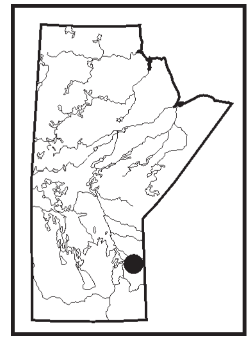
GS-22 Investigation of spruce bark and soil geochemistry at the Poundmaker Au deposit, Bissett, Manitoba (NTS 52M4)

by G.H. Gale and N. Yavorskaya[1]



Gale, G.H. and Yavorskaya, N. 2004: Investigation of vegetation and soil geochemistry at the Poundmaker Au deposit, Bissett, Manitoba (NTS 52M4); *in* Report of Activities 2004, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 236–253.

Summary

Spruce bark samples from trees growing on the Poundmaker Au-bearing quartz vein contain up to 9760 ppb (9.7 g/t) Au in bark ash and up to 1810 ppb Au in untreated bark; in contrast, samples 30 m from the vein have values of 1–4 ppb Au. Rare earth element (REE) determinations were made on aqua regia digestions of bark ash and on the untreated bark using instrumental neutron activation analysis (INAA), Enzyme Leach[SM] and Terrasol Leach[SM] analytical methods. The Enzyme Leach[SM] method identifies Eu fractionation in the bark samples, but none of the methods provided a positive Eu anomaly that is useful in discriminating the mineralized zone from the barren hostrocks. Both Enzyme Leach[SM] and Mobile Metal Ion (MMI)® analyses of soil samples clearly identify the Au-bearing quartz vein.

Introduction

This study forms part of a project designed to study the distribution of REE in soils and spruce bark in the vicinity of different types of mineral deposits. The Poundmaker (Figure GS-22-1) is a lode Au deposit emplaced into sheared granodioritic rocks (Theyer, 1994). The deposit has been explored with several shafts, stripping of outcrops and several diamond-drill holes. Portions of the deposit, including the old workings, are covered with spruce, tamarack and alder. This deposit was selected for an investigation into the behaviour of REE in spruce bark and soil as a potential exploration methodology (Gale, 2003). Initial results from samples collected in 2003 indicated very high Au contents in bark ash; consequently, a follow-up survey was undertaken in 2004 to resample the spruce trees and to collect soil samples. The REE contents of the vein and its hostrocks are unknown. A secondary objective of this study is to determine if deposits of this type are detectable with biogeochemical and selective-extraction methods. The soil samples, collected over and within 40 m of the vein (Figure GS-22-2) illustrate that Enzyme Leach[SM] and MMI® precious metal responses associated with narrow vein systems are probably restricted to the immediate vicinity of the vein.

Methodology

Samples were collected in autumn 2003 from five spruce trees over and immediately adjacent to the vein and one spruce 30 m northeast of the vein. Bark samples were ashed and analyzed by the 2Enh method (an enhanced analytical method that provides higher quality REE data) at Activation Laboratories Ltd. (Actlabs), Ancaster, Ontario. Because several samples had exceptionally high Au contents, additional bark samples were collected in early spring 2004 from the Au-rich spruce and from spruce along a line approximately 50 m north of the shafts (Figure GS-22-2). In addition, soil samples were collected from rubble adjacent to an old trench into the quartz vein and four sites adjacent to spruce trees sampled along the northern line. The soil samples were analyzed by the MMI Multi-Element Leach (MMI-M)® method at SGS Canada–Toronto and by the Enzyme Leach[SM] method at Actlabs.

Spruce bark analyses

Spruce bark samples were collected in 2003 to investigate their REE contents for comparison with spruce barks from other deposit types (cf. Gale, GS-9, this volume). The high Au values obtained from the 2003 bark samples prompted the use of both destructive (ash method, partial-leach methods) and nondestructive (instrumental neutron activation analysis) methods to investigate the Au and REE contents in the 2004 bark samples. The relative locations of the spruce bark samples are shown on Figure GS-22-2. Selected analytical data are presented in Table GS-22-1; complete analyses are available in Data Repository item 2004002.[2]

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[2] MGS Data Repository item 2004002, containing the data or other information sources used to compile this report, is available on-line to download free of charge at www2.gov.mb.ca/itm-cat/freedownloads.htm, or on request from minesinfo@gov.mb.ca or Mineral Resources Library, Manitoba Industry, Economic Development and Mines, 360–1395 Ellice Avenue, Winnipeg, MB R3G 3P2, Canada.

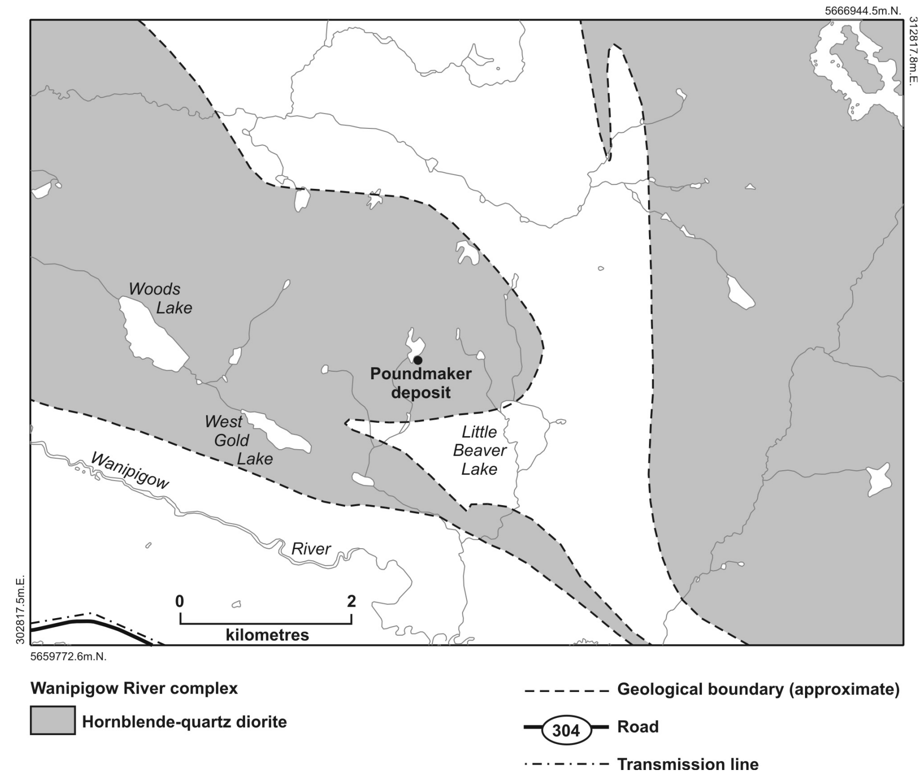

Figure GS-22-1: *Location of the Poundmaker Au deposit (*after *Theyer, 1994).*

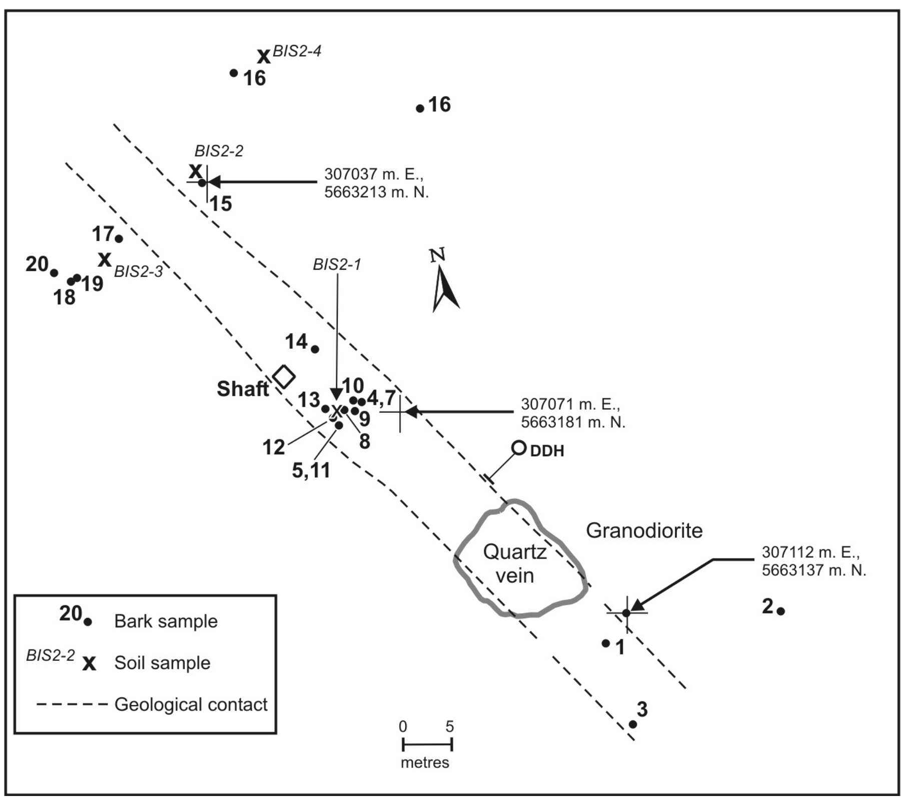

Figure GS-22-2: *Location of spruce bark (1 to 20) and soil samples (BIS2-1 to -4), Poundmaker Au deposit.*

Table GS-22-1: Selected analytical data for ashed spruce bark at sites BIS1 and BIS2, Poundmaker Au deposit. Analyses by Actlabs using 2Enh method. All data in ppm except for Au and Re, which are in ppb. Complete analytical data available in Data Repository item 2004002.

Sample no.	Easting[1]	Northing[1]	Tree diam. (cm)	Ash yield (%)	Re (ppb)	Au (ppb)	Sc	Mn	Co	Ni	Cu	Zn	As	Rb	Sr	Ag	Cd	Ba	La	Ce	Eu	Dy	Pb
Bis2-20	307024	5663212	15	2.64	2.9	7	1.4	2530	4	17	63	1180	13	30	1030	-0.2	2	292	6.78	12.5	0.250	0.715	64
Bis2-19	307026	5663207	15	2.53	1.2	-2	1.2	4040	6	21	78	977	12	114	1920	0.4	2	180	6.60	12.5	0.254	0.720	42
Bis2-18	307025	5663207	15	2.76	1.5	-2	0.9	4460	6	18	75	895	15	101	2420	0.4	3	201	5.13	9.80	0.201	0.571	41
Bis2-17	307026	5663207	15	2.10	3.1	6	1.5	4770	6	20	151	426	13	387	755	0.6	3	154	7.16	14.2	0.263	0.761	29
BIS2-5	307102	5662732	20	1.82	1.5	70	0.9	2550	4	19	105	2520	11	31	848	0.4	1	263	3.95	7.45	0.146	0.439	17
BIS2-3	307165	5662685	15	1.59	1.6	104	2.4	1430	5	17	114	1280	9	56	943	0.3	2	256	10.7	20.5	0.392	1.10	35
BIS2-1	307155	5662694	20	1.75	1.1	194	2.7	1960	6	20	119	803	7	81	858	0.4	5	304	12.3	23.6	0.394	1.12	41
BIS2-4	307096	5662960	15	4.70	0.5	5950	1.4	1420	10	17	46	511	14	40	214	0.6	1	1210	7.76	15.0	0.339	0.595	50
BIS2-4	307086	5662960	15	2.59	1.0	2660	1.3	3530	15	18	89	1260	13	49	529	0.5	2	614	7.05	13.6	0.281	0.636	45
Bis2-7	307086	5662960	15	2.79	1.9	5230	1.4	4080	18	20	85	1110	18	48	585	0.7	3	257	6.36	12.6	0.259	0.646	56
Bis2-8	307085	5662958	15	2.30	2.6	536	1.8	4460	8	25	93	1810	11	140	512	0.3	4	210	7.34	14.9	0.274	0.741	40
Bis2-9	307083	5662958	10	3.96	1.9	8730	2.5	2170	22	31	83	869	24	72	317	1.0	6	211	11.7	23.8	0.464	1.19	122
Bis2-10	307084	5662959	20	2.63	0.9	5650	1.0	6740	25	29	90	1930	20	56	885	0.8	6	243	4.64	9.52	0.200	0.493	49
Bis2-11	307083	5662958	12	1.48	3.6	48	1.9	1840	6	26	213	877	9	76	433	0.3	5	162	9.85	20.2	0.372	1.06	52
Bis2-12	307084	5662960	15	2.11	2.7	6	1.1	4300	6	32	107	2510	15	55	963	0.3	3	165	5.18	10.8	0.213	0.607	31
Bis2-13	307084	5662961	10	1.68	3.1	125	2.7	2350	6	31	131	1980	14	58	659	0.6	9	141	12.2	25.8	0.497	1.46	70
Bis2-14	307085	5662964	15	2.46	1.6	2	1.2	2680	6	27	106	2800	18	46	1250	0.3	2	279	5.80	11.6	0.224	0.646	35
BIS2-2	307180	5662691	10	2.44	0.8	86	1.0	2830	4	10	75	1810	12	27	788	0.3	1	1540	5.22	9.77	0.264	0.578	31
Bis2-15	307037	5663222	30	3.22	1.2	-2	0.8	2650	4	15	92	947	16	431	866	-0.2	3	821	3.83	6.97	0.168	0.364	25
Bis2-16	307050	5663225	15	2.33	2.2	-2	1.8	11900	14	27	101	581	13	92	643	0.2	8	142	7.52	15.0	0.279	0.822	30
BIS2-6	307139	5662765	15	1.95	1.8	6	2.0	5530	6	18	92	640	11	77	433	0.6	4	1010	9.47	18.0	0.372	0.952	46
BIS2-5 (redigestion)	307102	5662732	20	1.82	1.3	10	0.8	2590	4	21	115	2310	10	28	728	0.3	1	366	3.05	5.75	0.139	0.308	16
BIS2-3 (redigestion)	307165	5662685	15	1.59	1.5	97	2.5	1420	5	17	125	1280	10	55	800	0.3	2	298	8.75	16.4	0.407	0.856	38
BIS2-1 (redigestion)	307155	5662694	20	1.75	1.3	463	3.2	2180	6	24	128	898	9	82	775	0.5	5	412	10.3	19.6	0.428	0.959	47
BIS2-4 (redigestion)	307096	5662960	15	4.70	0.7	5030	1.8	2370	14	22	72	860	16	44	261	0.5	1	1360	7.04	13.4	0.337	0.575	59
BIS2-4 (rep. redigestion)	307096	5662960	15	4.70	0.5	8050	1.2	1250	9	16	44	485	14	29	142	0.5	1	729	5.26	10.3	0.236	0.415	41
BIS2-4 (redigestion)	307096	5662960	15	2.59	1.0	9760	1.5	3780	17	21	95	1140	14	48	460	1.0	2	805	6.28	11.9	0.414	0.525	50
BIS2-2 (redigestion)	307180	5662691	10	2.44	0.6	1410	1.3	3070	5	11	80	1710	16	28	783	0.4	1	1440	4.87	9.11	0.311	0.515	33
BISI-1	326560	5655093	10	0.42	0.8	6	3.2	2430	8	28	115	924	7	109	285	-0.2	8	347	16.5	32.8	0.527	1.53	37
BISI-2	326565	5655083	10	1.47	0.9	24	3.1	3350	8	29	141	994	8	68	268	0.3	9	292	12.6	24.5	0.406	1.21	28
BISI-2 (redigestion)	326565	5655083	10	1.47	0.8	14	3.0	3680	8	32	147	1100	9	65	263	0.2	9	268	11.4	22.3	0.338	0.982	27
BISI-3	326547	5655047	10	1.36	0.4	7	2.6	1820	6	28	148	1010	7	53	300	-0.2	9	354	15.0	29.0	0.463	1.37	30
BISI-4	326554	5655014	10	3.53	0.3	-2	1.8	7000	5	14	74	879	8	226	1260	0.0	6	922	12.4	24.1	0.420	1.15	59

[1] NAD 27 datum

Ash analyses

Bark samples BIS2-1 to -6, collected in 2003, were ashed and analyzed by the 2Enh method. Some of the 2003 samples contained bark from several trees; the trees making up these samples were resampled separately in 2004 to check the high Au contents. For example, samples BIS2-7 and -8 were collected in spring 2004 from two trees that were sampled together as BIS2-4 in autumn 2003. The Au values in sample BIS2-8, a dead tree, are considerably lower those than in sample BIS2-7, the live tree (Table GS-22-1; Figure GS-22-3). An Au content of >5000 ppb was obtained from the ash of sample BIS2-10, collected from a dead tree midway between samples BIS2-7 and -8. This suggests that bark

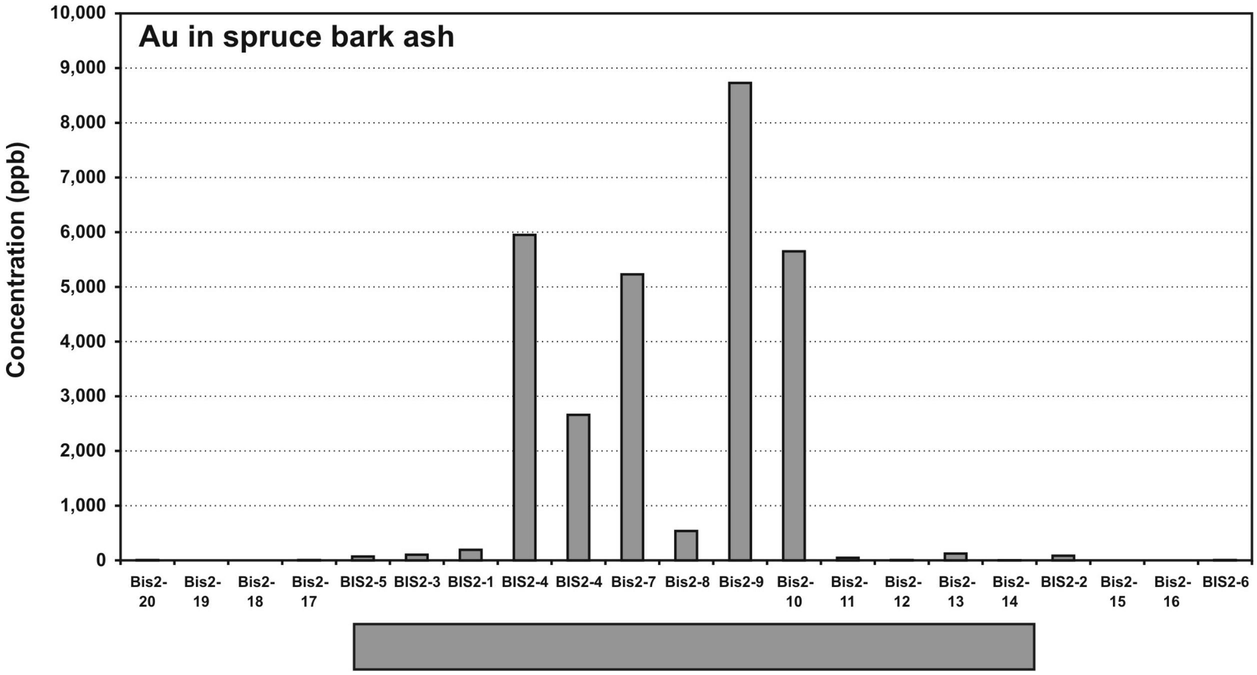

Figure GS-22-3: *Au (ppb) in spruce bark ash, Poundmaker Au deposit. Shaded bar below the sample numbers identifies samples from trees that are growing over the quartz vein. All samples are projected onto one section to give a profile normal to the strike of the vein (cf. Figure GS-22-2).*

from both living and dead trees retains Au and is suitable for detection of metal anomalies.

Samples BIS2-4 and -7 to -14 were collected from an area with a diameter of approximately 15 m. Samples BIS2-6 and -16, collected up to 40 m east of the known vein, have Au contents that are similar to some of the trees that are immediately adjacent to the vein (Table GS-22-1; Figure GS-22-2). Although some samples contain approximately 10 g of Au, not all of the samples from trees growing over the vein contain highly anomalous Au (Table GS-22-1; Figure GS-22-3). Analyses of ash from sample BIS2-4 provided Au concentrations that vary from 2660 ppb to approximately 9760 ppb. The analytical data show that there can be extremely wide variations in the Au contents of both individual ash analyses of the same sample and individual trees within a small area. Samples collected near the margins of the vein (BIS2-1, -3 and -5) have anomalous, but much lower Au contents than some of the trees growing over the Au-bearing vein. Samples BIS2-15, -17, -18, -19 and -20, collected across a soil-covered area north of the shaft, do not contain anomalous Au values in the ashed bark samples (Figure GS-22-2; Table GS-22-1). Figures GS-22-4 to -6 show the relative distribution of Re, Ag, Co and As in bark ash across the mineralized zone and wallrocks.

Rare earth element analyses of the ash samples do not show higher total REE contents in samples with high Au contents (Figure GS-22-6), and negative Eu anomalies are present in all samples.

INAA analyses

The 2004 bark samples (BIS2-7 to -20) were analyzed using the INAA analytical method at Actlabs. This method is nondestructive, Au is not lost during sample preparation and it provides direct high-quality measurements of elements such as Au and Eu in the bark (Table GS-22-2). The INAA method revealed anomalous Au values in the same samples as the ash method. The data also show similar wide variations in Au contents of bark from individual trees within a small area; for example, samples BIS2-7, -9 and -10 have 1200–1810 ppb Au, whereas sample BIS2-8 has only 64 ppb Au.

With the exception of samples BIS2-17, -14 and -19, all of the samples, including the background sample (BIS2-16; 0.5 ppb Au), contain anomalous levels of Au (Figure GS-22-7). These data also suggest that INAA is preferable to the ash method for detection of Au in spruce bark; the ashing of bark probably results in some degree of volatilization of Au in the samples during the process (cf. Tables GS-22-2 and -3).

Other elements in the INAA dataset (e.g., As, Sc, Co and Cr) and some REE (e.g., La, Eu) are also anomalous in spruce bark at the Poundmaker vein (Figures GS-22-8 to -10). The INAA method does not provide data for Gd and several other heavy REE, and is therefore not suitable for determination of Eu deviations. The high-precision data for

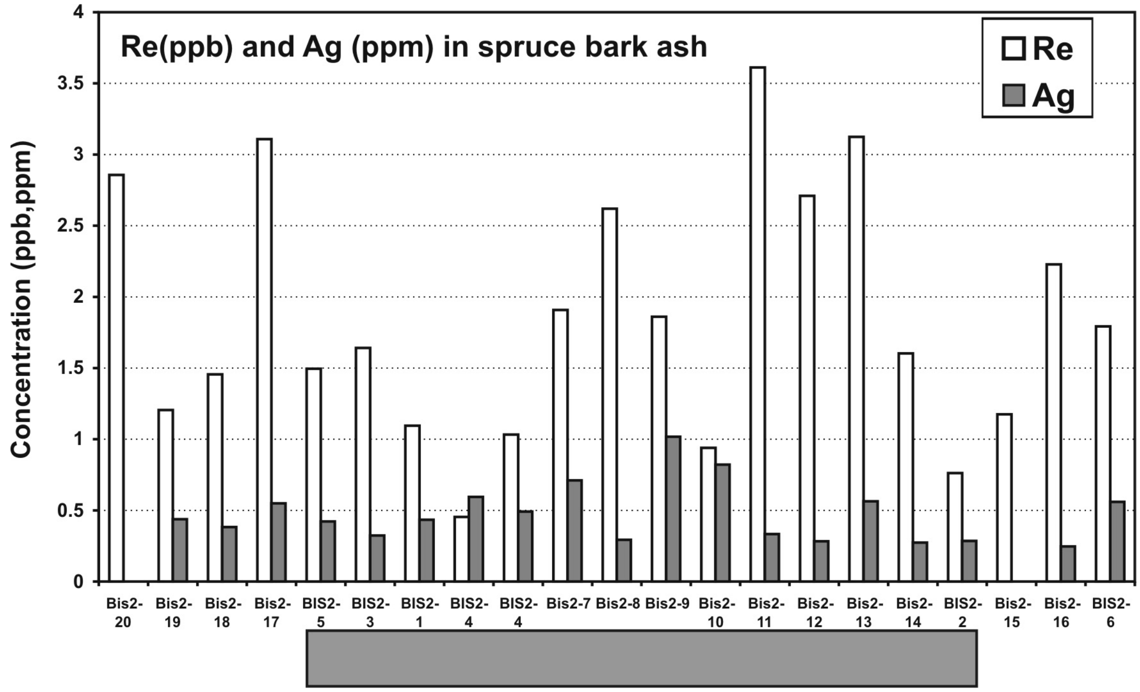

Figure GS-22-4: *Re (ppb) and Ag (ppm) in spruce bark ash, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

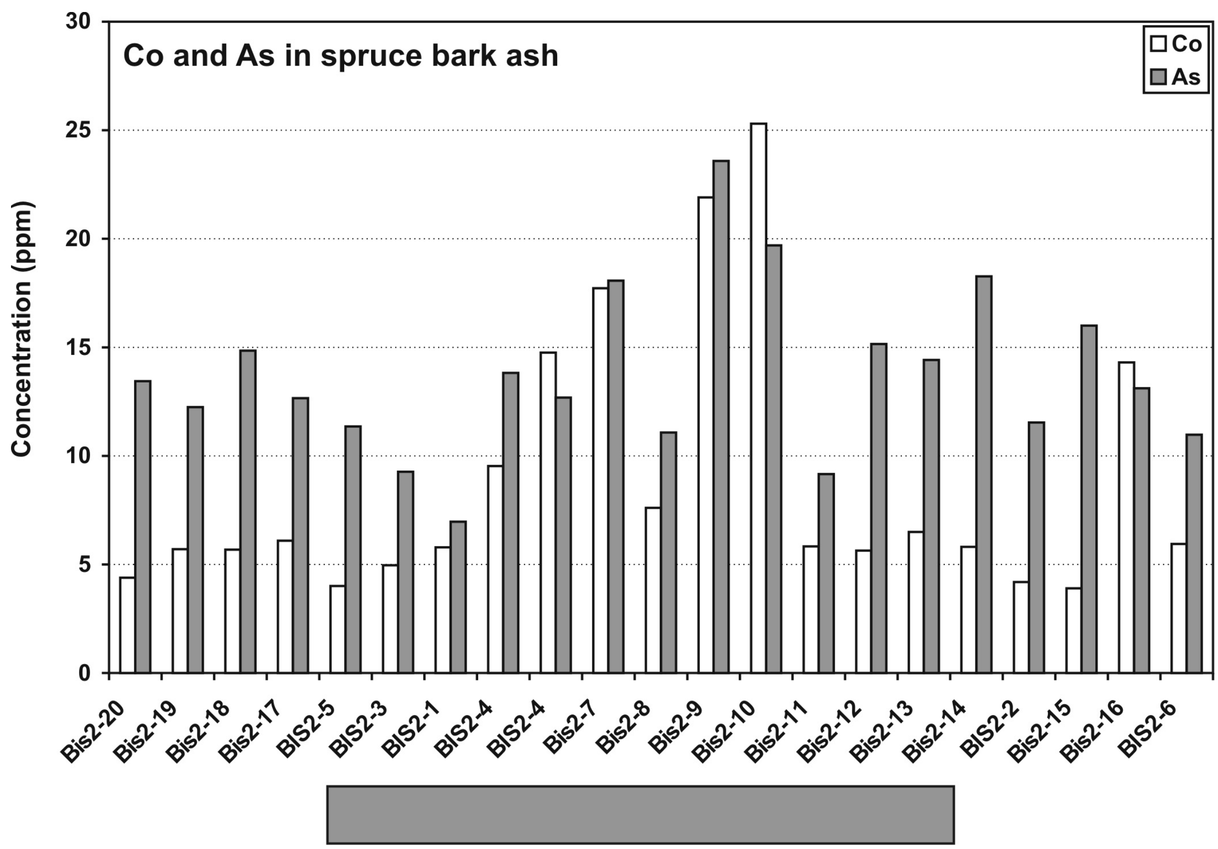

Figure GS-22-5: *Co (ppm) and As (ppm) in ashed spruce bark, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

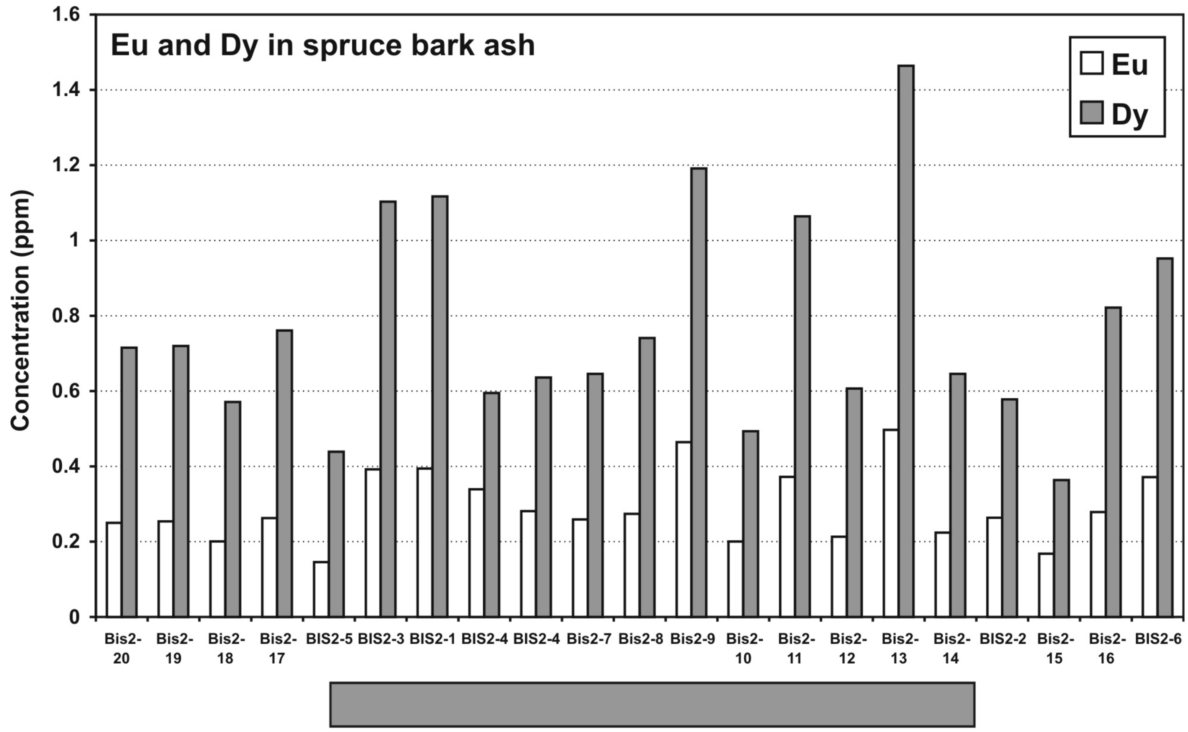

Figure GS-22-6: *Eu (ppm) and Dy (ppm) in spruce bark ash, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

Table GS-22-2: Selected INAA analytical data for spruce bark, Poundmaker Au deposit. Analyses by Actlabs. All data in ppm except for Au, which is in ppb. Complete analytical data available in Data Repository item 2004002.

Sample no.	Easting[1]	Northing[1]	Au (ppb)	As	Ba	Co	Cr	Hf	Hg	Mo	Na	Sc	La	Ce	Sm	Eu	Yb	Lu
BIS2-20	307024	5663212	4	0.2	29	0.2	1.2	0.1	0.1	0.1	91.1	0.1	0.3	0.6	0.04	0.01	0.025	0.0035
BIS2-19	307026	5663207	0	0.2	69	0.2	0.8	-0.1	0.1	0.1	64.4	0.1	0.2	0.4	0.03	0.008	0.014	0.002
BIS2-18	307025	5663207	3	0.2	95	0.2	0.9	-0.1	0.1	-0.1	78.6	0.1	0.3	0.5	0.03	0.008	0.017	0.002
BIS2-17	307026	5663207	1	0.2	43	0.2	1.4	0.1	0.1	-0.1	83.0	0.1	0.3	0.5	0.035	0.008	0.021	0.003
BIS2-7	307086	5662960	1230	1.0	100	1.0	2.7	0.2	0.1	-0.1	265.0	0.2	0.6	1.2	0.07	0.016	0.049	0.007
BIS2-9	307083	5662958	1780	2.0	64	1.4	5.4	0.4	0.2	0.3	572.0	0.5	1.4	2.4	0.16	0.044	0.104	0.016
BIS2-10	307084	5662959	1810	0.8	145	1.1	3.3	0.1	0.1	-0.1	252.0	0.2	0.5	0.9	0.055	0.019	0.051	0.008
BIS2-8	307085	5662958	64	0.4	61	0.4	1.7	0.1	0.1	0.1	142.0	0.1	0.4	0.7	0.045	0.012	0.031	0.004
BIS2-11	307083	5662958	19	0.2	36	0.2	1.9	0.1	0.1	0.1	111.0	0.1	0.4	0.7	0.045	0.01	0.027	0.004
BIS2-13	307084	5662961	10	0.2	40	0.2	1.5	0.1	0.1	0.1	92.4	0.1	0.3	0.6	0.04	0.01	0.024	0.004
BIS2-12	307084	5662960	4	0.3	110	0.2	1.4	0.1	0.1	0.1	130.0	0.1	0.3	0.5	0.03	0.008	0.02	0.002
BIS2-14	307085	5662964	1	0.1	105	0.2	1.0	0.1	0.1	0.1	72.4	0.1	0.2	0.4	0.03	0.008	0.015	0.002
BIS2-15	307037	5663222	2	0.1	75	0.2	1.1	-0.1	0.1	0.1	65.0	0.1	0.2	0.4	0.02	0.007	0.009	0.001
BIS2-16	307050	5663225	1	0.2	77	0.4	1.2	0.1	0.1	0.1	91.1	0.1	0.4	0.7	0.04	0.01	0.028	0.004

[1] NAD 27 datum

Eu suggest that there are no Eu depletions in the bark samples, as already indicated by the 2Enh ash analyses; however, the absence of Gd values precludes the accurate determination of positive Eu deviations in the INAA data. The high-precision Eu analyses do indicate that there are no strong negative Eu deviations in these bark samples.

Enzyme Leach[SM] analyses

The Enzyme Leach[SM] method was used to investigate the behaviour of REE in samples BIS2-7 to -20. This method

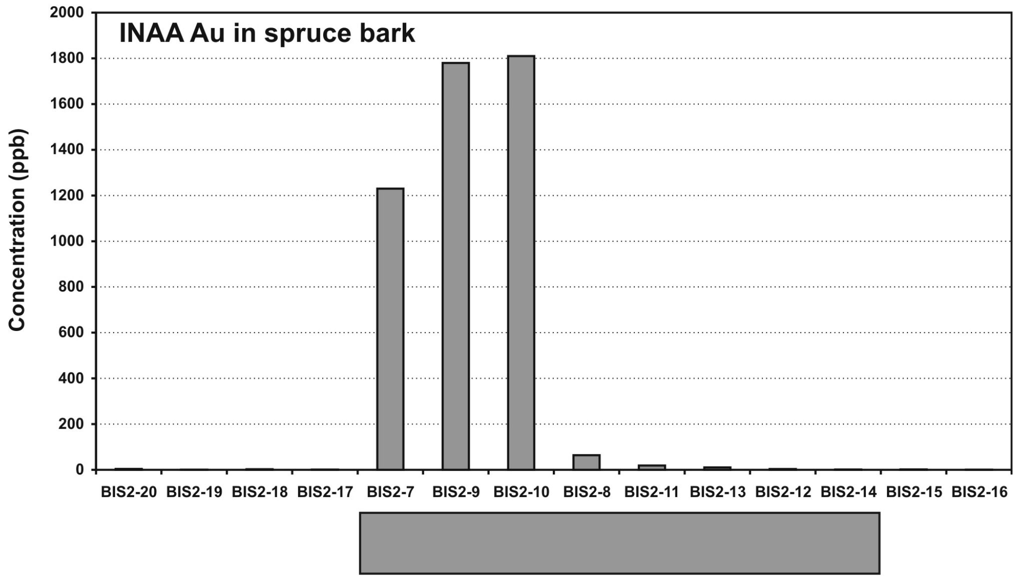

Figure GS-22-7: *Au (ppb) in spruce bark by INAA, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

Table GS-22-3: Selected Enzyme Leach^{SM} analytical data for spruce bark, Poundmaker Au deposit. Analyses by Actlabs. All data in ppb. Complete analytical data available in Data Repository item 2004002.

Sample no.	Easting[1]	Northing[1]	Location	As	Mo	Sb	W	Au	Co	Cu	Zn	Pb	Ga	Tl	La	Ce	Eu	Dy	Rb	Sr	Cs	Ba
Bis2-20	307024	5663212	West rockpile	8.5	2.1	0.68	0.7		9.2	42.1	2140	15.0	0.8	0.544	0.98	2.04	0.25	0.19	380	1820	2.58	1100
Bis2-19	307026	5663207	base rockpile	8.0	3.2	0.82	0.8		12.9	51.1	1640	13.6	0.7	1.49	1.08	2.24	0.76	0.20	1730	2980	9.26	3380
Bis2-18	307025	5663207	base rockpile	8.1	2.4	0.78	0.7		13.7	61.2	1620	22.0	1.8	1.09	1.27	2.60	1.09	0.29	1830	4390	9.87	4630
Bis2-17	307026	5663207	over vein ?	5.8	2.2	0.67	0.6		10.8	107	824	6.8	1.4	2.17	3.96	7.13	0.67	0.53	3660	827	26.8	2380
Bis2-7	307086	5662960	Shaft area	13.4	3.0	0.86	3.5	0.138	54.8	73.1	2350	27.0	1.3	0.595	2.52	4.66	1.09	0.38	503	1330	1.13	4810
Bis2-9	307083	5662958	Shaft area	18.1	5.6	1.43	3.0	0.051	55.4	67.3	2340	59.4	2.5	0.701	4.81	9.37	0.68	0.70	865	822	1.20	2590
Bis2-10	307084	5662959	Shaft area	12.3	1.7	0.60	1.4	0.062	64.8	72.7	2340	17.6	2.2	1.08	3.38	6.19	1.38	0.47	1010	1460	1.76	6040
Bis2-8	307085	5662958	Shaft area	8.5	3.0	0.85	2.3	0.048	20.9	69.8	2810	28.8	1.9	0.753	4.88	9.25	0.84	0.68	1480	835	3.15	3340
Bis2-11	307083	5662958	Shaft area	7.3	3.3	0.97	1.2	0.013	10.0	54.1	1210	10.3	0.4	0.478	3.58	6.74	0.49	0.56	624	502	2.56	1690
Bis2-13	307084	5662961	Shaft area	4.8	3.5	0.67	1.7		8.7	47.7	2240	15.2	0.8	0.472	0.94	1.95	0.51	0.19	335	858	8.32	2200
Bis2-12	307084	5662960	Shaft area	8.0	2.5	0.75	1.0	0.010	12.3	74.9	2950	18.2	0.9	0.397	3.26	6.39	1.07	0.55	680	1350	2.17	4910
Bis2-14	307085	5662964	Shaft area	8.1	1.9	0.61	1.1	0.006	11.6	74.5	3090	15.3	1.0	0.613	3.57	6.95	0.98	0.60	575	1820	2.58	3850
Bis2-15	307037	5663222	East 10'	3.4	1.5	0.36	0.5	0.016	10.9	121	2220	6.0	0.4	5.82	1.86	3.38	0.63	0.28	7170	1230	86.4	2720
Bis2-16	307050	5663225	East 65'	6.9	2.5	0.78	0.7		26.1	72.5	1090	9.6	1.3	0.942	2.96	5.46	0.99	0.43	1120	816	9.48	4120

[1] NAD 27 datum

detected anomalous Au in most of the bark samples over the Poundmaker vein and in sample BIS2-15 (Table GS-22-3; Figure GS-22-11). In addition, As and Pb are anomalous in samples from directly over the vein (i.e., they form apical anomalies), whereas Rb, Cs and Tl form haloes at the margin of the quartz vein (Figures GS-22-12 to -14). Analysis of REE in spruce bark by the Enzyme Leach^{SM} method produces strong positive Eu anomalies (Figure GS-22-15), but the background samples also have positive europium deviation (Eu^d) [1] anomalies and cannot be distinguished from the Au-enriched samples.

Terrasol Leach^{SM} analyses

Samples BIS2-7 to -20 were analyzed by the Terrasol Leach^{SM} method at Actlabs to determine if the method was capable of detecting both anomalous Au and positive Eu anomalies. This partial-leach method employs a stronger leach than Enzyme Leach^{SM} and should therefore extract more of the metals from the bark samples. Anomalous values of >600 ppm Pb and Co in samples BIS2-7, -9 and -10 (Table GS-22-4; Figure GS-22-16) form apical anomalies directly over

[1] $Eu^d = (Eu_n/(Sm_n/2 + Gd_n/2) - 1) \times 100$, where $_n$ is the chondrite-normalized value

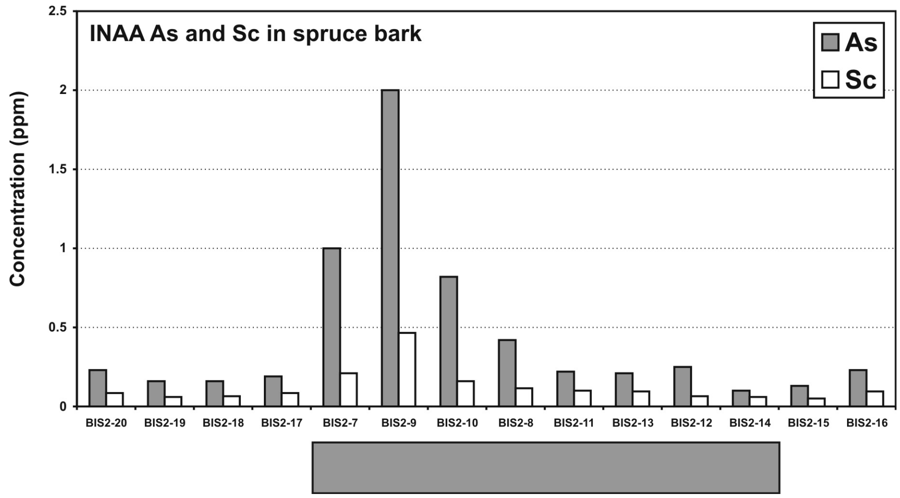

Figure GS-22-8: *As (ppm) and Sc (ppm) in spruce bark by INAA, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

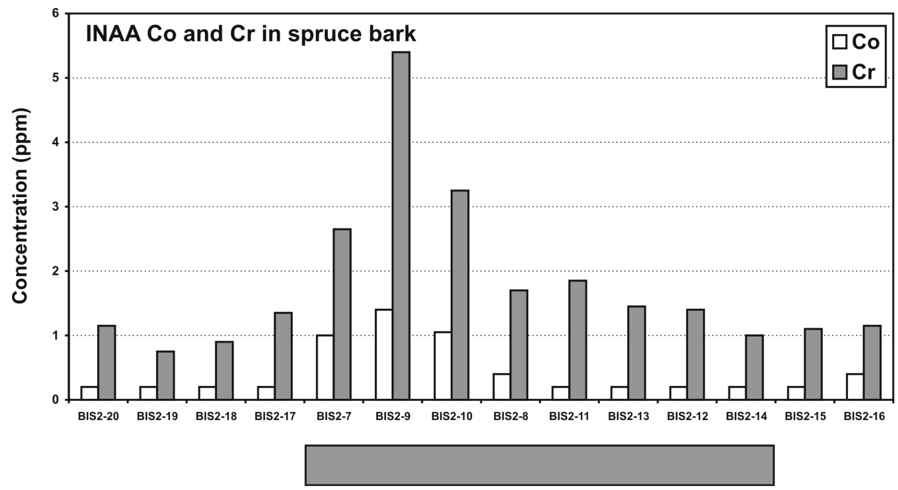

Figure GS-22-9: *Co (ppm) and Cr (ppm) in spruce bark by INAA, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

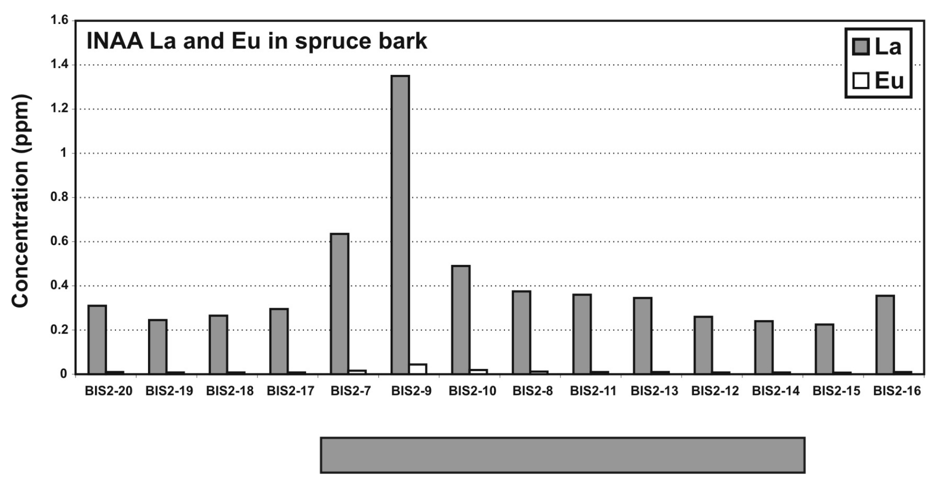

Figure GS-22-10: *La (ppm) and Eu (ppm) in spruce bark by INAA, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

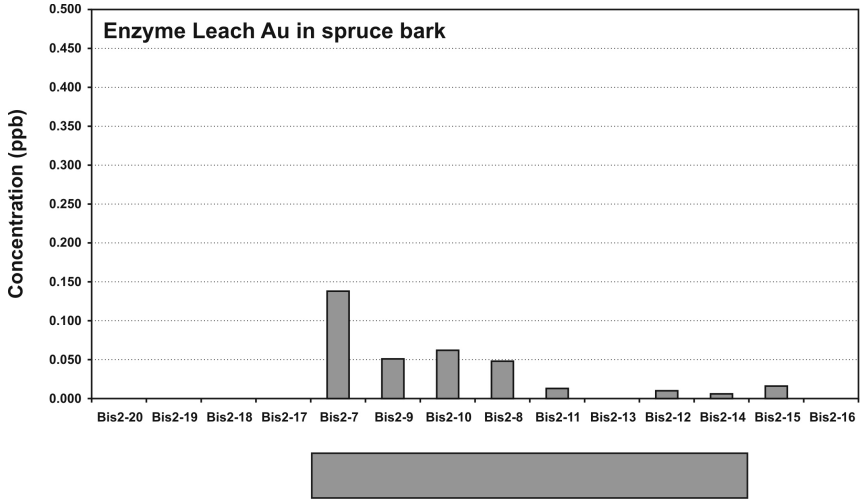

Figure GS-22-11: *Au (ppb) in spruce bark by Enzyme Leach^{SM}, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

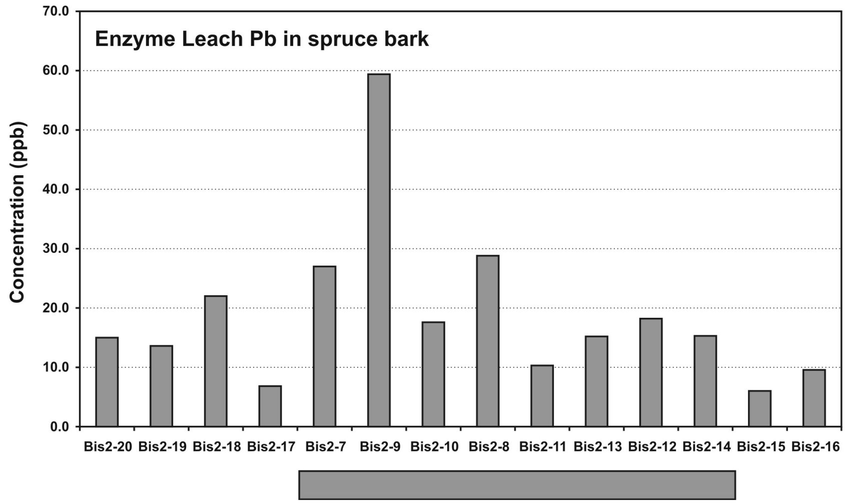

Figure GS-22-12: *Pb (ppm) in spruce bark by Enzyme Leach^{SM}, Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

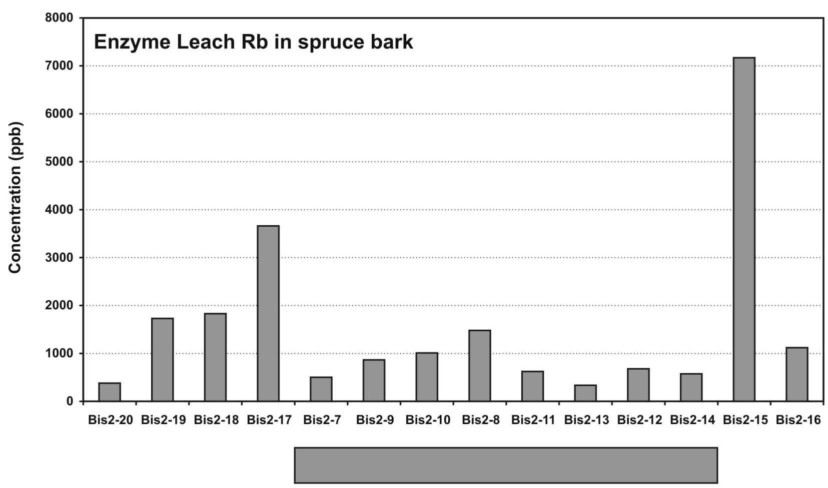

Figure GS-22-13: *Rb (ppm) in spruce bark by Enzyme Leach^{SM}, Poundmaker Au deposit. This element forms a moderate 'rabbit ear' anomaly at the edge of the vein. Shaded bar as in Figure GS-22-3.*

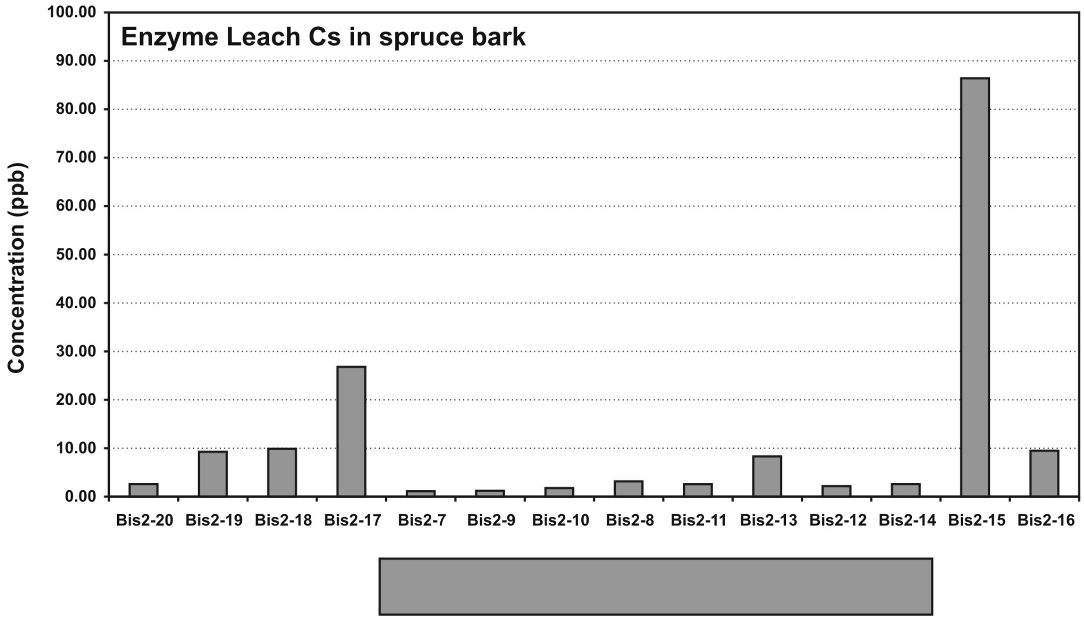

Figure GS-22-14: *Cs in spruce bark by Enzyme Leach^{SM}, Poundmaker Au deposit. This element forms a weak 'rabbit ear' anomaly at the edge of the vein. Shaded bar as in Figure GS-22-3.*

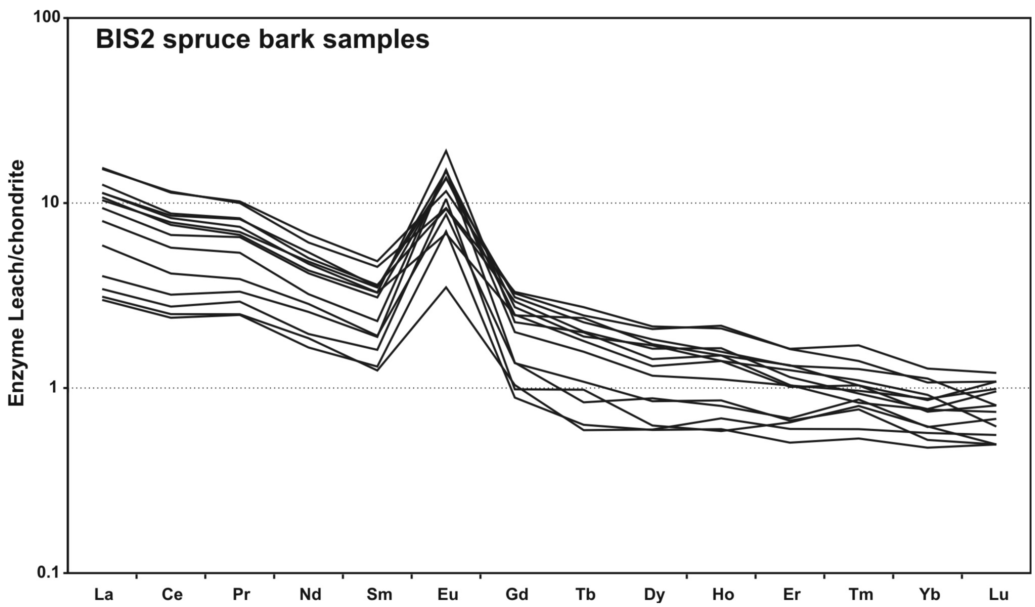

Figure GS-22-15: *REE plot of Enzyme Leach^{SM} data for spruce bark, Poundmaker Au deposit. Background samples (15 to 20) are not clearly separated from the remainder of the samples that directly overlie the vein.*

the vein; Cs forms a 'rabbit ear–type' halo at the margin of the vein (Figure GS-22-17) that is similar to the Cs anomaly observed in the Enzyme Leach^{SM} data. The Terrasol Leach^{SM} Au contents are below the detection limit, but the method provides higher total REE concentrations in some Au-enriched bark samples and all of the Eu anomalies are negative.

Partial-leach soil surveys

One of the objectives of this project is to determine the relationship, if any, between the REE values in spruce bark (vegetation) and those in the underlying soil. Soil samples were collected at various sample depths in the vicinity of sampled spruce trees to provide a complete soil profile (Tables GS-22-5, -6). These samples include organic and inorganic material. Material in the top 10 cm of the soil was separated into organic and inorganic fractions (e.g., A1 = organic). Samples were analyzed by the Enzyme Leach^{SM} and MMI-M® partial-leach methods. Sample locations are shown on

Table GS-22-4: Selected Terrasol Leach[SM] analytical data for spruce bark, Poundmaker Au deposit. All values in ppm. Complete analytical data available in Data Repository item 2004002.

Sample no.	Easting[1]	Northing[1]	As	Mo	Co	Pb	S.Q. Ti	Nb	Ta	La	Ce	Eu	Mn	Rb	Cs	Ba
Bis2-20	307024	5663212		15	92	173	319			121	230	5.5	66600	824	10	9280
Bis2-19	307026	5663207		14	117	147	339			125	238	7.4	82200	3240	25	28200
Bis2-18	307025	5663207		14	120	140	303			103	197	6.8	103000	3530	27	32700
Bis2-17	307026	5663207		14	92	101	423			93	191	5.9	84100	11900	79	24300
Bis2-7	307086	5662960		13	626	206	589	15	32	115	233	7.2	163000	1060	5	28300
Bis2-9	307083	5662958	72	26	678	974	1440	6	5	233	509	12.8	105000	2140	9	27000
Bis2-10	307084	5662959		11	742	187	376			91	184	7.5	192000	1960	7	44900
Bis2-8	307085	5662958		13	243	170	677	6	10	81	170	5.8	140000	3070	10	28200
Bis2-11	307083	5662958		10	61	278	295	4	7	78	181	5.1	18400	1100	8	14100
Bis2-13	307084	5662961		21	85	152	506			129	280	7.4	43500	746	27	18700
Bis2-12	307084	5662960		11	116	70	289			73	142	5.7	93700	1150	5	35000
Bis2-14	307085	5662964		15	123	100	354			102	206	7.0	63200	1260	9	33700
Bis2-15	307037	5663222			94	74				65	115	4.9	81300	21400	201	26700
Bis2-16	307050	5663225		15	211	136	426			128	255	8.5	156000	2300	28	34500

[1] NAD 27 datum

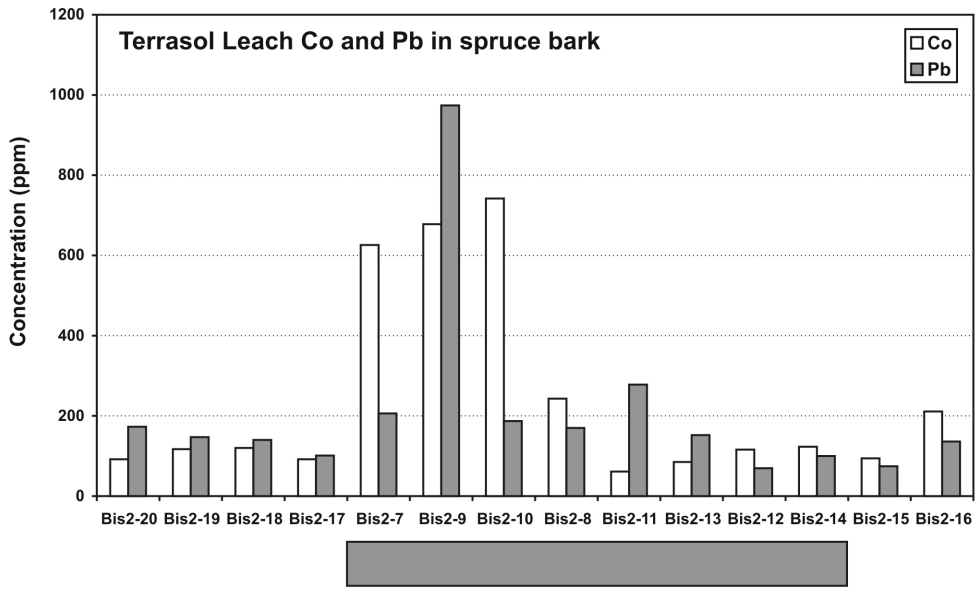

Figure GS-22-16: *Co (ppm) and Pb (ppm) in spruce bark by Terrasol Leach[SM], Poundmaker Au deposit. Shaded bar as in Figure GS-22-3.*

Figure GS-22-2. Selected analyses are presented in Tables GS-22-5 and -6, and the complete analytical dataset is available in Data Repository item 2004002.

MMI-M® analyses

Portions of the soil samples used for the Enzyme Leach[SM] analyses were submitted for analyses by the MMI Multi-element Leach (MMI-M)® method at SGS Canada–Toronto. Organic-rich samples cannot be analyzed by this method, so complete vertical profiles are not available. Selected analytical data are presented in Table GS-22-6. The complete analytical dataset is available in Data Repository item 2004002.

Figures GS-22-18 to -20 show that the mineralization is well defined by Au, Ag, Cu and Ni in the sample from a

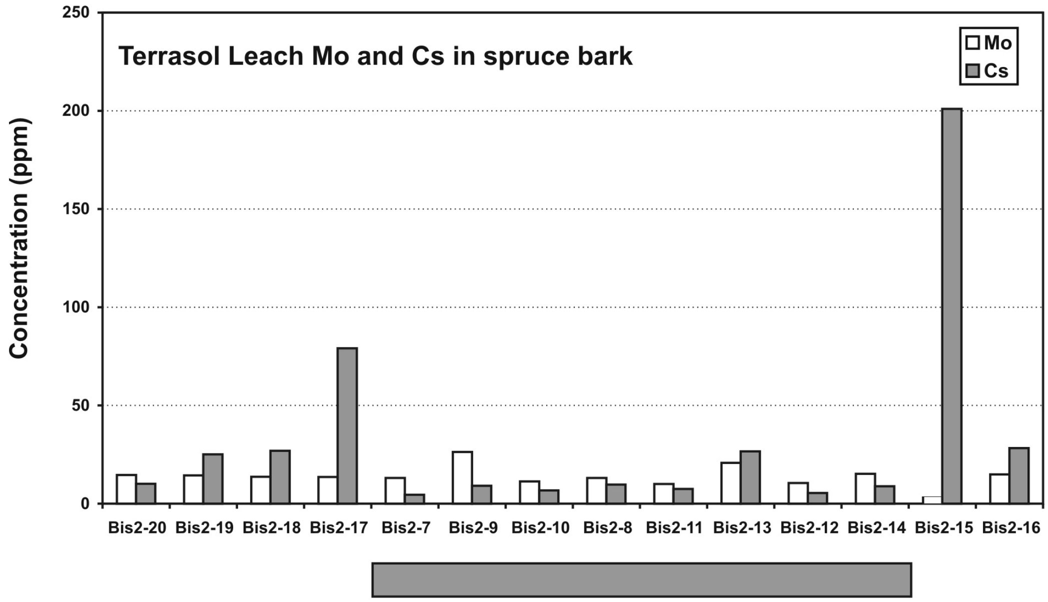

Figure GS-22-17: *Mo (ppm) and Cs (ppm) in spruce bark by Terrasol Leach^SM, Poundmaker Au deposit. Compare 'rabbit ear' anomaly for Cs with Enzyme Leach^SM (Figure GS-22-14) and INAA data for same samples. Shaded bar as in Figure GS-22-3.*

Table GS-22-5: Selected MMI-M® analytical data for soil samples, Poundmaker Au deposit. Analyses by SGS Canada–Toronto. All data in ppb. Complete analytical data available in Data Repository item 2004002.

Sample no.	Easting[1]	Northing[1]	Location	Start (cm)	End (cm)	Ag	As	Au	Ba	Cu	Zn	Co	Ni	La	Ce	Nd	Eu	Dy	Sb	Th	Y	Zr
					Detection limit:	1	10	0.1	1	10	20	0.5	3	0.1	0.5	0.1	0.1	0.1	1	0.5	0.5	1
Bis2-1B	307076	5662965	Vein centre	4	10	10	468	25.2	24	1032	232	83.7	2039	7.5	13.1	12	0.8	3.8	<1	1.4	25.8	25
Bis2-1B (dup)	307076	5662965	Vein centre	4	10	13	537	27.9	24	993	209	90.4	1949	8.5	14.2	13.3	0.8	4.2	1	1.2	27.8	28
Bis2-4A	307054	5663226	Background	0	10	2	44	<0.1	706	87	118	287	309	104	333	132	3.9	19.5	<1	23.1	88.1	23
Bis2-3B	307027	5663205	West of vein	17	25	4	-10	-0.1	351	83	22	35.3	283	93.2	253	133	3	13.7	<1	5.5	66.3	<1
Bis2-1C	307076	5662965	Vein centre	10	20	20	1136	75	31	1221	91	126	1630	6.5	10.8	9.9	0.7	3.4	4	1.6	20.4	40
Bis2-2B	307044	5663214	East of vein	10	20	14	27	-0.1	1076	130	87	68.6	261	187	550	165	2.8	10.1	<1	49.9	40.9	41
Bis2-4B	307054	5663226	Background	10	20	3	24	-0.1	699	97	314	98.8	244	300	831	292	5.9	23.1	<1	27.1	102	21
Bis2-3C	307027	5663205	West of vein	25	35	4	-10	-0.1	303	154	<20	10.5	358	217	546	224	4	16.1	<1	9.7	68.6	<1
Bis2-3D	307027	5663205	West of vein	35	45	3	-10	-0.1	483	142	22	17.1	243	1057	2071	738	9.7	27.7	<1	32.3	124	8
Bis2-2C	307044	5663214	West of vein	20	30	20	16	-0.1	1490	118	41	48.2	194	226	671	213	3.4	15.2	<1	45.7	58	33

[1] NAD 27 datum

depth of 10–20 cm at site BIS2-1. In sample BIS2-2B, anomalous Ag is also detected at the margin (up slope) of the vein and appears to provide an enlarged 'vein target'. Both Eu and Dy are lower in the sample over the vein relative to the background samples (Figure GS-22-20). All of the samples have negative Eu anomalies. In sample BIS2-1C, the negative Eu anomaly is slightly less than that observed in the other samples. It is uncertain from these data whether or not the MMI-M® REE data can contribute to the discrimination of auriferous zones.

Enzyme Leach^SM analyses

The same suite of soil samples used for the MMI-M® analyses was analyzed using the Enzyme Leach^SM enhanced method; this method can be used on organic-bearing samples and can therefore provide a complete profile through the sample medium (cf. Gale, GS-8, this volume). In addition, data for samples BIS1-1 to -4, collected adjacent to a different mineral prospect, are included in Table GS-22-6; none of these samples cross a mineralized zone and the data are presented here for comparison with Enzyme Leach^SM background values in similar soil and forest.

Soil sample site BIS2-1 is located in trench rubble directly over the Poundmaker quartz vein. Anomalous Au is

Table GS-22-6: Selected Enzyme Leach[SM] analytical data for soil samples, Poundmaker Au deposit and site BIS1. All data in ppb. Complete analytical data available in Data Repository item 2004002.

Sample no.	Material	Start (cm)	End (cm)	As	Mo	Sb	Au	S.Q. Hg	Th	Co	Ni	Cu	Zn	Pb	Sn	Tl	Bi	S.Q. Ti	Y	Zr	Nb	La	Ce	Eu	Dy	Mn	Rb	Sr	Ba
Bis2-1A	blk	0	4	329	26	2	0.810	2.6	5	103	179	65	1650	24	1.6	0.5	12	544	7	21	0.5	5.7	10.4	0.5	1.1	11400	359	1120	793
Bis2-1B	grey	4	10	714	6	2	0.269	1.7	1	138	332	163	27	5	1.6	0.1	3	115	7	14	0.2	3.8	5.5	0.3	1.0	4640	46	1000	46
Bis2-1C	grey w rocks	10	20	1530	3	7	0.695	1.8	1	187	480	233	-5	3	0.7	0.3	3	141	8	25	0.2	5.0	7.6	0.4	1.4	4220	38	722	43
Bis2-1C dup	grey w rocks	10	20	1520	3	6	0.715	1.6	1	152	433	242	-5	3	0.5	0.3	1	154	8	21	0.2	4.8	7.4	0.3	1.3	3430	37	653	37
Bis2-3A	blk	0	17	19	29	1	0.239	0.5	1	76	90	7	17	5	1.2	1.2	2	598	3	1	1.4	9.2	19.5	0.4	0.6	12200	186	2620	601
Bis2-3B	drk bwn	17	25	7	2	1	0.032	0.3	5	14	61	14	-5	1	0.4	0.6	1	789	6	6	3.3	15.6	33.7	0.5	1.2	579	122	811	312
Bis2-3C	drk bwn	25	35	8	1	1		0.4	13	8	67	24	-5	1	0.2	0.7	1	453	8	14	1.9	32.5	66.2	0.9	1.8	187	92	902	363
Bis2-3C rep	drk bwn	25	35	9	3	1		0.3	14	10	71	27	5	1	0.3	0.9	1	447	9	14	1.9	34.0	69.0	0.9	1.9	220	105	1000	423
Bis2-3D	bwn	35	45	9	1	0		0.3	13	10	67	29	36	6	0.3	0.4	1	345	6	15	1.6	31.4	61.7	0.8	1.4	154	30	924	383
Bis2-2A-1	blk	0	10	29	32	2	0.062	0.4	3	66	86	7	14	10	1.8	0.7	3	1560	1	6	3.5	2.5	4.7	0.5	0.3	20800	327	1630	2050
Bis2-2A-2	bwn	0	10	14	8	1	0.014	0.4	2	44	73	4	7	3	1.3	0.4	2	1580	1	4	3.3	2.2	4.7	0.3	0.2	6500	336	804	1130
Bis2-2B	bwn	10	20	9	3	2	0.042	0.3	6	45	115	15	25	4	0.4	0.5	2	2180	3	10	5.4	10.5	23.7	0.6	0.6	856	486	674	2000
Bis2-2C	bwn	20	30	3	2	1		0.3	4	25	76	9	-5	2		0.5	1	684	3	7	2.4	10.1	22.1	0.7	0.6	545	446	870	2830
Bis2-4A-1	blk	0	10	27	8	2	0.020	0.3	4	90	106	16	132	26	0.8	2.4	1	1480	2	7	3.5	5.0	10.8	0.4	0.6	1210	164	482	1330
Bis2-4A-2	bwn	0	10	19	5	1		0.3	4	73	99	20	95	8	0.4	2.2	1	1270	3	6	3.1	6.7	14.1	0.4	0.6	694	145	439	1370
Bis2-4B	bwn	10	20	11	3	1		0.2	5	34	106	17	51	7	0.5	1.1	1	1330	4	6	3.6	13.5	28.8	0.6	0.9	366	215	555	1270
BIS1-1H	roots,blk soil	0	3	96	41	8			26	22	49	19	254	10	3.19	0.3		1730	12	76	6.16	7.8	17.5	0.7	1.5	21800	100	1250	1380
BIS1-1I	blk	3	5	104	13	3			17	22	30	21		4	0.329	0.1		1320	5	46	6.27	5.6	15.6	0.3	0.7	876	48	618	374
BIS1-1G	Ae	5	10	42	10	2			32	26	31	28		4	0.264	0.1		1040	13	79	5.35	13.2	41.9	0.7	1.9	669	37	386	405
BIS1-1A	wetbwn clay	10	15	40	10	2			46	20	38	32		3		0.0		833	24	126	4.73	22.4	64.8	1.2	3.6	809	19	336	391
BIS1-1B	gry white clay dry	15	23	45	30	4			33	12	103	99		1		0.0		234	81	90	1.46	72.8	45.6	3.1	10.4	2230	4	558	316
BIS1-1C	gry white clay dry	25	31	60	14	3			11	8	29	98		1		0.0		173	22	41	1.22	18.3	14.8	0.8	3.0	1190	3	556	231
BIS1-1D	gry white clay dry	31	37	104	8	5			5	7	25	92		0		0.0		173	7	21	0.768	8.0	9.2	0.3	1.0	957	3	583	210
BIS1-1E	gry white clay dry	37	45	114	10	5			4	6	23	80		1		0.1		171	7	15	0.847	7.2	11.9	0.3	0.9	739	4	650	201
BIS1-1J	gry white clay dry	37	45	3	3	0			3	21	8	16		0		0.0		326	4	9	2.12	8.6	22.1	0.4	0.7	419	15	187	1250
BIS1-1F	trace bwn	45	50	84	8	9			5	5	18	52		0		0.0		173	6	10	0.856	6.7	12.8	0.3	0.9	557	4	691	211
BIS1-2G	litter,blk soil	0	5	48	31	6			10	36	46	20	504	6	1.28	0.2		1190	5	37	3.43	5.6	13.2	0.5	0.8	30700	60	1020	1560
BIS1-2F	clay	5	10	16	13	1			27	122	52	34	5	4		0.1		789	8	72	3.24	9.8	41.0	0.5	1.2	4900	100	376	481
BIS1-2A	clay	10	20	22	12	2			54	29	52	44		4		0.1		840	17	142	2.96	21.6	61.9	0.8	2.3	448	102	397	343
BIS1-2B	clay	20	30	31	19	2			92	15	67	50		3	0.528	0.2		777	56	313	3.88	45.3	126.0	2.7	9.0	240	59	389	285
BIS1-2C	clay	30	40	65	16	6			76	25	96	86		3	0.352	0.1		988	105	336	5.46	64.9	149.0	6.6	20.5	2100	20	414	327
BIS1-2D	clay	40	50	93	20	10			30	46	292	98		1	0.209	0.1		364	204	150	2.47	115.0	138.0	8.7	29.1	4520	6	458	309
BIS1-2E	bwn layer on rock	50	55	110	14	5			54	56	300	83		1	0.99	0.0		465	162	154	3.72	89.1	100.0	5.5	18.7	4000	8	409	396

Table GS-22-6: Selected Enzyme Leach[SM] analytical data for soil samples, Poundmaker Au deposit and site BIS1. All data in ppb. Complete analytical data available in Data Repository item 2004002. *(continued)*

Sample no.	Material	Start (cm)	End (cm)	As	Mo	Sb	Au	S.Q. Hg	Th	Co	Ni	Cu	Zn	Pb	Sn	Tl	Bi	S.Q. Ti	Y	Zr	Nb	La	Ce	Eu	Dy	Mn	Rb	Sr	Ba
BIS1-3H	bwn clay roots	2	10	17	23	3			39	9	72	62		2	0.368	0.0		274	55	145	1.13	53.8	117.0	2.4	7.8	334	7	348	257
BIS1-3G	bwn clay crumbly	10	20	23	19	4			28	13	85	74		2		0.0		296	71	156	1.32	64.5	119.0	3.1	9.4	296	5	274	197
BIS1-3A	bwn clay	20	30	20	9	3			7	3	36	28		1		0.0		183	24	31	0.765	21.4	29.6	1.1	3.3	103	2	195	169
BIS1-3B	pale dark grey	30	40	20	5	2			4	1	19	15		1		0.0		211	13	16	0.854	10.0	15.0	0.7	1.8	37	2	169	179
BIS1-3C	dark grey blk	40	50	26	10	2			6	2	16	15		1		0.0		227	13	18	1.02	9.0	11.3	0.6	1.8	72	2	171	164
BIS1-3D	bwn beige clay	50	60	29	4	2			10	5	10	9		1		0.0		243	15	23	1.32	10.2	14.3	0.9	2.5	153	2	153	163
BIS1-3E	bwn beige clay	60	67	55	21	3			7	8	28	16		1		0.0		278	17	19	1.51	12.5	15.8	0.9	2.6	514	4	181	163
BIS1-3F	bwn oxide clay	67	70	48	32	2			3	8	32	27		1		0.0		200	11	9	0.904	8.5	10.4	0.5	1.4	775	3	207	134
Average for	BIS1-1 10-30			48	18	3	0	0	30	13	57	76	0	2	0	0.0	0	413	42	86	2.47	37.8	41.7	1.7	5.7	1410	9	483	313
Average for	BIS1-2 10-30			27	15	2	0	0	73	22	59	47	0	4	0.264	0.2	0	809	37	228	3.42	33.5	94.0	1.7	5.7	344	81	393	314
Average for	BIS1-3 10-30			22	14	3	0	0	17	8	61	51	0	1	0	0.0	0	240	47	93	1.0425	43.0	74.3	2.1	6.3	200	3	235	183
Data used in figures:																													
Bis2-3EB	drk bwn	17	25	7	2	1	0.032	0.3	5	14	61	14	-5	1	0.4	0.6	1	789	6	6	3.3	15.6	33.7	0.5	1.2	579	122	811	312
Bis2-1EC	grey w rocks	10	20	1530	3	7	0.695	1.8	1	187	480	233	-5	3	0.7	0.3	3	141	8	25	0.2	5.0	7.6	0.4	1.4	4220	38	722	43
Bis2-2EB	bwn	10	20	9	3	2	0.042	0.3	6	45	115	15	25	4	0.4	0.5	2	2180	3	10	5.4	10.5	23.7	0.6	0.6	856	486	674	2000
Bis2-4EB	bwn	10	20	11	3	1		0.2	5	34	106	17	51	7	0.5	1.1	1	1330	4	6	3.6	13.5	28.8	0.6	0.9	366	215	555	1270
BIS1-1 10-30		10	30	63	19	6	0	0	66	29	152	78	0	3	0.363	0.1	0	710	122	266	3.93666	75.1	137.7	6.0	19.5	2287	28	420	307
BIS1-2 10-30		10	30	42	13	2	0	0	9	6	19	13	0	1	0	0.0	0	261	16	21	1.415	11.4	15.1	0.9	2.5	334	3	167	163
BIS1-3 10-30		10	30	13	8	1	0	0	37	11	30	24	0	2	0	0	0	404	18	114	2	17	47	1	3	172	40	197	157

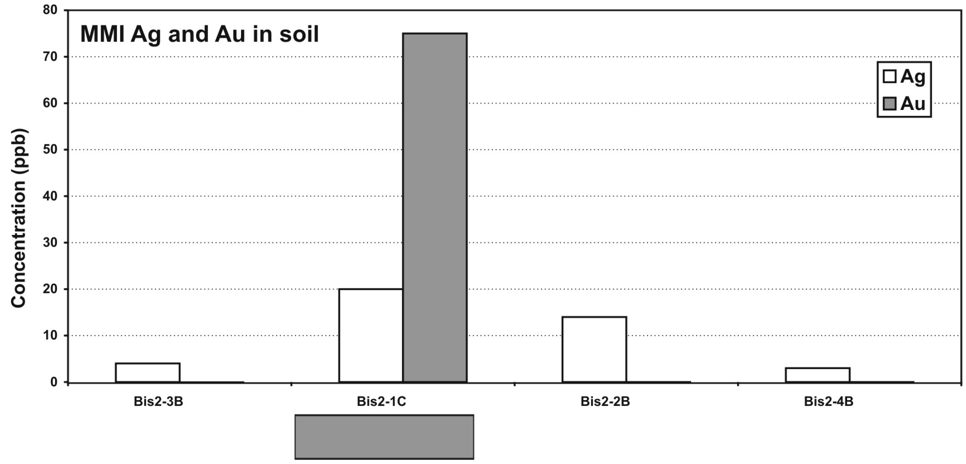

Figure GS-22-18: *Ag (ppb) and Au (ppb) in soil by MMI-M® leach, Poundmaker Au deposit. Samples arranged along a southwest-northeast profile normal to the quartz vein. Shaded bar represents position of quartz vein.*

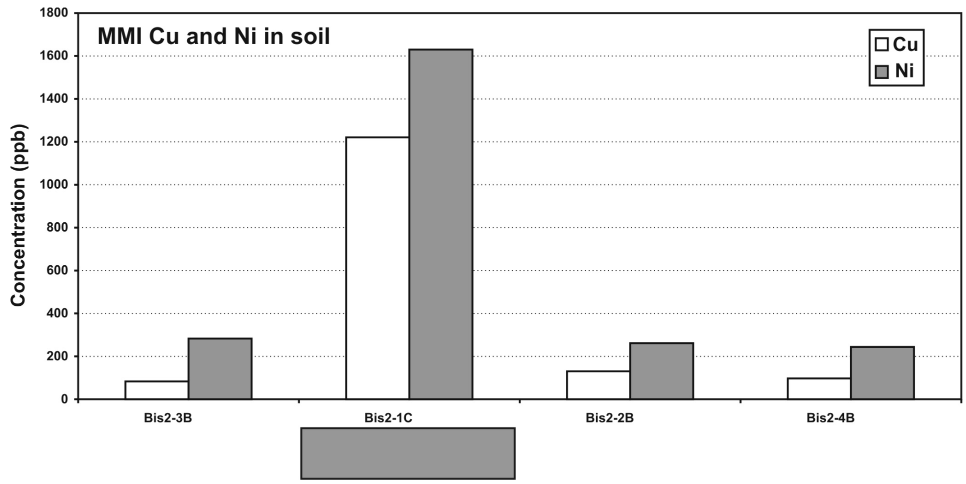

Figure GS-22-19: *Cu (ppb) and Ni (ppb) in soil by MMI-M ® leach, Poundmaker Au deposit. Shaded bar represents position of quartz vein.*

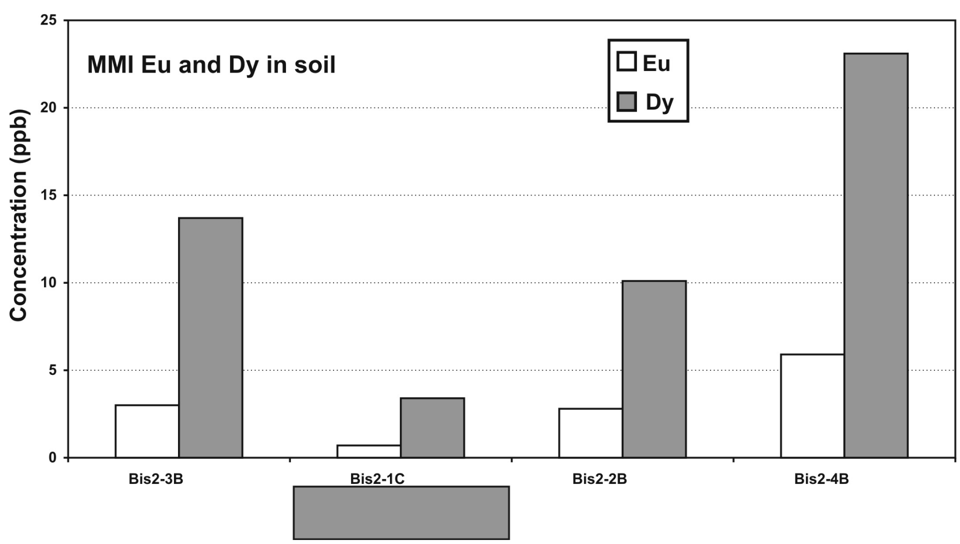

Figure GS-22-20: *Eu (ppb) and Dy (ppb) in soil by MMI-M® leach, Poundmaker Au deposit. Shaded bar represents position of quartz vein.*

present in all samples collected at this site. Samples at locations BIS2-3, collected over the vein, and BIS2-2, collected adjacent to the east margin of the vein, have higher Au values in the uppermost, organic portions of the soil profile than in the inorganic sand. Gold is detectable in the sandy portion of the upper 10 cm at site BIS2-2, but the value is lower than in the upper 5 cm of organic-rich soil at this site. In addition, Au is detectable in the organic fraction of background sample BIS2-4A (0–10 cm depth), but is below detection in the sandy portion of the same sample. Gold is below detection at a depth of 10–20 cm at site BIS2-4 and at a depth of 25–45 cm at site BIS2-3 (Figure GS-22-21). These data suggest that, for this type of deposit, Au determinations on the upper organic portions of the soil profile may extend anomalies beyond vein boundaries and provide larger exploration targets than samples of inorganic material.

The elements Cl, Mo, Mn, Zn and Pd are also concentrated in the organic upper portions of the samples. With the exception of sample BIS2-1A, the Zn and Pb values for the background sample site (BIS2-4) are considerable higher than values obtained adjacent to the vein. These two elements may provide haloes to the mineralization, but more extensive sampling is required to establish the range of background values.

In the 10–20 cm or >25 cm soil depth intervals, As, Co, Ni, Cu, Sb and Hg form apical anomalies over the vein (Figures GS-22-22 to -24). Cesium does not define a halo at the margins of the quartz vein. Near zero and strongly positive Eu^d anomalies are present in the organic-rich samples from each of the four sites. Values of Eu^d are near zero at all depths at site BIS2-1 and strongly negative below 17 cm at site BIS2-3, even though the REE elements, including Eu and Dy, are somewhat higher in BIS2-3C than in the other samples. Samples BIS2-2B and -2C have positive Eu^d values, suggesting that Eu forms an oxidation halo to the vein; this halo may not be real because the background sample

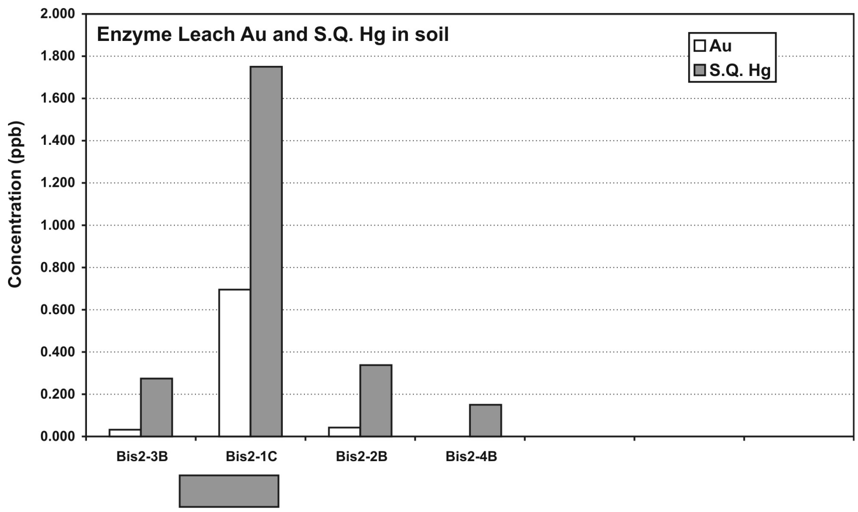

***Figure GS-22-21:** Au (ppb) and semiquantitative (S.Q.) Hg (ppb) in soil samples BIS2-1 to -4 by Enzyme Leach*^{SM}*, Poundmaker Au deposit. Shaded bar represents position of Poundmaker quartz vein. Samples BIS1-1 to -3 are background samples from another prospect.*

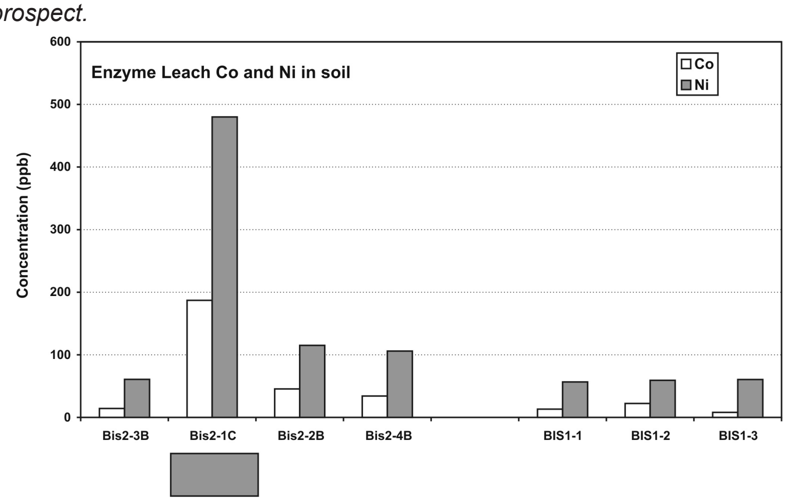

***Figure GS-22-22:** Co (ppb) and Ni (ppb) in soil by Enzyme Leach*^{SM}*, Poundmaker Au deposit. Shaded bar represents position of Poundmaker quartz vein. Samples BIS1-1 to -3 are background samples from another prospect.*

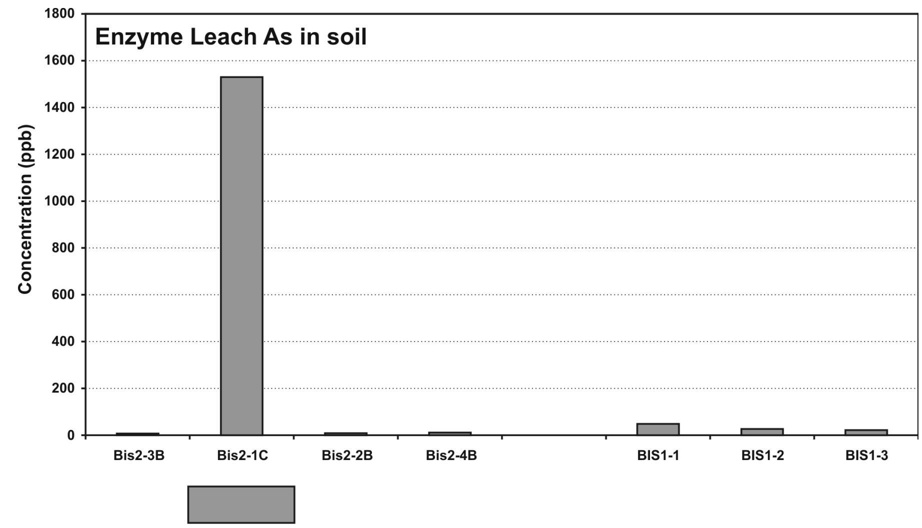

Figure GS-22-23: *As (ppb) in soil by Enzyme Leach[SM], Poundmaker Au deposit. Shaded bar represents position of Poundmaker quartz vein. Samples BIS1-1 to -3 are background samples from another prospect.*

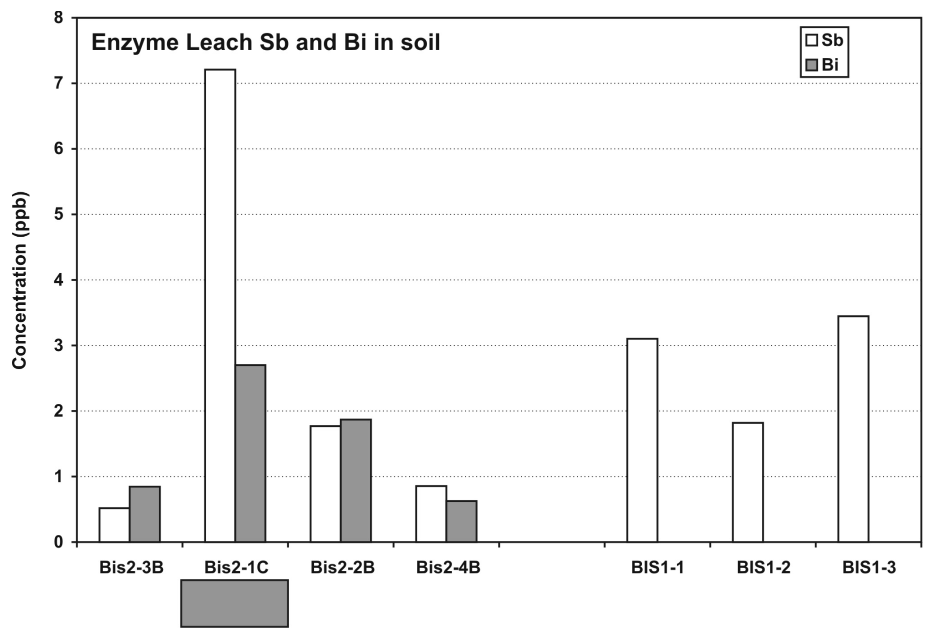

Figure GS-22-24: *Sb (ppb) and Bi (ppb) in soil by Enzyme Leach[SM], Poundmaker Au deposit. Shaded bar represents position of Poundmaker quartz vein. Samples BIS1-1 to -3 are background samples from another prospect.*

(BIS2-4B) has a value that is near zero. Further tests on similar lode Au deposits are needed to confirm if positive Eu^d haloes exist around this type of deposit.

Conclusions and economic considerations

This study illustrates the application of metal and REE studies of spruce bark in the exploration for vein Au deposits in the Bissett area. The data show that, although the ash from spruce tree bark contains up to 10 g/t Au, the amount of Au in adjacent trees is quite variable. Analytical data from the nondestructive INAA method may be a more reliable method for Au exploration because, when the ash weight is compared with the bark weight, considerable Au appears to have been lost during the ashing process.

Enzyme Leach[SM] analysis of the spruce bark provides positive Eu^d anomalies on REE data plots, but these are erratic and do not identify the mineralized zone. Neither the Enzyme Leach[SM] nor the Terrasol Leach[SM] partial-leach method assists in the determination of Eu fractionation anomalies in spruce bark; it is important to note that these methods are not specifically designed for application to vegetation. The INAA method is also not sensitive enough to provide the heavy REE data (Dy to Er) required to determine weak positive Eu^d anomalies. It is still uncertain, based on these data, whether the absence of positive Eu anomalies in the spruce bark is a function of an unsuitable analytical method or because fractionation of this element in rocks and soils is not mirrored in spruce bark.

Analysis of soil samples with both the Enzyme Leach℠ and MMI-M® partial-leach methods readily identifies this type of lode Au mineralization.

Acknowledgments

Eric Hoffman at Actlabs kindly provided high-quality REE data to test the INAA method in determining Eu fractionation in the spruce bark samples.

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