ENZYME LEACH-BASED SOIL GEOCHEMISTRY OF THE MOUNTAIN LAKE DIATREME, ALBERTA

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SUMMARY

Thirty-one soil samples were collected from one east-west transect line orientated roughly perpendicular to the larger of two north- south-trending positive magnetic anomalies interpreted to be possible kimberlites. The samples were treated using the enzyme leach process and the leachate was analyzed by inductively coupled plasma-mass spectrometry (ICP-MS).

A multi-element geochemical response, with contrasts of up to 29 times background, was obtained in soil above the Mountain Lake Diatreme. Elements that are elevated ≥4 times background include: As, Ce, Co, Cr, Cs, Cu, Ga, Hf, La, Mn, Mo, Nb, Ni, P, Pb, Pd, Pr, Rb, Sb, Sn, Th, Ti, U, V, W, Y, Yb, Zn and Zr. While the overall geochemical signature is indicative of an ultramafic source, apical and oxidation halo geochemical responses yield elevated concentrations of Co, CrO_3, Cu and Ni with the presence of high Ba, Ga, Hf, PO_4, Rb, Ta, Ti and light rare earth elements suggestive of a kimberlite or lamproite body.

Since the Mountain Lake Diatreme is near surface and forms a topographic high, the morphology of the enzyme leach-based geochemical signature is expected to yield an oxidation halo profile only. However, the geochemical signature over the Mountain Lake Diatreme combines a moderately strong to strong oxidation halo profile with a sharply-defined apical geochemical profile. The high contrasting apical signature is formed from a "single" reproducible sample (RE-ML97-015). Although apical responses generally indicate an anomalous source at depth, it is likely that the apical signature generated in this study is a direct indication the top of the diatreme is close to surface. Since altered ultrabasic volcanic rocks were observed at a depth of 1.8 m and represent the parent material to the soil, the geochemical abnormality at RE-ML97-015 may express the soil development profile that forms on top of kimberlitic and lamproitic bodies. The resultant apical anomaly profile from sample RE-ML97-015, in combination with an oxidation halo profile, is potentially something explorationists in Alberta should be aware of since diatremes discovered to date have been defined as predominantly topographic highs.

The results from analysis of the geochemical data indicate that the enzyme leach technique can be used as an exploration tool for kimberlite pipes, and that exploration companies may expand the method from base- and precious-metal exploration to include kimberlite, lamproite and related rocks. Furthermore, enzyme leach-based soil geochemical surveys may have a significant impact on exploration for kimberlite, lamproite and related rocks in Alberta by providing industry with a useful and cost effective tool to probe blind and/or buried anomalies identified by airborne and ground magnetic surveys in areas of complex glacially-derived overburden.

INTRODUCTION

In 1995, Monopros Ltd. publicly announced the discovery of an ultramafic diatreme (possible kimberlite) near Mountain Lake, Alberta (Wood and Williams, 1994). The significance of the find is that it exemplifies the potential for a completely new resource in Alberta - diamonds, and triggered a staking rush that currently has 81% of the stakeable ground in Alberta permitted for minerals exploration.

With the possible exception of uranium and Clear Hills iron deposit exploration in the late 1960's and 1970's, minerals exploration in Alberta has not received due attention. This has changed in response to the discovery of diamonds in the North West Territories, Saskatchewan and Alberta, and recent base- and precious-metals exploration in the northeast part of Alberta. Exploration companies have commented on the need for regional geological survey-type drift and overburden studies where thick glacial and fluvially reworked sediments have hampered exploration in Alberta. Tightly-spaced airborne geophysical surveys have revealed numerous possible kimberlite-type anomalies in the clastic sedimentary basin of Alberta but unfortunately, few exploration programs can afford drilling as a primary investigatory tool through thick drift.

The objective of this study is to evaluate the potential of geochemical surveys to detect kimberlite, lamproite and related rocks using an analytical technique based on enzyme leaching of the B soil horizon. Enzyme leach-based soil geochemical surveys have been used to detect buried oil and base- or precious-metal deposits where commodity elements have been effectively trapped, or complexed, on amorphous manganese oxides in the soil profile above the deposit. The Mountain Lake Diatreme, albeit a topographic high, was selected to test the enzyme leach technique and at the same time, report on the soil geochemical signatures over a known ultramafic volcanic pipe in Alberta.

GEOGRAPHICAL AND GEOLOGICAL SETTING

The Mountain Lake Diatreme is located directly north of Mountain Lake in northwestern Alberta, approximately 75 km northeast of Grande Prairie. The volcanic/volcanogenic rocks form a positive-relief, ovoid feature approximately 0.5 km wide by 1.5 km long and 30 m high, and occur within the early late Campanian to Early Paleocene Wapiti Formation sediments of the Western Canada Sedimentary Basin (Figure 1). The Wapiti Formation consists of light grey, fine- to medium-grained, argillaceous, carbonaceous sandstone with interbedded siltstone, silty shale, thin layers of bentonite and coal, and is locally conglomeritic (Dawson *et al.*, 1989). In a creek bank exposure, located north and northwest of Mountain Lake, the Wapiti Formation is dominantly friable and loosely cemented sandstone with minor lenses of coal. The depth to the First White Specks Formation, which is stratigraphically below the Wapiti, was measured at 250 m in a nearby hydrocarbon exploration well (6-7-74-26W5), however, in the vicinity of Mountain Lake the thickness of the Wapiti Formation is about 150 to 200 m (Leckie *et al.*, 1996).

GENERAL GEOLOGY OF THE MOUNTAIN LAKE VOLCANICS

The Mountain Lake Diatreme was located by stream sediment heavy mineral concentrate surveys completed by Monopros Ltd. Subsequent ground geophysics delineated two separate positive magnetic anomalies (Wood and Williams, 1994) and aeromagnetic interpretation indicated that the diatreme is an isolated feature in the local area (Peirce, 1996). In 1995, Monopros Ltd. permitted the Alberta Geological Survey and Geological Survey of Canada to study the ultramafic diatreme. In a collaborative effort, two drill holes totalling 340 m were cored and sampled, and a number of studies

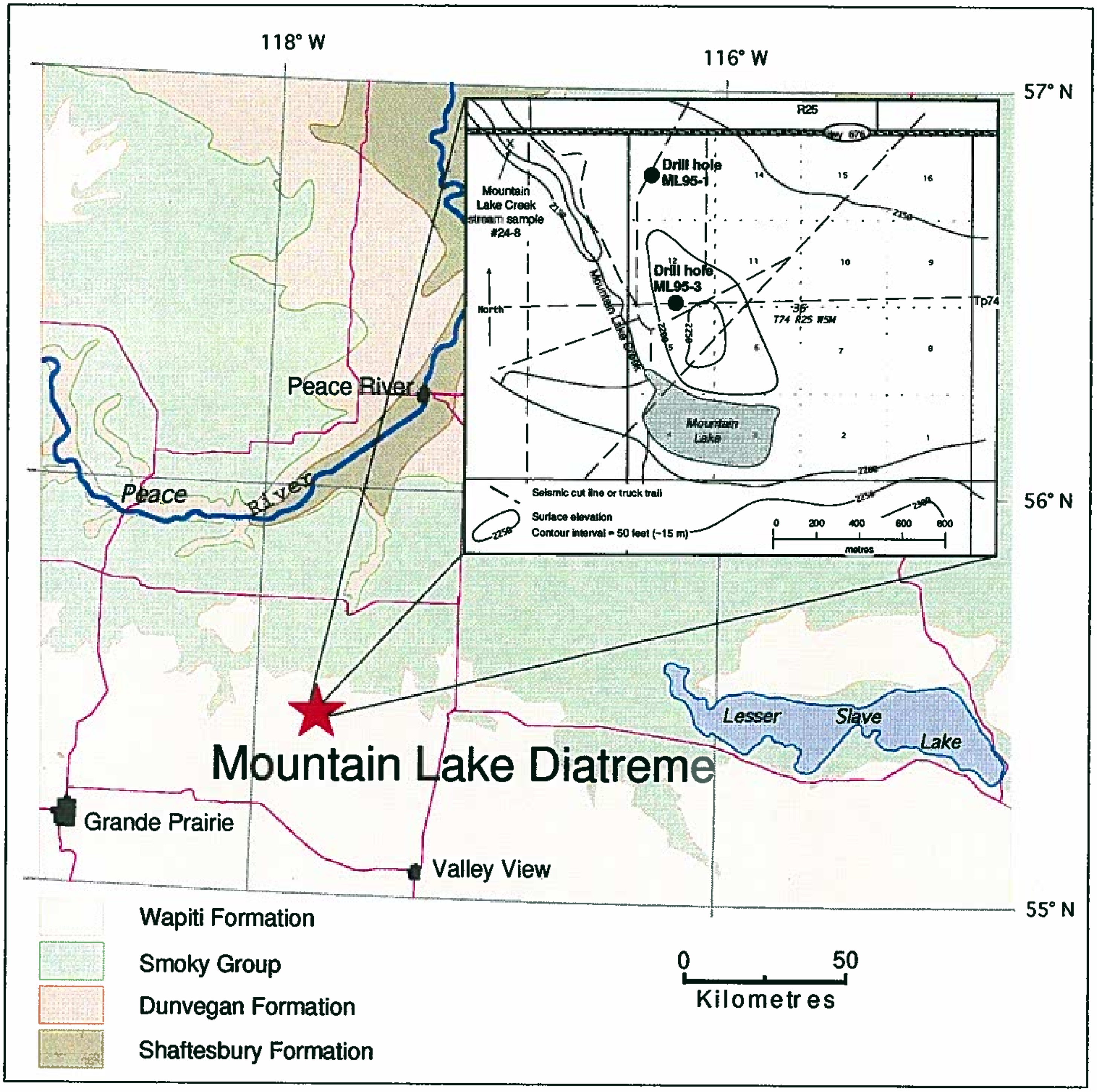

Figure 1. Regional geology of the Mountain Lake area and detailed sketch with topography and 1995 drill hole locations.

including chemistry, petrology, indicator minerals, aeromagnetic signature, age, stratigraphic position and setting were conducted (Leckie *et al.*, 1996). Kjarsgaard (1996) classified the Mountain Lake body as alkaline ultrabasic volcanics. Petrographic examination of pyroclastic material from drill core ML95-3 (Figure 1) consists mainly of olivine-rich juvenile lapilli tuffs with euhedral to anhedral olivine completely altered to clay minerals and serpentine. The lapilli consist of devitrified vesicular glass (serpentine) and microcrystalline phlogopite-biotite mica, clinopyroxene, spinel, rutile, perovskite and apatite. The drill core is available for viewing at the Alberta Geological Survey's Mineral Core Research Facility. There is no visible outcrop of the volcanic rock. However, persistent burrowing or augering near drill hole ML95-3 may reveal altered volcanic material.

OVERBURDEN AND VEGETATION

In the vicinity of Mountain Lake, the study area is partially covered with ground moraine composed mainly of discontinuous till. Rotary drilling has shown there is approximately 1.5 m of till on the top of the volcanic-derived hill, 1.5 m of clay on the northern flank, and thin or no till on the west and southwest flanks (Fenton *et al.*, 1996; Pawlowicz *et al.*, 1995). The low areas between the hummocks contain bog and fen deposits.

In addition to topographic expression, the most visible characteristic is the change in vegetation over the volcanics. The tree cover on top of the diatreme and on the main slopes of the elevated volcanics, is dominated (100%) by balsam poplar (*Populus balsamifera*) and an assortment of coarse grasses (*Salix sp.*). The woodland vegetation changes abruptly on the relatively low lying area at the base of the diatreme and comprises only 50 to 70% balsam poplar, which is in competition with 50 to 30% white spruce (*Picea glauca*) and a dense undergrowth of native shrubs.

SOIL PROFILE, SAMPLE COLLECTION AND PREPARATION

The Mountain Lake area is covered by luvisolic, gleysolic, brunisolic and organic soils that were developed on coarse outwash and shoreline material, and on alluvial and aeolian deposited material (Odynsky *et al.*, 1956). The sample sites along the east-west transect are characterized by weakly defined soil profiles. At the local scale, the parent material is likely till based on the presence of rounded, siliceous pebbles observed in layers and dispersed within the matrix throughout the soil profile. Organic-rich A horizons are very dark brown to black and 5 to 13 cm thick, except in the low lying areas directly east of Mountain Creek, where they are up to 25 cm thick. The A horizons are underlain by silty clay loam to silty loam soils, which are interpreted to be the B horizon. These soils occur on top of the diatreme, on the slopes of the diatreme and to the west of Mountain Creek on relatively low-lying topography. The B horizon soils are characterized by their grey- to yellow-brown colour, amorphous to weakly fine-granular structure and common iron stains. The B horizon colour is distinctly browner in the low lying areas directly east of Mountain Creek. The B-C horizon contact was not observed, except at sample site RE-ML97-015, where altered ultrabasic rocks were contacted at a depth of approximately 1.8 m with a Dutch soil auger. Brown to yellowish-brown loamy sand to sand and gravel were observed at the extreme eastern end of the sampling transect in samples RE-ML97-030 and RE-ML97-031.

Field work was conducted in September, 1997 and 31 soil samples were collected. The samples were collected every 50 m on a single east-west transect oriented roughly perpendicular to the larger of two positive magnetic anomalies interpreted to be possible kimberlites (Figure 2). Sample site RE-ML97-015 is centred on the top of the elevated diatreme, and is very close to the location of drill hole ML95-3 (Figure 1). Sampling attempted to focus on an individual soil horizon so that meaningful comparisons can be made and significant anomalies recognized. Channel samples were collected approximately 10 to 20 cm below the apparent A-B horizon contact, and over an interval of approximately 60 cm. Samples consisted of approximately 2 kg of B horizon material collected in large sized ZipLoc freezer bags. Upon completion of sampling, opening the ZipLoc bags during transport helped keep the sample temperatures below 25°C to avoid possible loss of volatile halogen and halide compounds. Duplicate samples were collected from three sites on the sampling transect.

The samples were air dried at room temperatures on plastic, disposable plates, and split into two equal portions. One split was crushed to -60 mesh and was forwarded to Activation Laboratories Ltd. for multi-element ICP-MS analysis subsequent to enzyme leach. The original split was retained for future analytical work.

ENZYME LEACH AND ANALYSIS

Trace elements liberated from slowly oxidizing mineral deposits in bedrock or glacial sediments will migrate up through overburden by various means, such as: upward flowing ground water; capillary action in the vadose zone; gaseous components emanating upwards from a deposit; ionic diffusion of compounds; and by electrochemical gradients resulting from the oxidation of reduced mineral phases in the deposit. Upon reaching the near surface environment, many of the trace elements migrating through the overburden will be adsorbed on manganese oxide and iron oxide coatings, which form on mineral grains in soils and particularly in the B horizon soils (Clark, 1993). The amorphous phase of manganese oxide is an effective trap for a variety of cations, anions and polar molecules because of its relatively large surface area and the random distribution of both positive and negative charges on its surface. The enzyme leach method is selective to metals bound to the amorphous manganese dioxide where a phase-selective leach employs an enzyme reaction to preferentially attack amorphous manganese oxide coatings (Clark, 1993; Hoffman, 1996). Very low concentrations of hydrogen peroxide produced by the enzyme reaction in aqueous media will react with manganese dioxide, consuming hydrogen ions, and resulting in the manganese being reduced to the divalent state, which is soluble.

$$MnO_{2(s)} + H_2O + 2H^+ \text{ ----> } Mn^{2+} + O_{2(aq)} + H_2O$$

In this process, dilute hydrogen peroxide readily reduces and dissolves amorphous manganese dioxide, releasing all the trace elements trapped in the amorphous manganese oxide coatings (Explore Newsletter, 1992). The hydrogen peroxide also reduces the normal solubility of Fe in the sample, making the leaching process even more selective. When all amorphous manganese dioxide in the

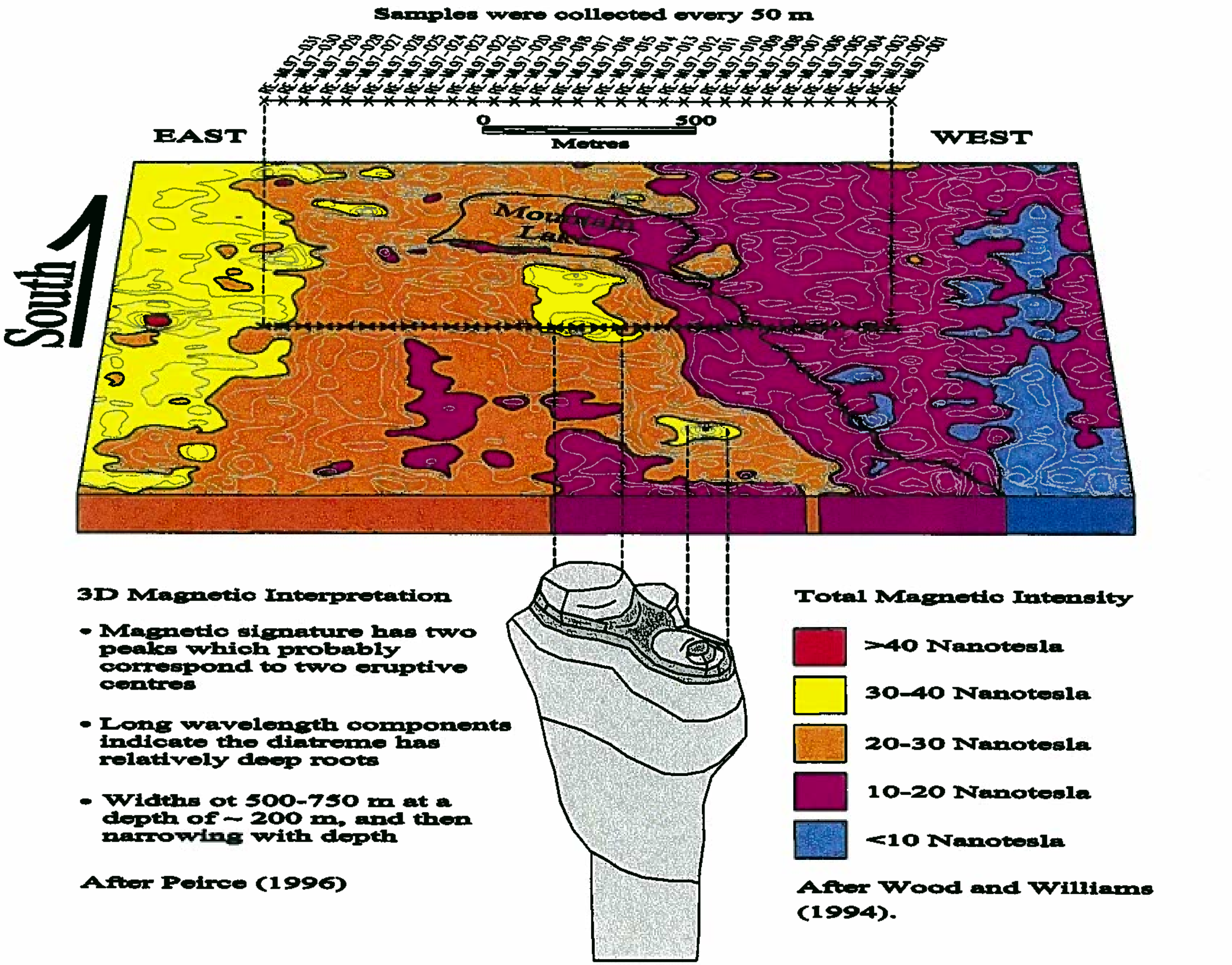

Figure 2. Soil sample locations over the Mountain Lake Diatreme. The sampling transect is plotted on a rotated ground magnetic survey (view from the north), with a 3D magnetic interpretation of the pipe.

sample has reacted, the enzyme reaction slows, and the leaching action ceases. Since the enzyme leach is self-limiting, there is minimal leaching of mineral substrates in the sample. This selective leach results in extremely low background concentrations and dramatically enhances anomaly/background contrast.

Trace elements that are trapped or complexed on the amorphous manganese oxides are considered to represent the chemical signatures of buried, oxidizing mineralization at depth, rather than signatures originating from a transported overburden source, such as till. However, it should be noted that the geochemical signature within the B horizon may be strongly affected by the weathering of till and the subsequent downward movement of metals. This has the potential to produce a "transported" till geochemical signature in combination with site specific geochemical signatures. Ground water will also have a significant effect on the vertical migration paths of elements, particularly highly soluble gases, which may be deflected away from the local recharge areas producing laterally offset soil geochemical anomalies. Although it is not known what effect ground water will have on "immobile" elements such as Co, Cr and Ni in the secondary environment, soil geochemical exploration will be improved if subsurface water flow is taken into account.

Multi-element analysis subsequent to enzyme leach was conducted on a Perkin-Elmer Elan 6000 inductively couple mass spectrometer (ICP-MS), and reports on 62 elements including halides, gold, toxic suite, base metals, oxidation suite and the rare earth element (REE) suite. The elements Cr and P, which are considered important to diamond exploration surveys, are not currently part of the enzyme leach package. The phosphate and chromate analyses were completed on a trial basis by DIONEX, using ion chromatography on the enzyme leach solution (Hoffman, 1998 *Pers.Comm.*). Replication of the chromate and phosphate analyses was poor and Activation Laboratories Ltd. is currently working on resolving detection limit and analytical procedures. Although adsorbed trace element concentrations on the amorphous manganese dioxides are likely very low, the part per billion detection limits of the enzyme leach technique permits the planning of a cost-effective exploration strategy to test airborne and ground magnetic anomalies in areas of glacial overburden.

ANOMALY PROFILES AND GEOCHEMICAL RESULTS

Kimberlites and lamproites are rich both in elements of ultramafic affinity (Mg, Co, Ni, Cr, Cu) and in incompatible elements (light REE, Ba, Sr, Rb, P Nb), which gives these rocks a characteristic geochemical signature. Geochemical analysis from soil samples over known kimberlitic and lamproitic pipes have shown that anomalous values of ultramafic-association elements (Co, Cr, Mg and Ni) and incompatible elements (Nb) occur immediately above pipes. For example, soil geochemistry from the Yakutia kimberlite, Russia (Litinskiy, 1964), Sekonomata kimberlite, Mali (Alcard, 1959), Skerring kimberlite and Ellendale lamproite, West Australia (Haebig and Jackson, 1996) yield anomalous Co, Cr, Ni and Nb concentrations of between 2 to 7 times background.

The 31 soil samples collected over the Mountain Lake Diatreme present a unique opportunity to evaluate the enzyme leach method over a known kimberlite pipe in Alberta. A multi-element geochemical response with contrasts of up to 29 times background was obtained in the B horizon above the Mountain Lake Diatreme. Elements that are elevated ≥4 times background include: As, Ce, Co, Cr, Cs, Cu, Ga, Hf, La, Mn, Mo, Nb, Ni, P, Pb, Pd, Pr, Rb, Sb, Sn, Th, Ti, U, V, W, Y, Yb, Zn and Zr. The geochemical data are presented on graphs as element concentration versus soil sample sites (Appendix 1).

Typically, three types of geochemical anomalies are found with the enzyme leach technique including: (1) oxidation halo anomalies; (2) apical anomalies; and (3) mechanical/hydromorphic dispersion anomalies. The shape, or morphology, of the enzyme leach-based geochemical signature over the Mountain Lake Diatreme combines moderately strong to strong oxidation halos, or a rabbit's-ear geochemical profile, with a sharply-defined apical geochemical profile (e.g. geochemical signature for Cu, Figure 3a; Appendix 1). The shift from one anomaly profile to another is related to the strength of the oxidation cell, which is usually a function of the depth of the reduced deposit target below the surface (Clark, 1998, *In Press*). Rabbit-ear profiles typically form over shallow deposits, which form strong oxidation cells, and apical profiles usually form over deeply buried deposits with no oxidation cells (Figure 3b). Combination profiles may form in areas where the deposit is at depth, but still produces a weak to moderate oxidation cell. Over the Mountain Lake Diatreme, the distance on the sampling transect between rabbit-ear responses for most elements is approximately 1000 m (RE-ML97-005 to RE-ML97-007 and RE-ML97-025 to RE-ML97-027). This distance parallels 3D magnetic interpretation by Peirce (1996), which suggests the Mountain Lake Diatreme obtains widths of up to 750 m at a depth of approximately 200 m. The apical signature forms a single-peaked, extremely high contrast response directly over the centre of the ground magnetometer anomaly and the top of the topographic high. The apical profile is formed from a "single" sample - RE-ML97-015 (Figure 2; Appendix 1). Sample material from site RE-ML97-015 was re-analyzed and the analytical reproducibility was good, particularly for important kimberlite indicator elements such as Co, Cu and Ni. For example, re-analyzed sample material yielded concentrations of 18 ppb Co, 97 ppb Cu and 222 ppb Ni versus original geochemical concentrations of 30 ppb Co, 108 ppb Cu and 277 ppb Ni. Although apical responses generally indicate an anomalous source at depth, the apical signature generated in this study likely is a direct indication the depth of the diatreme is close to surface. Since altered ultrabasic volcanic rocks were observed at a depth of 1.8 m and represent the parent material to the soil, the geochemical abnormality at RE-ML97-015 may express the soil development profile that forms on top of kimberlitic and lamproitic bodies. Since diatremes discovered to date have been defined as predominantly topographic highs, exploration companies in Alberta should be aware of combination profiles, such as the combined apical and oxidation halo developed over the Mountain Lake Diatreme. Elements that yield a combined apical and rabbit-ear geochemical pattern include: Ag, As, Ba, Bi, Ce, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, La, Li, Lu, Mo, Nb, Nd, Pb, Pr, Rb, Sm, Sn, Te, Th, Ti, Tm, U, W, T, Yb, Zn and Zr.

Apical responses generally provide the commodity element profile as a result of a diffusion of major and trace elements away from a highly concentrated source, where the source can be the actual source or a structure such as a fault that facilitates the movement of elements to the surface. Anomalous apical geochemical responses at RE-ML97-015 yield concentrations of: Co (103 ppb - 5 times background), Cr_20_3 (132 - 15 times background ppb), Cu (108 ppb - 4.5 times background), Ni (916 ppb - 9 times background) with the presence of high Ba (1308 ppb - 2 times background),

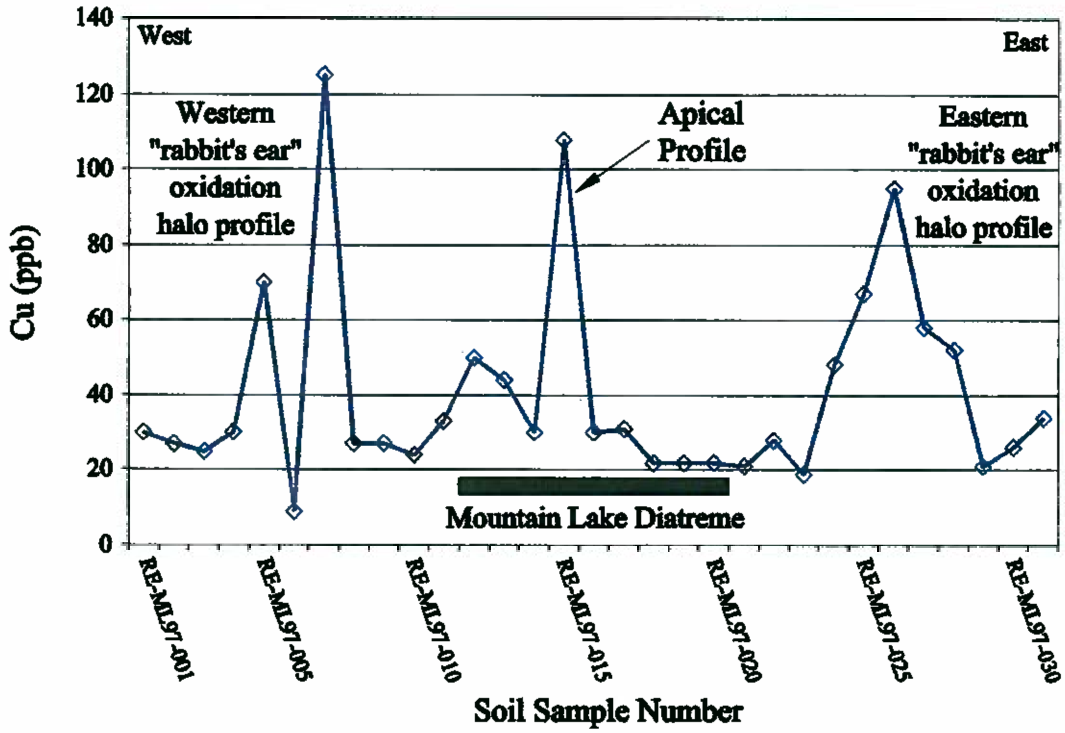

Figure 3a. Geochemical signature for Cu. Apical and oxidation halo profiles over the Mountain Lake Diatreme.

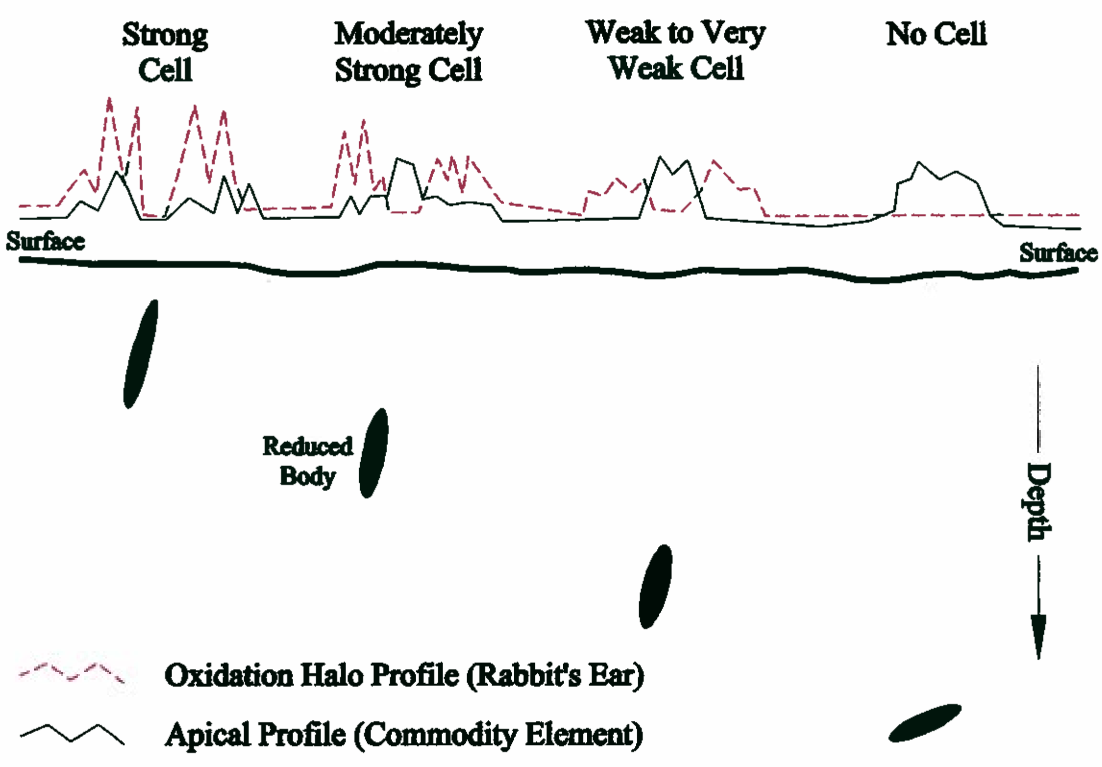

Figure 3b. Typical anomaly profile variations related to strength of oxidation cell (Clark, 1993).

Table 1. East - West oxidation halo geochemical concentrations for selected elements.

	East Anomaly		West Anomaly	
Element	Concentration (ppb)	Times Background	Concentration (ppb)	Times Background
As	60	4	47	3.5
Co	103	5	101	5
Cr	86	4.5	67	3.5
Cs	11	11	9	9
Cu	125	5	95	4
Ga	28	11.5	8	3
Hf	5	5	9	9
Mo	74	7.4	37	3.7
Nb	33	22	23	15
Ni	916	9	874	8.9
P	86	4	67	3.2
Pb	55	3.5	68	5
Rb	190	19	155	15
Th	13	7	15	7.5
Ti	6005	17	3870	11.5
U	30	10	12	4
W	10	10	4	4
Y	53	2.75	81	4
Yb	8	4	10	5
Zn	205	10	491	25
Zr	193	4	271	5.5
Light REE				
Eu	8	2.5	8	2.5
La	70	3.75	80	4
Nd	85	2.5	88	2.6
Pr	21	3	23	3.5
Sm	26	2.5	29	3

Hf (10 ppb - 10 times background), Nb (43 ppb - 29 times background), PO_4 (15,599 ppb - 5.5 times background), Rb (154 ppb - 15 times background) Ta (2 ppb - 2 times background) and Ti (5869 ppb - 17 times background) indicative of kimberlite or lamproite rocks. The light REE also yield elevated maximum apical concentrations including La (109 ppb - 5.5 times background), Ce (209 ppb - 4 times background), Pr (27 ppb - 4 times background) and Nd (110 ppb - 3 times background).

Oxidation anomalies are produced by the gradual oxidation of buried reduced bodies. Enrichment in diagnostic oxidation suite elements such as Br, I, As, Mo, Te, Th, V, U, W with the addition of a high proportion of commodity metals in the rabbit-ear geochemical responses suggest element migration to the surface formed under moderately strong to strong oxidizing conditions. Such conditions could occur in association with migration along electrochemical cells, where a redox cell is created between the edge of the altered ultramafic pipe (positive particles will flow away from the anode) and the Wapiti Formation sandstone (negatively charged ions will move away from the cathode). Notable kimberlite commodity elements detectable in rabbit-ear responses include Co, Cr, Cu, Ga, Hf, Ni, Nb, Rb, Ti and Zn (Table 1). The light REE also yield elevated concentrations including Eu, La, Nd Pr and Sm. While most of the elements display oxidation halo profiles that are spaced approximately 1000 m apart, the elements Au, As, Co, Nb, Ni, P and W display a pattern that is roughly 400 m wide and conforms more to the surface expression of the pipe (Appendix 1).

Elevated geochemical concentrations for V (2572 ppb - 13.5 times background), U (30 ppb - 7 times background), and Th (40 ppb - 20 times background) suggest the application of airborne radiometric and hand held spectrometers may provide a useful tool for exploration. However, it should be noted that the radiometric signatures of sandstones and shales, such as the Athabasca sandstone and Second White Specks shale, will also yield elevated radiometric signatures.

Dispersion haloes of Ni, Cr, Mg and Nb in soils normally extend only for a few tens of metres down slope from kimberlites and lamproites, and may vary with elemental contents in the background country rocks (Atkinson, 1989). For example, Litinskiy (1964) reported that the Yakutia kimberlite, Russia displayed dispersion haloes over an area 2-4 times larger than the pipes, and that the frequency of anomalies was typically 2-7 times greater than background levels in the surrounding limestone. Since the sampling transect over the Mountain Lake Diatreme was only 1500 m long, it remains to be determined if the enzyme leach-based soil geochemical survey yields a larger anomalous signature than that of typical geochemical surveys.

CONCLUSIONS

A multi-element geochemical response with contrasts of up to 29 times background was obtained in the soils above the Mountain Lake Diatreme. Elements that are elevated ≥4 times background include: As, Ce, Co, Cr, Cs, Cu, Ga, Hf, La, Mn, Mo, Nb, Ni, P, Pb, Pd, Pr, Rb, Sb, Sn, Th, Ti, U, V, W, Y, Yb, Zn and Zr. While the overall geochemical signature is indicative of an ultramafic source, oxidation halo geochemical responses yield elevated concentrations of Co, CrO_3, Cu and Ni with the presence of high Ba, Hf, PO_4, Rb, Ta, Ti and light REE suggestive of a kimberlite or lamproitic body.

The morphology of the enzyme leach-based geochemical signature over the Mountain Lake Diatreme combines a moderately strong to strong oxidation halo profile with a sharply-defined apical geochemical profile. The high contrasting apical signature is formed from a "single" sample. Although apical responses generally indicate an anomalous source at depth, the apical signature generated in this study is likely a direct indication the depth of the diatreme is close to surface. Since altered ultrabasic volcanic rocks were observed at a depth of 1.8 m and represent the parent material to the soil, the geochemical abnormality at RE-ML97-015 may express the soil development profile that forms on top of kimberlitic and lamproitic bodies. Since diatremes discovered to date have been defined as predominantly topographic highs, exploration companies in Alberta should be aware of combination profiles, such as the combined apical and oxidation halo developed over the Mountain Lake Diatreme.

The enzyme leach technique, which has proven to be a useful tool in base metal, precious metal, and petroleum exploration, may have a significant impact on exploration for kimberlite, lamproite and related rocks in Alberta by providing industry with a useful and cost effective tool to probe blind and/or buried anomalies identified by airborne and ground magnetic surveys in areas of glacial overburden.

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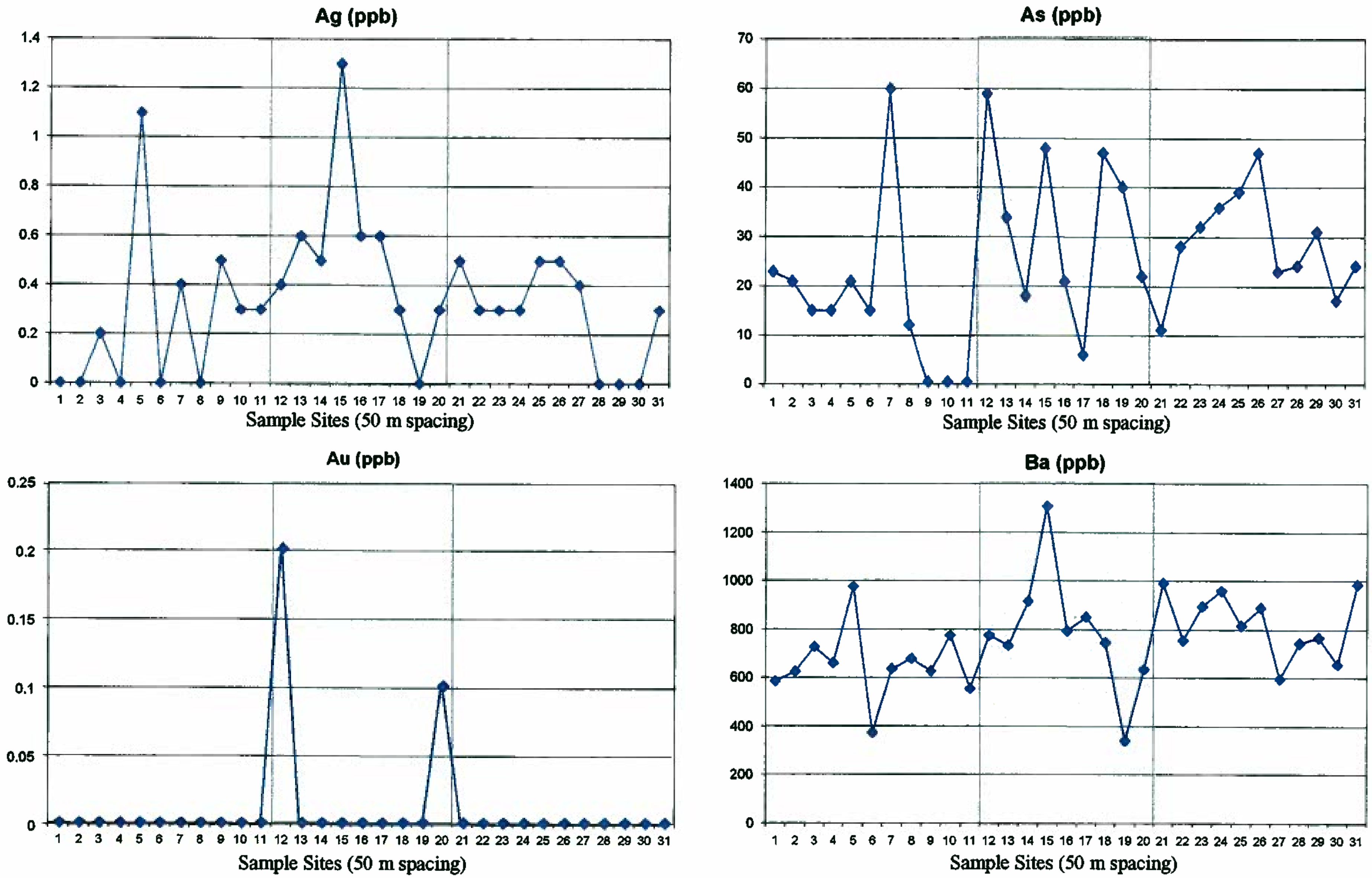
APPENDIX 1

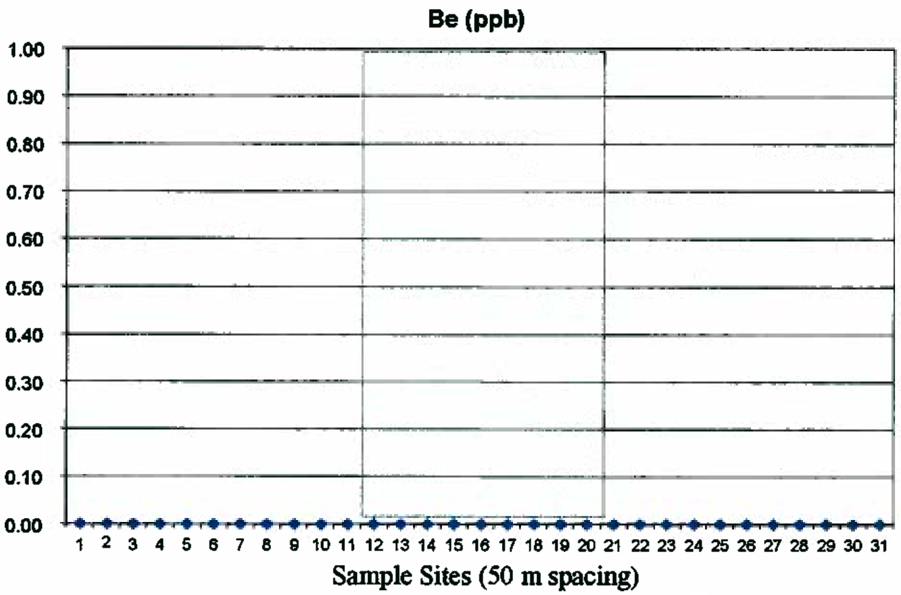
Enzyme Leach-Based Soil Geochemical Profiles

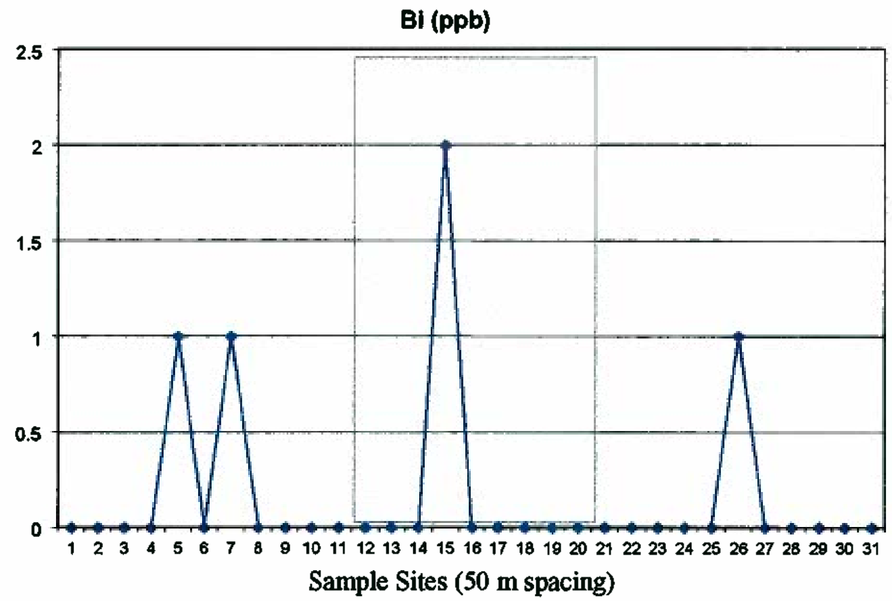
Mountain Lake Diatreme, Alberta

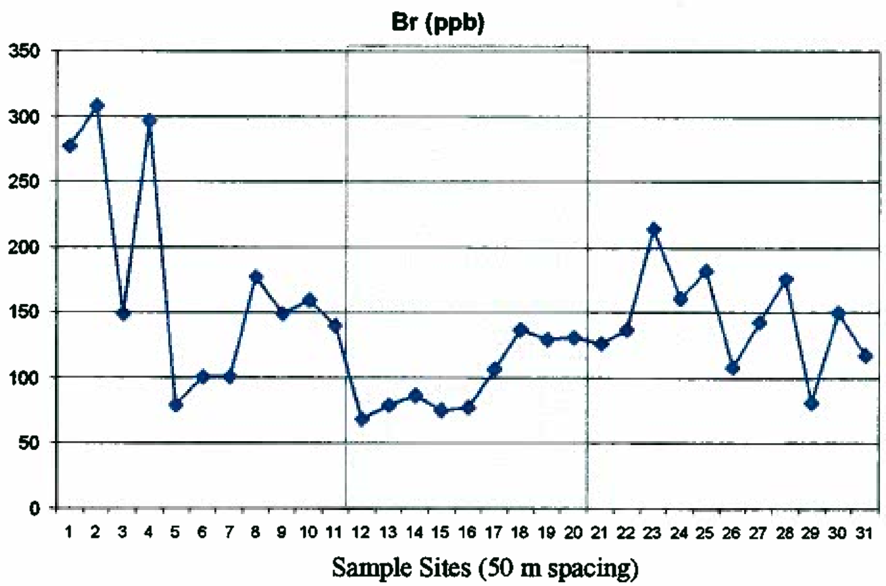
Mountain Lake Enzyme Leach-Based Soil Profiles Ag, As, Au and Ba (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

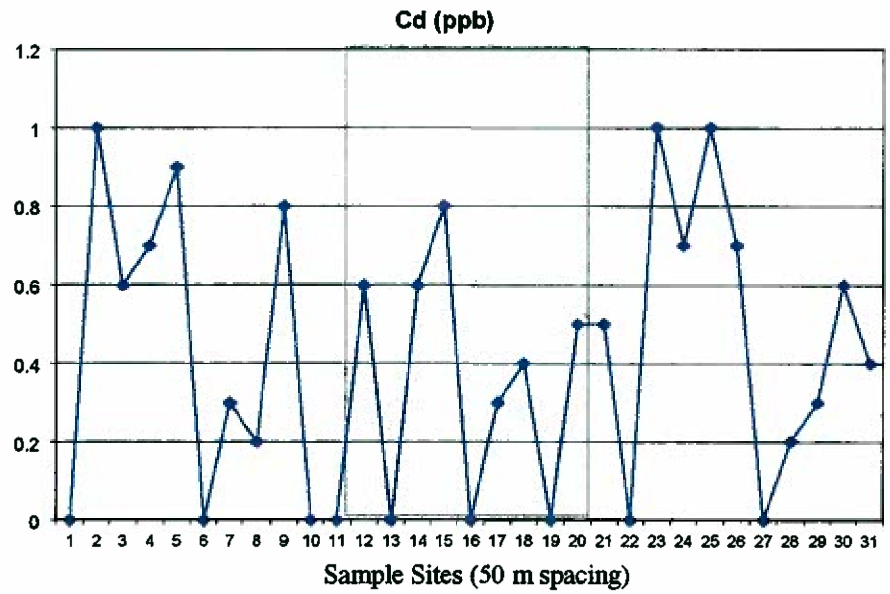


Mountain Lake Enzyme Leach-Based Soil Profiles Be, Bi, Br and Cd (ppb vs. samples RE-ML97-001 to REML97-031).
Shading represents the approximate surface expression of the pipe.

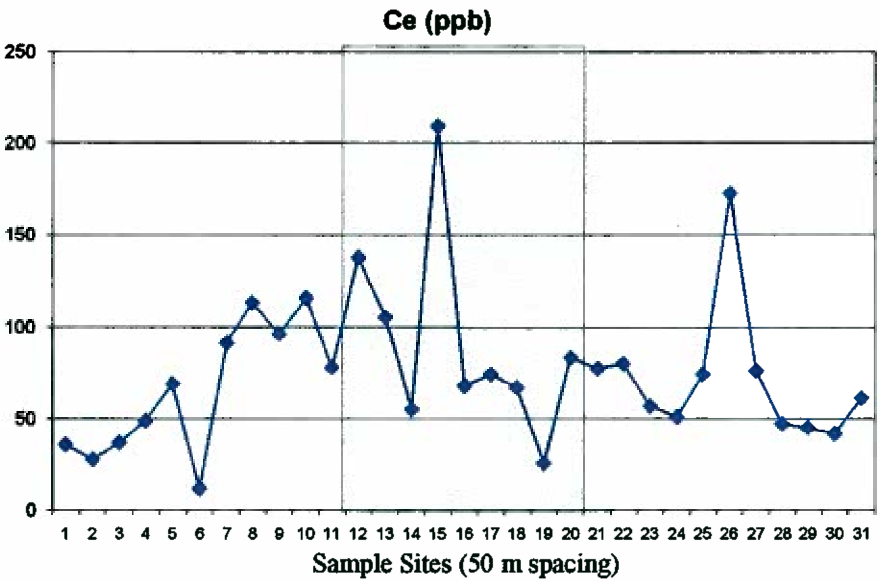


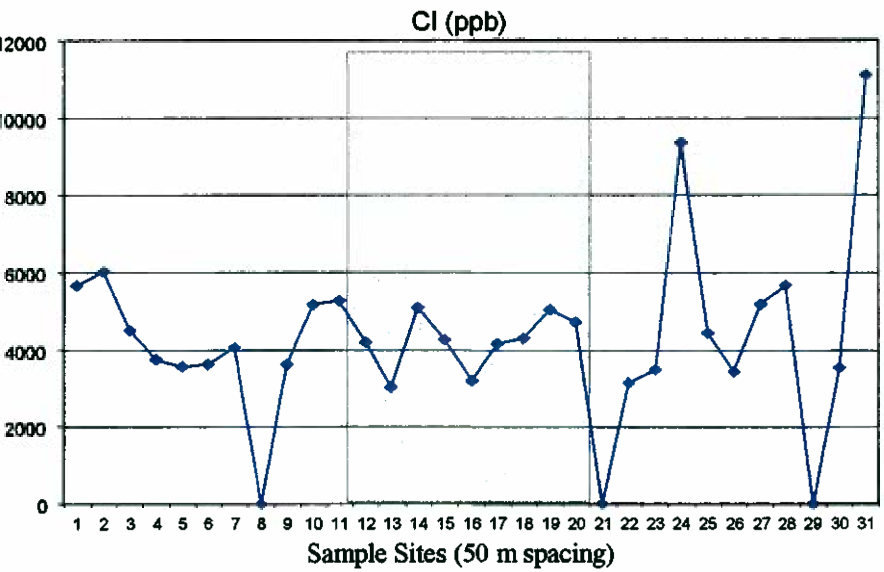


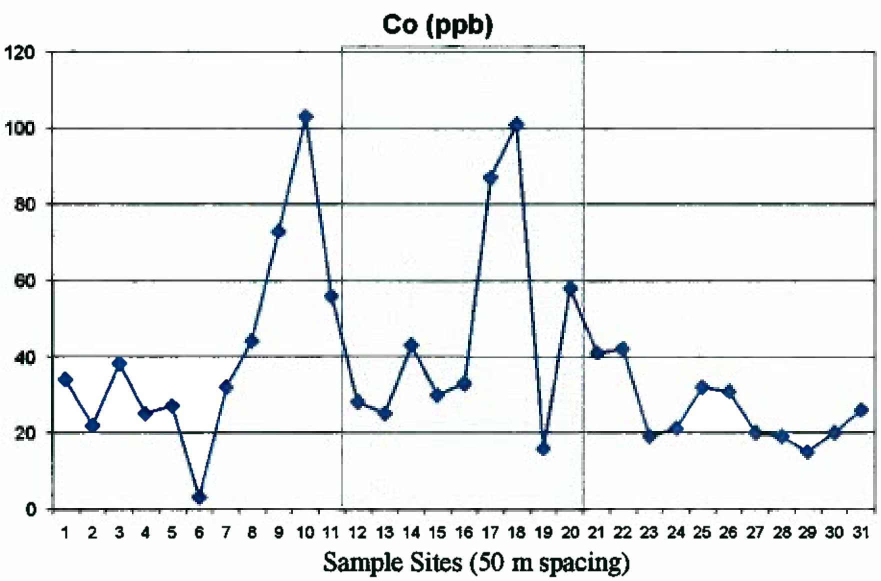


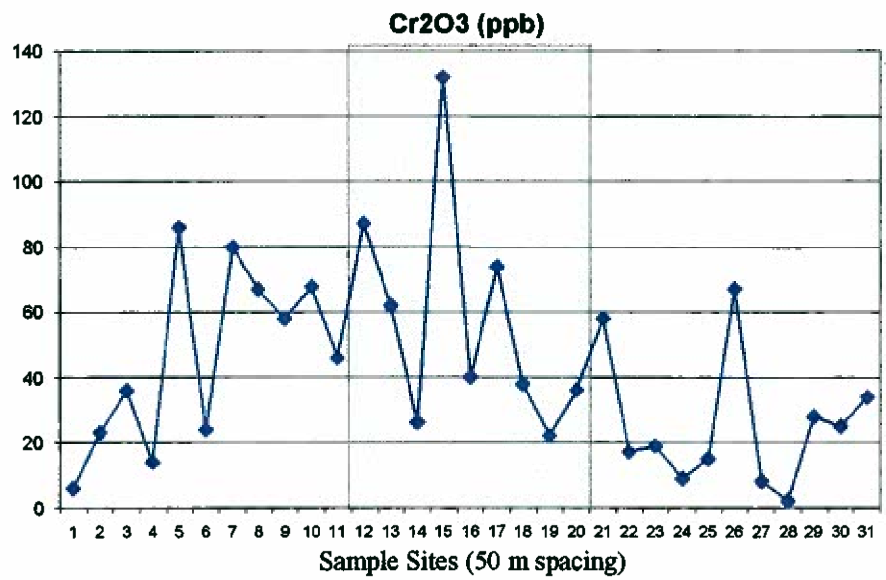


Mountain Lake Enzyme Leach-Based Soil Profiles Ce, Cl, Co and Cr (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

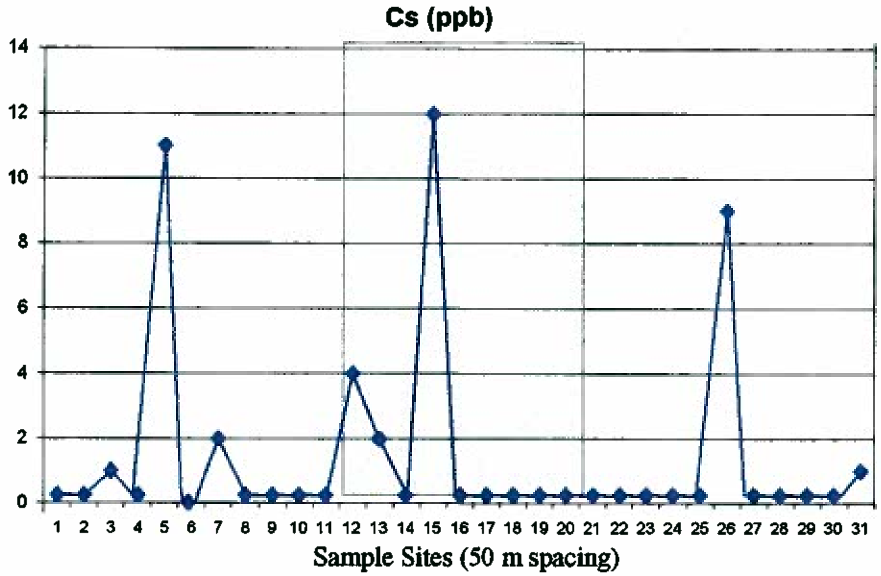


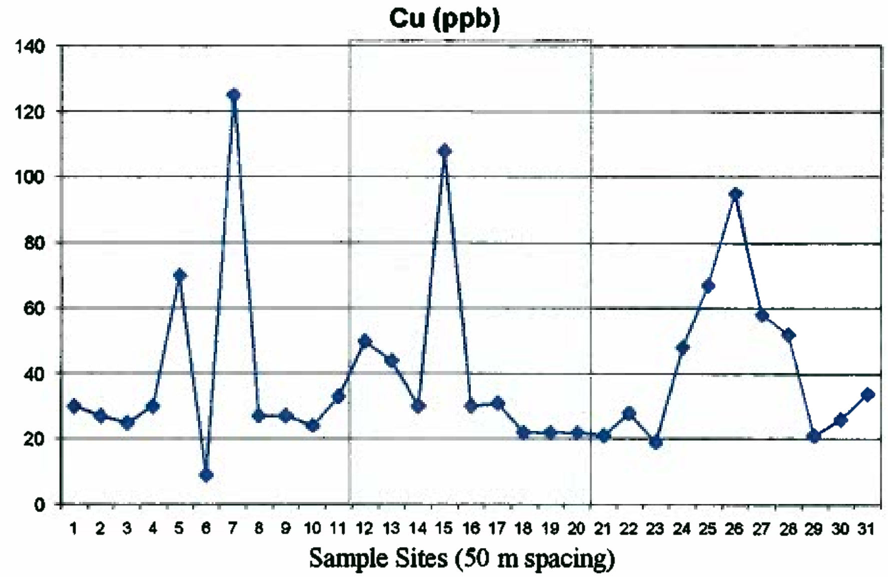


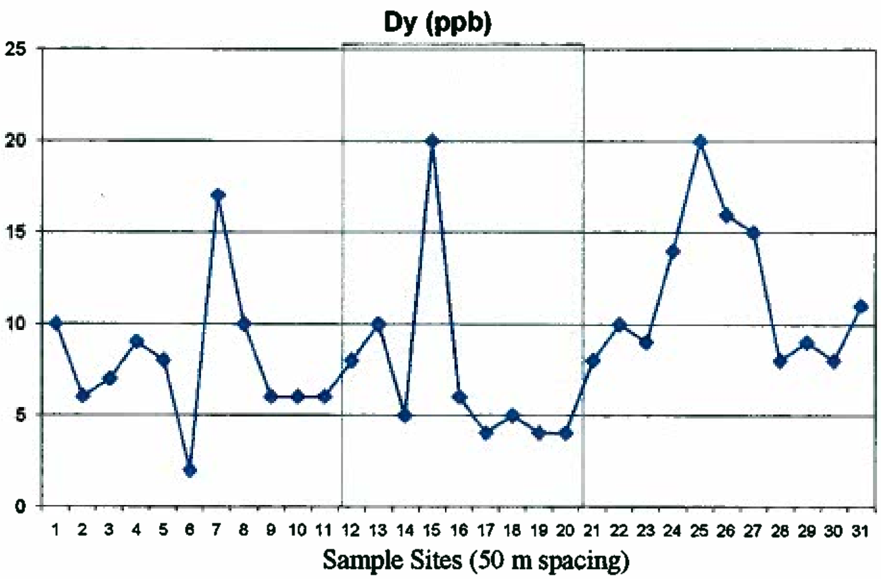


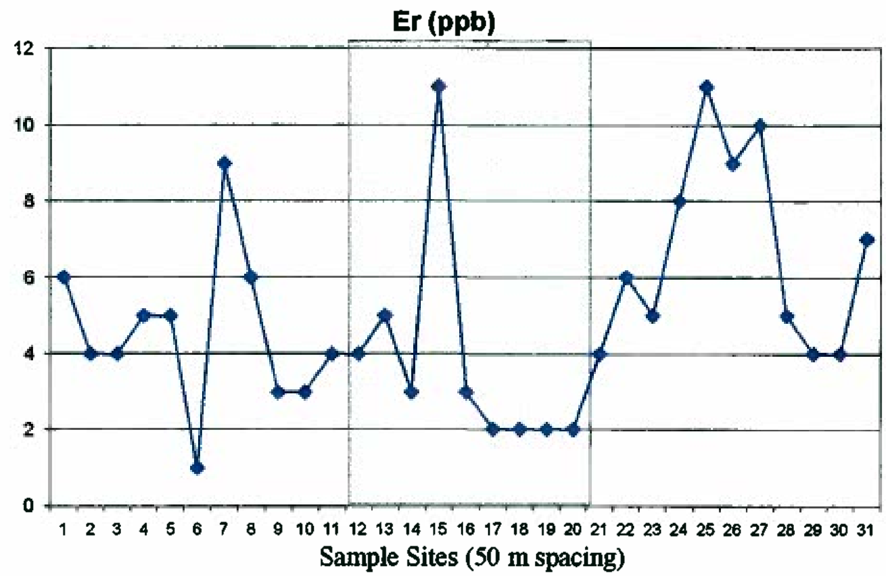


Mountain Lake Enzyme Leach-Based Soil Profiles Cs, Cu, Dy and Er (ppb vs. samples RE-ML97-001 to REML97-031).
Shading represents the approximate surface expression of the pipe.

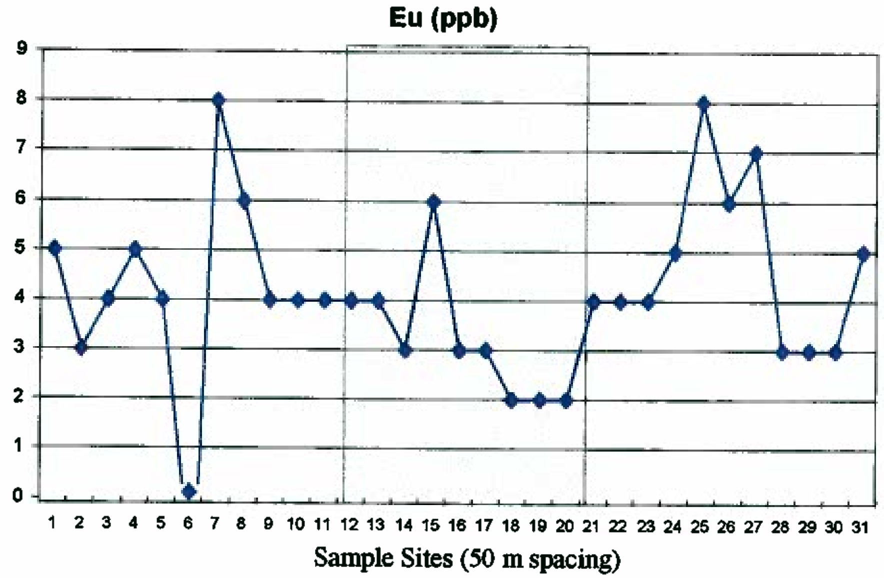


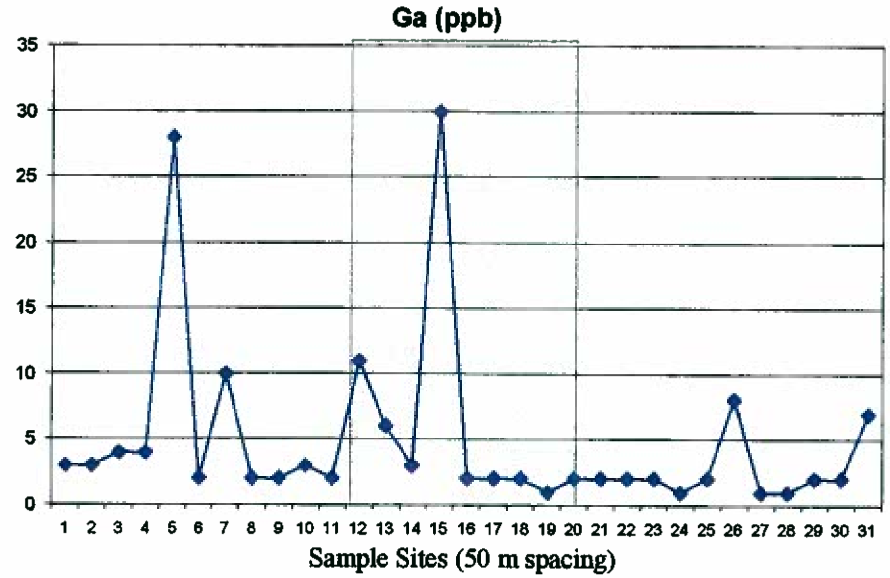


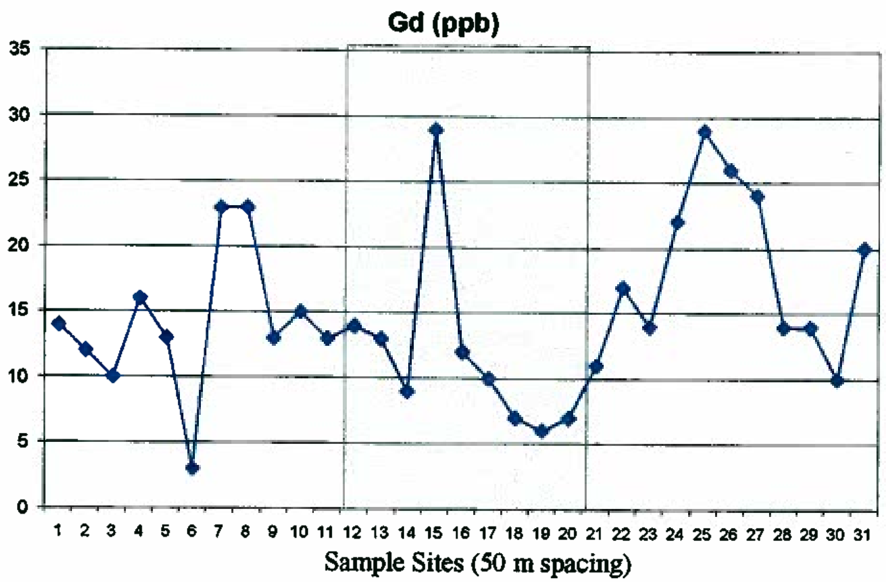


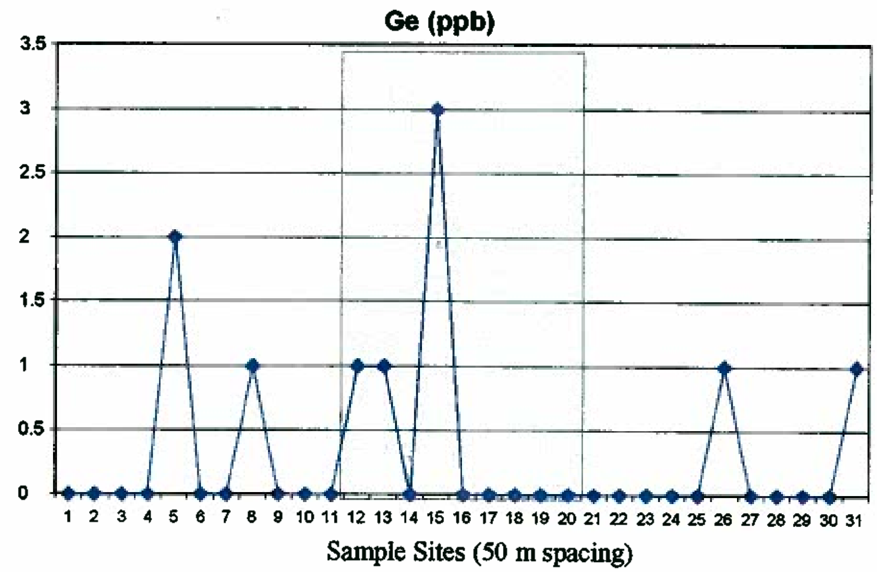


Mountain Lake Enzyme Leach-Based Soil Profiles Eu, Ga, Gd and Ge (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

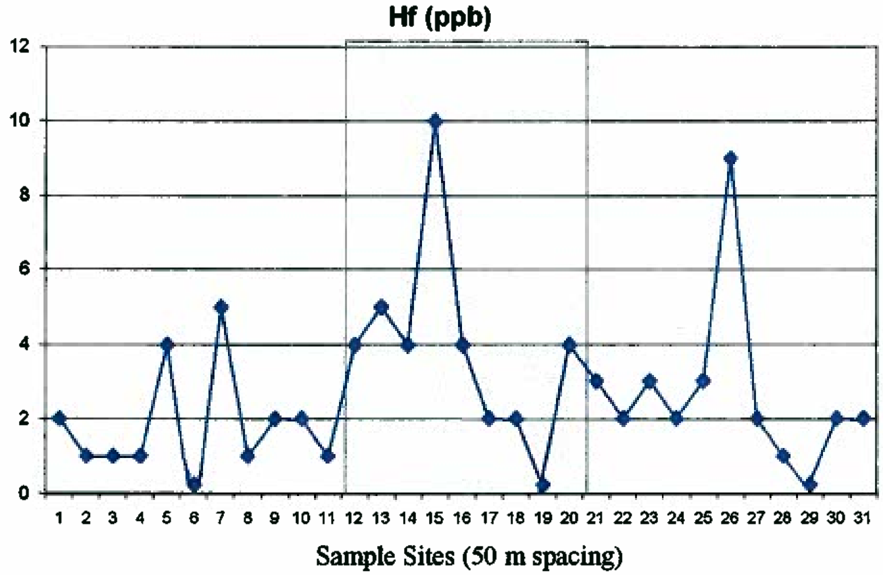


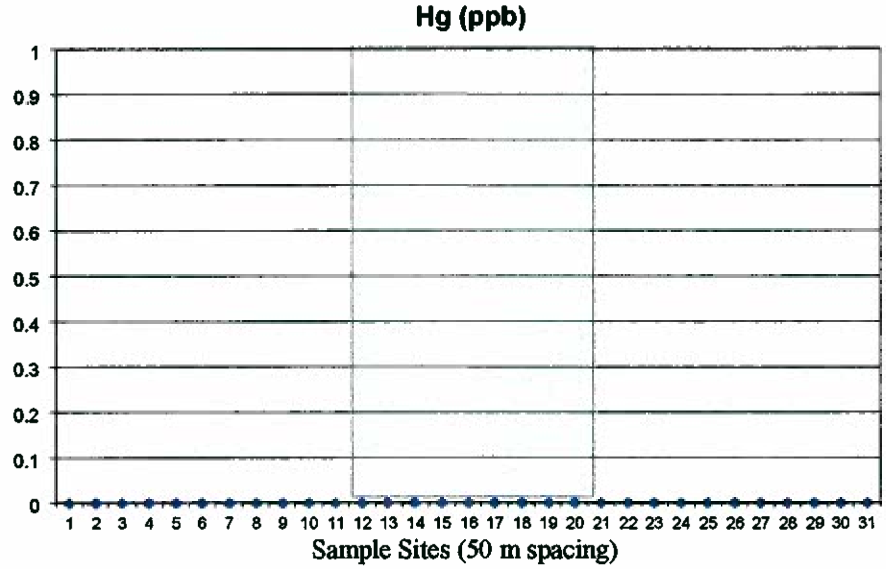


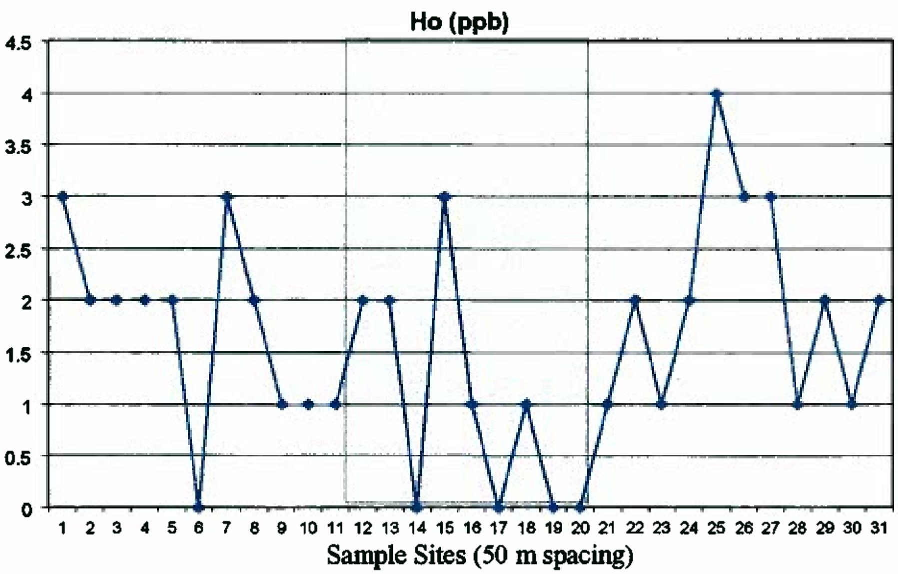


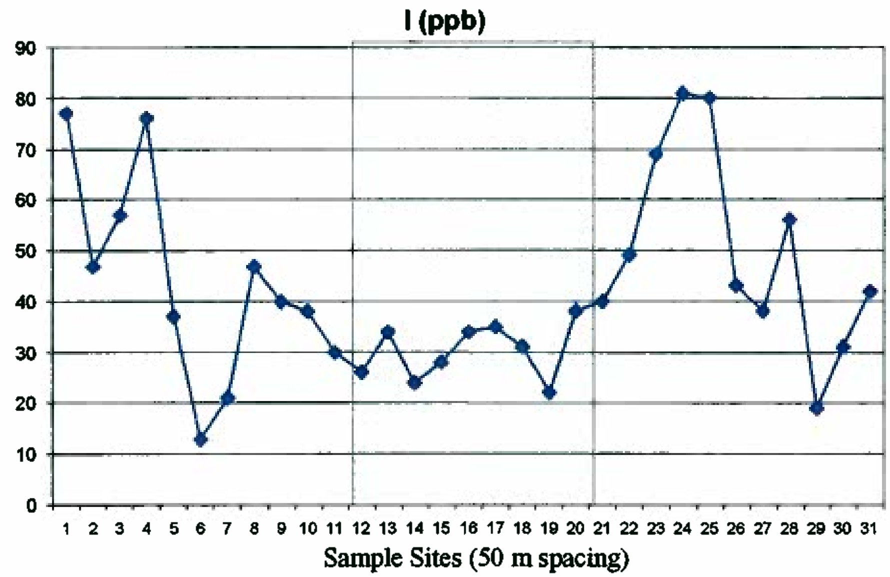


Mountain Lake Enzyme Leach-Based Soil Profiles Hf, Hg, Ho and I (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

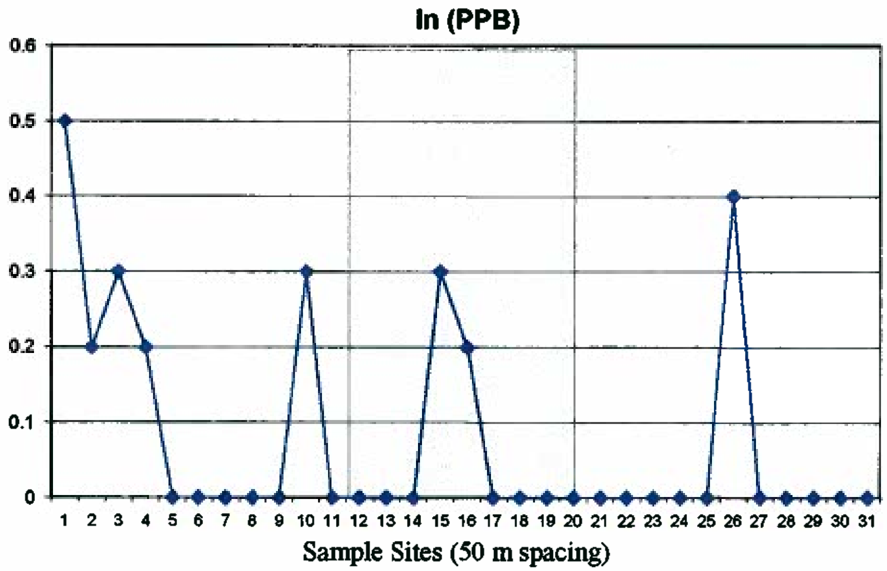


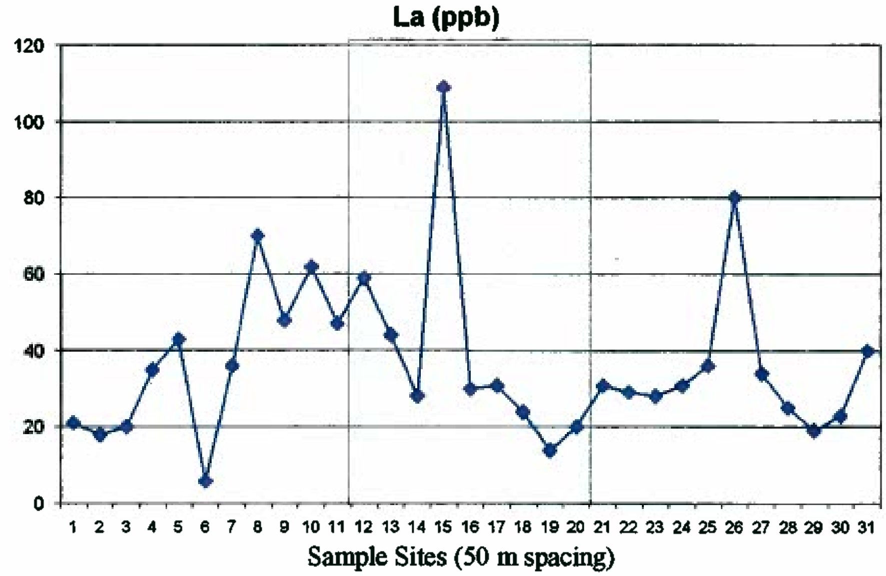


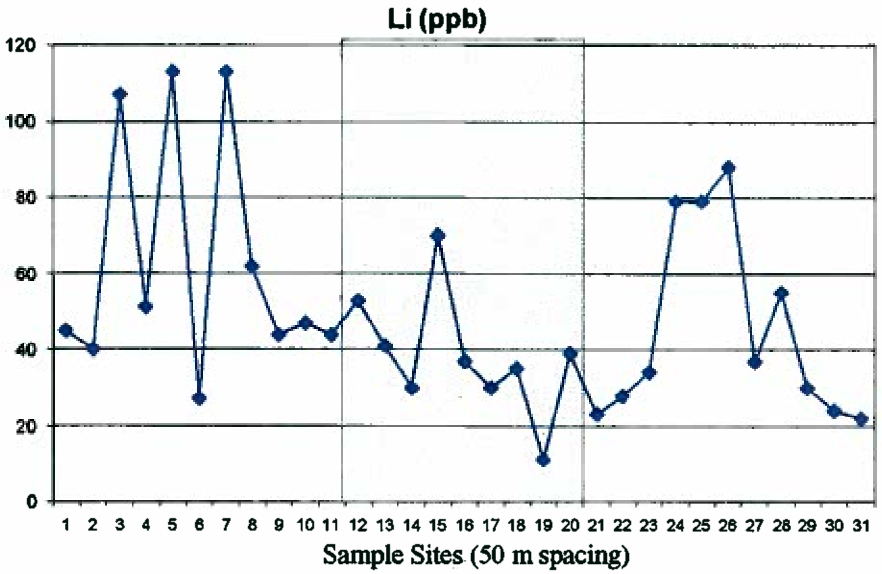


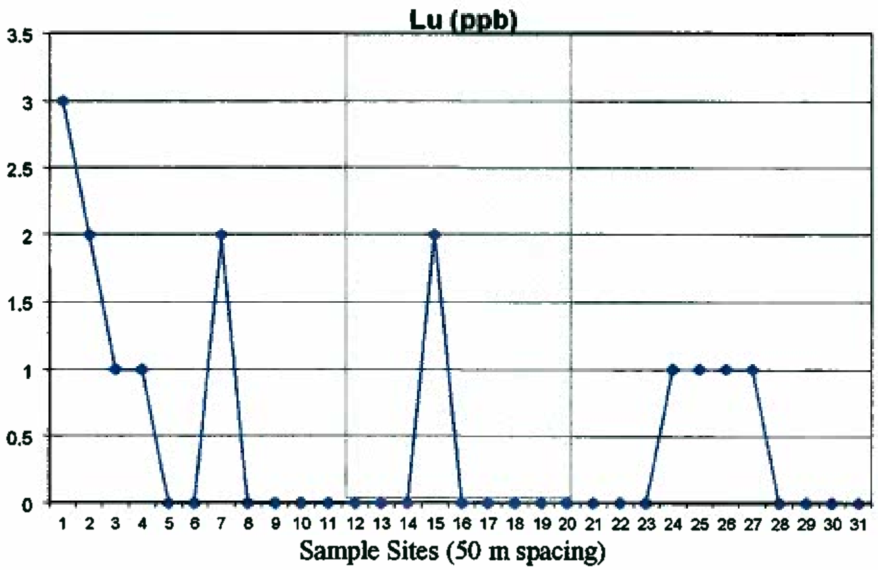


Mountain Lake Enzyme Leach-Based Soil Profiles In, La, Li and Lu (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

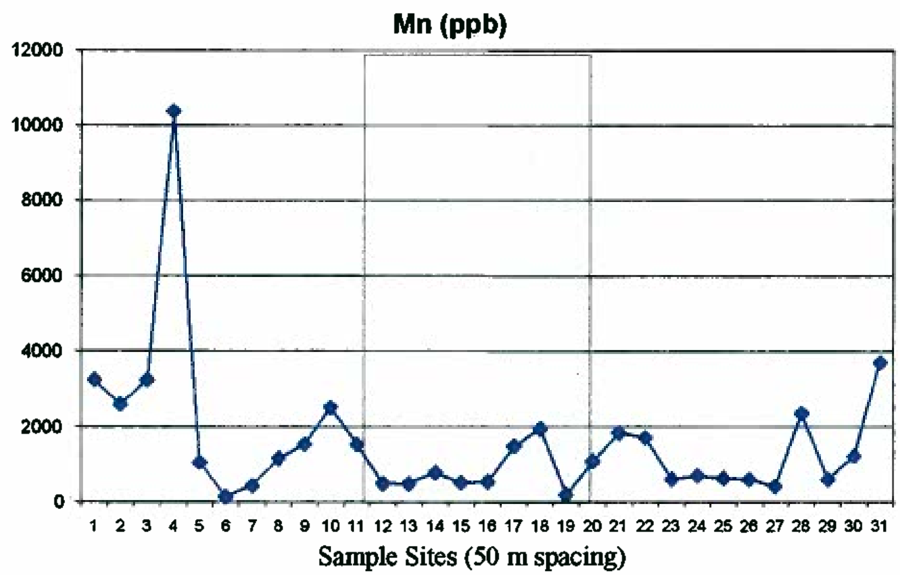


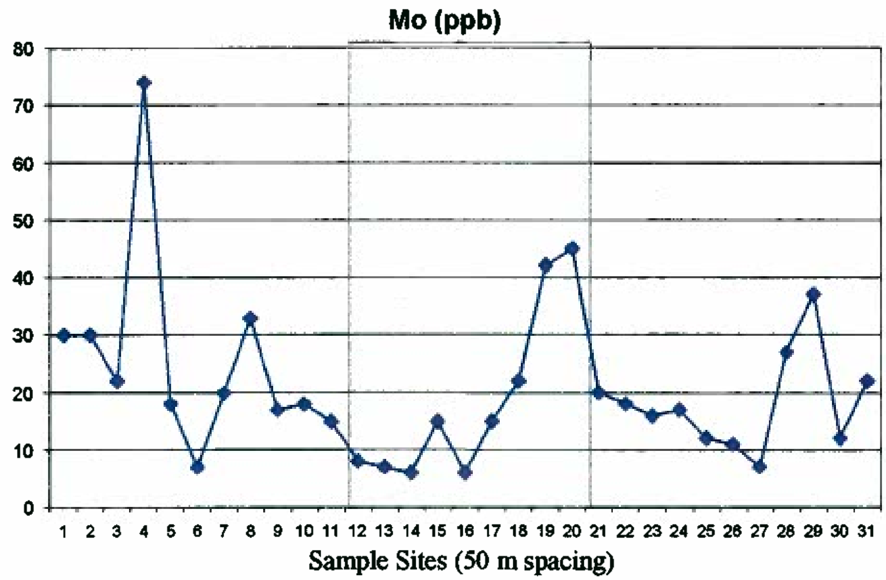


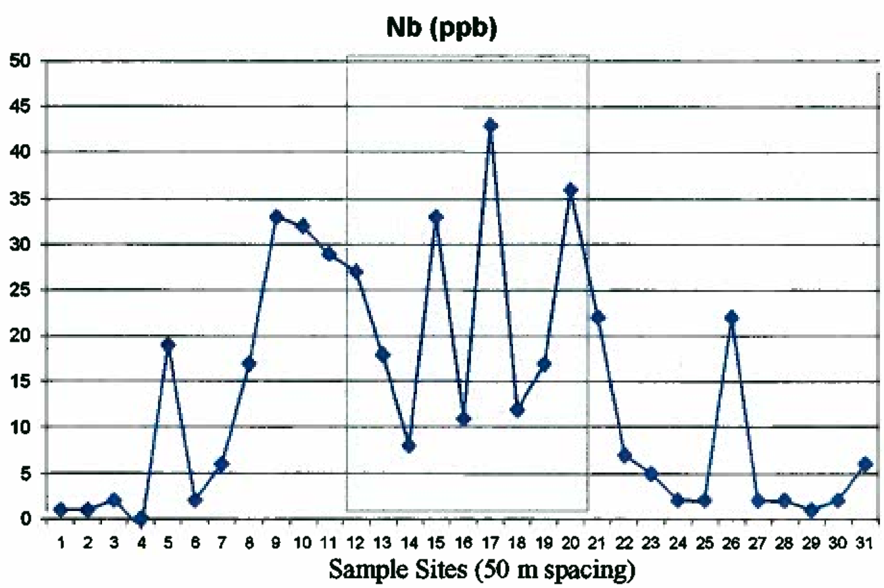


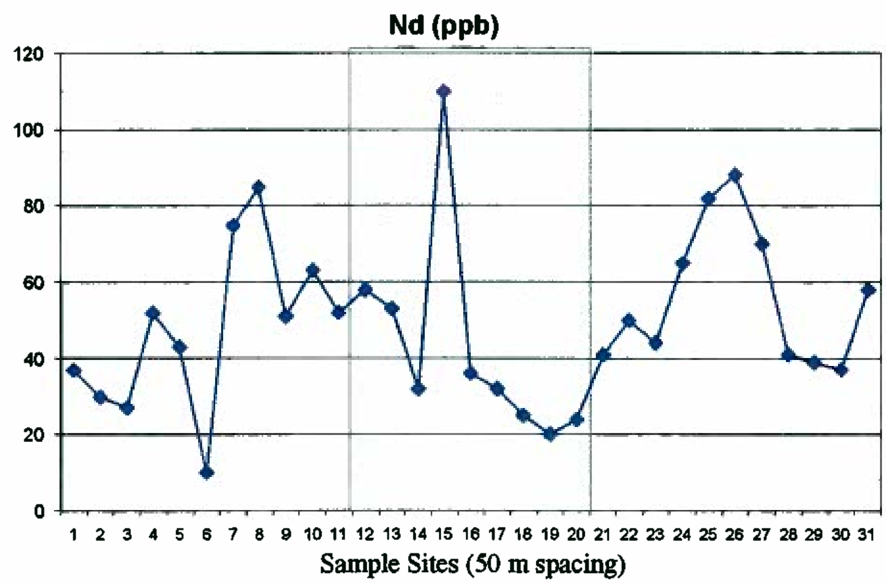


Mountain Lake Enzyme Leach-Based Soil Profiles Mn, Mo, Nb and Nd (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

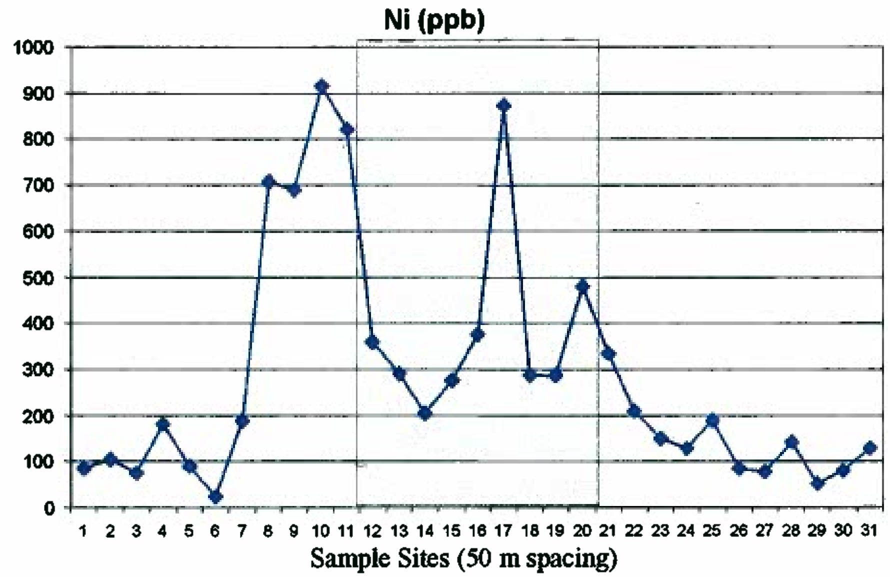


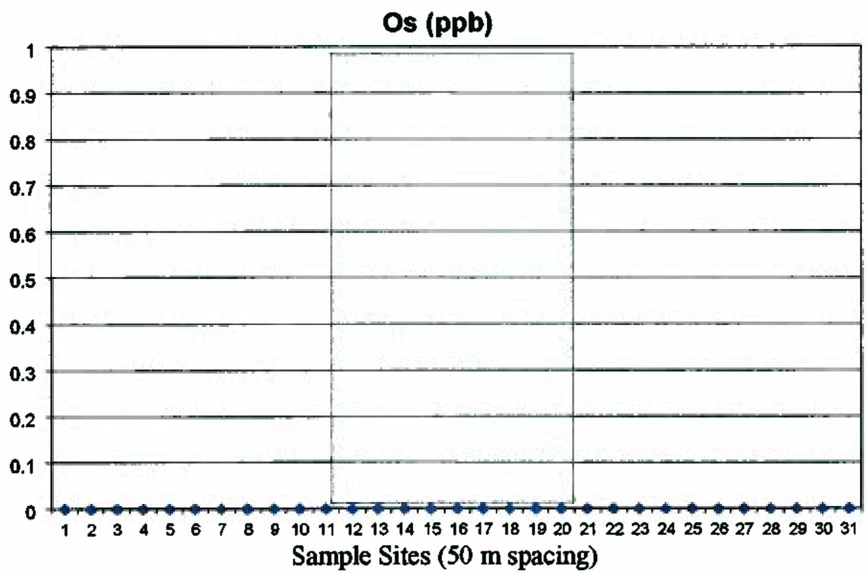


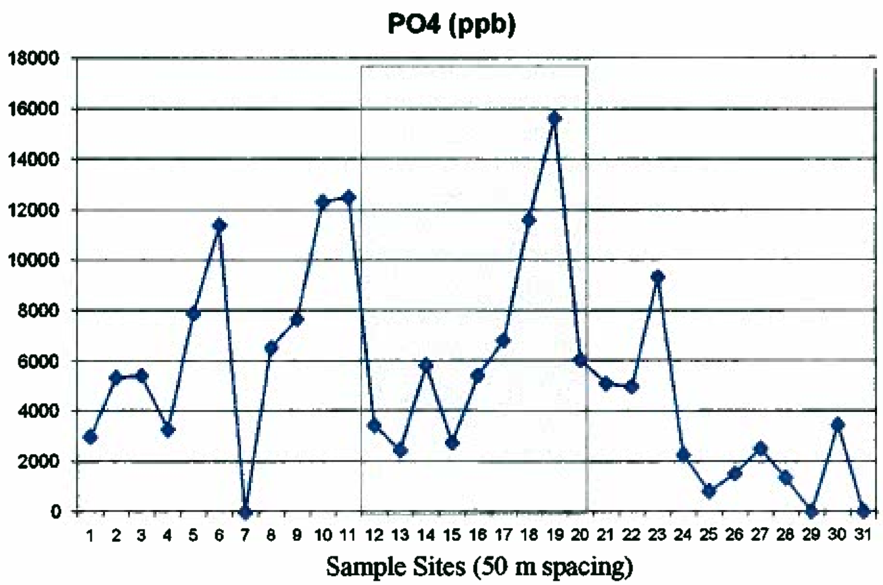


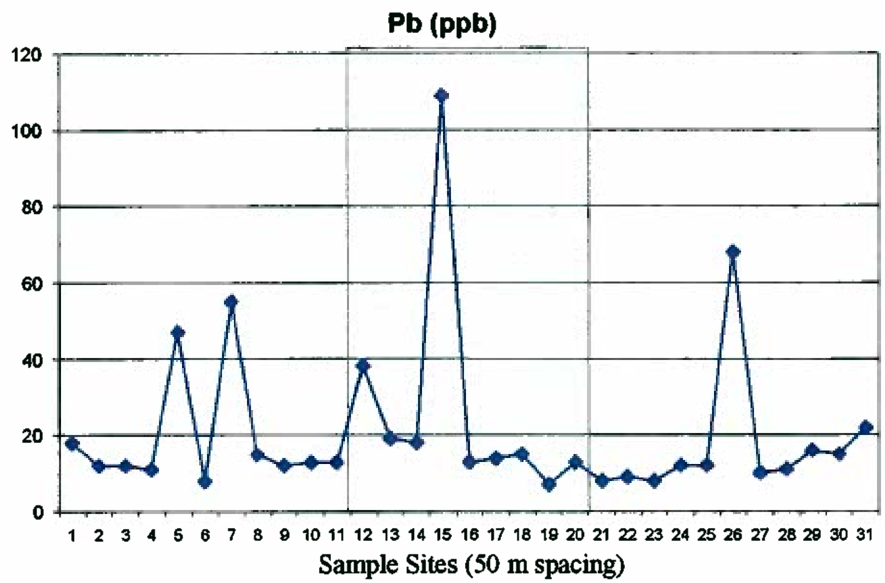


Mountain Lake Enzyme Leach-Based Soil Profiles Ni, Os, P and Pb (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

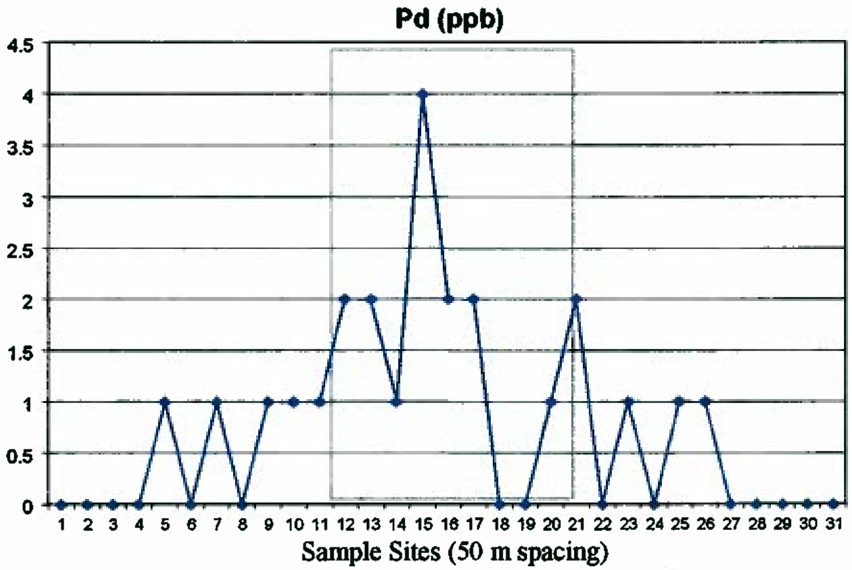


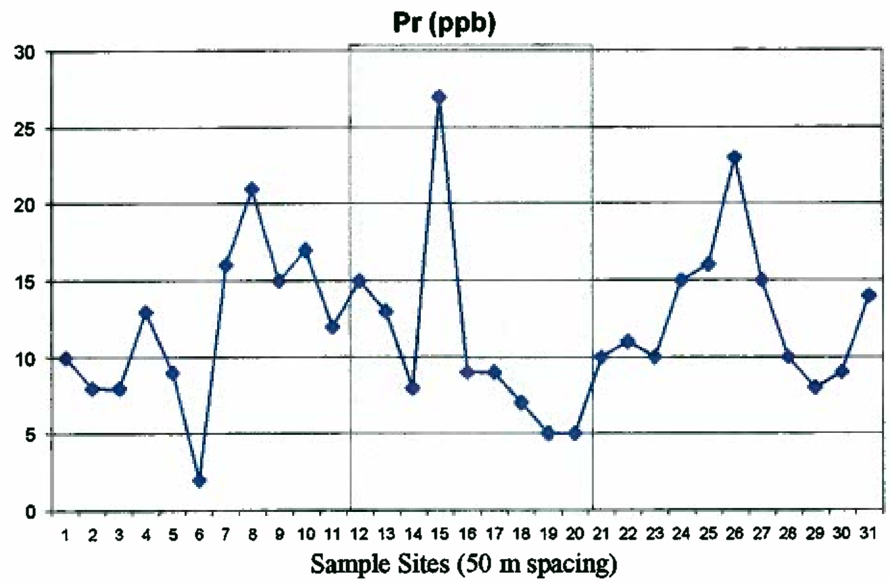


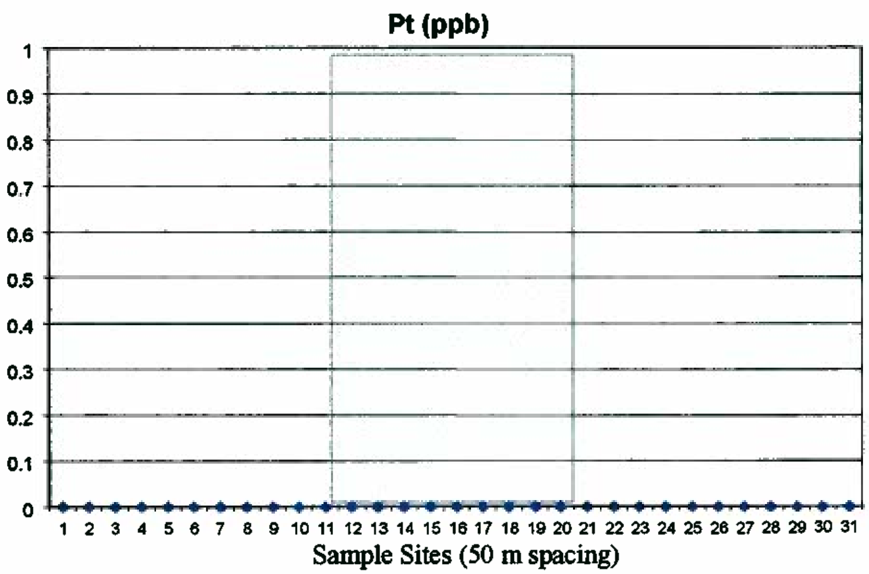


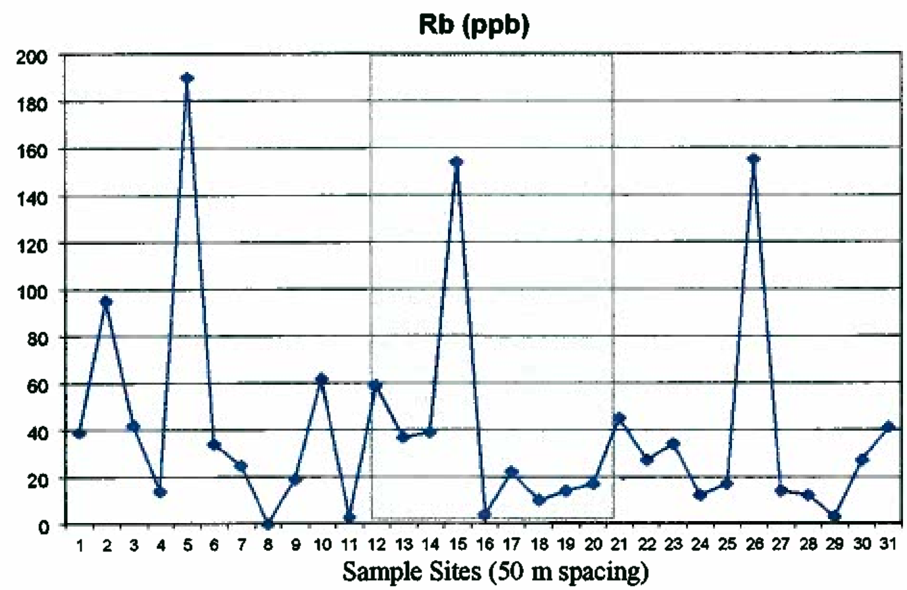


Mountain Lake Enzyme Leach-Based Soil Profiles Pd, Pr, Pt and Rb (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

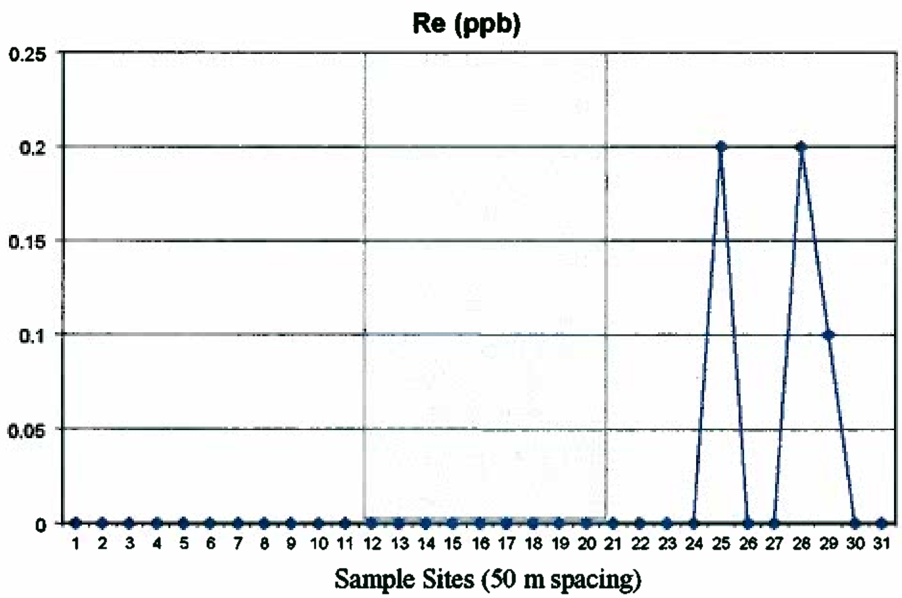


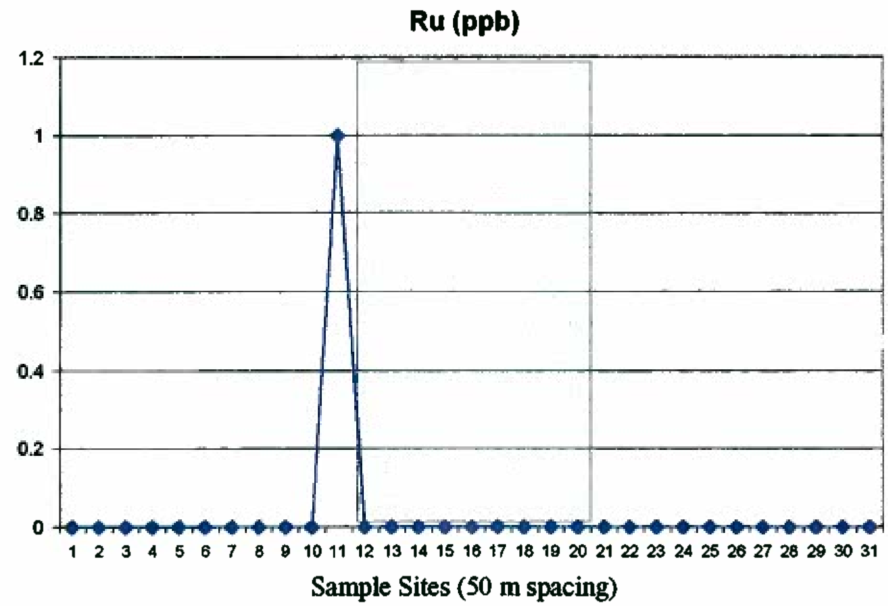


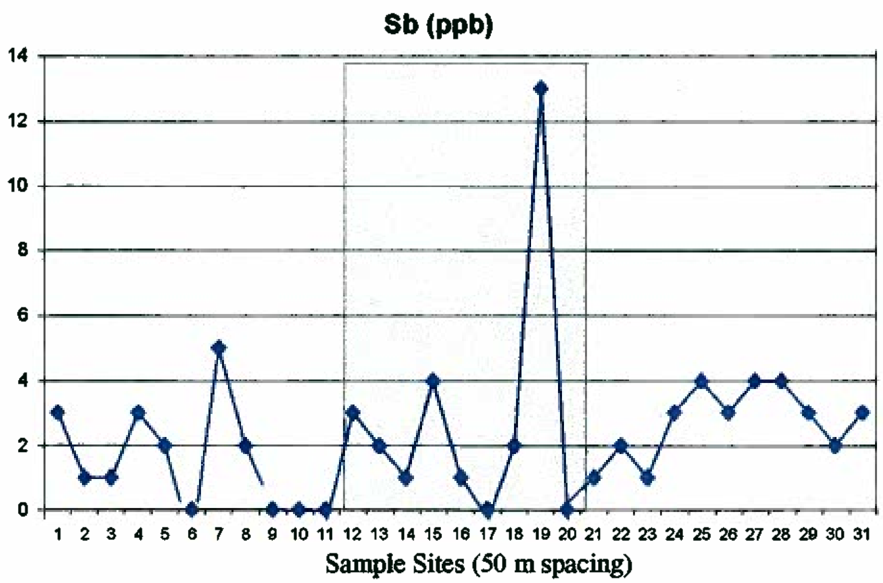


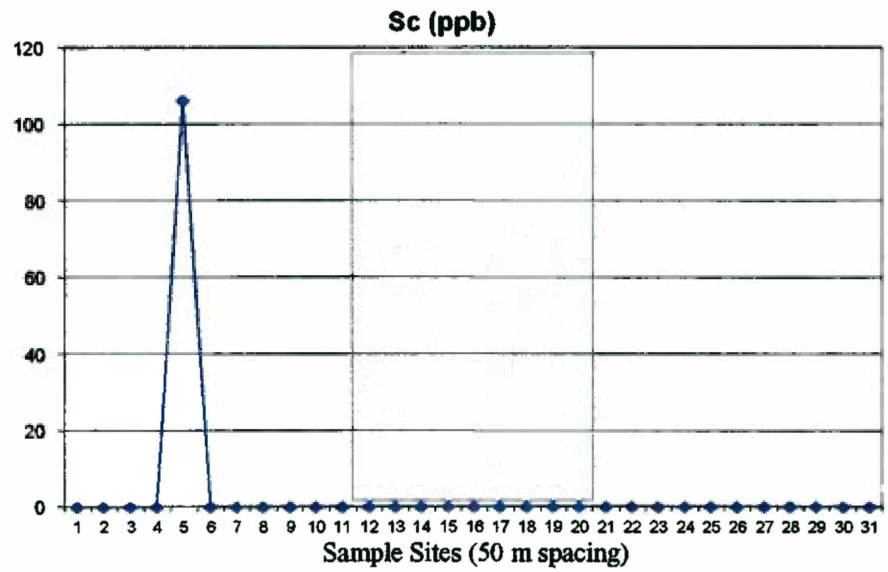


Mountain Lake Enzyme Leach-Based Soil Profiles Re, Ru, Sb and Sc (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

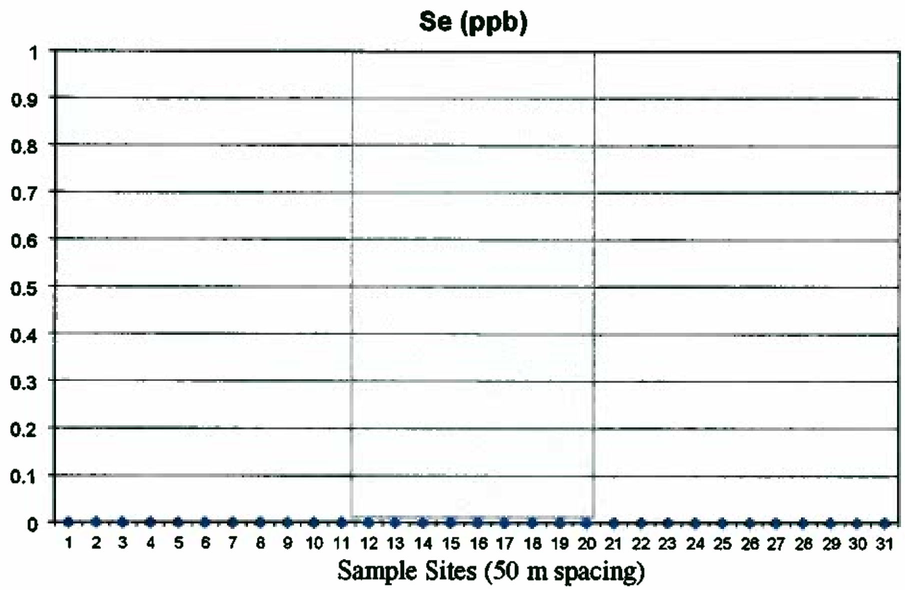


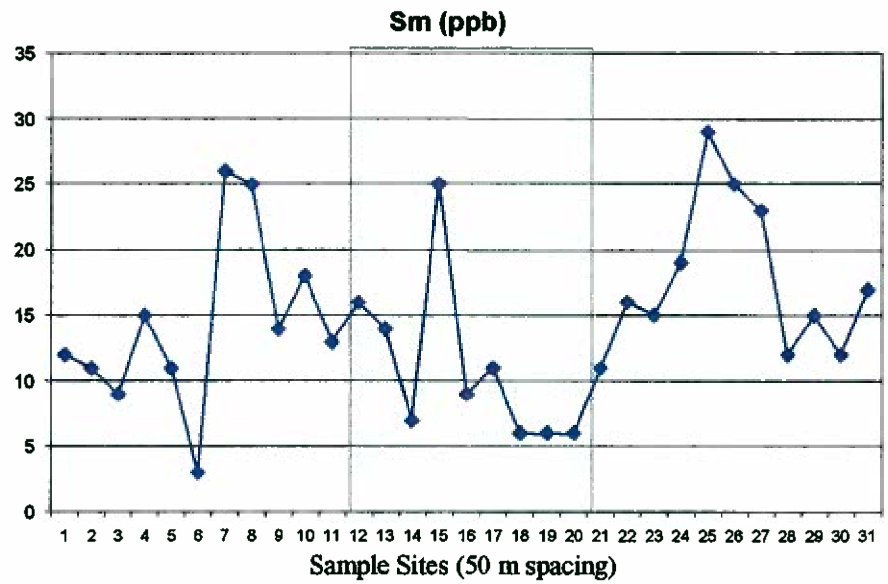


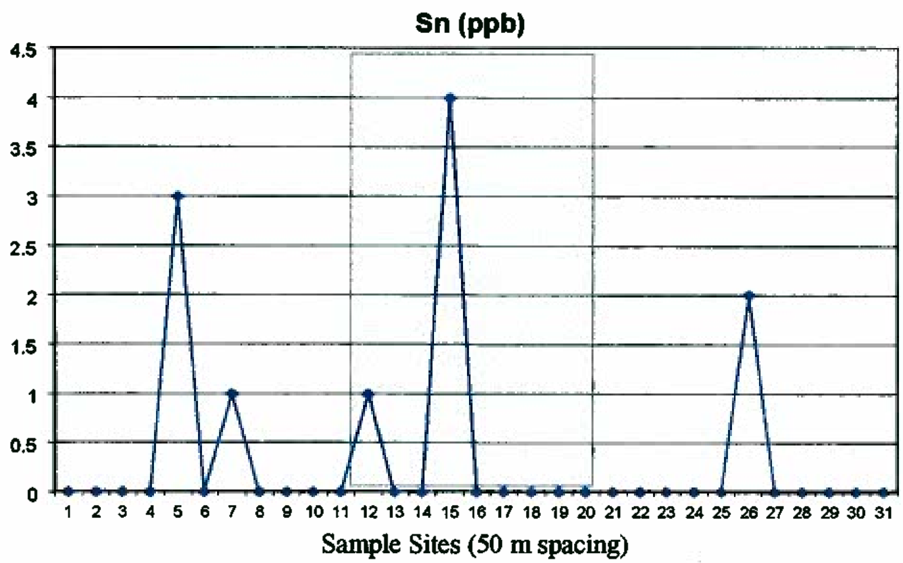


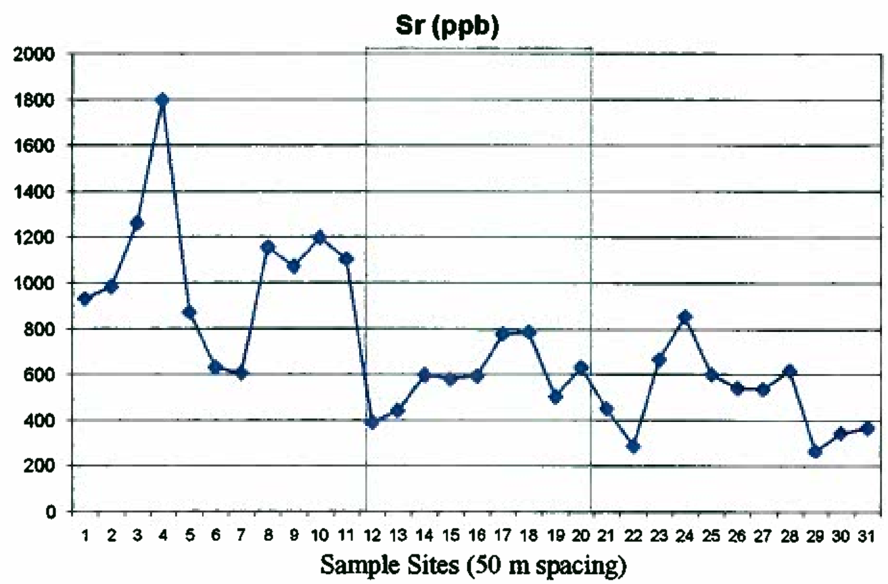


Mountain Lake Enzyme Leach-Based Soil Profiles Se, Sm, Sn and Sr (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

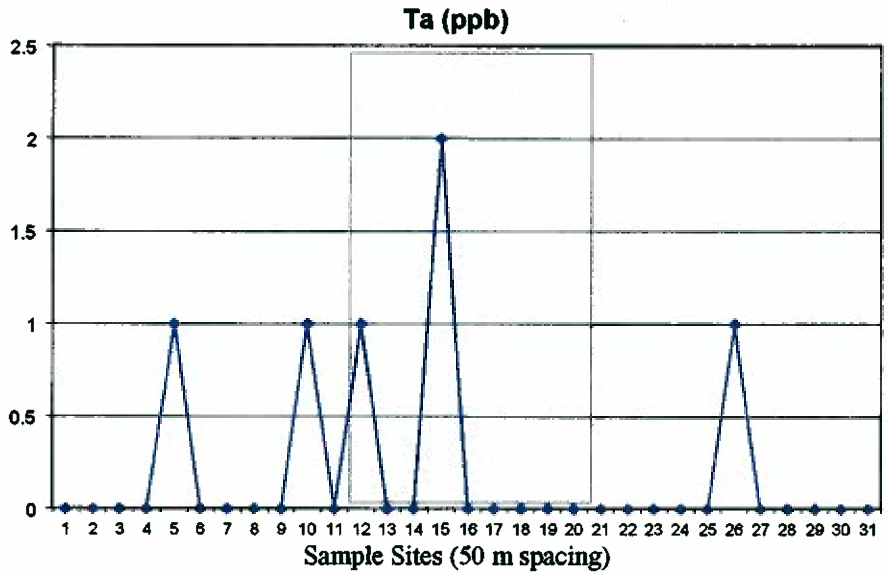


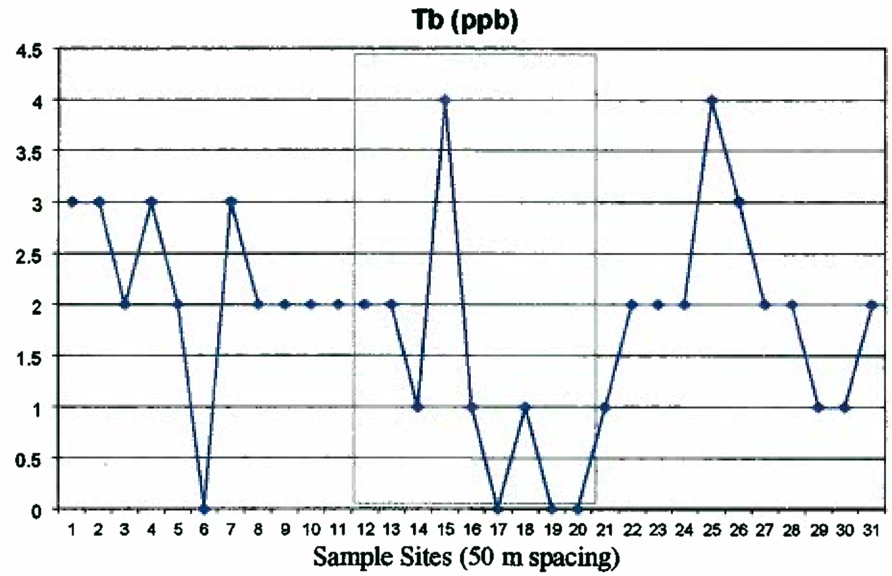


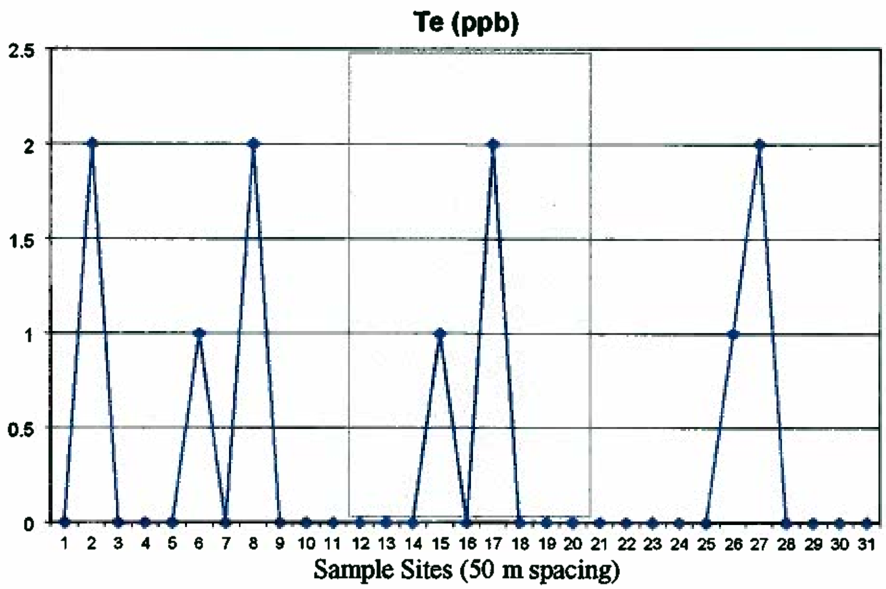


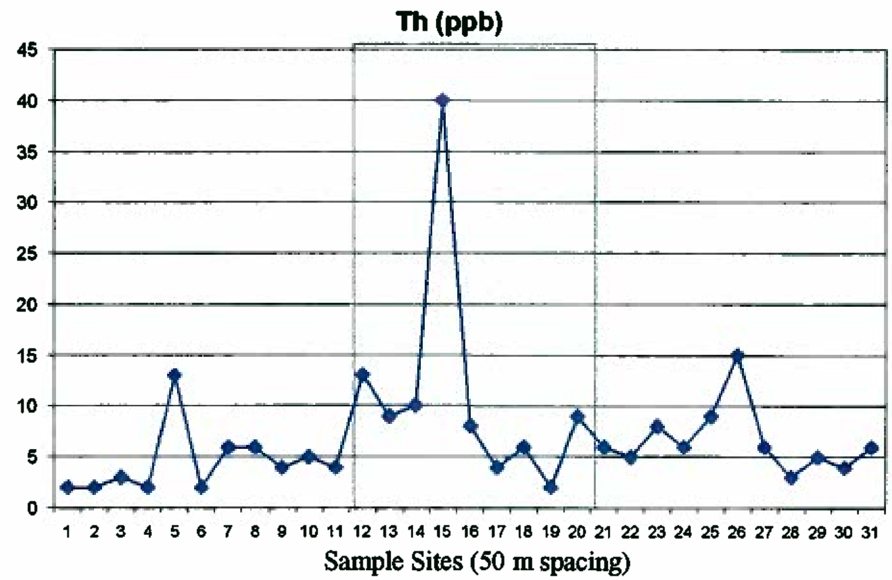


Mountain Lake Enzyme Leach-Based Soil Profiles Ta, Tb, Te and Th (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

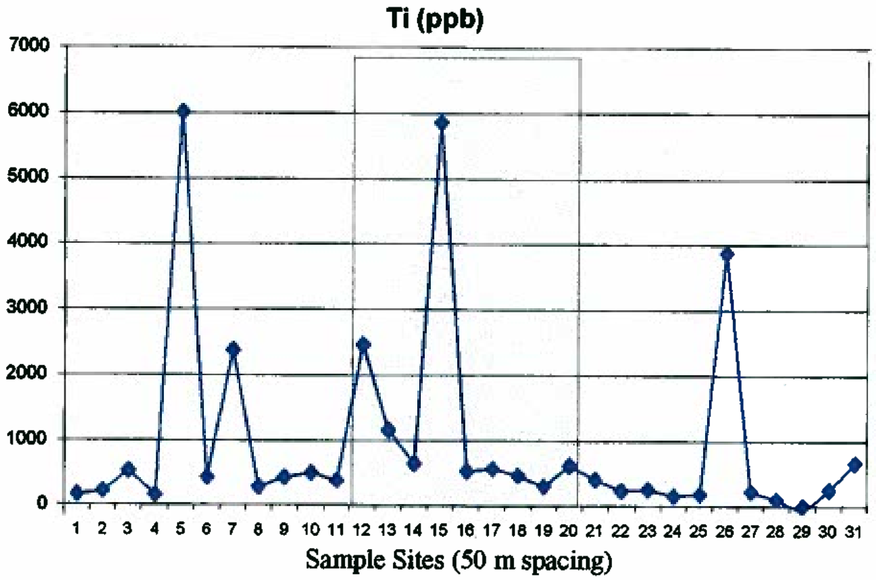


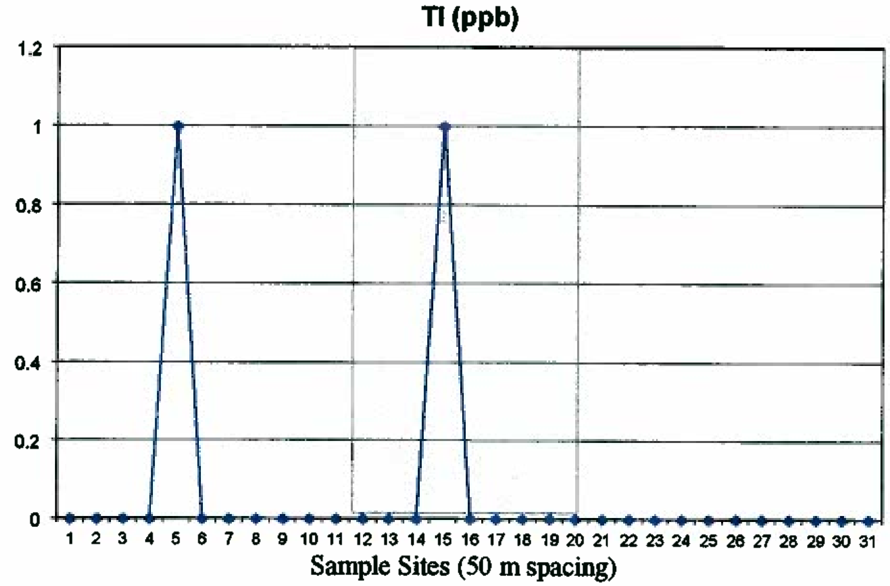


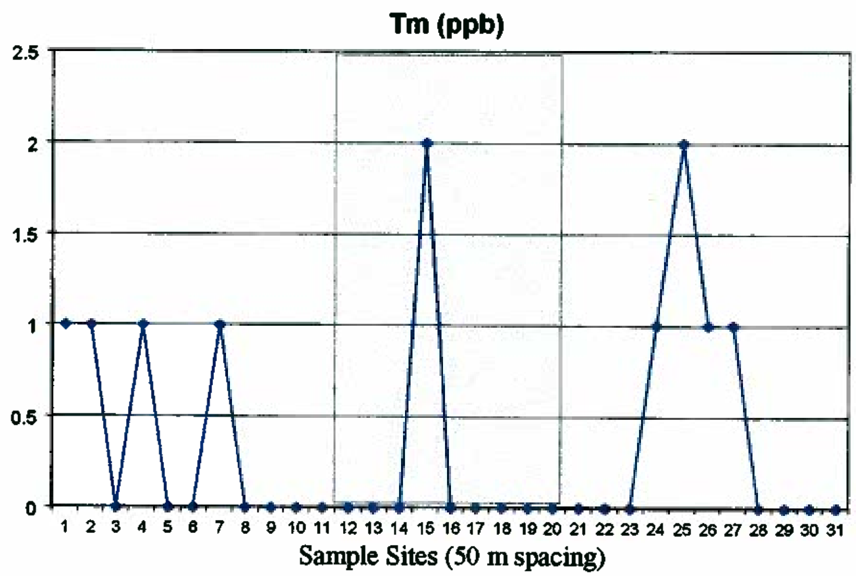


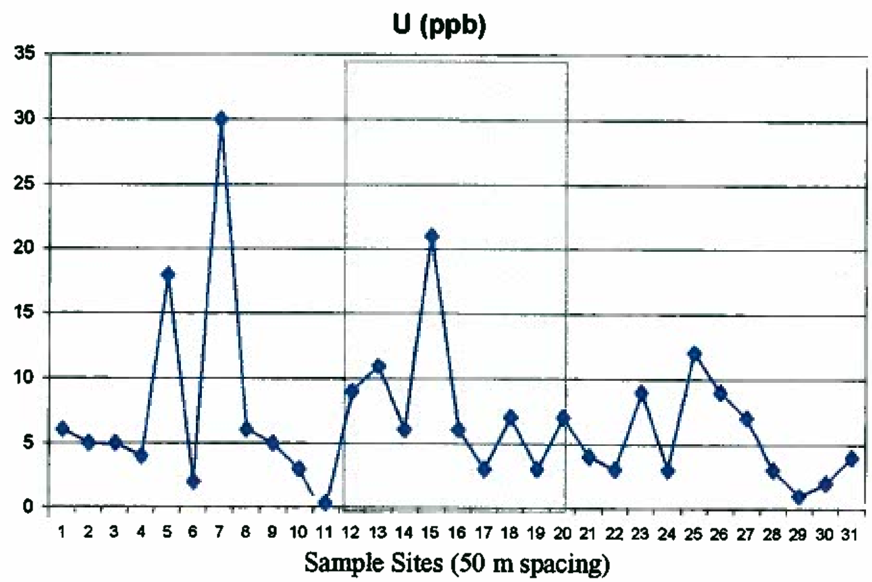


Mountain Lake Enzyme Leach-Based Soil Profiles Ti, Tl, Tm and U (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

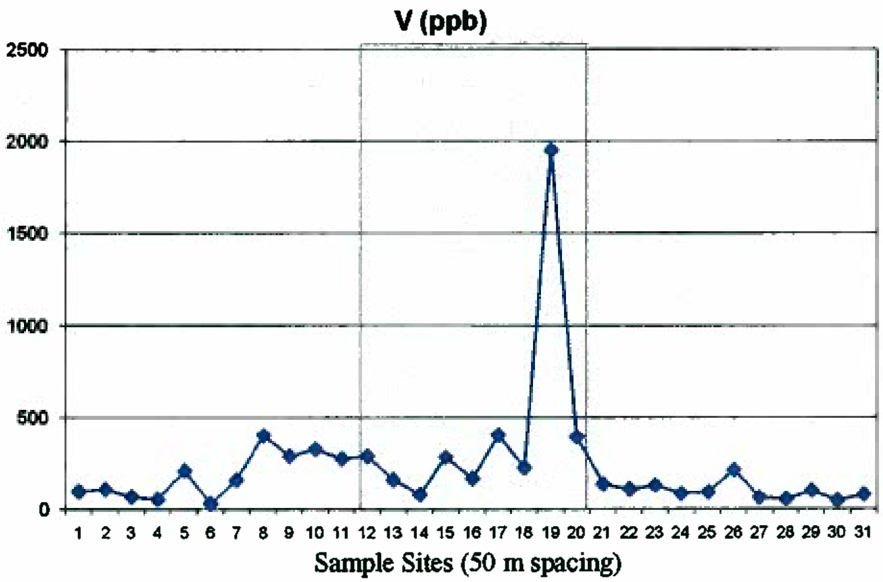


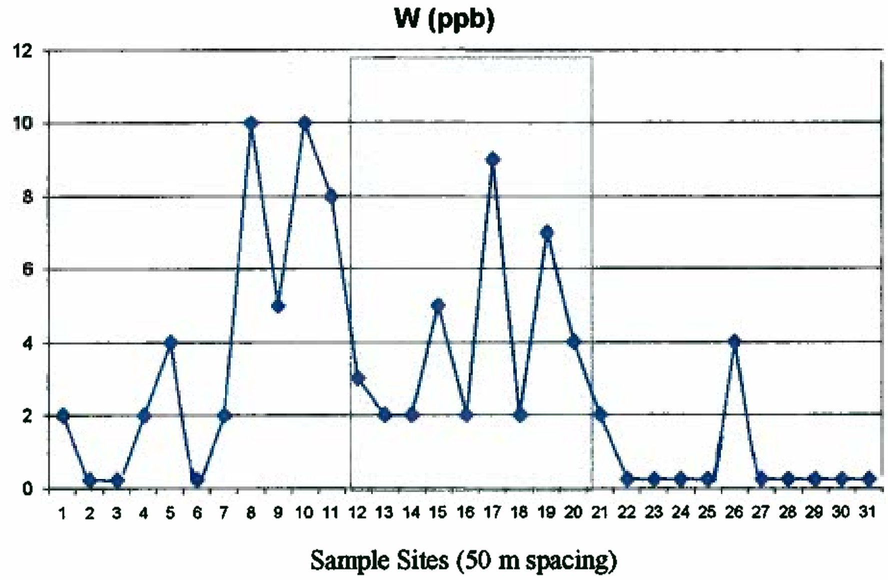


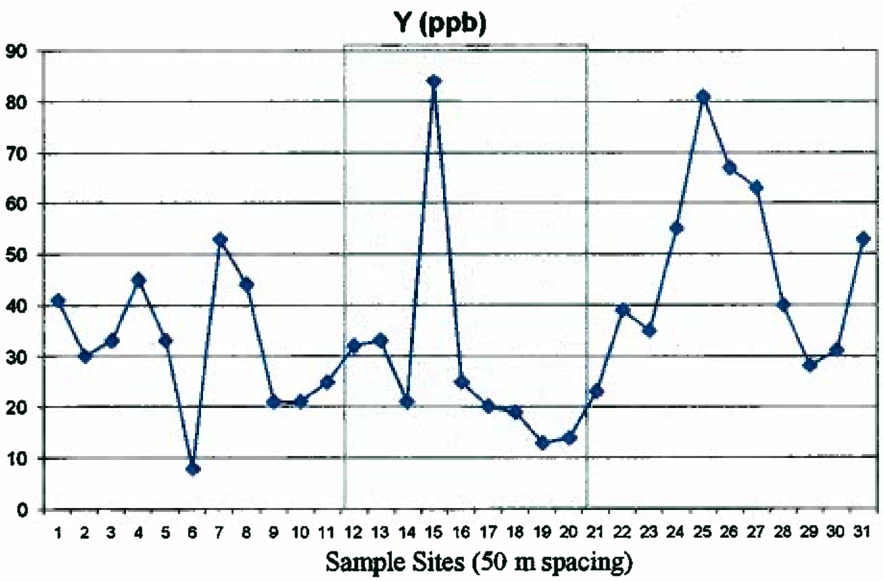


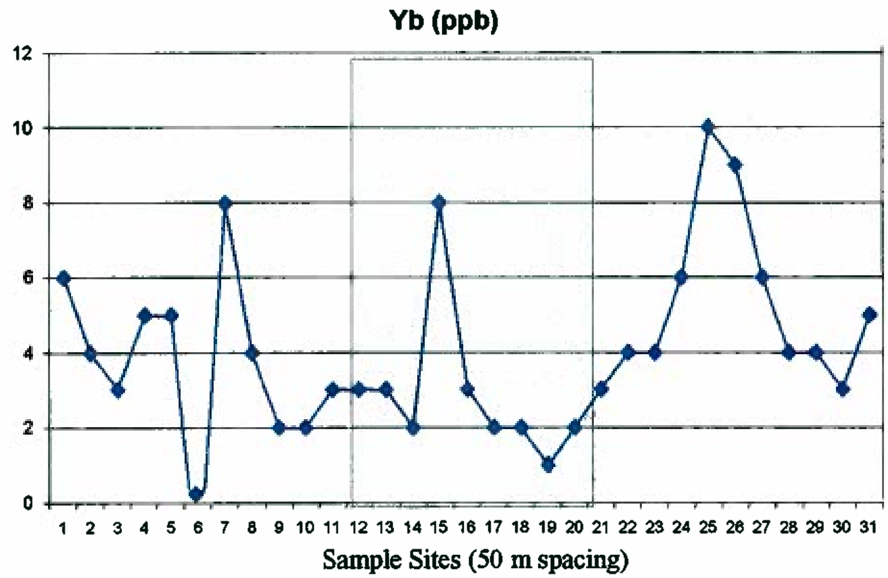


Mountain Lake Enzyme Leach-Based Soil Profiles V, W, Y and Yb (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.

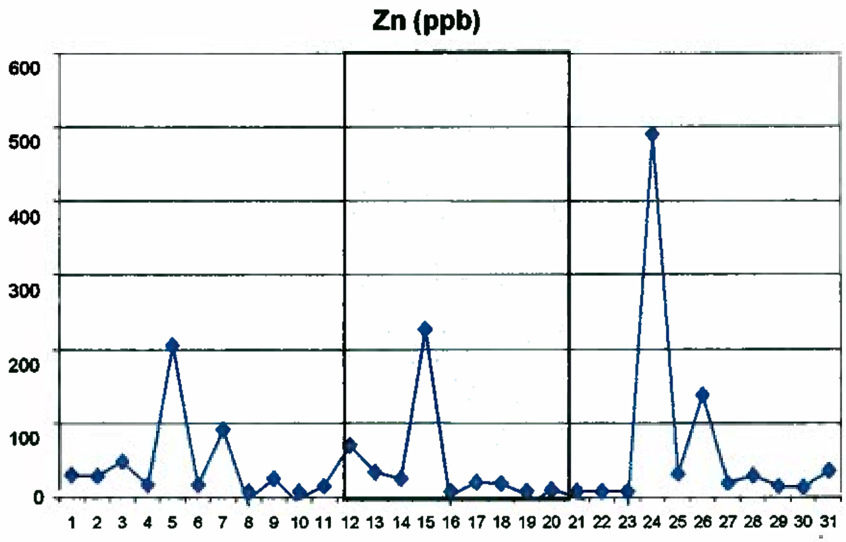




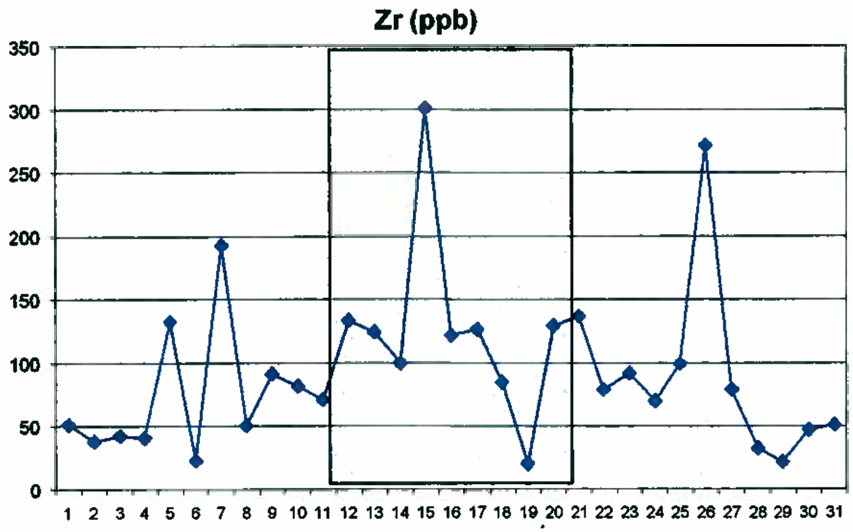




Mountain Lake Enzyme Leach-Based Soil Profiles Zn and Zr (ppb vs. samples RE-ML97-001 to REML97-031). Shading represents the approximate surface expression of the pipe.



Sample Sites (50 m spacing)



Sample Sites (50 m spacing)