labelled 0 to 15N were ran using the grid established for the Diadem program. Line RL-01 was done using compass and GPS control. MMI samples were taken at 50 metre intervals and 163 MMI were obtained. In addition 155 B horizon soil samples were taken on lines 7N to 11N . Line 9N was sampled both by MMI and B horizon soil for comparison. All samples were sent to XRAL Laboratories for analysis. Certificates of Analysis are presented in Appendix I.

Discussion of Results

Both the B horizon and MMI soil survey's clearly show areas of known mineralization on the property. Results from the MMI survey south of the known mineralized zone. Anomalous response ratios on Line 0, stations 0+00 to 2+50E and 9+00E to 10+00E, and Line RL-01, stations 3+50E to 4+50E indicate the mineralization may extend south for an additional 1000 meters. These anomalous zones are also coincident with an airborne magnetic anomaly. Other Significant MMI results are presented in table 1.

Table 1: Anomalous MMI Response Ratios

Line	Station	Response Ratio	Interpretation
15+00N	10+00E	23	West Zone Response
	10+50E	35	West Zone Response
	11+00E	20	West Zone Response
	11+50E	17	West Zone Response
	12+00E	12	West Zone Response
L9+00	4+00E	24	East Zone Response
	0+50E	23	Central Zone (New Zone)
	1+00E	21	Central Zone (New Zone)
	1+50E	11	Central Zone (New Zone)
	8+75E	9	West Zone Response
	9+00E	15	West Zone Response
	9+50E	8	West Zone Response
L3+00	1+00E	40	Central Zone
L0+00	3+00W	20	East Zone Response
	2+50W	24	East Zone Response
	5+00E	98	West Zone
	5+50E	59	West Zone
	6+00E	22	West Zone
L. RL-01	4+50E	253	Central Zone?
	5+00E	17	Central Zone?
	5+50E	177	Central Zone?
	8+50	25	West Zone
	9+50	14	West Zone
	10+00E	17	West Zone
	10+50E	31	West Zone

Table 2-Rock Sample Results

Sample Number	**Sample Type**	**Date**	**Easting**	**Northing**	**Cu ppm**	**Ni ppm**	**Co ppm**	**Pt ppb**	**Pd ppb**	**Au ppb**
26151	Grab	24/09/01	660944	5769048	6190	529	111	114	89	69
26152	Grab	24/09/01	661731	5769404	2770	171	33	34	41	47
26153	chip over 1m.	24/09/01	661727	5769417	4320	700	134	122	157	47
26154	Grab	27/09/01	660876	5768906	2790	248	51	37	42	32
26155	Grab	27/09/01	660870	5768875	5110	417	104	70	57	55
26156	Grab	27/09/01	660870	5768875	5950	540	120	115	96	45
26157	Grab	27/09/01	661462	5769302	113	30	12	<10	8	9
26158	Grab	27/09/01	661823	5769362	3720	198	32	40	27	38
26159	Grab	27/09/01	661823	5769362	3080	103	17	23	19	28
26160	7m. chip	27/09/01	661823	5769362	1560	105	18	12	16	27
26161	Grab	27/09/01	661823	5769362	4040	373	76	79	76	51
26162	Grab	27/09/01	661823	5769362	461	60	13	<10	9	9
26163	Grab	28/09/01	661729	5769385	463	83	18	24	12	11
26164	Grab	28/09/01	660726	5768456	556	82	18	<10	9	28

Sample Number	**Drill Core Samples**	**Core Length**	**From**	**To**	Cu	Ni	Co	Pt	Pd	Au
26165	Sagar Hole2	1.5m	38.75	40.25	7730	570	58	78	54	58
26166	Sagar Hole2	1.5m	40.25	41.75	>10000	810	77	119	86	143
26167	Sagar Hole2	1.5m	41.75	43.25	6290	418	45	120	56	88
26168	Sagar Hole2	1.85m	43.25	45.1	7850	494	55	110	64	112
26169	Sagar Hole2	1m	49.8	50.8	3530	382	74	68	44	38
26170	Sagar Hole2	1m	50.8	51.8	4310	372	61	86	52	45
26171	Sagar Hole2	1m	51.8	52.8	3480	334	58	75	43	35
26172	Sagar Hole4	1.1m	43.8	44.9	3820	334	69	68	55	51
26173	Sagar Hole4	1.5m	44.9	46.4	2480	274	54	58	35	47
26174	Sagar Hole4	1.5m	46.4	47.9	2960	314	59	53	35	22
26175	Sagar Hole4	1.5m	47.9	49.4	5420	542	85	62	62	65
26176	Sagar Hole4	0.6m	49.4	51.1	6180	642	95	123	74	53

Recommendations

The MMI response clearly indicates that the mineralized zone extends south beyond line 0+00. It is recommended that 3 lines at 2 meter spacing be added to the MMI survey to extend the survey area an additional 600 meters south from line RL-01. It is also recommended to add two in fill lines between L0 and Line RL-01 to better define the anomalous response. Anomoulous responses that show good continuity should be tested by diamond drilling

Cost of Recommendations.

Phase I	
MMI Sampling	
10 crew days @ $1000/ day	$ 10,000.00
Analysis	
160 samples @ 30.00/sample	$ 4,800.00
Mob-DeMob	$ 5,000.00
	Subtotal $ 19, 800.00
Phase II	
Diamond Drilling	
2000 meters @ $125.00/metre (includes engineering and analysis)	$ 250,000.00
Helicopter	$ 100,000.00
	Total Phase I & II $ 369,800.00

Graeme Scott BSc Geologist

REFERENCES

Department of Energy Mines and Resources Canada, 1975 Airborne Magnetic Map 5909G,

Sagar Project, Virginia Gold Mines, 1992, Report on Geology, Geophysics and Soils Sampling

Scott, F., 1997, Report on Drill program, Sarah Lake Project

APPENDIX I

STATEMENT OF COSTS

Prospecting Geophysics	
Aircraft	4376.00
Supplies and mobilization	3687.65
Field Crew	
10 days @ 500.00	$5,000.00
Supervision	
Fees	$ 3,500.00
Supplies	$ 2666.22
Demob of Daniel Headricks with Samples	$ 658.62
Analysis	4847 .58
Map and Report	$ 1,500.00
	TOTAL 26,230.00

APPENDIX II

CERTIFICATES OF ANALYSIS

Work Order: 065740 **Date:** 30/10/01 **FINAL**

		0.05	(1)	(5)	0.05	0.2	0.05
	Element.	Au	Co	Ni	Pd	Ag	Pt
	Method.	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B
	Det.Lim.	0.1	1	3	0.1	0.1	0.1
	Units.	ppb	ppb	ppb	ppb	ppb	ppb
13	L0+00-4+00W	<0.1	10 1	17 3	<0.1	0.40	<0.1
13	L0+00-3+50W	0.12 2	7	16 3	0.14 3	0.88 4	<0.1
20	L0+00-3+00W	0.14 2	13	15 3	0.20 4	0.55 3	<0.1
24	L0+00-2+50W	<0.1	14	10	<0.1	0.88 4	<0.1
7	L0+00-2+00W	0.13 2	4	13	0.13 3	1.29 6	<0.1
14	L0+00-1+50W	<0.1	11	10	0.13 3	0.28	<0.1
4	L0+00-1+00W	<0.1	4	8	0.12	0.38	<0.1
59	L0+00-0+50W	<0.1	6	10	0.12	0.75 3	<0.1
	L0+00-0+00	<0.1	2	4	0.12	0.12	<0.1
4	L0+00-0+50E	<0.1	2	6	0.12	0.89 4	<0.1
9	L0+00-1+00E	<0.1	9	7	<0.1	0.14	<0.1
9	L0+00-1+50E	<0.1	6	14 3	0.12	0.61	<0.1
10	L0+00-2+00E 4	<0.1	6	22 4	0.12	0.79 4	<0.1
13	L0+00-2+50E 4	<0.1	9	21 4	0.11	0.11	<0.1
4	L0+00-3+00E	<0.1	4	6	<0.1	0.16	<0.1
	L0+00-3+50E	<0.1	1	5	0.10	1.24 6	<0.1
7	L0+00-4+00E	<0.1	4	8	0.13 3	0.78 4	<0.1
	L0+00-4+50E	<0.1	2	9	0.14 3	1.61 8	<0.1
98	L0+00-5+00E 17	<0.1	81	87 17	<0.1	0.75 4	<0.1
59	L0+00-5+50E 5	<0.1	54	26 5	<0.1	1.15 6	<0.1
22	L0+00-6+00E 6	<0.1	16	31 6	<0.1	1.13 5	<0.1
19	L0+00-6+50E 4	<0.1	10	19 4	<0.1	0.32	<0.1
	L0+00-7+00E	<0.1	2	6	0.14 3	2.57 13	<0.1
6	L0+00-7+50E	<0.1	3	15 3	0.10	2.53 12	<0.1
5	L0+00-8+00E	<0.1	5	7	<0.1	<0.1	<0.1
	L0+00-8+50E	<0.1	2	13	<0.1	3.54 18	<0.1
	L0+00-9+00E	<0.1	2	10	<0.1	1.82 9	<0.1
7	L0+00-9+50E 4	<0.1	3	22 4	<0.1	2.90 15	<0.1
	L0+00-10+00E	<0.1	2	7	<0.1	2.77 14	<0.1
	L0+00-10+50E	<0.1	2	5	<0.1	0.31	<0.1
3	L0+00-11+00E	<0.1	2	13 3	<0.1	2.78 14	<0.1
	L0+00-11+50E	<0.1	2	8	<0.1	1.91 9	<0.1
	L0+00-12+00E	<0.1	2	9	0.13 3	1.43 7	<0.1
3	L0+00-12+50E	<0.1	2	14 3	<0.1	2.13 10	<0.1
	L0+00-13+00E	<0.1	5	10	<0.1	2.89 14	<0.1
	L0+00-13+50E	<0.1	2	7	<0.1	1.01 5	<0.1
	L0+00-14+00E	<0.1	2	6	<0.1	0.48	<0.1
	L3N-0+00	<0.1	2	5	<0.1	<0.1	<0.1
	L3N-0+50E	<0.1	6	10	<0.1	<0.1	<0.1
40	L3N-1+00E 10	<0.1	30	47 10	<0.1	0.53 3	<0.1
	L3N-1+50E	<0.1	2	6	<0.1	<0.1	<0.1
6	L3N-2+00E	<0.1	3	17 3	<0.1	0.58 3	<0.1
4	L3N-2+50E	<0.1	4	9	<0.1	0.52 3	<0.1
4	L3N-3+00E	<0.1	4	8	<0.1	<0.1	<0.1
	L3N-3+50E	<0.1	1	5	<0.1	<0.1	<0.1

Work Order: 065740 **Date:** 30/10/01 **FINAL**

Element.	Au	Co	Ni	Pd	Ag	Pt
Method.	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B
Det.Lim.	0.1	1	3	0.1	0.1	0.1
Units.	ppb	ppb	ppb	ppb	ppb	ppb
5 L3N-4+00E	<0.1	5	7	<0.1	0.11	<0.1
*Blk BLANK	<0.1	<1	<3	<0.1	<0.1	<0.1
*Std MMISRM07	~~0.15~~ 3	~~7~~	~~42~~ 8	~~<0.1~~	~~5.32~~ 26	~~<0.1~~
6 L3N-4+50E	<0.1	3	7	0.17 3	0.38	<0.1
L3N-5+00E	<0.1	1	5	<0.1	<0.1	<0.1
4 L3N-5+50E	<0.1	4	7	<0.1	<0.1	<0.1
7 L3N-6+00E	<0.1	7	9	<0.1	<0.1	<0.1
L3N-6+50E	<0.1	3	6	<0.1	<0.1	<0.1
L3N-7+00E	<0.1	1	6	<0.1	0.31	<0.1
L3N-7+50E	<0.1	3	8	<0.1	4.83 24	<0.1
L3N-8+00E	<0.1	2	6	<0.1	0.19	<0.1
L3N-8+50E	<0.1	1	6	<0.1	1.78 8	<0.1
L3N-9+00E	<0.1	1	5	<0.1	<0.1	<0.1
L3N-9+50E	<0.1	1	6	<0.1	2.24 11	<0.1
L3N-10+00E	<0.1	3	7	<0.1	<0.1	<0.1
L3N-10+50E	<0.1	4	8	<0.1	<0.1	<0.1
13 L3N-11+00E	<0.1	10	13 3	<0.1	0.57 3	<0.1
L3N-11+50E	<0.1	1	11	<0.1	0.34	<0.1
L3N-12+00E	<0.1	5	7	<0.1	<0.1	<0.1
L3N-12+50E	<0.1	3	10	<0.1	<0.1	<0.1
L3N-13+00E	<0.1	4	9	<0.1	0.13	<0.1
11 L3N-13+50E	<0.1	11	8	<0.1	<0.1	<0.1
L9N-5W	<0.1	8	7	<0.1	<0.1	<0.1
L9N-4+50W	<0.1	4	6	<0.1	<0.1	<0.1
24 L9N-4+00W 4	0.32 6	20	19 4	<0.1	0.11	<0.1
L9N-3+50W	<0.1	5	8	<0.1	<0.1	<0.1
L9N-3W	<0.1	5	11	<0.1	<0.1	<0.1
L9N-2+50W	<0.1	6	8	<0.1	<0.1	<0.1
L9N-2W	<0.1	1	5	<0.1	<0.1	<0.1
L9N-1+50W	<0.1	7	9	<0.1	<0.1	<0.1
L9N-1W	<0.1	1	6	<0.1	<0.1	<0.1
L9N-0+50W	<0.1	3	9	<0.1	0.38	<0.1
L9N-0+00	<0.1	5	9	<0.1	0.11	<0.1
23 L9N-0+50E 13	<0.1	10	64 13	<0.1	1.03 5	<0.1
21 L9N-1E	<0.1	12	16 3	0.30 6	<0.1	<0.1
11 L9N-1+50E 6	<0.1	5	33 6	<0.1	0.47	<0.1
L9N-2E	<0.1	5	7	<0.1	0.12	<0.1
L9N-2+50E	<0.1	6	18	<0.1	0.45	<0.1
L9N-3E	<0.1	9	15	<0.1	<0.1	<0.1
L9N-3+50E	<0.1	4	11	<0.1	<0.1	<0.1
L9N-4E	<0.1	2	6	<0.1	0.13	<0.1
L9N-4+50E	<0.1	5	11	<0.1	<0.1	<0.1
L9N-5E	<0.1	5	11	<0.1	<0.1	<0.1
L9N-5+50E	<0.1	3	9	<0.1	<0.1	<0.1
L9N-6E	<0.1	2	6	<0.1	0.11	<0.1

XRAL XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065740 **Date:** 30/10/01 **FINAL**

Element.	**Au**	**Co**	**Ni**	**Pd**	**Ag**	**Pt**
Method.	**MMI-B**	**MMI-B**	**MMI-B**	**MMI-B**	**MMI-B**	**MMI-B**
Det.Lim.	**0.1**	(1) **1**	**3**	**0.1**	**0.1**	**0.1**
Units.	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**	**ppb**
6 L9N-6+50E	<0.1	3	16 3	<0.1	0.37	<0.1
L9N-7E	<0.1	1	6	<0.1	0.14	<0.1
L9N-7+50E	<0.1	2	8	<0.1	0.11	<0.1
L9N-8+25E	<0.1	5	10	<0.1	<0.1	<0.1
*Blk BLANK	<0.1	<1	4	<0.1	<0.1	<0.1
~~*Std XRB1~~	~~<0.1~~	~~8~~	~~43~~ 8	~~<0.1~~	~~4.90~~ 25	~~<0.1~~
9 L9N-8+75E	<0.1	9	11	<0.1	0.16	<0.1
15 L9N-9+00E	<0.1	12	15 3	<0.1	0.16	<0.1
8 L9N-9+50E	<0.1	8	7	<0.1	0.26	<0.1
4 L9N-10+00E 4	<0.1	<1	184	<0.1	0.45	<0.1
L9N-10+50E	<0.1	2	9	<0.1	0.28	<0.1
*Dup L0+00-4+00W	<0.1	9	~~18~~ 4	<0.1	0.42	<0.1
*Dup L0+00-2+00E	<0.1	6	~~23~~ 5	<0.1	0.82	<0.1
*Dup L0+00-8+00E	<0.1	4	5	<0.1	<0.1	<0.1
*Dup L0+00-14+00E	<0.1	2	7	<0.1	0.39	<0.1
*Dup L3N-5+50E	<0.1	3	6	<0.1	0.11	<0.1
*Dup L3N-11+50E	<0.1	1	10	<0.1	0.43	<0.1
*Dup L9N-1+50W	<0.1	6	10	<0.1	0.12	<0.1
*Dup L9N-4+50E	<0.1	4	11	<0.1	0.13	<0.1
*Dup L9N-10+50E	<0.1	2	9	<0.1	0.40	<0.1
*Blk BLANK	<0.1	<1	4	<0.1	<0.1	<0.1
*Std MMISRM07	<0.1	9	49	<0.1	5.55	<0.1

XRAL

XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065741 **Date:** 30/10/01 **FINAL**

Element.	Au	Co	Ni	Pd	Ag	Pt
Method.	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B
Det.Lim.	0.1	1	3	0.1	0.1	0.1
Units.	ppb	ppb	ppb	ppb	ppb	ppb
L15+00N-6+50W	<0.1	6	6	<0.1	0.20	<0.1
L15+00N-6+00W	<0.1	1	4	<0.1	0.27	<0.1
L15+00N-5+50W	<0.1	4	8	<0.1	0.38	<0.1
L15+00N-5+00W	<0.1	3	9	0.10	0.80 4	<0.1
L15+00N-4+50W	<0.1	6	8	0.12	0.62	<0.1
L15+00N-4+00W	<0.1	2	5	<0.1	0.33	<0.1
L15+00N-3+50W	<0.1	2	4	<0.1	<0.1	<0.1
9 L15+00N-3+00W	<0.1	9	10	<0.1	0.12	<0.1
8 L15+00N-2+50W	<0.1	5	13 3	<0.1	1.02 5	<0.1
L15+00N-2+00W	<0.1	3	10	<0.1	0.12	<0.1
L15+00N-1+50W	<0.1	3	10	<0.1	2.46 12	<0.1
L15+00N-1+00W	<0.1	1	8	<0.1	1.94 9	<0.1
L15+00N-0+50W	<0.1	2	5	<0.1	1.10 5	<0.1
L15+00N-0+00W	<0.1	3	5	0.10	0.18	<0.1
L15+00N-0+50E	<0.1	1	5	<0.1	0.34	<0.1
14 L15+00N-1+00E 8	<0.1	6	38 8	0.12	0.46	<0.1
L15+00N-1+50E	<0.1	3	5	<0.1	0.25	<0.1
L15+00N-2+00E	<0.1	1	7	<0.1	8.07 40	<0.1
L15+00N-2+50E	<0.1	2	7	<0.1	5.65 28	<0.1
23 L15+00N-3+00E	<0.1	20	16 3	0.10	0.18	<0.1
35 L15+00N-3+50E 7	<0.1	28	34 7	<0.1	1.46 7	<0.1
20 L15+00N-4+00E 5	<0.1	15	23 5	<0.1	3.06 15	<0.1
17 L15+00N-4+50E 6	<0.1	11	31 6	<0.1	1.77 9	<0.1
12 L15+00N-5+00E	<0.1	9	17 3	<0.1	0.20	<0.1
L15+00N-5+50E	<0.1	4	5	<0.1	0.19	<0.1
114 L15+00N-6+00E 10	<0.1	104	49 10	<0.1	0.42	<0.1
L15+00N-6+50E	<0.1	1	8	<0.1	<0.1	<0.1
L15+00N-7+00E	<0.1	5	9	<0.1	0.10	<0.1
L15+00N-7+50E	<0.1	2	6	<0.1	<0.1	<0.1
L15+00N-8+00E	<0.1	1	6	<0.1	<0.1	<0.1
10 R.L#1-1+00E	<0.1	7	11	0.13 3	0.21	<0.1
R.L#1-1+50E	<0.1	8	7	<0.1	0.56 3	<0.1
R.L#1-2+00E	<0.1	3	5	<0.1	0.16	<0.1
R.L#1-2+50E	<0.1	2	8	<0.1	2.52 12	<0.1
R.L#1-3+00E	<0.1	7	10	<0.1	0.43	<0.1
R.L#1-3+50E	<0.1	9	15	0.10	0.22	<0.1
R.L#1-4+00E	<0.1	10	10	<0.1	0.56	<0.1
253 R.L#1-4+50E 22	<0.1	229	109 22	0.13	0.62 3	<0.1
19 R.L#1-5+00E 9	<0.1	10	46 9	0.10	2.07 10	<0.1
177 R.L#1-5+50E 4	<0.1	173	22 4	0.11	0.10	<0.1
R.L#1-6+00E	<0.1	2	5	<0.1	2.70 13	<0.1
R.L#1-6+50E	<0.1	2	10	<0.1	0.13	<0.1
R.L#1-7+00E	<0.1	4	8	<0.1	1.27 6	<0.1
R.L#1-7+50E	<0.1	5	9	<0.1	0.35	<0.1
R.L#1-8+00E	<0.1	8	12	<0.1	0.35	<0.1

XRAL XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065741 **Date:** 30/10/01 **FINAL**

Element.	Au	Co	Ni	Pd	Ag	Pt
Method.	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B	MMI-B
Det.Lim.	0.1	1	3	0.1	0.1	0.1
Units.	ppb	ppb	ppb	ppb	ppb	ppb
25 R.L#1-8+50E	<0.1	21	19 4	<0.1	0.42	<0.1
~~*Blk BLANK~~	~~<0.1~~	~~<1~~	~~3~~	~~<0.1~~	~~<0.1~~	~~<0.1~~
~~*Std MMISRM07~~	~~43.4~~	~~714~~	~~6110~~	~~0.14~~	~~74.8~~	~~<0.1~~
R.L#1-9+00E	<0.1	~~2~~	9	<0.1	1.42 7	<0.1
14 R.L#1-9+50E 6	<0.1	8	29 6	<0.1	0.34	<0.1
17 R.L#1-10+00E 5	<0.1	12	24 5	0.12	0.30	<0.1
31 R.L#1-10+50E 9	<0.1	19	45 9	0.14 3	0.65 3	<0.1
R.L#1-11+00E	<0.1	7	9	<0.1	0.68 3	<0.1
R.L#1-11+50E	<0.1	3	7	<0.1	0.27	<0.1
R.L#1-12+00E	<0.1	~~2~~	11	<0.1	0.95 4	<0.1
R.L#1-12+50E	<0.1	~~2~~	9	<0.1	2.72 13	<0.1
R.L#1-13+00E	<0.1	~~2~~	7	<0.1	1.22 6	<0.1
R.L#1-13+50E	<0.1	~~2~~	5	<0.1	0.14	<0.1
R.L#1-14+00E	<0.1	~~2~~	17 3	<0.1	1.58 8	<0.1
R.L#1-14+50E	<0.1	3	8	<0.1	0.85	<0.1
R.L#1-15+00E	<0.1	4	8	<0.1	1.45 7	<0.1
10 R.L#1-15+50E	<0.1	7	14 3	<0.1	0.59	<0.1
R.L#1-16+00E	<0.1	2	9	<0.1	1.34 6	<0.1
R.L#1-16+50E	<0.1	~~1~~	7	<0.1	0.49	<0.1
R.L#1-17+00E	<0.1	3	8	<0.1	0.85 4	<0.1
R.L#1-17+50E	<0.1	3	7	0.13	0.73 3	<0.1
R.L#1-18+00E	<0.1	~~1~~	15 3	<0.1	0.58 3	<0.1
*Dup L15+00N-6+50W	<0.1	6	7	<0.1	0.13	<0.1
*Dup L15+00N-0+50W	<0.1	2	7	<0.1	1.40	<0.1
*Dup L15+00N-5+50E	<0.1	~~1~~	6	<0.1	0.11	<0.1
*Dup R.L#1-4+00E	<0.1	12	12	<0.1	0.52	<0.1
*Dup R.L#1-10+00E	<0.1	14	25	0.13	0.60	<0.1
*Dup R.L#1-16+00E	<0.1	~~2~~	9	<0.1	1.30	<0.1
*Blk BLANK	<0.1	<1	4	<0.1	<0.1	<0.1
*Std XRB1	45.3	744	6340	0.22	76.6	<0.1

XRAL XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065742 **Date:** 31/10/01 **FINAL**

Element.	Cu
Method.	ICP70
Det.Lim.	0.5
Units.	ppm
L7N-5W	12.3
L7N-4+75W	26.4
L7N-4+50W	52.5
L7N-4+25W	17.6
L7N-4+00W	26.8
L7N-3+75W	208
L7N-3+50W	105
L7N-3+25W	25.2
L7N-3+00W	11.1
L7N-2+75W	222
L7N-2+50W	50.3
L7N-2+25W	11.6
L7N-2+00W	8.8
L7N-1+75W	13.6
L7N-1+50W	8.8
L7N-1+25W	7.3
L7N-1+00W	9.2
L7N-0+75W	15.0
L7N-0+50W	562
L7N-0+25W	24.8
L7N-0+25E	17.9
L7N-0+75E	14.6
L7N-1+00E	7.9
S.W.RIDGE-001	5.6
S.W.RIDGE-002	6.6
S.W.RIDGE-003	5.4
S.W.RIDGE-004	6.8
S.W.RIDGE-005	1.3
S.W.RIDGE-006	<0.5
S.W.RIDGE-007	10.8
S.W.RIDGE-008	0.5
S.W.RIDGE-009	0.9
L8N-5+00W	3.0
L8N-4+75W	6.5
L8N-4+50W	30.6
L8N-4+25W	10.9
L8N-4+00W	13.2
L8N-3+75W	11.4
L8N-3+50W	5.8
L8N-3+25W	55.7
L8N-3+00W	42.9
L8N-2+75W	10.1
L8N-2+50W	112
L8N-2+25W	12.0
L8N-2+00W	11.0

Work Order: 065742 **Date:** 31/10/01 **FINAL**

Element.	Cu
Method.	ICP70
Det.Lim.	0.5
Units.	ppm
L8N-1+75W	12.4
*Blk BLANK	<0.5
*Std XRAL01	67.6
L8N-1+50W	15.8
L8N-1+25W	7.5
L8N-1+00W	8.2
L8N-0+75W	136
L8N-0+50W	12.4
L8N-0+25W	78.0
L8N-0+00	29.9
L8N-0+25E	23.4
L8N-1+00E	39.0
L9N-5+00W	1.9
L9N-4+75W	3.3
L9N-4+50W	6.5
L9N-4+25W	8.3
L9N-4+00W	18.5
L9N-3+75W	2.0
L9N-3+50W	1.6
L9N-3+25W	18.3
L9N-3+00W	68.5
L9N-2+75W	65.5
L9N-2+50W	17.1
L9N-2+25W	9.3
L9N-2+00W	5.5
L9N-1+75W	17.2
L9N-1+50W	9.7
L9N-1+25W	11.1
L9N-1+00W	13.8
L9N-0+75W	145
L9N-0+50W	631
L9N-0+25W	330
L9N-0+00	185
L9N-0+50E	19.9
L9N-0+75E	15.9
L9N-1+00E	22.7
L10N-5+00W	1.4
L10N-4+75W	0.9
L10N-4+50W	1.3
L10N-4+25W	4.5
L10N-4+00W	6.8
L10N-3+75W	3.7
L10N-3+50W	0.7
L10N-3+25W	0.7
L10N-3+00W	58.2

Work Order: 065742 **Date:** 31/10/01 **FINAL**

Element.	Cu
Method.	ICP70
Det.Lim.	0.5
Units.	ppm
L10N-2+75W	1.4
L10N-2+50W	8.1
L10N-2+25W	25.5
L10N-2+00W	11.5
*Blk BLANK	<0.5
*Std XRAL01	67.8
L10N-1+75W	14.9
L10N-1+50W	25.4
L10N-1+25W	51.4
L10N-1+00W	16.1
L10N-0+75W	90.4
L10N-0+50W	169
L10N-0+00E	17.8
L10N-0+25E	14.1
L10N-0+50E	42.2
L10N-0+75E	13.2
L10N-1+00E	13.8
L11N-4+50W	10.3
L11N-4+25W	7.3
L11N-4+00W	8.4
L11N-3+75W	16.6
L11N-3+50W	82.4
L11N-3+25W	100
L11N-3+00W	24.2
L11N-2+75W	1.7
L11N-2+50W	6.1
L11N-2+25W	2.8
L11N-2+00W	4.3
L11N-1+75W	1.5
L11N-1+50W	2.1
L11N-1+00W	8.7
L11N-0+75W	14.4
L11N-0+50W	7.4
L11N-0+25W	18.5
L11N-0+00	27.8
L11N-0+25E	46.7
L11N-0+50E	22.8
L11N-0+75E	18.3
L11N-1+00E	10.1
*Dup L7N-5W	12.3
*Dup L7N-2+00W	8.1
*Dup S.W.RIDGE-002	7.0
*Dup L8N-4+00W	14.5
*Dup L8N-1+00W	7.5
*Dup L9N-3+75W	1.8

XRAL XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065668 **Date:** 30/10/01 **FINAL**

Element.	Au	Pt	Pd
Method.	FA301	FA301	FA301
Det.Lim.	1	10	1
Units.	ppb	ppb	ppb
26151	69	114	89
26152	47	34	41
26153	47	122	157
26154	32	37	42
26155	55	70	57
26156	45	115	96
26157	9	<10	8
26158	38	40	27
26159	28	23	19
26160	27	12	16
26161	51	79	76
26162	9	<10	9
26163	11	24	12
26164	28	<10	9
26201	44	32	25
26202	27	14	11
26203	29	25	16
26204	6	<10	13
26205	25	17	17
26206	5	65	52
26207	31	35	24
26208	43	102	85
26165	58	78	54
26166	143	119	86
26167	88	120	56
26168	112	110	64
26169	38	68	44
26170	45	86	52
26171	35	75	43
26172	51	68	55
26173	47	58	35
26174	22	53	35
26175	65	62	62
26176	53	123	74
*Dup 26151	63	138	93
*Dup 26163	12	29	16
*Dup 26167	79	119	64

XRAL XRAL Laboratories
A Division of SGS Canada Inc.

Work Order: 065668 **Date:** 30/10/01 **FINAL**

Element.	Co	Cu	Ni
Method.	ICP70	ICP70	ICP70
Det.Lim.	1	0.5	1
Units.	ppm	ppm	ppm
26151	111	6190	529
26152	33	2770	171
26153	134	4320	700
26154	51	2790	248
26155	104	5110	417
26156	120	5950	540
26157	12	113	30
26158	32	3720	198
26159	17	3080	103
26160	18	1560	105
26161	76	4040	373
26162	13	461	60
26163	18	463	83
26164	18	556	82
26201	22	3190	126
26202	43	2350	268
26203	22	2020	126
26204	20	235	66
26205	18	522	77
26206	14	41.1	45
26207	23	1580	119
26208	62	4700	286
26165	58	7730	570
26166	77	>10000	810
26167	45	6290	418
26168	55	7850	494
26169	74	3530	382
26170	61	4310	372
26171	58	3480	334
26172	69	3820	334
26173	54	2480	274
26174	59	2960	314
26175	85	5420	542
26176	95	6180	642
*Dup 26151	112	6240	536
*Dup 26163	19	467	88
*Dup 26167	46	6480	417
*Blk BLANK	<1	<0.5	<1
*Std XRAL01	514	67.1	696

APPENDIX III

OUTLINE OF MOBIL METAL ION SAMPLING TECHNIQUE

CONTENTS

Mobile Metal Ion
mmi
TECHNOLOGY

Important Information

This **MMI Operations Manual** has been prepared to assist exploration personnel with more effective application of Mobile Metal Ion geochemical surveys. This is the third edition of the MMI Process Information Manual, containing the feedback MMI TECHNOLOGY has received and any additional information that it feels is relevant.

To date, the main application for MMI geochemistry has been directed at defining more precise drill targets following directly on from the surface soil sampling phase of exploration. The technique has demonstrated an ability to reduce costs by eliminating the RAB drilling phase of exploration.

An ongoing program of development is continuing to systematically expand the applicability of the technique to other aspects of mineral exploration. It is the intention to upgrade this manual as further relevant applications pass through the various stages of research and testing that MMI TECHNOLOGY undertakes as part of its on-going internal research and development program.

The MMI Process is an innovative, robust, and cost effective integrated geochemical exploration package. However, it does requires careful application and specific data treatment to maximise the value from interpretation. Applied diligently the MMI Process can deliver significant benefits from the soil sampling phase of exploration.

Should you have any queries regarding the analytical aspects of MMI Geochemistry, or require assistance with orientation surveys and interpretation, please do not hesitate to contact the members of our staff:

Mr Russell Birrell	Managing Director
Dr Alan Mann	Director
Mr Andrew Mann	Technical Consultant
Mrs Sue Staltari	Technical Assistant
Ms Karen McDowell	Marketing Assistant

Please Note:

1. Copyright in the manual is held by Wamtech Pty. Ltd.
2. The names **Mobile Metal Ion Process**, **Mobile Metal Ion Analysis** and **Mobile Metal Ion Technology** are registered business names of Wamtech Pty. Ltd.
3. Wamtech Pty. Ltd. is the owner of the MMI Process.
4. No responsibility whatsoever is taken for improper use of the information contained in the manual, or application of the MMI Process or unauthorised application of MMI digestion liquors.
5. The manual should not be copied or duplicated or parts taken from it in any way or form whatsoever without prior written consent of Wamtech Pty. Ltd.

1.0 INTRODUCTION

'Mobile Metal Ions' is a term used to describe ions which have moved in the weathering zone and that are only weakly or loosely attached to surface soil particles. It is a widely held belief that these Mobile Metal Ions are transported from deeply-buried ore bodies to the surface. Studies from Australia and overseas have shown that such Mobile Metal Ions are useful in locating buried mineralization. Mobile Metal Ions are generally at very low concentrations in the soil. To successfully interpret these weak signals, a series of very carefully quality-controlled steps have been developed that, when put together, constitute an integrated package **'The MMI Process'**.

The steps, which are necessary to ensure the successful application of Mobile Metal Ion geochemistry for mineral exploration, include:

- A field, commodity and exploration situation appropriate for application of MMI geochemistry;
- An understanding of landform and regolith relationships;
- Application of appropriate specialized digestions;
- Access to advanced ICP-MS analytical equipment/techniques; and
- Correct interpretation of the partial extraction analytical data.

Detailed information on a number of these steps remains confidential. At this point in the development of MMI technology and its role in exploration, orientation surveys are recommended, where possible, to develop a level of confidence for any particular prospect or project area.

Currently, the optimum application for MMI geochemistry is to define specific mineralization targets for detailed drilling, making broad reconnaissance RAB programmes redundant. In this scenario, the assumption is that a number of target areas have been defined and MMI is used to prioritize and more accurately define targets for RC drill programmes.

Developmental work is ongoing to allow extension of the technique to a regional application, and ultimately a target definition role is envisaged. Research is also underway to explore its applicability down hole.

Integral to the successful transition to these new applications will be the continued development in the understanding of Mobile Metal Ion anomalies and a competitive cost structure allowing the technique to deliver cost effective exploration programmes aimed at reducing first pass drilling campaigns. Both matters have been addressed via ongoing research programmes, and the initiative to Licence commercial laboratories to undertake MMI digestions and analyses on a non-exclusive basis.

2.0 BACKGROUND INFORMATION

The key attributes of Mobile Metal Ion surface soil geochemical anomalies include:

- Constrained, precise anomalies, vertically above mineralization and occasionally at up-dip projection positions on the surface;
- Commodity elements respond reducing the need for pathfinders;
- The anomalies can precisely target base metals mineralization at significant depths (greater than 700 m);
- The incidence of false anomalies is very low in comparison to conventional geochemistry;
- Surface soil anomalies are repeatable and persist over time; and
- Anomalies have a better signal to noise ratio related to mineralization in a much wider range of regolith units when compared with conventional techniques.

The Mobile Metal Ion geochemical technique has been developed since 1990 and resulted from a series of 13 case studies where the attributes summarized above were first observed. After this initial field testing in Australia and off-shore, a larger scale research and development initiative was instigated culminating in the establishment of The Geochemistry Research Centre at Technology Park in Perth. In an effort to understand and effectively apply MMI geochemistry to mineral exploration, its first project, The Mechanism of Formation of Mobile Metal Ion Anomalies, was supported by 11 mining companies, WAMTECH and the Western Australian State Government. As a result of the success of the first project a second project titled, Geochemical Anomalies – Their Dynamic Nature and Interpretation, began in late 1995 and ran for a period of two years. Wamtech is still actively involved with the Geochemistry Research Centre today.

It is important to realize that the MMI approach to geochemical exploration is significantly different to that used in conventional surveys. The principal aim of the process is to remove the smallest amount of metal ions from the exterior of soil particles whilst leaving the substrate unaffected. This is the essential difference between MMI and other partial digestion techniques that specifically attack substrates, such as iron oxides and manganese oxides. This approach optimizes the use of improved analytical instrumentation with lower detection limits now available. While absolute metal concentration levels are significantly less than those from 'total digestions', the signal to noise ratios are significantly enhanced using MMI procedures.

Early case studies clearly suggested that, on an empirical basis, better contrast was achieved over a number of different styles of mineralization using MMI when compared to conventional (total) techniques. It was postulated that the very loosely-attached ions were sourced from mineralization and that input from other sources of metals, for example lateritic or lithological contributions would be minimized.

Currently the element suite for MMI analysis includes the following nine elements:

Cu, Pb, Zn, Ni, Cd, Au, Ag, Co, and Pd.

The concept of the **MMI Process** has been introduced to reinforce the requirement that the method is not simply an analytical technique. It is a series of integrated steps that, when combined correctly and intelligently, is proving to be a powerful addition to the existing exploration geochemistry techniques.

A cautionary note: as initial scepticism starts to abate, history confirms the tendency to regard a new technique as a panacea and usually it is grossly mis-applied. MMI technology will be no different. There is a current practical limit to its usefulness and cost effective application. As MMI TECHNOLOGY's on-going research progresses and a better understanding of the technique continues to develop, those limits will be revised, extended and up-dated in this manual.

3.0 APPROPRIATE LANDFORM AND REGOLITH SITUATIONS

Mobile Metal Ion geochemistry has proved successful in a broad range of landform situations including relict, erosional, and depositional regimes. It is also proving effective in lateritic terrains by identifying primary sources of mineralization from the surface within broader conventional anomalies influenced by specific regolith units.

Surface Mobile Metal Ion geochemistry essentially responds to sources of mineralization, so that weakly-mineralized structures, like subsurface supergene mineralization blankets, are defined at a lower contrast level than the primary zones from which they are derived.

3.1 Relict and Erosional Regimes

Surface regolith units developed on relict and erosional landforms respond well to MMI geochemistry., The key advantage is a superior signal to noise ratio over mineralization. Compared to conventional geochemistry, it allows better focusing on follow-up exploration, either further surface sampling or more precise target drilling. Conventional responses are usually broader and maxima are often not directly over mineralization, particularly in deeply-weathered terrains. MMI responses are more constrained, and provided that the correct background levels are applied when calculating MMI Response Ratio values during interpretation, commodity element anomalies are usually closely related to primary mineralization.

This does not automatically ensure that a commercially-viable deposit is identified beneath each MMI anomaly. However, the success rate for ore-grade drill intercepts early within an exploration programme can be significantly improved.

At an operational level, MMI samples can easily be collected from the surface of these regimes in a straightforward manner as discussed in the sampling procedure section

3.2 Depositional Regimes

Surface soils on depositional regimes need to be addressed with extra care. Case studies have shown that the MMI technique extends the range of effective surface soil geochemistry further into more complex transported regolith units, when compared to conventional geochemical techniques. Again it is the superior *signal to noise* or *anomaly to background* responses provided by MMI geochemistry that allow the technique to identify and highlight anomalous responses from mineralization while reducing the effects of spurious background levels.

Terrain with colluvial soils, where coarser components are obvious, usually respond well to the MMI technique. In terrain with extensive alluvium, particularly within larger tracts of sheetwash with intermittent flood activity, care is required with any geochemical technique. MMI anomalies in this terrain type can be of the order of 1 ppb or less. At these analytical levels, great care must be taken to ensure quality of data, and correct interpretation.

An effective *orientation study* is strongly recommended if possible to provide data before embarking on a survey.

4.0 ORIENTATION STUDIES

Although MMI geochemistry is a powerful technique, it should not be regarded as a panacea for exploration. Field inspection can be important to establish whether any major landform or regolith changes are likely to influence the MMI results. Other relevant background material that can contribute to a successful MMI survey programme and interpretation includes: geological maps, aerial photographs, geophysical data including aeromagnetic maps and any interpretation thereof, conventional geochemistry results showing broader anomalies or corridors, and styles of any known mineralization.

As with any geochemical survey, an orientation programme can provide valuable information if a suitable target can be accessed and soils collected at the surface. Prior to any orientation, it is also important for the explorationist to define the parameters for minimum target size, especially when considering sample spacing for future exploration surveys. An important feature of MMI geochemistry is that it essentially responds to primary mineralization. Weakly-mineralized structures may not respond clearly or distinctly to an MMI programme so an orientation should preferably test a target considered significant.

A 50-metre interval sample spacing along lines is recommended for orientation surveys.

To obtain the maximum benefit from the analytical data generated using commercial MMI analyses, response ratios (discussed below) should be calculated. Background samples provide the necessary data to allow meaningful response ratios to be calculated and therefore orientation sampling **must** include soils collected off the known mineralization.

5.0 SAMPLE DENSITY AND GRID ORIENTATION

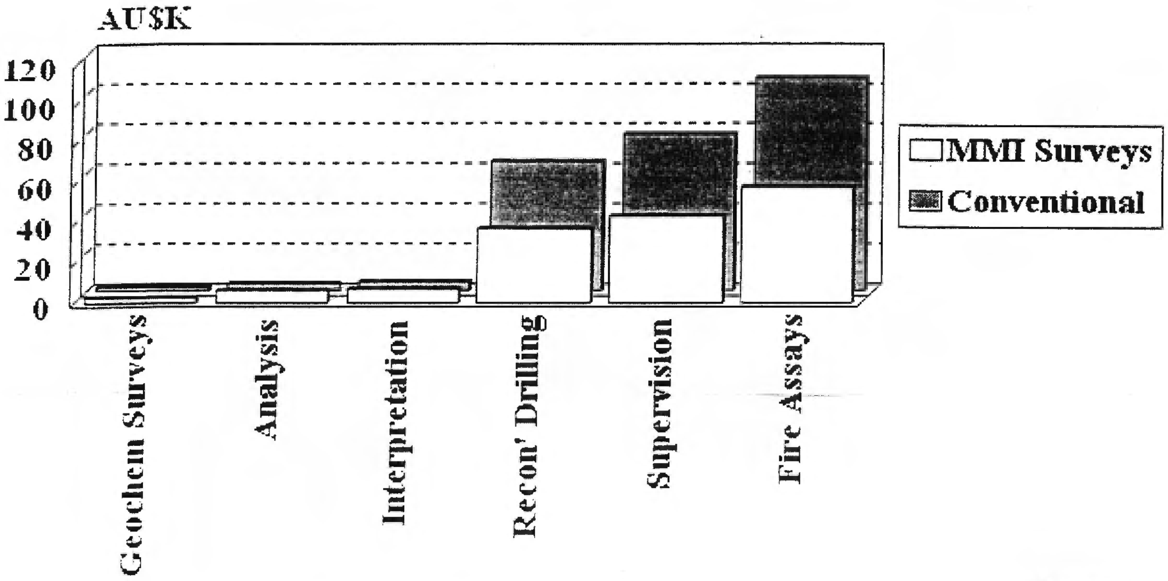
Density of sampling is largely influenced by the type and style of mineralization being sought. Narrow, higher grade styles require a maximum of 50-m sample intervals along lines spaced according to the required strike length of mineralization considered as an economic target within the specific project area. If the minimum strike length is 200 m, then the maximum line spacing should be 400 m. This is assuming that the target mineralization is likely to produce a geochemical halo, giving rise to an anomaly that may extend further than 200 m (for example along strike of a mineralized structure). However, it is recommended that the line spacing be equal or less than the target mineralization length. Generally for gold targets a sample spacing of 100 m x 50 m will allow a focused drill programme to commence eliminating blanket RAB drilling.

Larger sedimentary styles (for example Mississippi Valley style) can have expanded sample patterns. However, in these cases it is vital that background is also sampled. Very specific targets, for example massive Ni sulphides along basal contacts, have in the past required 25 m x 25 m spacing to allow detailed anomaly definition prior to the first phase of drilling. This pattern density may represent the second or third infill phase of MMI sampling after an initial broader-spaced programme to identify contacts.

One important aspect of incorporating MMI geochemistry into an exploration programme is that it can substantially reduce drilling costs (see Figure 1). If anomalies remain strong along significant strike lengths and more precise targets are desired, it is still more cost effective to undertake infill surface sampling at 50 m x 50 m spacing within the anomalous trend rather than to blanket drill.

COST COMPARISION:
CONVENTIONAL vs MMI

Case Study: Discovery of the Golden Web Gold Deposit, St Francis Mining
Exploration Phase 1 - Grassroots to Pre-definition drilling



Cumulative Costs

Figure 1

5.1 Sampling Grids

Pre-designated sample grids and numbers should be established prior to sampling to avoid irregular sample spacing/numbering which disrupts later data interpretation and any subsequent follow-up work. Sampling should be conducted in a methodical way, preferably starting from the lowest easting and northing and working upwards. Avoid allocating negative eastings and northings for sample co-ordinates.

For orientation, survey traverses across known targets are ideal. These traverses can be assessed independently; however, it is imperative that background samples are collected for the general area, even at the expense of maintaining a consistent spacing along the line once the mineralized zone has been covered.

6.0 SAMPLE COLLECTION

IMPORTANT

There is abundant evidence to suggest that in the overwhelming majority of regolith situations, soil samples should be collected at or near surface (within 20cm) using picks or shovels. This represents the best position within the soil profile for sampling. Unless clearly shown by orientation surveys within specific landforms, sampling deeper in soil profiles brings with it a range of complications, particularly for interpretation that can be avoided by sampling nearer surface.

6.1 Sampling Position

Do not vary depth, or target a specific layer/feature of a soil profile when sampling. - Extensive research has shown that element concentrations can vary markedly with a change in sampling depth. Any significant variation in sampling depth and technique can cause severe problems for interpretation. It is imperative that all samples are collected in a consistent manner.

In undisturbed environments samples should be collected approximately 50 to 200 mm below the surface at a consistent depth. - The initial step in taking an MMI soil sample requires the surface soil layer to be scraped away eliminating loose organic matter, debris, and any possible contamination. Before actually taking the soil sample material, equipment should be brushed to eliminate residue from previous samples and preferably flushed with the soil from the new sample site. During sample collection and handling, **no jewellery** (watches, rings, bracelets, and chains) should be worn, as this can be a major source of contamination.

Moist Samples. - Damp samples should be collected in a similar manner to soils in dry environments. Samples should not be dried in ovens or pulverised in crushers or mills. In the case of dry plastic clays, sample material can be desegregated by crushing with a mallet between disposable plastic sheets. Sieving should be avoided if there is any possibility of serious cross-contamination during sample collection via the sieve. In this case, larger rocks and twigs/leaves etc can be removed by hand.

Organic Material. - Organic material in the form of fine roots and hairs, decomposing leaf material and other fine organic debris **WILL NOT** adversely affect MMI analyses. Experimental work has shown that variability in sampling depth has a more significant impact on element responses.

Contaminated Sites. - Where there is a potential contamination problem, samples should be collected at a depth so as to avoid any contaminated material and the sampler's judgment must be relied upon. Another option available to the sampler if there is possible site contamination is to sample in the lee of a tree and/or under a thick layer of organic litter.

6.2 Equipment

- A 30-cm diameter **plastic** garden sieve or kitchen colander with minus 5-mm apertures, available from hardware and super markets, is ideal for sample collection;
- **Plastic** collection dish with similar diameter and a kitchen floor brush used for cleaning the sieve and dish between samples;
- A bare steel (no paint) garden spade; and
- **Plastic** snap seal bags, **do not use calico.**

6.3 Sample Specification

A 500-gram sample is collected and stored in a plastic bag (a 90 x 150-mm plastic snap seal sample bag is recommended). Once sealed in the snap seal plastic bags, samples should be placed in polyweave sample dispatch bags (maximum 40 per bag). Stored in this manner, samples can be carried on tray-back vehicles during summer without problems and be stored for long periods.

6.4 Sample Site

Sample sites should be undisturbed and preferably away from any major contamination: creek beds, drainage, drilling lines, pads, roads, etc. Wind borne contamination should also be eliminated during sample collection by sampling just below the surface.

MMI SOIL SAMPLING - IN SUMMARY

- **Use one laboratory wherever possible.**
- **For a particular survey, avoid submitting samples in small batches (if possible). If this cannot be avoided, calculate Response Ratios for each batch, BEFORE combining the data.**
- **Always sample consistently 50 – 200mm below surface.**

6.5 Other Assistance

MMI TECHNOLOGY has assembled a number of technical bulletins to assist users with their sampling programs. This information can be accessed via the MMI Web Page or copies can be obtained from MMI Technology or its licensed laboratories worldwide. MMI staff can be made available to visit survey sites, discuss sampling procedures, train personnel, and perform sample collection.

Relevant MMI Technical Bulletins available

1.	TB01	Sampling Procedures in Active Desert Terrain
2.	TB02	Size Fraction Analysis
3.	TB03	Improving Anomaly Resolution
4.	TB04	Repeat Sampling Study
5.	TB05	The Application of MMI Geochemistry in Tropical Environments
6.	TB06	MMI Geochemistry in Deeply Weathered Lateritic Environments
7.	TB07	MMI Geochemistry in Porphyry Systems
8.	TB08	The Application of MMI Geochemistry in Carbonate Environments
9.	TB09	Geochemical Programme Specifications
10.	TB10	Analysis for Path Finders
11.	TB11	WAMRD8

7.0 STANDARD REFERENCE MATERIAL CHECKS AND DUPLICATE SAMPLES

Standard Reference Material (SRM) and duplicate samples are a very important part of quality assurance and control, by identifying any human or equipment error. They also provide the required measure of confidence in the data reported by the laboratory.

One check and one duplicate sample should be inserted for every batch of 50 samples. Preferably these should be inserted within the normal sample number sequence submitted to the laboratory. MMI TECHNOLOGY can supply standard reference material and a sample request form is provided in Appendix II at the rear of this manual. Companies can also collect their own check material once values from a specific sample site are known.

Mobile Metal Ion responses in soils are consistent, repeatable and there is no nugget effect. The ions are distributed homogenously throughout the soil and it is possible to engineer a desired standard reference sample value by mixing samples with known responses (see Figure 2). As can be seen from this case study, the mean of the two samples that were combined in equal proportions and thoroughly mixed gave an accurate indication of the results of four sub samples.

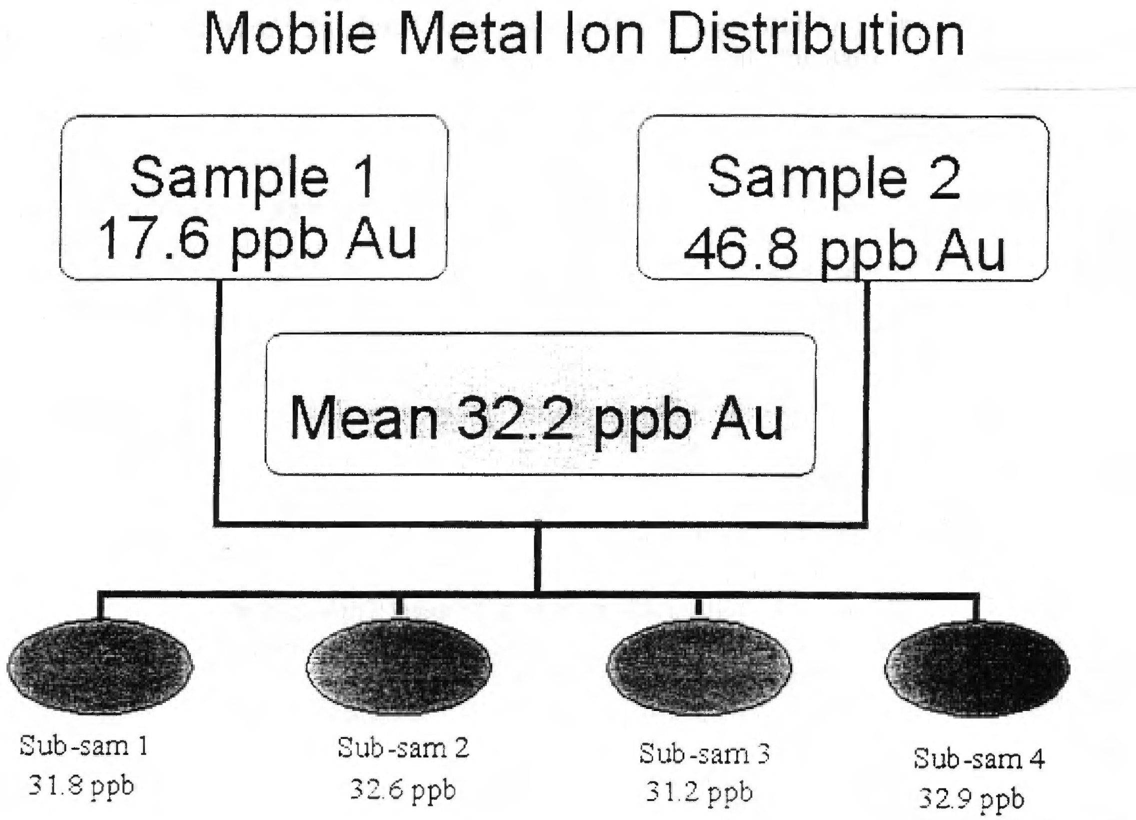


Figure 2

8.0 SAMPLE SUBMISSION

Before submitting the samples to the laboratory, samples for the survey should be collected and stored until the whole job has been completed. Only then should the samples be submitted as a single batch to a laboratory licensed by WAMTECH to undertake Mobile Metal Ion Analyses. A **Sample Submission Form** is included in Appendix II at the rear of the manual. By submitting the samples as a single batch, the samples are less prone to any slight degree of variation that may occur due to different laboratory conditions. This also allows the data to be received as a single batch reducing the chance of database corruption.

8.1 Overseas Sample Submission

Samples dispatched to laboratories overseas, depending upon local legislation, must go through various custom and quarantine procedures. Generally, laboratories must be registered as a quarantine laboratory to accept deliveries of samples from overseas for chemical analysis. This registration usually requires that the laboratory render the samples and packaging biologically sterile prior to disposal by heat treating samples and packaging. To allow efficient and quick release by Customs and Quarantine services, it is imperative that all documentation is clearly and concisely filled out. For the correct documentation and procedures contact your local Customs services and the analysing laboratory or MMI Technology, Perth, Australia. Samples arriving from overseas are usually subject to various government charges on each consignment. The laboratories will also most likely have an additional charge to cover their cost of handling and disposal of quarantine samples. For this reason the larger the sample batches or consignments, the more cost effective the analyses.

9.0 ANALYSES

XRAL Laboratories in Canada are currently licensed to undertake **Mobile Metal Ion Analysis**. Prior to this agreement, a detailed development programme was undertaken to ensure that the required analytical standards were being met and could be delivered on a routine, commercial basis. MMI Technology has a rigorous quality control check programme to ensure that the required laboratory standards are being maintained and the digest liquors provided to the laboratory meet the required stringent extraction criteria. Each digest liquor supplied to the laboratories is provided with an individual warranty form for that specific liquor, and to which it must conform.

The MMI Process uses two leachant solutions which have been specially developed to selectively 'release' the adsorbed ions from the soil material. The aim of the selective leaching is to remove metals which are loosely bound on the surface of particles within existing soil profiles, without attacking or influencing the natural mineralization of the soil or specific substrates. Using sensitive ICPMS instrumentation, the MMI Process is able to detect Mobile Metal Ions in digest solutions at parts per billion level.

Two digests are required for the current suite of 9 elements:

MMI - DIGEST A. For Cu, Pb, Zn, Cd	**MMI - DIGEST B. For Au, Ag, Ni, Pd, Co**
XRAL Method Code - MMI-A	XRAL Method Code - MMI-B

9.1 Quality Control

As with any geochemical survey, it is important to maintain a check sample programme independent from that undertaken by the laboratory. One standard reference material and one duplicate sample should be inserted within each sequence of 50 samples to monitor precision and accuracy. It is preferred that the QC samples be inserted as part of the numbering sequence but not essential. If MMI TECHNOLOGY is to be actively involved in the programme as consultants, standard reference material and duplicate sample will be monitored and reported upon. The precision and accuracy of MMI analyses is typically very high.

10.0 DATA HANDLING

Each individual laboratory has its own method of data presentation, most will usually supply the results in a combination of four different ways: via fax, mail, computer disk, or through a modem. The dispatch and retrieval of results is the responsibility of the laboratory and client. Once the results have been received care should be taken not to corrupt the original data and to safe-guard against its loss. As the samples should have been submitted as a single batch, the results should also be available as a single database. This helps avoid possible data corruption by reducing data transfer and manipulation.

Although MMI TECHNOLOGY retains a copy of data supplied by exploration companies for interpretation and reporting, both on computer and as a hard-copy, it takes no responsibilities for the inability to supply raw data at a later date.

10.1 MMI Response Ratios

To maximize the benefits from MMI analytical data, it is recommended that for each element, a background for the data is calculated, using (say) the lowest quartile of the data. Then a peak to background ratio (**response ratio**) is calculated for each element for each sample. A simple work sheet on MMI Response Ratios is included in Appendix I.

Response ratios provide a number of benefits for interpretation:

- Reduce the effects of dissolution variables during extraction, for example time and temperature;
- Allow the splicing of different data batches or data from varying regolith situations;
- Reduce the effects of sampling in different regolith units; and
- Facilitate multi-element data presentations for interpretation.

Before presenting MMI data in any graphical form, individual element response ratios are calculated for each sample. The concept of response ratios is simple: it involves determining a background value for each element in a survey area and ratioing all the data to that background. In more detail:

Determining the Background

- Select an element, for example Au, and determine the lowest 25% of the data for all the samples analysed in the survey area.

- Any values less than the detection limit need to be included and a value half of the detection limit should be substituted as an estimate value (based on scientific reports). For example, if Au has a detection limit of 0.25 ppb, any sample that analysed below this should be given a substituted value of 0.125 ppb.

- After determining the lowest quartile (25%) of the data, the average of these values is then calculated. This is the BACKGROUND value for that element within the specific dataset of a survey area.

Calculating MMI Response Ratios

- Response ratios are calculated by dividing each sample value by the predetermined background value for that element. The numbers are then rounded to give whole numbers greater than or equal to one (1).

- A sample with a response ratio of 2, or less, is considered low and is a background sample. Samples with response ratios greater than 5 could be considered significant depending upon the regolith/landform characteristics of the area and the sample spacing used for the survey. *Note however, that due to the greater contrast inherent in the MMI technique, response ratios in general need to be greater than 2-5 times background before being considered "anomalous".* If composite sampling has been employed then response ratios greater than 5 may be highly significant. Obviously, this may change depending upon the overall distribution and magnitude of response ratios in an area. For example, some areas may have anomalous Au values at 10 (RR) whereas for an another area the anomalous Au values may be those samples with a response ratio greater than 20.

Additional advantages of using response ratios are:

1. The effective application of MMI Response ratios relies upon correct determination of the background for the survey area. It is important that the survey area covers sufficient ground and has not just been conducted over a mineralized sequence. Correct determination of the background and ratioing of all the data to that value helps distinguish between those samples which are anomalous and those which are not. With MMI we are not looking at the absolute value of an element (for example Au) in a sample as it is a partial extraction technique. Instead, we are interested in the relative difference between background samples and those which are anomalous and which may overlie mineralization.

2. Response Ratio data is in a uniform format, allowing individual elements to be compared directly for coincident anomalies that can be easily identified using stacked bar charts.

3. Data presented as ratioed numbers are easier to interpret and contour than decimals, particularly those less than 1 ppb.

4. Response ratios are also valuable for dealing with multiple batch analysis where slight batch variations can occur during extraction. In some cases response ratios have been useful where highly-transported soils exist in conjunction with relict and erosional regimes by enabling the samples to be treated in separate datasets according to their regolith type.

The method of calculating response ratios for MMI data is certainly not a new one in geochemistry, although many people will argue it is an attempt to enhance the data. This is not the case as response ratios are merely a relative comparison of signal to background. It is also important to remember that all data from a laboratory are going to be relative; that is, relative to the standard used in the laboratory.

After response ratios have been calculated, the data can easily be presented in various ways to show required features and indicate trends. There is no set formula for defining the significance of any particular set of response ratio data. A number of factors will influence the final results. Orientation sampling can provide some assistance; however, like most exploration techniques experience with the technique is invaluable.